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# Bulletin 603

# Central Foreland NATMAP Project: Proterozoic to Devonian stratigraphic sections in British Columbia and Yukon

## Edited by L.S. Lane and R.B. MacNaughton

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# Central Foreland NATMAP Project: Proterozoic to Devonian stratigraphic sections in British Columbia and Yukon

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**Cover illustration**

Aerial view northward across Redfern Lake (NTS 94G/05). The ridge north of the lake reveals well-exposed thrust-faulted repetitions of Ordovician to Devonian carbonate strata of the Beaverfoot, Nonda, Muncho-McConnell and Stone formations. 2017-099

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## SUMMARY

The Central Foreland NATMAP Project was initiated in 1997, and received NATMAP support between 1998 and 2002. Its principal objectives were to carry out new bedrock and surficial mapping through two contrasting transects across the Cordilleran foothills of northern British Columbia and adjacent southeastern Yukon and Northwest Territories.

The two transects straddle a geologically unique transition, marked by a dramatic broadening and change in trend of the Cordilleran deformed belt, and by related changes in stratigraphy, sedimentary environments, paleogeography, and structural style. These profound changes in the style and scale of folds and faults reflect the influence of older structures at depth. Improved knowledge of how these influences have interacted help to improve the efficiency of resource exploration and development, and reduce its cumulative impact on this ecologically sensitive region.

A significant aspect of the project included measuring stratigraphic sections in outcrop within and near the areas of detailed mapping, using the project's base camp to facilitate the logistics. This work was done by staff scientists, graduate students, post-doctoral fellows, and faculty affiliated with collaborating universities. This bulletin provides detailed descriptions of most of the stratigraphic sections measured in Proterozoic to Devonian strata as part of the Central Foreland NATMAP Project, as well as a number of sections that were measured in the project area in the 1960s and 1970s. These earlier-measured sections have either not been published or have been published only in summary form. In addition to detailed section descriptions, this bulletin includes additional documentation such as correlation charts and field photographs, as well as a digital file of quality-assured metadata (Appendix) for each section representing a step toward a digital-data repository of stratigraphic sections. The result is a citable, data-rich document that serves as a basis for synthesis reports in external scientific journals.

A single, detailed section through an unnamed Proterozoic map unit in southeast Yukon (MacNaughton's contribution), represents the only study from the northern transect included here, whereas the remainder of the studies focus on Paleozoic strata in northeastern British Columbia. MacNaughton's contribution describes the sedimentary structures that document a deep-marine, distal turbidite depositional setting for this unit.

In the first of two contributions, Pyle and Barnes describe twelve sections through Upper Cambrian to Lower Silurian strata along a transect across the



## SOMMAIRE

Le projet de l'avant-pays central du programme CARTNAT a été lancé en 1997 et a bénéficié du soutien de ce programme de 1998 à 2002. Le projet avait pour principaux objectifs de produire une nouvelle cartographie du substratum rocheux et des formations superficielles le long de deux transects contrastants dans le piémont de la Cordillère, s'étendant au nord de la Colombie-Britannique et aux parties adjacentes du sud-est du Yukon et des Territoires du Nord-Ouest.

Les deux transects s'étendent de part et d'autre d'une transition unique sur le plan géologique, qui se manifeste par un élargissement marqué et un changement de direction de la zone déformée de la Cordillère, ainsi que par des changements connexes dans la stratigraphie, les milieux sédimentaires, la paléogéographie et le style structural. Ces profonds changements dans le style et la dimension des plis et des failles témoignent de l'influence de structures anciennes en profondeur. L'amélioration des connaissances sur la façon dont ces influences ont interagi, devrait contribuer à rendre plus efficaces l'exploration et la mise en valeur des ressources et à réduire leurs effets cumulatifs sur cette région écosensible.

L'un des aspects importants de l'étude consistait à mesurer des coupes stratigraphiques en affleurement dans les secteurs de cartographie détaillée et à proximité de ceux-ci, en se servant du camp de base du projet pour faciliter la logistique. Les travaux ont été accomplis par des chercheurs internes, des étudiants diplômés, des boursiers de recherche postdoctorale et du personnel d'universités participantes. Ce bulletin fournit des descriptions détaillées de la plupart des coupes stratigraphiques mesurées dans les strates couvrant l'intervalle du Protérozoïque au Dévonien dans le cadre du projet de l'avant-pays central du CARTNAT, ainsi que d'un certain nombre de coupes situées dans le secteur d'étude qui ont été mesurées dans les années 1960 et 1970. Les descriptions de ces coupes plus anciennes sont inédites ou n'ont été publiées que sous forme sommaire. En plus des descriptions détaillées des coupes stratigraphiques, ce bulletin comporte de la documentation supplémentaire, comme des tableaux de corrélation et des photos prises sur le terrain, ainsi qu'un fichier numérique de métadonnées (en annexe) dont la qualité a été vérifiée pour chacune des coupes, ce qui constitue un pas vers la création d'un dépôt de données numériques sur les coupes stratigraphiques. Il en résulte un document riche en données et pouvant être cité qui sert de base à des rapports de synthèse publiés dans des revues scientifiques externes.

Une seule coupe détaillée s'étendant à une unité cartographique non dénommée du Protérozoïque dans le sud-est du Yukon (contribution de MacNaughton), constitue l'unique étude du transect nord incluse dans le présent bulletin. Les autres études sont axées sur les strates du Paléozoïque dans le nord-est de la Colombie-Britannique. La contribution de MacNaughton décrit les structures sédimentaires qui étayent le dépôt de cette unité sous forme de turbidite distale en milieu marin profond.

MacDonald Platform, Kechika Trough, and Cassiar Terrane. These sections reflect depositional-facies transitions from the platform into the trough as well as temporal variations, documented by over 300 conodont ages. In a second contribution, the same authors present ten sections in Lower Ordovician to Middle Devonian units deposited on the MacDonald Platform and in the Ospika Embayment. The facies transition from platformal successions into the basinal facies Road River Group is described in terms of age and depositional setting, and supported by over 250 conodont ages.

Similar stratigraphic and geographic coverage is provided by Norford, who presents 36 stratigraphic sections from Ordovician and Silurian strata, as well as a synthesis of biostratigraphic data from micro- and macrofossils. Five significant unconformities are identified in the platformal and transitional facies; one, of latest Ordovician and early Silurian age, is documented in the basinal facies. Many of the sections presented by Norford predate the Central Foreland Project, but are included here because they are an important historical documentary data set for this region. Five of those were restudied by Pyle and Barnes. In the interest of completeness, both versions of those sections are included.

The contribution by Nadjiwon and coauthors focuses on the Lower and Middle Devonian platform succession and presents 20 sections measured in strata of this age. They document six sections containing dolomites of the Presqu'ile Barrier reef complex, corroborate the contact relationships of the Dunedin Formation, and confirm the presence of siliciclastic rocks within the Laurier Embayment, a broad bypass channel through the Presqu'ile Barrier reef.

The 79 detailed stratigraphic sections presented in this bulletin do not exhaust the stratigraphic work carried out as part of the Central Foreland NATMAP Project. Additional outcrop stratigraphic sections that were measured as part of the project have appeared in a number of Geological Survey of Canada and external publications.

The Appendix is a complete listing of the metadata attributes of the 79 stratigraphic sections detailed in the body of the work.

Dans la première de deux contributions, Pyle et Barnes décrivent douze coupes dans des strates s'étendant du Cambrien supérieur au Silurien inférieur le long d'un transect traversant la plate-forme de MacDonald, la cuvette de Kechika et le terrane de Cassiar. Ces coupes témoignent des transitions de faciès sédimentaires de la plate-forme à la cuvette, ainsi que de variations temporelles, documentées par plus de 300 âges sur conodontes. Dans la seconde contribution, les mêmes auteurs présentent dix coupes s'étendant à des unités de l'Ordovicien inférieur au Dévonien moyen déposées sur la plate-forme de MacDonald et dans le rentrant d'Ospika. Le faciès de transition des successions de la plate-forme au faciès de bassin du Groupe de Road River est décrit du point de vue de l'âge et du milieu de dépôt et la description s'appuie sur plus de 250 âges sur conodontes.

Une couverture stratigraphique et géographique semblable est offerte par Norford, qui présente 36 coupes stratigraphiques dans des strates de l'Ordovicien et du Silurien, ainsi qu'une synthèse des données biostratigraphiques provenant de microfossiles et de macrofossiles. Cinq discordances importantes ont été relevées dans le faciès de plate-forme et celui de transition; l'une d'elles, remontant à l'Ordovicien terminal et au Silurien précoce, est documentée dans le faciès de bassin. Plusieurs descriptions de coupes présentées par Norford sont antérieures au projet de l'avant-pays central. Cependant, elles sont présentées ici, car elles constituent un important jeu de données d'intérêt historique pour cette région. Cinq de ces coupes ont été étudiées à nouveau par Pyle et Barnes. Afin d'offrir la couverture la plus exhaustive, les deux versions des descriptions de ces coupes sont incluses.

La contribution de Nadjiwon et ses collègues est axée sur la succession de plate-forme du Dévonien inférieur et moyen et elle présente vingt coupes mesurées dans les strates de cet âge. Ils ont documenté six coupes contenant des dolomies du complexe de récif barrière de Presqu'ile, corroboré les relations qu'affichent les contacts de la Formation de Dunedin et confirmé la présence de roches silicoclastiques dans le rentrant de Laurier, un large chenal de dérivation recoupant le récif barrière de Presqu'ile.

Les 79 coupes stratigraphiques détaillées présentées dans ce bulletin ne rendent pas compte de l'ensemble des travaux stratigraphiques menés dans le cadre du projet de l'avant-pays central du CARTNAT. D'autres coupes stratigraphiques en affleurement qui ont été mesurées dans le cadre du projet ont été présentées dans un certain nombre de publications de la Commission géologique du Canada et dans des publications externes.

L'annexe comprend la liste exhaustive des attributs de métadonnées des 79 coupes stratigraphiques décrites dans l'ensemble de la publication.

# Introduction to stratigraphic sections from the Central Foreland NATMAP Project Area: Proterozoic to Devonian successions

L.S. Lane[1] and R.B. MacNaughton[1]

*Lane, L.S. and MacNaughton, R.B., 2017. Introduction to stratigraphic sections from the Central Foreland NATMAP Project area: Proterozoic to Devonian successions: in Central Foreland NATMAP Project: Proterozoic to Devonian stratigraphic sections in British Columbia and Yukon,, (ed.) L.S. Lane and R.B. MacNaughton; Geological Survey of Canada, Bulletin 603, p. 3–6. https//doi.org/10.4095/306301*

**Abstract :** The NATMAP Program (1991-2003) of the Geological Survey of Canada had a mandate to support fleld-based bedrock and surflcial mapping projects. The Central Foreland NATMAP Project (1997-2002) focused on the bedrock and surflcial geology of two contrasting transects across the Cordilleran foothills, one in the northern Rocky Mountain of British Columbia, the other across the Liard Plateau of southeast Yukon and adjacent Northwest Territories. Numerous stratigraphic sections were measured in support of this work. The present Bulletin provides detailed descriptions and photographic documentation of most of the Proterozoic to Devonian sections measured during the Project, as well as a number of sections measured in the project area in the 1960s and 1970s but not previously published in detailed form. This introductory chapter summarizes the Bulletin and points the reader to additional Central Foreland NATMAP Project stratigraphic sections that have been published in other venues.

**Résumé :** Le programme CARTNAT (1991-2003) de la Commission géologique du Canada avait pour mandat de soutenir les travaux sur le terrain de cartographie du substratum rocheux et des formations superflcielles. Le projet de l'avant-pays central (1997-2002) du CARTNAT était axé sur la géologie du substratum rocheux et des matériaux superflciels le long de deux transects contrastants dans le piémont de la Cordillère, l'un situé dans le nord des montagnes Rocheuses en Colombie-Britannique et l'autre, dans le plateau de la Liard dans le sud-est du Yukon et la partie adjacente des Territoires du Nord-Ouest. De nombreuses coupes stratigraphiques ont été mesurées dans le cadre de ces travaux. Le présent bulletin fournit des descriptions détaillées et des photos de la plupart des coupes du Protérozoïque au Dévonien mesurées pendant le projet, ainsi que d'un certain nombre de coupes situées dans le secteur du projet qui ont été mesurées dans les années 1960 et 1970, mais dont des descriptions détaillées n'avaient pas encore été publiées. Ce chapitre d'introduction résume le bulletin et dirige le lecteur vers l'information relative à d'autres coupes stratigraphiques du projet de l'avant-pays central du CARTNAT ayant été publiée dans d'autres publications.

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## INTRODUCTION

The NATMAP Program of the Geological Survey of Canada was proposed as a National Geoscience Mapping Program, and subsequently endorsed by participants at a national workshop in March of 1990. The program was managed through the office of the Chief Scientist of the Earth Sciences Sector, Natural Resources Canada, with the advice of a thirteen-member steering committee consisting of representatives from the Geological Survey of Canada, Provincial/Territorial governments, academia, and industry. Active between 1991 and 2003, the program funded a total of 13 major projects nationwide. Its mandate was to support field-based bedrock and surficial mapping projects that are designed to support Canada's minerals and hydrocarbons industries, to fill gaps in the national geoscience database, or to respond to environmental or societal concerns (Robertson, 2017). The funding support was intended to enhance each project with emphasis on three specific objectives: to promote efficiency and technology transfer through enhanced collaboration with other government geoscience agencies; to promote the application of digital technologies to data collection, data management and map production; and to provide training opportunities for Canadian geoscience students.

The Central Foreland NATMAP Project was initiated in 1997, and received NATMAP support between 1998 and 2002. Its principal objectives were to carry out new bedrock and surficial mapping through two contrasting transects across the Cordilleran foothills: one in the Trutch area of the northern Rocky Mountains midway between Fort St. John and Fort Nelson, British Columbia; and the other across the Liard Plateau area of southeastern Yukon and adjacent Northwest Territories.

The two foothills transects straddle a geologically unique transition, marked by a dramatic broadening and change in trend of the Cordilleran deformed belt, and by related changes in stratigraphy, sedimentary environments, paleogeography, and structural style. These profound changes in the style and scale of folds and faults reflect the influence of older structures at depth. These older structures also influenced the evolution and preservation of petroleum and mineral resources in this frontier area, which lies on the northwest edge of the Western Canada Sedimentary Basin. Improved knowledge of how these influences have interacted help to improve the efficiency of resource exploration and development, and reduce its cumulative impact on this ecologically sensitive region. Geological mapping and detailed thematic studies (stratigraphy and biostratigraphy, petroleum source-rock potential, and mineral deposit studies), were carried out in collaboration with the British Columbia Geological Survey, Yukon Geology Program (now the Yukon Geological Survey), Indian and Northern Affairs Canada (now Indigenous and Northern Affairs Canada) (INAC), the Government of the Northwest Territories, 12 universities, and the private sector.

A significant aspect of the project was the measurement of stratigraphic sections in outcrop within and near the areas of detailed mapping, using the project's base camp to facilitate the logistics. This work was done by staff scientists and by graduate students, post-doctoral fellows, and faculty affiliated with collaborating universities. This bulletin provides detailed descriptions of most of the stratigraphic sections measured in Proterozoic to Devonian strata as part of the Central Foreland NATMAP Project, as well as a number of sections that were measured in the project area in the 1960s and 1970s. These earlier-measured sections have either not been published or have been published only in summary form. In addition to detailed section descriptions, this bulletin includes additional documentation such as correlation charts and field photographs, as well as a digital data set of quality-assured metadata for each section (Fig. 1), which we view as a step toward a digital data repository of stratigraphic sections. The result is a citable, data-rich document that serves as a basis for synthesis reports in external scientific journals.

Aside from a short contribution that presents a single section through an unnamed Proterozoic map unit in southeast Yukon Territory (MacNaughton), the studies focus on Paleozoic strata in northeastern British Columbia. In the first of two contributions, Pyle and Barnes document twelve sections through Upper Cambrian to Lower Silurian strata along a transect across the MacDonald Platform, Kechika Trough, and Cassiar Terrane. In a second contribution, the same authors present ten sections in Lower Ordovician to Middle Devonian units deposited on the MacDonald Platform and in the Ospika Embayment. Similar stratigraphic and geographic coverage is provided by Norford, who presents thirty-six stratigraphic sections from Ordovician and Silurian strata, as well as a synthesis of biostratigraphic data from micro- and macrofossils. Many of the sections presented by Norford predate the Central Foreland Project but are included here because they are an important historical documentary dataset for this region. Five of those were restudied by Pyle and Barnes. In the interest of completeness, both versions of those sections are included. A final contribution, by Nadjiwon and coauthors, focuses on the Lower and Middle Devonian and presents twenty sections measured in strata of this age. Also included is an Appendix which is provided both as a Microsoft® Excel® spreadsheet and as a .csv file that provides a complete list of the metadata attributes of the seventy-nine stratigraphic sections detailed in the body of the work.

The seventy-nine detailed stratigraphic sections presented in this bulletin do not exhaust the stratigraphic work carried out as part of the Central Foreland NATMAP Project. Additional outcrop stratigraphic sections that were measured as part of the project have appeared in a number of Geological Survey and external publications. Additional observations on Proterozoic and Cambrian strata in northeast British Columbia were provided by Post (2001) in an unpublished Master's thesis (also, Post and Long, 2008). The

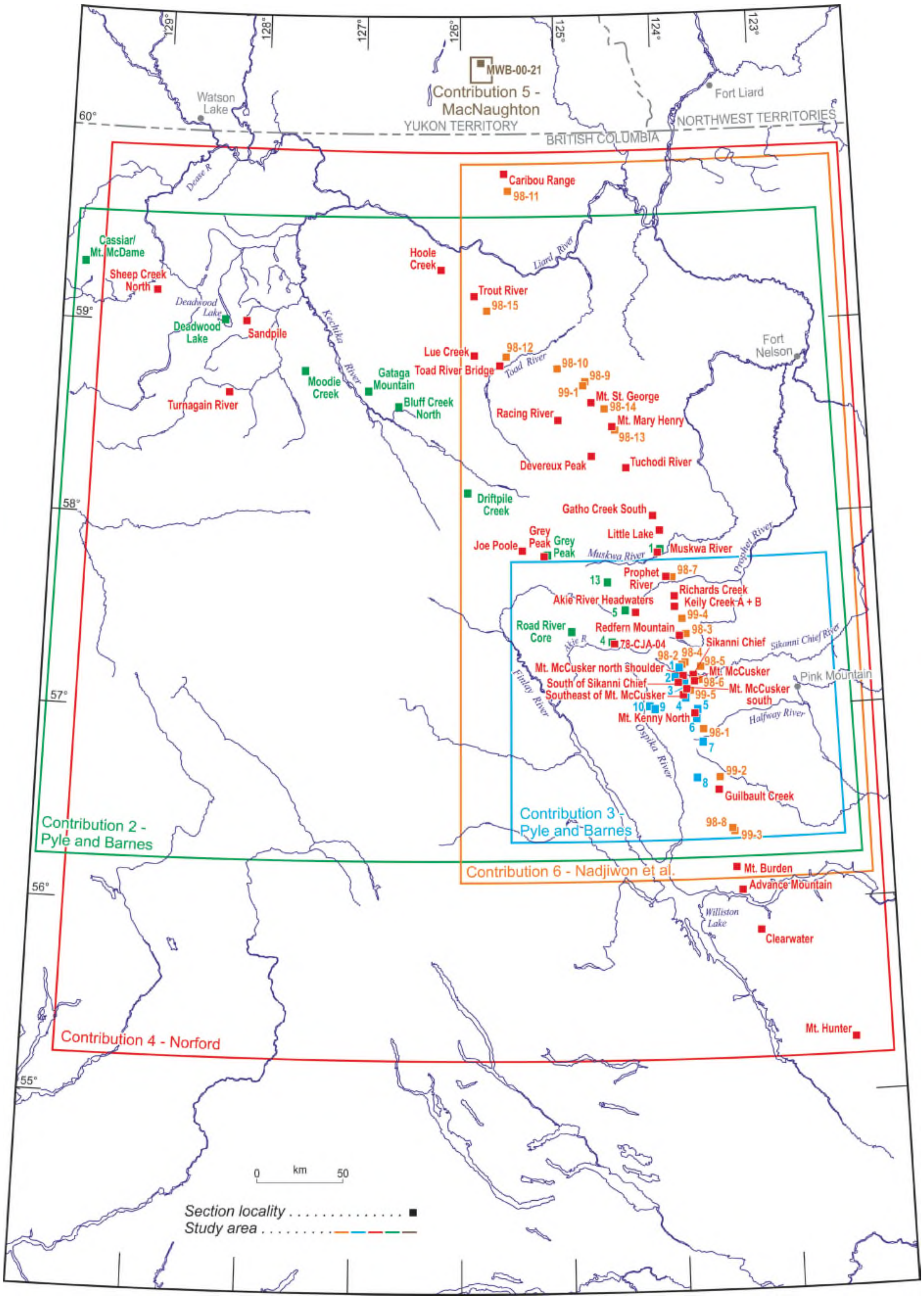


**Figure 1.** Regional map of the project area showing the locations of stratigraphic sections reported on in this volume. Refer to Appendix for detailed location information.

Triassic interval was studied in northeastern British Columbia by Zonneveld and Orchard (2002) and Zonneveld et al. (2004) and in southeastern Yukon Territory by MacNaughton (2002) and MacNaughton and Zonneveld (2010). Jurassic and Cretaceous sections have been published by Schröder-Adams and Pedersen (2003), by MacNaughton (2006a, b), and by Jowett and Schröder-Adams (2005). Additional unpublished stratigraphic sections were measured by B.C. Richards (Carboniferous–Permian) and M.J. Johns (Triassic).

In addition to the measuring of sections, the Central Foreland NATMAP Project supported a review and analysis of the techniques used in the collection and recording of locational and stratigraphic metadata during the project. The results of this work were published as a Current Research article (Palmer et al., 2005) that focused on reusability of stratigraphic data, including methods for ensuring collection of rigorous positional data to make the stratigraphic sections more useful to future researchers.

The editors are grateful for the authors' commitments to undertake this collaboration, and also to the numerous critical reviewers who contributed significant effort to ensure the scientific integrity of each chapter. We also acknowledge the important contributions of the scientific and technical support people who contributed to the organization and presentation of the bulletin.

## Critical Reviewers

Dr. Mario Coniglio (University of Waterloo), Dr. Larry Lane (GSC Calgary), Dr. Darrell Long (Laurentian University), Dr. Jeff Lukasik (PetroCanada Oil and Gas), Dr. David Morrow (GSC Calgary), Dr. Brian Norford (GSC Calgary), Dr. Godfrey Nowlan (GSC Calgary), Dr. Leanne Pyle (University of Victoria; now at VI Geoscience Services Ltd), Dr. Tom Uyeno (GSC Calgary).

## Technical Contributors

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# Upper Cambrian to Lower Silurian stratigraphy of a Macdonald Platform–Kechika Trough–Cassiar Terrane transect, Ware, Tuchodi Lakes, Kechika, and Cry Lake map areas (94-F, K, L, 104-P), northeastern British Columbia

L.J. Pyle[1] and C.R. Barnes[2]

*Pyle, L.J. and Barnes, C.R., 2017. Upper Cambrian to Lower Silurian stratigraphy of a Macdonald Platform–Kechika Trough–Cassiar Terrane transect, Ware, Tuchodi Lakes, Kechika, and Cry Lake map areas (94-F,K,L, 104-P), northeastern British Columbia: in Central Foreland NATMAP Project: Proterozoic to Devonian stratigraphic sections in British Columbia and Yukon, (ed.) L.S. Lane and R.B. MacNaughton; Geological Survey of Canada, Bulletin 603, p. 7–51. https://doi.org/10.4095/299864*

**Abstract:** The Kechika Formation, a laterally extensive platform-to-basin facies, typically lies unconformably on Cambrian strata. Its five members, which are diachronous, have gradational and conformable contacts. Basinal facies of the Road River Group comprise three formations: the Ospika (Lower to Middle Ordovician), Pesika (Lower Silurian), and Kwadacha (upper Lower Silurian to Lower Devonian). Volcanism, prominent unconformities, and abrupt changes in deposition indicate a complex history delineated temporally by conodont biostratigraphy. Deposition of the Kechika and Ospika formations is attributed to periods of renewed extension followed by thermal subsidence. Silurian units unconformably and conformably overlie the Ospika Formation. The Pesika Formation, a transitional facies, is present mainly in the eastern part of the Kechika Trough. The Kwadacha Formation records an influx of quartz silt and sand into the trough. The Kechika–Road River boundary in the displaced Cassiar Terrane is older than that east of the Northern Rocky Mountain Trench Fault.

**Résumé :** La Formation de Kechika est une unité latéralement étendue qui présente des faciès représentatifs de milieux s'étendant de la plate-forme au bassin. De façon caractéristique, elle repose en discordance sur des strates du Cambrien. Les cinq membres qui la composent sont diachrones et présentent des contacts progressifs et concordants. Les faciès de bassin du Groupe de Road River sont constitués de trois formations, soit la Formation d'Ospika (Ordovicien inférieur et moyen), la Formation de Pesika (Silurien inférieur) et la Formation de Kwadacha (de la partie supérieure du Silurien inférieur au Dévonien inférieur). Un volcanisme, des discordances très marquées et des changements brusques dans la sédimentation indiquent une histoire complexe étalonnée dans le temps par la biostratigraphie des conodontes. Le dépôt des formations de Kechika et d'Ospika est attribué à des périodes de réactivation d'une déformation en extension suivies d'une subsidence thermique. Des unités siluriennes reposent en discordance et en concordance sur la Formation d'Ospika. La Formation de Pesika, un faciès de transition, se trouve surtout dans la partie orientale de la cuvette de Kechika. La Formation de Kwadacha témoigne d'un apport de silt et de sable quartzeux dans la cuvette. La limite séparant la Formation de Kechika du Groupe de Road River dans le terrane de Cassiar déplacé est plus ancienne que la limite correspondante à l'est de la faille du sillon des Rocheuses du Nord.

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# INTRODUCTION

Twelve sections were measured and described in detail at four localities across two east–west, platform-to-basin transects situated within the Ware (94-F), Tuchodi Lakes (94-K), Kechika (94-L), and Cry Lake (104-P) map areas, Northern Rocky Mountains and Cassiar Mountains (Fig. 1). Exposed autochthonous strata include shallow-water carbonate rocks of the Macdonald Platform bounded to the west by equivalent deep-water, slope-and-basin facies of the Kechika Trough (Fig. 2). The western boundary of the Foreland Belt and Kechika Trough is the Northern Rocky Mountain Fault/Trench-; the eastern boundary is the erosional edge of preserved lower Paleozoic strata below the regional sub-Devonian unconformity.

Nine of the sections span autochthonous strata of the Canadian Cordillera from which over 9000 m of strata were measured and 320 conodont samples (4–5 kg each) collected. The first transect spans platform and shelf strata in the east (Sections 1, 5, 13) to slope (Grey Peak Section) and basin strata in the west (Section 4, Road River Core A-95–19, Driftpile Creek, Bluff Creek North, and Gataga Mountain sections) (Fig. 1). The second transect consists of three sections (over 3000 m of strata) that span the parautochthonous Cassiar Terrane from shallow-water facies (Moodie Creek and Deadwood Lake sections) to deeper water facies

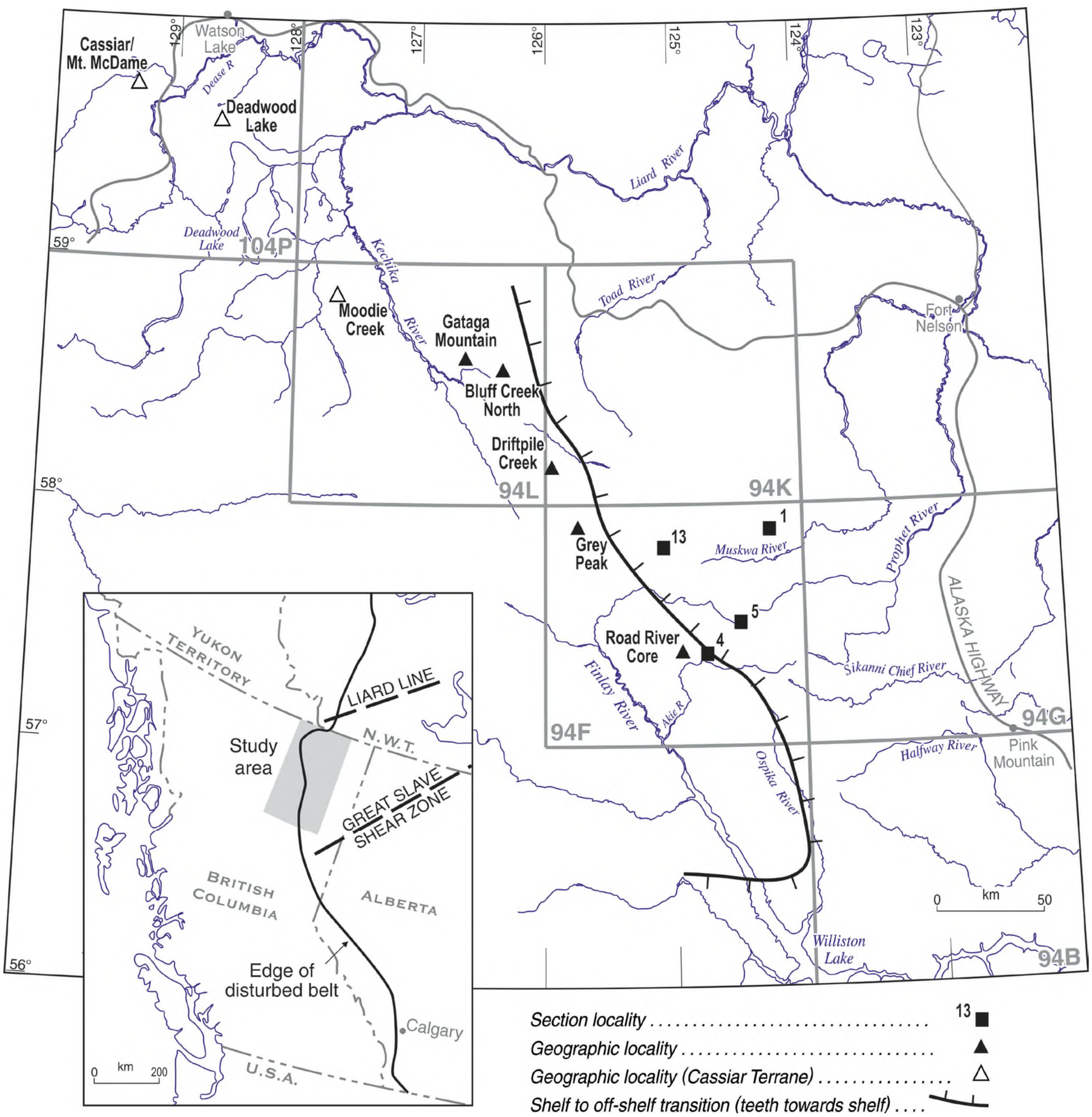


**Figure 1.** Geographic localities, section localities, position of shelf to off-shelf transition (teeth point toward shelf; *after* Cecile and Norford, 1979, and Thompson, 1989).

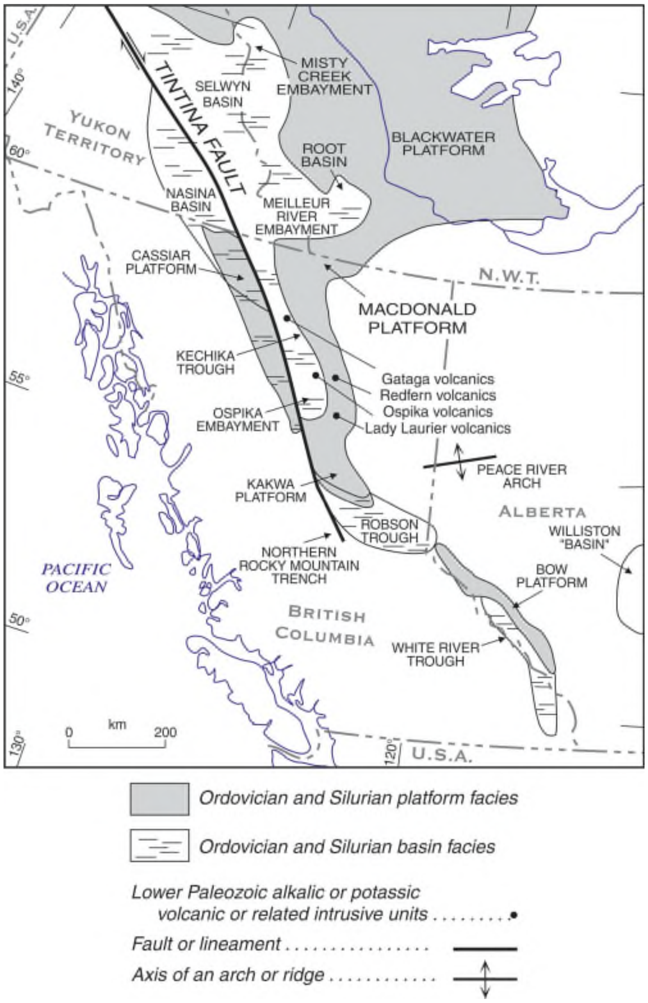


**Figure 2.** Lower Paleozoic paleogeography and present position of the Cassiar Terrane. (*modified from* Cecile et al., 1997).

(Cassiar section). Eighty-five conodont samples (4–5 kg each) were collected from this transect. Ferri et al. (1996) and MacIntyre (1992) described the overall structural and metamorphic character of the autochthonous strata in the study area, and Gabrielse (1998) described the geology of the Cassiar Terrane. Conodont elements have colour alteration index (CAI) values ranging from 3 to 5, indicating burial temperatures of 110 to 200°, to more than 300°C.

Revised stratigraphic terminology established by Pyle and Barnes (2000) and refined conodont biostratigraphic framework of Pyle and Barnes (2002) are followed here. The lower Paleozoic succession of the Macdonald Platform consists of platform carbonate of the Kechika Formation (Upper Cambrian to Lower Ordovician), a laterally extensive unit that thickens westward into the Kechika Trough. The Kechika Formation was formally divided into five members by Pyle and Barnes (2000). It is overlain by platform carbonate rocks of the Skoki Formation (upper Lower Ordovician, Arenigian to lower Upper Ordovician, Caradocian), which was divided into three formal members by Pyle and Barnes (2000) based on this transect, and a fourth member based on a second transect in north-central British Columbia (Pyle and Barnes, 2001a). The Skoki Formation abruptly changes facies westward to the Road River Group (Arenigian to Lower Silurian, Llandovery) that overlies the Kechika Formation in the Kechika Trough (Fig. 3, 4, 5).

The lower Paleozoic stratigraphy and conodont biostratigraphy of the parautochthonous Cassiar Terrane, which represents a northward-displaced margin segment, were described by Pyle and Barnes (2000, 2001b). All sections were measured by L.J. Pyle and C.R. Barnes during the 1994 to 1996 field seasons, and detailed lithological descriptions of sections and conodont samples can be found in Pyle and Barnes (2002). UTM co-ordinates are given based on Datum 27.

## SECTIONS FROM THE MACDONALD PLATFORM

Three sections (1, 13, and 5, of Cecile and Norford, 1979) were measured and described in detail from platform and shelf facies of the transect. They were originally measured by Cecile and Norford (1979) but their detailed descriptions are unpublished.

### Section 1

#### *Location*

The section is situated 12 km north of Muskwa River (94-F/16; 57° 56′N, 124° 03′W; Fig. 1). Camp was established in a cirque southwest of the north-south-trending ridge section that was measured and collected. The first unit of Kechika where samples were collected was an outcrop on the east part of the ridge at 438900E, 6420600N, and the section was measured up to the contact with the cliff-forming Beaverfoot Formation at 438700E, 6421300N. Sample numbers bear the prefix 96-1.

#### *Synthesis*

The section (481 m thick, Fig. 6a) consists of brown-weathering Cambrian siliciclastic units underlying the Kechika Formation. The Lloyd George Member (62 m thick) at the base of the Kechika Formation contains orange--grey-weathering, silty dolostone. The overlying Quentin Member (50 m thick) contains light grey- to yellow-grey-weathering, thin-bedded lime mudstone to trilobitic grainstone and rudstone. The member becomes dolomitic with increased shale upsection. The Quentin Member is younger at Section 1 (*Rossodus manitouensis* Zone, Tremadocian) than at Section 13 (*Iapetognathus* Zone and older, spanning the Cambro–Ordovician boundary) (Fig. 3), indicating the diachronous nature of the Kechika Formation. The Grey Peak Member (85 m thick) consists of an alternation of grey,

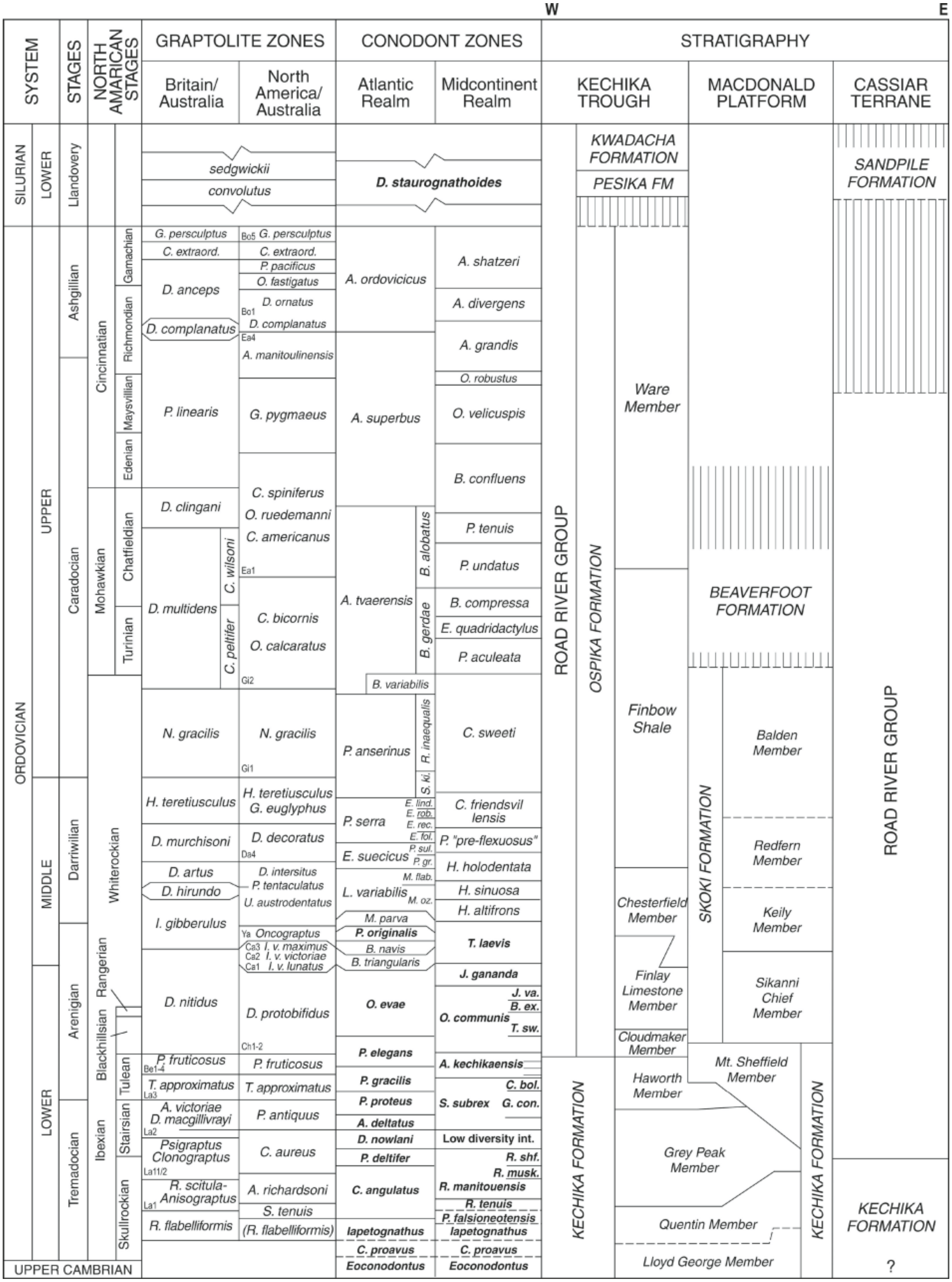


**Figure 3.** Stratigraphic framework showing lithostratigraphic units and conodont biostratigraphic framework of Pyle and Barnes (2002). Conodont zones in bold indicate those recognized from the study area; others are based on the standard time scale *after* Webby (1998) and Cooper and Nowlan (1999). Silurian time scale *after* Norford (1997). Zones determined for the Cassiar Terrane *after* Pyle and Barnes (2001b) and age of the Sandpile Formation *from* Gabrielse (1998). The Lower Cambrian Rosella Formation and Upper Silurian to Devonian Ramhorn Formation are not shown in the Cassiar Terrane column. Dashed lines indicate approximate contacts. Shaded areas indicate zones not represented.

platy-weathering, calcareous shale and thin-bedded lime mudstone to rudstone with orange-weathering, silty dolostone containing abundant horizontal burrows. It spans the *R. manitouensis* Zone and ranges into the upper *Paltodus deltifer* Zone (middle to late Tremadocian). The fourth member of the Kechika Formation, the Haworth Member, is absent at Section 1 (Fig. 3) and the Mount Sheffleld Member overlies the Grey Peak Member. The Mount Sheffleld Member (204 m thick) contains platy, dolomitic limestone facies and grey-weathering, bedded limestone and chert. Conodonts from the upper part of the unit indicate a late Tremadocian age, *Scolopodus subrex* Zone (Fig. 3). The Kechika Formation is abruptly overlain by the massive, cliff-forming dolostone of the Beaverfoot Formation.

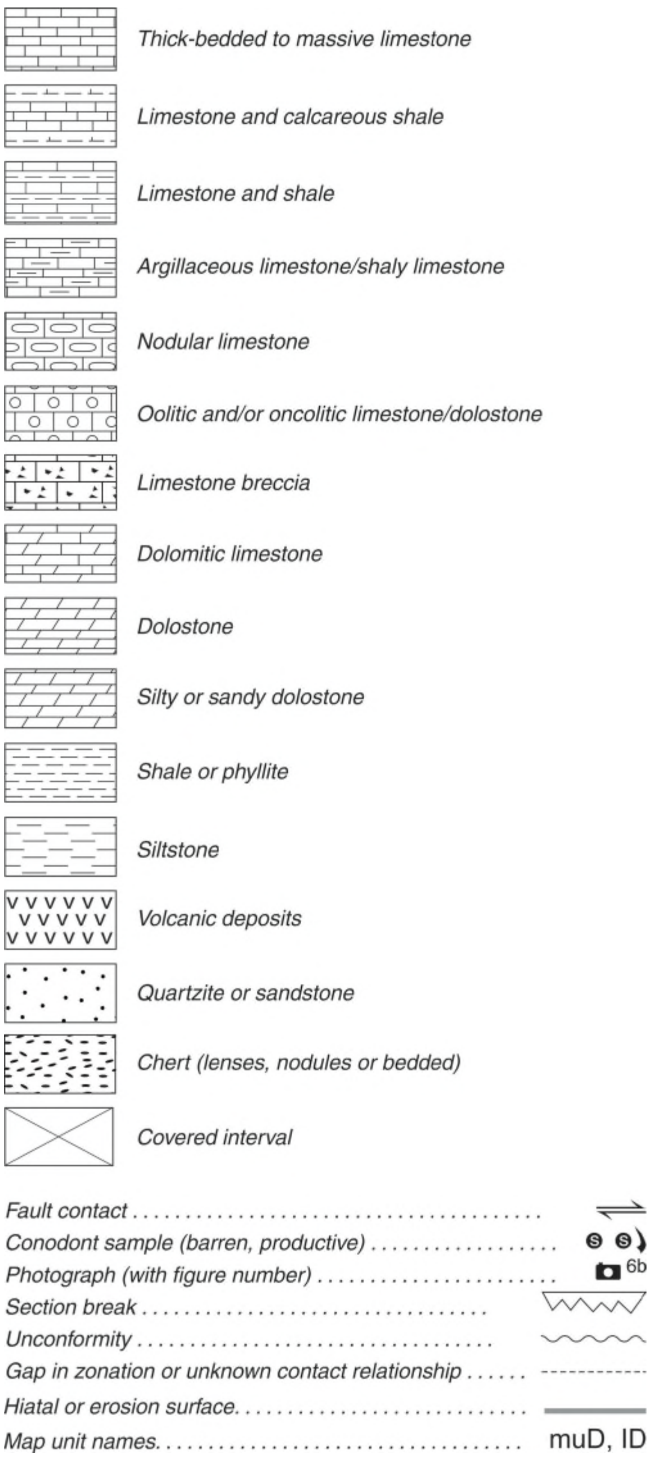


**Figure 4.** Legend for Figures 5 through 17.

## Section 13

### *Location*

The section is situated 4 km southwest of Mount Sheffleld, and trends east-west toward two glacial lakes to the west (94-F/10; 57° 42′N, 124° 35′W; Fig. 1). The basal Kechika Formation was measured starting at 405000E, 6396400N up to the contact with the Skoki Formation at 401500E, 6395500N. The section was measured in three parts — A, B and C — and sample numbers given a preflx of 96-13A, B, or C.

Camp was located on a grassy area along a creek running east from the glacial lakes. Section C was reached by walking about 2 km east and down-creek from camp along the north side of the creek and then north along the tree line to collect the basal parts of the Kechika Formation. The contact with underlying Cambrian units was not observed. Sample collection began at the lowest outcrop on the north side of the main gully. Section A was started to the east, down the creek bed from camp to the tree line, where the Kechika Formation is no longer prominent and underlies the grassy and bush-covered hill south of the creek. Collection of samples given the preflx of 96–13A began on the south side, where the creek takes a bend southward, and where slump breccia and folding-in blocks of the creek bed were noted. Section B continued with the Grey Peak Member west of camp and up the creek section.

### *Synthesis*

The basal part of the Kechika Formation, the Lloyd George Member (78 m thick), contains nodular lime mudstone to wackestone, weathering dark grey and interbedded with cleaved, calcareous shale. The unit is late Cambrian, *Eoconodontus* Zone. The contact with the underlying Cambrian unit was not observed. The overlying Quentin Member (over 400 m thick in Section C) contains largely putty-grey-weathering shale and minor lime mudstone to packstone beds (Fig. 7a). The Quentin

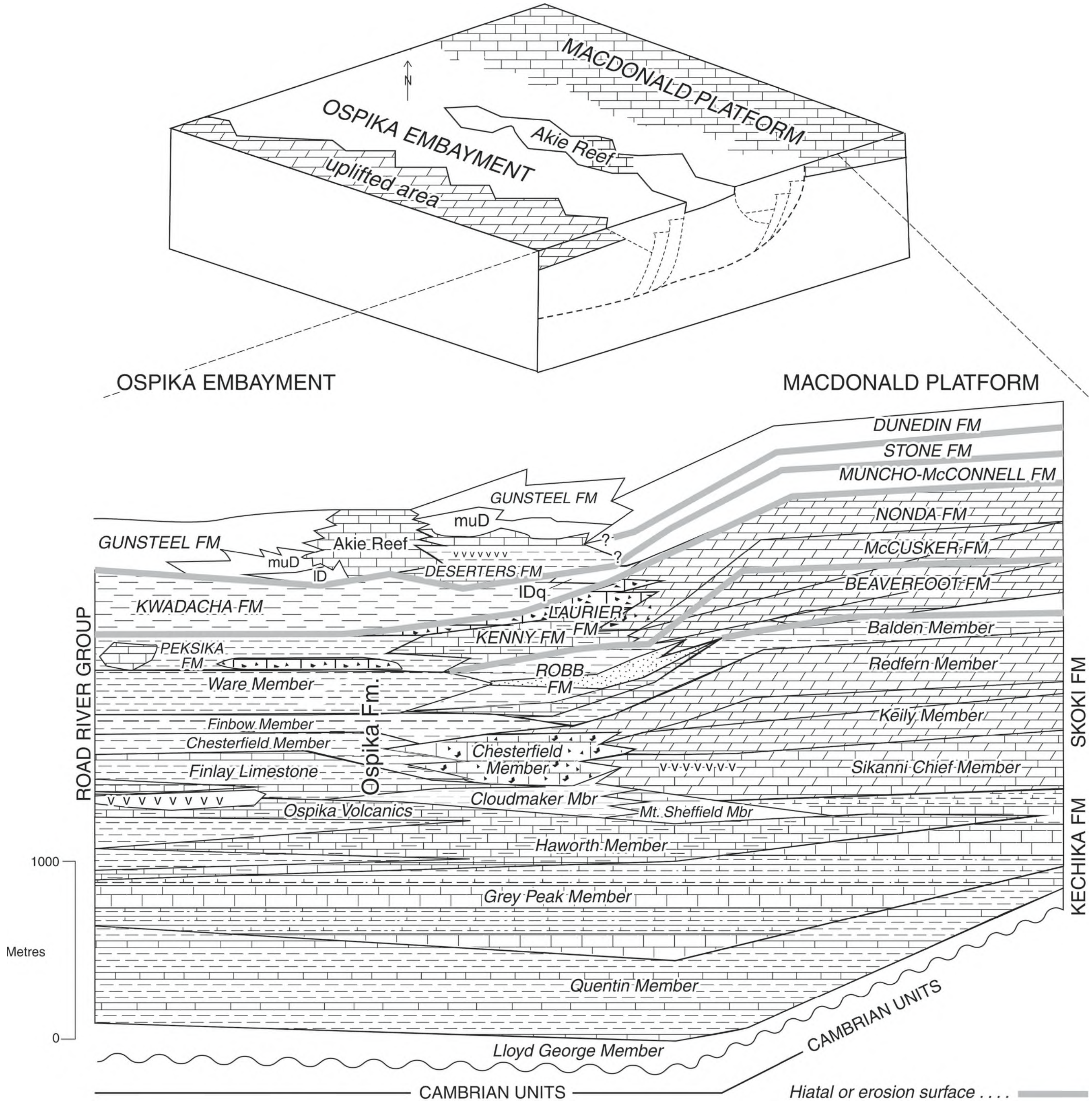


**Figure 5.** East–west cross-sections from platformal sections 1 and 5 through outer-shelf facies of Grey Peak and outer shelf-to-basin facies of Section 4, showing lateral facies changes (*modified from* Cecile and Norford, 1979; Pyle and Barnes, 2000, 2003). *See* Figure 4 for legend.

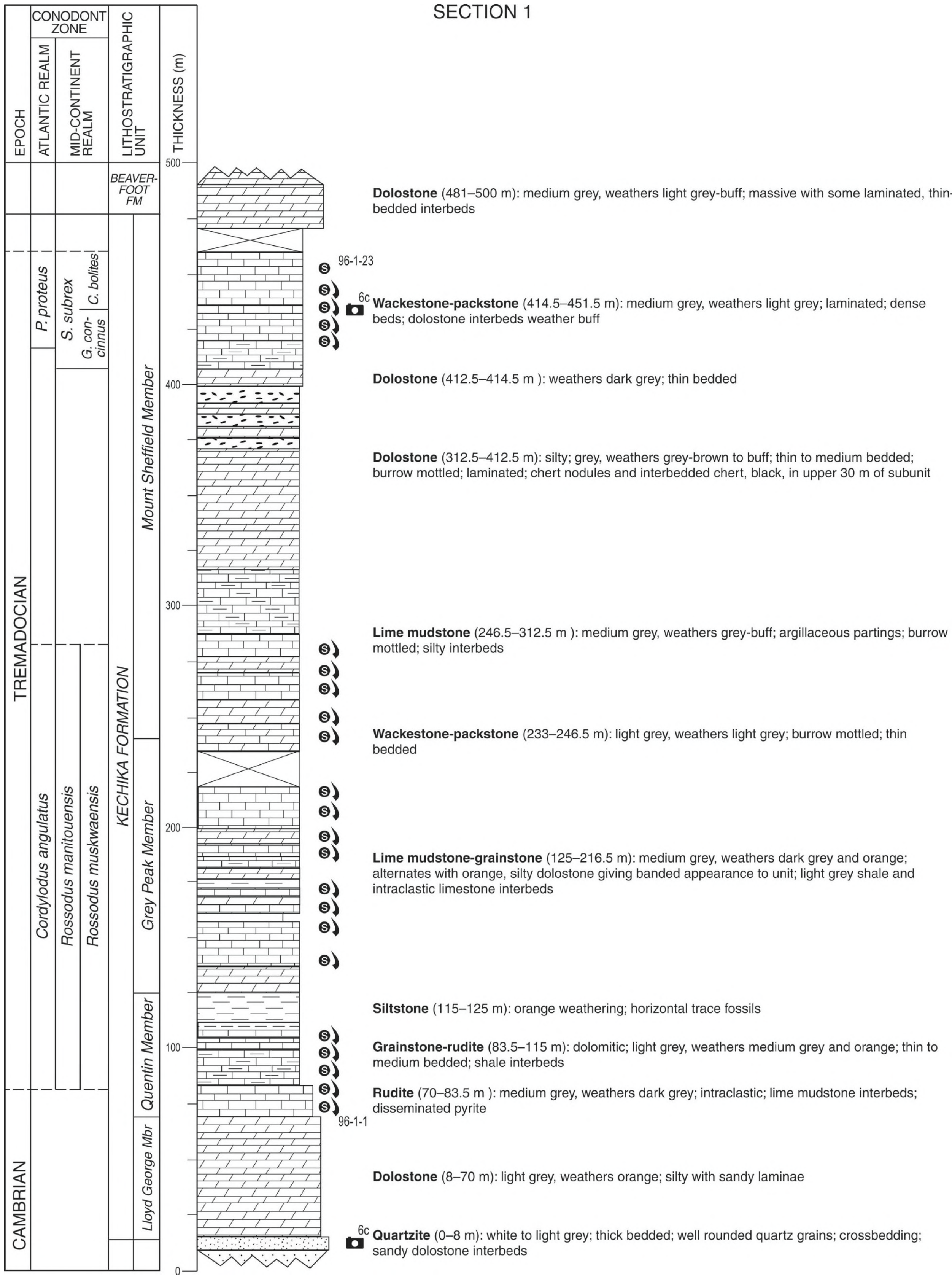


**Figure 6a.** Measured strata of Section 1.

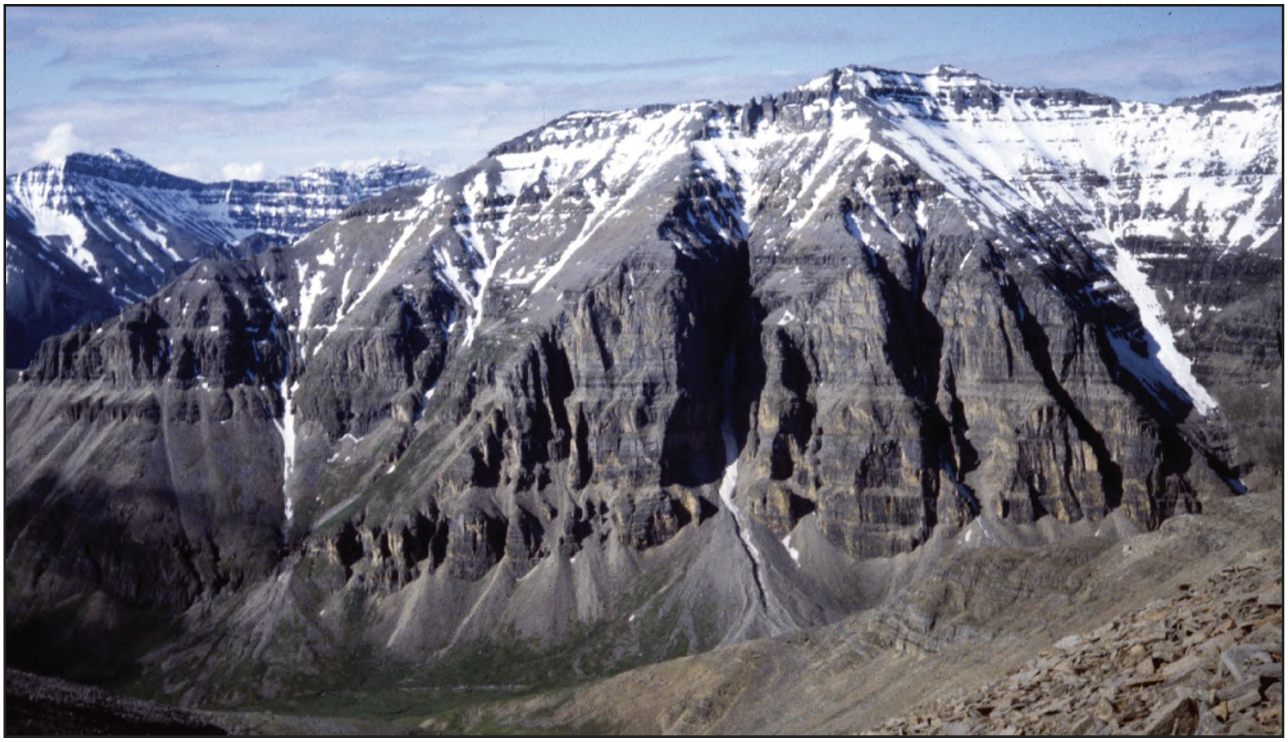

**Figure 6b.** View to the southeast across the valley from Section 1, showing members of the Kechika Formation (430 m thick). 2010-088

**Figure 6c.** View to the north from the top of the Skoki Formation, showing the underlying Kechika Formation and Cambrian units thrust over Mesozoic strata. 2010-089

Member is fault-repeated such that it was recollected within Section A, although its base was not observed. It is at least 325 m thick in Section A, consisting of wackestone to grainstone beds that weather buff and grey among the putty-grey-weathering shale (Fig. 7b). The unit is homogeneous, with undulatory bedding planes. The member spans the Cambro-Ordovician boundary based on the *Cordylodus lindstromi* and *Iapetognathus* zones, and ranges into the *C. angulatus* Zone (Fig. 3).

The contact with the overlying Grey Peak Member is within a covered interval. A change to more regular repetition of thin limestone beds and metre-scale intervals of grey shale occurs at the base of the unit, giving a banded appearance. The member (625 m thick) generally contains an alternation of nodule-rich beds with argillaceous partings and nodule-poor, shaly intervals (Fig. 7b, d). The member spans the *R. manitouensis* Zone and ranges into the upper *S. subrex* Zone (middle to late Tremadocian) (Fig. 3).

The Haworth Member (630 m thick) contains 70% shale and 30% argillaceous limestone or nodular limestone to grainstone beds, and overall is massive (Fig. 7e). It ranges into the base of the *Paracordylodus gracilis* Zone (late Tremadocian) (Fig. 3). The overlying Mount Sheffleld Member (453 m thick) contains platy, orange-weathering, thick-bedded, lenticular limestone, dolomitic limestone, and cleaved shale with bedding-parallel partings (Fig. 7e, f). The unit spans the Tremadocian-Arenigian boundary, ranging into the *Oepikodus communis* Zone (Fig. 3). The contact with the Haworth Member is conformable and gradational over a few metres. The contact with the overlying Skoki Formation is also gradational, marked by a change to massive, burrow-mottled, orange- and grey-weathering, fossiliferous dolostone. The basal Skoki Formation lies within the *O. communis* Zone (Arenigian) (Fig. 3, 7f).

## Section 5

### Location

The section is situated 12 km southwest of where the Prophet River bifurcates (94-F/8 and 94-F/9; 57° 30′N, 124° 26′W; Fig. 1). Camp was established in a cirque, and the section was walked out, south down a creek bed to a gully of the uppermost Kechika Formation at 413650E, 6373550N. Measurement and sample collection occurred north toward camp through the Skoki Formation and north beyond camp, up the ridge to 413300E, 6374900N. Sample numbers bear the preflx 96-5.

### Synthesis

The section complements Section 13. Uppermost beds of the Kechika Formation consist of platy limestone, weathering buff-orange and grey (6 m), within the *O. communis* Zone. The Skoki Formation is marked by a change to more resistant, massive overall, dark grey, lenticular limestone within orange-weathering dolomitic shale. The basal Sikanni Chief Member (440 m thick) contains a number of carbonate lithologies that weather medium to dark grey overall. The contact with the Kechika Formation is conformable and gradational over less than a metre (Fig. 8a). A distinct subunit of light-grey-weathering dolostone containing abundant macluritid gastropods occurs near the top of the unit, and conodonts indicate that the unit ranges into the *Tripodus laevis* Zone, Late Arenigian (Middle Ordovician) (Fig. 3). The contact with the overlying Keily Member (340 m thick) is obscured and the lithology changes to a succession of predominantly light-grey- and yellow-weathering, massive dolostone that is extensively burrow mottled. The overlying Redfern Member is at least 300 m thick and contains alternating subunits of dark-grey-weathering, massive dolostone and crossbedded, sandy dolostone, and yellow, light-grey- and buff-weathering, laminated dolostone (Fig. 8c).

## The ancient shelfbreak: Grey Peak Section

The Grey Peak Section is Section 11 of Cecile and Norford (1979), but their detailed description is unpublished. The section preserves a thick succession of shaly Kechika Formation that abruptly overlies Cambrian siliciclastic units, and is overlain by the Ospika Formation, which contains spectacular breccia debris flows with clasts of Skoki Formation dolostone.

### Location

The stratigraphic section at Grey Peak (94-F/14; 57° 48′N, 125° 13′W; Fig. 1.) was sampled in eight segments, beginning at the Kechika-Ospika Formation contact at approximately 370000E, 6409000N, and progressing upward through the Ospika Formation, eastward along the ridge to the cliff-forming platformal carbonate debris-flow deposits of the Chesterfleld Member. The upper two members of the Ospika Formation and the Pesika Formation are cut out by an unconformity. The overlying orange-weathering Kwadacha Formation was walked out over a spur to the east. The Kechika Formation was collected in segments: segments 2 though 5 are the upper part that form Grey Peak; segments 6 though 8 are the lower part, which overlies Cambrian units. The base of the section, at the base of the Kechika Formation, is at 368700E, 6408250N, and the top of the section, in the Kwadacha Formation, is at 370950E, 6409900N. The Grey Peak Section is the type section for all members of the Kechika Formation, except the Mount Sheffleld Member, which shales out to the west and is partly coeval with the basal member of the Ospika Formation (Fig. 3, 5). Sample numbers of the section were given the preflxes GP-94-1 through GP-94-8 to correspond to segments.

SECTION 13, SEGMENT C

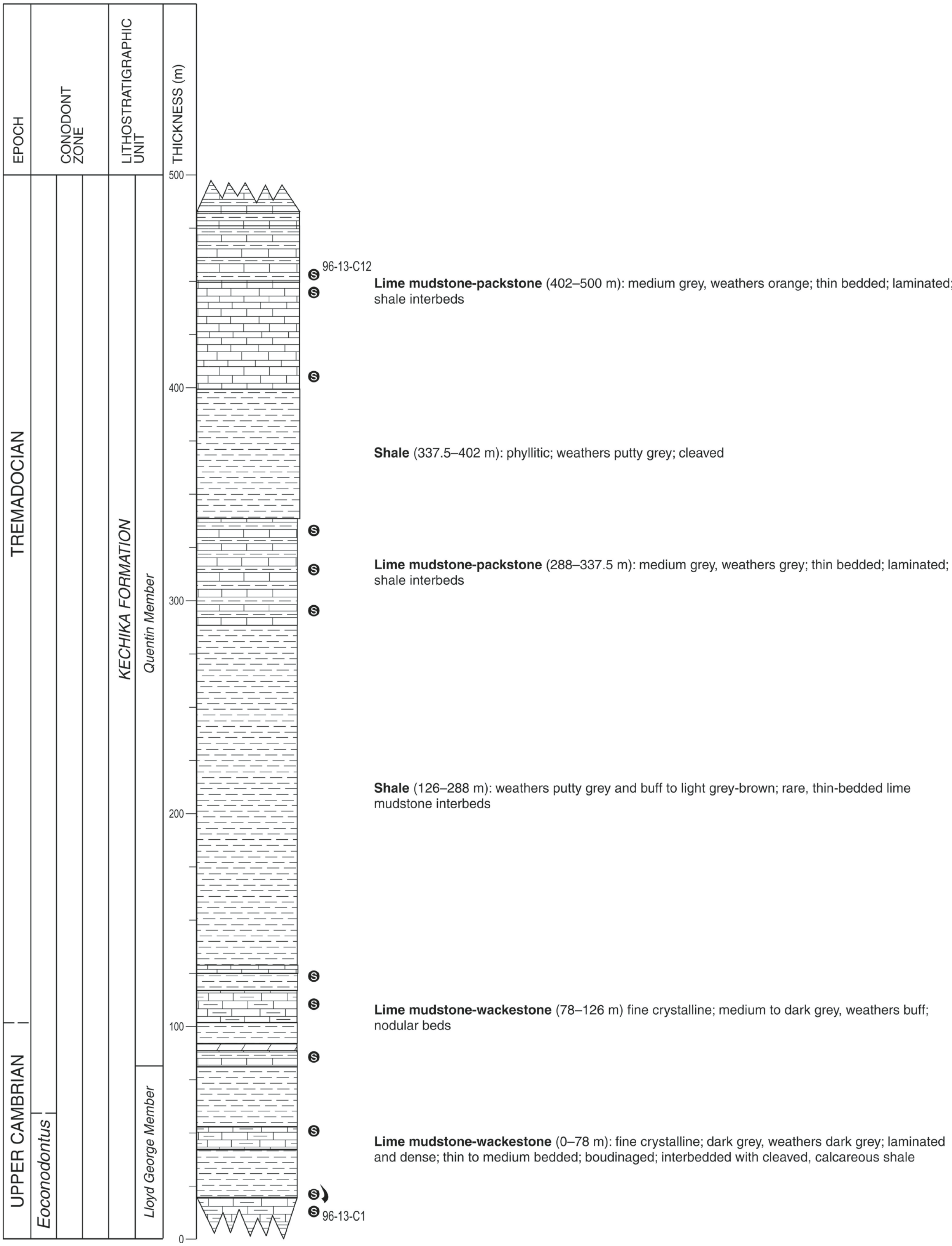


**Figure 7a.** Measured strata of Section 13, segment C.

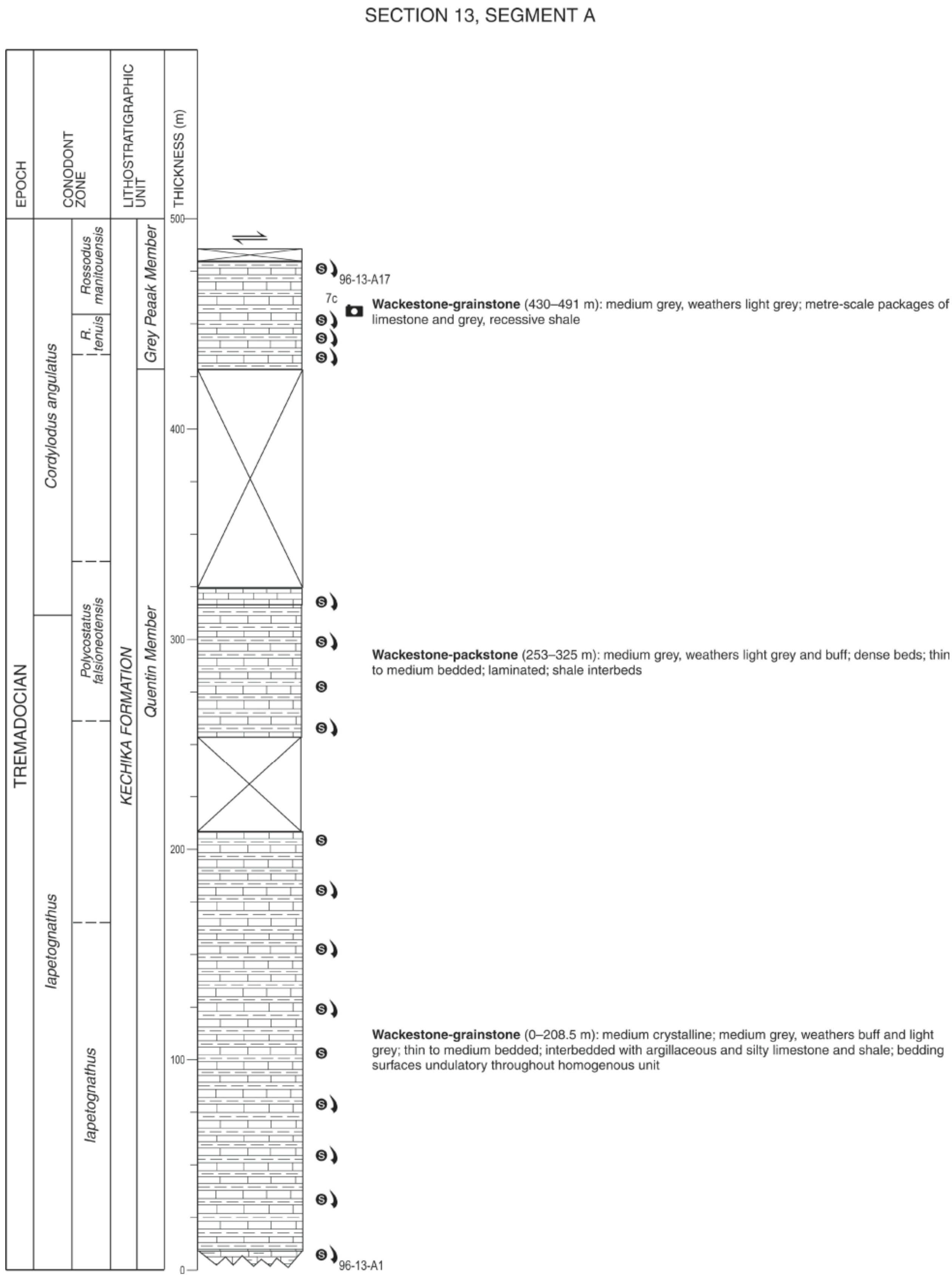


**Figure 7b.** Measured strata of Section 13, segment A.

**Figure 7c.** Gradational contact of the Quentin and Grey Peak members of the Kechika Formation, Section 13. 2010-090

## *Synthesis*

The members of the Kechika Formation have conformable and gradational contacts over a few metres. The Kechika Formation is 1408 m thick at Grey Peak. The basal Lloyd George Member unconformably overlies Cambrian sandstone and contains oolitic and conglomeratic facies. The recessive Quentin Member (560 m thick) is deflned by strongly cleaved, calcareous shale (70%) that has bedding-parallel partings, with characteristic putty-grey-weathering surfaces. The thin, argillaceous to silty, flnely laminated lime mudstone to wackestone beds are commonly nodular and have undulatory bedding surfaces. The base of the Quentin lies within the Late Cambrian, *Cordylodus proavus* Zone, and the unit ranges into the Tremadocian (Fig. 9a). The more resistant Grey Peak Member forms the main peak of the mountain and is a 230 m thick succession of thin-bedded, medium-grey-brown limestone with grey shale partings alternating with metre-scale intervals of light grey, calcareous, phyllitic shale. The thin-bedded carbonate units include platy, grey-brown-weathering, dolomitic shale and limestone with abundant horizontal burrows (Fig. 9b). The Haworth Member (455 m thick) is distinguished by prominent, widely spaced, nodular, argillaceous limestone beds that increase upsection from 20% at the base to 80% at the top of the unit. The shale interbeds weather light grey and brown (Fig. 9b, c). The contact with the overlying Ospika Formation is abrupt but conformable, marked by a change to brown-black-weathering shale over less than one metre. The Grey Peak and Haworth members are Tremadocian in age, the Haworth ranging into the *P. gracilis* Zone (Fig. 3).

The Ospika Formation (409 m thick) consists of four units at Grey Peak and is unconformably overlain by the Kwadacha Formation. The Cloudmaker Member (88 m thick) contains dark grey, cleaved shale and rare, nodular, medium grey limestone beds (Fig. 9c). The Finlay Limestone Member (62 m thick) is more resistant, consisting of bedded limestone that weathers platy and yellow-grey. The

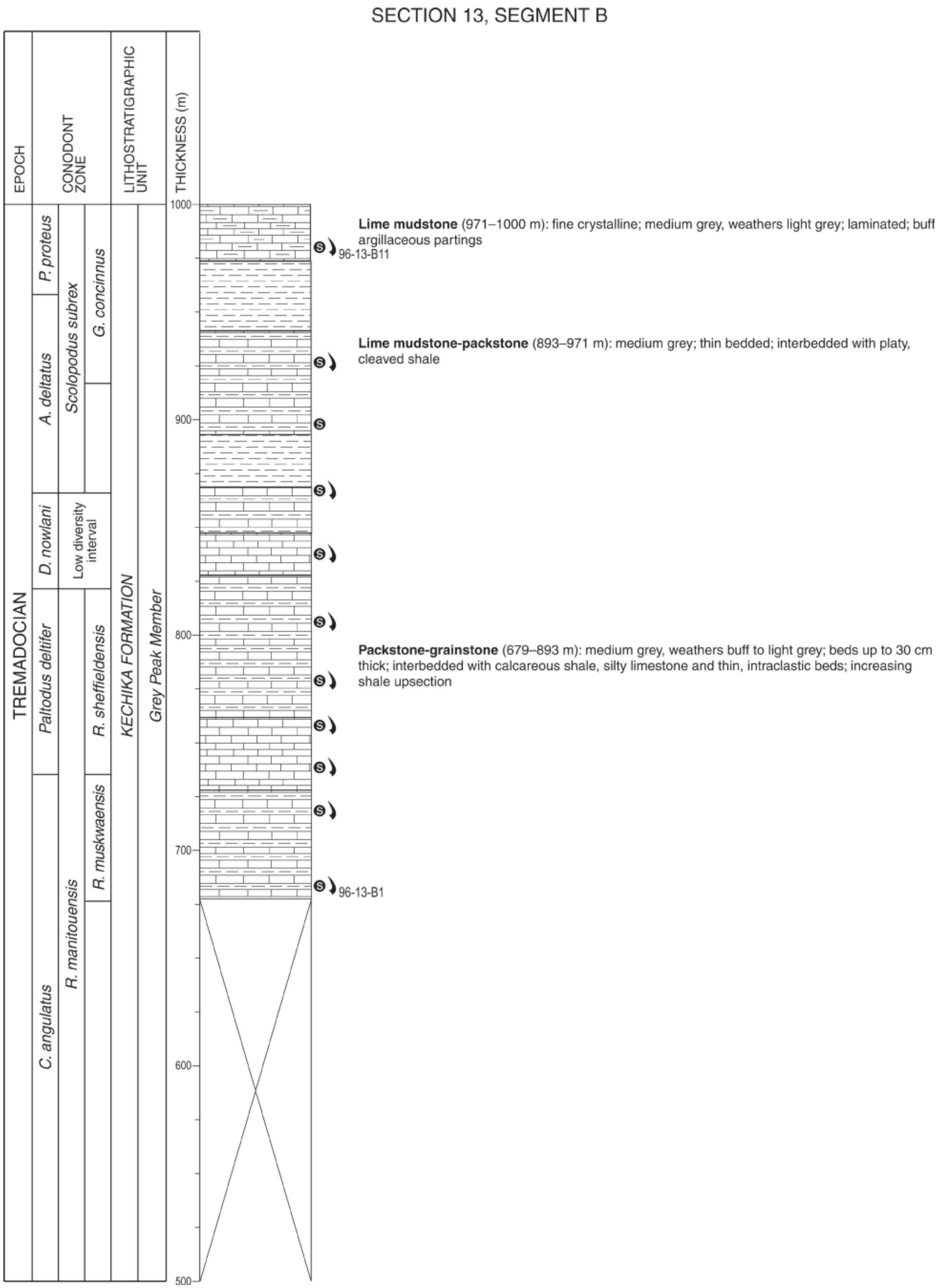


**Figure 7d.** Measured strata of Section 13, segment B.

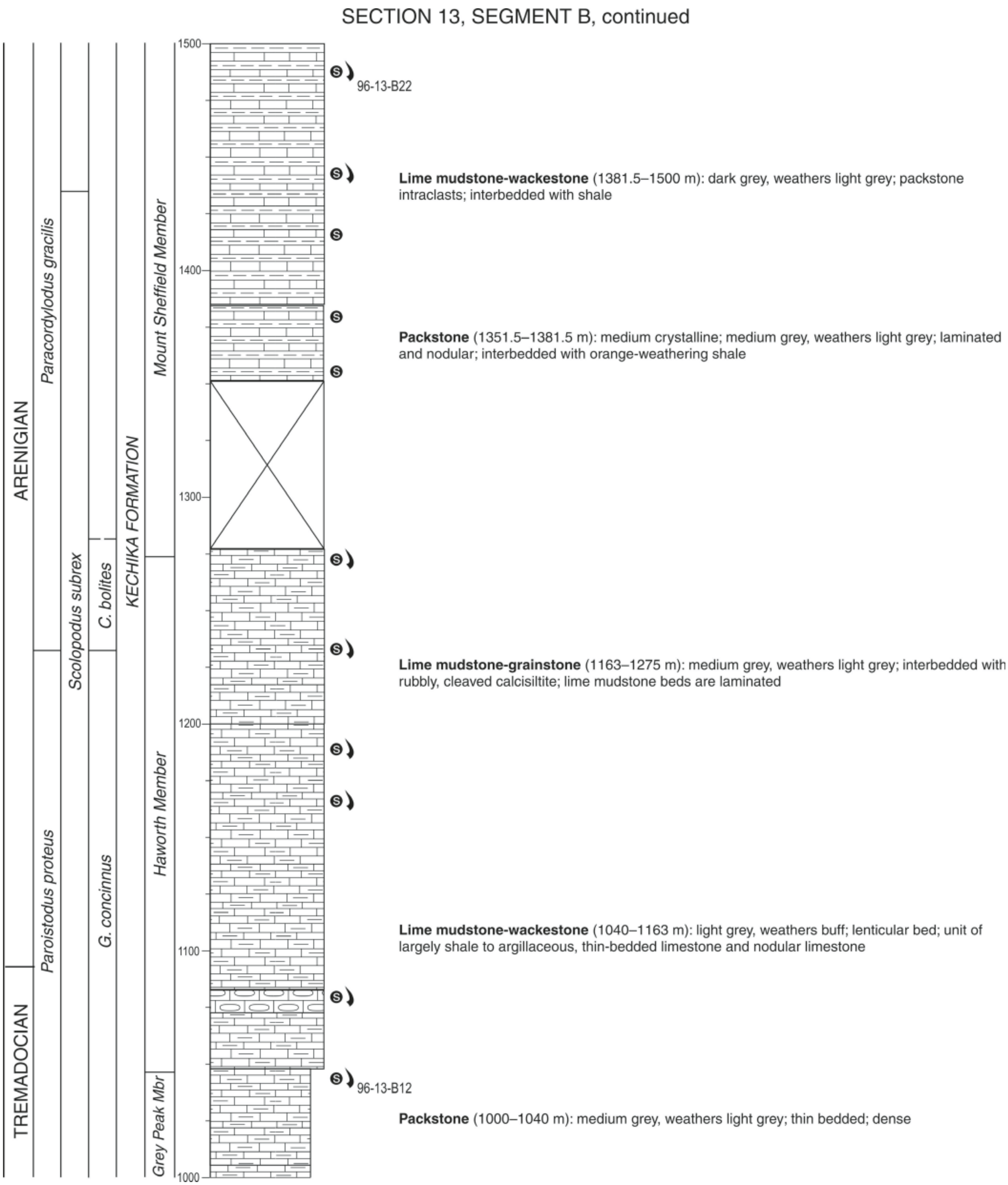


**Figure 7e.** Measured strata of Section 13, segment B, continued, type section of the Mount Sheffield Member.

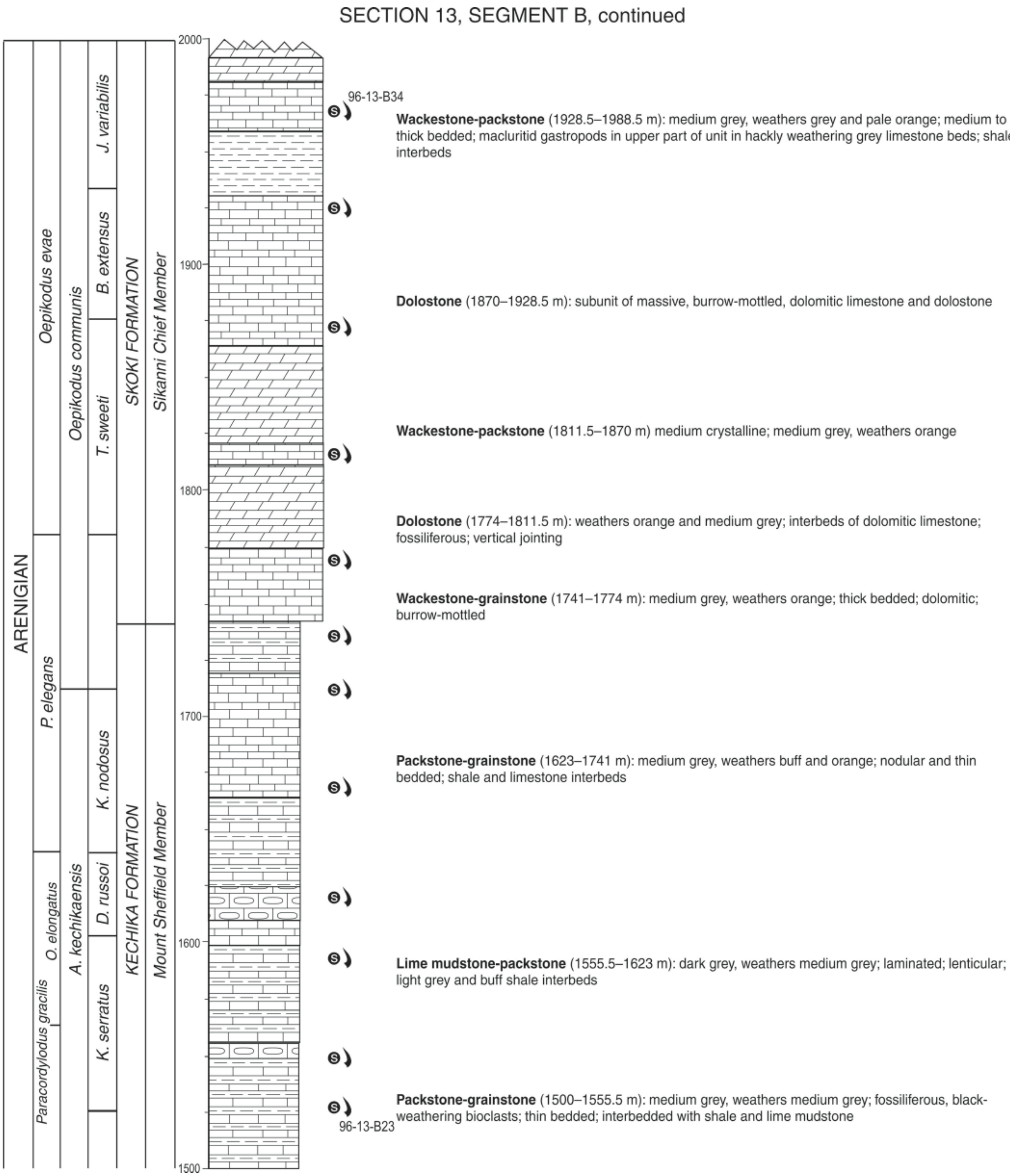


**Figure 7f.** Measured strata of Section 13, segment B, continued, type section of the Mount Sheffield Member.

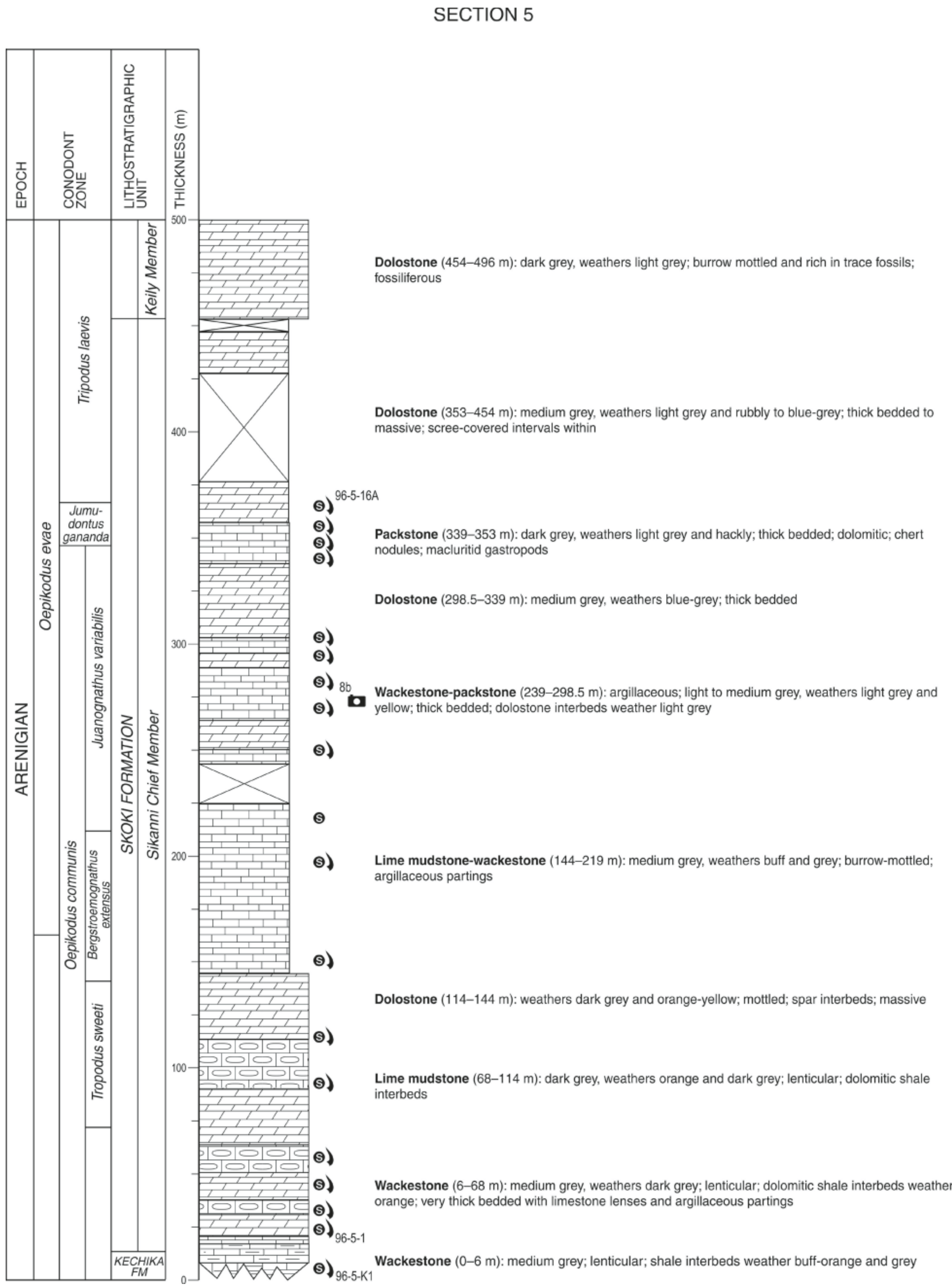


**Figure 8a.** Measured type section of the members of the Skoki Formation, Section 5.

**Figure 8b.** Sedimentary characteristics of the Sikanni Chief Member, Skoki Formation, Section 5, showing dark grey weathering colour and medium to massive bedding of dolostone and dolomitic limestone (30 cm sample bag for scale). 2010-091

Chesterfield Member (191 m thick) contains dark grey shale and siltstone, and a series of debris-flow breccias with clasts of Skoki Formation dolostone (Fig. 9e). The Finbow Shale Member overlies the carbonate debris flows and is at least 68 m thick. It is distinguished by the rusty-weathering shale, interbedded with silty dolostone and chert. It is abruptly overlain by orange-weathering siltstone of the Kwadacha Formation (Fig. 9d, 9f). The Ospika Formation at Grey Peak is Arenigian to Darriwilian in age and is part of a spectacular section that preserves the ancient shelfbreak. The base of the Darriwilian was not determined precisely, but Lenz and Jackson (1986) reported graptolites indicative of the *P. tentaculatus* Zone at a level high in the Ospika Formation (at 1736 m based on measurements by Cecile and Norford).

## SECTIONS FROM THE KECHIKA TROUGH

Five basinal facies sections of the Kechika Trough were measured and described in detail. The number and diversity of conodont taxa decrease from platform to basin. Biostratigraphic constraints were determined for Section 4 of Cecile and Norford (1979), Gataga Mountain, and the Road River Core, but no conodonts were recovered from the Driftpile Creek and Bluff Creek North sections.

### Section 4

#### *Location*

The ridge section, situated 6 km north of the Akie River (94-F/7; 57° 26′N, 124° 35′W; Fig. 1) trends northeast to southwest. The Kechika Formation is exposed from a col to the northeast at 404600E, 6360500N to the contact with the Road River Group at 404500E, 6360000N. The ridge-forming Kwadacha Formation makes up the peak to the southwest, its basal contact at 404400E, 6359900N. The top of the section is at 404100E, 6359650N. Camp was established on a flat, grassy col within the Road River Group. Measurements and collections proceeded from the Kechika Formation to the north up to the ridge to the south of camp. This section is the type section for three formations of the Road River Group (the Ospika, Pesika, and Kwadacha), and for four of the formally named members of the Ospika (the Finlay Limestone, Chesterfield, Finbow Shale, and Ware members; Pyle and Barnes, 2000). Sample numbers bear the preflx 96-4.

#### *Synthesis*

The upper part of the Kechika Formation (178.5 m) consists of light-grey-weathering shale and thin-bedded and lenticular limestone. The Finlay Limestone Member (175 m thick) of the Ospika Formation unconformably overlies the Kechika Formation. The Cloudmaker Member is absent. The Finlay Limestone is distinguished by platy, yellow-grey-weathering limestone and also contains thin-bedded, argillaceous limestone and grey-weathering shale and dolomitic limestone. The Chesterfield Member (55 m thick) is characterized by a distinct, recessive sequence of dolomitic, dark-grey- to green-weathering shale, and minor, pale-weathering dolostone interbeds. The Finbow Shale (25 m thick) contains cleaved, dark grey shale that weathers distinctly rusty orange and dark grey-orange with minor, thin-bedded dolostone. The Ware Member (184 m thick) contains black shale at its base, and thick-bedded dolostone

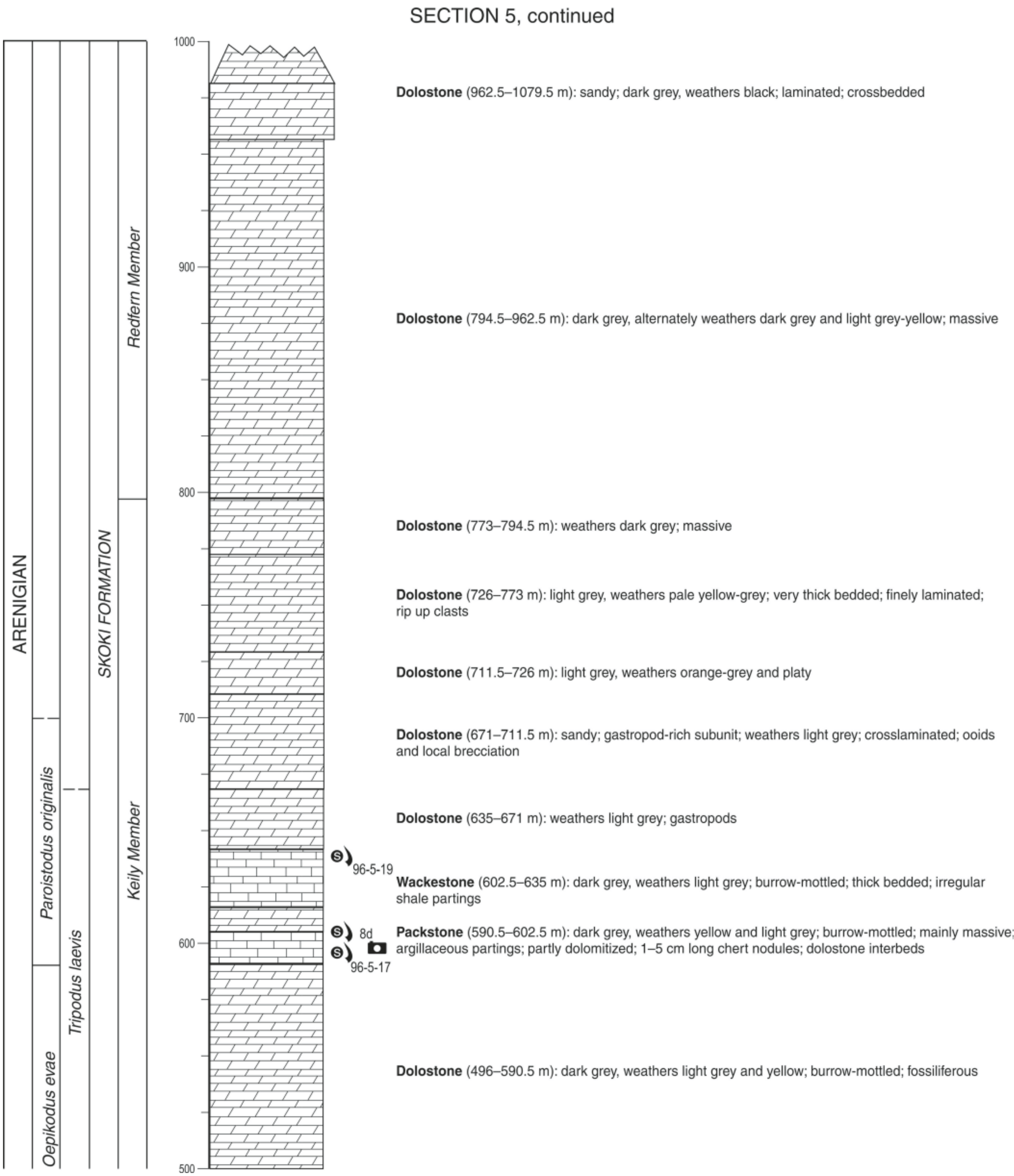


**Figure 8c.** Measured type section of the members of the Skoki Formation, Section 5, continued.

**Figure 8d.** Burrow-mottled texture of yellow and light grey weathering dolostone, lower part of the Keily Member, Skoki Formation, Section 5 (1 m stick for scale). 2010-092

and rare blue-grey weathering quartzite that becomes thick bedded upsection. All the members of the Ospika Formation have abrupt but conformable contacts (Fig. 10a, c).

The Pesika Formation (230 m thick) is characterized by thin-bedded, grey, dolomitic limestone and dark grey, graptolitic shale and minor breccia. Its lower contact with the Ware Member and upper contact with the Kwadacha Formation were snow covered when studied by the authors, but were reported to be conformable by Cecile and Norford (1979, Figure 36.2). The Pesika is Early Silurian (Llandovery) in age, within the *Distomodus staurognathoides* Zone (Fig. 3). The overlying Kwadacha Formation (approximately 300 m thick) is a uniform, resistant, cliff-forming unit of orange to brown weathering, thin-bedded, laminated, argillaceous siltstone, and dolomitic siltstone (Fig. 10c). The Kwadacha Formation, based on graptolite collections, is latest Llandovery or Wenlock in age (B.S. Norford, unpub. rept, 1980). Conodonts from the upper part of the formation in the Kechika Trough indicate an Early to Middle Devonian age (Ferri et al., 1996).

## Driftpile Creek Section

### *Location*

The ridge section (94-K/4; 58° 07′N, 125° 51′W; Fig. 1) is situated 5 km northeast of a British Columbia Geological Survey/Teck Corporation base camp and airstrip set up near Driftpile Creek. The section was collected along a southwest spur of the ridge from the contact of the Kechika Formation with an overthrust, ridge-forming Cambrian unit at 331500E, 6444400N, to the Kechika-Road River contact at 331500E, 6444200N. Sample numbers bear the preflx D-94.

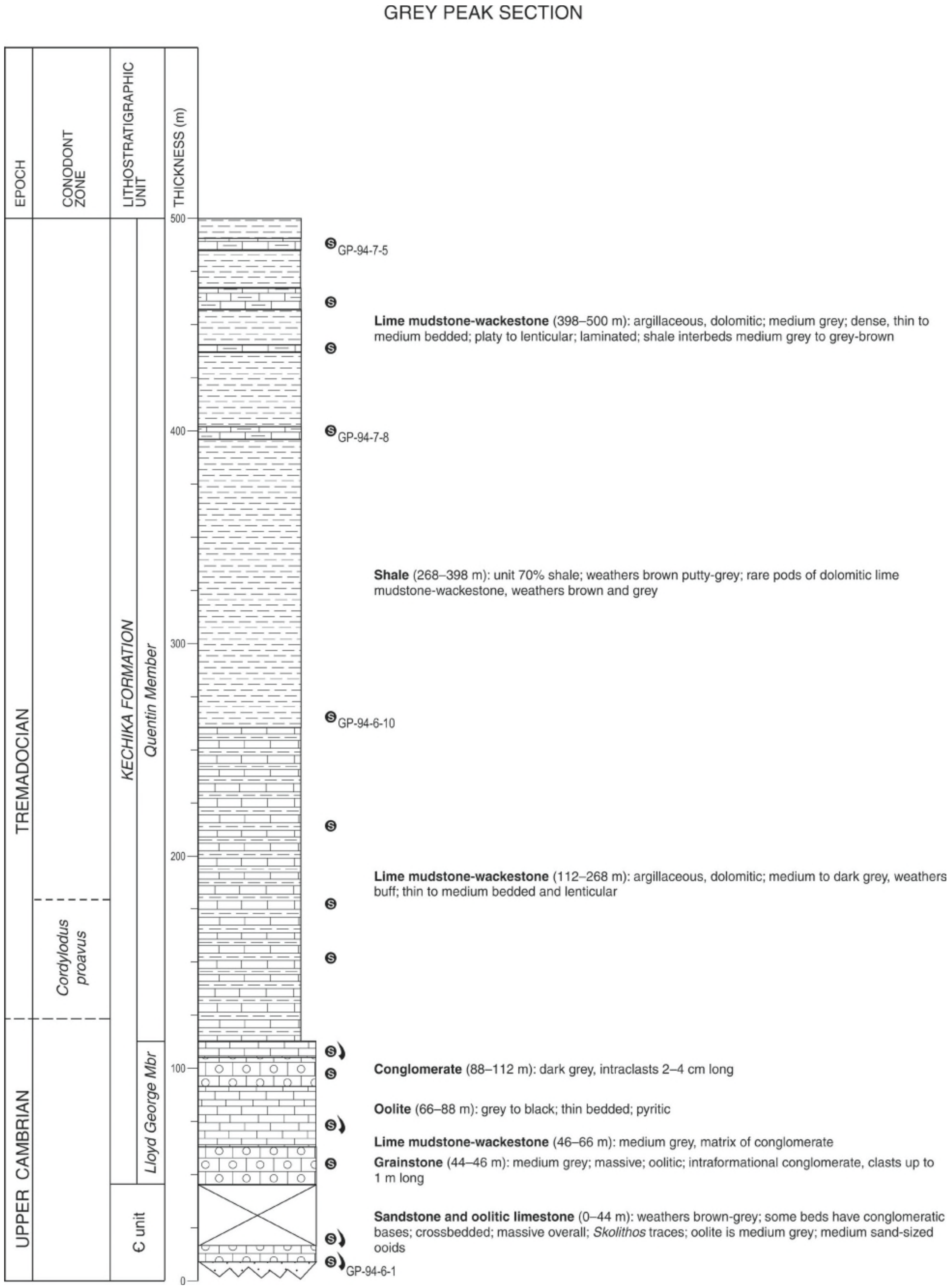


**Figure 9a.** Measured type section of the members of the Kechika Formation, Grey Peak Section.

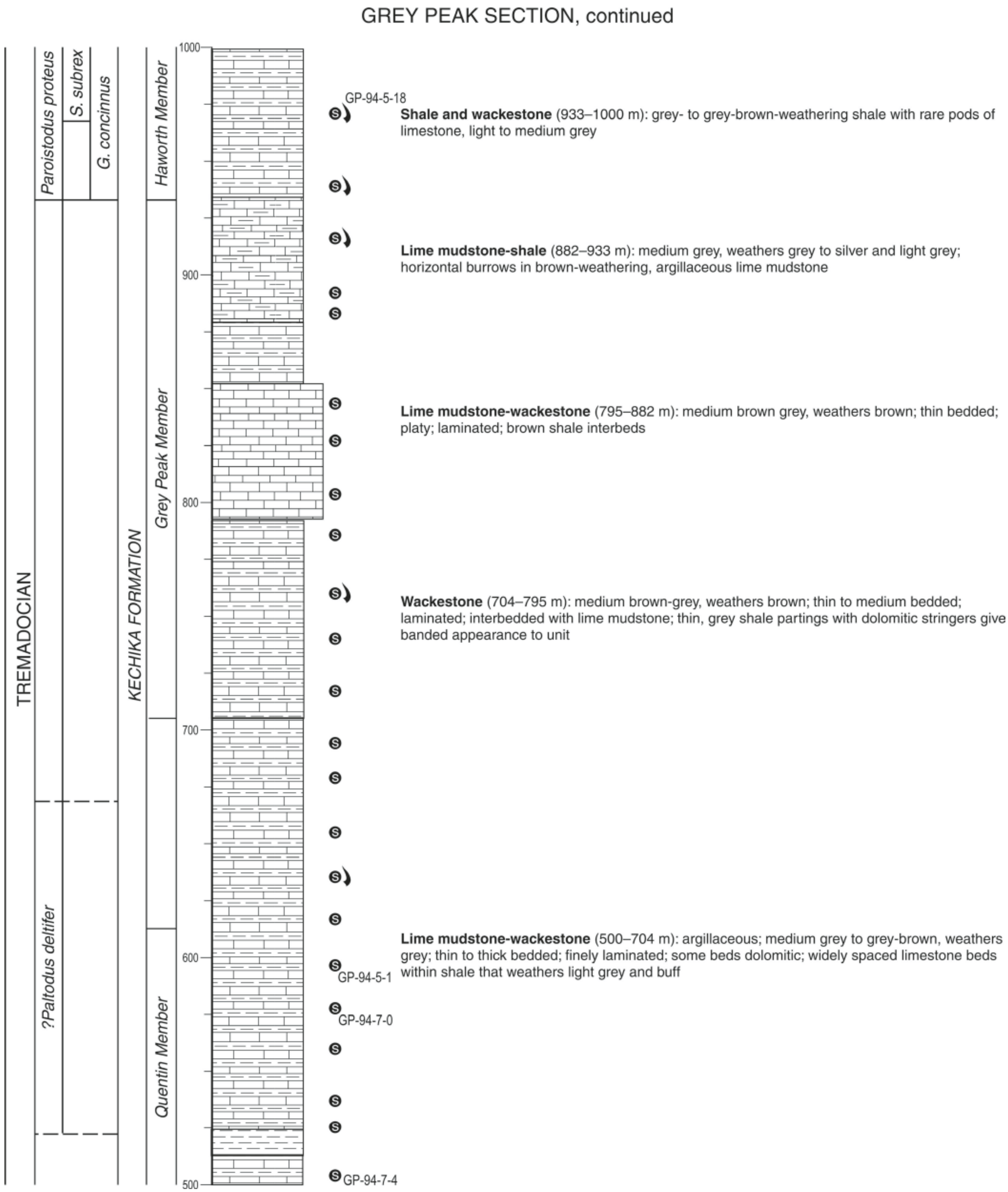


**Figure 9b.** Measured type section of the members of the Kechika Formation, Grey Peak Section, continued.

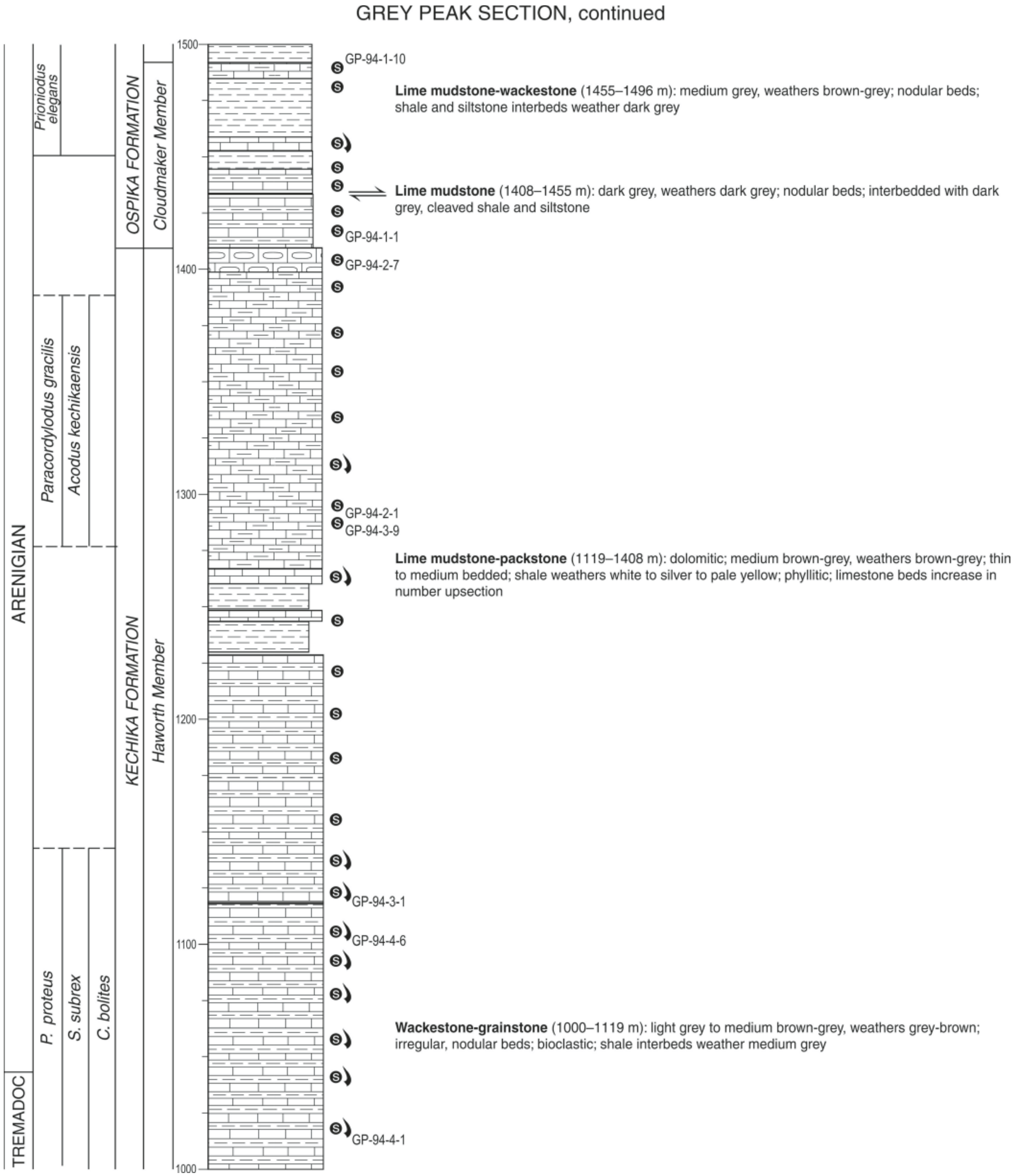


**Figure 9c.** Measured type section of the members of the Kechika Formation, Grey Peak Section, continued.

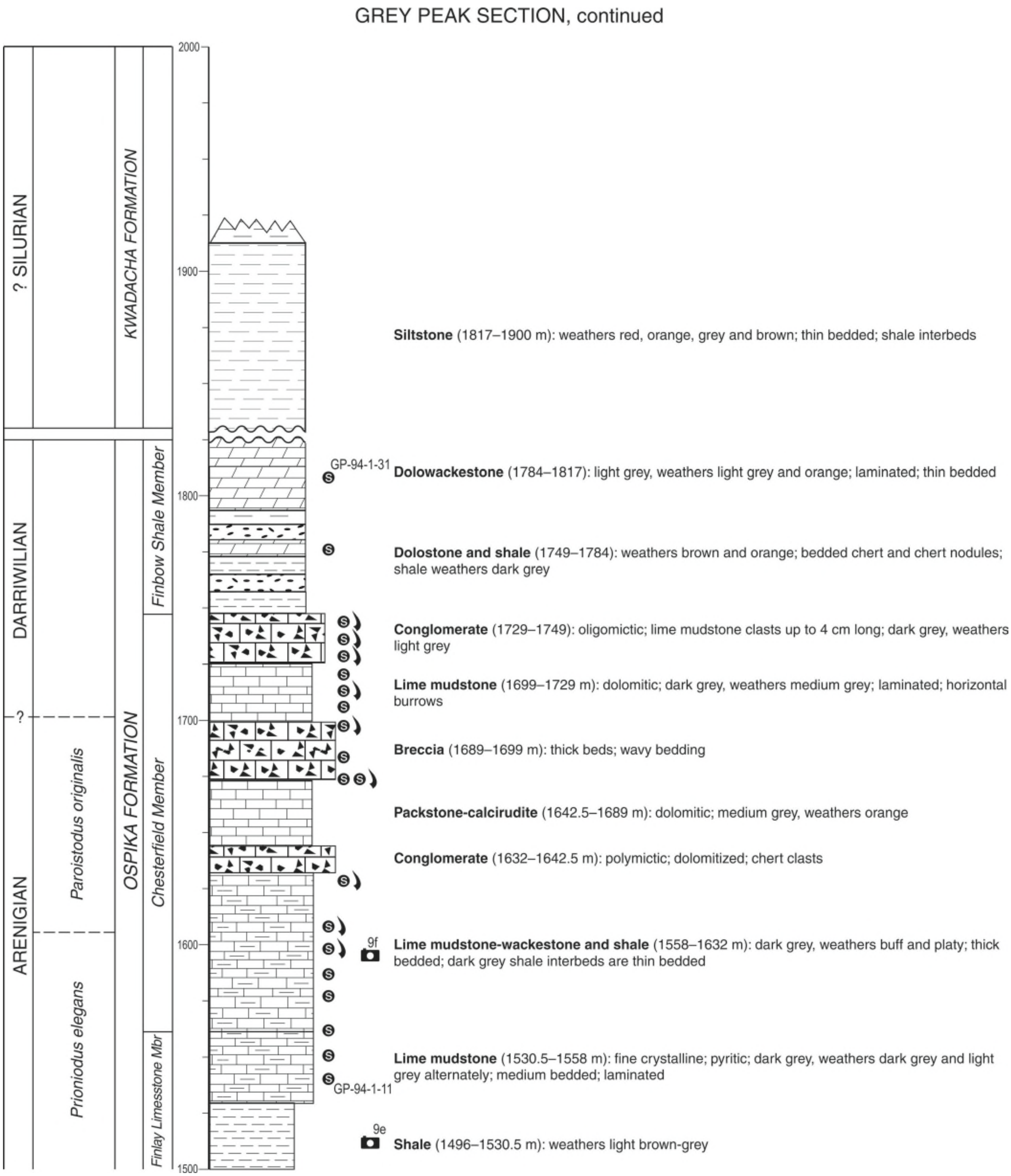


**Figure 9d.** Measured section of the Ospika Formation, Grey Peak Section, continued.

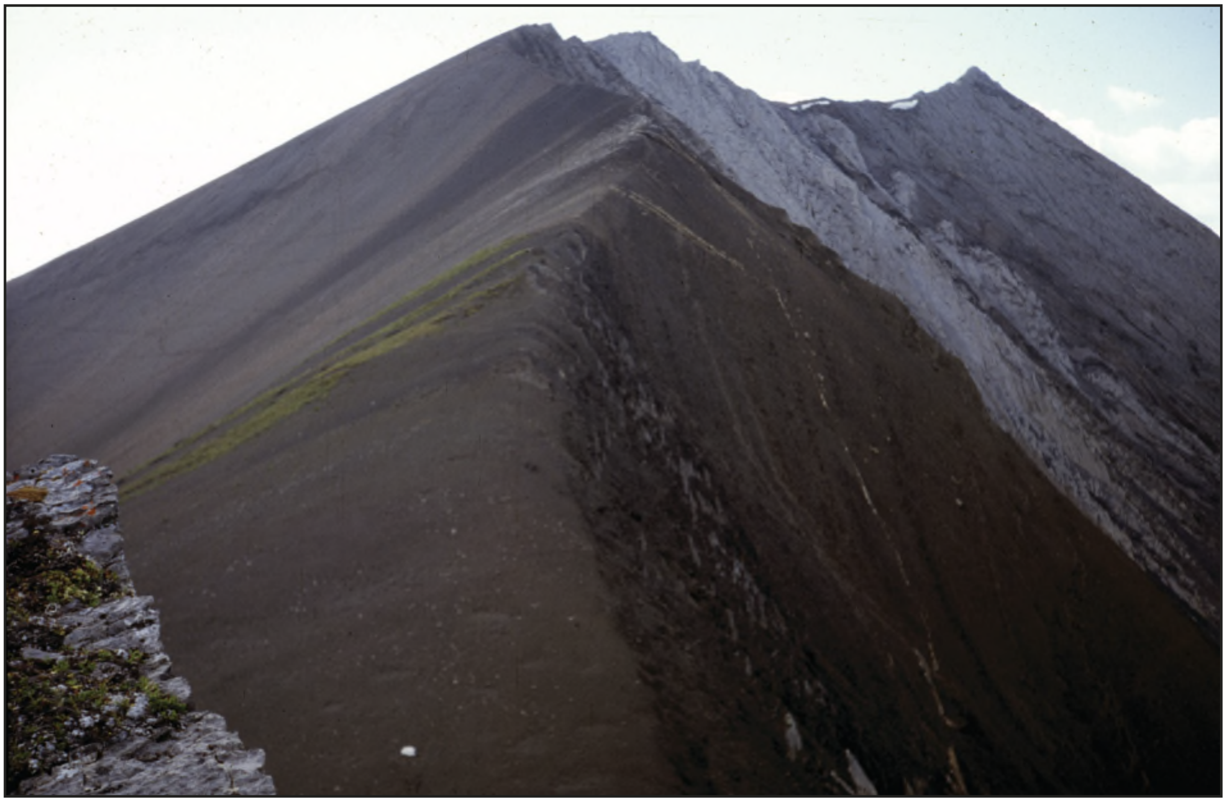

**Figure 9e.** Grey Peak Section showing Grey Peak in the distance, composed of the Kechika Formation, Grey Peak Member which is gradationally overlain by the Haworth Member. The Cloudmaker Member (80 m thick) of the Ospika Formation is in the foreground. 2010-093

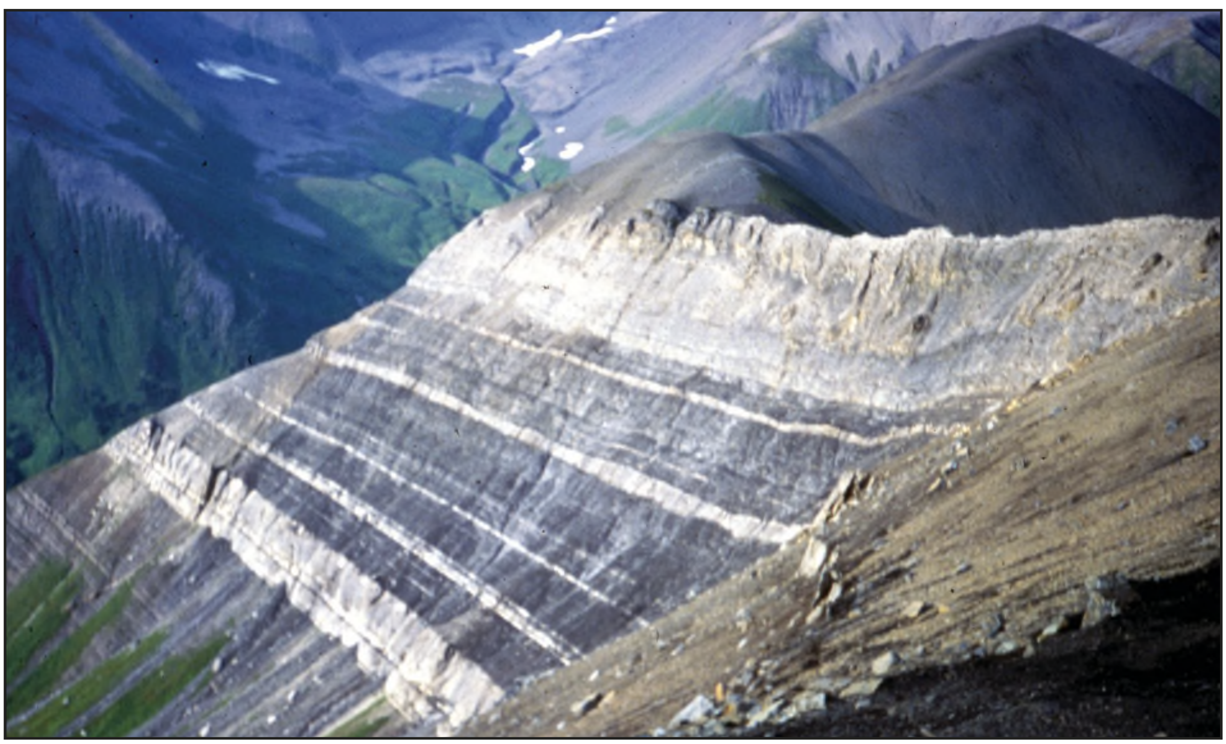

**Figure 9f.** Continuation of Grey Peak Section, showing cliff-face of Chesterfield Member and Kwadacha Formation in the distance. 2010-094

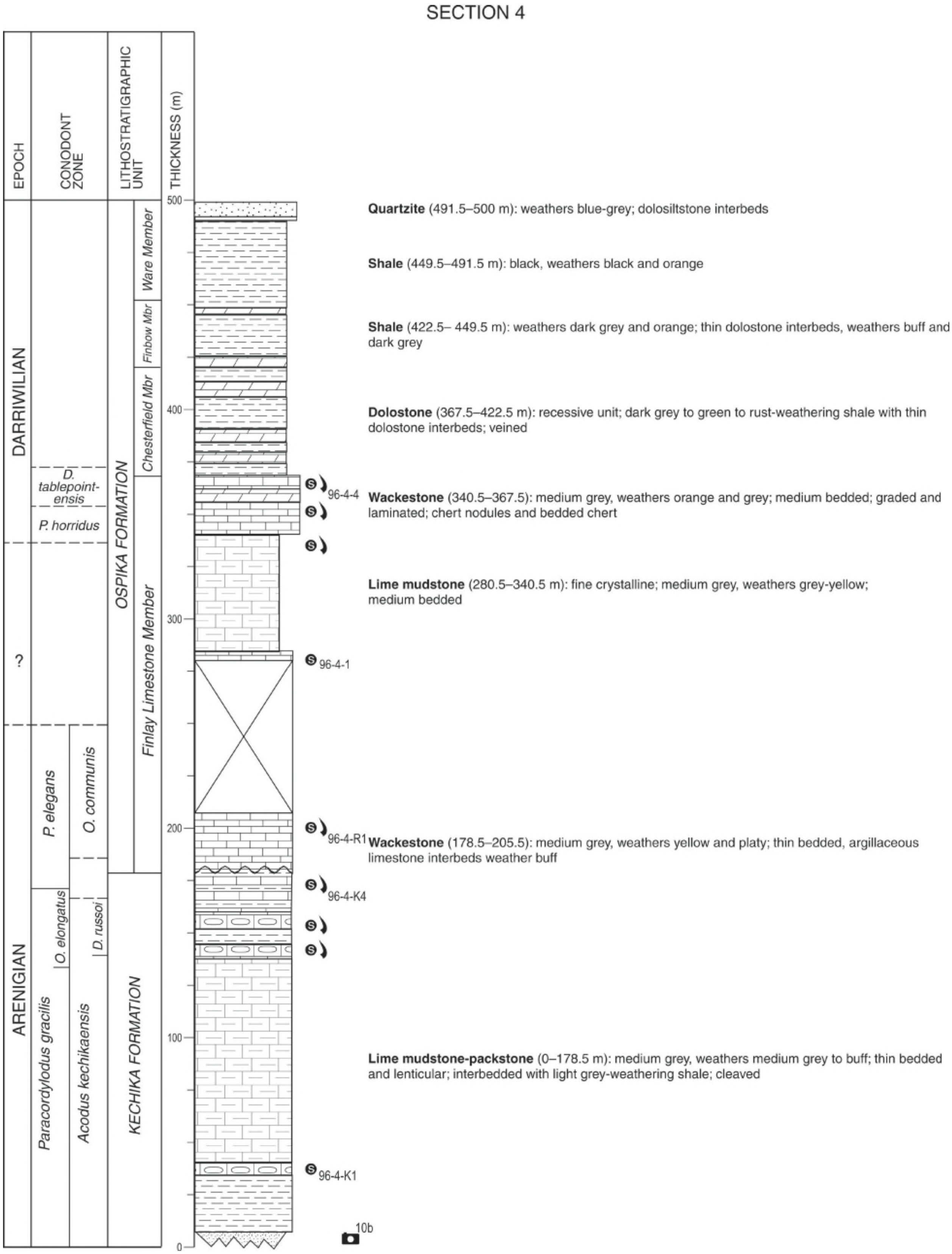


**Figure 10a**. Measured type section of the Ospika Formation and its members, Section 4.

**Figure 10b.** Measured type Section 4, showing the members of the Ospika Formation. 2010-95

### *Synthesis*

The section is part of an inverted sequence. Measurements began at the obscured, talus-covered Kechika Formation (about 45 m) contact with overthrust, massive, Cambrian dolostone that forms the ridge. The Kechika Formation (170 m) contains thin-bedded, orange dolostone and buff-weathering dolomitic shale and siltstone with thin-bedded, isolated, weakly calcareous mudstone beds. The contact with the overlying Road River Group (73 m thick) is marked by a gradual change to dark grey paper shale with thin lime mudstone beds (Fig. 11a).

## Gataga Mountain Section

### *Location*

The section is situated 30 km south of a hunting lodge called Terminus Mountain Camp, on the east side of Gataga Mountain (94-L/10; 58° 38′N, 126° 55′W; Fig. 1). Camp was established in a cirque east of the mountain. The Kechika Formation extends along-ridge from northeast to southwest from 621300E, 6506000N to Road River contact at 620800E, 6504000N. Sample numbers have the preflx GBK-95 for the Kechika Formation and GB-95 for a single sample from the Road River Group.

### *Synthesis*

The section was measured in segments, beginning at the boundary of the Kechika Formation and Road River Group in a saddle marked by a 20 m interval of frost-heaved volcanic rocks referred to as the Ospika Volcanics (Goodfellow et al., 1995). The section contains ridges of the mountain below the overthrust Proterozoic(?) units making up the main peak of Gataga Mountain. The Kechika Formation was measured and sampled along the north-south ridge east of camp in two segments (GBK-95-A and B). The formation (720 m, tectonically thickened) contains cleaved, light-grey-weathering shale and thin-bedded to lenticular limestone. The fault-repeated sequence of Kwadacha Formation and Ospika Formation was measured toward Gataga Mountain from the volcanic rocks (Fig. 12).

The Ospika Formation along the ridge section consists of recessive units of dark grey to black, cleaved pencil shale. An isolated carbonate concretion within the Ospika Formation was collected in a creek bed along strike and yielded conodont elements that indicate a Late Ordovician age. The Kwadacha Formation contains resistant, orange-weathering, dolomitic siltstone. The overthrust Proterozoic(?) carbonate and volcanic units forming the crest of Gataga Mountain are light grey weathering.

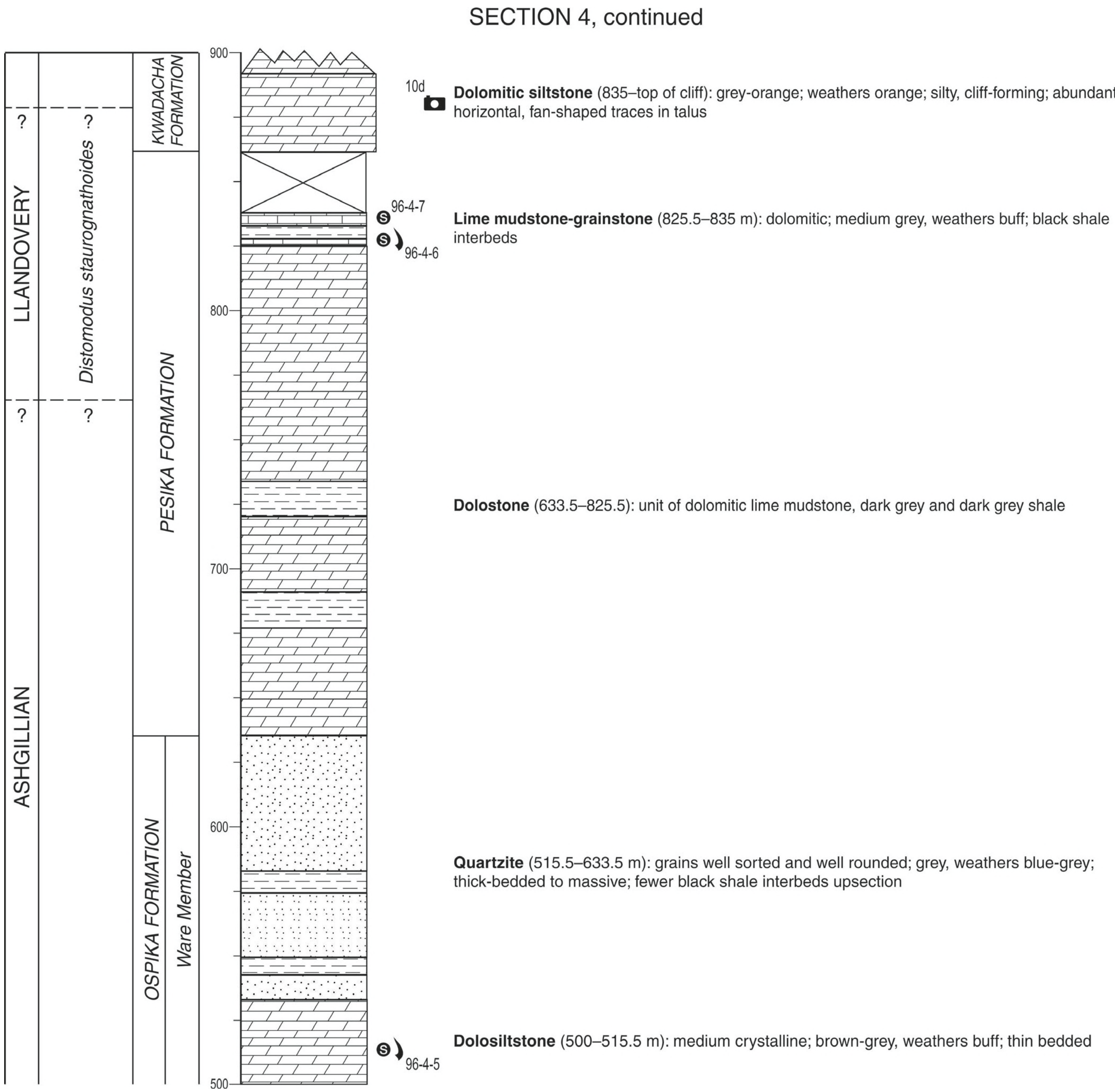


**Figure 10c.** Measured type section of the Pesika and Kwadacha formations, Section 4.

**Figure 10d.** Sedimentary characteristics of the Kwadacha Formation, Section 4. Dolomitic siltstone weathers orange and platy, bedding planes covered by abundant fan-shaped horizontal burrows. 2010-096

## Bluff Creek Section

### *Location*

Camp was established near a grassy saddle (major animal crossing) at the top of the Cambrian sequence, north of Bluff Creek (94-L/10; 58°34′N, 126°37′W; Fig. 1). The nature of the Cambrian units, Kechika Formation, and Road River Group at this locality make formation contacts difficult to discern. Measurement began within the ?Cambrian unit at 638500E, 6495500N and ended within the Road River at 638700E, 6495000N. Sample numbers bear the preflxes BCN-95-A and BCN-95-B.

### *Synthesis*

Typical Kechika Formation and Road River Group lithologies were not recognized at Bluff Creek. The base of the Kechika Formation is drawn where several recessive units (80 m thick) of mainly shale with dark grey and brown, isolated, platy limestone, overlie a ?Cambrian unit of siltstone, shale, and limestone. The contact with the overlying Road River (200 m thick) lies at the change from the orange- and grey-weathering shale and minor limestone to bedded limestone, platy, calcareous siltstone, and interbedded chert and black shale. Subsequent units were distinguished based on weathering colour of shale from blue-black to orange and brown. The uppermost unit contains phyllitic shale, weathering green to white, and compact siltstone beds weathering silver (Fig. 13a,b).

## Road River Core

### *Location*

Core from Inmet Mining Corp. was sampled at their core shack (94F/7; 57° 23′N, 124° 52′W; 387600E, 6362500N; Fig. 1), located east of a Repeater Station (57° 24′N, 124° 53′W), 5 km north of the Akie River and 37 km northeast of Finbow. The core is from hole A-95-19, ‘Cardiac Creek.’ Beds dip at about 40° in the core; measurements are directly of core and not corrected for dip. Core sample were given the preflx RR-96.

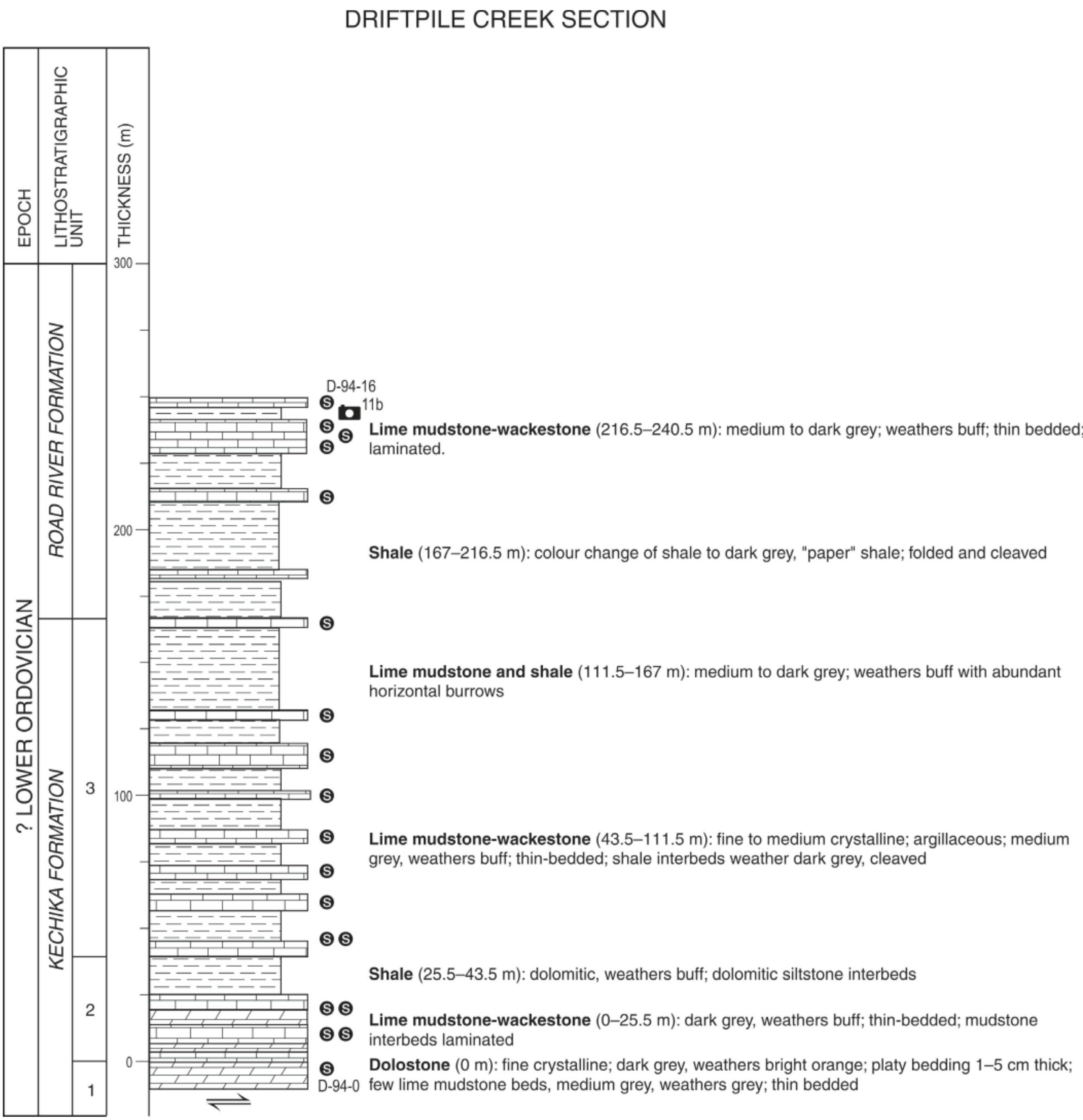


**Figure 11a.** Measured strata of the Driftpile Creek Section.


**Figure 11b.** Driftpile Creek Section showing the inverted sequence of cliff-forming Cambrian units overlying the recessive grey shale and thin bedded dolomitic limestone of the Kechika Formation. The black paper shale and thin bedded lime mudstone of the Road River Group are in the foreground. 2010-097

### *Synthesis*

The core (over 600 m) consisted of mainly black, graphitic, sheared shale and phyllite, grey siltstone, calcareous siltstone, and rare lime mudstone. The predominance of siltstone suggests the unit is the Kwadacha Formation of the Road River Group, and a few, poorly preserved conodont elements were assigned to species that indicate a Late Ordovician to Silurian age (Fig. 14).

# CASSIAR TERRANE SECTIONS

The parautochthonous Cassiar Terrane represents a Cordilleran margin segment bounded to the east by the Tintina-Northern Rocky Mountain Trench Fault (NRMT, Fig. 2), which offsets strata from autochthonous strata of ancestral North America. Lower Paleozoic strata of the Kechika Formation and Road River Group were examined from three key sections: near Moodie Creek, south of Deadwood Lake, and near the township of Cassiar, at the base of Mount McDame. Stratigraphy of the Kechika Formation and Road River Group is broadly similar to that of the lower Paleozoic succession east of the NRMT (Fig. 3). A total of 3032 m of strata was measured and described in detail. Eighty-five conodont samples were collected (4 to 5 kg each) through the Kechika Formation and Road River Group.

## Moodie Creek Section

### *Location*

The section is situated west of the NRMT along a ridge 1 km east of Moodie Creek. Camp was established near an old mining exploration cabin ‘Ewe Drop Inn,’ located past the Silurian siltstone and intrusions examined by Pell (1994) (94-L/12; 58° 44′N, 127° 33′W; Fig. 1). Six kilometres of ridge were walked out, trending southwest-northeast and swinging north toward Cambrian strata (94-L/13; 58° 46′N, 127° 33′W). The section was sampled in three parts (A, B, and C), and samples were given the prefix MC-95-A, B, or C. The Kechika Formation extends from 585000E, 6515400N to Road River contact at 584300E, 6510700N (Pell, 1994).

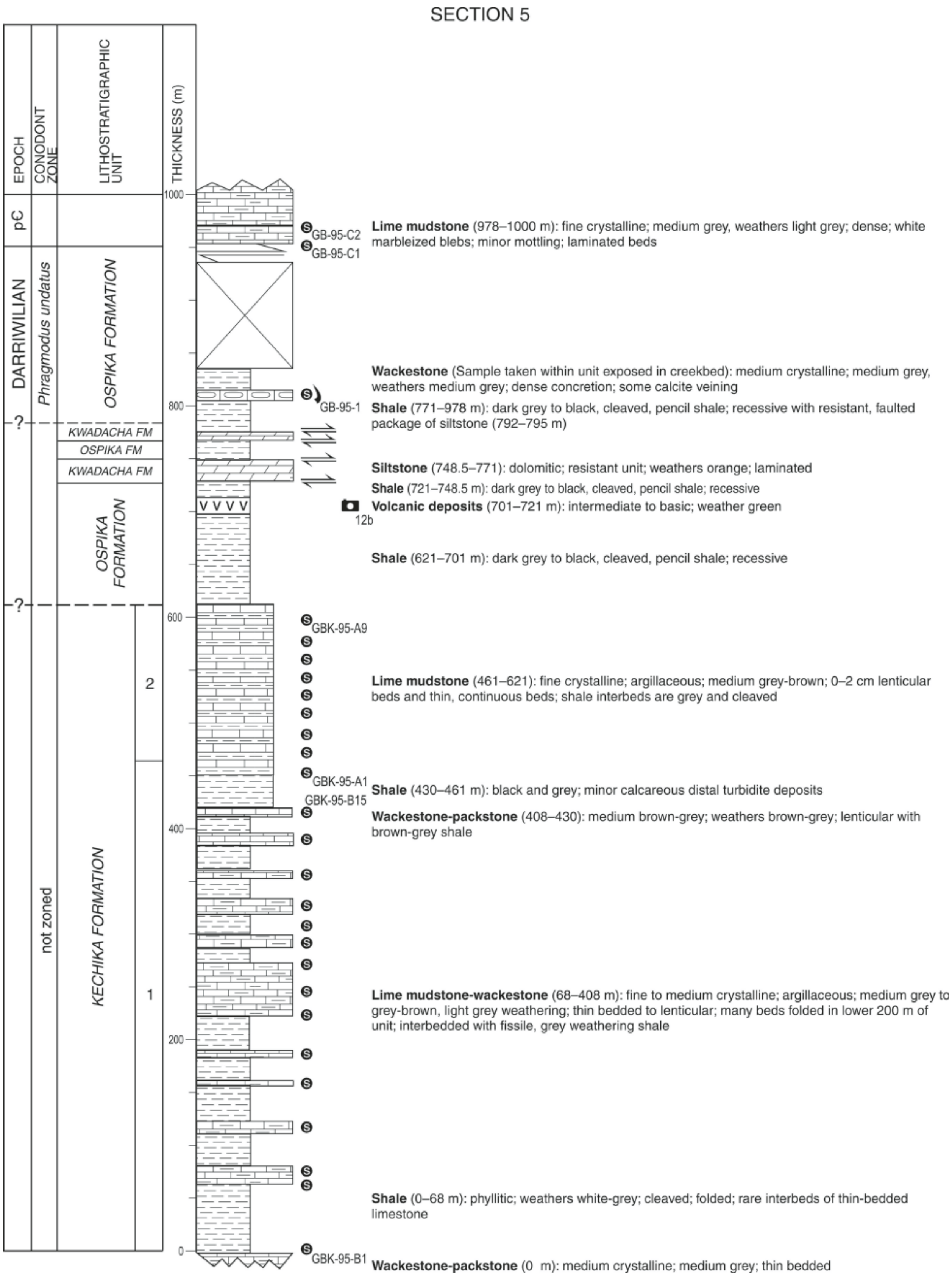


**Figure 12a.** Measured strata of the Gataga Mountain Section.

**Figure 12b**. Gataga Mountain Section showing the fault repeated sequence of black shale of the Ospika Formation and orange dolomitic siltstone of the Kwadacha Formation. The Kechika Formation in the foreground consists of light grey weathering shale and thin lime mudstone beds. 2010-098

## *Synthesis*

The section is tectonically thickened and deformed such that the maximum depositional thickness of the Kechika Formation in the area is approximately 900 m (Gabrielse, 1998). Recessive shaly units of the Kechika Formation disconformably overlie resistant carbonate and siltstone of the Lower Cambrian Rosella Formation. The Kechika Formation consists of 1940 m of a variety of lithologies including pink-brown, sericitic, cleaved phyllites; orange-brown, massive dolostone with prominent quartz veins; green, argillaceous, sheared siltstone; and grey weathered, thin- to thick-bedded dolomitic limestone (Fig. 15a, b). The contact with the overlying Road River Group is conformable and gradational over a few metres, marked by a change to darker-grey-weathering shale and dolostone. The Road River Group (90 m thick) contains cleaved grey and brown shale and recrystallized silty limestone and dolostone (Fig. 15b). Samples from the basal part of the unit yielded conodont species of the Tremadocian, Lower Ordovician (Pyle and Barnes, 2001b). Dolomite veins are common in the upper unit of shale and silty dolostone. A unit of dolomitic siltstone and sandstone sharply overlies the Road River Group and is assigned to the Silurian Sandpile Formation (Gabrielse, 1998).

# Deadwood Lake Section

## *Location*

The section was reached by driving south on Highway 37 from Watson Lake to Centerville and fly camping at the southwest end of Deadwood Lake (104-P/1; 59° 01′N, 128° 23′W; Fig.1) in a natural cleared area east of a major creek in which the section is exposed. The creek runs north and bends to the southwest to drain into the southernmost tip of the lake. Measurements and collections began just above tree line, within the uppermost Kechika Formation at 536200E,

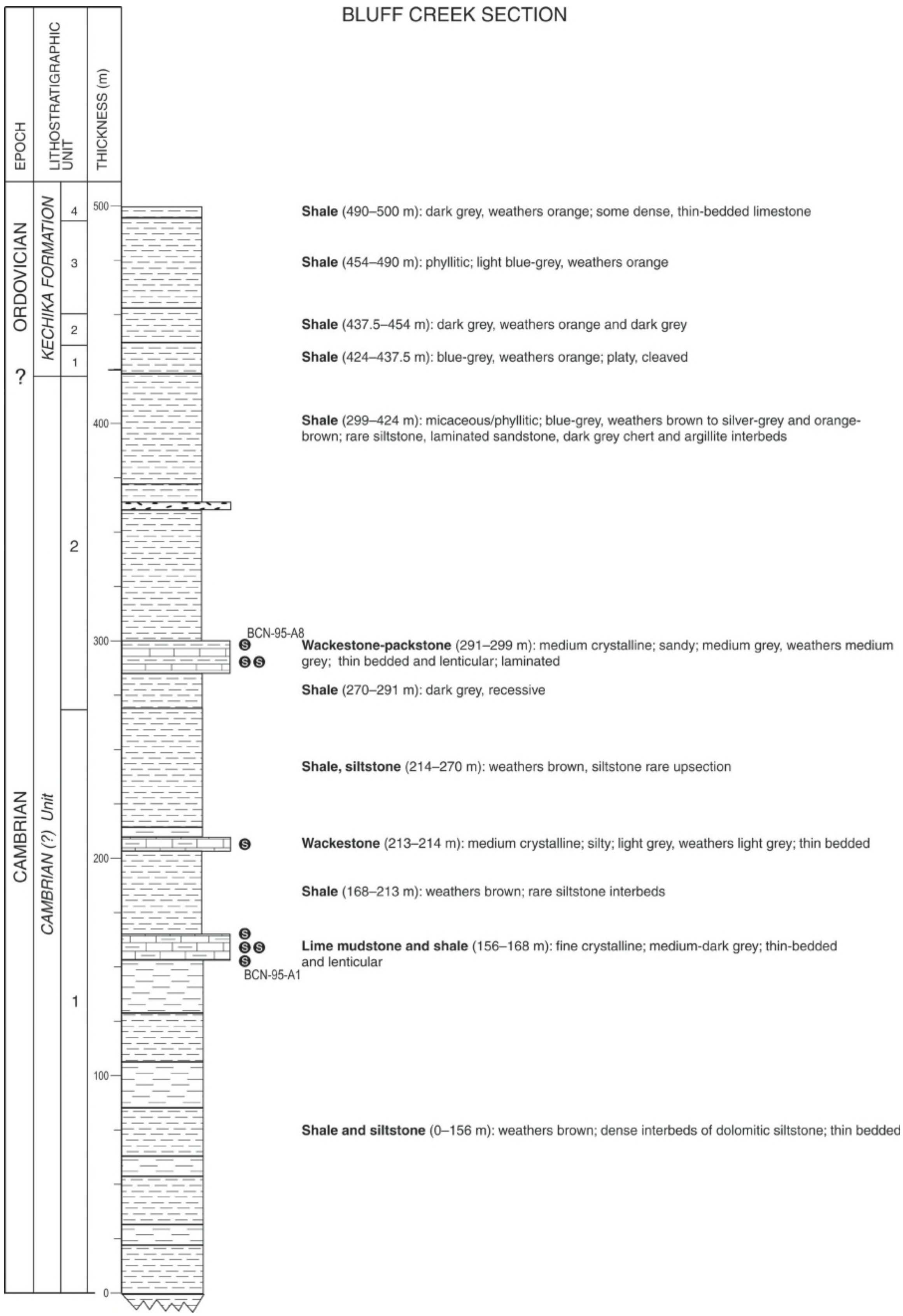


**Figure 13a.** Measured strata of the Bluff Creek Section.

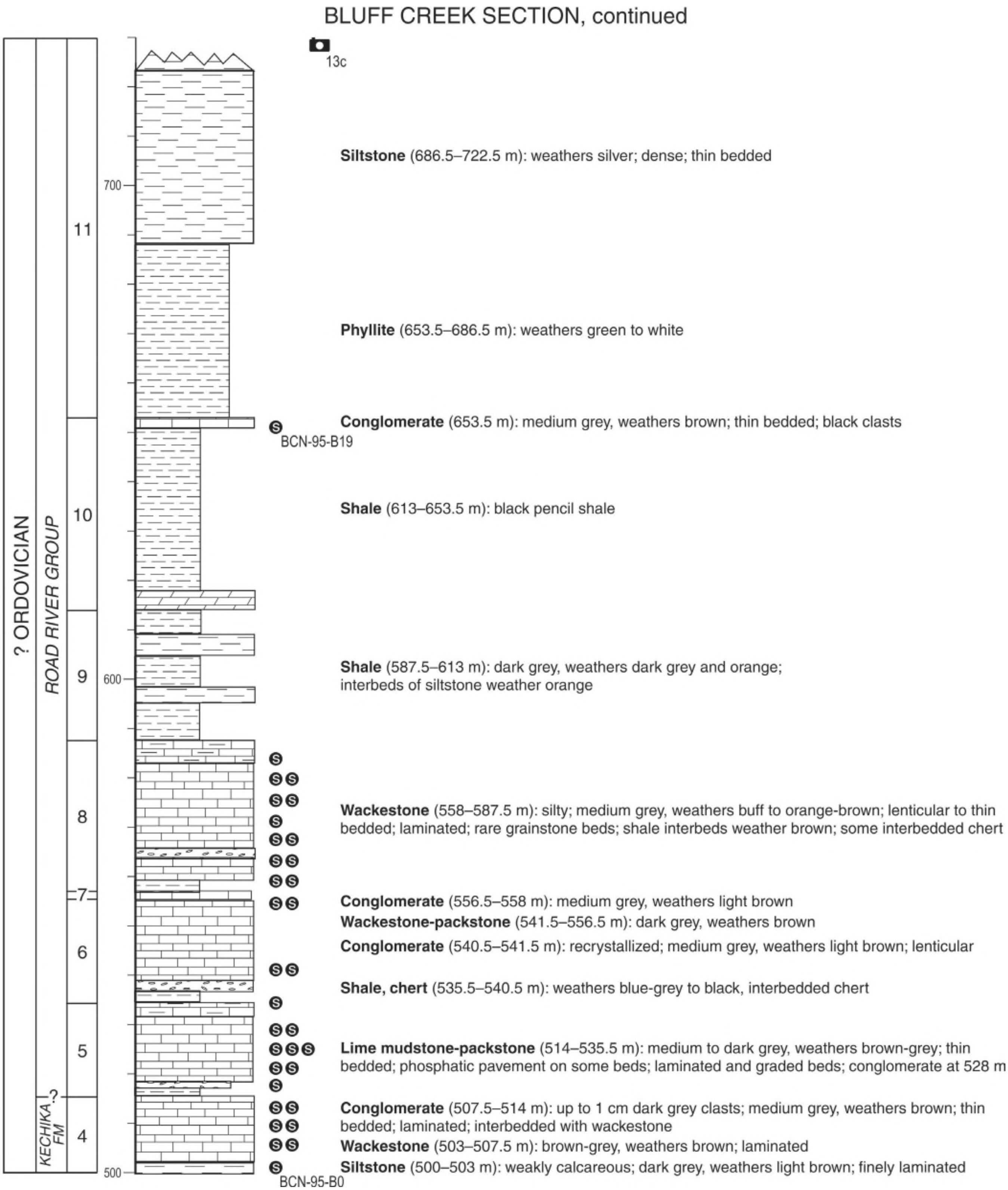


**Figure 13b.** Measured strata of the Bluff Creek Section, continued (note change in scale from Figure 13a).

**Figure 13c.** View to the north from camp of ?Kechika Formation and Road River Group. 2010-099

6542100N, and ended at the Road River Group-Ramhorn Formation contact at 536300E, 6541500N. Sample numbers bear the preflx DL-96.

### *Synthesis*

The uppermost Kechika Formation (65 m) contains grey, thin-bedded to nodular limestone and cleaved, folded, light grey and buff shale. The contact with the overlying Road River Group is conformable and gradational over less than one metre. The basal unit of the Road River Group contains lenticular limestone and shale in metre-scale packages that weather orange-grey. The lenses increase in number and lateral continuity upsection. The basal unit (155 m) is overlain by a series of grey quartzite beds, quartz veins, interbedded dolostone and black phyllite (117 m). A third unit (52 m) contains mostly grey, dolomitic siltstone, black shale, and phyllite with minor lime mudstone beds. The uppermost unit (144 m) contains bedded limestone interbedded with black shale, which decreases from 30% at the base to less than 5% at the top of the unit. The limestone is medium to dark grey, thin to medium bedded, and ranges from lime mudstone to grainstone with some intraclast breccia (Fig. 16). The unit is disconformably overlain by thick-bedded, light grey dolostone that Gabrielse (1963) called the Sandpile Group, now referred to as the Ramhorn Formation (Gabrielse, 1998). Conodonts from the base of the Road River indicate it is much older than the Road River east of the NRMT, lying within the Tremadocian *Rossodus manitouensis* Zone. The Road River Group ranges into the Caradocian *Amorphognathus superbus* Zone (Fig. 3). (Gabrielse 1963)

## Mount McDame sections

### *Location*

The township of Cassiar, now abandoned, is reached from the Cassiar-Stewart Highway 37. Two creek beds on the west face of Mount McDame (104-P/5; 59° 17′N, 129° 47′W; 450350E, 6570300N and 450400E, 6570200N; Fig. 1) were measured and sampled. The flrst creek measured is situated farther west on Mount McDame, and was collected as Section A. Section B occurs in a second major creek about 1 km east of Section A. To reach both sections, the creek running south on the east side of town was crossed. Sample numbers bear the preflx C-95-A and C-95-B.

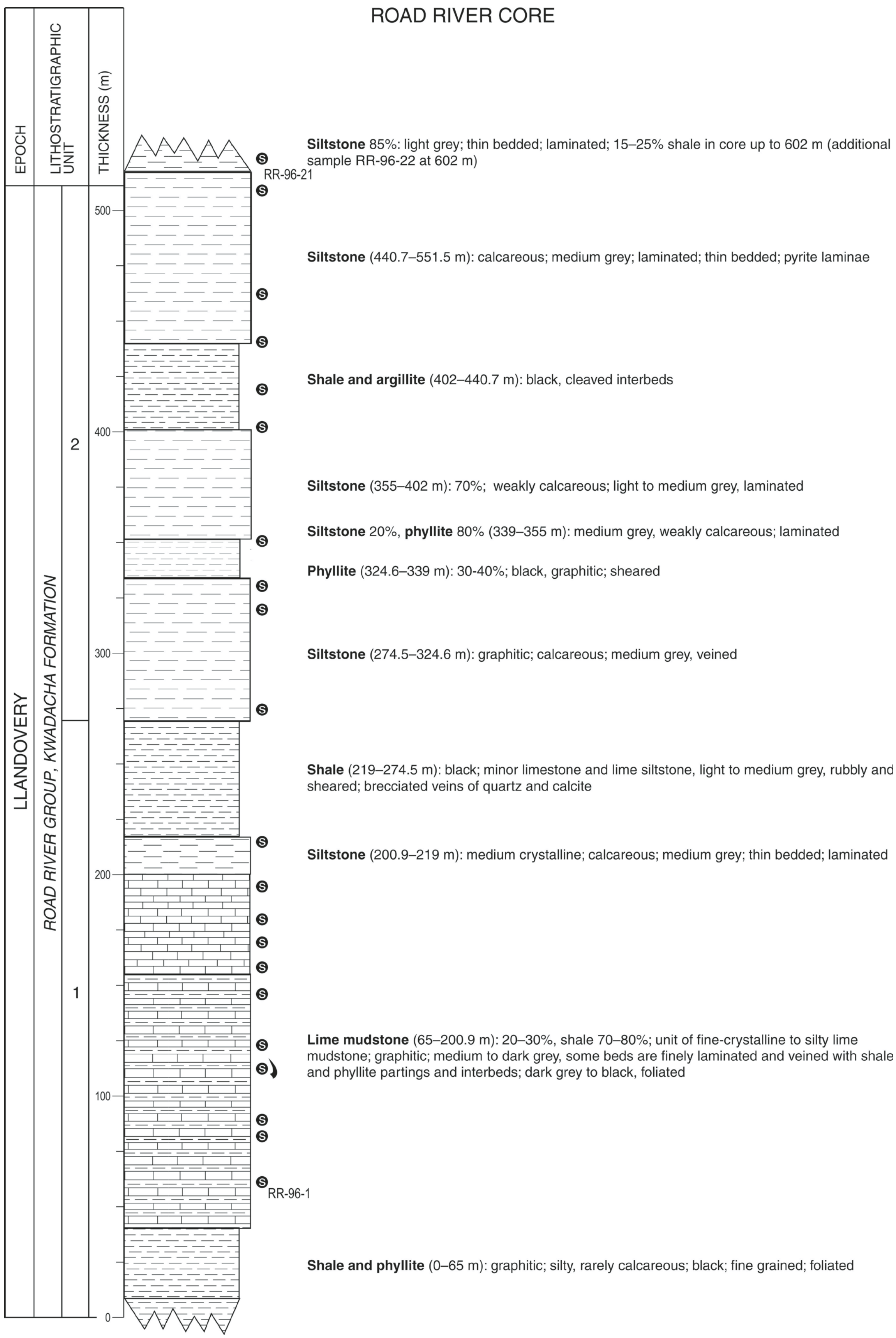


**Figure 14.** Measured strata of Road River core.

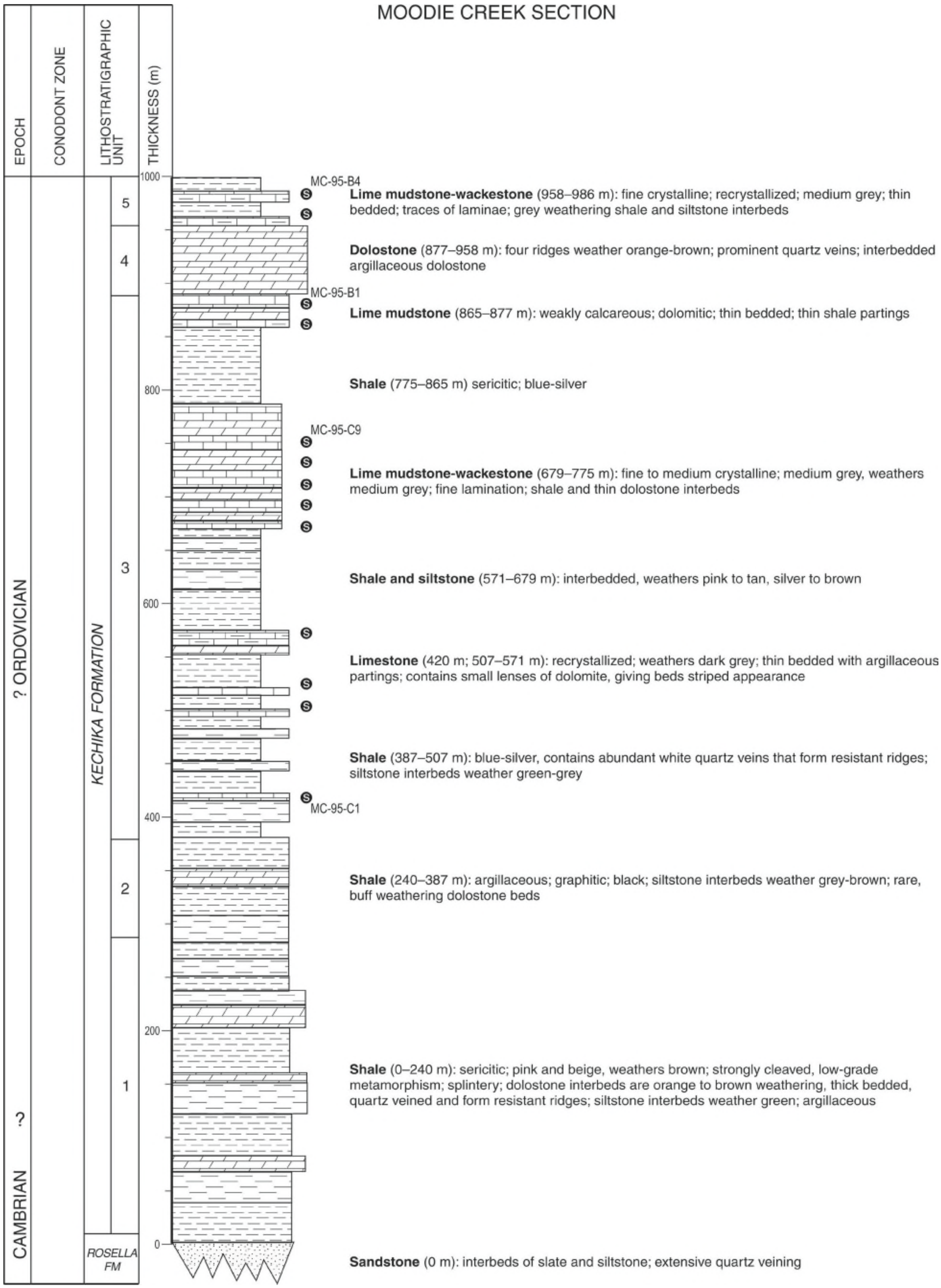


**Figure 15a.** Measured strata of the Moodie Creek Section.

MOODIE CREEK SECTION, continued

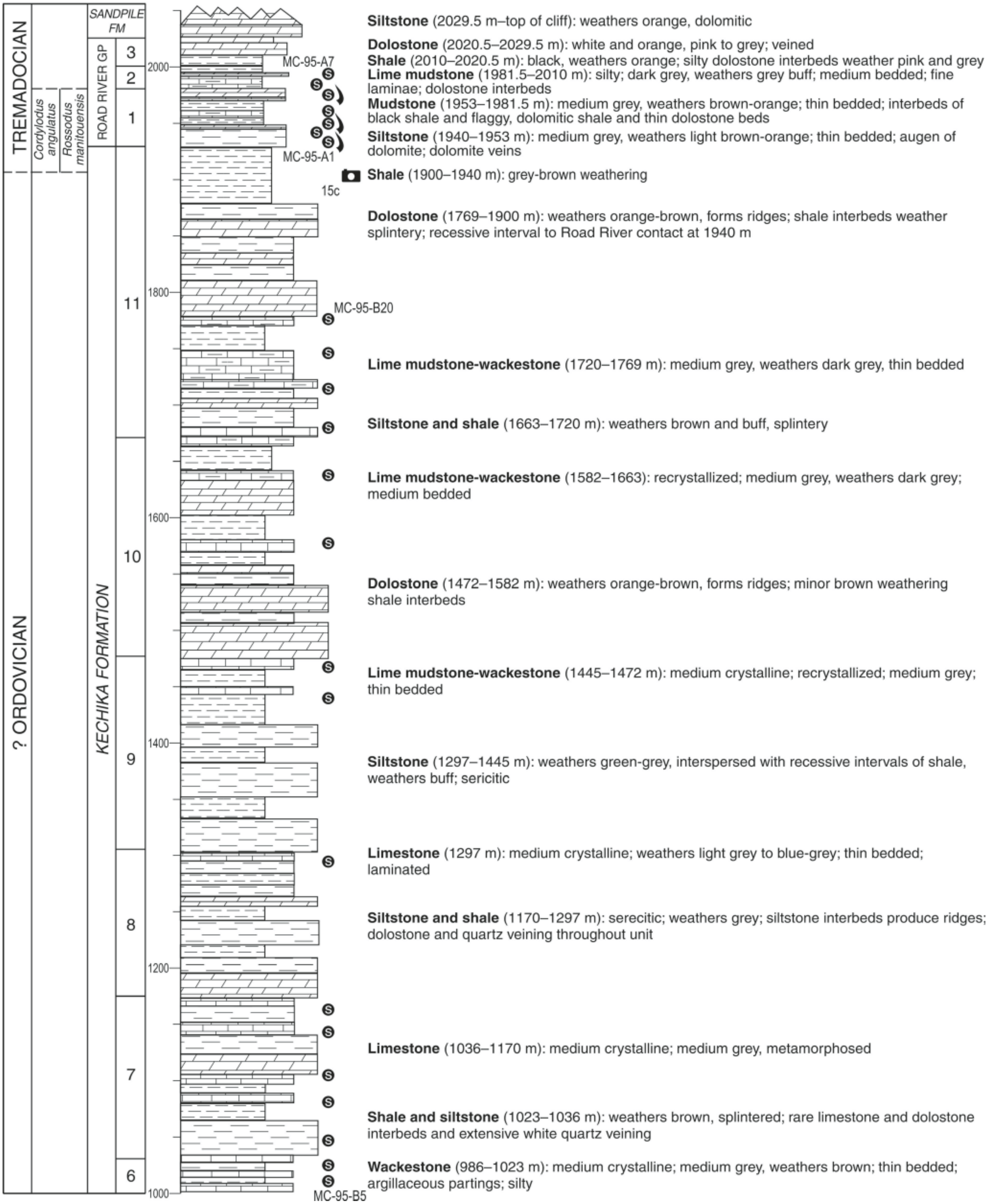


**Figure 15b.** Measured strata of the Moodie Creek Section, continued.

**Figure 15c.** Moodie Creek Section within the Cassiar Terrane showing a 6 km long section of Kechika Formation which is gradationally overlain by black shale and thin dolomitic lime mudstone of the Road River Group and orange dolomitic siltstone of the Sandpile Formation. 2010-100

### *Synthesis*

The Road River Group within both sections (120 m and 200 m) contains nodular lime mudstone interbedded with blue-black shale and slate. Thin, rare limestone beds were typically veined with quartz and pyrite. Volcanic rocks were observed near the top of the black shale units (Fig. 17). The Road River Group is conformably overlain by sandstone of the Sandpile Formation (of Gabrielse, 1998).

## REGIONAL SYNTHESIS

Regional syntheses by Pyle and Barnes (2003) and Zhang et al. (2005) discussed the implications of these transects (Macdonald Platform to Kechika Trough and across the Cassiar Terrane) to the tectonic evolution of the Laurentian margin. Details of stratigraphic interpretations and regional correlation from the transects are also discussed in Pyle and Barnes (2000). The refined biostratigraphic framework for the Upper Cambrian to Lower Silurian stratigraphic succession of the transects was established by Pyle and Barnes (Pyle and Barnes, 2001a; Pyle and Barnes, 2002). The refined biostratigraphic framework for the correlative succession of Wilcox Pass, Alberta (Outram, Skoki, and Owen Creek formations) and southeastern British Columbia (McKay Group) and was established by Pyle et al. (2003) and Pyle et al. (2007).

In summary, the Kechika Formation (latest Cambrian to Arenigian) is a laterally extensive unit, thickening westward from 451 m at Section 1 to 1741 m at Section 13 (Fig. 5). It contains platform to outer shelf and basin facies deposited on a broad ramp with gradual lateral facies changes. Five members of the Kechika Formation have gradational and conformable contacts. The basal Lloyd George Member unconformably overlies Cambrian units at most localities. The uppermost Mount Sheffield Member shales out to the west and is laterally equivalent to the Haworth Member and to the basinal Cloudmaker Member of the Ospika Formation (Road River Group) (Fig. 3, 5). The diachronous nature of the members, such as the eastward younging of the Quentin Member from Section 13 to Section 1, is interpreted using the refined conodont biozonation.

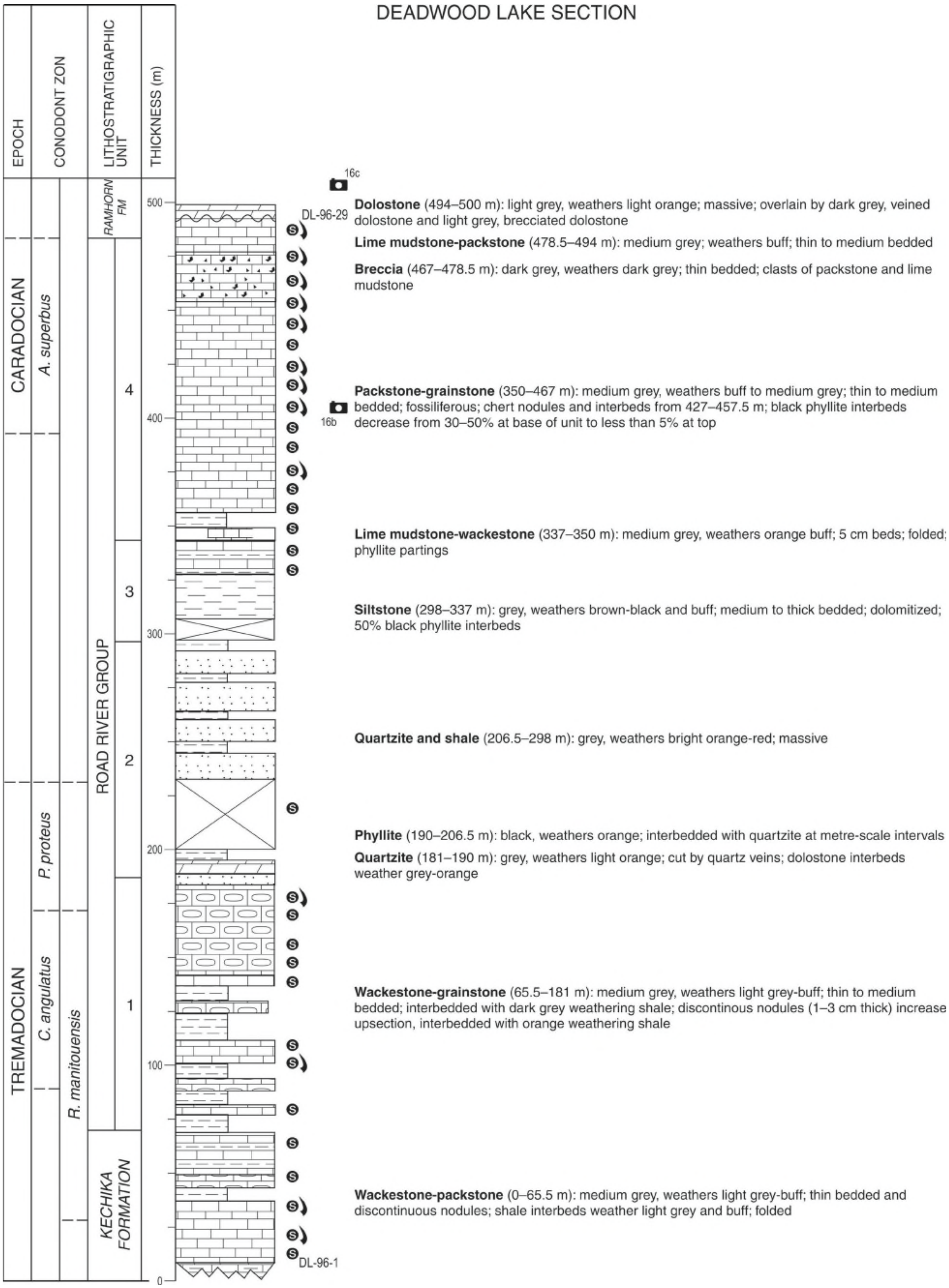


**Figure 16a.** Measured strata of the Deadwood Lake Section.

**Figure 16b.** Upper unit of the Road River Group, Deadwood Lake Section, showing the dark-grey- to black-weathering, well bedded, thin, lime mudstone to grainstone. 2010-101

**Figure 16c**. Deadwood Lake Section within the Cassiar Terrane showing the uppermost part of the light-grey-weathering Kechika Formation overlain by dark shale and limestone of the Road River Group. 2010-102

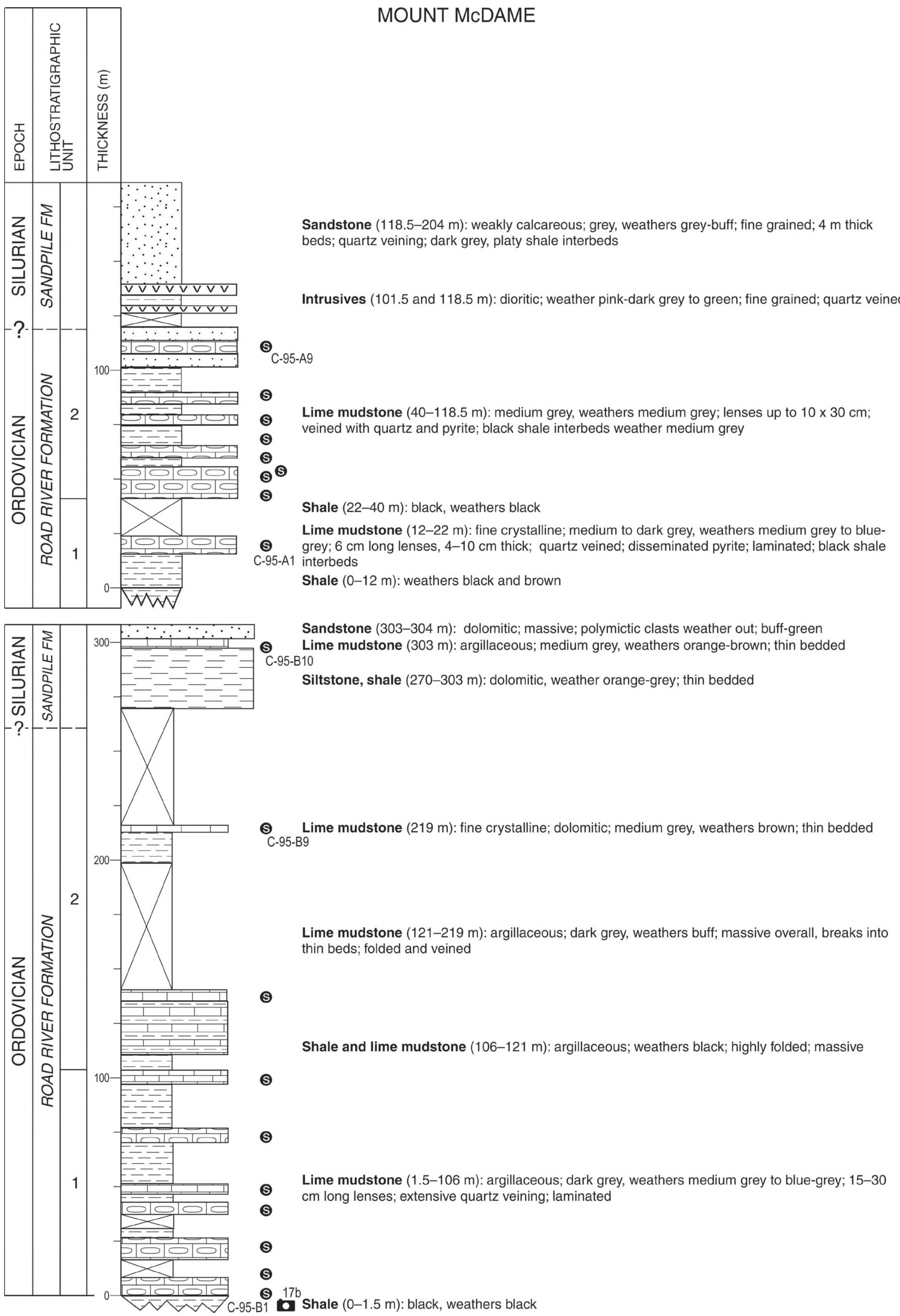


**Figure 17a.** Measured sections at Mount McDame.

**Figure 17b.** View of creek section on Mt. McDame. 2010-103

The Ospika Formation represents a pronounced platform to off-shelf transition of abrupt lateral facies changes from platformal dolostone of the Skoki Formation to the east (Fig. 5). The three members of the Skoki Formation recognized in this transect are Arenigian to Darriwilian (Lower to Middle Ordovician) in age. From complementary sections discussed in the following chapter, a fourth unit is recognized that ranges into the Caradocian. Platformal carbonate of the Skoki Formation is laterally equivalent to the basinal facies of the Ospika Formation (Fig. 3, 5). Basinal facies of the Road River Group are divided into three formations. The Opsika Formation (Arenigian to Ashgillian) consists of five formal members. It is overlain by the Pesika (Lower Silurian) and Kwadacha (upper Lower Silurian to Lower Devonian) formations.

Within the lower Paleozoic succession along an east-west platform-to-basin transect, abrupt changes in deposition, phases of volcanism, and prominent unconformities indicate that the history of the rifted margin is more complex than that of a simple passive margin. Underlying Cambrian units are shallow-water siliciclastic and carbonate deposits. Initiation of the Kechika Formation, which shows a westward change in depositional environment from platform to shelf to deep shelf, indicates part of a post-rift subsidence phase and differentiation of platform and basin strata from the latest Cambrian to Early Ordovician (MacIntyre, 1992; Pyle and Barnes, 2000). The Kechika Formation represents a westward-thickening, platform to outer shelf-and-basin facies deposited on a broad ramp with gradual lateral facies changes.

Depositional changes in the late Early Ordovician are more abrupt as observed in the well defined Skoki Formation-Road River Group transition. Steepening of the shelf-break margin is recorded in transitional facies in the Grey Peak Section, particularly in the facies of the Chesterfield Member, which include thick debris-flow breccias, conglomerate, and distal turbidites interbedded with black shale. This steepening of the margin possibly coincided with a period of renewed extension along the margin. Silurian units unconformably and conformably overlie the Ospika Formation. The Pesika Formation represents continued deposition of transitional facies and is present mainly in the eastern part of the Kechika Trough. The Kwadacha Formation is a prominent unit that represents an influx of quartz silt and sand to the Kechika Trough.

Depositional onset of both the Kechika and Ospika formations, in the latest Cambrian and late Early Ordovician respectively, can most likely be attributed to renewed periods of extension of the margin followed by thermal subsidence. Local alkaline volcanic deposits are found within the succession, such as those at the Kechika-Ospika formational boundary within the Gataga Mountain Section. The volcanic units localized along reactivated faults within basins are summarized by Goodfellow et al. (1995).

Stratigraphy of the Cassiar Terrane is broadly similar to that east of the NRMT and is regarded as displaced northward along the dextral strike-slip Tintina-NRMT fault a minimum of 450 km to 750 km from the Kakwa Platform (Gabrielse, 1985) or up to 1700 km as a margin segment from Idaho (Pope and Sears, 1997). Stratigraphy and conodont biostratigraphy reveals that the Kechika Formation-Road River Group boundary is older than that east of the NRMT (Pyle and Barnes, 2001b).

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# Lower Ordovician to Middle Devonian stratigraphy, Macdonald Platform–Ospika Embayment transect, Halfway River, Ware, and Trutch map areas, northeastern British Columbia

L.J. Pyle[1] and C.R. Barnes[2]

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**Abstract:** This study describes a transect across the Macdonald Platform to Ospika Embayment. At least two periods of renewed extension along the early Paleozoic Cordilleran margin occurred in the latest Cambrian and late Early Ordovician, marked by deposition of the Kechika Formation and the abrupt platform-to-basin transition marking deposition of the Skoki-Ospika formations. Alkalic volcanic rocks associated with abrupt facies changes are consistent with multiphase rifting. Several prominent unconformities punctuate the succession. Conodont biostratigraphy provides new age control for the Skoki, Beaverfoot, McCusker, and Nonda formations. The Robb, Kenny, and Laurier formations are transitional facies of the Road River Group. The lower part of the Kenny Formation is coeval with the McCusker Formation, and the upper part interfingers with the Nonda Formation. The Laurier Formation is correlative with the upper Nonda Formation. The Deserters Formation (Road River Group) was deposited in a linear sub-basin of the Ospika Embayment.

**Résumé :** Cette étude décrit un transect traversant la plate-forme de Macdonald jusqu'au rentrant d'Ospika. Au moins deux périodes de réactivation d'une déformation en extension se sont manifestées le long de la marge de la Cordillère du début du Paléozoïque, au Cambrien terminal et vers la fin de l'Ordovicien précoce. Elles ont été marquées par le dépôt de la Formation de Kechika ainsi que par le brusque passage d'un milieu de plate-forme à un milieu de bassin révélé par le dépôt des formations de Skoki-Ospika. La présence de roches volcaniques alcalines et les changements brusques de faciès s'accordent avec un rifting polyphasé. Plusieurs discordances marquées parsèment la succession. Une biostratigraphie des conodontes offre un nouveau contrôle chronologique des formations de Skoki, de Beaverfoot, de McCusker et de Nonda. Les formations de Robb, de Kenny et de Laurier sont des faciès transitionnels du Groupe de Road River. La partie inférieure de la Formation de Kenny est contemporaine de la Formation de McCusker, et sa partie supérieure est interdigitée avec la Formation de Nonda. La Formation de Laurier est en corrélation avec la partie supérieure de la Formation de Nonda. La Formation de Deserters (Groupe de Road River) s'est déposée dans un sous-bassin linéaire du rentrant d'Ospika.

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# INTRODUCTION

Strata of the northeastern Canadian Cordillera studied across a platform-to-basin transect record the tectonic evolution of the rifted margin of Laurentia from the Early Ordovician to Middle Devonian. The northeast-southwest transect spans more than 70 km within the northern Halfway River, southern Ware, and southern Trutch map areas (94-B, F, G; Fig. 1) and follows the facies transition of the Macdonald Platform to the shelf-break and basinal facies of the Ospika Embayment, the southern extension of the Kechika Trough (Pyle and Barnes, this volume; Fig. 1).

The study area in northeastern British Columbia includes ten stratigraphic sections, in which more than 8000 m of strata were measured and described and a total of 258 conodont samples, 4 to 5 kg each, were collected. Within the study area, the transect spans platform and shelf strata in the east (Sections 1, 2, 3, 4, 8), the ancient shelf-break (Sections 5, 6, 7) and the basin (Sections 9, 10). All sections were measured during the 1998–1999 field season as part of the GSC NATMAP Central Foreland Project. The study complements the detailed stratigraphic framework established for the lower Paleozoic succession studied across a transect about 100 km north in the Ware and Kechika map areas (Pyle and Barnes, 2000, this volume). The general stratigraphic framework was known from previous regional mapping. The objective of this detailed study is to describe the Lower Ordovician to Middle Devonian stratigraphy and document the conodont biostratigraphic framework (Fig. 2, 3).

Previous stratigraphic nomenclature consisted of several informal subunits within formations and several formations that were referred to by their map unit designation (*see* Norford, 1991, Fig. 2; and Thompson, 1989, Fig. 6, 7; Table 1). Detailed work by Pyle and Barnes (2000) described

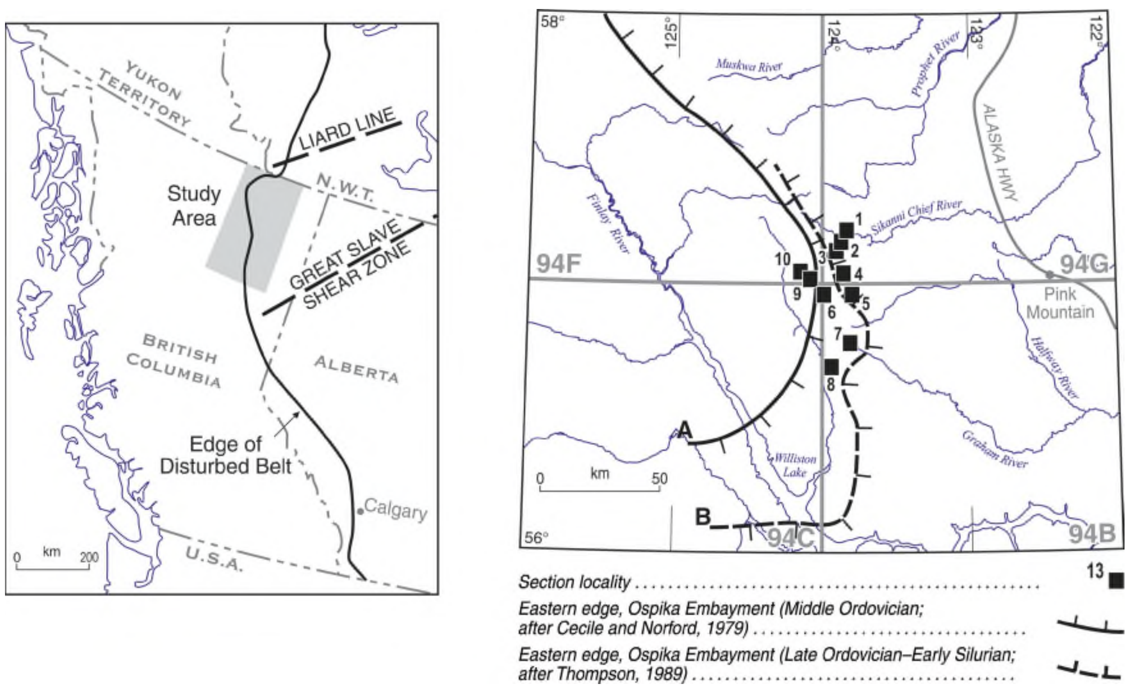
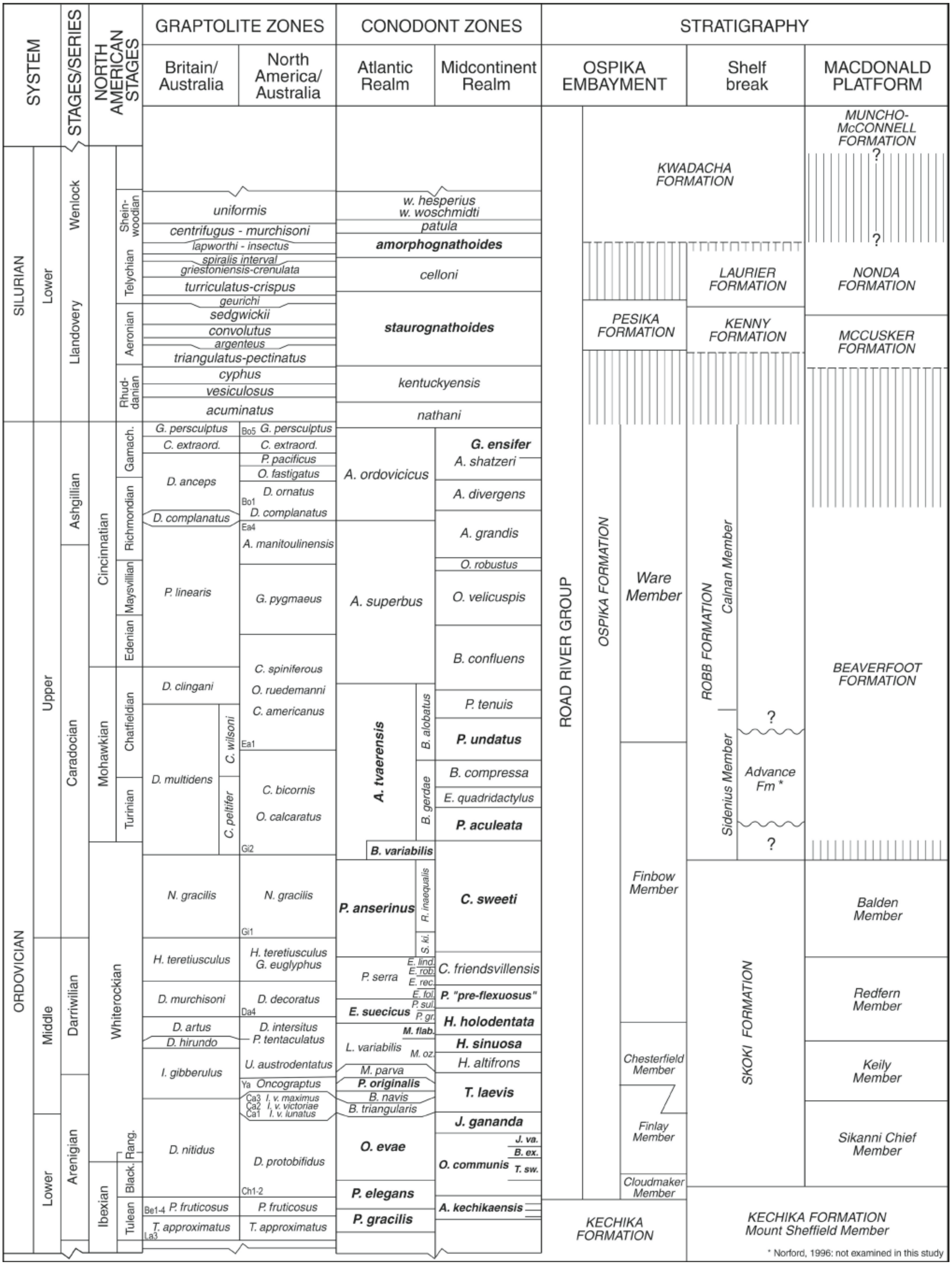



**Figure 1.** Study area and sections within the Ware (94-F), Trutch (94-G) and Halfway River (94-B) map areas. Section localities: 1. Sikanni Chief River North, 2. Sikanni Chief River South, 3. Gautschi Creek, 4. Mount McCusker, 5. Mount Kenny, 6. Mount Kenny East, 7. Mount Robb, 8. Mount Lady Laurier, 9. Ospika River, 10. Ospika River North.

**Figure 2.** Biostratigraphic correlation chart for the Ordovician and Silurian. Standard conodont and graptolite zones for the Ordovician *after* Fortey et al. (1995), Harris et al. (1995), and Webby (1995), and time scale *after* Webby (1998) and Cooper et al. (2001). The conodont zonation for the Lower Ordovician as shown was revised by Pyle and Barnes (2002). The Silurian standard graptolite and conodont zonations are *after* Norford et al. (1997). Shading indicates hiatuses and dashed lines indicate that the exact age of the formational boundary is unknown. The lower and upper contacts of the Advance Formation are unconformable; * indicates that the Advance Formation (Norford, 1996) was not examined in this present study.


SYSTEM
STAGES/SERIES
NORTH AMERICAN STAGES
GRAPTOLITE ZONES
Britain/ Australia
North America/ Australia
CONODONT ZONES
Atlantic Realm
Midcontinent Realm
STRATIGRAPHY
OSPIKA EMBAYMENT
Shelf break
MACDONALD PLATFORM
SILURIAN
ORDOVICIAN
Lower
Upper
Middle
Wenlock
Llandovery
Ashgillian
Caradocian
Darriwilian
Arenigian
Cincinnatian
Mohawkian
Whiterockian
Ibexian
Shein-woodian
Telychian
Aeronian
Rhud-danian
Gamach.
Richmondian
Maysvillian
Edenian
Chatfieldian
Turinian
Rang.
Black.
Tulean
uniformis
centrifugus - murchisoni
lapworthi - insectus
spiralis interval
griestoniensis-crenulata
turriculatus-crispus
geurichi
sedgwickii
convolutus
argenteus
triangulatus-pectinatus
cyphus
vesiculosus
acuminatus
G. persculptus
C. extraord.
D. anceps
D. complanatus
P. linearis
D. clingani
D. multidens
C. wilsoni
C. peltifer
N. gracilis
H. teretiusculus
D. murchisoni
D. artus
D. hirundo
I. gibberulus
D. nitidus
Be1-4 P. fruticosus
T. approximatus
La3
Bo5 G. persculptus
C. extraord.
P. pacificus
O. fastigatus
D. ornatus
Bo1
D. complanatus
Ea4
A. manitoulinensis
G. pygmaeus
C. spiniferous
O. ruedemanni
C. americanus
Ea1
C. bicornis
O. calcaratus
Gi2
N. gracilis
Gi1
H. teretiusculus
G. euglyphus
D. decoratus
Da4
D. intersitus
P. tentaculatus
U. austrodentatus
Ya Oncograptus
Ca3 I. v. maximus
Ca2 I. v. victoriae
Ca1 I. v. lunatus
D. protobifidus
Ch1-2
P. fruticosus
T. approximatus
w. hesperius
w. woschmidti
patula
amorphognathoides
celloni
staurognathoides
kentuckyensis
nathani
A. ordovicicus
A. superbus
A. tvaerensis
B. alobatus
B. gerdae
B. variabilis
P. anserinus
R. inaequalis
S. ki.
P. serra
E. lind.
E. rob.
E. rec.
E. foli.
P. sul.
E. suecicus
P. gr.
M. flab.
L. variabilis
M. oz.
M. parva
P. originalis
B. navis
B. triangularis
O. evae
P. elegans
P. gracilis
G. ensifer
A. shatzeri
A. divergens
A. grandis
O. robustus
O. velicuspis
B. confluens
P. tenuis
P. undatus
B. compressa
E. quadridactylus
P. aculeata
C. sweeti
C. friendsvillensis
P. "pre-flexuosus"
H. holodentata
H. sinuosa
H. altifrons
T. laevis
J. gananda
J. va.
B. ex.
O. communis
T. sw.
A. kechikaensis
KWADACHA FORMATION
MUNCHO-McCONNELL FORMATION
?
LAURIER FORMATION
NONDA FORMATION
PESIKA FORMATION
KENNY FORMATION
MCCUSKER FORMATION
ROAD RIVER GROUP
OSPIKA FORMATION
Ware Member
ROBB FORMATION
Calnan Member
Sidenius Member
Advance Fm *
BEAVERFOOT FORMATION
Finbow Member
Chesterfield Member
Finlay Member
Cloudmaker Member
SKOKI FORMATION
Balden Member
Redfern Member
Keily Member
Sikanni Chief Member
KECHIKA FORMATION
KECHIKA FORMATION Mount Sheffield Member
* Norford, 1996: not examined in this study

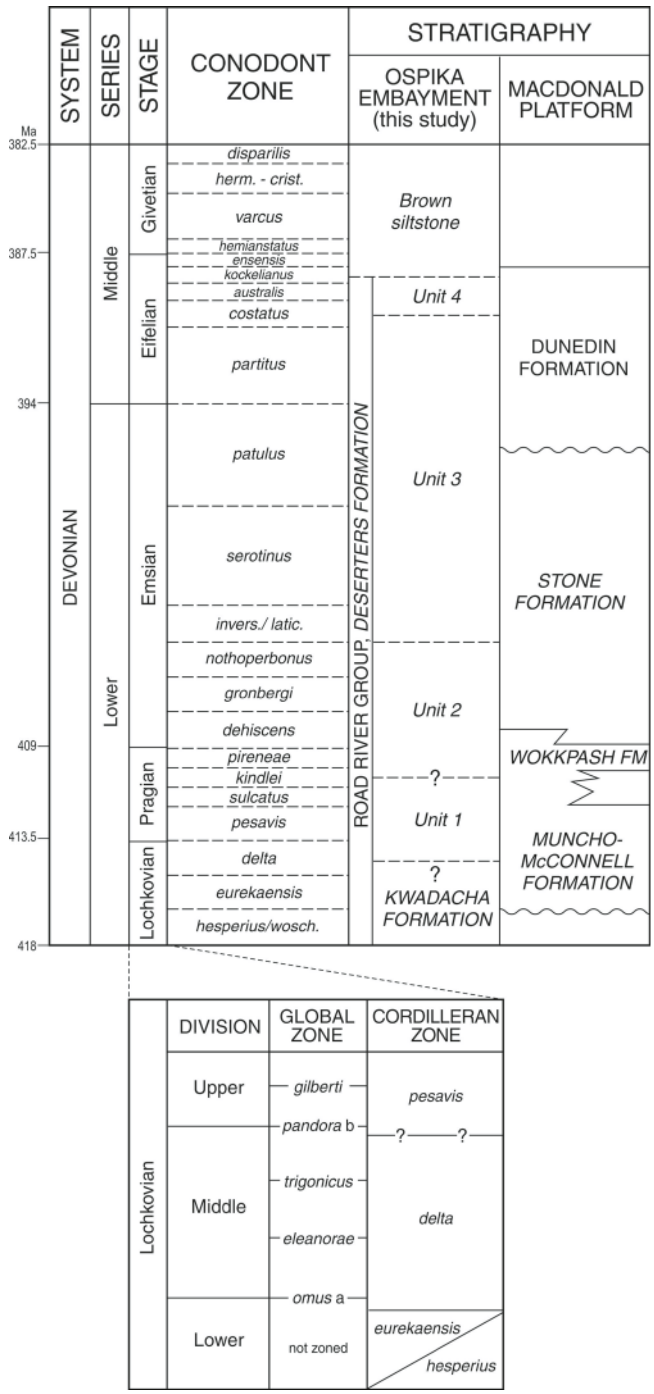



**Figure 3.** Conodont biostratigraphy of the Lower and Middle Devonian (*after* Tucker et al., 1998) and stratigraphy of the Ospika Embayment (this study) and Macdonald Platform (*after* Gabrielse and Yorath, 1991).

the stratigraphic framework and history of nomenclature for the Kechika and Skoki formations and Road River Group based on the more northern transect. Their revised stratigraphic nomenclature is applied to this present transect. In addition, further revision of the lower Paleozoic stratigraphic framework, particularly the overlying platform succession and the units that preserve the ancient shelf-break, was detailed by Pyle and Barnes (2001) and Pyle et al. (2003a). These publications contain the detailed stratigraphy, regional correlations, and stratigraphic interpretations. The conodont biostratigraphy, taxonomy, and faunal lists from the present transect are detailed in Pyle and Barnes (2003a), which builds on the refined biostratigraphy established by Pyle and Barnes (2002).

Platformal units include the Kechika (Lower Ordovician), Skoki (Lower to Upper Ordovician), Beaverfoot (Upper Ordovician), McCusker (Lower Silurian), and Nonda (Lower Silurian) formations. Three new formations defined by Pyle and Barnes (2001) preserve shelf-break facies and are off-shelf equivalents of the Beaverfoot, McCusker, and Nonda formations. They are part of the off-shelf Road River Group and include the Robb Formation (formerly the Upper Ordovician shale and quartzite), Kenny Formation (formerly the Upper Ordovician–Silurian carbonaceous limestone), and Laurier Formation (formerly the unnamed Silurian breccia) (Fig. 2). The basinal facies of the Road River Group measured in the Ware map area are the Ordovician Ospika Formation and Silurian Pesika and Kwadacha formations of Pyle and Barnes (2000) (Fig. 2). Section 9 was examined on the premise that it contained Ordovician–Silurian strata. It yielded a Lower to Middle Devonian conodont fauna and represents a new formation of the Road River Group preserved within the Ospika Embayment (Pyle et al., 2003a).

All sections were measured by L. J. Pyle and C. R. Barnes from the School of Earth and Ocean Sciences, University of Victoria during the 1998 and 1999 field seasons. UTM coordinates are given based on NAD Datum 27. Lithological terminology for depositional textures of carbonate rocks is based on the classification scheme of Dunham (1962). The siliciclastic rocks were not classified beyond a basic field determination.

# SECTIONS FROM THE MACDONALD PLATFORM

## Section 1 (Sikanni Chief River North)

### *Location*

The section is situated 4 km north of the Sikanni Chief River (123°51′W, 57°14′N) and is the northern extension of the Sikanni Chief section measured 3 to 4 km south of the river (B. S. Norford, GSC, unpub. report). The mountain on the north side of river has a tight fold, with the horizontal limb extending halfway up the cliff to the bottom of the cliff facing the river. Camp was established two creeks to the east of the section. The section was measured and collected starting near the axis of the fold at the base of the main cliff through the top of the Skoki, Beaverfoot, and Nonda formations, to the sandstone at the base of the Muncho-McConnell Formation, from west to east, at 6341500N from 445500 E to 446300 E. Conodont samples from this section bear the preflx SCN-98.

### *Synthesis*

A total of 694 m of strata was measured, ranging from the uppermost Skoki Formation to base of the Muncho-McConnell Formation (Fig. 4, 5). The upper Skoki Formation (65 m thick) consists of grey, medium- to thick-bedded, mottled dolostone of Middle Ordovician age, within the *Histiodella holodentata* Zone. An abrupt change to brown-weathering sandstone and sandy dolostone of the Beaverfoot Formation (290 m thick) occurs at 65 m above the section base. Overall the Beaverfoot Formation consists of silty, mottled dolostone with intervals of two, prominent, orange-white weathering dolomitic quartzite units at 115 and 138 m from the section base. It is Late Ordovician in age, within the *Plectodina aculeata* Zone and possibly extending into the Ashgillian (Fig. 2). The Nonda Formation (335 m thick) is in sharp contact with the underlying Beaverfoot Formation dolostone and overlying Muncho-McConnell Formation. The basal 45 m is medium-grey-weathering, rubbly, thin-bedded dolostone, with abundant pentamerid brachiopods and minor chert. The upper 290 m is predominantly thick bedded to massive, light brown-grey-weathering dolostone with common to abundant silicifled fossils (crinoids, halysitid and rugose corals, brachiopods) throughout. A conodont zone was not determined for the Nonda Formation at Section 1.Elsewhere, the Nonda is Early Silurian in age. The Muncho-McConnell Formation was not measured but is marked by a distinct change to white-weathering, massive sandstone and dolostone.

## Section 2 (Sikanni Chief River South)

### *Location*

Camp was established in a gully between the ridges of the upper Kechika Formation. The section is situated 3 to 4 km south of the Sikanni Chief River (123°55′W, 57°10′N), south of Section 1. The contact between the Kechika and Skoki formations is at 444500E, 6336500N, and collection began along the peak east of the camp. The base of the Skoki Formation is marked by a break of slope in the main scree slope and highest saddle/col at the edge of the ridge overlooking the Sikanni Chief River. In order to describe the upper Kechika Formation, collections were started from the cliff edge overlooking Sikanni Chief River (cliff of lower Kechika Formation below). There are three ridges

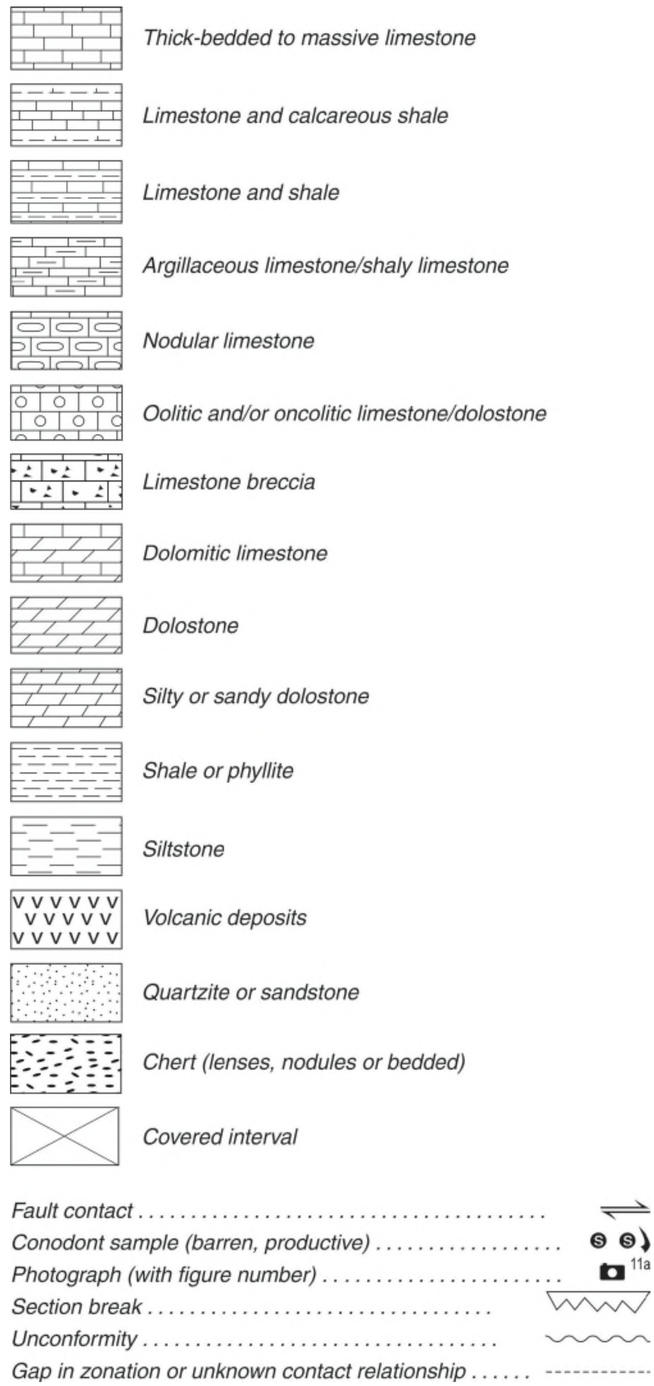



**Figure 4.** Legend to accompany Figures 5 through 14.

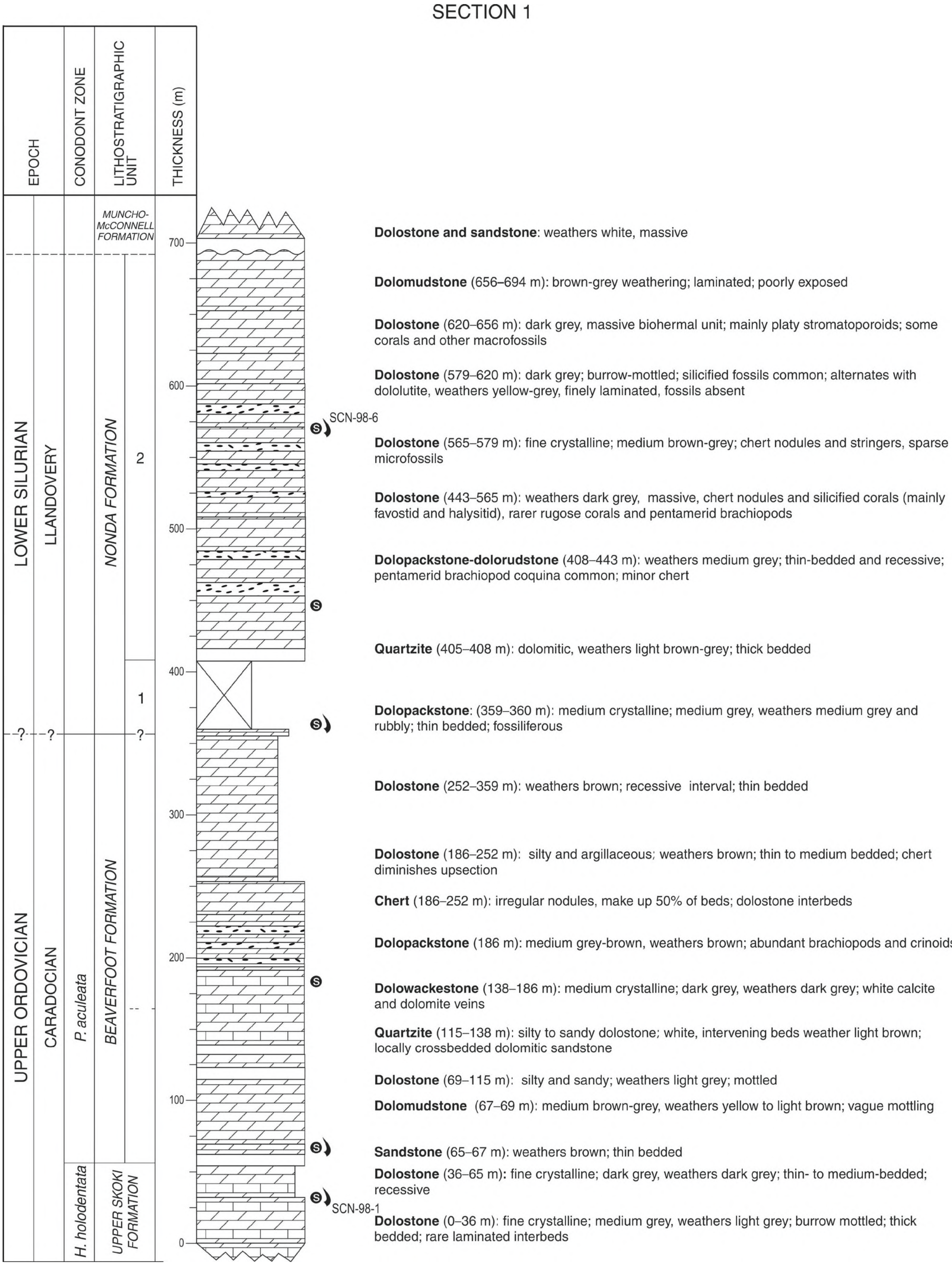



**Figure 5.** Measured strata of Section 1.

of Kechika Formation to the base of the Skoki Formation, beginning at 443500E, 6337500N. A complete section of Skoki Formation is present, except for the uppermost Balden Member. The basal part of the Beaverfoot Formation forms the top of the ridge section, and Section 3 is a continuation of the succession. Conodont samples from this section bear the prefix SCS-98.

### *Synthesis*

The Mount Sheffield Member of the Kechika Formation (258 m thick) consists of light grey to brown, cleaved, phyllitic, calcareous shale interbedded with nodular or thin-bedded lime mudstone to wackestone beds, and rare, medium-bedded packstone to grainstone beds. Conodonts recovered from the Mount Sheffield Member are Arenigian in age, ranging from the *Acodus kechikaensis* Zone to the *Oepikodus communis* Zone (of Pyle and Barnes, 2002). The Skoki Formation (217 m thick) conformably overlies the Kechika Formation and is marked by a lithological change to brown-grey-weathering, thick-bedded, mottled dolostone (Fig. 6). The Skoki Formation is late Early to early Late Ordovician in age, within the *O. communis* Zone to *P. aculeata* Zone. Oncolites are abundant within the Sikanni Chief Member (54.5 m thick). The Keily Member (50.5 m thick) also contains abundant oncolites and large macluritid gastropods. The Redfern Member (112 m thick) consists of pale, yellow-grey-weathering, mottled dolostone. It is abruptly overlain by dark-brown-weathering, sandy dolostone and quartzite, and brown, finely laminated siltstone of the Beaverfoot Formation (8.5 m thick). The Balden Member of the Skoki Formation is missing below the sub-Beaverfoot unconformity.

## Section 3 (Gautschi Creek)

### *Location*

The section is situated 2 km east of Gautschi Creek and is south of the Sikanni Chief sections collected in 1998, allowing for additional study and collection of the Beaverfoot, McCusker, and Nonda formations as a continuation of Section 2. The ridge section continues on a ridge from the peak where collecting stopped at Sikanni Chief River South. Camp was established at 123°54′04"W, 57°09′09"N, and the section began up a cliff of the Skoki and Beaverfoot formations, from 445600E, 6334700N, trending west to east, and then continued on a north-south trend along the ridge up to the Nonda at 445800E, 6333900N. Conodont samples from this section bear the prefix GC-99.

### *Synthesis*

Dolostone of the Redfern Member of the Skoki Formation is 159 m thick (Fig. 7). The upper contact of the Skoki Formation is marked by a lithological change to thin-bedded, dark grey-weathering dolostone and orange-brown-weathering sandstone and dolostone of the Beaverfoot Formation (160 m thick). The Beaverfoot is Late Ordovician in age, ranging into the *Phragmodus undatus* Zone (Caradocian) and younger. Section 3 is the type section of the McCusker Formation (Pyle and Barnes, 2001). The McCusker Formation unconformably overlies the Beaverfoot Formation and is Early Silurian in age, within the *Distomodus staurognathoides* Zone (Fig. 7). It is 223 m thick and the basal 4 m contains a sharp lithological change from the underlying quartzite to thin-bedded, medium-grey-weathering dolostone, dark grey shale and dolomitic intraclast breccia. The rest of the formation is a uniform package of cleaved, medium- to dark-grey-weathering, thin-bedded lime mudstone to wackestone, and yellow to brown-grey-weathering shale interbeds and argillaceous and dolomitic partings. The Nonda Formation conformably overlies the McCusker Formation and contains abundant lime mudstone to grainstone facies in the basal 100 m, and medium-grey-weathering, thick-bedded, fossiliferous dolostone in the upper 48 m. The contact with the McCusker Formation appears gradational. The Nonda Formation is also Early Silurian in age, within the *D. staurognathoides* Zone (Fig. 2).

## Section 4 (Mount McCusker)

### *Location*

The section is situated 3 km southeast of Mount McCusker in a cirque with a creek flowing south to Sidenius Creek. The McCusker Formation and lower Nonda Formation are exposed and to the west the Nonda is cut by a thrust. Measurement and collection began at the base of the outcrop on the west side of the valley, 100 m west of camp up to the mouth of the cirque (123°54′W, 57°04′N; 445000E, 6325000N) . Conodont samples from this section bear the prefix MM-99.

### *Synthesis*

The section lies on a thrust panel overlying that of Section 3. Because this section originated somewhat farther west, the McCusker Formation contains more argillaceous, relatively deeper water facies. The upper 153 m of the McCusker Formation is a monotonous package of thin-bedded, cleaved, yellow-grey limestone and brown-weathering, dolomitic shale with rare bioclastic lenses. The contact with the overlying Nonda Formation is gradational and marked by a change within the basal 50 m to massive weathering

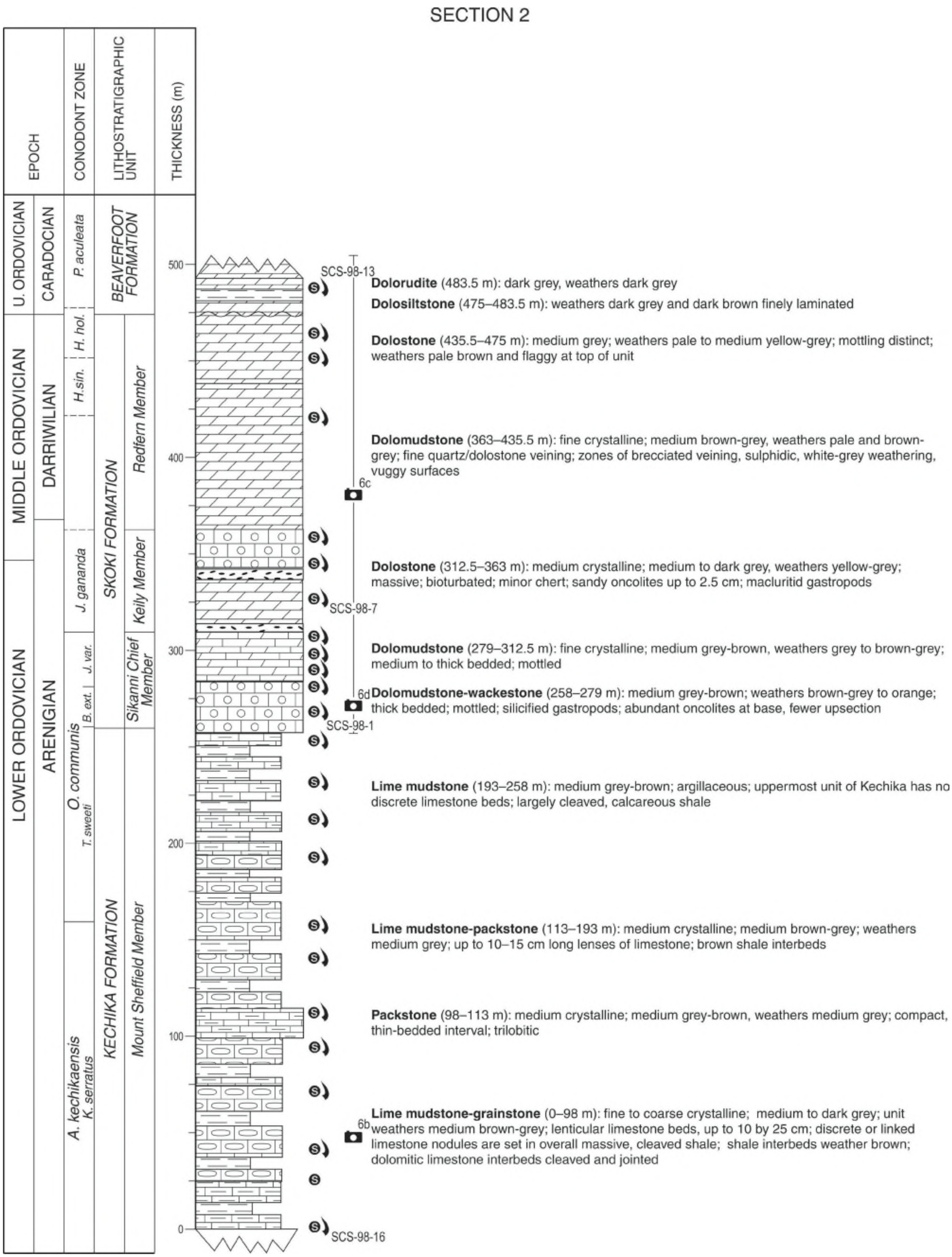



**Figure 6a.** Measured strata of Section 2.


**Figure 6b.** View northwest toward Sikanni Chief River, showing the nature of the Kechika Formation at Section 2. 2010-104


**Figure 6c.** Section 3 showing the nature of the Skoki and Beaverfoot along strike with Section 2. 2010-105


**Figure 6d.** Oncoid (Canadian dollar coin for scale) within the Sikanni Chief Member, Section 2. 2010-106

beds in which the dominant lithology is grey wackestone and packstone with argillaceous stringers and partings. Abundant horizontal burrows indicate shallower facies than the underlying shale and lime mudstone of the McCusker Formation. The upper 35 m is thick-bedded, fossiliferous dolostone that is cut by a thrust fault so the upper contact is missing (Fig. 8). Both formations are Early Silurian in age, within the *D. staurognathoides* Zone (Fig. 2).

## Section 8 (Mount Lady Laurier)

### *Location*

This section is Section 9 of Thompson (1989), and is the first east-west ridge south of Mount Lady Laurier (123°47′W, 56°38′N). Collections were made from the Kechika Formation by walking to the peak of the crest about 1.5 km east of camp to approximately the axis of the Balden Creek Anticline (overturned). The uppermost Kechika Formation was examined, overlain by a complete section of the Skoki Formation, itself overlain by the Robb Formation of the Road River Group. The Road River-Skoki contact is at 451000E, 6277500N, and the Skoki-Kechika contact is at 453200E, 6277400N. Conodont samples from this section bear the prefix LL-98.

### *Synthesis*

The Kechika Formation (upper 346 m measured and sampled) is similar to the same unit observed at Section 2, consisting of light grey to brown, cleaved, phyllitic, calcareous shale interbedded with lenticular and thin-bedded limestone beds. The Kechika Formation ranges from the *O. communis* Zone to *Tripodus laevis* Zone (Arenigian)

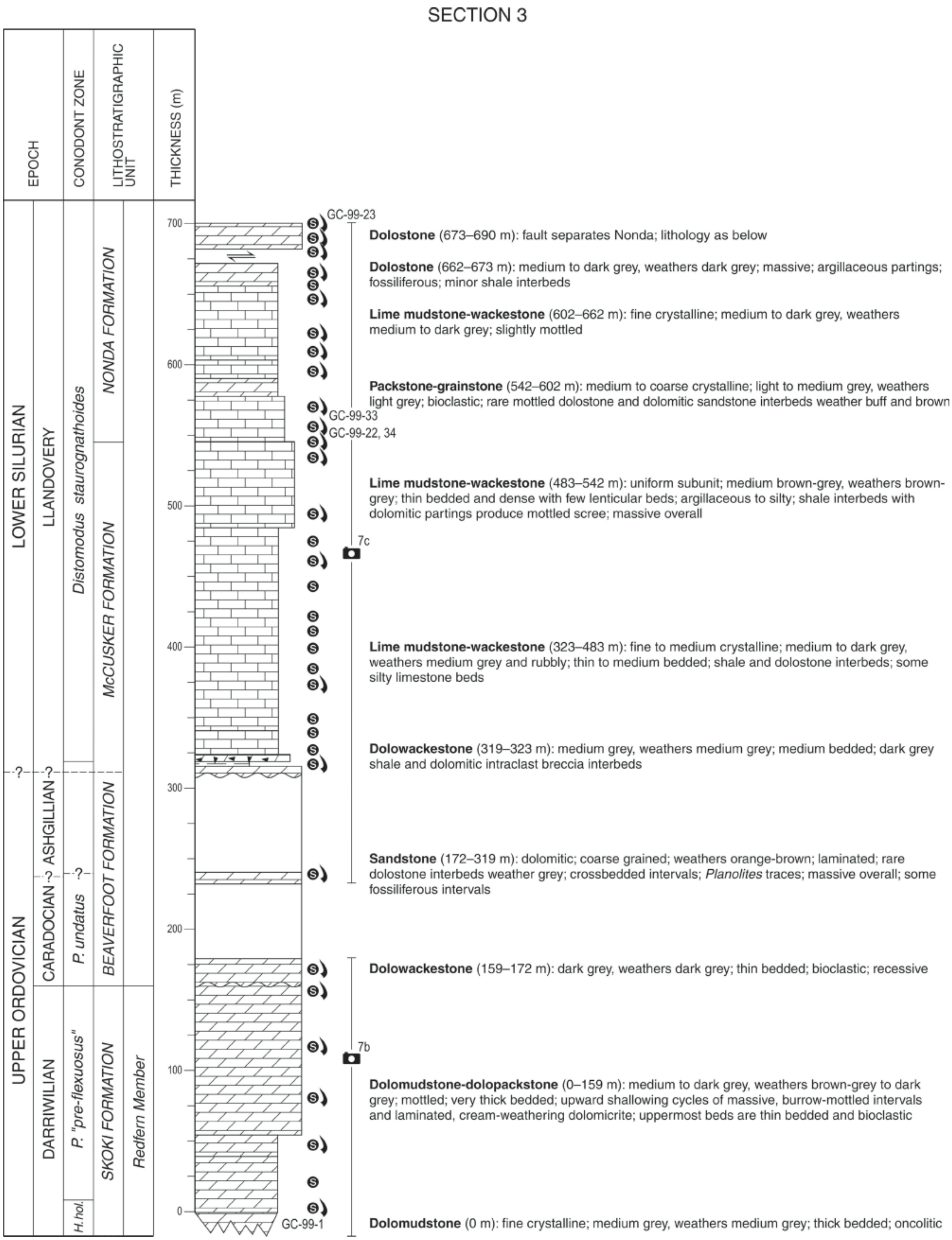



**Figure 7a.** Measured strata of Section 3.


**Figure 7b.** Section 3 showing the nature of the Skoki and Beaverfoot along strike with Section 2. 2010-107


**Figure 7c.** Beaverfoot, McCusker, and Nonda formations of Section 3. 2010-108

(Fig. 9a). The age of the Kechika-Skoki boundary is younger than that observed to the north, within the Ware map area (Pyle and Barnes, 2000), and it is possible that strata interpreted as upper Kechika Formation may be a more offshore, argillaceous facies of the Skoki Formation. The Skoki Formation conformably overlies the Kechika Formation and is characterized by a lithological change to brown-grey-weathering, massive, mottled limestone with fewer shale interbeds than in the Kechika Formation. Four members of the Skoki Formation (647 m thick) are present. The first three members were described by Pyle and Barnes (2000) and the uppermost Balden Member was defined at this section by Pyle and Barnes (2001). An interval of volcanic deposits (56 m thick) occurs at the top of the Sikanni Chief Member and is Middle Ordovician (Darriwilian) in age (Fig. 9b). The Keily Member is mainly dolostone characterized by large macluritid gastropods and rare intervals of bedded chert. The Redfern Member is light grey and pale weathering dolostone and contains abundant oncolites and oolites. The uppermost Balden Member (95 m thick) consists of dark grey limestone and silty dolostone and is early Late Ordovician in age (*Pygodus anserinus* Zone, Caradocian). The Skoki Formation is abruptly overlain by dark grey, argillaceous limestone and silty dolostone of the Robb Formation of the Road River Group that is early Caradocian in age, within the *Baltoniodus variabilis* Zone (Fig. 2).

# SECTIONS OF PLATFORM-TO-BASIN TRANSITION

## Section 5 (Mount Kenny and Mount Kenny Creek/Cirque)

### *Location*

The section is situated 10 km north of Mount Kenny (camp at 123°46.6′W, 56°58.8′N), and was sampled in two legs. The first leg lies along the ridge north of camp, east of the Sidenius thrust. Measurement proceeded from 452800E, 6316500N west along the ridge to 452000E, 6316500N, and then southwest along the ridge to 451900E, 6316000N, toward the Nonda Formation that occurs as a thin, grey-weathering wedge on the crest of ridge. Conodont samples

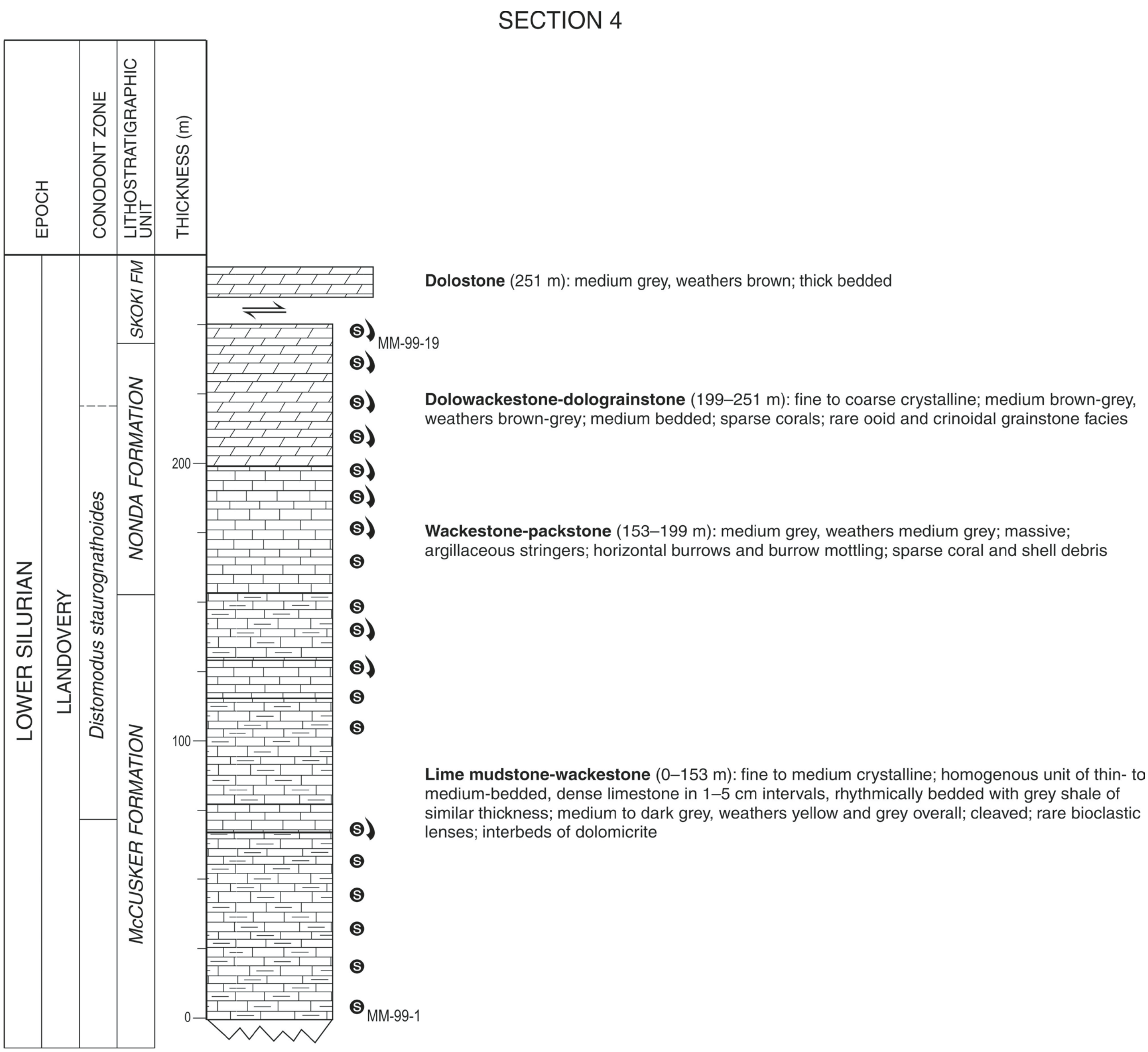



**Figure 8.** Measured strata of Section 4.

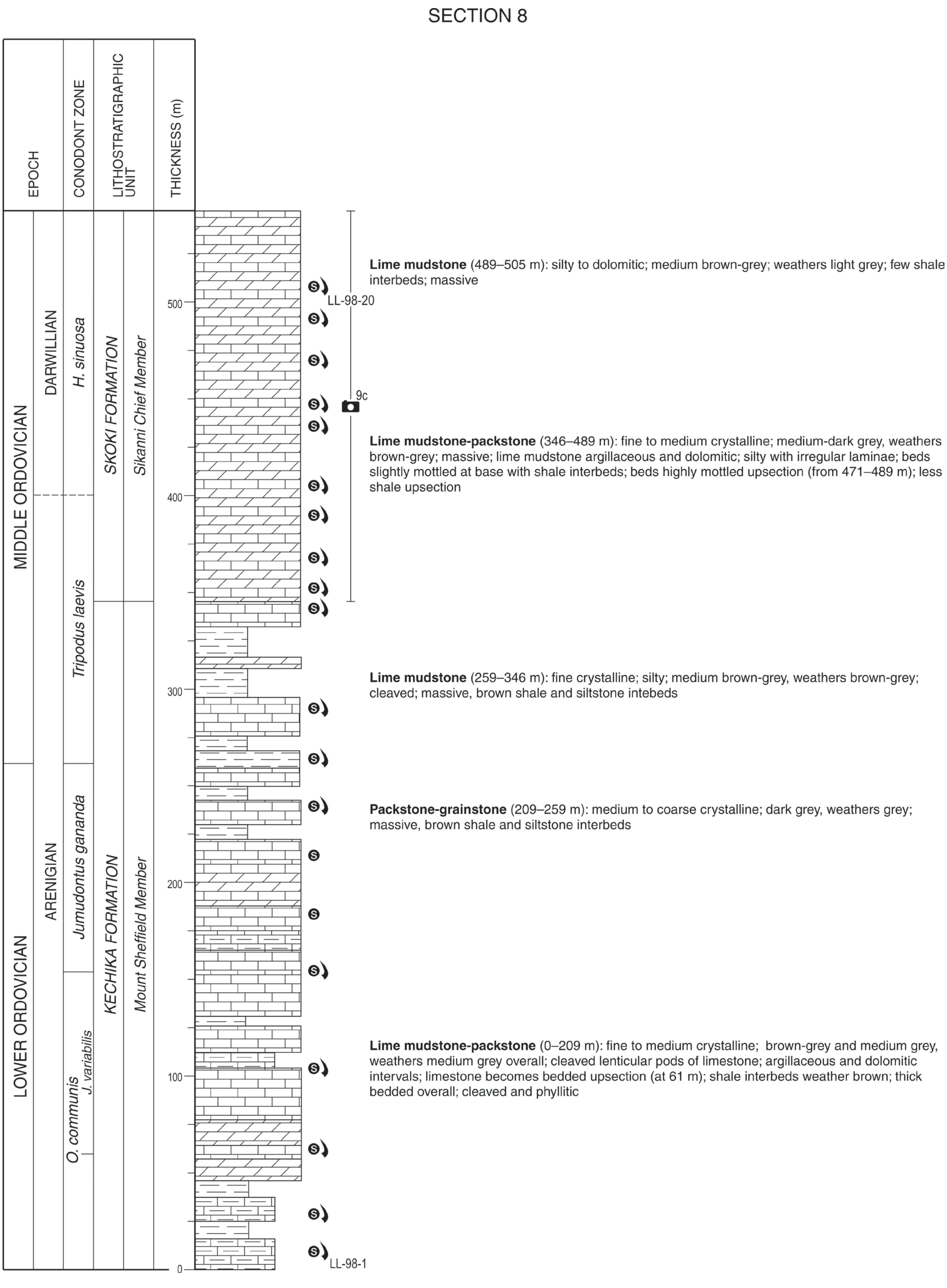



**Figure 9a.** Measured strata of Section 8.

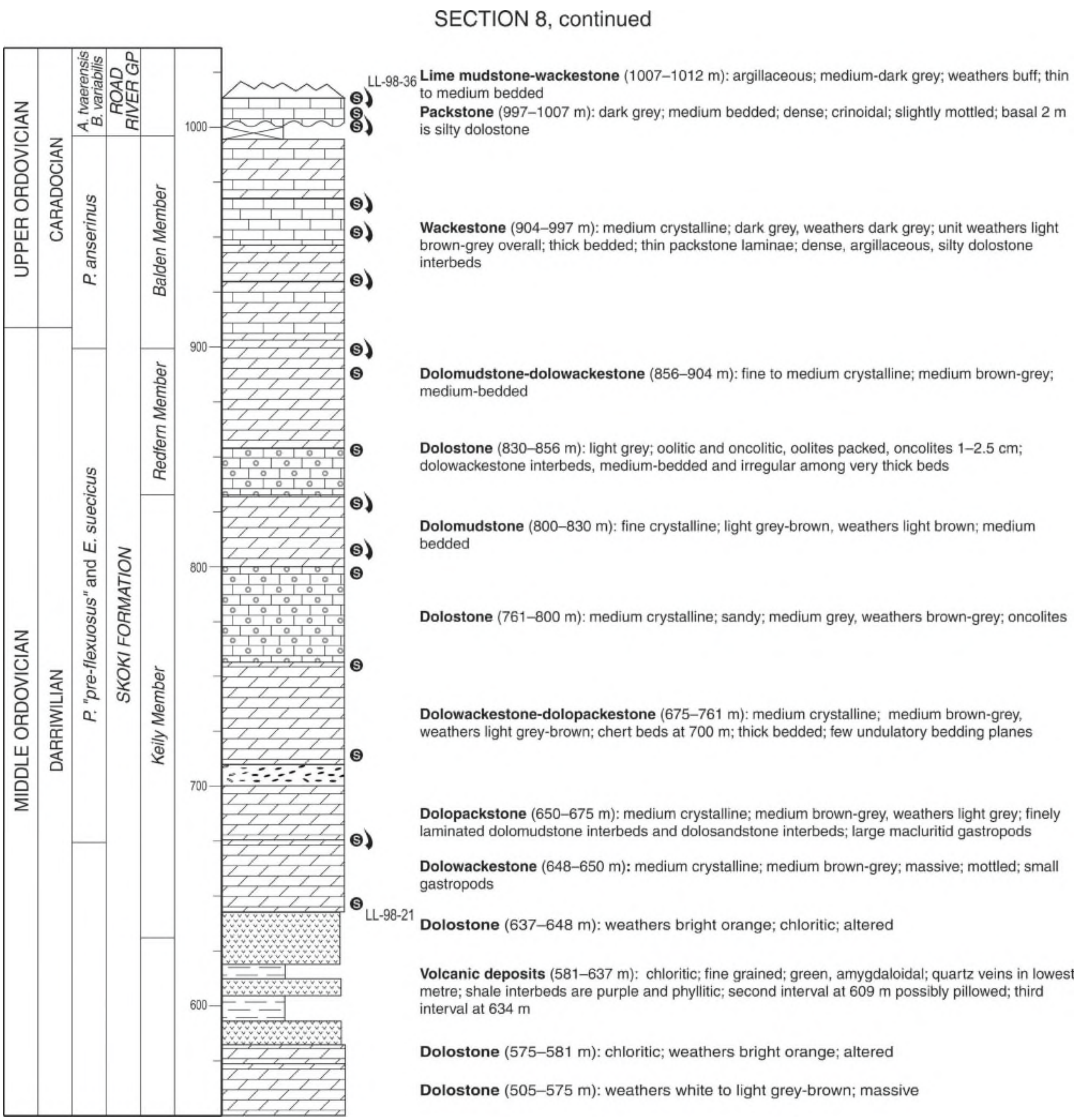



**Figure 9b.** Measured strata of Section 8, continued.

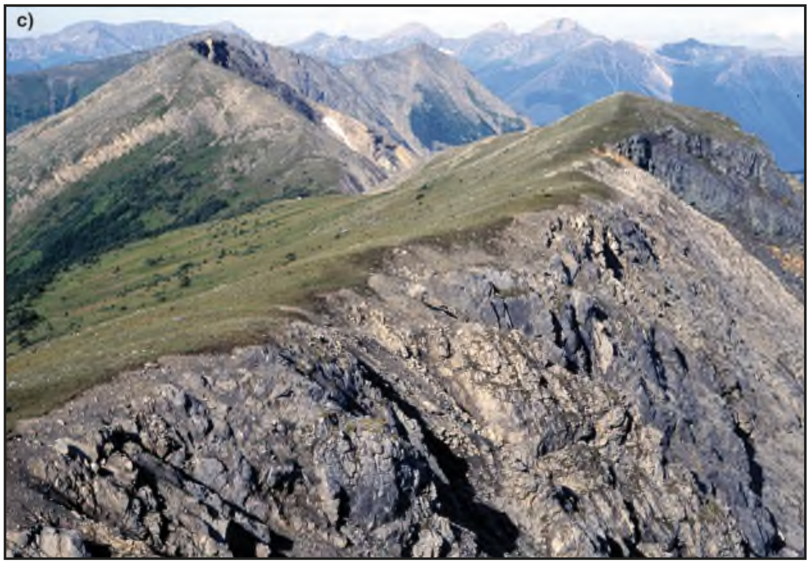



**Figure 9c.** Strata of Section 8, type section of Balden Member of the Skoki Formation; Sikanni Chief Member in foreground. 2010-109

from this leg bear the preflx MK-99. The second leg extends southwest along the creek south of the camp, beginning at the Sidenius thrust exposed in the north side of the creek (452500E, 6315300N). The section continues west within the cirque to the cliff-forming Muncho-McConnell Formation (measurement ended at 452100E, 6315000N). Conodont samples from the second leg bear the preflx MKC-99.

### *Synthesis*

At the base of the ridge section (Fig. 10a), the Kenny Formation is in the thrust contact with the SDMS unit of Thompson (1989). The basal part of the formation is similar in nature to the McCusker Formation described from Sections 3 and 4, but brown weathering overall, with more shale, siltstone, and thin-bedded dolostone. Upsection, there is a change to rubbly weathering intraclastic packstone to grainstone representing sediment gravity flow deposits containing crinoidal debris. Very thick beds (2–3 m thick) of dark grey weathering dolostone contain abundant silicified pentamerids and corals (from 377 m above the base to the top of the measured section).

Along the creek section (Fig. 10b), the lower part of the formation contains more carbonaceous, silty limestone beds that weather steel blue and flaggy. These are overlain by debris flows that occur from 120 to 271 m above the section base and interfinger with tongues of Nonda dolostone from the ridge. A change to light-grey-weathering dolostone of the Nonda Formation occurs at 325 m above the section base. The Nonda Formation is overlain by sandy dolostone of the Muncho-McConnell Formation. The Kenny and Nonda formations are Early Silurian, containing conodonts representative of the *D. staurognathoides* Zone (Fig. 2).

## Section 6 (Mount Kenny Road River)

### *Location*

Camp was established in the top of a cirque southwest of the main ridge that is the measured section (123°45.9′W, 56°56.8′N; 453500E, 6311700N). Measurement and sampling began on the east side of the saddle where the top of the Skoki Formation outcrops up a dip slope (453000E, 6312000N) and extended south across the recessive Robb and Kenny formations to the top of the cliff-forming Laurier Formation (452800E, 6311400N). Conodont samples from this section bear the preflx MKR-99.

### *Synthesis*

The upper Skoki Formation (15 m) consists of light-grey-weathering, very thick-bedded, oncolitic dolostone. It is abruptly overlain by the recessive, thin-bedded dolostone of the Sidenius Member of the Robb Formation (263 m thick). The Calnan Member of the Robb Formation is primarily black, graptolitic shale with minor, thin-bedded dolostone with intervals of resistant quartzite occurring from 267 m above the section base. A lithological change to more resistant, brown-weathering dolostone marks the base of the Kenny Formation (333 m thick). The Kenny Formation is overlain abruptly by a ridge-forming unit of dolomitic debris-flow breccia deposits with dolostone interbeds belonging to the Laurier Formation (lower 22 m measured, unit extends about 50 m higher as a precipitous cliff). At Section 8, the Sidenius Member yielded conodonts that are Caradocian in age, within the *Baltoniodus variabilis* Zone, and it may range questionably into the Ashgillian, within the *Gamachignathus ensifer* Zone. The lower part of the Laurier Formation is Llandovery in age, within the *D. staurognathoides* Zone (Fig. 2, 11).

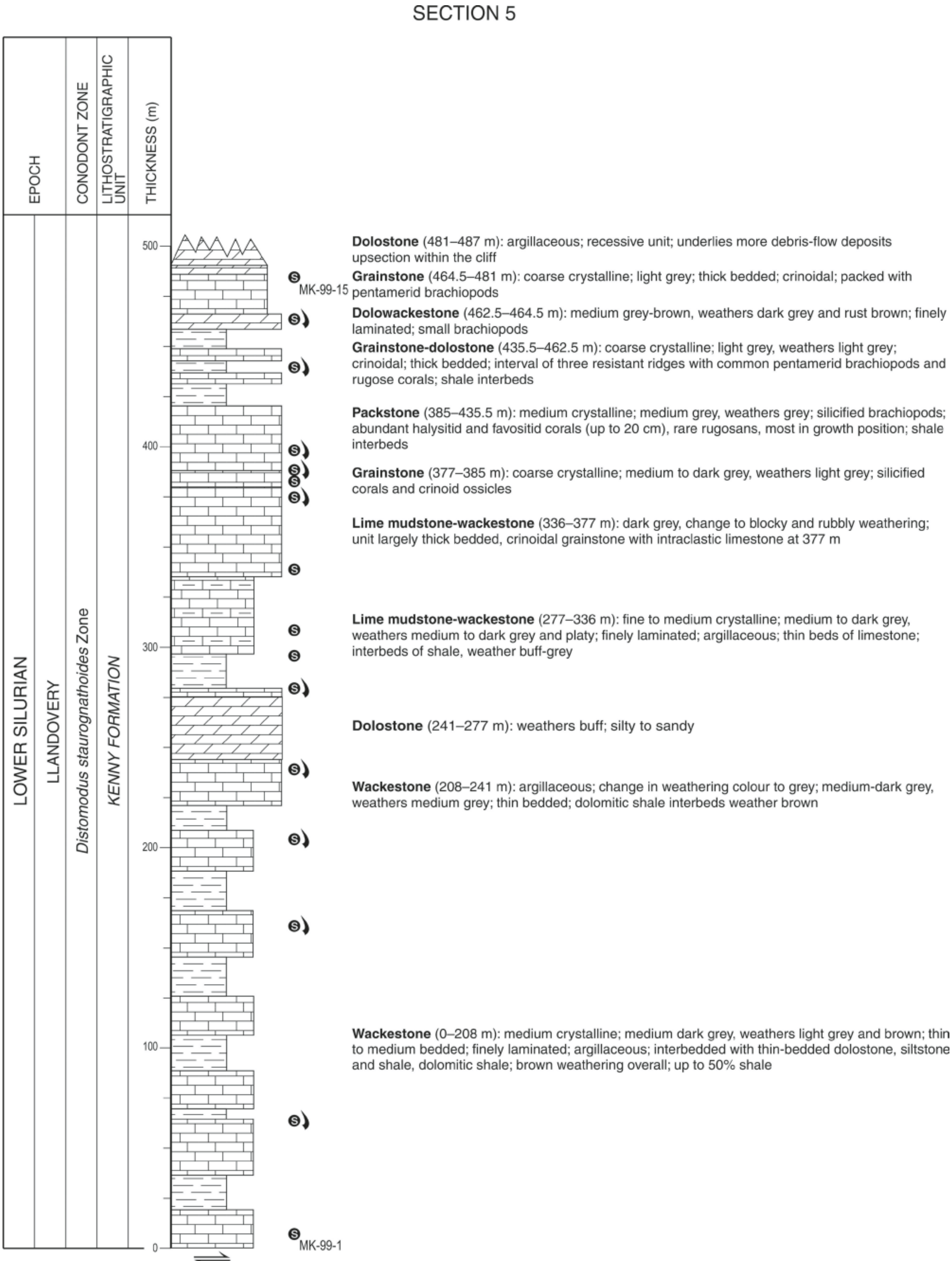



**Figure 10a.** Measured strata of Section 5.

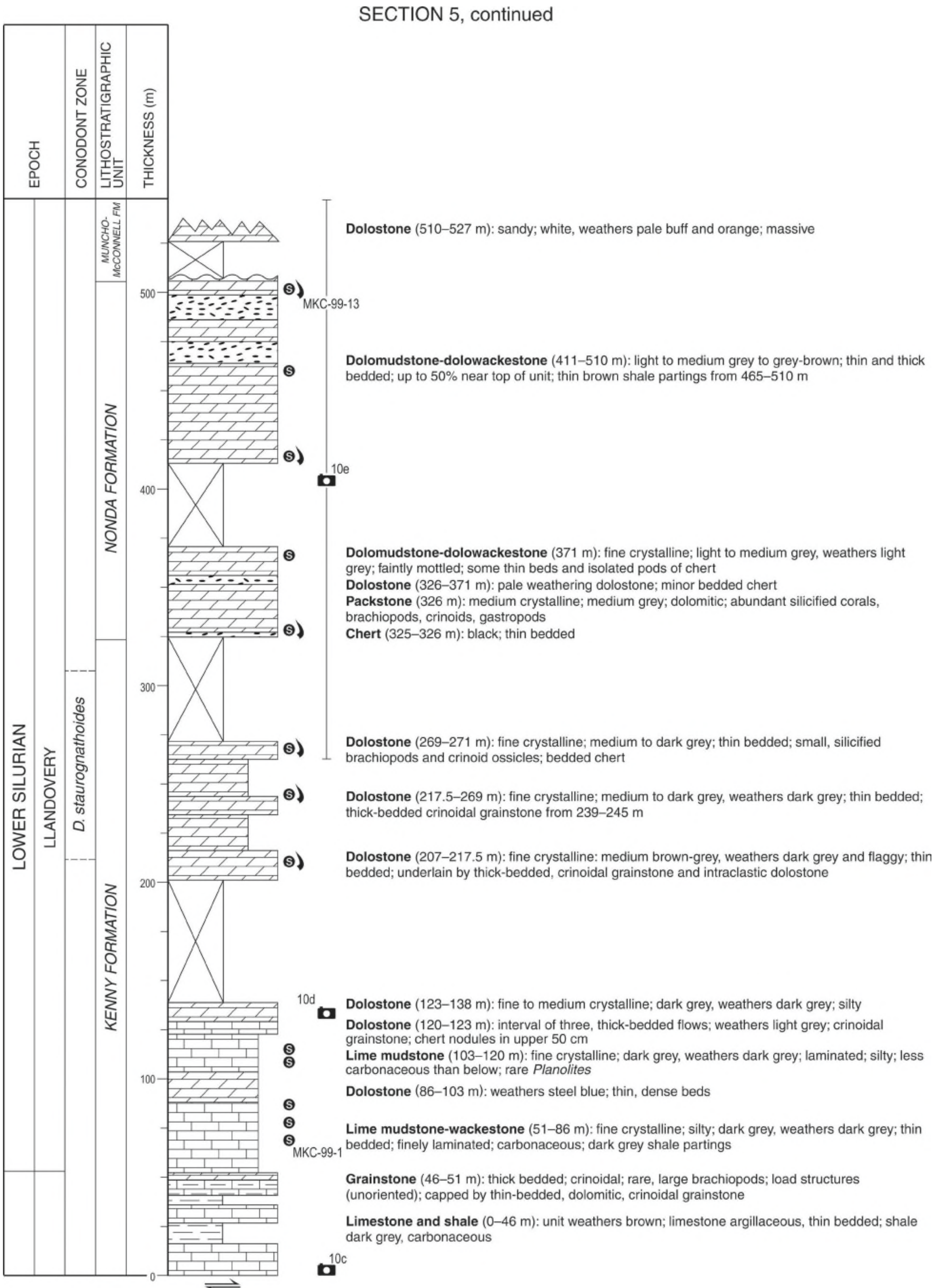



**Figure 10b.** Measured strata of Section 5, continued.


**Figure 10c.** View of the Mount Kenny section from the northeast showing Nonda Formation debris-flow deposits, thinning to the south within the Kenny Formation. 2010-110

**Figure 10d.** Contact of a debris-flow deposit with carbonaceous limestone and shale of the Kenny Formation, Section 5. 2010-111



**Figure 10e.** View of the Mount Kenny Section from the southeast showing Nonda Formation debris-flow deposits interfingering with the carbonaceous lime mudstone of the Kenny Formation, Section 5. 2010-112

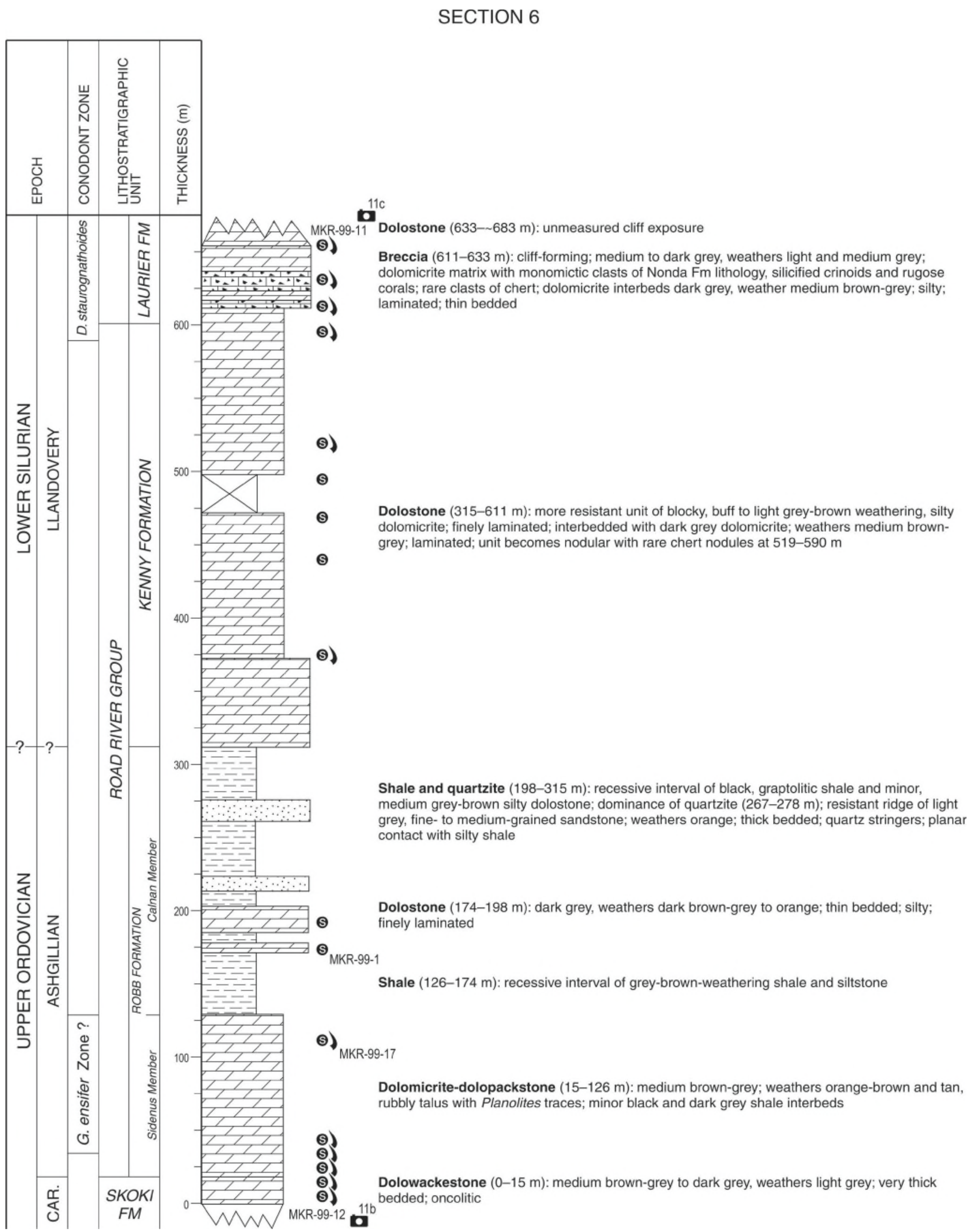



**Figure 11a.** Measured strata of Section 6.

**Figure 11b.** View from the northeast toward Mount Kenny showing the succession of Skoki Formation overlain by transitional facies of the Robb Formation, Calnan Member (Sidenius Member not in view, on dip slope), recessive Kenny Formation, and cliff-forming Laurier Formation slope breccia. Mount Kenny in the background. 2010-113

**Figure 11c.** Large monomictic clasts of Nonda Formation lithology and coral debris of the Laurier Formation breccia. 2010-114

## Section 7 (Mount Robb)

### *Location*

The section is situated on a ridge (123°43′W, 56°50′N) 5.5 km southeast of Mount Robb. Camp was established in a col at the base of the Kenny Formation. The section was walked out over ridges of quartzite across the Robb Formation to the contact with the Skoki Formation, to a dry creek (section starts at 455300E, 6298500N) and measurement proceeded back across black shale and quartzite of the Robb, up the ridge of Kenny overlain by a resistant cap of Laurier Formation (measurement ended at 456500E, 6298300N). Conodont samples from this section bear the prefix MR-98.

### *Synthesis*

This section is the type section of three formations of the Road River Group proposed by Pyle and Barnes (2001). The Robb Formation (481 m thick) is divided into the Sidenius Member (55 m thick) containing limestone, shale, dolostone, and siltstone, and the Calnan Member (426 m thick), which is largely black shale and quartzite. Both the lower and upper contacts with the Skoki Formation and Kenny Formation, respectively, are sharp and unconformable. The Kenny Formation (212 m thick) is a recessive unit of dark brown-grey to black, flaggy-weathering, thin- to medium-bedded, silty lime mudstone, siltstone, and shale. The Laurier Formation (175 m thick) consists mainly of thick- to very thick-bedded, medium-grey slope-debris breccias in a series of flow deposits. Most, but not all, of the breccias are monomictic, and chert, silicified coral, and fossil debris are common. Interbeds include finely laminated dolomudstone turbidites, thin-bedded, grey, dense, uniform shale, and dolomite sandstone. The lower and upper contacts with the Kenny and Kwadacha formations, respectively, are sharp. Conodonts from the *Pterospathodus amorphognathoides* Zone indicate an age close to the Llandovery–Wenlock boundary (late Early Silurian) for the Laurier Formation (Fig. 12).

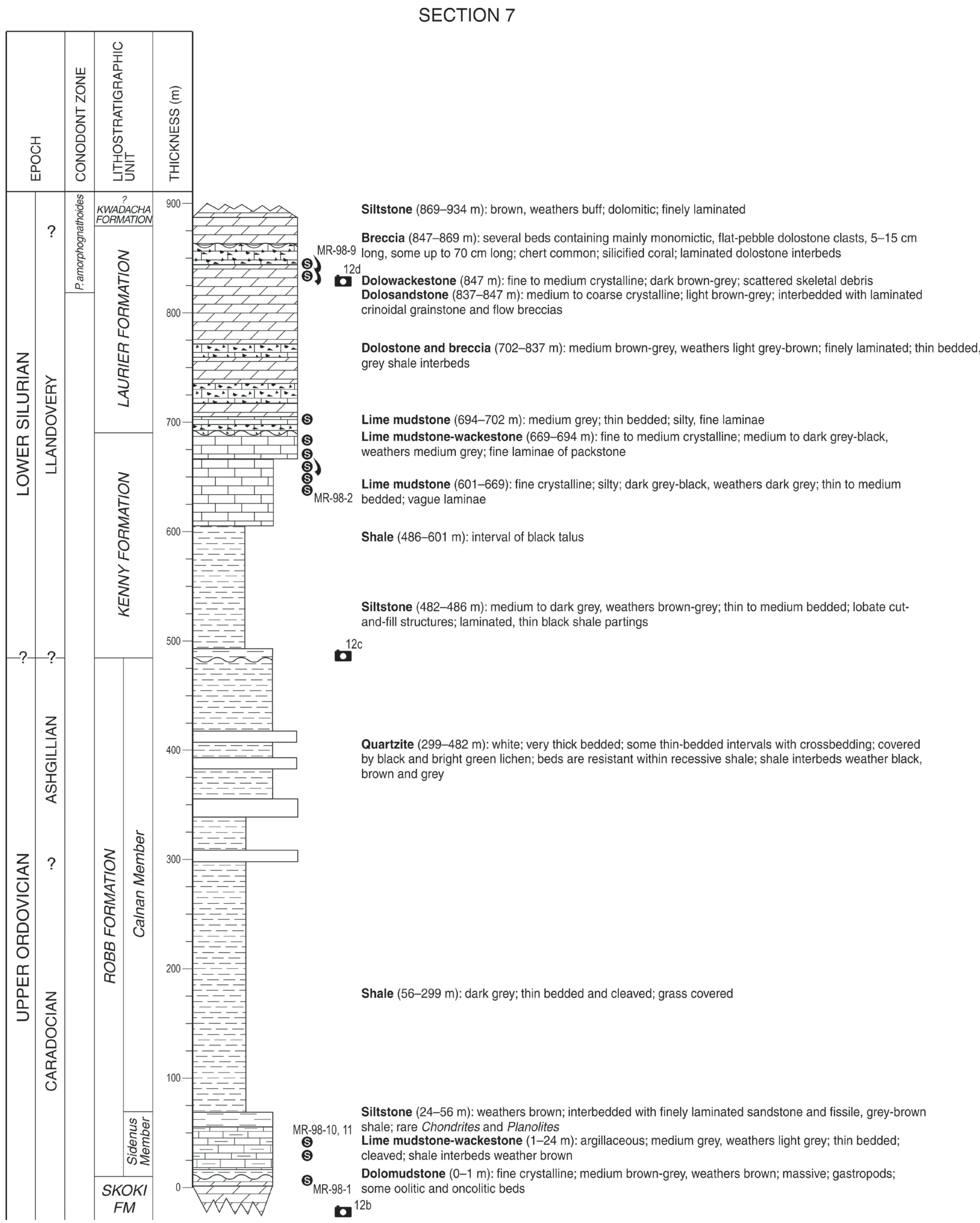



**Figure 12a.** Measured strata of Section 7.


**Figure 12b.** Section 7, type section of the Robb, Kenny, and Laurier formations. 2010-115


**Figure 12c.** Another view of Section 7. 2010-116

**Figure 12d.** Close-up of the cliff-forming, slope-debris breccia of the Laurier Formation. 2010-117

## SECTIONS FROM THE OSPIKA EMBAYMENT

Two sections (9, 10; Fig. 1) were measured and described in detail in the 1998 and 1999 field seasons while examining the basinal facies of the Road River Group. Section 9 was initially measured on the premise that it was Ordovician–Silurian Road River (as shown on the regional map of Taylor, 1979) but conodonts indicate it represents a Lower–Middle Devonian interval. Section 10 represents the Ordovician–Silurian Ospika and Kwadacha formations.

### Section 9 (Ospika River Section)

#### *Location*

The section is situated east of the Ospika River and west of McCusker Creek. Camp was established at 124°12.72′ W, 57°00.70′N. Measurement and sampling of the Deserters Formation (of Pyle et al., 2003a) began in the core of an anticline at 429800E, 6319250N and continued southwest to the contact with a brown siltstone unit at 427550E, 6317350N. Conodont samples from this section bear the prefix OR-98.

#### *Synthesis*

A new Lower to Middle Devonian basinal unit of the Road River Group was named the Deserters Formation by Pyle et al. (2003a). There are four distinct units numbered 1 through 4 that are in fault repetition throughout the 1800 m of measured section. Lithologies include dark-grey-weathering, thin-bedded, argillaceous, crinoidal limestone and black shale representing distal turbidites, and units of dolostone, quartz arenite, volcanic deposits, and shale. The part of the section from 303 m above section base to 1217 m was proposed as the type section.

Unit 1 is the oldest (Lochkovian) and occurs at 303 m above the section base and again at 1217 m above the section base (Fig. 13a, c). It is overlain by Units 2, 3, and 4 (Emsian–Eifelian) in the lower part of the section, up to 1217 m. In the upper part of the section (1299–1800 m), Unit 1 is overlain by a fault repetition of Units 3 and 4 that are overlain by a brown siltstone unit at 1695 m (Fig. 13c, d).

Unit 1 is at least 82 m thick and consists of dark-grey-weathering limestone and shale. It contains a subunit (1217–1280 m) of thin-bedded, compact sandstone at its base that contains a thick-bedded (4 m thick), fossiliferous, sandstone debris-flow deposit containing crinoid columnals, favositid corals, rare brachiopods, and chert fragments. Unit 1 is Lochkovian in age, based on conodonts representative of the *kindlei* Zone and older (Fig. 3). Unit 2 is at least 380 m thick and is predominantly grey weathering, laminated, dolomitic siltstone and brown-orange weathering, feldspathic sandstone interbedded with thin beds of laminated, dolomitic mudstone and shale. Unit 2 is Emsian in age (Fig. 3, 13a). Unit 3 is at least 253 m thick and consists mainly of medium-grey-weathering, thin- to medium-bedded, crinoidal limestone (some of which is graded), distal turbidite. Unit 3 is Emsian in age and ranges into the Eifelian based on conodonts from the *costatus* Zone in the upper part of the unit (Fig. 3, 13b). Unit 4 is at least 267 m thick and contains abundant crinoidal limestone, but more argillaceous limestone, dolostone, and sandstone beds than does Unit 3. It is Eifelian in age, within the *costatus* and *australis* zones (Fig. 3, 13b–d). The unit contains volcanic deposits that are Eifelian in age (Fig. 13c, d).

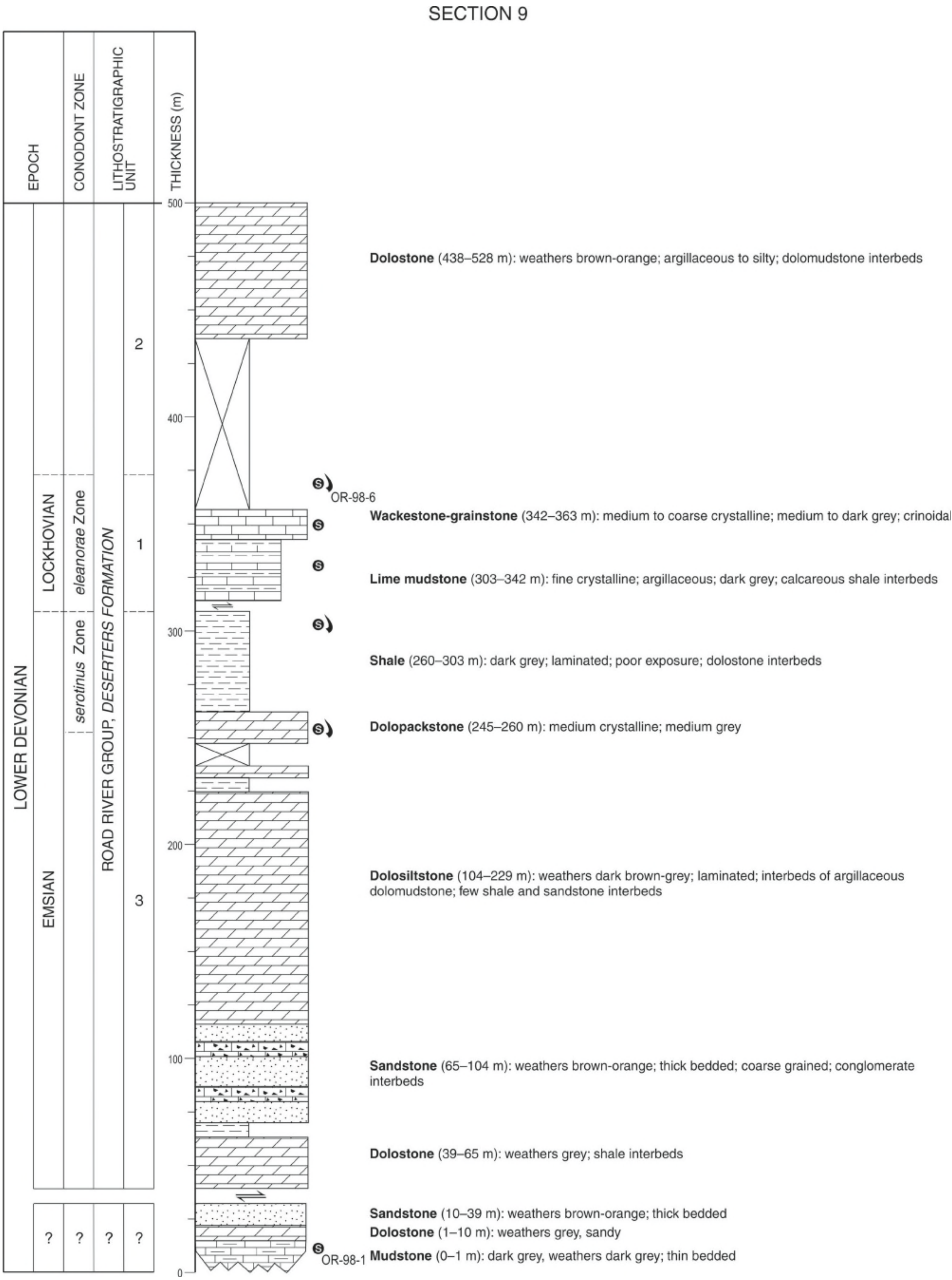



**Figure 13a.** Measured strata of Section 9.

SECTION 9, continued

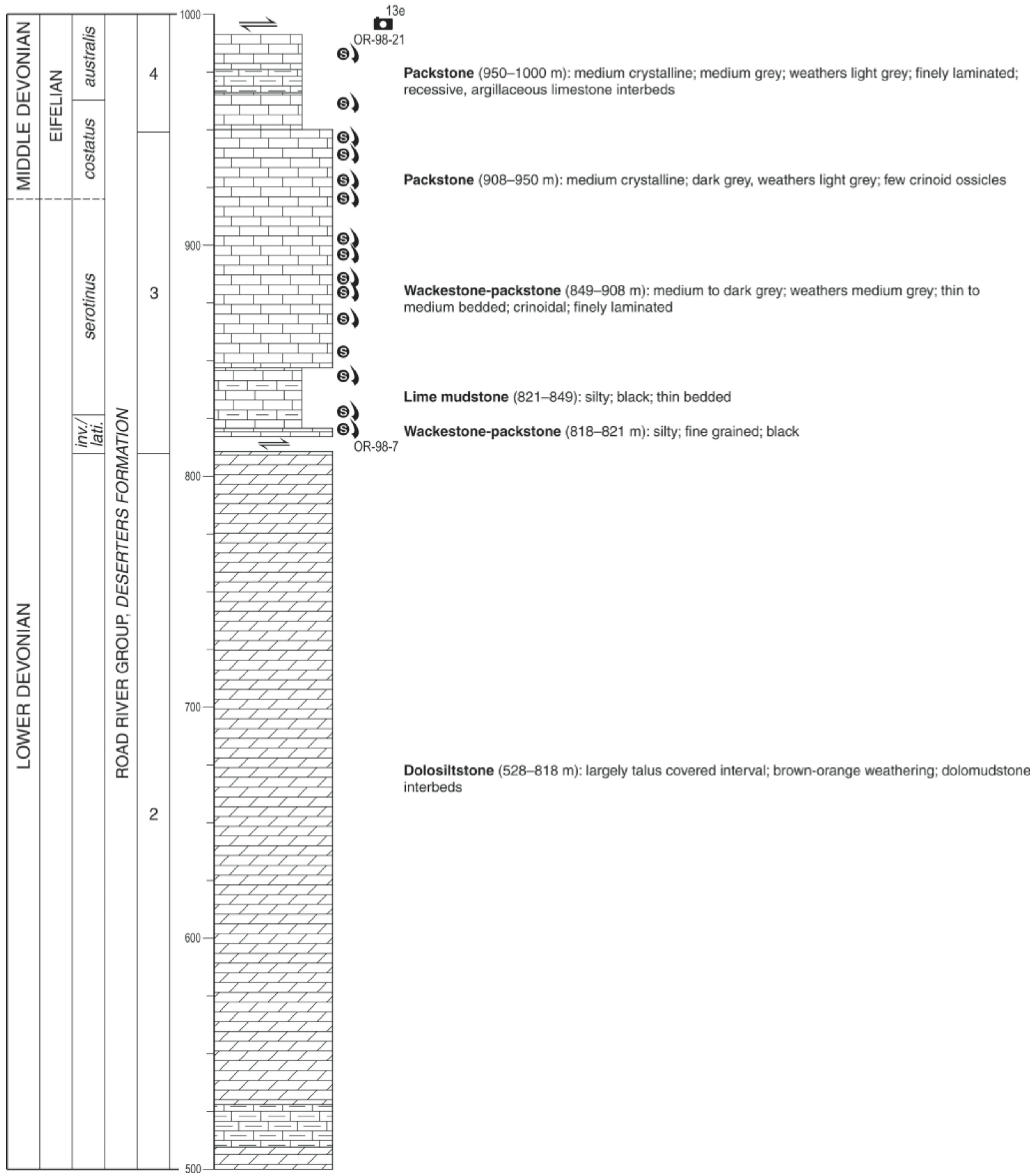



**Figure 13b**. Measured strata of Section 9, continued.

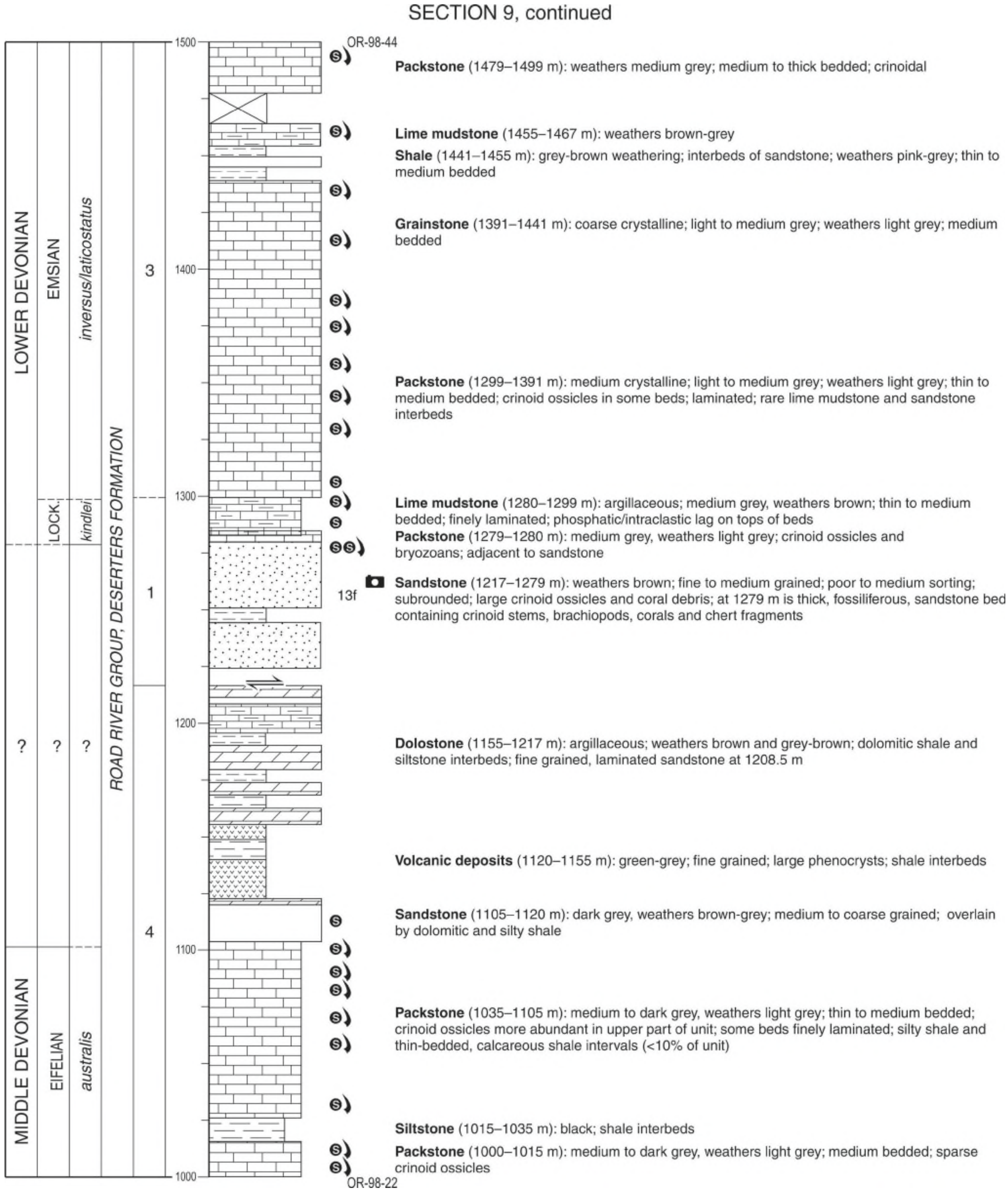



**Figure 13c**. Measured strata of Section 9, continued.

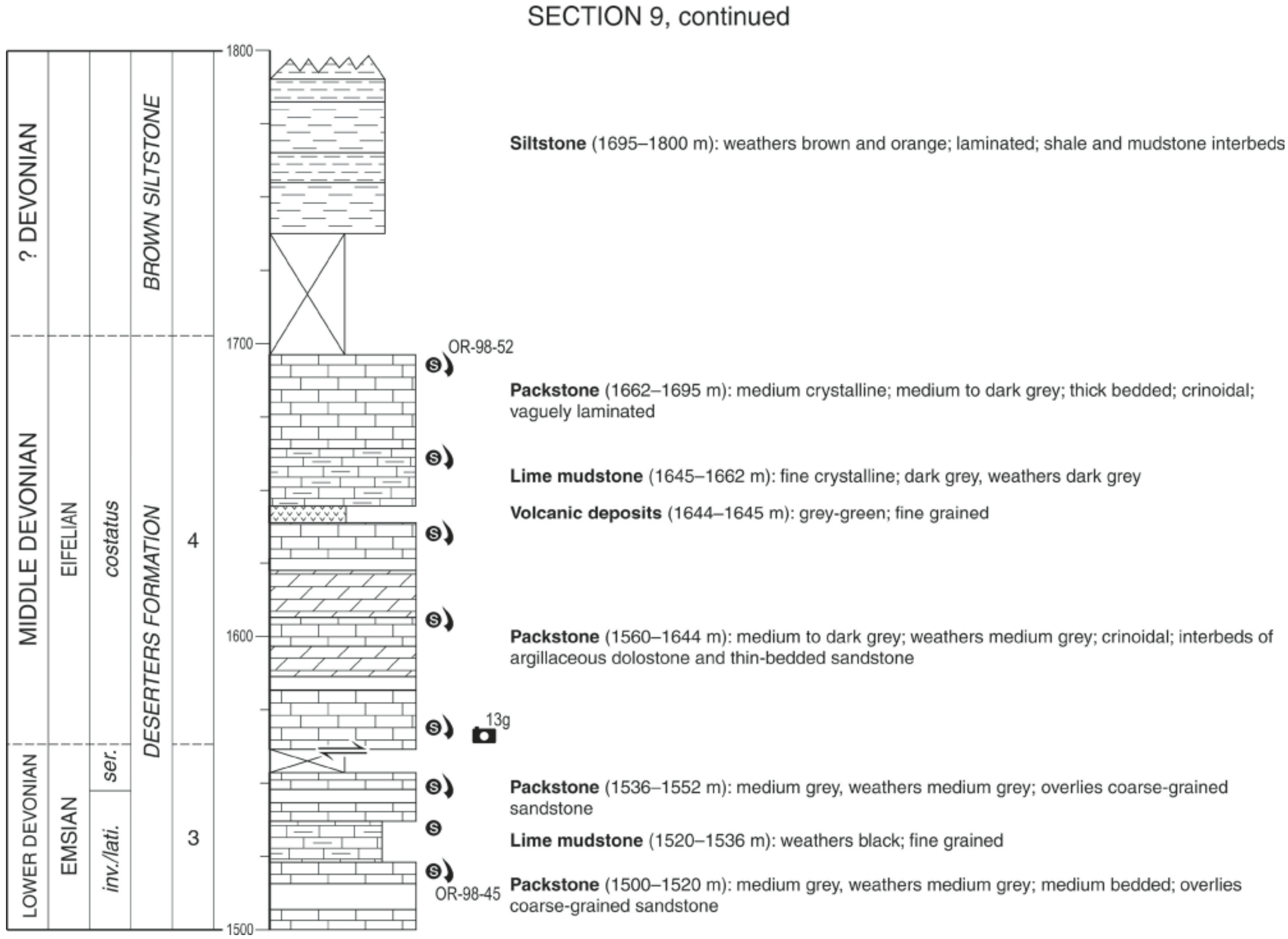



**Figure 13d**. Measured strata of Section 9, continued.


**Figure 13e.** View of the lower part of the ridge section of Deserters Formation, looking east, showing the resistant nature of the dolostone of the upper part of Unit 2 and recessive nature of Units 3 and 4. 2010-118


**Figure 13f.** Subunit of fossiliferous sandstone. 2010-119


**Figure 13g.** View of the upper part of the ridge section, looking west, showing the fault-repeated Unit 4 overlain sharply by the brown siltstone unit. 2010-120

## Section 10 (Ospika River North)

### *Location*

Camp was established near the ridge section (94 F/1; 124°12.72′W, 57°0.7′N). Measurement began in an unnamed, recessive shale unit (425700E, 6318300N) underlying the Ospika Formation, and proceeded up to the more resistant Kwadacha Formation (426500E, 6319900N). The Kwadacha Formation is in thrust contact with the Deserters Formation from Section 9 and along strike from the highest level collected across the valley at Section 9. Conodont samples from this section bear the prefix OS-99.

### *Synthesis*

The section (1288 m thick) consists of the Ospika Formation (814 m thick) overlain by the Kwadacha Formation (474 m thick), which is in thrust contact with the dark grey, crinoidal limestone of the Deserters Formation (Fig. 14). The Ospika Formation consists primarily of alternating beds of medium- to dark-grey-weathering, dense lime mudstone, and shale. Two intervals of thin-bedded breccia containing micritic clasts in an argillaceous matrix occur from 135 to 139 m and 221 to 232 m above the section base. Two volcanic units, 5 m and 85 m thick, occur at 240 m and 263 m above the base of the unit, respectively. Overlying both volcanic units are shale, siltstone, and rare, silty, dolomicrite beds. Conodonts indicate the *Eoplacognathus suecicus* Zone and thus a Middle Ordovician (Darriwilian) age. The Kwadacha Formation is a uniform unit of medium-brown weathering, thin-bedded, platy, finely laminated siltstone that lacks macrofossils and trace fossils.

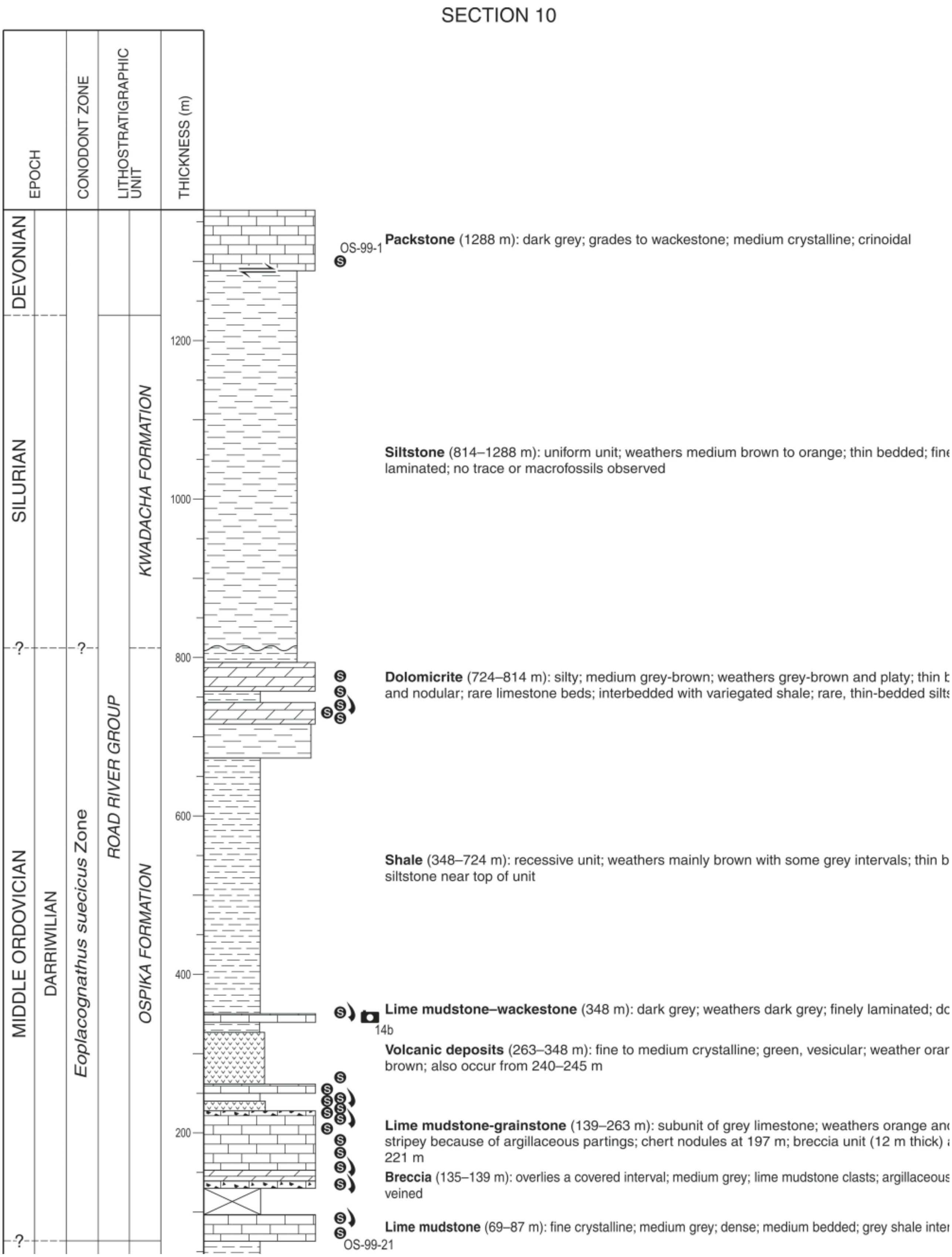



**Figure 14a.** Measured strata of Section 10.


**Figure 14b.** View of Section 10 from unit of volcanic deposits, east to shale of Ospika Formation and overlying siltstone of the Kwadacha Formation. 2010-121

## REGIONAL SYNTHESIS

The present detailed stratigraphic study complements a more northern transect study of Pyle and Barnes (2000,this volume). Regional syntheses by Pyle and Barnes (2003b) and Zhang et al. (2005) discuss the tectonic evolution of the Laurentian margin based on the stratigraphic framework from the northern transects the transect across the Cassiar Terrane, and a transect from the Bow Platform to White River Trough in the Southern Canadian Rockies. A refined biostratigraphic framework for the southern transect was established by Pyle et al. (2003b) and Pyle et al. (2007). In summary, at least two periods of renewed extension along the margin occurred in the latest Cambrian and late Early Ordovician, marked by the onset of deposition of the Kechika Formation, and the abrupt platform-to-basin transition associated with the onset of the Skoki–Ospika formation deposition, respectively. Alkalic volcanic units in the succession (Middle Ordovician and Middle Devonian) associated with abrupt facies changes, are consistent with multiphase rifting throughout this interval. Siliciclastic deposits in the succession were likely sourced by a reactivation of tectonic highs such as the Peace River Arch. Several prominent hiatuses punctuate the succession, including unconformities of early Late Ordovician, sub-Llandovery, possibly Early to Middle Silurian, and Early Devonian ages.

A fourth member of the Skoki Formation was formally called the Balden Member by Pyle and Barnes (2001). Conodont biostratigraphy indicates the Skoki Formation is Arenigian to early Caradocian in age (Fig. 2). The Beaverfoot Formation is Caradocian in age and likely ranges into the Ashgillian; the McCusker and Nonda formations are Llandoverian in age. The Nonda Formation may extend into the Wenlock. The Ospika Embayment preserves the shelf-break and basinal facies equivalents of the Beaverfoot, McCusker, and Nonda formations that overlie the Skoki Formation at the shelf break. These are the previously unnamed transitional facies of the Road River Group that are divided into three new formations: the Robb, Kenny, and Laurier formations. The Robb Formation is further subdivided into the Sidenius and Calnan members and is Caraodocian to Ashgillian in age. The lower part of the Kenny Formation (Llandovery in age) is coeval with the McCusker Formation and the upper part interfingers with the Nonda Formation at the ancient shelf-break. The Laurier Formation is correlative to the upper part of the Nonda Formation and is Llandoverian in age, possibly extending into the Wenlock (Fig. 2). A new formation of the Road River Group, the Deserters Formation, spans several zones through the Lower–Middle Devonian (Lochkovian–Eifelian) and was deposited in a linear sub-basin of the Ospika Embayment, southern Kechika Trough.

## ACKNOWLEDGMENTS

We gratefully acknowledge logistical support provided by the Geological Survey of Canada's Central Foreland NATMAP Project and additional financial support from the Natural Sciences and Engineering Research Council of Canada. Two successful field seasons were made possible by the co-ordinating efforts of M. Cecile and L. Lane (Geological Survey of Canada, Calgary). Discussions on field localities and stratigraphy with A. Legun, M. Cecile, L. Lane, B. Norford, R. Thompson, A. Hedinger, and I. McIlreath were appreciated. We thank G. Ortega and S. H. Williams for graptolite identifications and D. Canil for examining volcanic thin sections. We also thank M. Landry and C. Mohoruk for both field and laboratory assistance, and D. Hanchar, T. Peron, S. Yaqzan, E. Delahaye, and M. Deagle for laboratory assistance. We appreciate the comments from D. Morrow and B. Norford, which improved the manuscript.

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# Ordovician and Silurian strata of northeastern British Columbia: stratigraphic sections and synthesis of biostratigraphy

B.S. Norford[1]

*Norford, B.S., 2017. Ordovician and Silurian strata of northeastern British Columbia: stratigraphic sections and synthesis of biostratigraphy:* in *Central Foreland NATMAP Project: Proterozoic to Devonian stratigraphic sections in British Columbia and Yukon, (ed.) L.S. Lane and R.B. MacNaughton; Geological Survey of Canada, Bulletin 603, p. 85–203. https://doi.org/10.4095/299866*

**Abstract:** Thirty-six stratigraphic sections document the Ordovician and Silurian strata of northeastern British Columbia. The sections were measured through outcropping strata deposited on the MacDonald and Cassiar platforms, in the adjoining Kechika Trough of the Selwyn Basin, the Nasina Basin, and within transitional zones between these regions. Synthesis of published and unpublished data from studies of microfossils and of invertebrate and vertebrate macrofossils constrains the ages of the formations and assists in the interpretation of the stratigraphic history of the region. Several regional unconformities are recognized within the successions. From the platformal rocks and the transitional rocks, hiatuses can be documented during the earliest Caradoc, mid to late Caradoc, late Ashgill to very early Llandovery, mid Llandovery and within the interval Wenlock to Ludlow. Within the basinal rocks, only the Llandovery hiatuses have been recognized.

**Résumé :** Trente-six coupes stratigraphiques permettent de décrire les strates ordoviciennes et siluriennes du nord-est de la Colombie-Britannique. Ces coupes ont été mesurées à l'aide de strates en affleurement ayant été déposées sur les plates-formes de MacDonald et de Cassiar, dans la cuvette de Kechika avoisinante (qui fait partie du bassin de Selwyn), dans le bassin de Nasina et dans les zones de transition entre ces régions. Grâce à une synthèse de données publiées et inédites provenant d'études de microfossiles et de macrofossiles d'invertébrés et de vertébrés, on a pu déterminer des limites d'âge pour ces formations, ce qui facilite l'interprétation de l'histoire stratigraphique de la région. Plusieurs discordances régionales ont été reconnues dans les successions. Dans les roches de la plate-forme et des zones de transition, des hiatus sédimentaires peuvent être mis en évidence au Caradoc initial, au Caradoc moyen-tardif, à l'Ashgill tardif-tout début du Llandovery, au Llandovery moyen et dans l'intervalle du Wenlock au Ludlow. Dans les roches de bassin, seuls les hiatus du Llandovery ont été reconnus.

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# INTRODUCTION

Valuable stratigraphic data on Ordovician and Silurian rocks have been acquired over several decades and the present report places these basic data in the public domain. Almost all the following stratigraphic sections were examined in 1961, 1964, and 1978, but two were studied in 1999. M.P. Cecile participated in several of the 1978 studies, and a few of these localities subsequently were visited by Pyle and Barnes (2002a, b, 2003). These and sections at other localities are described by them within the present volume. Many of the present sections (Appendix A) have been referred to within publications by Jin and Norford (1992), Norford (1962, 1965, 1991 and 1996) and Norford et al. (1967, 1994).

Figure 1 shows the locations of the stratigraphic sections and also the approximate outboard edges of the carbonate platforms. Adjacent to the Lady Laurier Embayment, this margin can be interpreted as intricate from geophysical data presented by McIlreath et al. (1995). Doubtless the margin was also intricate in other areas, with similar embayments of relatively deep water into the carbonate platforms. The Kakwa and Cassiar platforms may have been connected in the early Paleozoic, prior to faulting that moved the Kakwa Platform and the adjacent parts of the Nasina Basin and the Kechika Trough laterally to their present site (Fig. 1).

The observations presented here are those made during the fieldwork and use a dated form of lithological description of carbonate rocks. These have not been revised to conform with Pyle and Barnes' descriptions in their contributions to this publication (Pyle and Barnes, this volume).

# SYNTHESIS OF BIOSTRATIGRAPHY

The region was situated about the western margin of shallow cratonic seas and included transitions to deeper environments to the west. The margin was complex, with geophysical evidence indicating several embayments of relatively deep water into the MacDonald Platform from the Kechika Trough (McIlreath et al., 1995; Fig. 1 and 2). Outboard of the Kechika Trough were the shallow environments of the Cassiar Platform, and beyond these the deep water of the Nasina Basin, a southern continuation of the Selwyn Basin of the Yukon Territory.

Depositional environments of subtidal to tidal depths on the MacDonald Platform hosted carbonate sediments and quartz sand and silt. Their faunas included stromatoporoids, corals, brachiopods, gastropods, and other benthic animals. Transitional facies at the margin of the platform were mostly debris flows and slumps from the platform facies and contained similar faunal assemblages, albeit transported (Cecile and Norford, 1979). The transitional facies dovetailed with the western basinal facies of deeper water that had few benthic organisms, but pelagic animals such as graptolites, conodonts, and sponges. Conodonts also were present in the shallower waters of the transitional and platform facies.

Global and regional Ordovician and Silurian schemes of biostratigraphic zonation use graptolites, conodonts, and benthic macrofossils, and the relationships are well established between the schemes based on different animals (Fig. 3). Pyle and Barnes (2002b, 2003) published comprehensive descriptions of conodonts, but there has been little taxonomic description of Ordovician and Silurian macrofossils. However, a few descriptions of significant species have been published, including some of brachiopods (Boucot and Chiang, 1974; Jin and Norford 1992, 1996), gastropods (Rohr et al., 1995), corals (Norford, 1963) and sponges (Rigby and Harris 1979; Rigby et al., 1998). This published information, together with unpublished identifications of taxa from many of the stratigraphic sections, has allowed the ages of the formations to be assessed (Fig. 4).

Of particular paleontological interest are the reports of the Late Ordovician echinoderms *Pleurocystites filitextus* Billings and *P. squamosus* Billings (collection GSC O-45513; R. L. Parsely, pers. comm., 1993) from the Beaverfoot Formation in the Mount Hunter Section. Also interesting are the presence of *Listraspis* and other heterostracans, thelodonts, and fragments of other fish within the Muncho-McConnell Formation in the Keily Creek A Section (collections GSC O-64501 and O-64502; R.Thorsteinsson, pers. comm., 2005). These vertebrates probably indicate a Late Silurian (Ludlow or Pridoli) age for beds 46 m above the base of the Muncho-McConnell Formation, and provide the best known dating of the Formation. Conodonts recovered from these same two collections include elements probably assignable to *Ozarkodina remscheidensis* (Ziegler) and indicate a Late Silurian to Early Devonian age (A.D. McCracken, pers. comm., 2005). At a locality to the northwest, east of Gundahoo River within the Rabbit River map area, fragments of fish from siltstone that probably represents the Muncho-McConnell Formation have been considered Pridolian (Gabrielse, 1998, p. 30; R. Thorsteinsson, pers. comm., 1984). Denison (1964) reported species of *Lisatraspis* and *Pionaspis* from a bed in the same general locality. The Muncho-McConnell Formation was measured as 477.9 m thick at its type locality within the Trout River Section, and higher beds of the Formation probably include Early Devonian horizons.

# GEOLOGICAL HISTORY

Several regional unconformities are present, reflecting episodes of uplift and transgression of the North American craton and of the platforms at its margins (Fig. 4). Subsequent to the deposition of the Skoki Formation, an early Caradoc hiatus can be recognized in the platformal areas throughout the southern and northern Rocky Mountains and in the

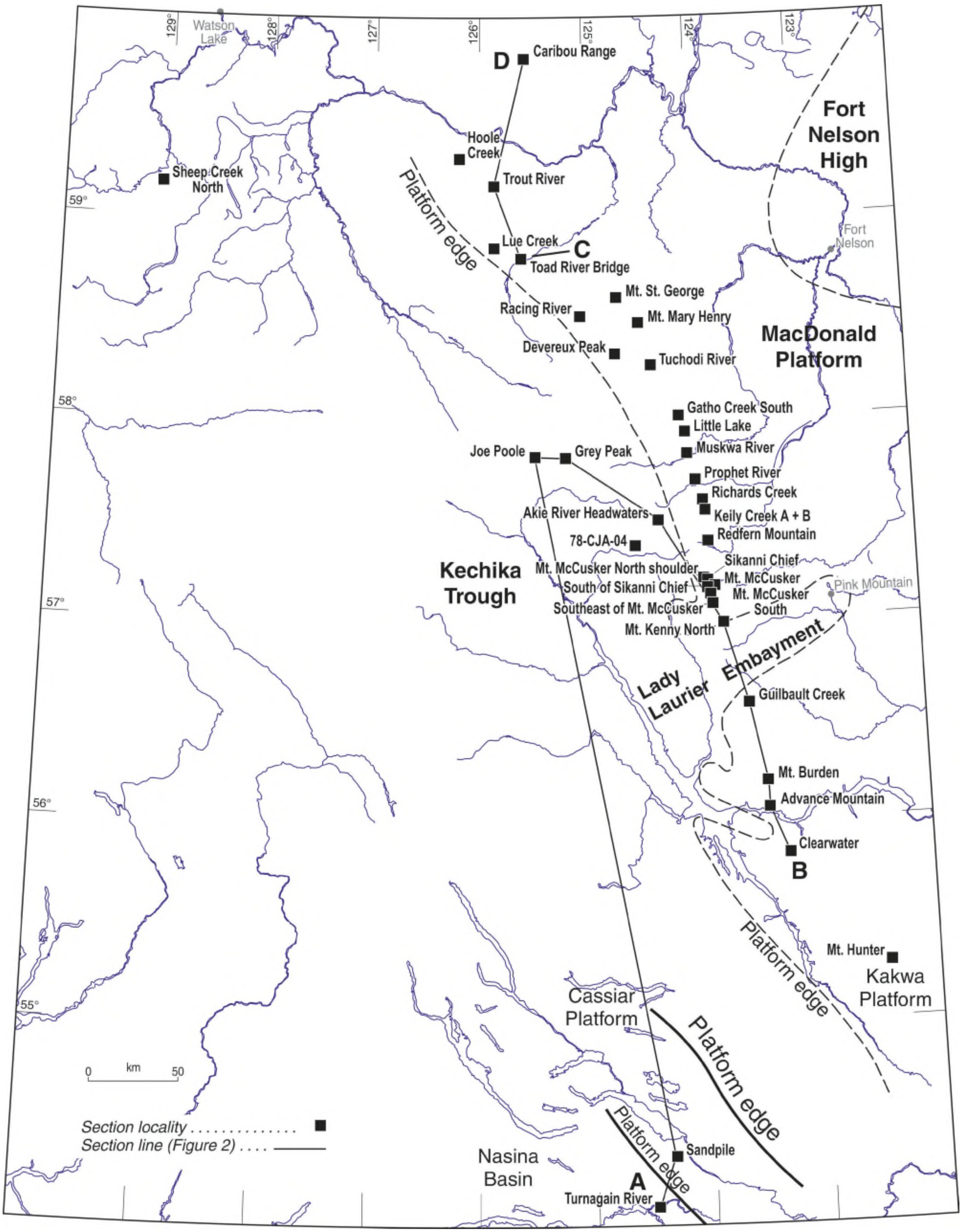


**Figure 1.** Paleogeography in Early Silurian time with the Cassiar Platform and its adjacent region restored southeastward to an assumed geographic position (*modified from* McIlreath et al.,1995; Norford et al., 1994; Rigby et al.,1998; Pyle and Barnes, 2003). Lines A-B and C-D indicate the transects shown in Figure 2.

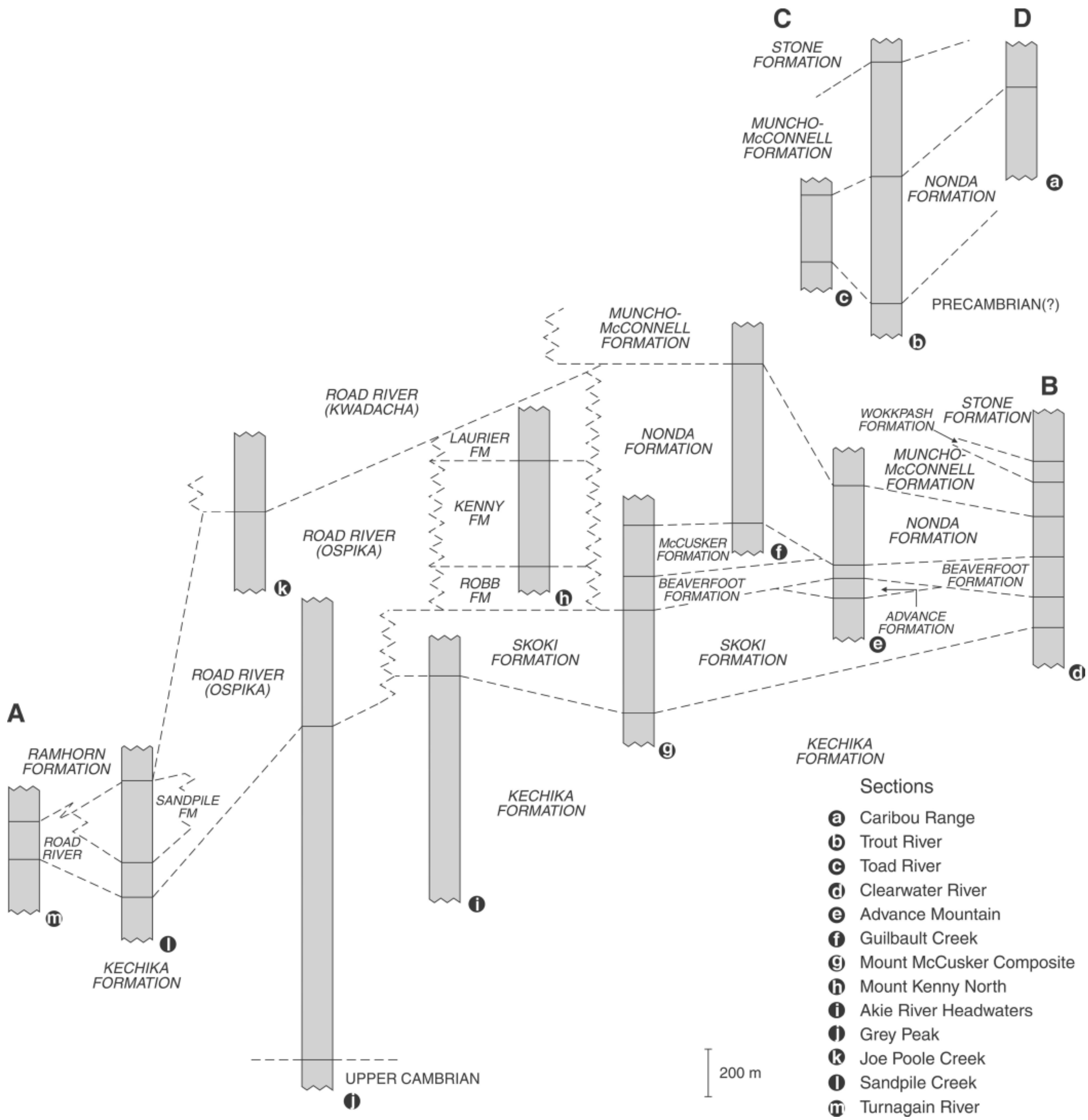


**Figure 2.** Fence-diagram showing relations between some of the stratigraphic sections shown in Figure 1.

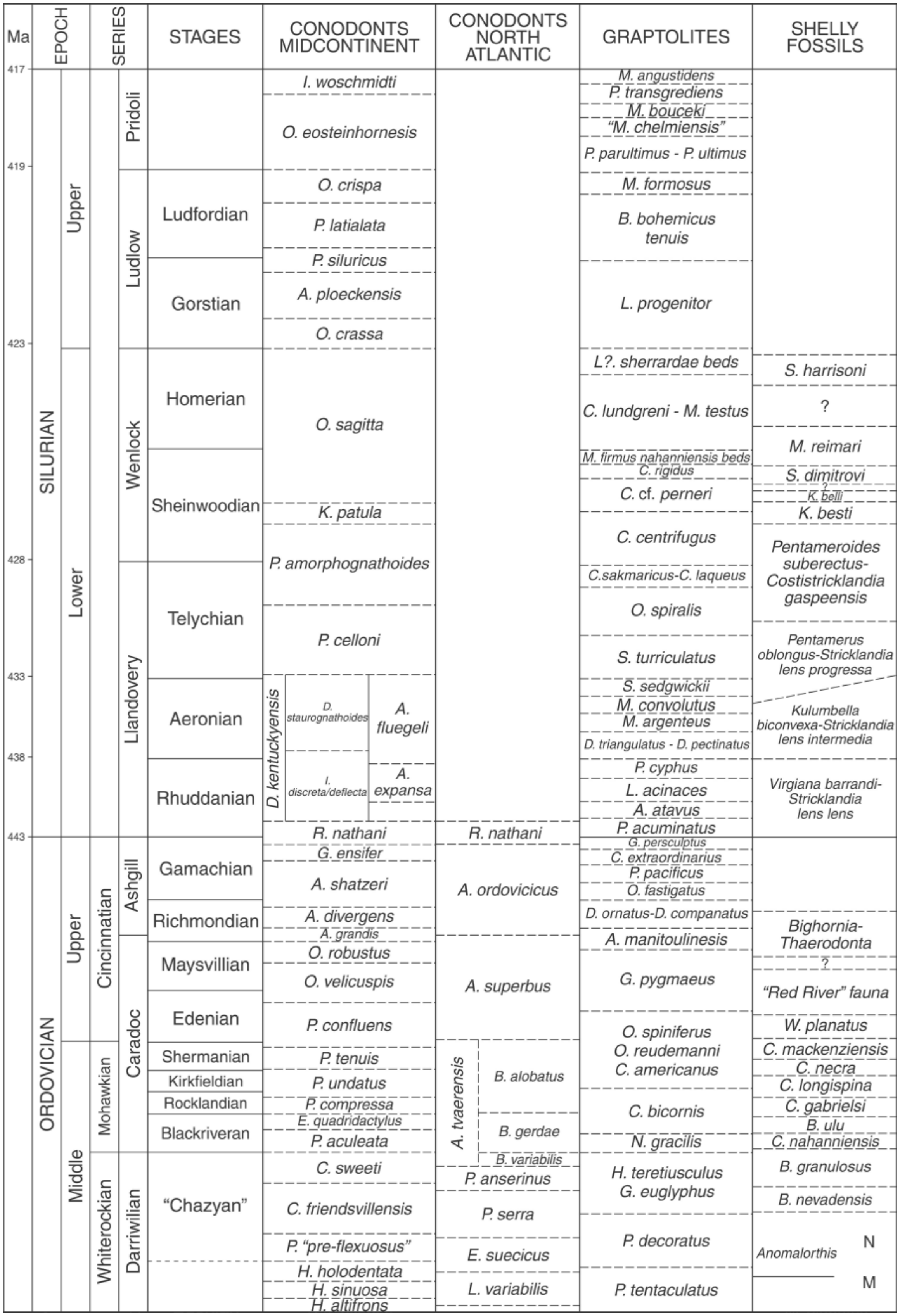


**Figure 3.** Biostratigraphic zonations (*modified from* Norford 1997 and Dewing et al., 2008).

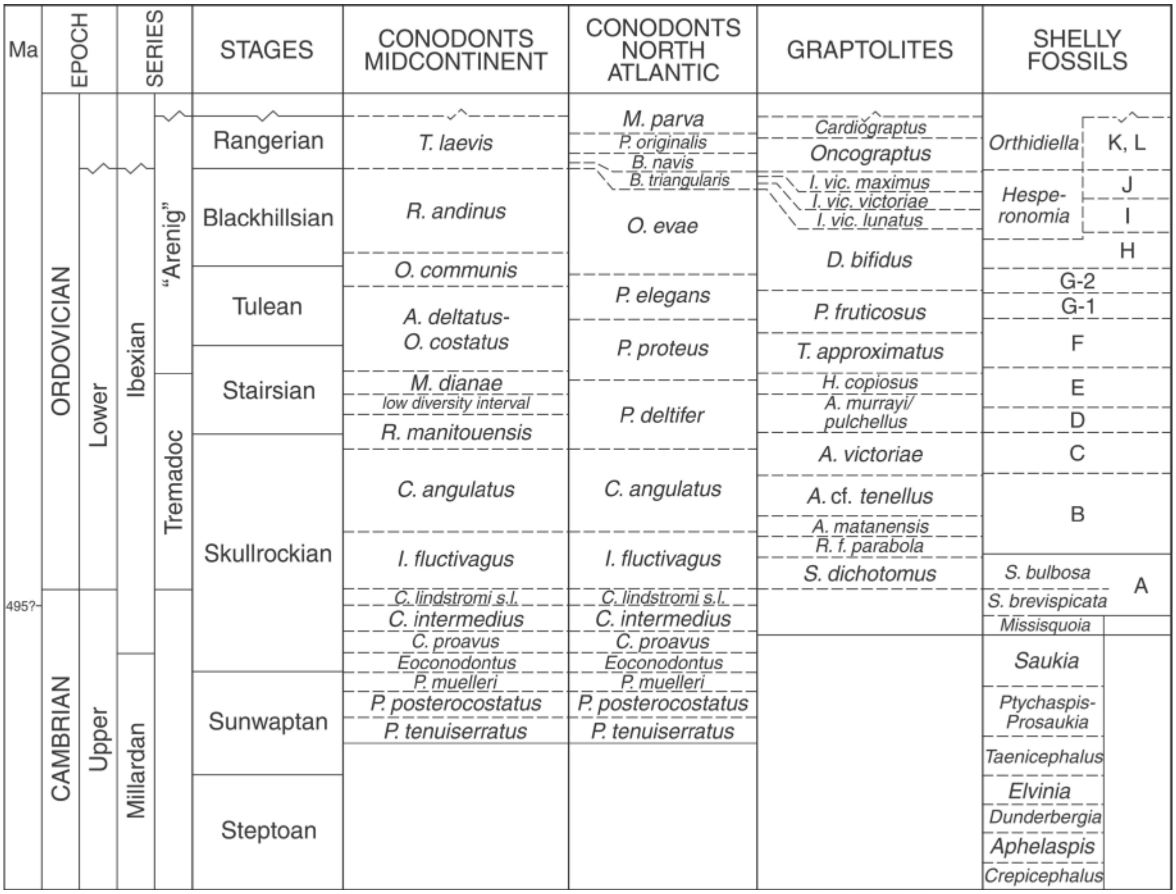


**Figure 3. (Cont.)** Biostratigraphic zonations (*modified from* Norford 1997 and Dewing et al., 2008).

Williston and Hudson Bay basins (Norford et al., 1994). This hiatus indicates a widely emergent craton over which late Middle and Late Ordovician transgressions deposited marine sediments. The basal deposits of these transgressions incorporated large amounts of mature quartz sand that had accumulated on the craton while it was land during much of Precambrian to mid-Ordovician time. Earlier, within Blackhillsian time, rivers had transported similar sand (now known as the Monkman and Tipperary quartzites) into the platformal areas of the Rocky Mountains.

There were two distinct transgressions during Caradoc time. The earlier is documented by the Mount Wilson Formation in the southern Rocky Mountains and by the Winnipeg Sandstone in the Williston Basin and reflected by the disconformity below the Advance Formation in the northern Rocky Mountains. Uplift followed in many parts of the craton and much of the sedimentary package of this transgressive cycle was removed by erosion prior to the later transgression at the onset of deposition of the Beaverfoot Formation. In the southern Rocky Mountains, the Beaverfoot oversteped the Mount Wilson Quartzite in late Caradoc time to rest unconformably on older Ordovician rocks. In the northern Rocky Mountains, the Advance Formation is the only relic of the earlier Caradoc sedimentary package.

Most of the craton was above sea level at the beginning of the Silurian. McCusker and Nonda carbonate deposits followed a late Rhuddanian transgression, with periodic influxes of quartz sand and silt from still emergent parts of the Fort Nelson High and the Peace River Arch (Fig. 1). Unconformities above the Kenny and Pesika formations document unsettled conditions in parts of the transitional facies and of the eastern part of the basin facies. The margin of the MacDonald platform was steep and was the site of slumping and debris flows (*see* Plate 2, figure 1 *in* Norford et al., 1967). Uplift in Wenlock time allowed erosion of platform sediments while quartz silt was transported across the platform to be incorporated within the Kwadacha Formation that appears to range in age from Wenlock to Devonian. A late Silurian or early Devonian transgression following deposition of the Nonda Formation deposited the Muncho-McConnell Formation, which contains significant amounts of quartz silt similar to that within the Kwadacha Formation.

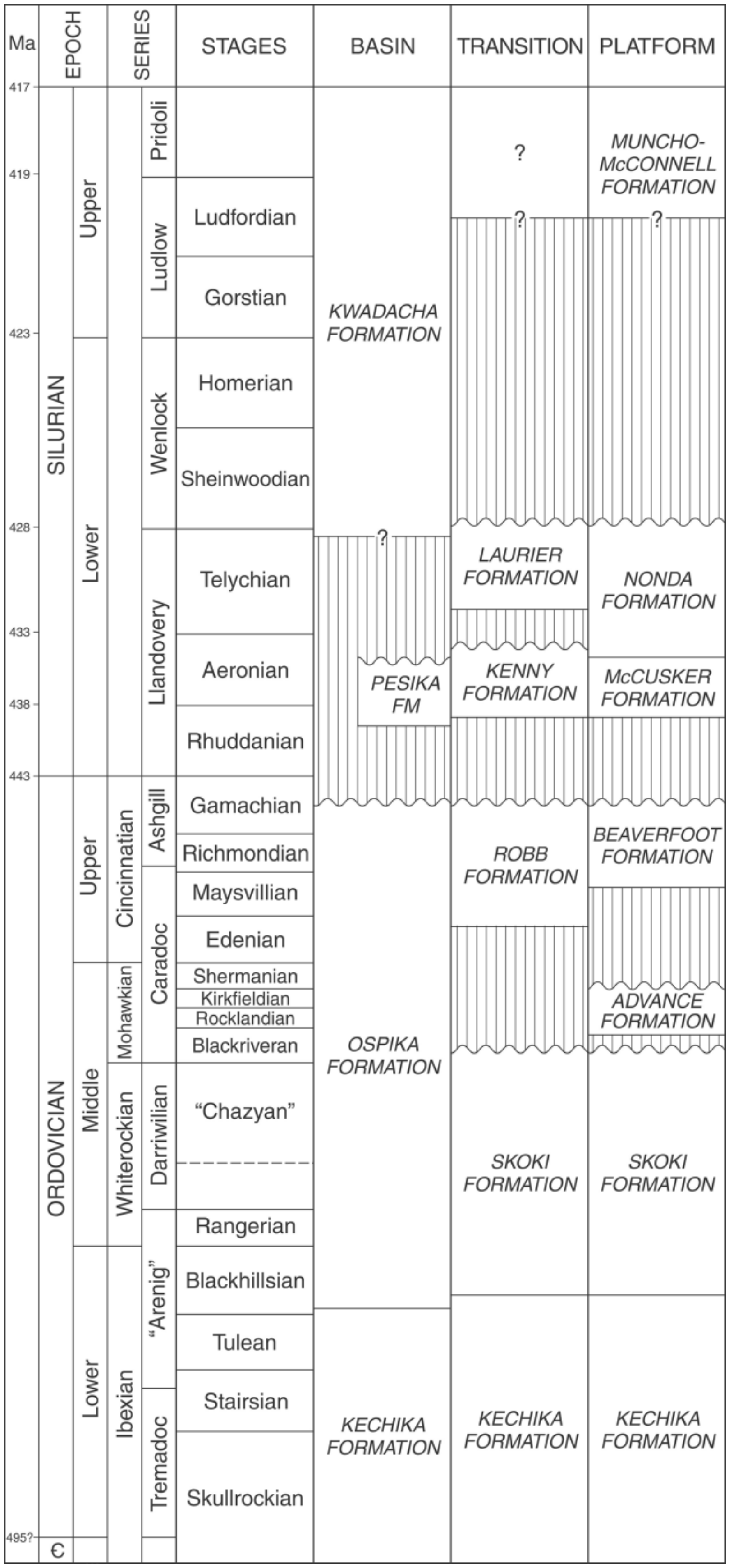


**Figure 4.** Formations, ages and hiatuses.

## ACKNOWLEDGMENTS

M.J. Copeland, D.E. Jackson, A.D. McCracken, D.J. McLaren, A.W. Norris, G.S. Nowlan, R.L. Parsely, R. Thorsteinsson, and T.T. Uyeno kindly studied some of the paleontological collections for the author; the rest of the identifications were his responsibility. M.P. Cecile participated in the study of several of the stratigraphic sections. Sylvia Leong provided exemplary assistance in the compilation of the plots of the stratigraphic sections and in the drafting of the figures.

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# Appendix A: Stratigraphic sections

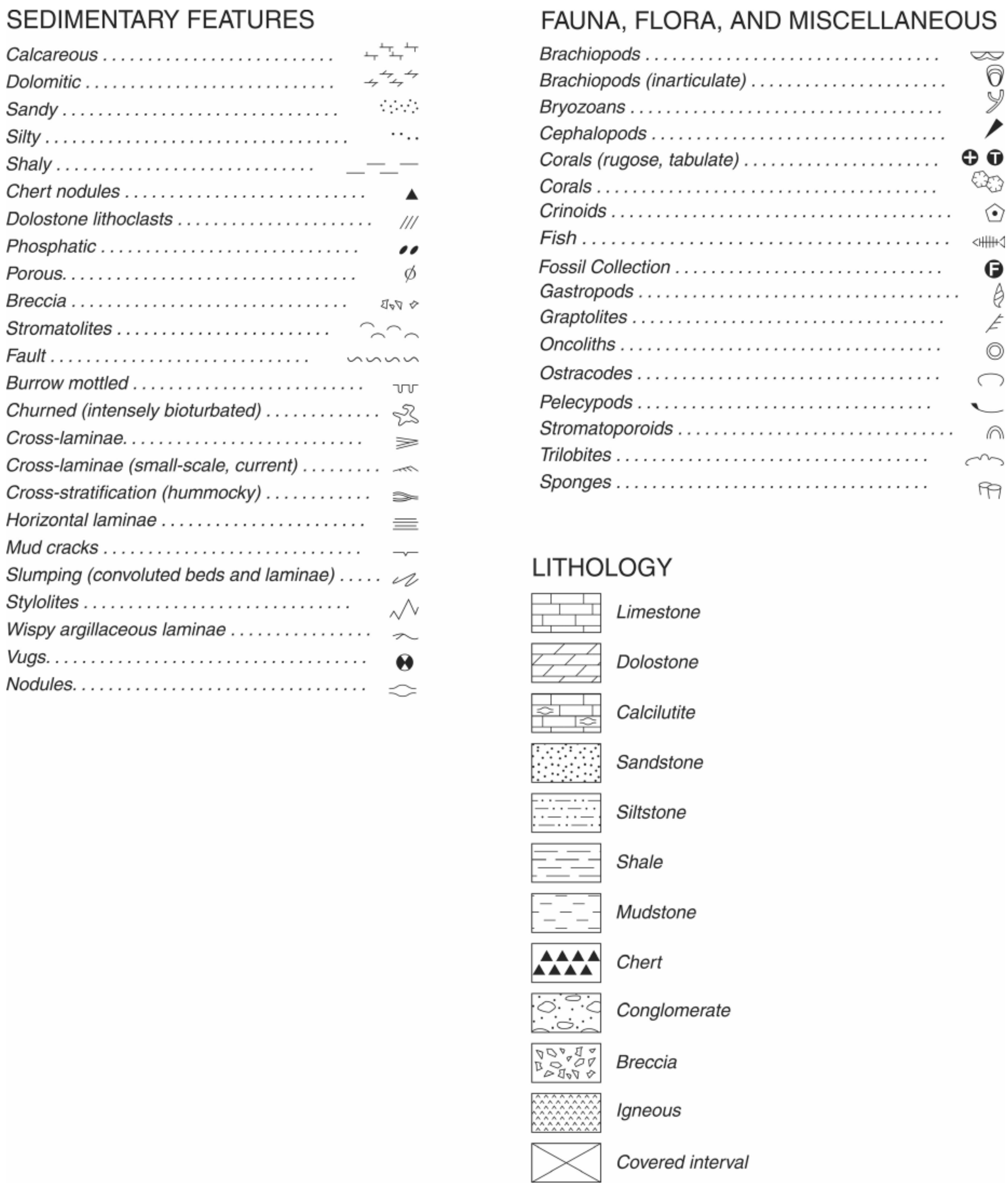
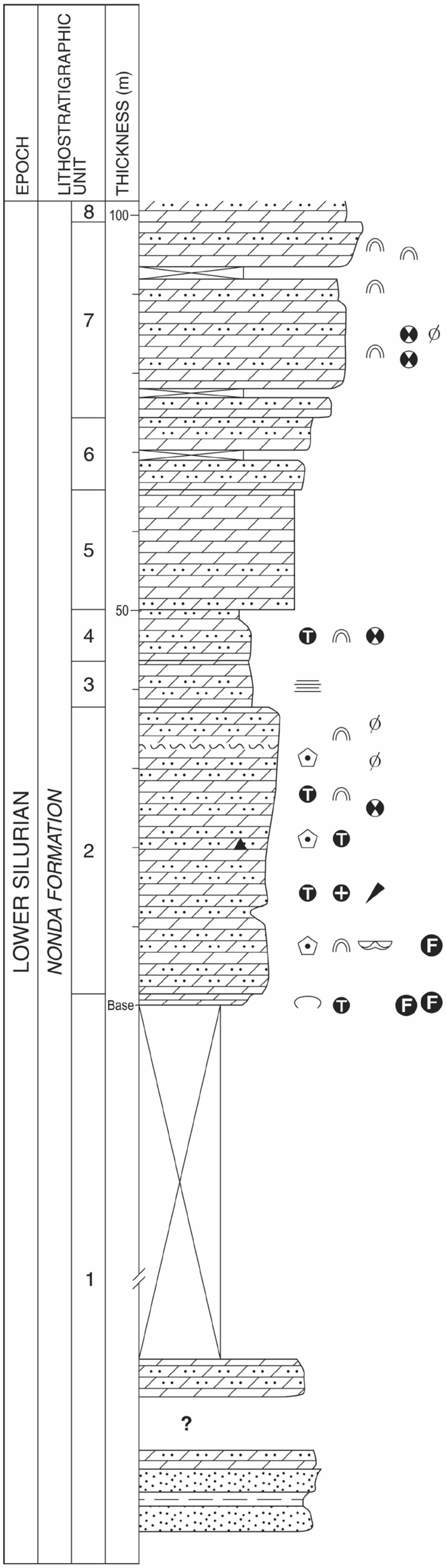



**Figure A1.** Caribou Range (Norford et al., 1967, p. 508). This figure also includes a legend for symbols used in the columnar sections illustrated in Figures A1 to A37 inclusive.

## CARIBOU RANGE SECTION




**Unit 8** (99.1–105.2 m): Dolostone; fine to very fine crystalline; grey, weathers light grey; bedding thickness 60–90 cm; slightly silty, unit contains grey and light grey weathering dolostone

**Unit 7** (74.4–99.1 m): Dolostone; very fine to fine crystalline; dark grey, weathers dark grey and dark brown-grey; bedding thickness 15 cm to 2 m; at 93.3–93.9 m and at bottom of unit is light grey weathering dolostone; 8% large vugs and cavities at 84.7–85.6 m, dolomite stringers and coarse vugs around 80 m; slightly silty to silty in bottom half of unit, slightly silty in top quarter of unit

Unit 6 **(65.2–74.4 m):** Silty dolostone; microcrystalline to very fine crystalline; light grey, weathers light grey; bedding thickness 30 cm to 1 m; light grey weathering dolostone in top half of unit with bedding thickness 5–8 cm

**Unit 5** (50.3–65.2 m): Dolostone; fine to medium crystalline; dark grey, weathers dark grey; bedding thickness 90 cm to 3 m; slightly silty and slightly fetid at bottom half of unit

**Unit 4** (43.6–50.3 m): Silty dolostone; medium to coarse crystalline; grey, weathers grey; bedding thickness > 2 m, some coarse crystalline calcite-filled vugs present

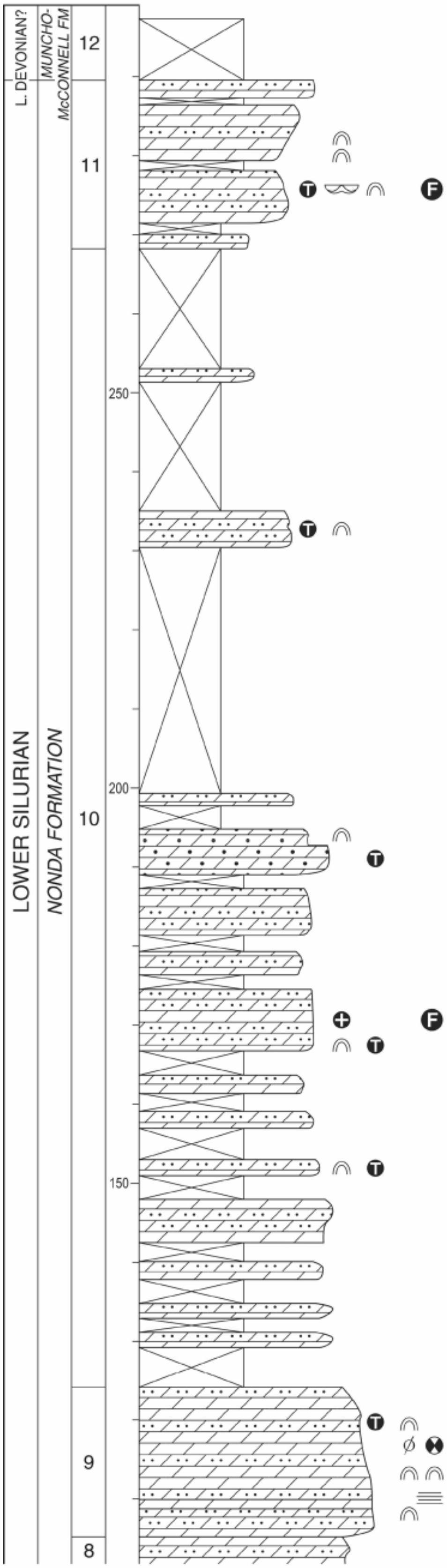
**Unit 3** (37.8–43.6 m): Silty dolostone; very fine crystalline; grey, weathers light grey; bedding thickness 60 cm to 2 m, poorly developed lamination

**Unit 2** (1.5–37.8 m): Silty dolostone; very fine to medium crystalline; dark grey and grey, weathers dark grey; bedding thickness 30 cm to > 2 m; rare grey beds at bottom of unit; 1% large, calcite-filled vugs around 25 m, up to 0.5% drusy cavity porosity in top quarter of unit. Fault present
O-69779 (7.6–12.8 m)

**Unit 1** (0–1.5 m): Dolostone, silty dolostone. Dolostone: fine crystalline; brown-grey, weathers grey, brown-grey and light brown-grey; bedding thickness 1–8 cm, weathers platy. Silty dolostone: bedding thickness 15–46 cm; 034/26 SE at bottom of unit. Large covered interval is estimated to be 61 m. Outcrop below covered interval located in creek east of the rest of the section; silty dolostone, quartz sandstone, and mudstone
O-69778 (0.3–0.6 m)
O-69777 (0.0–0.2 m)

**Figure A1.** Caribou Range (note Norford et al., 1967, p. 508).

CARIBOU RANGE SECTION, page 2 of 2




**Unit 12** (289.6 m–end of section): Float of earthy dolostone; microcrystalline to very fine crystalline; dark yellow-grey, weathers pale orange; weathers blocky

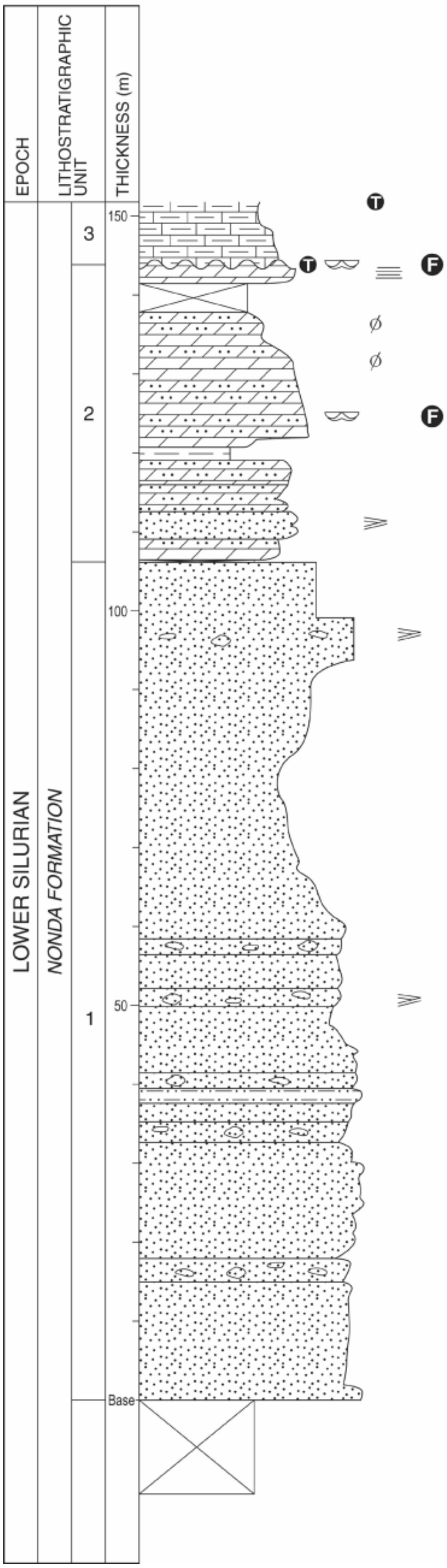
**Unit 11** (268.2–289.6 m): Dolostone and silty dolostone. Dolostone: fine to coarse crystalline; grey, weathers light grey and light olive-grey; bedding thickness 15–90 cm; slightly silty. Silty dolostone: fine to medium crystalline; grey, weathers light grey; bedding thickness 30 cm to 1 m; at bottom of unit, rare beds weather grey; bedding attitude at bottom of unit: 017/26 SE, at top of unit: 016/25 SE
O-69781 (275.8–276.1 m)

**Unit 10** (124.1–268.2 m): Thick, poorly exposed interval. Top half is largely covered with local outcrops of silty dolostone. Silty dolostone: weathers grey and dark grey; interbedded grey and dark grey weathering dolostone around 233 m. Bottom half of unit is silty dolostone: weathers light grey, grey and dark grey; at 186.5 m, light grey weathering dolostone present: arenaceous; fine to medium crystalline; bedding thickness 15 cm to 1 m; contains minor dark dolostone; resistant around 190 m. At 170.7 m, dark grey weathering dolostone present: bedding thickness 46–60 cm. At bottom of unit, bedding attitude 015/25 SE, around 157 m, 008/27 SE, and around 188 m, 005/20 SE
O-69780 (170.7–173.7 m)

**Unit 9** (105.2–124.1 m): Dolostone and silty dolostone. Dolostone (in top third of unit): fine to medium crystalline; dark grey, weathers dark grey; bedding thickness 60 cm to 2 m; stromatoporoids are common at the base of a superjacent dark dolostone bed; rock is slightly silty and fetid in top third of unit and contains 20% grey weathering, barren dolostone, coarse crystalline calcite vugs, and 5–10% drusy cavity porosity, around 110 m dolostone is light grey and has poorly developed lamination. Silty dolostone: fine crystalline; grey, weathers grey and dark grey; bedding thickness 30–90 cm, laminated.
**Unit 8** (99.1–105.2 m): See previous page for description.

**Figure A1. (Cont.)** Caribou Range (note Norford et al., 1967, p. 508).

TROUT RIVER SECTION




**Unit 3** (143.9–153.9 m): Argillaceous limestone; microcrystalline to very fine crystalline; dark blue-grey and dark black-grey, weathers dull brown-grey, brown-grey, grey, and light grey; bedding thickness 30 cm to 3 m, cleaved, some nodular beds, weathers rubbly at top of unit; *Favosites* and pentamerid present; erosion surface between Units 2 and 3
O-45570 (143.9–147.8 m)

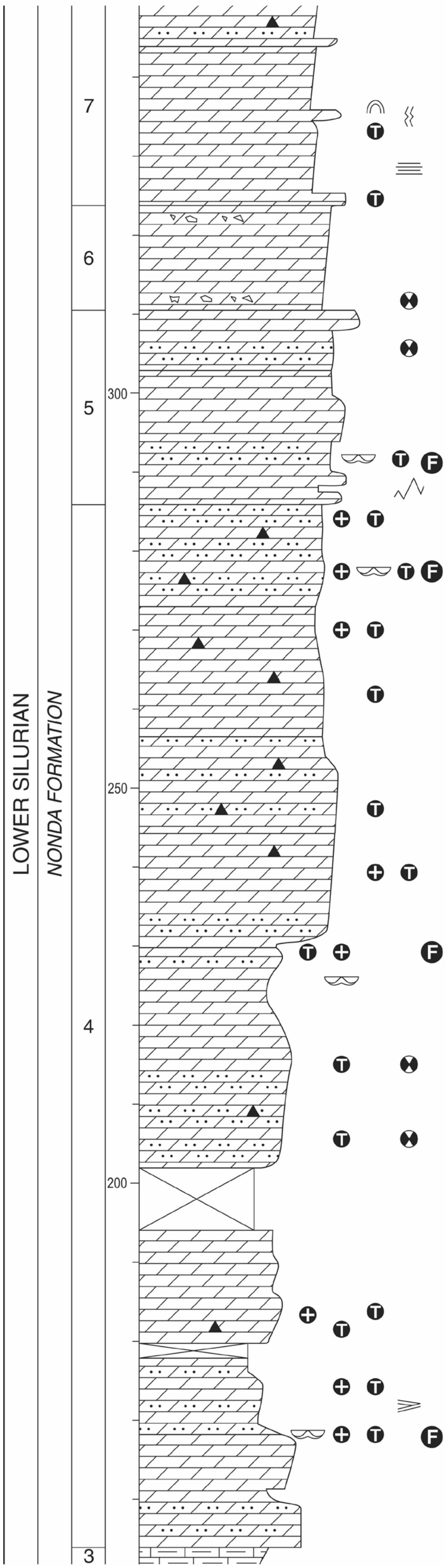
**Unit 2** (106.1–143.9 m): Dolostone, shale, argillaceous quartz sandstone, dolomitic quartz sandstone, and quartz sandstone. Dolostone: microcrystalline to medium crystalline; light grey, grey, dark grey, and brown-grey, weathers light grey, dull grey, dull dark grey, dull brown-grey, and yellowish brown; bedding thickness 8–90 cm, some lamination, at 137–141 m rock contains 1–5% vuggy porosity and dolomite stringers; pentamerid present; locally slightly silty to very silty, contains some sandy beds in bottom half of unit. Shale: 46 cm thick at 123 m. Quartz sandstone: pale yellow, weathers yellowish white, and light brown; bedding thickness 15–60 cm, crosslaminated. Contact between Units 2 and 1 is covered
O-45572 (124.7–125.3 m)

**Unit 1** (0.0–106.1 m): Quartz sandstone interbedded with quartz sandstone pebble conglomerate. Quartz sandstone: off-white, yellowish white, grey, and greenish dark grey, weathers yellowish white, off-white, rusty brown-grey, and white-grey, lichens or lichen stains present; bedding thickness 30 cm to 2 m; some dolostone grains at bottom of unit, some amethyst grains around 35 m, outcrop partly covered from 15% around 38 m to 40% around 76 m, rare siltstone at 38 m. At 61 m, 85% of outcrop is quartz sandstone, 15% conglomerate. Quartz sandstone pebble conglomerate: subangular to well rounded, small to large pebbles, poorly sorted; pale yellowish white, weathers off-white, lichen stains present; crosslamination common; pebble conglomerate beds at 15–18 m

**Pre-Unit 1:** Base of section taken at first outcrop concordant with section. Some problematic similar quartz sandstones 90 m to east. Probably faults with high dip. Below covered interval (apparently conformable) silty shale and minor siltstone. Silty shale: green-grey, weathers light brown to yellow-brown; bedding thickness 15–60 cm

**Figure A2.** Trout River, type section of the Muncho-McConnell Formation.

TROUT RIVER SECTION, page 2 of 6




**Unit 7** (323.7–389.2 m): Dolostone; very fine crystalline to medium crystalline; grey and dark grey, weathers grey, light grey, dull dark grey, dull grey, and dark grey; bedding thickness 15 cm to over 2 m, poorly developed in some places, laminated in some places, dolomitic veins and vugs present, dolomitic stringers near bottom of unit; at 365–370 m poorly silicified fossils and abundant ghost fossils; locally slightly silty to silty, around 360 m some beds are sedimentary breccias, some with subjacent erosion, conglomerate bed at 356 m, chert nodule bed at 355 m, light grey dolostone interbeds at 338 m and bottom of unit, irregular silica nodules around 340 m

**Unit 6** (310.9–323.7 m): Dolostone; very fine to fine crystalline; dark grey, weathers dull dark grey; bedding thickness 30 cm to 1 m, irregular dolomite stringers throughout, poorly developed towards top of unit, dolomite vugs in bottom half of unit; breccia bed present at 323 m, dolomite breccia at bottom of unit

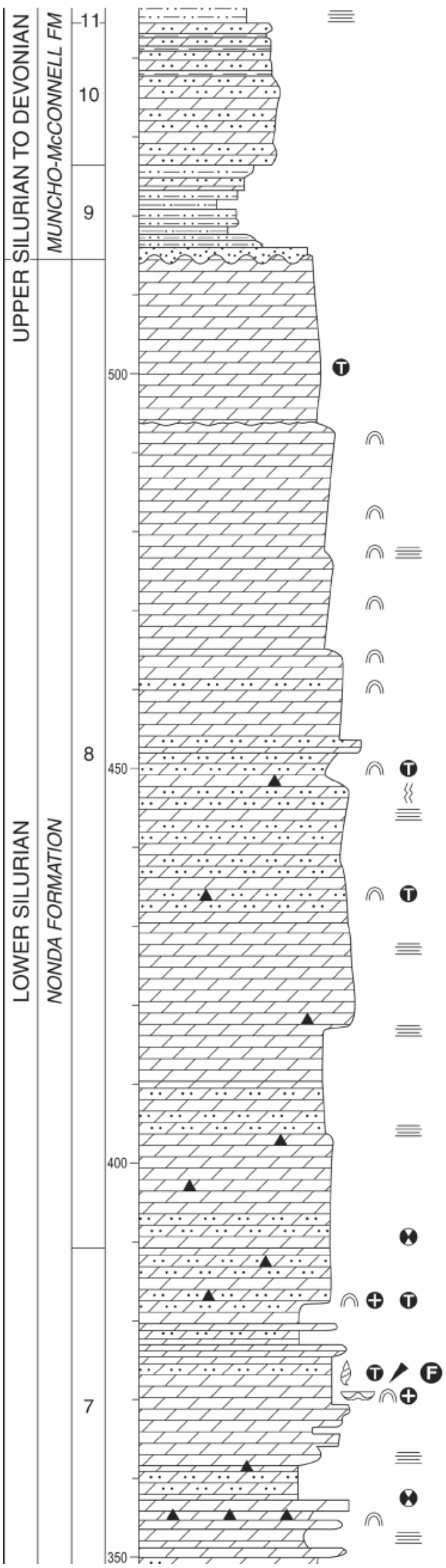
**Unit 5** (285.9–310.9 m): Dolostone; microcrystalline to fine crystalline; dark grey, grey, dull grey, dull dark grey, and light grey, weathers dull dark grey and light grey; bedding thickness 15 cm to 2 m, irregular dolomite vugs at top of unit, contains irregular silicification layers around 300 m, stylolites present at bottom of unit; *Camarotoechia* and *Syringopora* present around 292 m; locally silty, contains light grey interbeds in bottom quarter of unit, red stains on bedding around 292 m
O-45523 (291.1–292.6 m)

**Unit 4** (153.9–285.9 m): Dolostone; microcrystalline to very fine crystalline; grey, dark grey, brown-tinged dark grey, and light grey, weathers dull dark grey, dull grey, light grey, and light buff; bedding thickness 5 cm to 3 m, 5–60 cm partings in upper third of unit, 5 cm partings at 168 m, at 230 m bedding is well developed, coarse crosslamination, weathers rubbly at lower quarter and middle of unit, dolomite stringers throughout, dolomite vugs present around 215 m; *Camarotoechia?* at 229 m, *Syringopora* around 213 m; locally slightly silty to silty, grades up into dark-weathering dolostones in top half of unit, light-grey-weathering beds at 158 m, rusty stains on bedding around 235 m, contains 1% yellow-weathering chert nodules around 260 m, slightly fetid around 207 and 265 m. Poor intermittent outcrop around 158 m
O-45569 (277.4–280.4 m)
O-45568 (229.2–230.1 m)
O-45571 (167.9–175.3 m)

**Unit 3** (143.9–153.9 m): See previous page for description

**Figure A2. (Cont.)** Trout River, type section of the Muncho-McConnell Formation.

TROUT RIVER SECTION, page 3 of 6




**Unit 11** (544.4–555.3 m): Siltstone and shale. Siltstone: grey, light brown to light brown-grey, weathers light brown and light yellow to yellowish grey; bedding thickness 60 cm to 2 m, poorly developed, some lamination. Shale: dark brown; silty

**Unit 10** (526.4–544.4 m): Silty to very silty dolostone; microcrystalline to fine crystalline; grey, mauve-tinged grey, and yellowish grey, weathers light grey, and light buff; bedding thickness 30–90 cm; contains brown shaly interbeds at 541–543 m

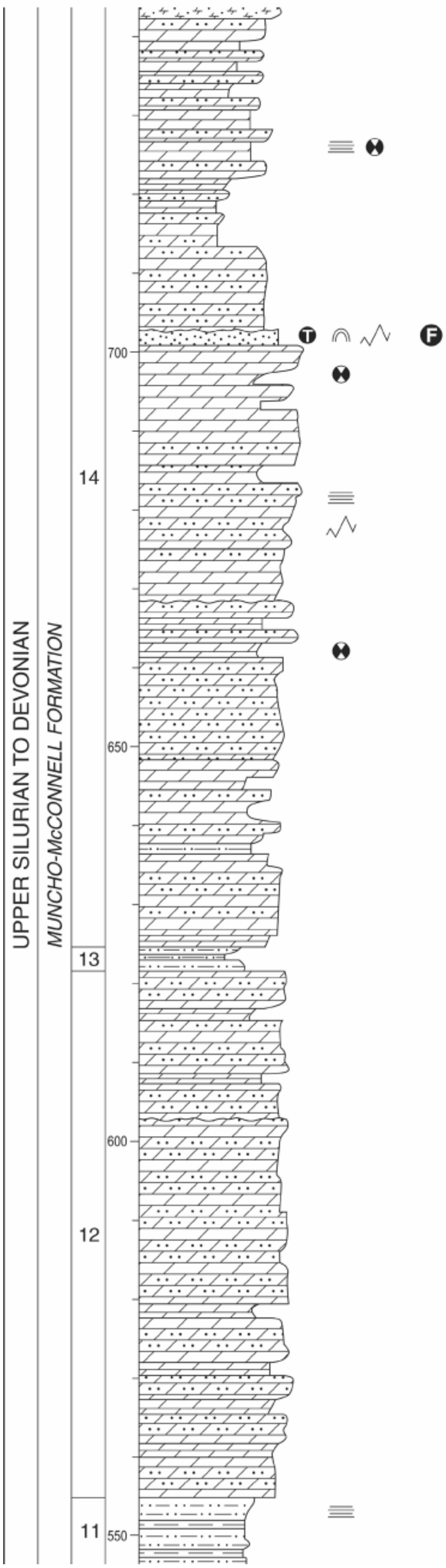
**Unit 9** (514.5–526.4 m): Dolostone, siltstone, argillite, and quartz sandstone. Dolostone: very fine crystalline; dark grey, weathers dark grey and green-grey; slightly silty. Siltstone: green-grey, weathers brown-grey and mud brown; bedding thickness 15 cm to 1 m. Argillite: weathers mauve. At bottom of unit, irregular, basal, quartz sandstone bed 15–30 cm thick overlies a 20 cm deep erosion surface

**Unit 8** (389.2–514.5 m): Dolostone; microcrystalline to coarse crystalline; grey, flesh-grey, and dark grey, weathers dull grey, grey, dull dark grey, dull brown grey, black grey, and light grey; bedding thickness 30 cm to 2 m, poorly developed in some places, laminated in some places, weathers granular around 466 m, abundant dolomite veins around 448 m, rare irregular silicification at top of unit and around 514 m, rare dolomite vugs and irregular cherty bodies at bottom of unit; at 466 m contains 30% silicified stromatoporoids, *Favosites* at 501 m; locally silty, contains 90% dark-grey-weathering beds at 429 m, 5% light grey interbeds around 450 m, 10% lighter-grey-weathering dolostone around 415 m, 30 cm thick light-grey-weathering bed at 442 m, 60 cm thick lighter-grey-weathering dolostone at 415 m, somewhat fetid around 433 m, erosion surface present at 496 m

**Unit 7** (323.7–389.2 m): See previous page for description
O-45573 (373.4–375.2 m)

**Figure A2. (Cont.)** Trout River, type section of the Muncho-McConnell Formation.

TROUT RIVER SECTION, page 4 of 6




**Unit 14** (624.7–780.0 m): Dolostone, dolomitic sandstone, quartz sandstone, argillite. Dolostone: microcrystalline to fine crystalline; dark grey, grey, light grey, light brown-grey, weathers dull dark grey, light grey, grey, and dark grey; bedding thickness 8 cm to 2 m, laminated in some places, stylolites present, silica vugs in middle of unit, silica stringers around 724 m; 0–75% of beds dark grey dolostones, 10–70% of beds light grey dolostones, locally slightly silty to very silty, contains 60% light grey silty dolostones at 667 m, contains sandy layers around 748 m, at 713–722 m outcrop is intermittent, erosion surface 20 cm deep at 668 m. Dolomitic sandstone: grey, weathers light grey and light buff-grey; bedding thickness 30 cm. Quartz sandstone: at 701 m, off-white, weathers white, lichens present; 76 cm thick. Argillite: minor silty argillite at 636 m; weathers light brown
O-45616 (702.0–780.0 m)

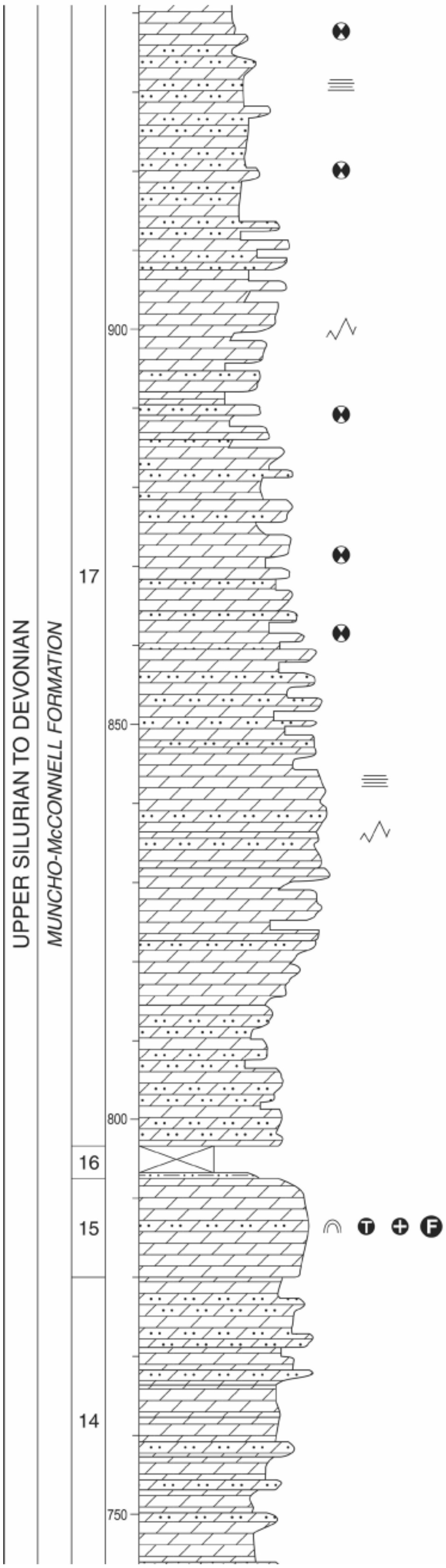
**Unit 13** (621.6–624.7 m): Siltstone and argillite. Siltstone: dark grey, weathers light buff; bedding thickness 30–60 cm. Argillite: mauve-grey. About 1 m of unit is not exposed

**Unit 12** (555.3–621.6 m): Dolostone; microcrystalline to very fine crystalline; dark grey, grey, and brown-grey, weathers light grey, light buff grey, and dark yellowish grey, yellow stains around 590 m; bedding thickness 15–90 cm, well developed around 590 m and 570 m, khaki-brown partings along some bedding planes at 590 m, argillaceous partings at 570 m; locally slightly silty to silty, 5–15% of beds are dark grey to dark-brown-grey-weathering dolostones, around 558 m 90% of beds are light-grey-weathering dolostones, in upper half of unit 90–97% of beds are light-grey-weathering silty dolostones, 5 cm thick interbeds of silty shale at 601 m

**Unit 11** (544.4–555.3 m): See previous page for description

**Figure A2. (Cont.)** Trout River, type section of the Muncho-McConnell Formation.

TROUT RIVER SECTION, page 5 of 6




**Unit 17** (796.7–964.7 m): Dolostone; microcrystalline to finely crystalline; dark grey, grey, dull grey, light grey, and mauve-grey, weathers dull grey, dull dark grey, dark grey, light grey, and light yellowish-grey; bedding thickness 5 cm to over 2 m, red stains on bedding around 876 m, laminated in some places, well developed bedding at bottom fifth of unit, 5 cm partings at top of unit, weathers platy around 820 m, weathers rubbly around 953 m, rare styliolites, dolomite stringers and vugs present, 2 m thick bed of abundant dolomite stringers and vugs at 861–863 m, quartz vugs around 888 m; 10–90% of beds dark-weathering dolostones, 10–80% of beds more resistant light-grey-weathering dolostone, locally slightly silty to silty, contains very minor brown argillite around 910 m

**Unit 16** (792.5–796.7 m): Mostly covered siltstone; light green-grey, weathers dull yellowish brown; bedding thickness about 30 cm

**Unit 15** (780.0–792.5 m): Dolostone; very fine crystalline; light grey and grey, weathers grey and light grey; bedding thickness 30 cm to 2 m; locally slightly silty, poor silicification in top half of unit
O-45615 (786.4–789.4 m)

**Unit 14** (624.7–780.0 m): See previous page for description

**Figure A2. (Cont.)** Trout River, type section of the Muncho-McConnell Formation.

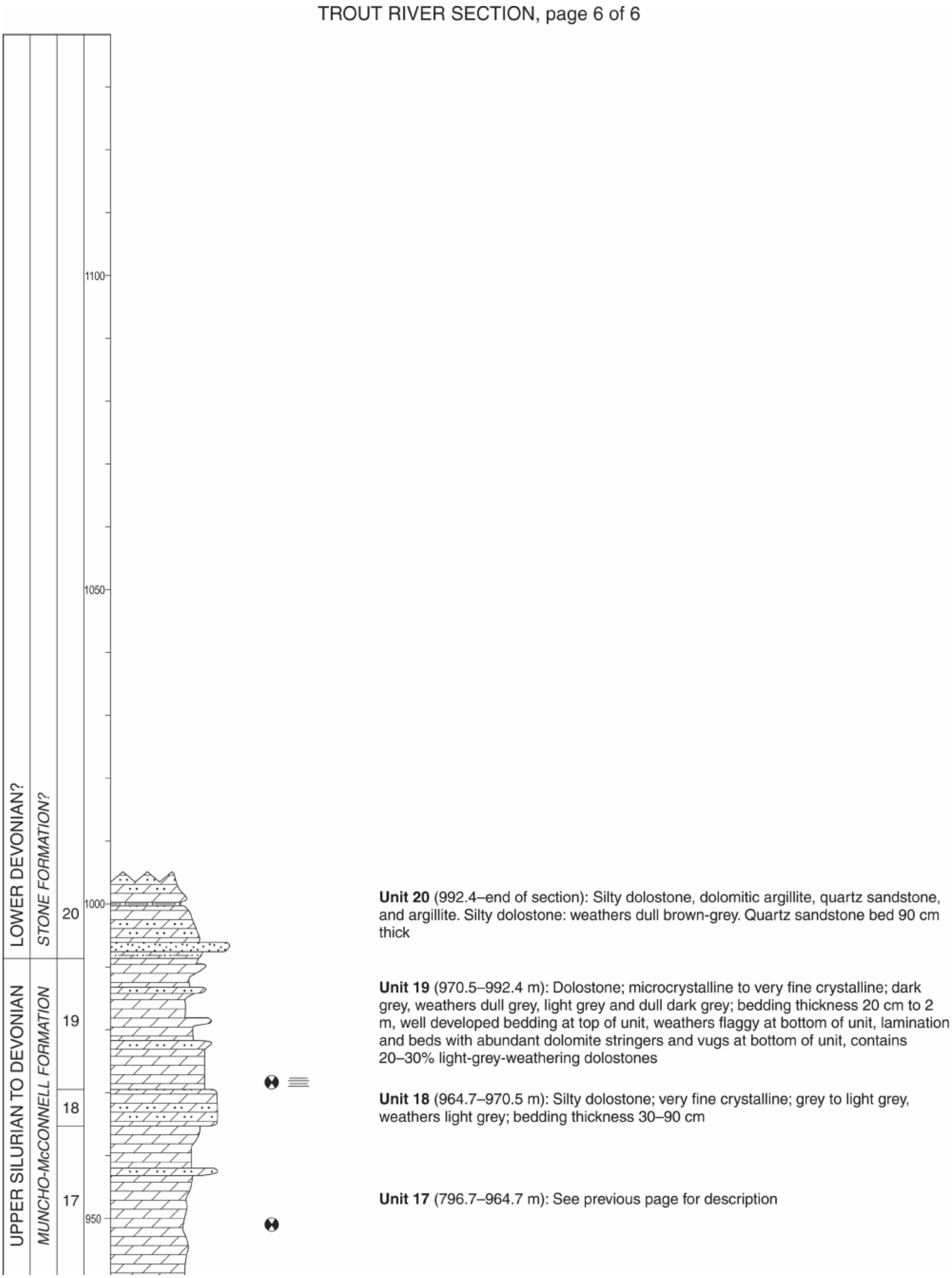
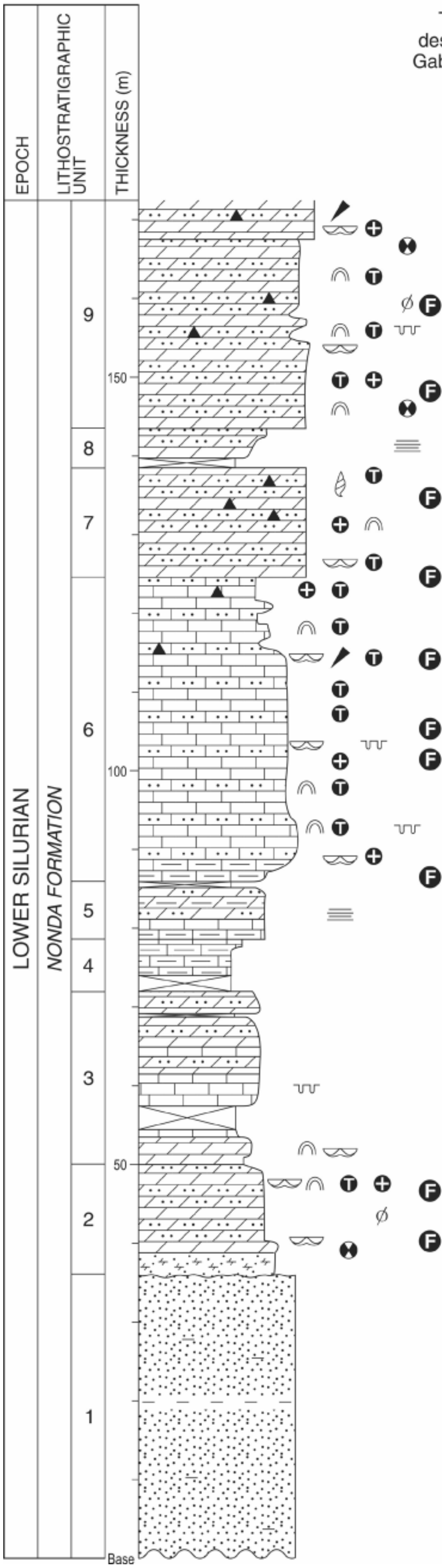



**Figure A2. (Cont.)** Trout River, type section of the Muncho-McConnell Formation.

## TOAD RIVER BRIDGE SECTION

Type section of the Nonda Formation; description given in more detail in Norford, Gabrielse and Taylor, 1967, p. 507, 515-519




**Unit 9** (143.6–196.0 m): Slightly silty and silty dolostone, dolostone. Slightly silty dolostone: fine crystalline; dark grey, weathers light grey, dark dull grey, and dull dark brown-grey; bedding over 2 m, contains 1% irregular chert nodules, from 146.3 m on contains 1% very large calcite-filled vugs, dolomitic stringers present. Silty dolostone: very fine crystalline; dark grey, weathers dull grey and dull dark grey; bedding thickness 15 cm to 30 m, indistinct, at 121–122 m rock contains 1% drusy cavity porosity, rare dolomite-filled vugs; some beds mottled slightly on weathered surface, irregular silicification at 142.6 m. Dolostone (119.2–120.1 m): weathers light grey; less resistant than other rocks in unit, dolomite stringers, rare calcite-filled vugs
O-64547 (159.1–167.4 m)
O-64548 (148.2–153.0 m)

**Unit 8** (138.7–143.6 m): Silty dolostone; very fine crystalline; dark grey, weathers light grey and yellow-grey; bedding thickness 15–38 cm, well-developed bedding, mostly laminated

**Unit 7** (124.7–138.7 m): Silty dolostone; very fine to medium crystalline; dark grey, weathers dull dark grey, dull grey, and dull light grey; bedding thickness 61 cm to 2 m; *Columnaria columbia* at 132–134 m; at 135–138 m contains 5% irregular chert layers, irregular calcification above 132 m
O-64549 (134.8–138.7 m)
O-64550 (124.7–134.8 m)

**Unit 6** (86.0–124.7 m): Limestone; microcrystalline to very fine crystalline, rare larger grains at bottom of unit; dark grey, weathers light grey, grey, dark grey, and olive-grey; bedding thickness 61 cm to 1 m, weathers platy at top of unit, rubbly in upper 2/3 of unit and flaggy at bottom of unit, calcite stringers at bottom of unit; *Favosites* common, abundant at top of unit; upper 4/5 of unit is silty, argillaceous at bottom of unit, some dolomitic mottling, orientation 342/5 NE
O-64551 (114.6–121.3 m)
O-64552 (105.2–106.1 m)
O-64553 (101.5–103.7 m)
O-64554 (86.6–89.3 m)

**Unit 5** (78.7–86.0 m): Silty dolostone and limestone. Silty dolostone: microcrystalline to very fine-grained; dark grey, weathers light olive-grey; bedding thickness 15–30 cm; at 85.4–85.7 m beds weather very light yellow, many beds are laminated; contains 40% platy-weathering argillaceous dolostone, bedding thickness weathers 0.5–3 cm. Limestone (78.7–80.2 m): microcrystalline; light brown-grey, weathers very light grey; bedding thickness around 30 cm

**Unit 4** (72.0–78.7 m): Argillaceous limestone; microcrystalline to very fine-grained; dark grey, weathers dull grey; bedding thickness 5–15 cm, poorly cleaved, cleavage is not parallel to bedding, calcite stringers present; contains 10% less argillaceous, more resistant limestone beds, bedding thickness 8–30 cm

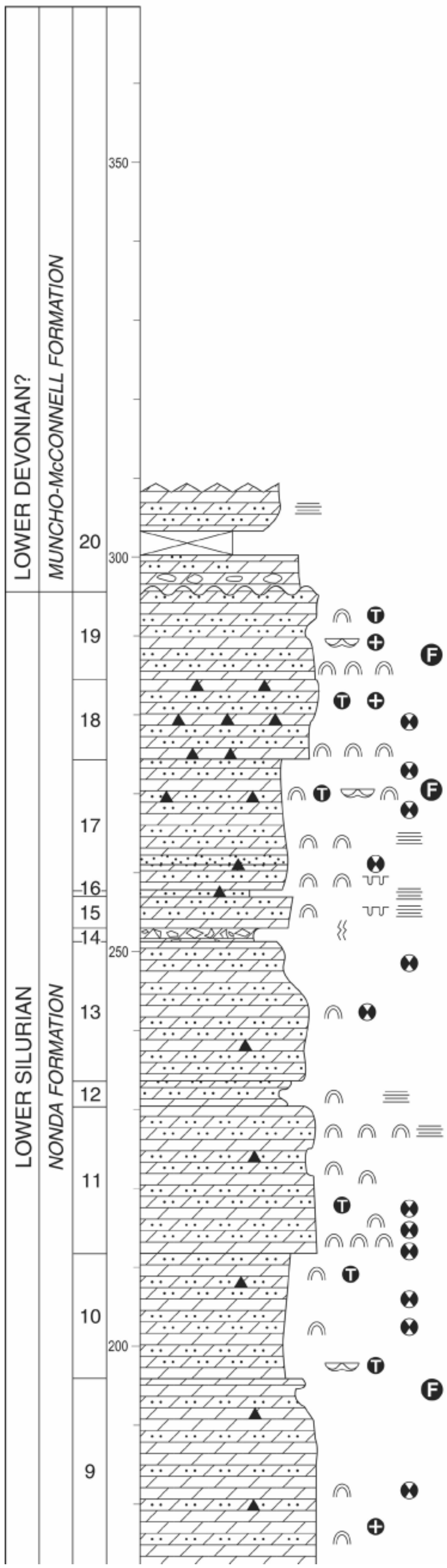
**Unit 3** (50.0–72.0 m): Silty dolostone, limestone, and dolostone. Silty dolostone: very finely crystalline, 5% coarsely crystalline; dark grey, weathers dull grey; bedding thickness 15–31 cm, indistinct, dolomite stringers. Limestone: microcrystalline to very fine crystalline; brown olive-grey and dark grey, weathers very light grey; bedding thickness 20–61 cm, some beds weather rubbly, some beds dolomite-mottled, calcite stringers. Dolostone: fine to medium crystalline; dark brown-grey, weathers light grey, dull grey and pale yellow-brown; bedding thickness 30 cm to 1 m, indistinct

**Unit 2** (36.0–50.0 m): Silty dolostone and quartz sandstone. Silty dolostone: fine- to coarse-grained; brown-grey, brown, dark yellow-brown, weathers dull grey, light brown, yellow brown, and pale yellow-brown; bedding 8 cm to 2 m, sparse calcite-filled vugs at base. Dolomitic quartz sandstone: very fine crystalline matrix, well-rounded, fine to very coarse quartz sand grains; light yellow-brown, weathers yellow-brown; bedding: 3–8 cm
O-64555 (46.7–47.9 m)
O-64556 (40.3–40.6 m)

**Unit 1** (0.0–36.0 m): Quartz sandstone; very fine- to coarse-grained; yellow-brown and off-white, weathers very pale orange; bedding thickness 0.3–6 m, orientation 301/22 NE, some lamination and crosslamination; angular unconformity beneath unit 1 above ?Precambrian rocks; argillaceous with layers and patches of argillaceous material, minor interbedded shaly mudstones, abundant lichens

**Figure A3.** Toad River Bridge, type section of the Nonda Formation (note Norford et al., 1967, p. 507, 508; Jin and Norford, 1992, p. 779).

TOAD RIVER BRIDGE SECTION, page 2 of 2




**Unit 20** (295.7–end of section): Silty dolostone and conglomerate. Silty dolostone: very fine crystalline; dark grey, weathers yellow-grey, light grey, and olive-grey; bedding thickness 15–60 cm, well developed, laminated; argillite at 303.3–303.9 m. Conglomerate: monomict pebbles to coarse cobbles of silty dolostone (coarsely to medium crystalline), subround to round grains; grey, weathers dull light grey; bedding thickness around 2 m; patches and layers of subangular, dark-grey-weathering chert pebbles

**Unit 19** (284.7–295.7 m): Dolostone and silty dolostone; coarse crystalline; dark grey, weathers light grey and dull grey; bedding thickness 30–90 cm; contact between units 18 and 19 (Muncho-McConnell Formation) is a shallow erosion surface that cuts out bed (295.4–295.7 m) laterally; silty dolostone is microcrystalline to very fine crystalline, interbedded with stromatoporoid-bearing dark grey, grey, and dark olive-grey weathered beds, contains 25% stromatoporoids at 287.8–289.9 m, 295.4–295.7 m, 8% at 292.9–293.3 m
O-64544 (287.8–293.3 m)
O-64544 (287.8–293.3 m)

**Unit 18** (274.4–284.7 m): Silty dolostone; fine to medium crystalline; dark brown-grey, weathers dull dark grey; bedding thickness over 2 m, thick bed at 274.7 m, 20–40% chert nodules present, 10% large coarsely crystalline calcite-filled vugs; contains 10% stromatoporoids

**Unit 17** (257.9–274.4 m): Silty dolostone; fine to medium crystalline; dark grey, weathers dull dark olive-grey, dark grey, yellow-grey, and dull dark grey; bedding thickness 30 cm to 2 m, indistinct at top of unit, in bottom half of unit some beds weather mottled, quartz sand laminae present at 258.8–259.1 m and 260–260.2 m, coarse crystalline calcite-filled vugs from 260.9–261.1 m, dolomite stringers present at top of unit; contains 20% silicified stromatoporoids at 262.5–263 m and 264–264.4 m, 10% at 264.9–265.2 m and 272.2–272.8 m and 15% at 273.1–273.7 m; rare irregular silicification
O-64545 (270.7–272.2 m)

**Unit 16** (257.0–257.9 m): Silty dolostone; dark grey, weathers light grey and light yellow-grey; bedding thickness 6–23 cm, finely laminated, recessive

**Unit 15** (253.0–257.0 m): Silty dolostone; fine to medium crystalline; brown-grey, weathers dull grey, dull dark olive-grey and dull dark grey; bedding thickness around 4 m, some beds are mottled, fine dolomite stringers present

**Unit 14** (251.2–253.0 m): Silty, dolomitic breccia; very fine crystalline matrix; dark grey, weathers light grey, very light grey and yellow-grey; laminated blocks are slightly displaced in a 2 m thick bed, collapse breccia?, contains 5% irregular coarse crystalline calcite veins

**Unit 13** (246.0–251.2 m): Silty dolostone; fine to medium crystalline; dark grey and dark brown-grey, weathers dull grey and dull olive brown-grey; bedding thickness over 2 m, indistinct at bottom of unit; 25–30% of beds contain 10–20% coarsely crystalline calcite-filled vugs that are leached on weathered surfaces

**Unit 12** (230.5–246.0 m): Silty dolostone; very fine crystalline; brown-grey, weathers light grey; bedding thickness around 45 cm, finely laminated; 10% stromatoporoids from 231–233 m contains 60% interbedded dark olive-grey weathered dolostone with poorly developed lamination

**Unit 11** (211.9–230.5 m): Silty dolostone; very fine to fine crystalline; dark grey, weathers dull grey, dull dark grey and dull olive-grey; bedding thickness 30 cm to 2 m, bedding is indistinct at top of unit, some beds have poorly developed lamination, some beds weather pocked (leached calcite vugs); at 214–216 m, 217.7–218 m, 227.7–228 m and 228.9–230 m rock contains 5–20% stromatoporoids; at 211.9–212.9 m, rock contains 10% silicified stromatoporoids and coarse crystalline calcite-filled vugs

**Unit 10** (196.0–211.9 m): Silty dolostone; microcrystalline to fine crystalline; dark grey, weathers dull dark grey, olive-grey, dull grey, and light grey, at top of unit 20% of beds weather light grey, at middle of unit 40% of beds weather dark grey and olive-grey; bedding thickness 23 cm to 2 m, well-developed bedding dominates top half of unit, rare coarse crystalline calcite-filled vugs; *Syringopora* present; interbedded light grey and dark grey dolostones at bottom of unit, chert layers and 10% irregular calcification at 209.4–209.7 m
O-64546 (194.5–203.6 m)

**Unit 9** (143.6–196.0 m): See previous page for description

**Figure A3. (Cont.)** Toad River Bridge, type section of the Nonda Formation (note Norford et al., 1967, p. 507, 508; Jin and Norford, 1992, p. 779).

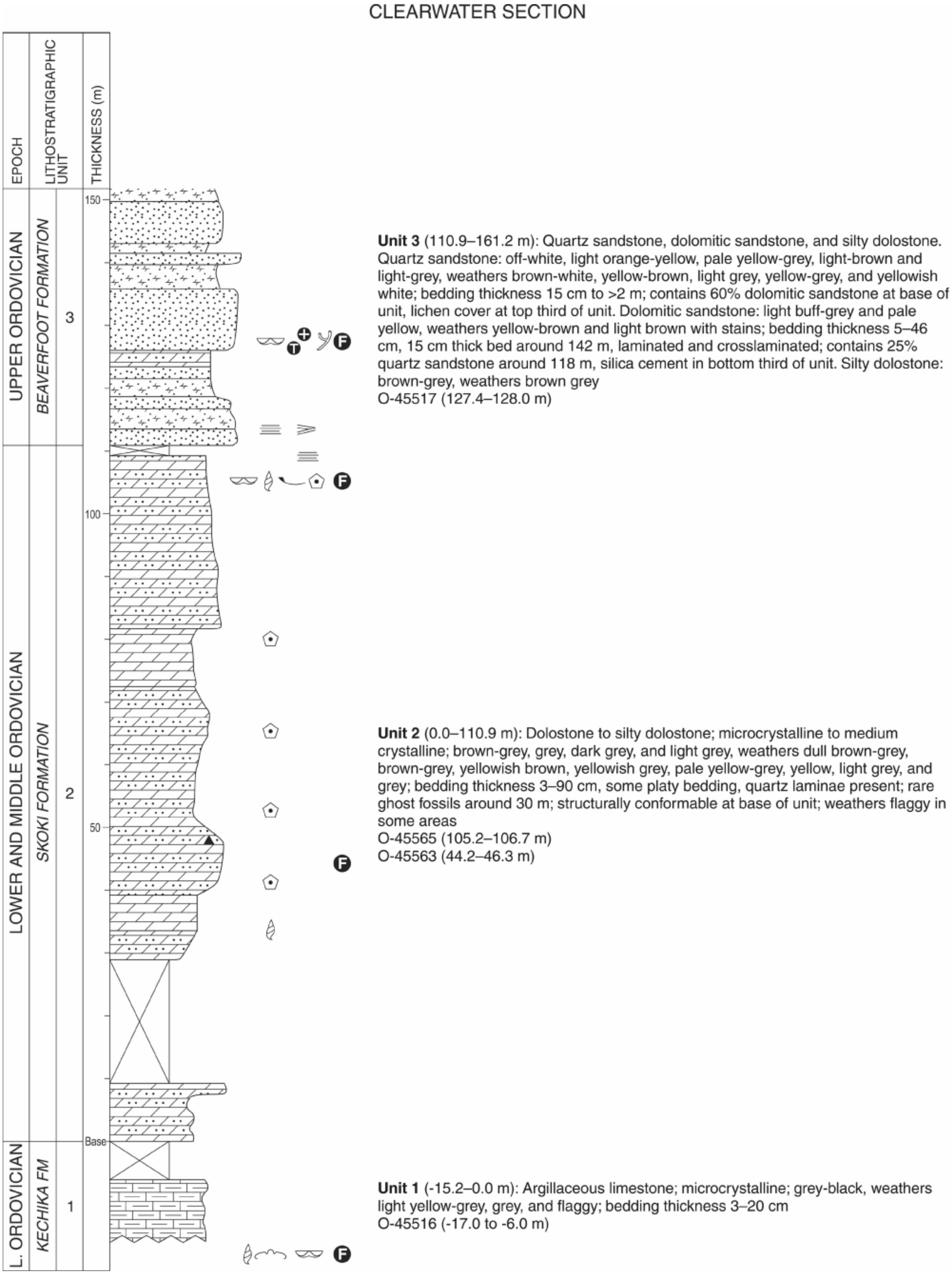
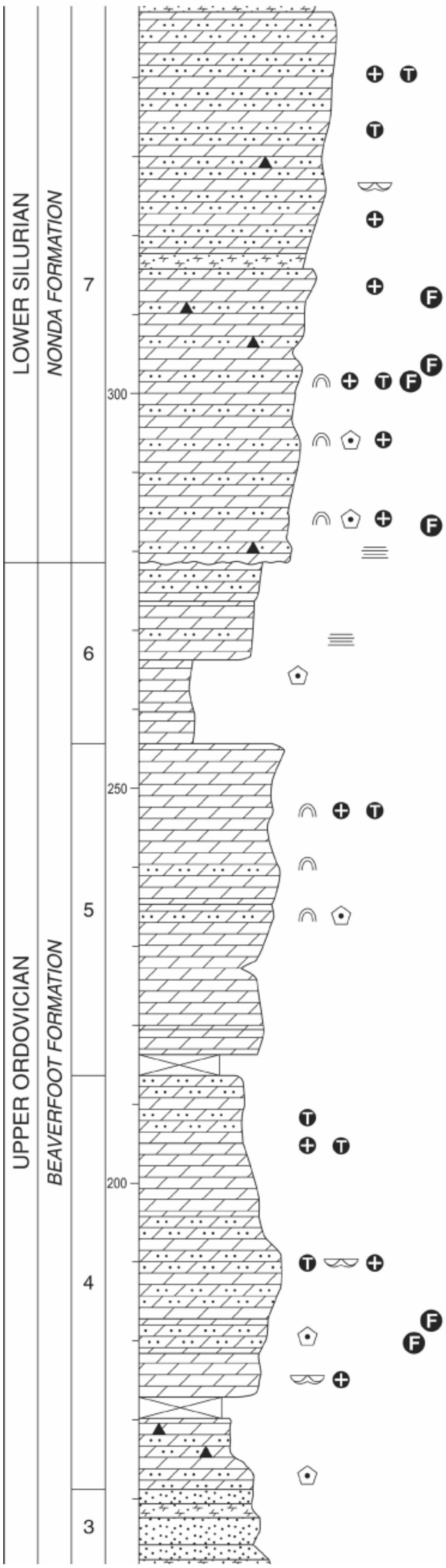



**Figure A4.** Clearwater (note Norford, 1965, p. 46, 47).

CLEARWATER SECTION, page 2 of 6




**Unit 7** (278.6–353.6 m): Silty dolostone, dolostone, and dolomitic sandstone. Silty dolostone: microcrystalline to fine crystalline; yellow-grey, grey, brown-grey, light grey, and dark grey, weathers light grey, grey, yellow-grey, and pale yellow-grey; bedding thickness 60 cm to >2 m; *Columnaria columbia* from 310–315 m; locally contains about 3–5% chert nodules, irregular silicification at 345 m, rare silty laminae at 285 and 334 m. Dolostone: brown-grey and dark grey, weathers brown-grey, grey and dull grey; very fine crystalline; bedding thickness 60 cm to >2 m, rubbly around 303 m; slightly silty, contains 5% rare chert. Dolomitic sandstone at 316 m: light grey, weathers light yellow-grey; 1.2 m thick; contains very fine- to fine-grained quartz sand
O-45614 (312.1–316.7 m)
O-45613 (303.6–308.2 m)
O-45567 (301.5–332.0 m)
O-45562 (283.2–289.3 m)

**Unit 6** (255.7–278.6 m): Silty dolostone and dolostone. Silty dolostone: very fine crystalline; brown-grey and grey, weathers grey and yellow-grey; bedding thickness 15–90 cm; 3 cm deep erosion surface at top of unit. Dolostone: microcrystalline to fine crystalline; brown-grey, dark brown-grey, dark grey, and black-grey, weathers grey, dull brown-grey, light grey, and light brown-grey; bedding thickness 15 cm to >2 m, blocky and rubbly in bottom half of unit, recessive; locally slightly silty; contains 70% dark brown, thin beds in bottom half of unit, contains some sandstone laminae around 269 m

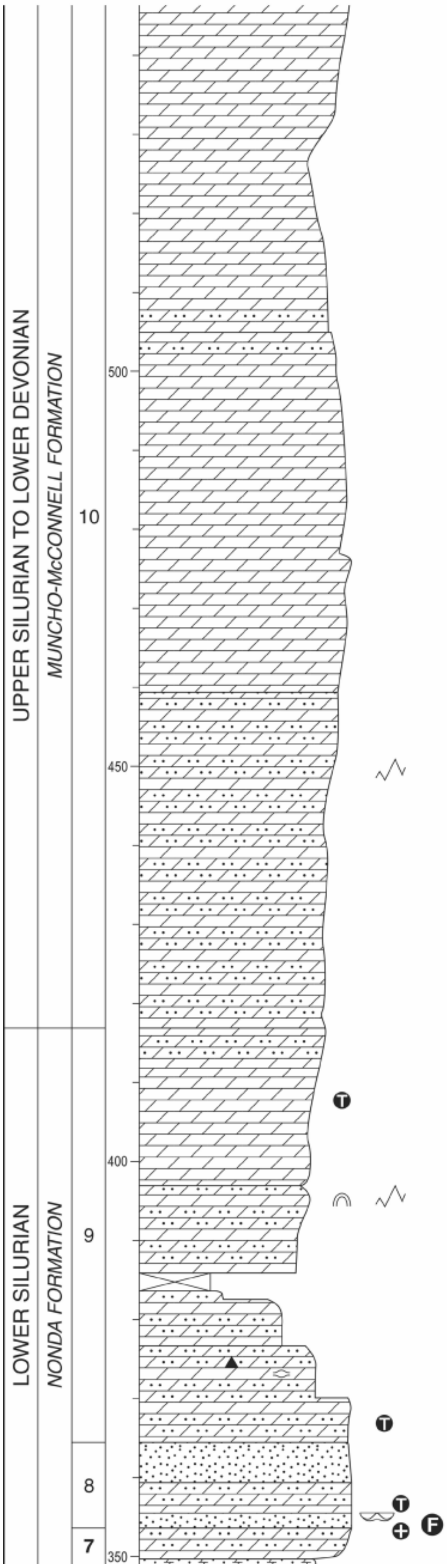
**Unit 5** (213.7–255.7 m): Dolostone: very fine crystalline to fine crystalline; dark brown-grey, brown-grey, grey, and light grey, weathers dull brown-grey, dull grey, and yellow-grey; bedding thickness 30 cm to >2 m, weathers rubbly throughout; poorly preserved silicified fossils around 246 m; locally slightly silty

**Unit 4** (161.2–213.7 m): Silty dolostone and dolostone. Silty dolostone; very fine crystalline to medium crystalline; grey and light grey, weathers grey, light grey, yellow grey, pale yellow-grey, and brown-grey; bedding thickness 15 cm to >2 m, local rubbly weathering; *Bighornia* clasts at 190 m; contains 5%, small pebble sized clasts, quartz sand at base of unit, barren at top of unit. Dolostone: very fine crystalline to fine crystalline; grey, dark grey, dark brown-grey, and brown-grey, weathers light brown-grey, dull grey, dark brown-grey, grey and light grey; bedding thickness 5 cm to >2 m, poorly developed bedding around 174 m, platy bedding around 168 m, weathers rubbly around 205 m; dolomitized corals around 190 m, ghost crinoids around 180 m; locally slightly silty
O-45564 (182.6–190.2 m)
O-45561 (179.8–184.4 m)

**Unit 3** (110.9–161.2 m): See previous page for description

**Figure A4. (Cont.)** Clearwater (note Norford, 1965, p. 46, 47).

CLEARWATER SECTION, page 3 of 6




**Unit 10** (416.9–549.9 m): Dolostone and silty dolostone. Dolostone: microcrystalline; light grey, weathers light grey, yellow-grey, and grey; bedding thickness over 2 m. Silty dolostone: microcrystalline; light grey and brown-grey, weathers pale yellow-grey, light grey, and grey; bedding thickness 90 cm to >2 m; contains 5% quartz sand around 418 and 512 m, rare silica structures around 441 m, rare silica blebs around 512 and 529 m, irregular silica nodules around 373 m, rare stylolites around 449 m

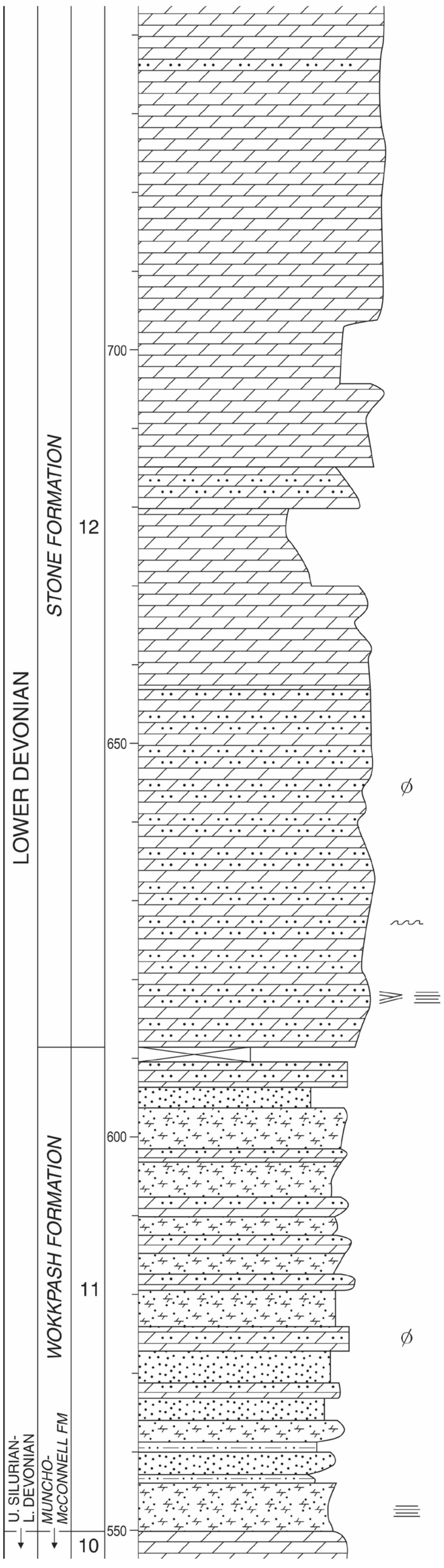
**Unit 9** (364.5–416.9 m): Dolostone and silty dolostone. Dolostone: medium to coarse crystalline; dark grey and light brown-grey, weathers dark grey to dull grey; bedding thickness >2 m. Silty dolostone: fine to coarse crystalline; brown-grey, weathers brown-grey and pale yellowish grey; bedding thickness mostly >2 m; poorly preserved corals at 416 m

**Unit 8** (353.6–364.5 m): Silty dolostone, quartz sandstone, and dolomitic sandstone. Silty dolostone: 50% of unit. Quartz sandstone (30% of unit): very fine to fine grained; light grey and white, weathers off-white. Dolomitic sandstone (20% of unit): bedding thickness 8–60 cm
O-45566 (354.0–366.0 m)

**Unit 7** (278.6–353.6 m): See previous page for description

**Figure A4. (Cont.)** Clearwater (note Norford, 1965, p. 46, 47).

CLEARWATER SECTION, page 4 of 6




**Unit 12** (611.4–878.1 m): Dolostone and silty dolostone. Dolostone: microcrystalline; very light grey, light grey, light yellowish grey, white-grey, and pale brown-grey, weathers light grey, pale yellowish grey, grey, and white-grey; bedding thickness 50 cm to > 2 m, some lamination on weathered surfaces around 753 m, rubbly around 721 m; rare to common stylolites. Silty dolostone: microcrystalline to very fine crystalline; yellowish white, very light grey, light grey, light pinkish grey, and light brown-grey, weathers light yellowish grey, light grey, white-grey, grey and buff-grey; contains 10% vuggy porosity at 644 m, ripple marks around 626 m, laminated and crosslaminated in places; in top1/6 of unit, 23–30% of beds contain quartz sand; 30% dolomitic sandstone at base of unit; rare silicification structures at 653 m

**Unit 11** (549.9–611.4 m): Dolomitic sandstone and silty dolostone. Dolomitic sandstone: grey, light grey, light brown-grey, light brown, and pale yellow-brown, weathers light grey, yellowish grey, pale yellowish grey, yellow-brown, and brown-grey; bedding thickness 15 cm to > 2 m, bedding attitude 278/45 W; contains 65–80% rounded to well rounded, very fine to coarse quartz sand, 20–50% silty dolostone in top half of unit, 10–60% siltstone in bottom half of unit, some silica cement at top and bottom of unit. Silty dolostone: light brown-grey, weathers pale yellow-brown; bedding thickness 30–45 cm, vuggy porosity present

**Unit 10** (416.9–549.9 m): See previous page for description

**Figure A4. (Cont.)** Clearwater (note Norford, 1965, p. 46, 47).

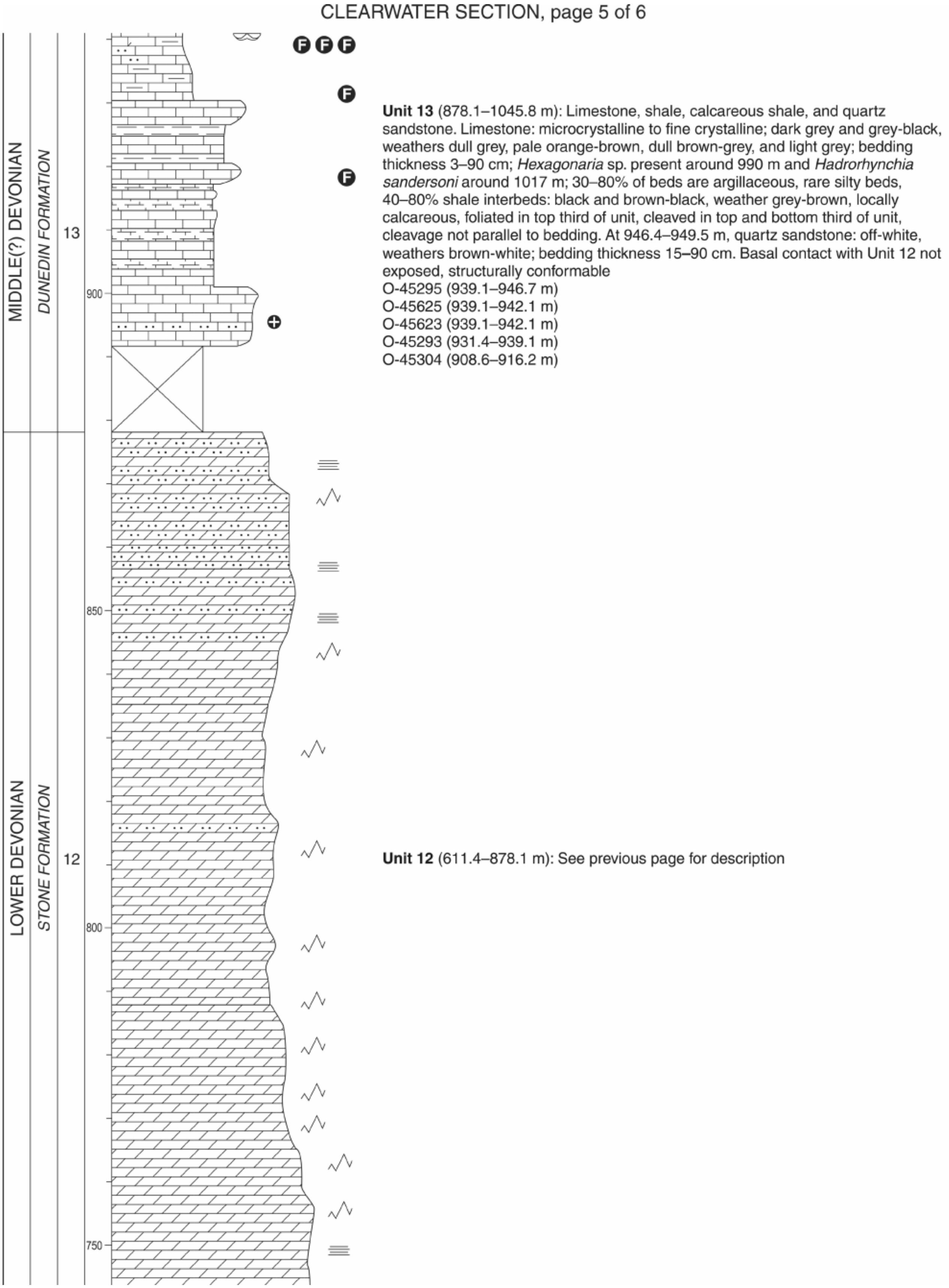
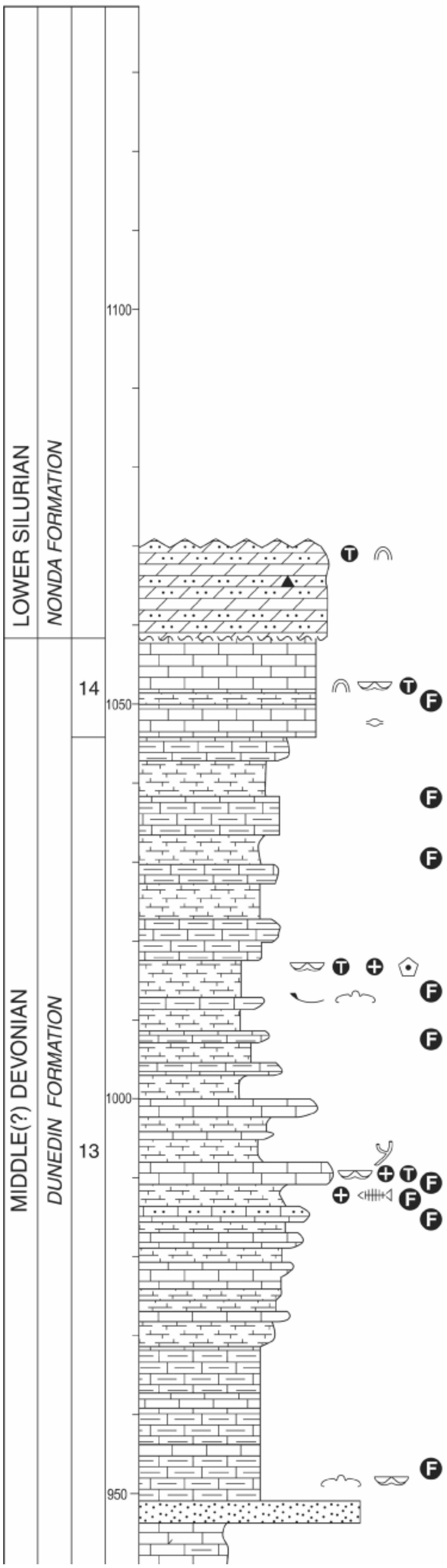



**Figure A4. (Cont.)** Clearwater (note Norford, 1965, p. 46, 47).

CLEARWATER SECTION, page 6 of 6




(1058.3–end of section): Thrust fault; silty dolostone above bears halysitid corals

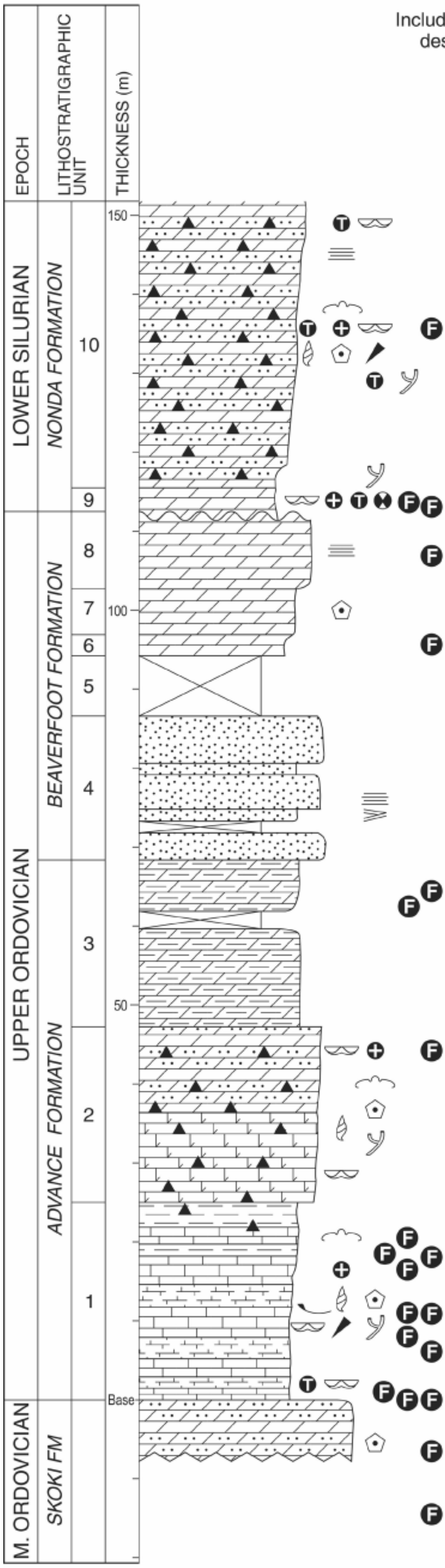
**Unit 14** (1045.8–1058.3 m): Limestone; dark grey, weathers dull grey to light grey; contains 20% calcareous shale beds, some nodular beds; *?Stringocephalus* present around 1053 m
O-45622 (1050.4–1053.4 m)

**Unit 13** (878.1–1045.8 m): See previous page for description
O-45306 (1038.1–1045.7 m)
O-45294 (1030.5–1038.1 m)
O-45620 (1013.7–1019.8 m)
O-47298 (1007.6–1015.2 m)
O-45619 (989.3–992.7 m)
O-45621 (987.2–989.3 m)
O-45303 (984.8–992.7 m)
O-45624 (953.1–953.4 m)

**Figure A4. (Cont.)** Clearwater (note Norford, 1965, p. 46, 47).

## ADVANCE MOUNTAIN SECTION

Includes type section of the Advance Formation; description given in more detail in Norford, 1996, p. 14, figures 2-4.




**Unit 10** (115.5–176.8 m): Dolostone; very fine crystalline; weathers light grey and very light grey; bedding thickness 1–10 cm, laminated, platy; locally contains 15% chert nodules (banana- shaped)
C-078646 (135.9–136.6 m)

**Unit 9** (112.5–115.5 m): Dolostone; weathers dark grey; rubbly, dolostone stringers and vugs abundant; basal contact a concordant erosion surface with 60 cm of local relief
C-078645 (113.7–114.3 m)
C-078644 (113.1–116.1 m), Conodont

**Unit 8** (102.7–112.5 m): Dolostone; fine to medium crystalline; weathers light grey and very light grey; bedding thickness 61–183 cm; arenaceous
C-078643 (107.0–111.6 m), Conodont

**Unit 7** (96.9–102.7 m): Dolostone; very fine crystalline; weathers dull grey; bedding thickness 3–8 cm, slightly rubbly

**Unit 6** (94.2–96.9 m): Dolostone; microcrystalline; weathers light grey and pale yellow-brown; bedding thickness 30–60 cm, rubbly
C-078642 (95.0–102.0 m), Conodont

**Unit 5** (86.6–94.2 m): Covered interval

Unit 4 (68.3–86.6 m): Quartz sandstone; weathers grey-orange and off-white; bedding thickness 3–61 cm, some beds with lamination and crosslamination; feeding trails abundant; locally slightly dolomitic in upper third of unit; rubbly dolomitic quartz-sandstone weathers grey-red

**Unit 3** (47.2–68.3 m): Argillaceous dolostone; weathers dull yellow-brown and rubbly; bedding thickness 1–5 cm, contains nodular bedding and shaly partings
C-078641 (64.3–66.5 m), Conodont
C-205925 (62.5–65.5 m)

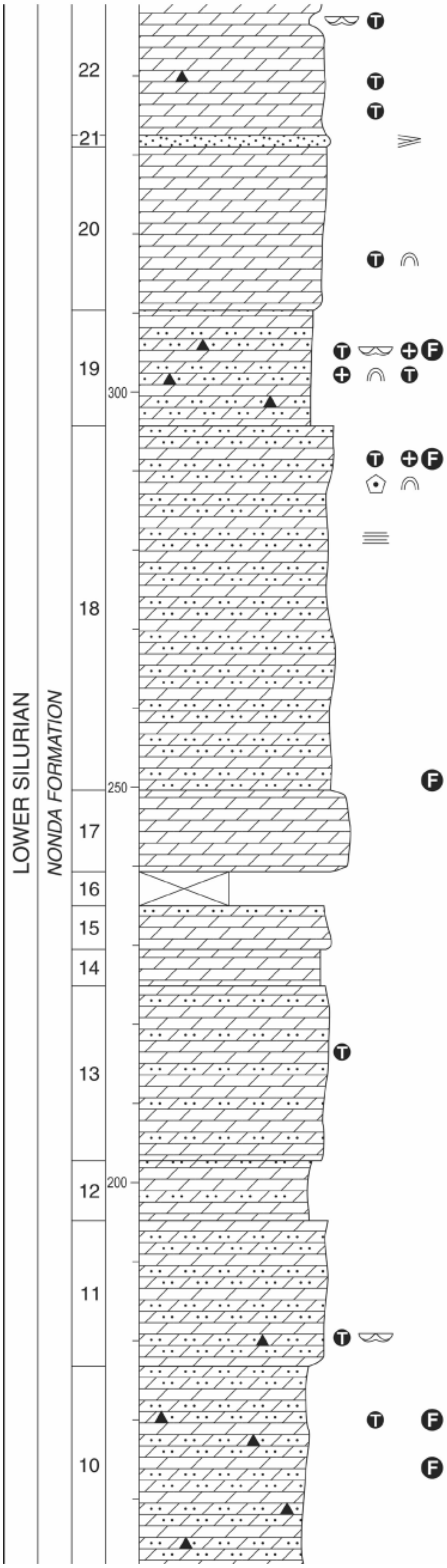
**Unit 2** (25.0–47.2 m): Dolostone, silty dolostone, and limestone. Dolostone: very fine crystalline; weathers yellow-grey and very pale orange; bedding thickness 20–51 cm. Silty dolostone: weathers light grey and very pale yellow-brown; bedding thickness 15–91 cm. Limestone: weathers grey and light grey; some beds are argillaceous
Fossil sample: C-078640 (44.2–46.0 m)

**Unit 1** (0.0–25.0 m): Limestone; microcrystalline to very fine crystalline; weathers grey and light grey; bedding thickness 3–20 cm, bedding is undulatory, very fossiliferous and contains 10–15% limy shale in bottom two-thirds of unit; limestone is slightly nodular bedded
C-205924 (20.5–21.0 m)
C-205923 (18.5–19.5 m)
C-078639 (17.7–22.9 m), Conodont
C-205922 (16.5–17.5 m)
C-205921 (11.0–13.0 m)
C-078638 (10.7–16.8 m)
C-205920 (8.0–9.5 m)
C-205919 (6.0–8.0 m)
C-205918 (1.0–3.0 m)
C-078637 (0.0–6.1 m), Conodont
C-078636 (0.0–1.5 m)

**Pre-Unit 1** (-6.1–0.0 m): Silty dolostone; very fine to fine crystalline; weathers light grey and very pale brown; bedding thickness 20–40 cm
C-078635 (-6.1–0.0 m), Conodont
C-205917 (-14.5 to -4.5 m), Conodont

**Figure A5**. Advance Mountain (note Norford, 1991, p. 51–52; 1996, p. 7, 14, 17–19).

ADVANCE MOUNTAIN SECTION, page 2 of 4




**Unit 22** (332.5–361.2 m): Dolostone; very fine crystalline; weathers light brown-grey and blocky; bedding thickness 30–61 cm; some mottled beds

**Unit 21** (331.0–332.5 m): Quartz sandstone; crosslaminated; lenticular beds and layers in dolostone

**Unit 20** (310.3–331.0 m): Dolostone; light grey and light brown; bedding thickness 46–91 cm; mottled

**Unit 19** (295.7–310.3 m): Silty dolostone; very fine crystalline; weathers pale yellow-brown and light brown-grey; bedding thickness 15–122 cm, weathers blocky; contains 5% irregular chert nodules and layers
C-078651 (305.4–306.6 m)

**Unit 18** (249.6–295.7 m): Silty dolostone; weathers dull brown, pale yellow-brown, light grey and light olive-brown-grey; bedding thickness 15–61 cm, some weak lamination present; 260.9 m, east cairn of mountain
C-078650 (293.5–294.4 m)
C-078649 (249.9–254.5 m), Conodont

**Unit 17** (239.3–249.6 m): Dolostone; micro to very fine crystalline; weathers very light grey; bedding thickness 61–122 cm

**Unit 16** (235.0–239.3 m): Covered interval

**Unit 15** (229.5–235.0 m): Dolostone; weathers light grey

**Unit 14** (224.9–229.5 m): Dolostone; weathers light brown-grey

**Unit 13** (202.7–224.9 m): Dolostone; very fine crystalline; weathers light grey; bedding thickness 60 cm to 3 m; slightly silty

**Unit 12** (195.1–202.7 m): Dolostone; weathers light brown-grey; slightly rubbly; slightly silty

**Unit 11** (176.8–195.1 m): Silty dolostone; very fine crystalline; weathers light grey; bedding thickness 30–152 cm

Unit 10 (115.5–176.8 m): See previous page for description
C-078648 (170.1–170.7 m)
C-078647 (164.3–171.6 m), Conodont

**Figure A5**. **(Cont.)** Advance Mountain (note Norford, 1991, p. 51–52; 1996, p. 7, 14, 17–19).

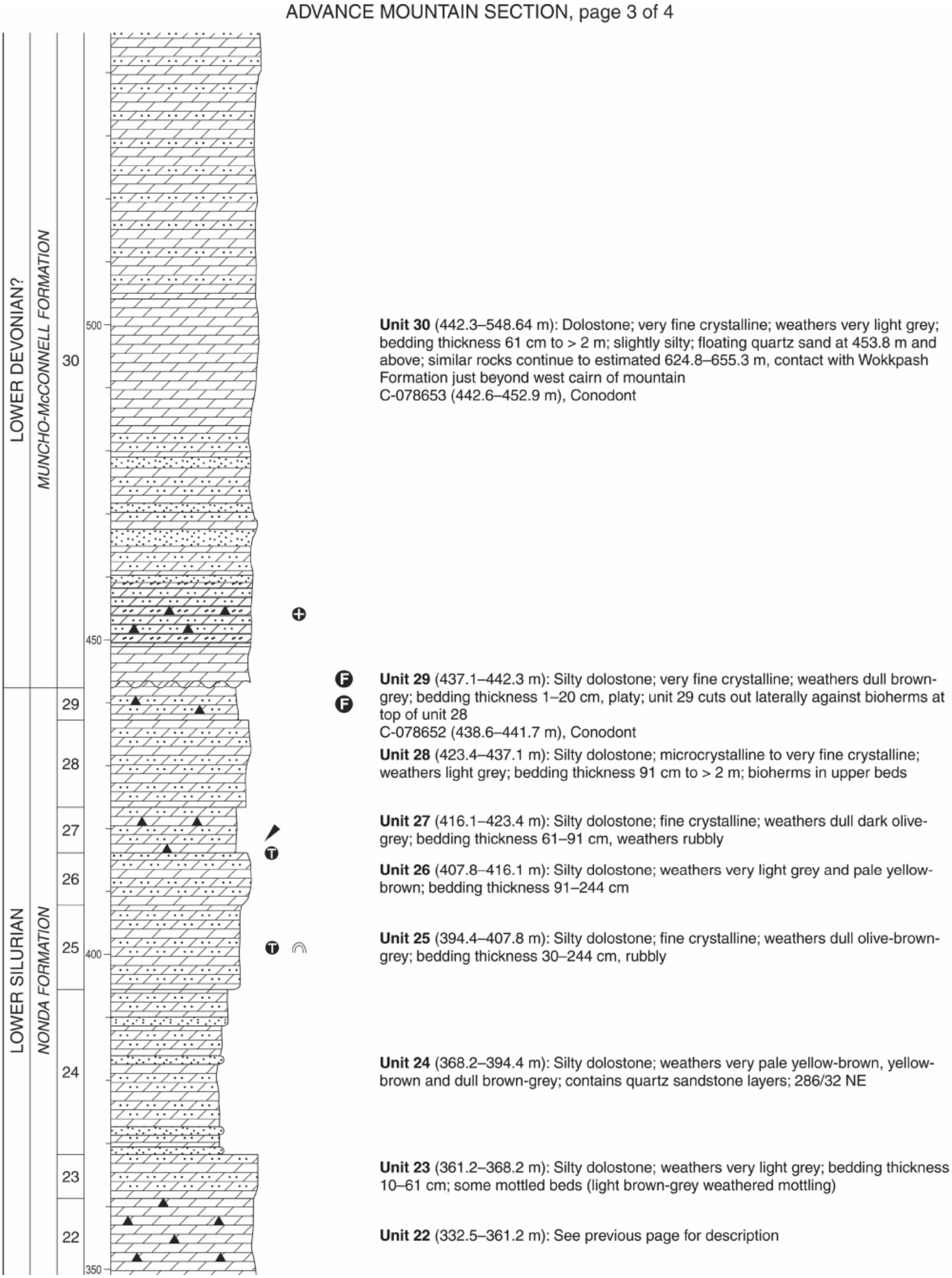



**Figure A5**. **(Cont.)** Advance Mountain (note Norford, 1991, p. 51–52; 1996, p. 7, 14, 17–19).

ADVANCE MOUNTAIN SECTION, page 4 of 4

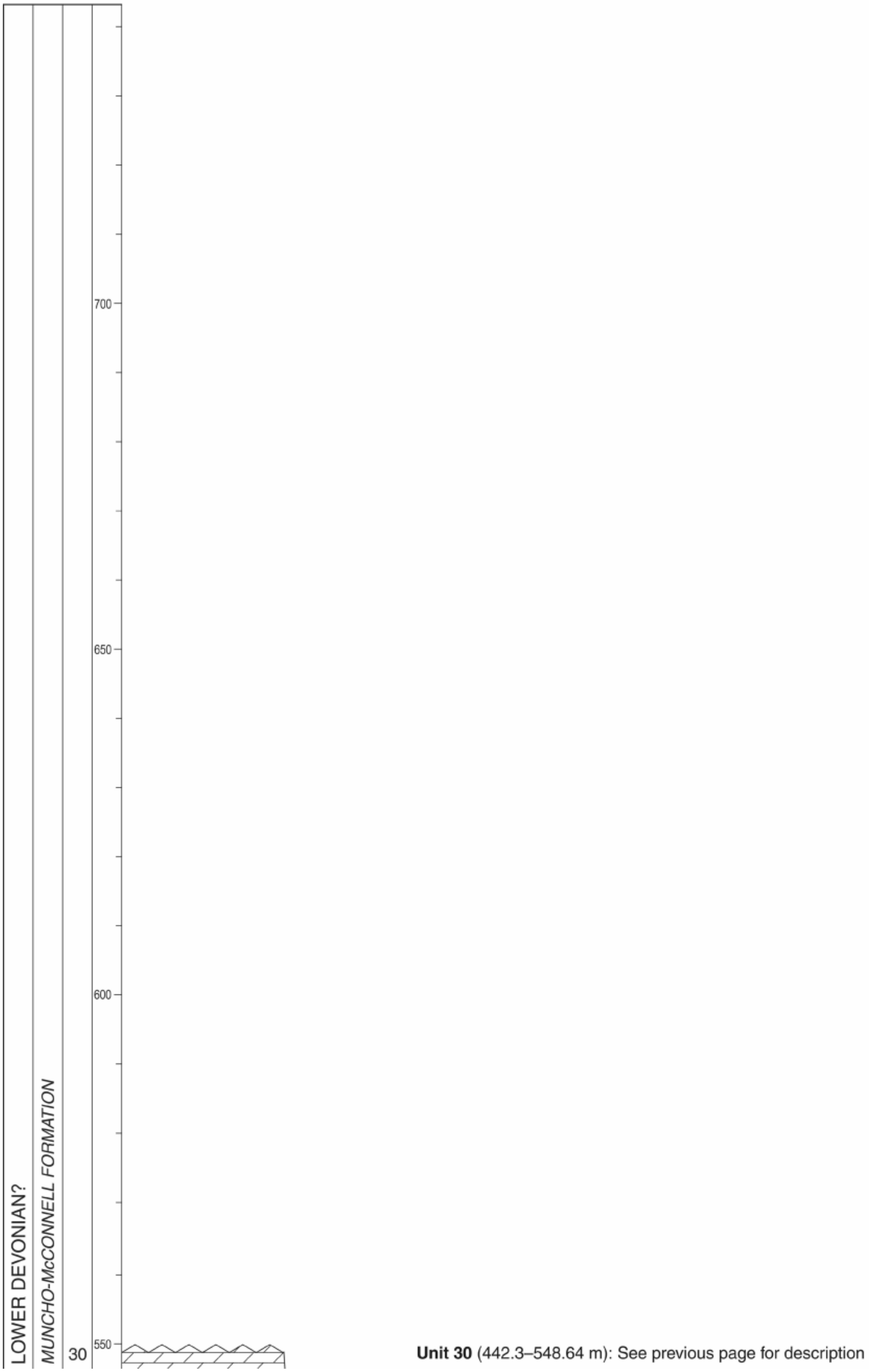
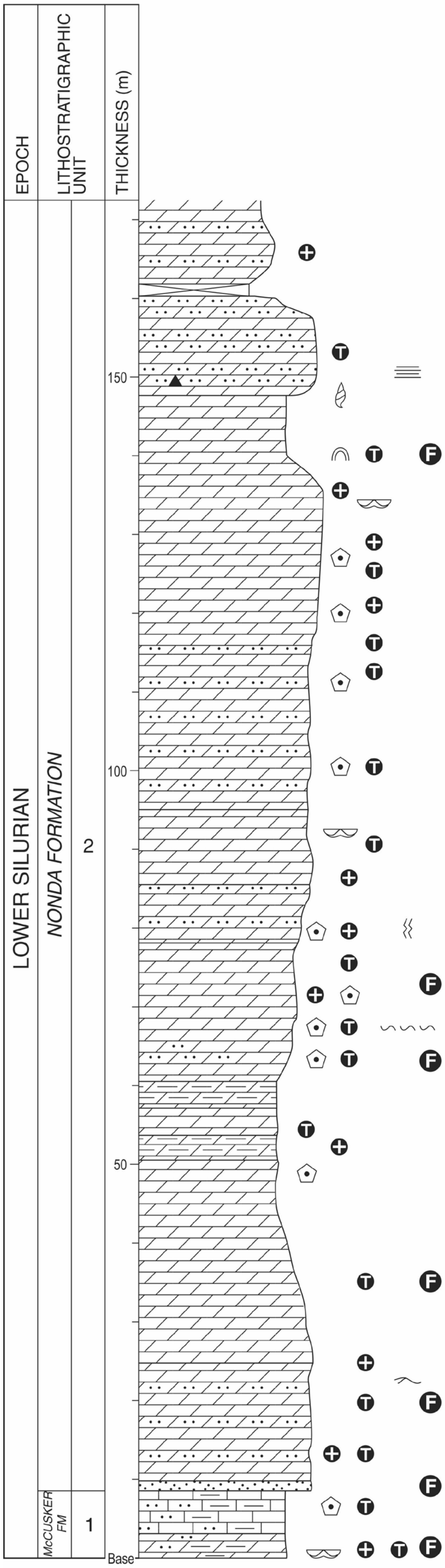



**Figure A5**. **(Cont.)** Advance Mountain (note Norford, 1991, p. 51–52; 1996, p. 7, 14, 17–19).

GUILBAULT CREEK SECTION

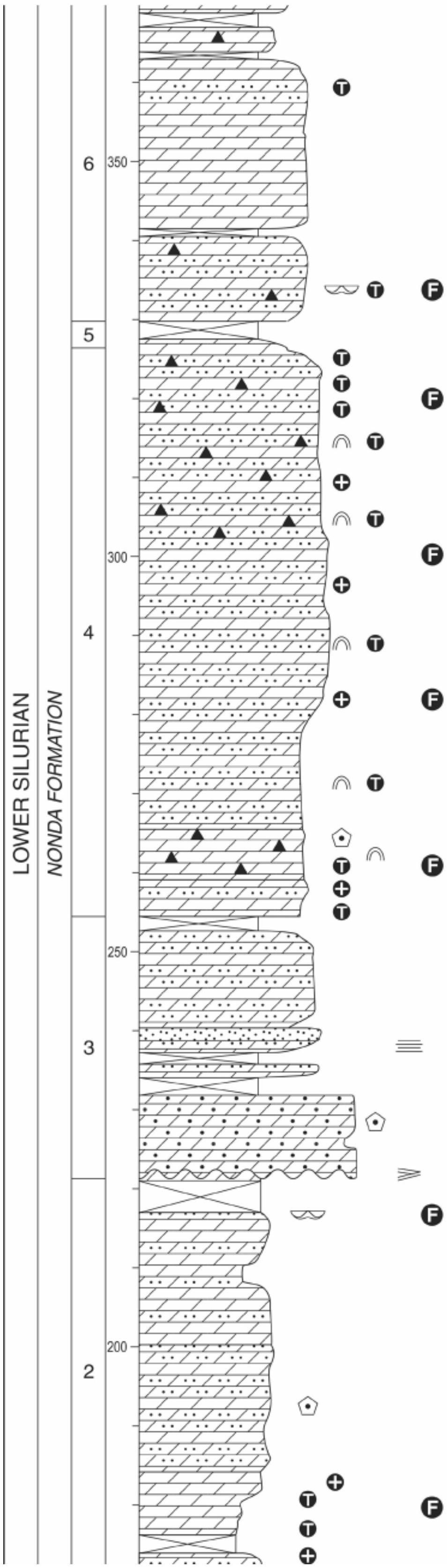



**Unit 2** (8.5–221.0 m): Dolostone, silty dolostone, slightly silty dolostone and quartz sandstone.Silty dolostone: very fine to fine crystalline; dark grey or brown-grey, weathers a dull, dark grey; bedding thicknesses 3 cm to 6 m in some places, some coarse lamination, dolomite stringers at 80 and 200 m, wispy argillaceous partings at 9 m; contains 10% dolomite fragments at 150 m: coarse crystalline, light coloured, olive-grey or orange-brown. Slightly silty dolostone: very fine to medium crystalline; dark grey or grey, weathers olive-grey, yellow-grey or a light dull grey, some orange-grey stains; bedding thickness 3–91 cm, recessive layers 3–7 cm at 104 m, irregular partings 3–91 cm thick in some places, dolomite stringers at 21 and 104 m, wispy silty and argillaceous layers at 21 m; coquina of brachiopods at 217 m; contains 20% dolomite fragments at 213 m: medium to coarse grained, light coloured. Dolostone: very fine to medium crystalline; dark grey, grey, or light brown-grey, weathers dull grey, olive-grey or yellow-brown, some bedding planes stained a reddish orange-grey; bedding thickness 10 cm to 122 m, dolomite stringers found throughout, rare calcite veins at 80 m, minor faults at 67 m; *Columnaria columbia* present at approximately 140 m and 175 m; contains 10% coarse dolomite fragments at 26 m, argillaceous dolomite layers common around 45 m. Quartz sandstone: basal 15 cm
O-64483 (140.2–147.8 m)
O-64484 (72.9–73.5 m)
O-64485 (63.1–65.8 m)
O-64486 (35.1–37.5 m)
O-64487 (19.8–22.9 m)
O-64488 (9.1–13.7 m)

**Unit 1** (0–8.5 m): Limestone and dolostone. Limestone: microcrystalline to very fine crystalline; dark grey, weathers grey, argillaceous component weathers brown; bedding thickness 1–5 cm, irregular partings; locally slightly silty and slightly argillaceous. Dolostone: very fine to fine crystalline; grey, weathers light olive-grey to yellow-brown; bedding thickness 3–10 cm, dolomite stringers present locally; slightly silty and slightly argillaceous, irregular argillaceous layers.
O-64489 (0–8.5 m)

**Figure A6.** Guilbault Creek (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

GUILBAULT CREEK SECTION, page 2 of 4




**Unit 6** (329.8–368.8 m): Dolostone and silty dolostone. Dolostone: very fine crystalline; dark grey, weathers grey and light grey; bedding thickness 30 cm to 2 m, 5–61 cm when weathered, bedding is indistinct in some places, rare dolomite stringers. Silty dolostone: very fine crystalline; dark grey, weathers grey or light grey; bedding thickness 30 cm to 3 m, at 360 m, 3–61 cm when weathered, rare chert nodules, dolomite stringers present
O-64476 (333.8–336.8 m)

**Unit 5** (326.4–329.8 m): Silty dolostone: very fine crystalline; dark grey, weathers dark grey; bedding thickness 3–11 cm

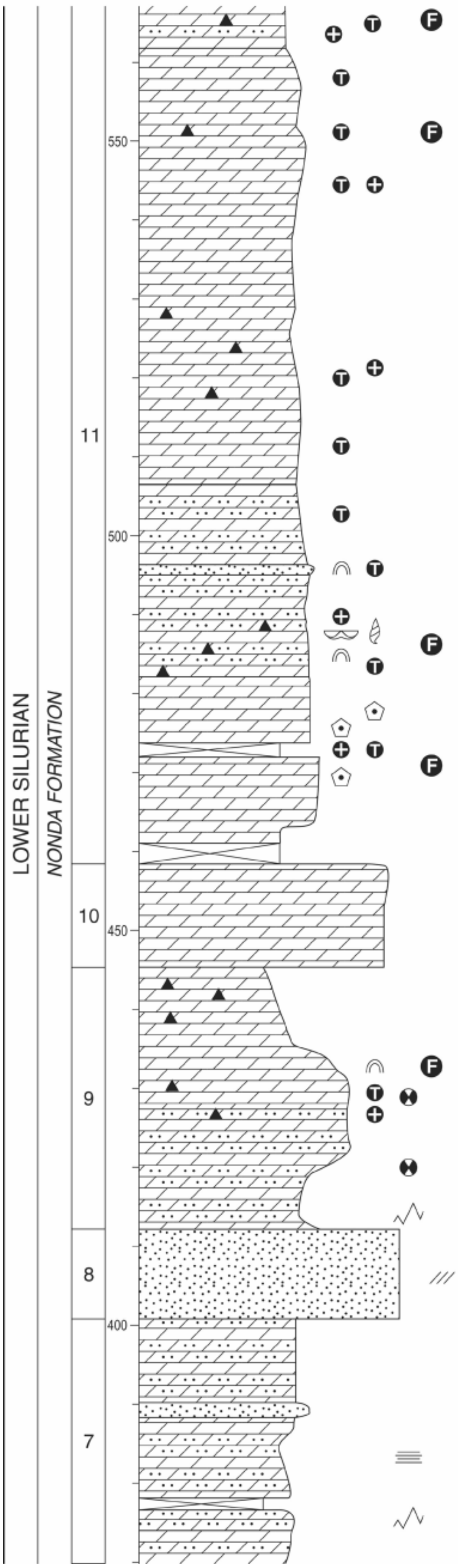
**Unit 4** (254.5–326.4 m): Dolostone and silty dolostone. Dolostone: very fine to fine crystalline; dark grey, weathers dull grey or light grey; bedding thicknesses 15–91 cm. Silty dolostone: very fine to medium crystalline; dark grey or grey, weathers light grey or dull grey; bedding thickness 5 cm to 3 m, chert nodules make up 5% of rock, rare dolomite stringers; irregular silicification layers
O-64477 (320.0–326.4 m)
O-64478 (300.2–312.1 m)
O-64479 (281.9–294.7 m)
O-64480 (260.9–269.8 m)

**Unit 3** (221.0–254.5 m): Silty and sandy dolostone. Silty dolostone: very fine to fine crystalline; dark grey, light grey, or brown-grey, weathers light grey or yellow-grey; bedding thicknesses 15 cm to 2 m, some lamination; contains 5% sand and silt. Locally sandy dolostone: very fine crystalline; brown-grey, weathers light grey; bedding thickness 5 cm to 2 m, rare crosslamination; contains 30% quartz sand. Erosion surface 15 cm deep at 221.3 m

**Unit 2** (8.5–221.0 m): See previous page for description
O-64481 (216.7–217.2 m)
O-64482 (179.8–182.9 m)

**Figure A6. (Cont.)** Guilbault Creek (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

GUILBAULT CREEK SECTION, page 3 of 4




**Unit 11** (458.4–576.1 m): Dolostone and silty dolostone. Dolostone: very fine to fine crystalline; dark grey or dark brown-grey, weathers light grey, dark grey or grey; bedding thickness 30 cm to 5 m, dolomite vugs and stringers, irregular sillicification layers and silica stringers from 515 m to end of unit. Silty dolostone: very fine to fine crystalline; dark grey or dark brown-grey, weathers dark grey and olive-grey; bedding thickness 30 cm to 3 m, dolomite stringers common, irregular silicification layers at 564 m; *Pentamerus* at 488 m; abundant quartz sand at 495 m
O-64471 (565.4–573.0 m)
O-64472 (551.1 m)
O-64473 (486.2–493.8 m)
O-64474 (470.9–478.5 m)

**Unit 10** (445.3–458.4 m): Dolostone and silty dolostone. Dolostone: finely to coarse crystalline; dark grey, weathers light grey; bedding thickness 61 cm to 2 m, rare dolomite stringers, rare quartz-filled vugs. Silty dolostone: medium crystalline; dark grey, weathers light grey; bedding thickness 30 cm to 2 m, fine dolomite stringers

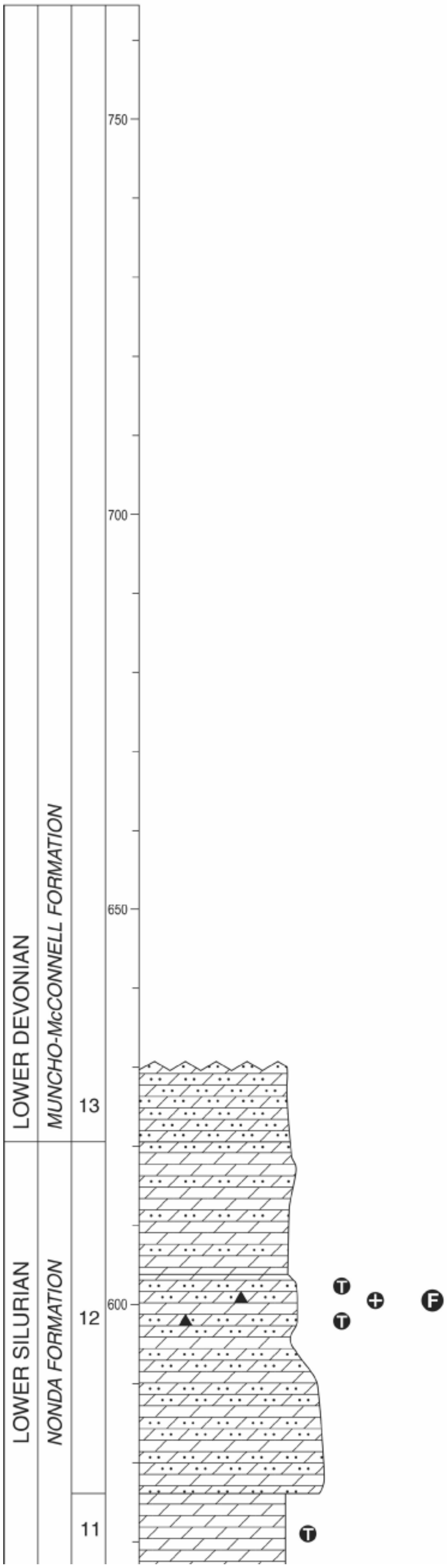
**Unit 9** (412.1–445.3 m): Dolostone and silty dolostone. Dolostone: dark grey, weathers dark grey and grey; finely to medium crystalline; bedding thickness 15 cm to 1 m; irregular sillicification common around 440 m; abundant dolomite stringers; at 429 m, rock contains 5% large dolomite vugs and 2% stringers. Silty dolostone: dark grey, weathers dark grey and grey; fine to coarsely crystalline; well bedded; bedding thickness 30-60 cm irregular silt layers; dolomite vugs; stylolites
Fossil sample: O-64475 (432.8–433.4 m)

**Unit 8** (400.8–412.1 m): Quartz sandstone; medium to coarse crystalline; very light grey or very pale orange, weathers light grey with grey-orange stains; bedding thickness greater than 2 m, rare crossbeds; unit thickens from east to west

**Unit 7** (368.8–400.8 m): Dolostone, silty dolostone, and quartz-sandstone. Dolostone: very fine crystalline; grey, weathers light grey and yellow-grey; bedding 30–61 cm; contains 25% dark grey weathering dolomite, some beds contain quartz sand. Silty dolostone: very fine crystalline to fine crystalline; light olive-grey or dark grey, weathers light grey, yellow-grey or grey to dark grey; bedding ranges from 30 to 91 cm, dolomite stringers, stylolites, some crude lamination. Quartz sandstone: very pale orange, weathers yellow grey; bedding thickness: 61 cm

**Figure A6. (Cont.)** Guilbault Creek (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

GUILBAULT CREEK SECTION, page 4 of 4



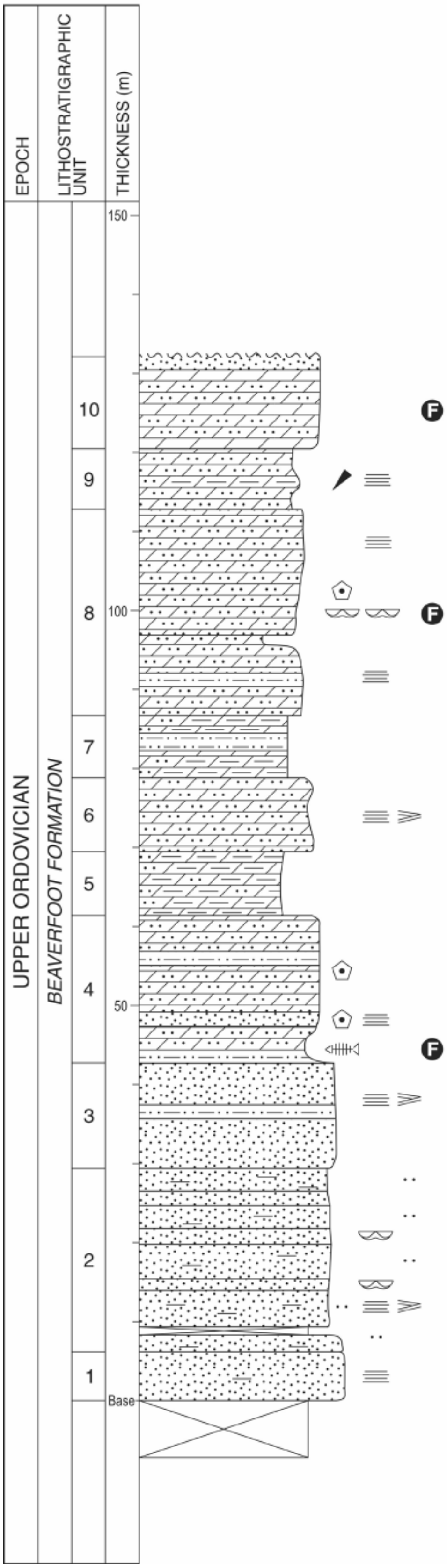

**Unit 13** (620.6 m–end of section): Very silty dolostone; weathers light grey and yellow-grey; bedding thickness 30 cm to 2 m; contains quartz sand. Outcrop continues

**Unit 12** (576.1–620.6 m): Slightly silty to silty dolostone and dolostone. Slightly silty to silty dolostone: very fine to fine crystalline; dark grey, weathers dark grey; bedding thickness 60 cm to greater than 2 m, rare silicification layers, dolomite stringers, chert nodules 2% of rock; halysitid corals at 603 m. Dolostone: very fine crystalline; dark grey, weathers olive-grey and dark grey; bedding greater than 2 m, rare layers of silicification
O-64470 (600.5–602.0 m)

**Unit 11** (458.4–576.1 m): See previous page for description

**Figure A6. (Cont.)** Guilbault Creek (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

## MOUNT McCUSKER SECTION




**Unit 10** (120.4–130.5 m): Silty dolostone and quartz sandstone. Silty dolostone: weathers light olive-grey and very pale yellow-brown. Quartz sandstone found just below fault. Bedding orientation 171/60
C-078660 (125.0–129.5 m) Conodont.

Unit 9 (112.8–120.4 m): Very silty dolostone; weathers yellow-grey; bedding: 15–46 cm, laminated; contains 40% quartz sand

**Unit 8** (86.6–112.8 m): Very silty dolostone; very fine crystalline; weathers yellow-grey, grey-orange, and light yellow-brown; bedding 10–61 cm, laminated, orientation 173/57
C-078274 (99.1–99.2 m)

**Unit 7** (78.9–86.6 m): Silty dolostone; very fine crystalline; weathers olive-grey; bedding 10–30 cm, rubbly

**Unit 6** (69.5–78.9 m): Very silty dolostone; very fine crystalline; weathers olive-grey and pale yellow-brown; bedding 5–61 cm, laminated and crosslaminated

**Unit 5** (61.3–69.5 m): Argillaceous dolostone; very fine crystalline; weathers dull olive-grey

**Unit 4** (42.7–61.3 m): Very silty dolostone; very fine to fine crystalline plus 40% quartz sand; weathers pale yellow-brown and grey-orange; bedding 15–91 cm, laminated
C-078273 (43.6–44.2 m)

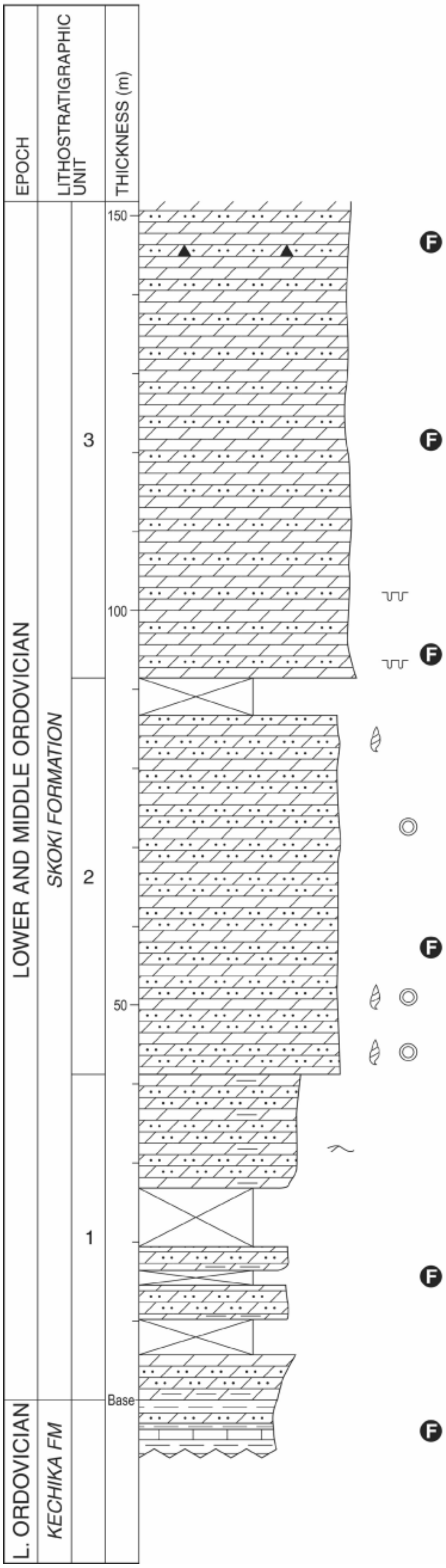
**Unit 3** (29.3–42.7 m): Quartz sandstone; very fine to fine crystalline; weathers grey-orange; bedding 20–91 cm, lamination and crosslamination present; ~2% of unit argillaceous and silty

**Unit 2** (6.1–29.3 m): Quartz sandstone; very fine to fine crystalline; weathers grey-orange; bedding thickness 5–30 cm, contains some lamination and crosslamination, some silty and argillaceous partings; possible *Thaerdonta;* locally silty towards top of unit, contains argillaceous flecks and layers, with 40% of rock quartz sandstone

**Unit 1** (0.0–6.1 m): Quartz sandstone; fine crystalline; weathers grey-orange; bedding 30–122 cm, some lamination; some argillaceous and silty content ("dirty quartz-sandstone")

**Figure A7.** Mount McCusker.

NORTHERN SHOULDER OF MOUNT McCUSKER




**Unit 3** (91.4–164.6 m): Dolostone and silty dolostone. Dolostone: very fine crystalline; weathers dull light grey, light olive-grey and grey; bedding thickness 15 cm to 3 m. Silty dolostone: very fine crystalline; weathers pale grey-orange, light olive-grey and dull grey, some mottling; thickly bedded dolostone ranging from 31 cm to >3 m
C-078309 (146.3–155.5 m), Conodont
C-078308 (121.6–122.2 m)
C-078307 (94.5–102.4 m), Conodont

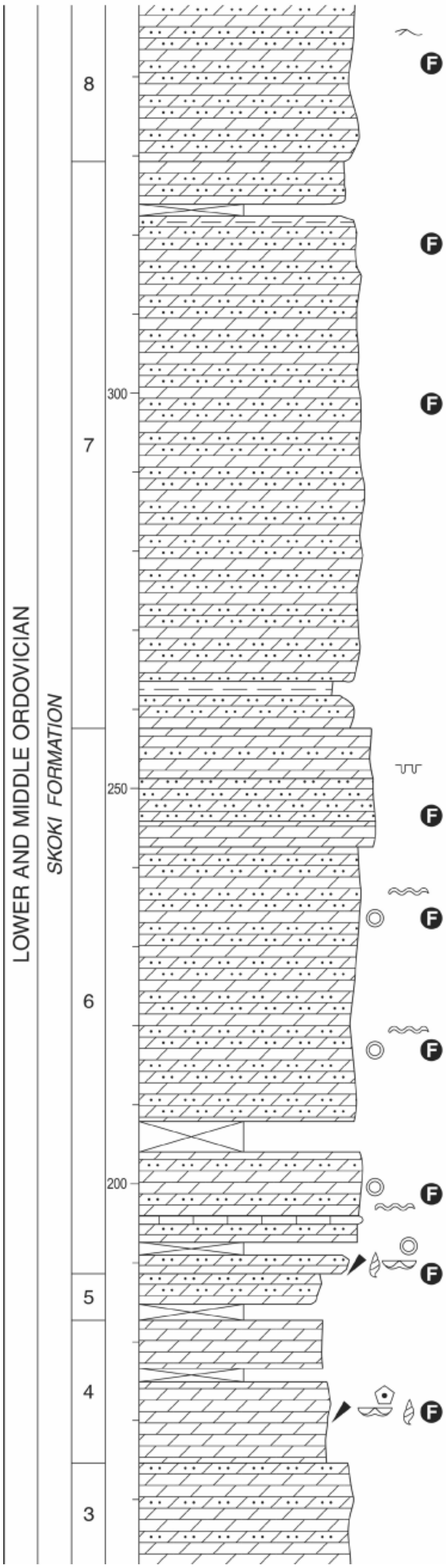
**Unit 2** (41.2–91.4 m): Silty dolostone; fine to medium crystalline; weathers dull olive-grey, light grey and yellow-grey; bedding thickness 5–61 cm, very rare wispy partings in lower third of unit, none present in upper two thirds, weathers blocky; oncolites common throughout unit
C-078306 (57.3–60.1 m), Conodont

**Unit 1** (0.0–41.2): Silty dolostone; very fine to fine crystalline; weathers yellow-grey, light olive-grey, very pale yellow-brown, and grey-orange; bedding thickness 15–61 cm, common dark brown, orange-grey wispy layers in bottom third of unit, sparse wispy layers in middle third of unit, argillaceous laminae locally present in upper third of unit
C-078305 (15.2–17.1 m), Conodont

**Pre-Unit 1** (-12.2–0.0 m): Silty dolostone; very fine crystalline; bedding thickness 3–8 cm, cleaved; calcilutites and rare calcarenites present
C-078304 (-9.1–0.0 m), Conodont

**Figure A8.** Mount McCusker, northern shoulder.

NORTHERN SHOULDER OF MOUNT McCUSKER, page 2 of 3




**Unit 8** (329.2–363.0 m): Silty dolostone and dolostone. Silty dolostone: very fine crystalline; weathers dull brown olive-grey and pale grey-orange; well-developed interbeds, thickness 3–46 cm, rare wispy lamination. Dolostone: very fine crystalline; weathers dull olive-grey and grey; bedding thickness 8–90 cm. Bedding attitude 125/25 SW
C-078318 (341.4-351.7 m), Conodont

**Unit 7** (257.6–329.2 m): Silty dolostone; microcrystalline to very fine crystalline; interbedded light olive-grey, light grey, yellow-grey and pale-yellow-brown-weathering beds; bedding thickness 15–60 cm, locally 3–6 cm in upper quarter of unit, some platy beds present in unit; non-silty dolostone present in lower portions of unit, in interval from 309.7–311.2 m dull olive grey beds present
C-078317 (319.1–327.1 m), Conodont
C-078316 (298.7–304.8 m), Conodont

**Unit 6** (188.7–257.6 m): Silty dolostone and dolostone. Silty dolostone: very fine to fine crystalline; weathers dull light olive-grey and yellow-grey; bedding thickness 15–91 cm; oncolites very common in lower three quarters of unit. Dolostone: very finely crystalline; weathers dull light olive-grey, some mottling; bedding thickness 30 cm to 1 m. Receptaculitid algae
C-078315 (246.9–257.6 m)
C-078314 (234.7–235.3 m)
C-078313 (217.0–217.3 m)
C-078312 (198.1–204.2 m), Conodont
C-078311 (189.0–192.0 m), includes *Teiichispira*

**Unit 5** (182.9–188.7 m): Silty dolostone; very fine crystalline; weathers yellow-grey and light grey; bedding thickness 8–90 cm

**Unit 4** (164.6–182.9 m): Dolostone; very fine crystalline; weathers dull grey and dull olive-grey; bedding thickness 5–60 cm, well developed, weathers blocky
C-078310 (170.7–171.9 m)

**Unit 3** (91.4–164.6 m): See previous page for description

**Figure A8. (Cont.)** Mount McCusker, northern shoulder.

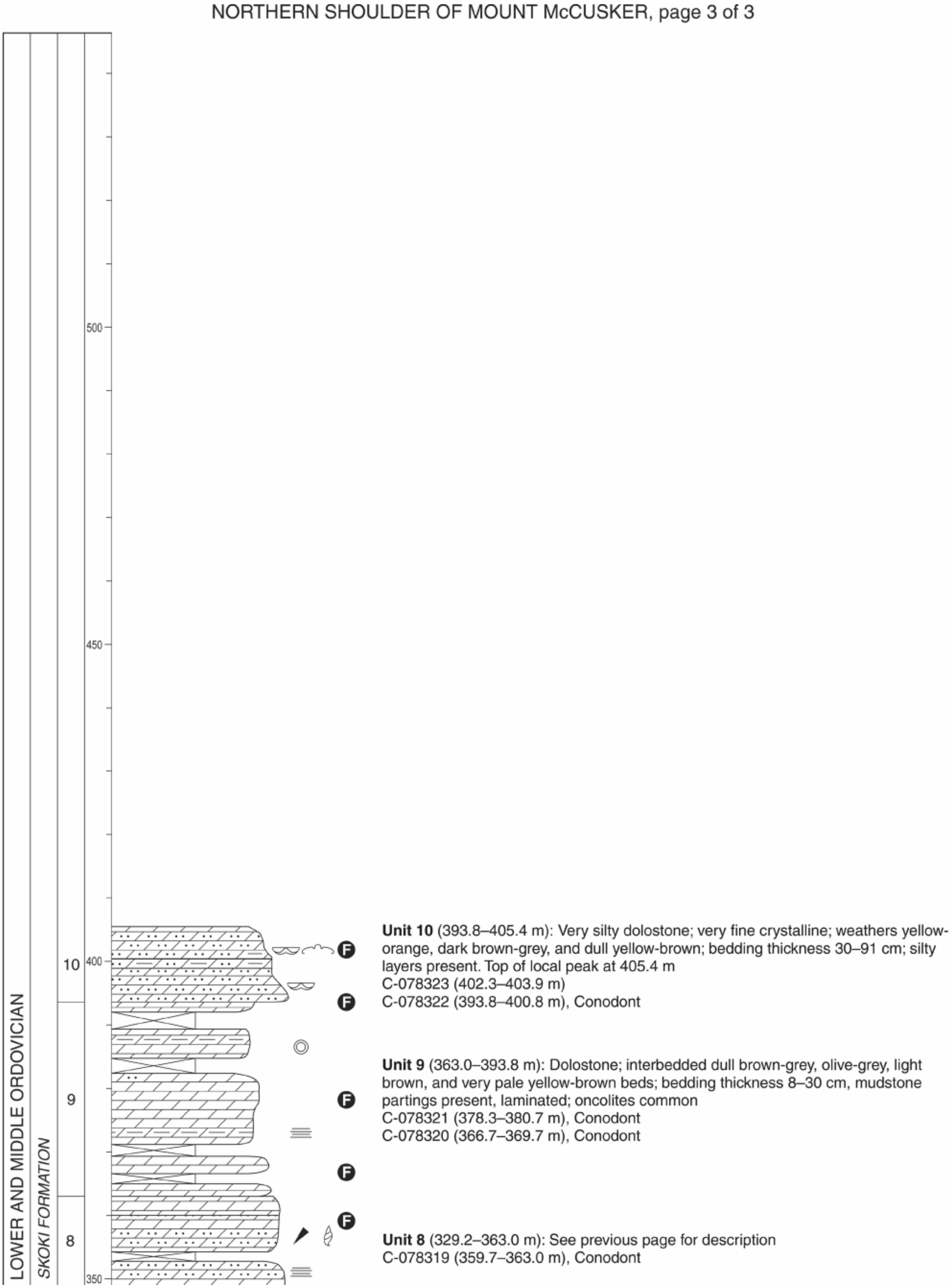
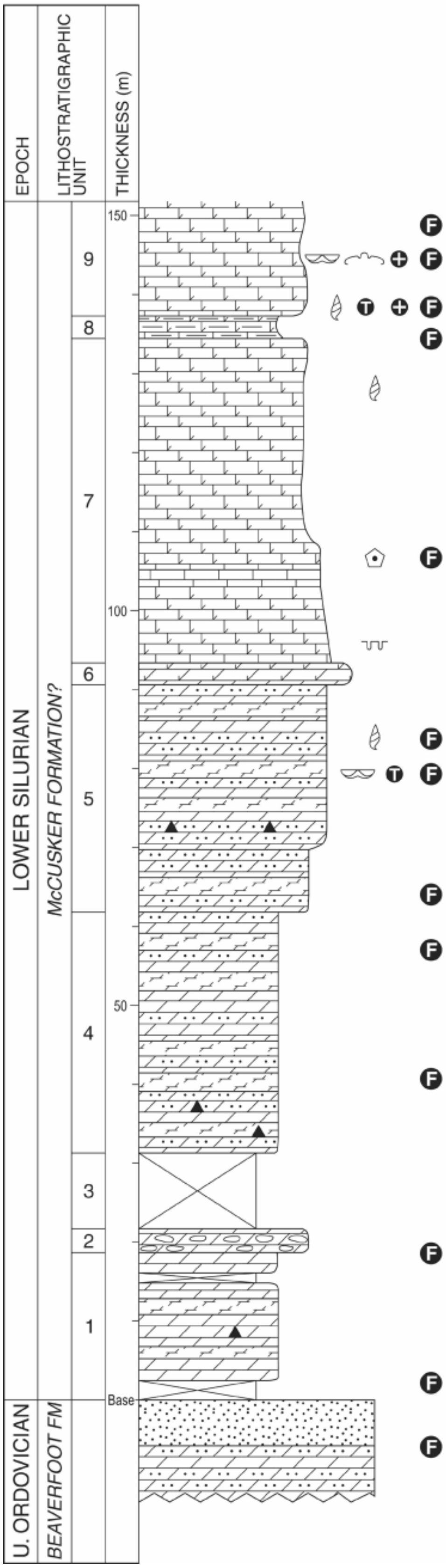



**Figure A8. (Cont.)** Mount McCusker, northern shoulder.

## MOUNT McCUSKER SOUTH SECTION




**Unit 9** (137.2–193.9 m): See next page for description
C-078287 (147.8–153.9 m), Conodont
C-078286 (144.5–145.1 m)
C-078285 (138.4–140.5 m)

**Unit 8** (134.4–137.2 m): Dolomitic limestone; weathers yellow-grey; nodules and layers in dolostone matrix, recessive and banded unit; slightly argillaceous
C-078284 (134.4–137.2 m), Conodont

**Unit 7** (93.3–134.4 m): Dolomitic limestone and limestone. Dolomitic limestone: microcrystalline to very fine crystalline; dark grey, weathers dark grey, dull grey, and yellow-brown; in upper two-thirds of unit, contains dark-grey-weathering limestone nodules and layers in yellow-grey dolostone matrix, mottles and layers weather flaggy at bottom of unit. Limestone: microcrystalline to very fine crystalline; weathers dark grey and yellow-grey; contains nodules and layers; contains 40% yellow-grey-weathering dolomitic matrix
C-078283 (106.7–112.8 m), Conodont

**Unit 6** (90.8–93.3 m): Calcareous doloarenite; weathers dull light grey; bedding thickness 15–30 cm

**Unit 5** (61.9–90.8 m): Silty dolostone; weathers dull light grey, grey and yellow-grey; bedding thickness 3–15 cm; contains 5% silty lamination and 5% platy dolomitic mudstone at bottom of unit, contains 40% dolomitic mudstone at upper half of unit
C-078282 (83.8–89.9 m), Conodont
C-078281 (79.3–83.8 m)
C-078280 (64.0–70.1 m), Conodont

**Unit 4** (31.1–61.9 m): Slightly silty to silty dolostone; very fine crystalline; weathers grey, dull grey, light grey, olive-grey and yellow-grey; bedding 1–10 cm; top half of unit is slightly silty, contains 5–10% quartz silt layers, 20% dolomitic mudstone and 20% argillaceous platy dolostone; bottom half of unit is silty, contains 25% quartz silt layers, 5% chert and 20–30% platy dolomitic mudstone
C-078279 (57.0–61.9 m), Conodont
C-078278 (40.8–46.9 m), Conodont

**Unit 3** (21.6–31.1 m): Covered interval; laterally slumped outcrop, similar to unit 1

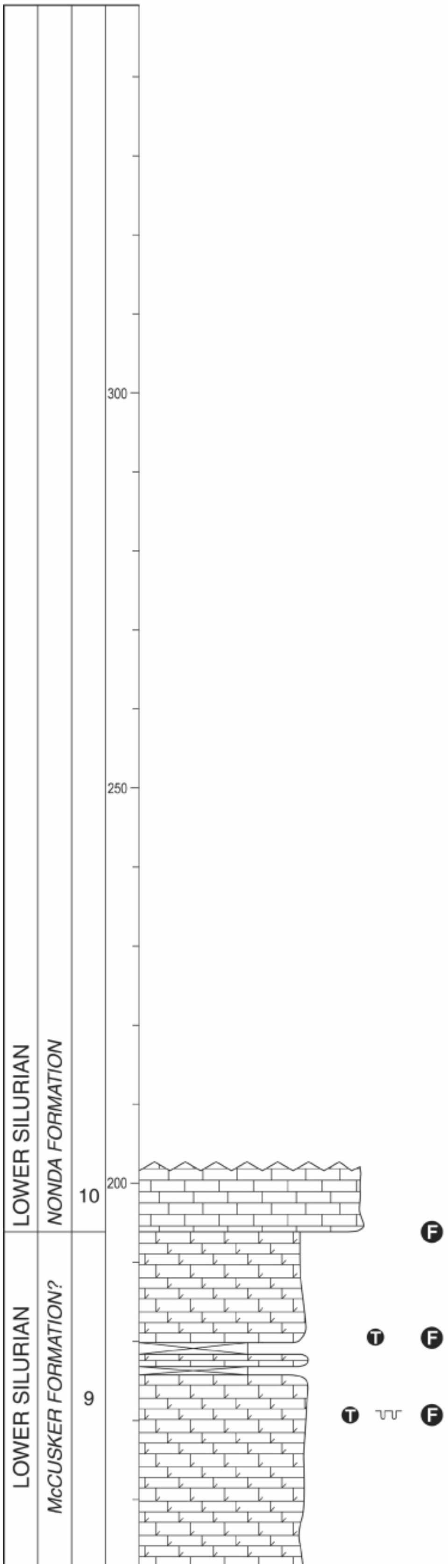
**Unit 2** (18.6–21.6 m): Slightly silty dolostone; very fine crystalline with conglomerate; weathers dull olive-grey; bedding thickness around 3 m
C-078277 (18.6–21.6 m), Conodont

**Unit 1** (0.0–18.6 m): Dolostone; microcrystalline; weathers dull grey; bedding thickness 1–15 cm, weathers platy; upper third of unit contains 30% dolomitic mudstone, middle third of unit contains 20% yellow-grey-weathering dolostone and 8% platy dolomitic mudstone, lower beds contain platy dolostone interbeds
C-078276 (2.1–4.0 m), Conodont

**Pre-Unit 1** (-6.1–0 m): Dolostone and quartz sandstone
C-078275 (-6.1–0 m), Conodont

**Figure A9.** Mount McCusker, south.

MOUNT McCUSKER SOUTH SECTION, page 2 of 2




**Unit 10** (193.9–205 m): Limestone; microcrystalline to very fine crystalline; weathers grey, not mottled; bedding thickness 15–46 cm, well and evenly bedded; contact conformable and drawn above last mottled dolomitic limestone
C-078290 (193.9–198.1 m), Conodont

**Unit 9** (137.2–193.9 m): Dolomitic limestone; microcrystalline to very fine crystalline; grey, weathers dull grey; bedding thickness 15–122 cm; upper half of unit has dull-grey-weathering mottles in yellow-grey matrix, dolostone makes up less than 15% of rock, dolostone mottling in less than 45% of rock, lower half of unit weathers slightly rubbly, contains weathered limestone nodules and layers in yellow-grey dolostone matrix
C-078289 (179.8–193.9 m)
C-078288 (170.7–178.3 m)

**Figure A9. (Cont.)** Mount McCusker, south.

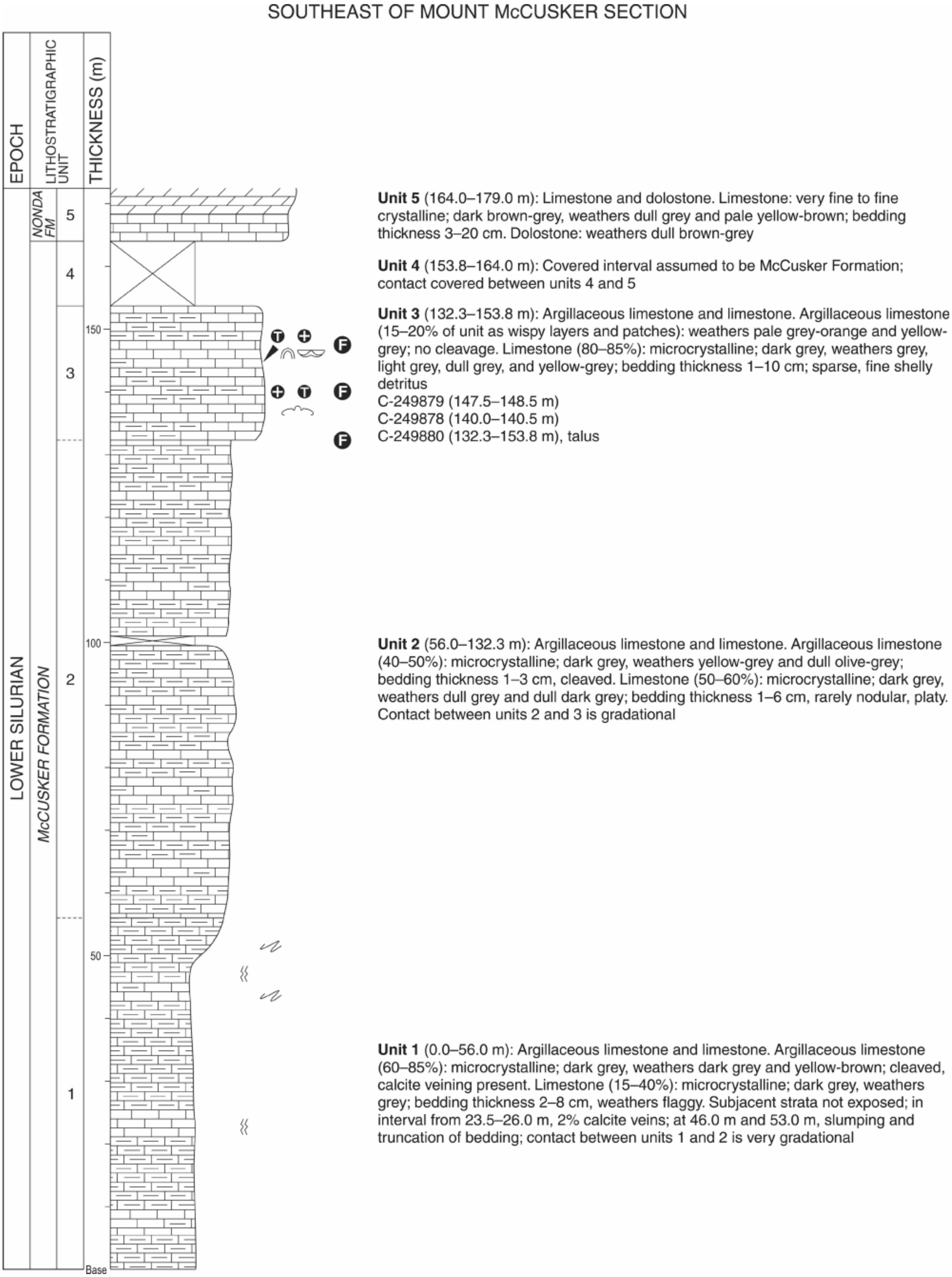
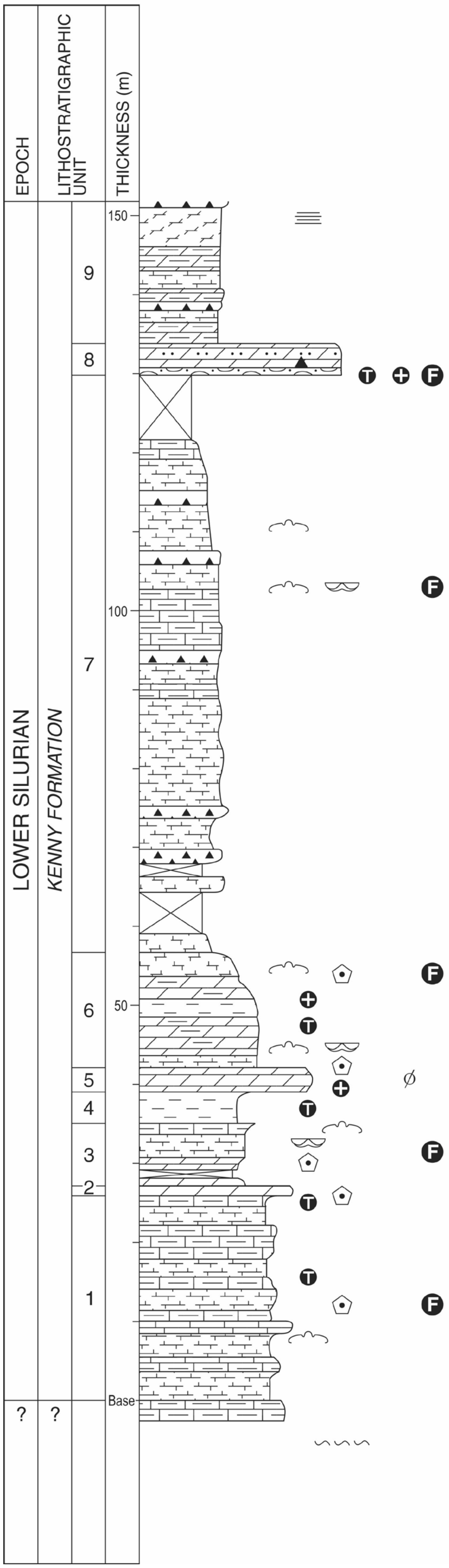



**Figure A10.** Mount McCusker, southeast of.

## MOUNT KENNY NORTH SECTION




**Unit 9** (133.8–207.0 m): See next page for description

**Unit 8** (129.8–133.8 m): Silty dolostone; very fine crystalline; dark grey, weathers light grey and light olive-grey; bedding thickness 1–2 m; rare chert nodules present. Conglomerate in lower 30 cm of outcrop; unit thins to less than 3 m in about 200 m
O-64495 (129.8–133.8 m)

**Unit 7** (56.7–129.8 m): Very argillaceous limestone, chert, calcareous shale, and calcareous mudstone. Very argillaceous limestone: very fine crystalline; grey black or dark grey, weathers dark grey and grey; bedding thickness 64 mm to 3 cm; contains 20–50% calcareous shale, contains 8–10% argillaceous brown-grey chert that weathers dark grey. Chert: dark grey, weathers dark grey to dark brown; bedding thickness 64 mm to 3 cm; argillaceous, slightly calcareous. Calcareous shale: dark brown-grey or dark grey, weathers dark grey; bedding thickness 1–30 cm, moderately to non-fissile; contains 5–8% rare cherty layers; around 105 m, 75% very argillaceous limestone layers present, poor to moderately cleaved, cleavage not parallel to bedding; around 73 m, 20% calcareous mudstone present. Calcareous mudstone: dark grey, weathers grey; contains 25% calcareous shale and 10% argillaceous cherty layers. Outcrop is laterally argillaceous limestone and shale; bedding attitude 135/33 SW at bottom of unit
O-64496 (103.0–103.6 m)

**Unit 6** (42.1–56.7 m): Dolostone; very fine to medium crystalline; grey, weathers light grey; bedding thickness 60 mm to 30 cm
O-64497 (54.0–55.5 m)

**Unit 5** (39.0–42.1 m): Dolostone; grey, weathers grey and brown-grey; bedding thickness 60 cm to 2 m, contains 50% coarse vuggy porosity

**Unit 4** (35.1–39.0 m): Shaly mudstone; dark grey, weathers dark grey; bedding thickness 30 mm to 1 cm, poorly fissile

**Unit 3** (27.1–35.1 m): Dolostone; dark grey, weathers light grey; bedding thickness 3–30 cm; contains 25% calcareous shale
O-64498 (31.4–34.1 m)

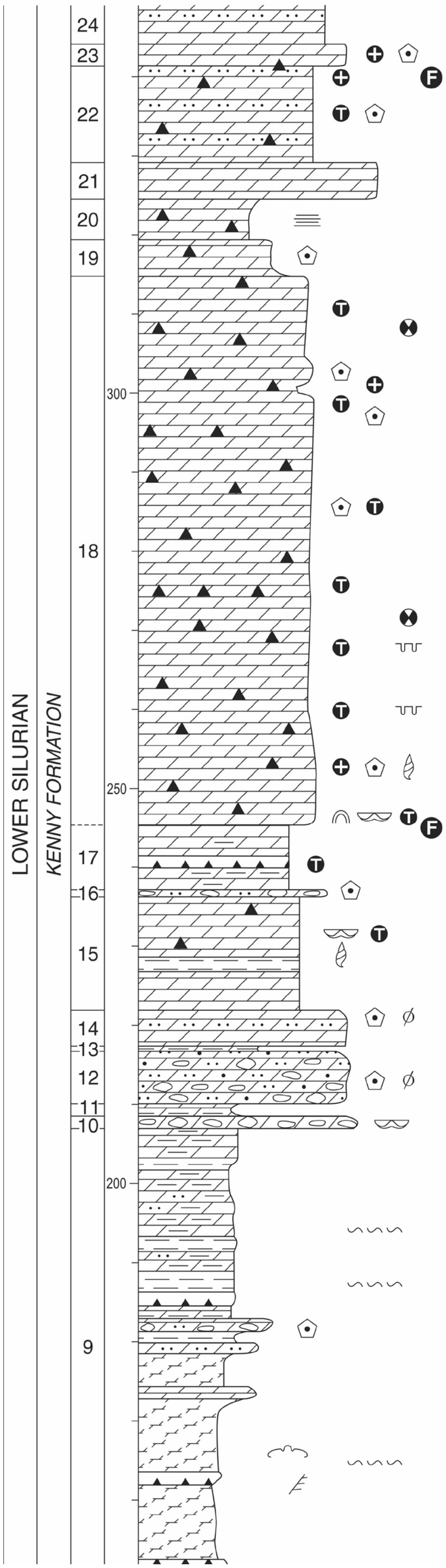
**Unit 2** (25.9–27.1 m): Dolostone; very fine to coarsely crystalline; grey, weathers light grey; bedding thickness around 1 m; contains 30% echinoderm fragments

**Unit 1** (0.0–25.9 m): Argillaceous limestone, limestone, and calcareous shale. Argillaceous limestone: very fine crystalline; dark grey, weathers grey, stained yellow-grey; bedding thickness 3–15 cm, poorly fissile; contains 15–40% calcareous shale. Limestone (9.1–9.8 m): dark grey, weathers light grey; bedding thickness 5–8 cm; echinoderm fragments as debris. Calcareous shale: dark grey, weathers dark grey and grey; bedding thickness 30–91 cm, fairly developed cleavage
O-64499 (12.1–15.2 m)

**Pre-Unit 1:** Argillaceous limestone; very fine crystalline; dark grey, weathers grey and light grey; bedding thicknesses 3–5 cm, dolomite stringers

**Figure A11.** Mount Kenny North (note Norford, 1991, p. 51).

MOUNT KENNY NORTH SECTION, page 2 of 3




**Unit 24** (344.1–366.4 m): See next page for description

**Unit 23** (341.4–344.1 m): Dolostone; very fine to medium crystalline; dark grey, weathers light grey; bedding thickness 60–90 cm

**Unit 22** (329.2–341.4 m): Slightly silty dolostone; very fine crystalline; dark grey, weathers dull grey; bedding thickness 8–60 cm, dolomite stringers; contains rare grey-brown-weathering chert nodules
O-64493 (339.9–341.4 m)

**Unit 21** (324.6–329.2 m): Dolostone; dark grey, weathers light grey; bedding thickness 91 cm to 2 m; interpreted as tongue of reef detritus

**Unit 20** (319.4–324.6 m): Dolostone; very fine crystalline; dark grey, weathers light olive-grey; bedding thickness 3–15 cm, most beds have poorly defined lamination; contains brown-weathering chert nodules; 117/31 SW

**Unit 19** (314.9–319.4 m): Dolostone; very fine to fine crystalline; dark grey, weathers grey and olive-grey; bedding thickness 1–8 cm, distinct; nodular

**Unit 18** (245.4–314.9 m): Dolostone; very fine to medium crystalline; dark grey, weathers dark grey, light grey, and similar colors, in bottom third of unit mottled grey, dark grey and light grey; bedding thickness 30 cm to over 2 m, some platy-weathering beds and shaly partings at bottom of unit, local dolomite stringers and vugs; contains 4–15% grey-black- and brown-weathering chert nodules; at 253 m platy beds are overlain by an erosion surface

**Unit 17** (237.1–245.4 m): Dolostone; slightly earthy dark grey, weathers dull dark grey and grey; bedding 1–8 cm, platy; gradational contact with unit 18
O-64494 (245.0–250.6 m)

**Unit 16** (236.2–237.1 m): Dolostone conglomerate; dark grey, weathers very light grey; slightly silty

**Unit 15** (221.9–236.2 m): Dolostone; very fine crystalline; slightly earthy dark grey and dark brown-grey, weathers dull grey, brown-grey, and olive-grey; bedding 60 mm to 8 cm, bedding is platy towards top of unit; contains 5% shaley partings

**Unit 14** (217.3–221.9 m): Slightly silty dolostone; dark grey, weathers light grey and very light grey; bedding thickness 91 cm to 5 m; contains 1% coarse vuggy porosity; rare pebbles; unit thins laterally

**Unit 13** (216.7–217.3 m): Argillaceous dolostone

**Unit 12** (210.0–216.7 m): Sandy dolostone conglomerate; dark grey, weathers light grey; very silty; contains 30% quartz sand and 2% local vuggy porosity; rare dolostone pebbles

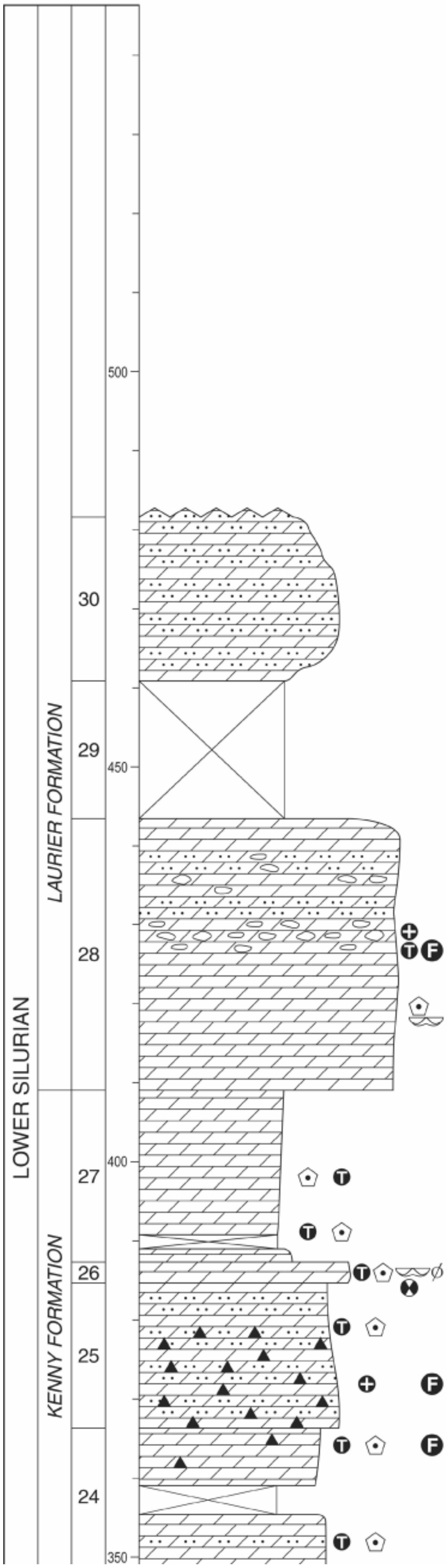
**Unit 11** (208.5–210.0 m): Dolomitic sandstone; weathers light grey and yellow-grey; bedding thickness over 2 m; contains 80% quartz sand, rounded grains

**Unit 10** (207.0–208.5 m): Dolostone conglomerate; grey, weathers light grey and yellow-grey; contortions in subjacent beds; unit thins laterally

**Unit 9** (133.8–207.0 m): Argillaceous dolostone, silty dolostone, and mudstone. Argillaceous dolostone: dark grey, weathers dull grey and dull olive-grey; bedding thickness 60 mm to 10 cm, some poorly defined lamination; locally silty in upper third of unit; contains 2–10% shale, calcareous and fissile in lower third of unit; rare chert nodules and layers, up to 5%, argillaceous chert present around 150 m. Silty dolostone: at 182–182.9 m, very fine crystalline to coarse with cobbles; dark brown-grey, weathers light grey; bed thins to southeast. Mudstone: very fine crystalline; dark grey, weathers dull grey, dark dull grey, and olive-grey; bedding thickness 1–8 cm, most beds are poorly laminated, coarse crystalline dolomite stringers around 166 m; trilobite and diplograptid in talus; dolomitic to slightly dolomitic; contains 5% rare cherty layers and 2–30% fissile shale. Minor faults

**Figure A11. (Cont.)** Mount Kenny North (note Norford, 1991, p. 51).

MOUNT KENNY NORTH SECTION, page 3 of 3




Similar outcrop continues above 482 m, but thrust postulated

**Unit 30** (460.9–481.6 m): Silty dolostone; microcrystalline to very fine crystalline; dark grey, weathers very light grey; bedding thickness 30 cm to 5 m, bedding is indistinct; light grey fine to medium dolomite crystals

**Unit 29** (443.5–460.9 m): Covered interval

**Unit 28** (409.4–443.5 m): Dolostone and silty dolostone. Dolostone: microcrystalline matrix; dark grey, weathers light grey and light yellow-grey; bedding thickness 30 cm to over 2 m, indistinct bedding and some conglomerate at top of unit, dolomite stringers throughout; pentamerid brachiopods at 418 m; contains 80–90% very fine to coarse light-grey dolomite crystals
Fossil sample: O-64490 (426.7–443.5 m)

**Unit 27** (387.4–409.4 m): Dolostone; very fine to coarse crystalline with microcrystalline matrix in bottom half of unit; dark grey and grey, weathers dull grey, dull olive-grey, and dull light olive-grey; bedding thickness 3–90 cm, slightly nodular, dolomite stringers

**Unit 26** (384.7–387.4 m): Dolostone; very fine to medium crystalline; grey, weathers light grey; bedding thickness 90 cm to 1 m, dolomite stringers and vugs, minor vuggy porosity; reef detritus

**Unit 25** (366.4–384.7 m): Silty dolostone; very fine to medium crystalline; dark grey, weathers dull grey, dull dark grey and dark olive-grey; bedding thickness 3–38 cm, dolomite stringers in upper half of unit, nodular; contains 5% grey black chert nodules at 378 m
O-64491 (371.9–381.0 m)

**Unit 24** (344.1–366.4 m): Dolostone; grey and dark grey, weathers dull grey, dull olive-grey and dull light olive-grey; bedding thickness 8–60 cm, weathers slightly rubbly, dolomite stringers; contains 1% chert nodules; at 354 m two light-grey-weathering beds are present with abundant echinoderm fragment debris; interpreted as tongues of reef detritus

**Figure A11. (Cont.)** Mount Kenny North (note Norford, 1991, p. 51).

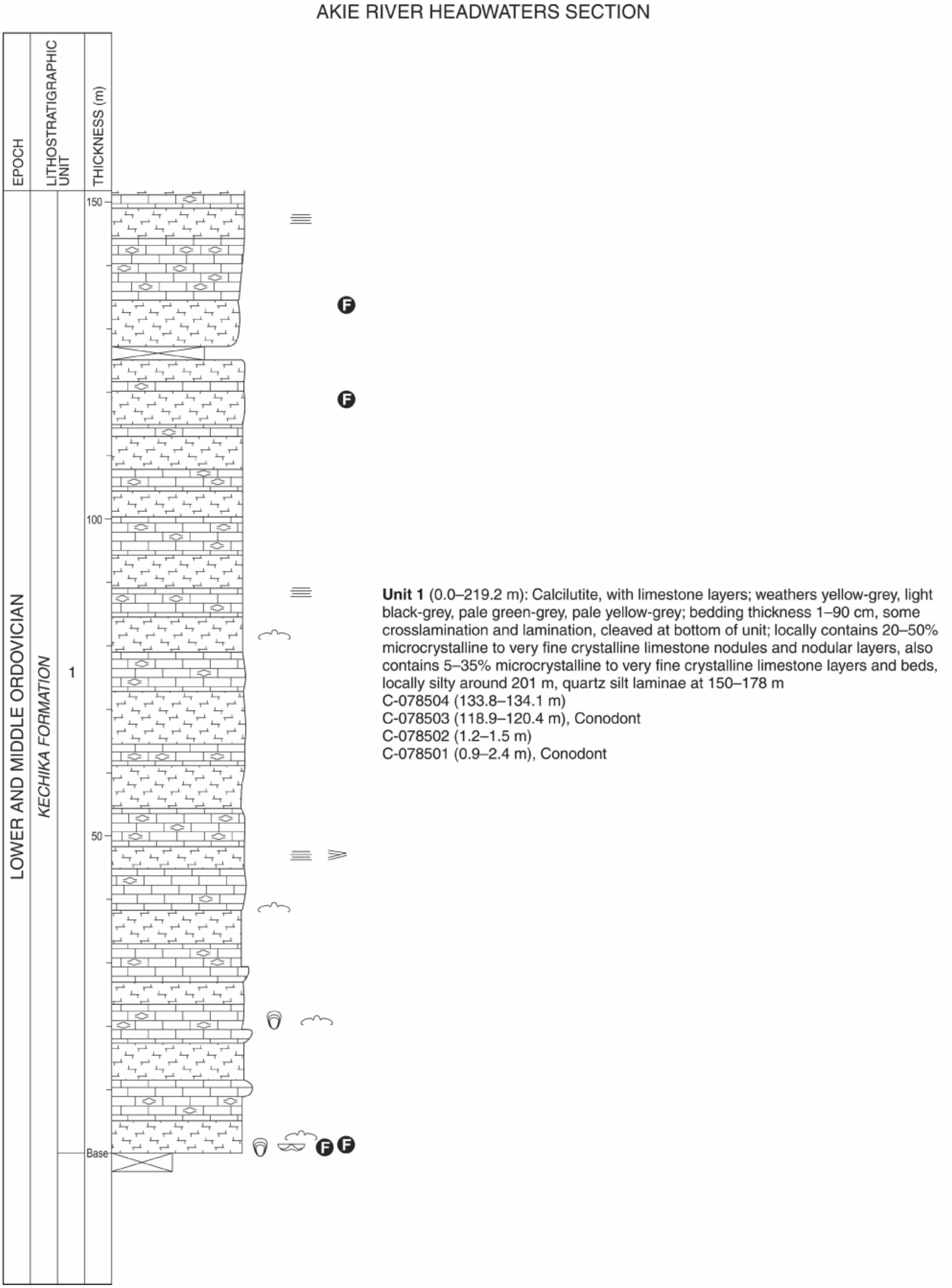
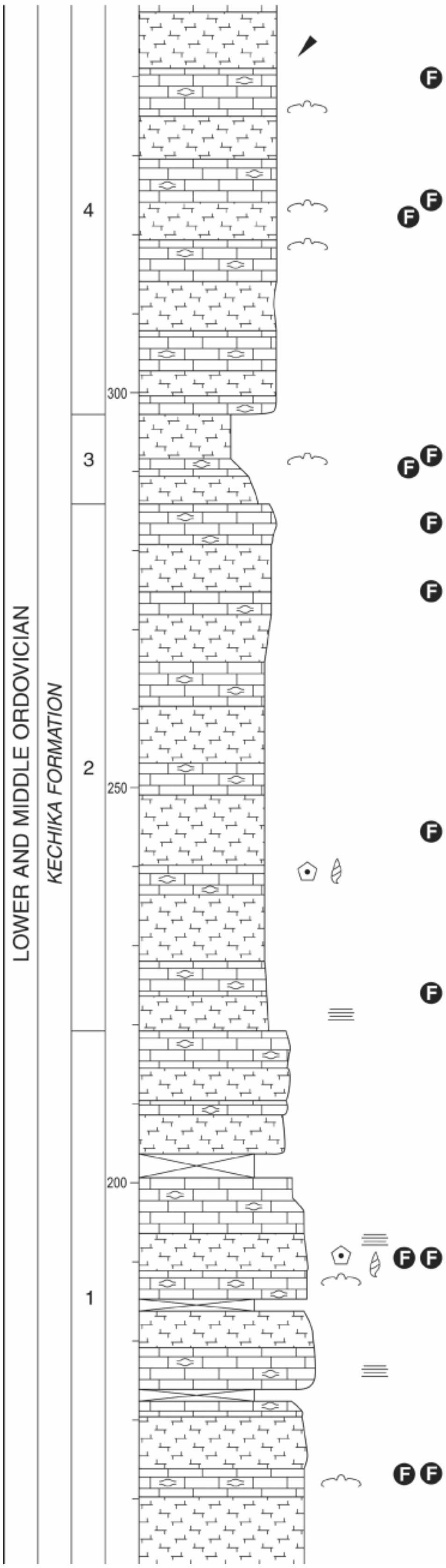



**Figure A12**. Akie River Headwaters.

AKIE RIVER HEADWATERS SECTION, page 2 of 5




**Unit 4** (297.2–359.1 m): Calcilutite; weathers yellow-grey; bedding thickness over 2 m; contains 3–40% limestone nodules and layers
C-078513 (339.9–340.0 m)
C-078656 (324.3 m), Conodont
C-078655 (322.2–335.9 m)

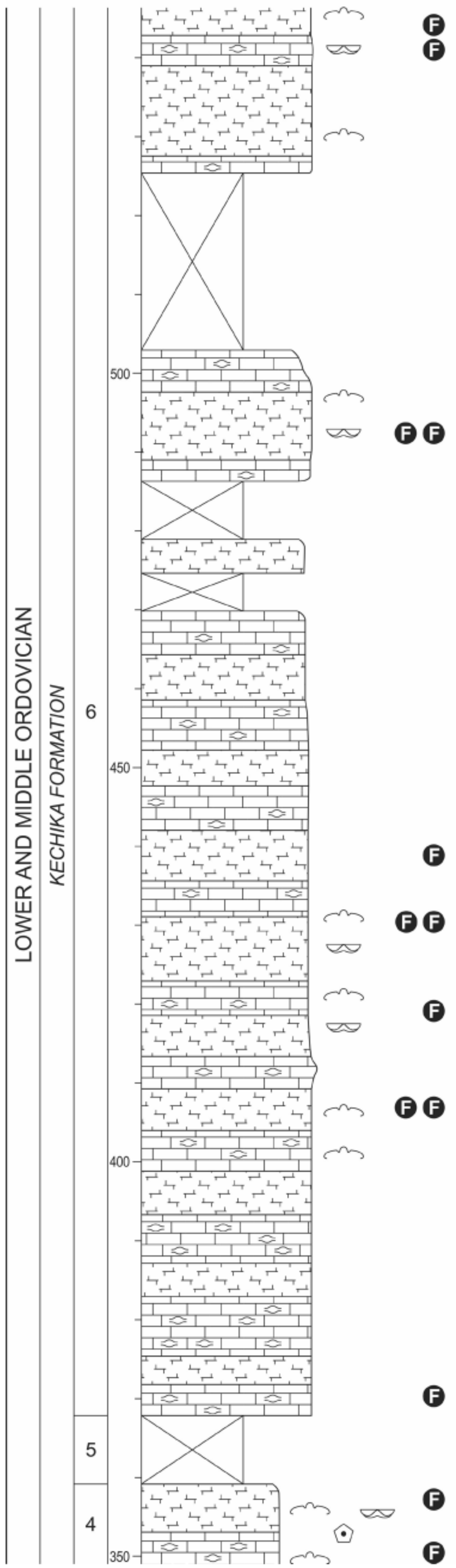
**Unit 3** (285.9–297.2 m): Slaty calcilutite; weathers light olive-grey; cleaved; contains 20% nodular limestone
C-078512 (292.0–292.3 m)
C-078510 (290.5–290.8 m)
C-078511 (283.5–292.3 m), Conodont

**Unit 2** (219.2–285.9 m): Calcilutite; microcrystalline to very fine crystalline; weathers grey and light green-grey; bedding thickness 30 cm to 1 m, cleaved at top of unit; contains 30% silty limestone nodules at top of unit, 40–50% very fine crystalline limestone nodules elsewhere, contains very fine-grained calcarenites around 238 m, some quartz silt lamination at base of unit
C-078654 (274.9–283.5 m), Conodont
C-078661 (244.4–270.4 m), Conodont
C-078509 (224.0–236.2 m), Conodont

**Unit 1** (0.0–219.2 m): See previous page for description
C-078508 (190.5–197.5 m), Conodont
C-078507 (190.5–191.4 m)
C-078506 (163.1–163.4 m), Conodont
C-078505 (163.1–163.4 m)

**Figure A12**. **(Cont.)** Akie River Headwaters.

AKIE RIVER HEADWATERS SECTION, page 3 of 5




**Unit 6** (367.9–710.2 m): Calcilutite, calcarenite, and limestone conglomerate. Calcilutite: weathers yellow-grey, pale orange-grey, light olive-grey, and very pale yellow-brown; bedding thickness over 2 m, cleaved around 366 m; contains 20–60%, microcrystalline to very fine crystalline limestone nodules, 40% nodular layers at bottom of unit, rare calcisiltite lenses around 637 and 610 m. Calcarenite: rare, around 570 and 544 m. Limestone conglomerate: at 414 m. Around 518 m, unit covered on ridge, but rocks on cliff-face similar to underlying rocks
C-078523 (544.1 m)
C-078522 (541.0–547.1 m), Conodont
C-078521 (492.3 m)
C-078520 (492.3–498.3 m), Conodont
C-078519 (438.9–447.8 m), Conodont
C-078518 (430.4–431.3 m), Conodont
C-078517 (430.4 m)
C-078659 (419.1–429.8 m), Conodont
C-078658 (406.9–417.6 m), Conodont
C-078657 (406.9 m)
C-078516 (370.3–392.3 m), Conodont

**Unit 5** (359.1–367.9 m): Covered interval; beds similar to beds above outcrop laterally in cliff-face

**Unit 4** (297.2–359.1 m): See previous page for description

**Figure A12**. **(Cont.)** Akie River Headwaters.

AKIE RIVER HEADWATERS SECTION, page 4 of 5

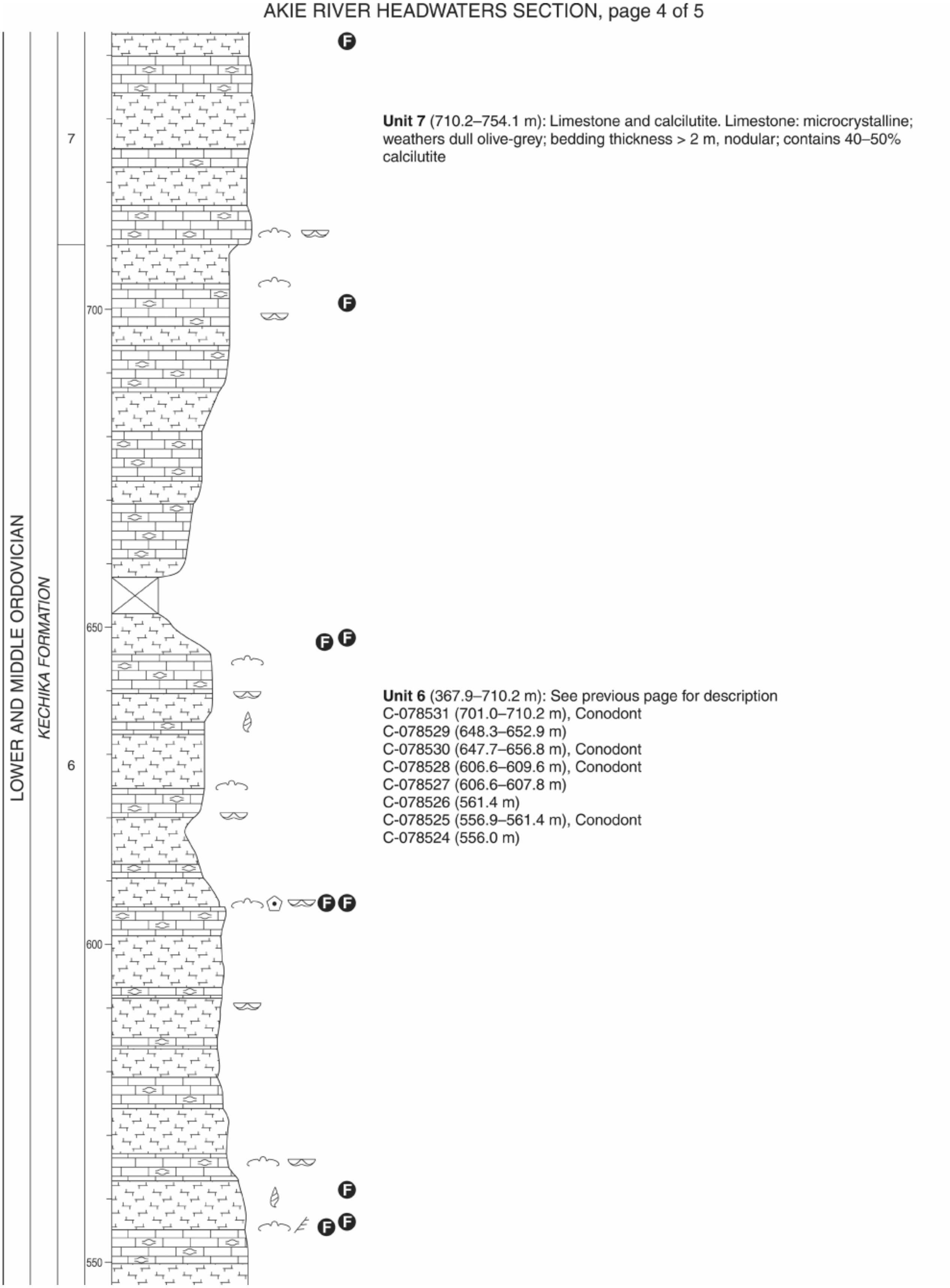
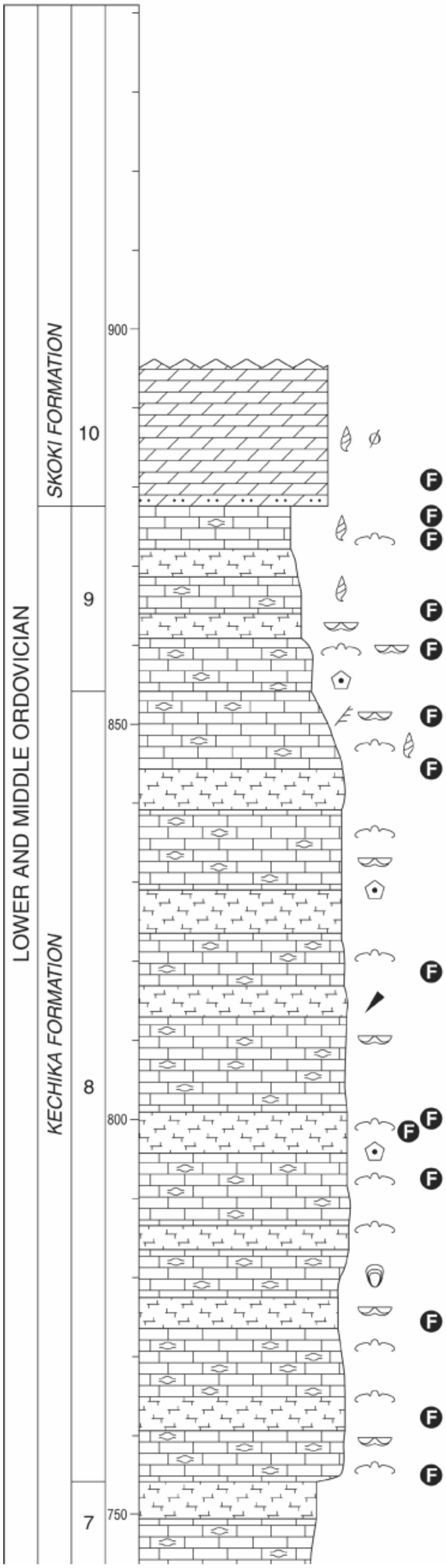



**Figure A12**. **(Cont.)** Akie River Headwaters.

AKIE RIVER HEADWATERS SECTION, page 5 of 5




**Unit 10** (877.2–end of section): Dolostone; very fine crystalline; weathers light grey with sparse orange-grey pockmarks; bedding thickness 30–60 cm, contains 5% vuggy porosity; base of Unit 10 is covered and concordant
C-078546 (880.9–887.3 m), Conodont

**Unit 9** (854.1–877.2 m): Limestone; microcrystalline to very fine crystalline; weathers grey; bedding thickness 30 cm to 2 m, weathers flaggy throughout; at middle of unit, contains 90% nodular limestone beds with 50% calcilutite matrix, contains 5% calcilutite in bottom third of unit, contains 5% calcilutite partings in upper third of unit
C-078545 (876.3–876.9 m)
C-078544 (873.3–877.2 m), Conodont
C-078543 (864.4–864.4 m)
C-078542 (859.5–865.6 m), Conodont

**Unit 8** (754.1–854.1 m): Limestone, as nodular layers in calcilutite matrix. Limestone: microcrystalline to very fine crystalline; weathers grey and yellow-grey, unit weathers orange-grey in distant aspect; bedding thickness 30 cm to over 2 m; contains 20–40% calcilutite matrix
C-078541 (851.0–854.1 m)
C-078540 (844.3–850.4 m)
C-078539 (818.7–823.6 m), Conodont
C-078538 (800.1–804.7 m)
C-078537 (797.4–798.0 m)
C-078536 (792.5–802.8 m), Conodont
C-078535 (774.5–780.3 m), Conodont
C-078534 (762.3–762.9 m)
C-078533 (755.0–755.3 m)

**Unit 7** (710.2–754.1 m): See previous page for description

**Figure A12**. **(Cont.)** Akie River Headwaters.

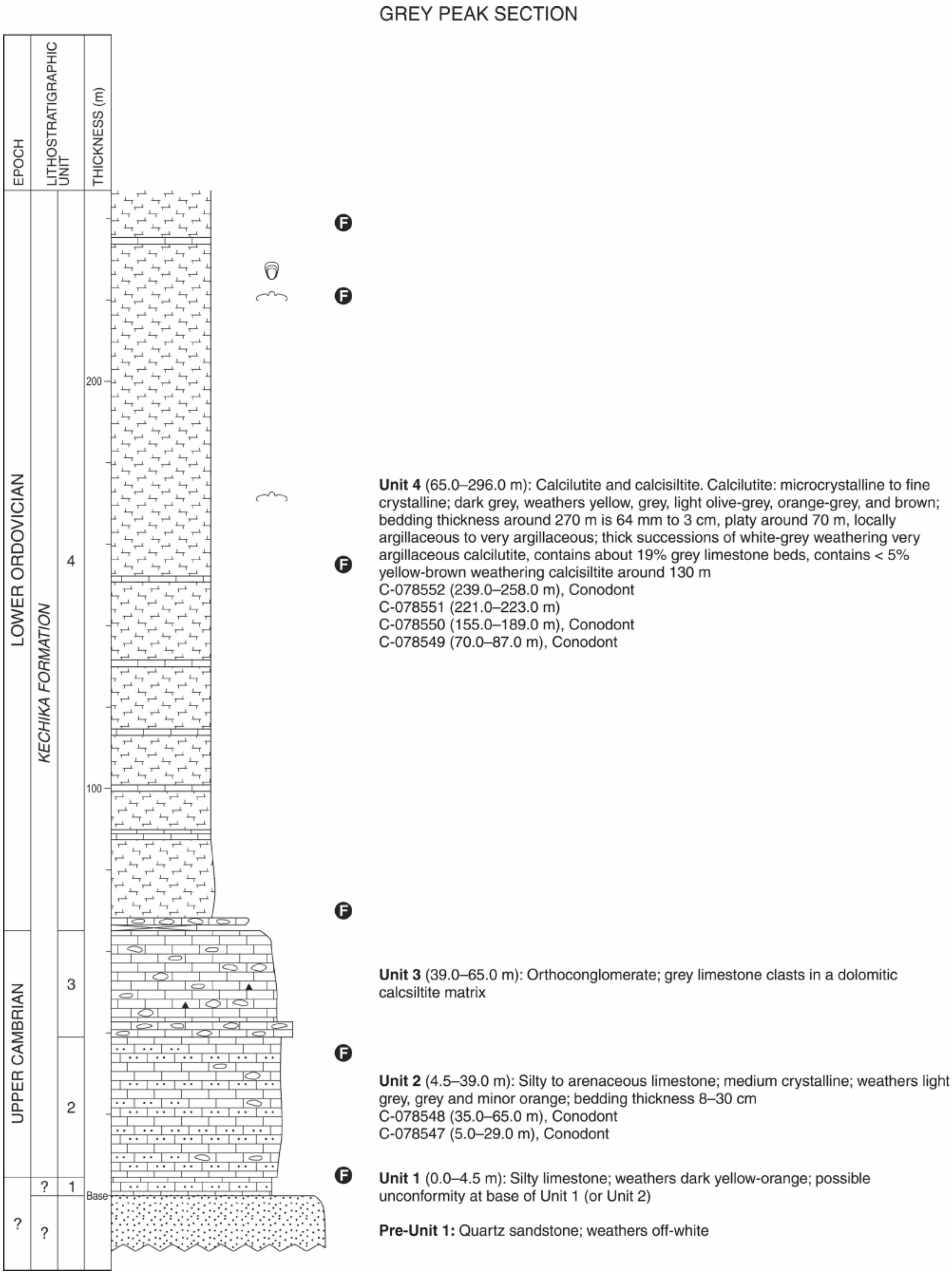
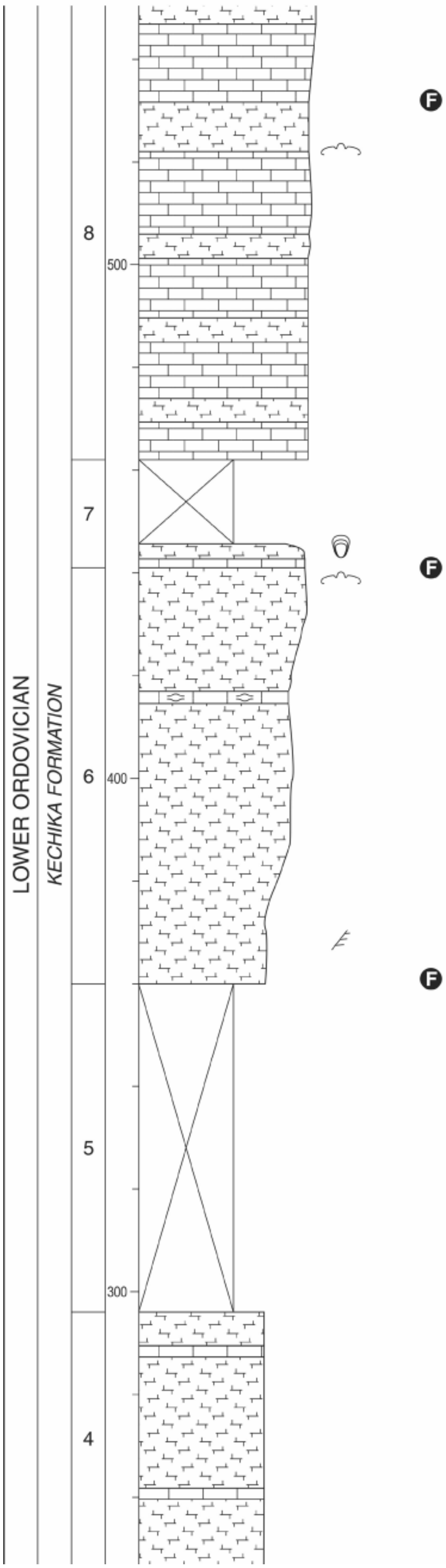



**Figure A13**. Grey Peak (note Lenz and Jackson, 1986, p. 29; Norford, 1991, p. 51; Pyle and Barnes, 2002a, p. 140–145).

## GREY PEAK SECTION, page 2 of 7




**Unit 8** (462.0–886.0 m): Calcilutite and limestone. Calcilutite: dark grey, weathers grey, pale yellow, yellow-grey, and orange; contains 5% nodular limestone beds around 840 m, minor phosphorite pavements and nodules from 750–810 m, papery partings around 560 m, platy partings at base of unit, nodular beds around 815 and 760 m; less dominant than limestone, interstratified slightly argillaceous to very argillaceous calcilutite. Limestone: fine crystalline; weathers dull grey; contains poorly developed cleavage around 475 m
C-078555 (532.0–558.0 m), Conodont

**Unit 7** (441.0–462.0 m): Calcilutite
C-078554 (441.0–474.0 m), Conodont

**Unit 6** (360.0–441.0 m): Calcilutite; dark grey, weathers yellow-grey; contains rare limestone nodules and nodular beds; interstratified argillaceous and white-grey weathering, very argillaceous intervals
C-078553 (361.0–387.0 m)

**Unit 5** (296.0–360.0 m): Covered, but with felsenmeer of strata similar to those described below

**Unit 4** (65.0–296.0 m): See previous page for description

**Figure A13**. **(Cont.)** Grey Peak (note Lenz and Jackson, 1986, p. 29; Norford, 1991, p. 51; Pyle and Barnes, 2002a, p. 140–145).

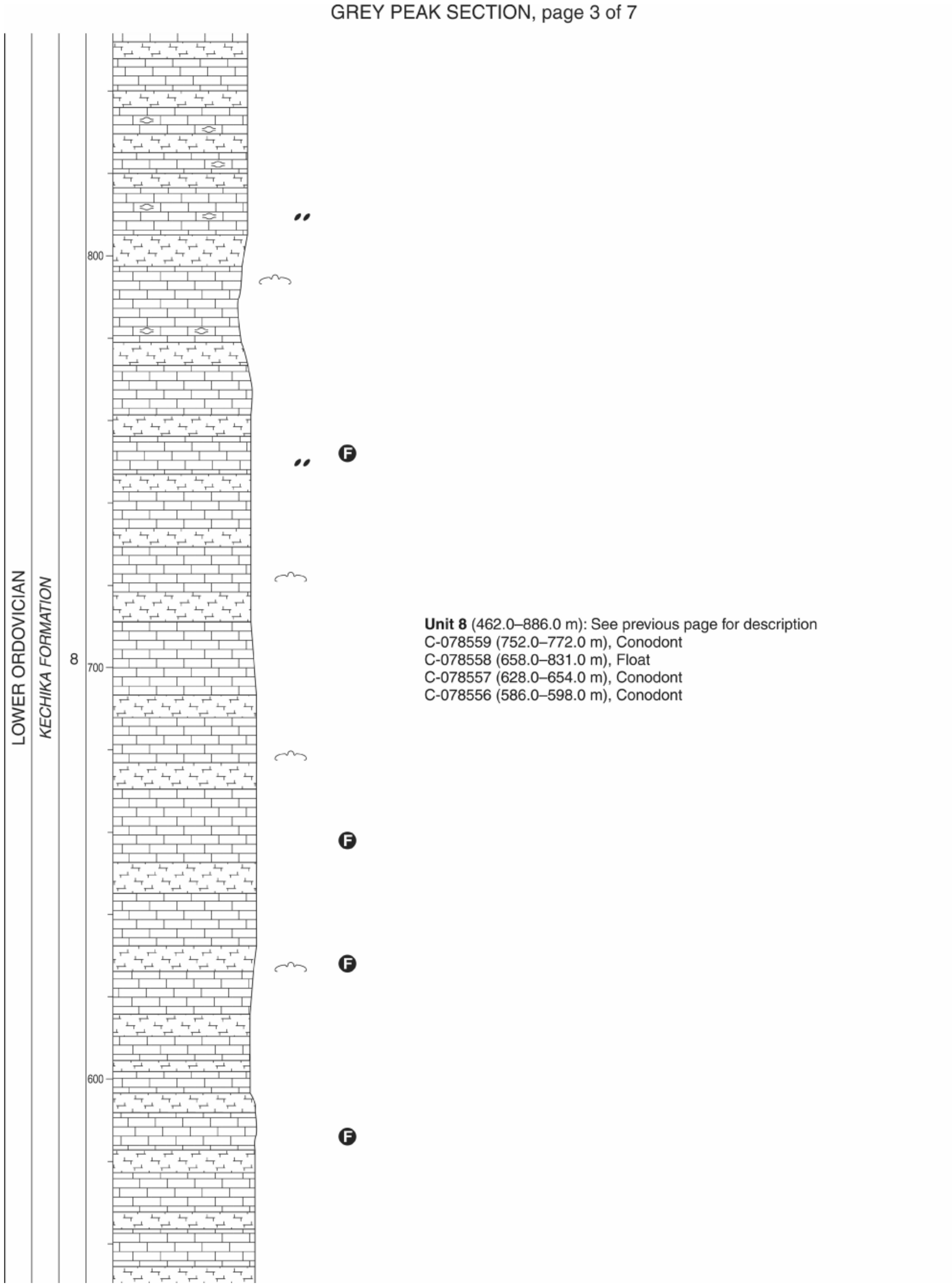
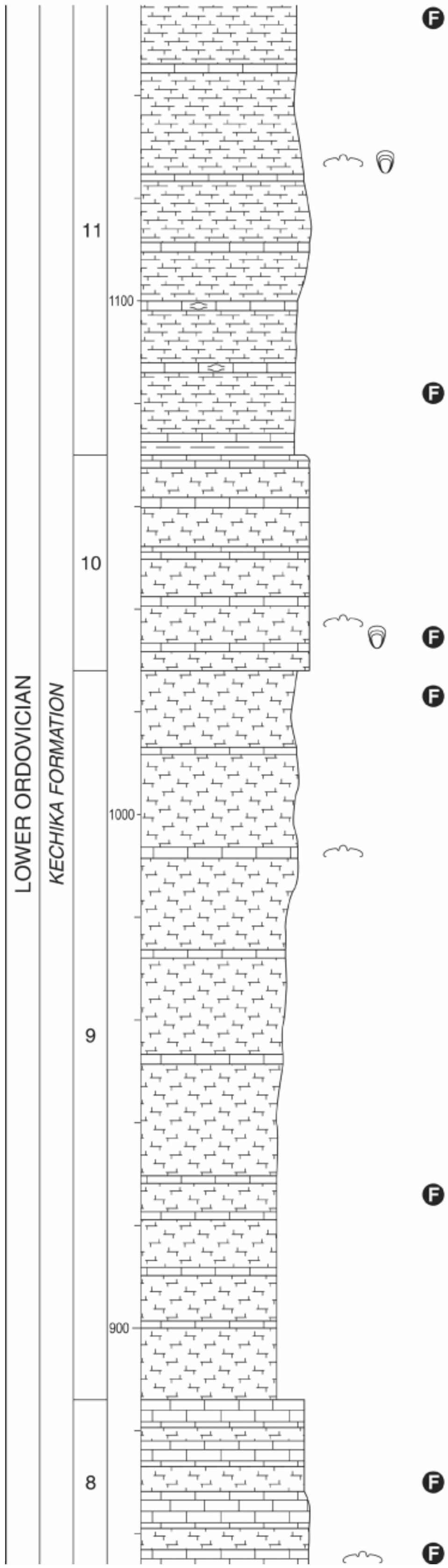



**Figure A13**. **(Cont.)** Grey Peak (note Lenz and Jackson, 1986, p. 29; Norford, 1991, p. 51; Pyle and Barnes, 2002a, p. 140–145).

GREY PEAK SECTION, page 4 of 7




**Unit 11** (1070.0–1240.0 m): Calcareous shale, very argillaceous calcilutite, calcirudite and calcarenite. Calcareous shale: dark grey, weathers dark grey and brown; contains 10–20% grey limestone nodules and calcirudite beds every 6–10 m, minor very thin phosphorite beds near top of unit, rare calcirudite at base of unit. Very argillaceous calcilutite: dark grey, weathers grey-white; contains 20% grey limestone nodules and beds of calcarenite or calcirudite every 15–30 m
C-078566 (1155.0–1178.0 m), Conodont
C-078565 (1082.0–1113.0 m), Conodont

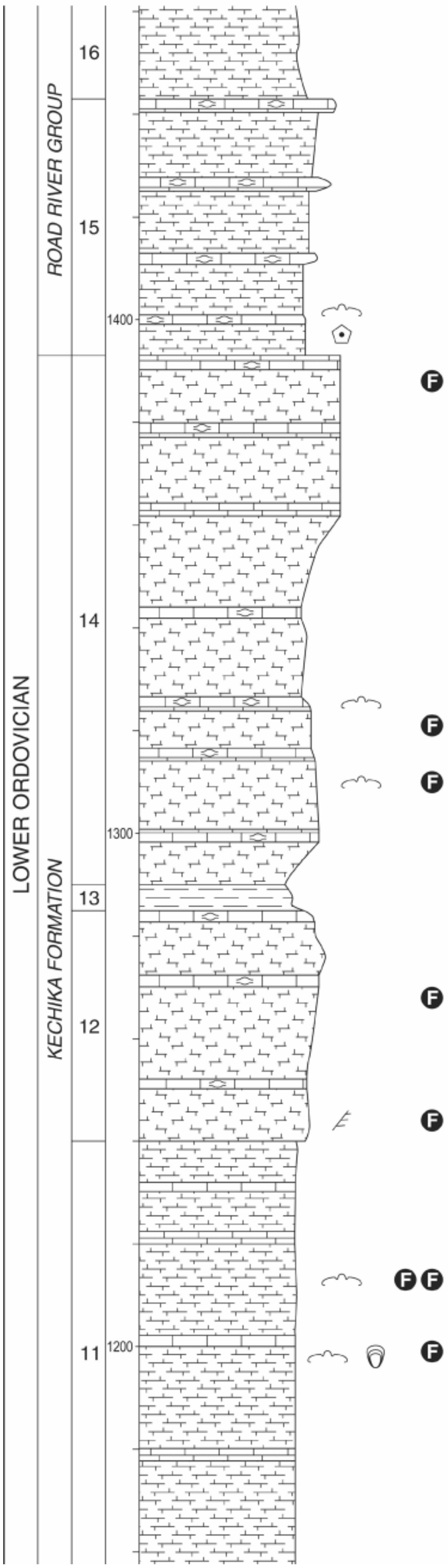
**Unit 10** (1028.0–1070.0 m): Very argillaceous calcilutite and shale. Very argillaceous calcilutite: dark grey, weathers grey-white; contains 20–40% calcilutite and minor calcarenite. Shale: very dark grey, weathers grey; contains 30% very thin, lensing limestone beds
C-078564 (1034.5–1034.6 m)

**Unit 9** (886.0–1028.0 m): Very argillaceous calcilutite and calcareous shale. Very argillaceous calcilutite: dark grey, weathers grey-white and yellow-grey; bedding thickness 7–60 cm, well cleaved, cleavage not parallel to bedding; contains 5–10% very thin beds of calcilutite at top of unit, contains 10% platy limestone beds. Calcareous shale: dark grey, weathers brown
C-078563 (1023.0–1035.0 m), Conodont
C-078562 (926.0–943.0 m), Conodont

**Unit 8** (462.0–886.0 m): See previous page for description
C-078561 (870.0–895.0 m), Conodont
C-078560 (855.0–855.1 m)

**Figure A13**. **(Cont.)** Grey Peak (note Lenz and Jackson, 1986, p. 29; Norford, 1991, p. 51; Pyle and Barnes, 2002a, p. 140–145).

GREY SECTION, page 5 of 7




**Unit 16** (1443.0–1485.0 m): Shale, mostly calcareous; black, weathers dark olive-brown and grey; pencil cleavage not parallel to bedding; contains 5% limestone/calcisiltite nodules and rare beds

**Unit 15** (1393.0–1443.0 m): Shale, mostly calcareous; black, weathers dark yellow-brown; pencil cleavage not parallel to bedding; contains 5–10% limestone nodules and nodular beds

**Unit 14** (1290.0–1393.0 m): Calcilutite and calcarenite. Calcilutite: weathers grey and grey-white; locally very argillaceous, contains 15% nodular grey limestone beds, minor very thin phosphorite beds, minor calcirudite. Rare calcarenite at 1363 m: bedding thickness around 1 m
C-078574 (1388.0–1393.0 m), Conodont
C-078573 (1321.0–1358.0 m), Conodont
C-078572 (1310.0–1315.0 m)

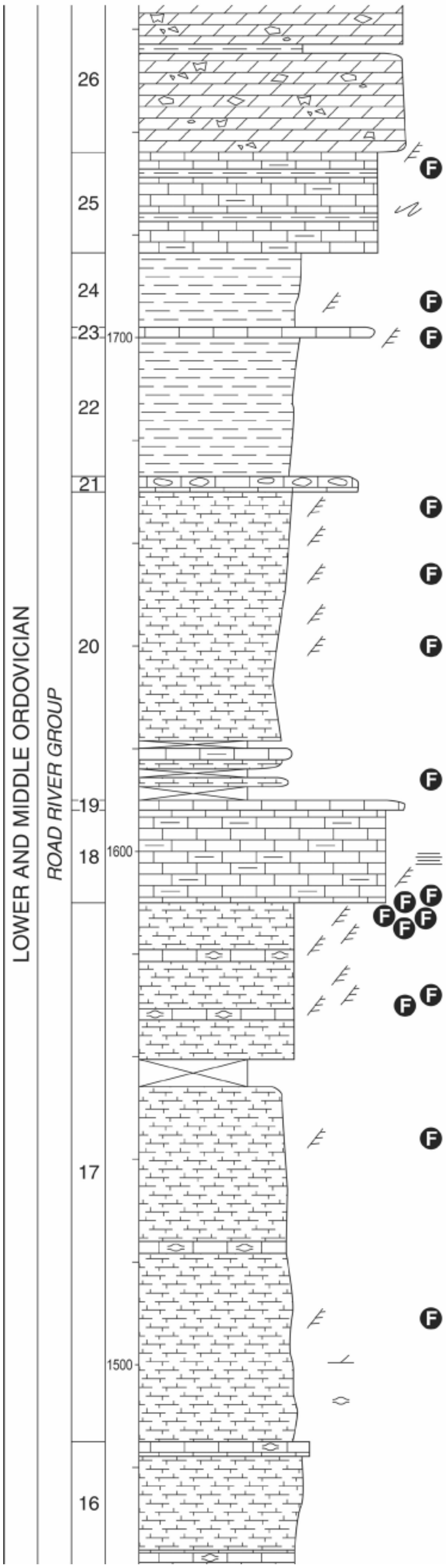
**Unit 13** (1285.0–1290.0 m): Shale; weathers dark grey

**Unit 12** (1240.0–1285.0 m): Calcilutite and calcareous shale. Calcilutite: dark grey, weathers yellow-grey, grey-white and light grey; locally argillaceous to very argillaceous; locally calcareous; contains approximately 5% nodular limestone beds. Calcareous shale: cleaved, cleavage not parallel to bedding
C-078571 (1268.0–1268.1 m)
C-078570 (1244.0–1244.5 m)

**Unit 11** (1070.0–1240.0 m): See previous page for description
C-078569 (1213.0–1240.0 m), Conodont
C-078568 (1213.0–1214.0 m)
C-078567 (1190.0–1190.1 m)

**Figure A13**. **(Cont.)** Grey Peak (note Lenz and Jackson, 1986, p. 29; Norford, 1991, p. 51; Pyle and Barnes, 2002a, p. 140–145).

GREY PEAK SECTION, page 6 of 7




**Unit 26** (1736.0–1771.0 m): Limestone and dolomite paraconglomerate and breccia; grey and dark grey; succession of interstratified paraconglomerate and limestone breccia, boulder and block-sized, some resemble Skoki Formation; 100 m south of section these strata are cut by a channel filled with a boulder and block-sized dolostone breccia containing shallow-water macrofauna

**Unit 25** (1716.5–1736.0 m): Limestone; dark grey, weathers grey; unit is conformable with younger and older strata; thick slabs of limestone are separated by breccia and are slumped
C-078590 (1733.0–1735.0 m)

**Unit 24** (1702.0–1716.5 m): Shale
C-078589 (1707.0–1707.5 m)

**Unit 23** (1700.0–1702.0 m): Limestone
C-078588 (1700.0–1700.05 m)

**Unit 22** (1673.0–1700.0 m): Shale

**Unit 21** (1670.0–1673.0 m): Limestone conglomerate.

**Unit 20** (1610.0–1670.0 m): Calcareous shale; black, and dark grey; contains very minor platy beds of calcilutite
C-078587 (1667.0–1667.4 m)
C-078586 (1654.0–1654.1 m)
C-078585 (1640.0–1641.0 m)
C-078584 (1614.0–1626.0 m)

**Unit 19** (1608.0–1610.0 m): Limestone; weathers light grey; bedding thickness 30–90 cm

**Unit 18** (1590.0–1608.0 m): Limestone; weathers grey, light olive-grey, and yellow; bedding thickness 5–20 cm, contains orange-grey wispy laminae, weathers platy
C-078582 (1591.0 m)
C-078583 (1590.0–1610.0 m), Conodont

**Unit 17** (1485.0–1590.0 m): Shale, mostly calcareous; black, weathers dark olive brown-grey, and dull dark olive grey, and black with brown spots; cleaved, cleavage not parallel to bedding; locally slightly dolomitic around 1500 m, contains up to 5% limestone nodules and beds, pyrite nodules in lower third of unit
C-078581 (1589.0–1589.1 m)
C-078580 (1587.0–1587.1 m)
C-078579 (1585.0–1585.3 m)
C-078578 (1572.0–1572.01 m)
C-078577 (1570.0–1570.1 m)
C-078576 (1544.0–1548.0 m)
C-078575 (1509.0–1509.1 m)

**Unit 16** (1443.0–1485.0 m): See previous page for description

**Figure A13**. **(Cont.)** Grey Peak (note Lenz and Jackson, 1986, p. 29; Norford, 1991, p. 51; Pyle and Barnes, 2002a, p. 140–145).


**Figure A13**. **(Cont.)** Grey Peak (note Lenz and Jackson, 1986, p. 29; Norford, 1991, p. 51; Pyle and Barnes, 2002a, p. 140–145).

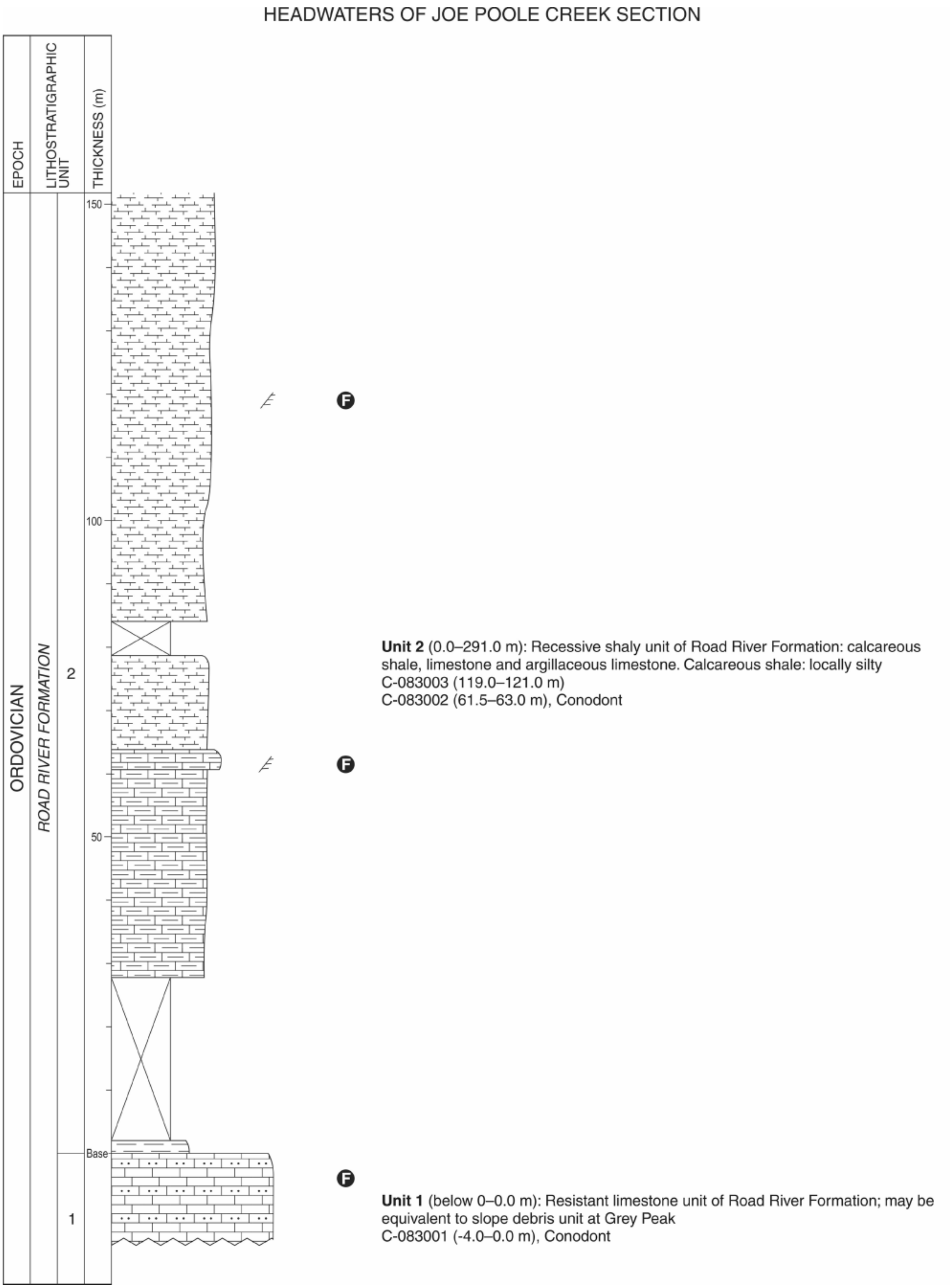



**Figure A14**. Headwaters of Joe Poole Creek.

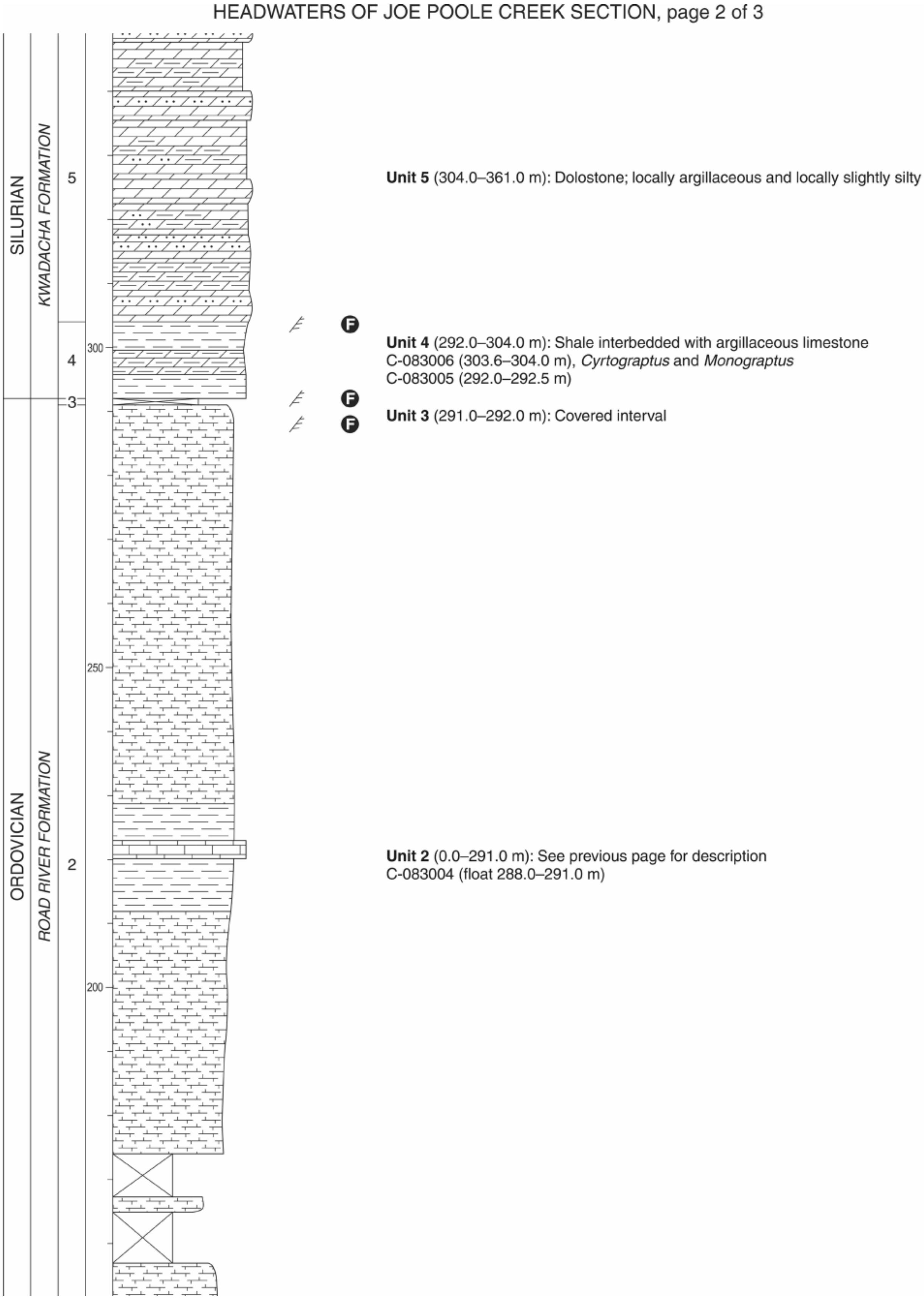
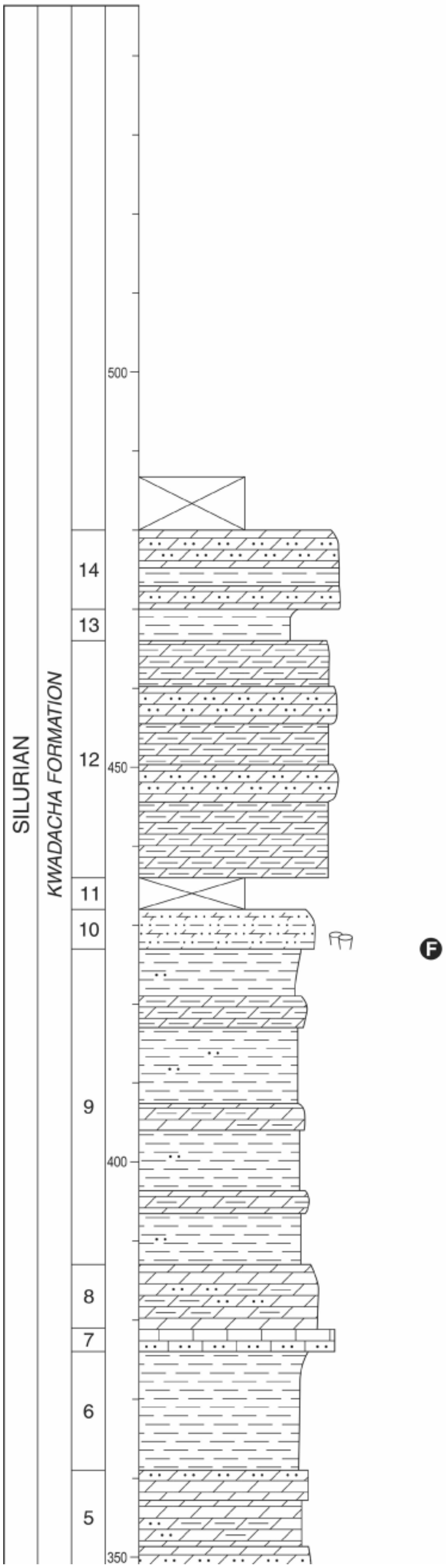



**Figure A14**. **(Cont.)** Headwaters of Joe Poole Creek.

HEADWATERS OF JOE POOLE CREEK SECTION, page 3 of 3




**Unit 14** (470.0–480.0 m): Silty dolostone; interbedded with shale. From 480 m onward, covered. Top of section dip slope to recessive Besa River Fomation shale

**Unit 13** (466.0–470.0 m): Silty shale

**Unit 12** (436.0–466.0 m): Silty and argillaceous dolostone

**Unit 11** (432.0–436.0 m): Covered interval

**Unit 10** (427.0–432.0 m): Dolomitic siltstone
C-083007 (427.0–432.0 m), Sponges, *Diagoniella* and *Protospongia*

**Unit 9** (387.0–427.0 m): Shale and slightly argillaceous limestone. Shale: locally silty

**Unit 8** (379.0–387.0 m): Slightly argillaceous and silty dolostone

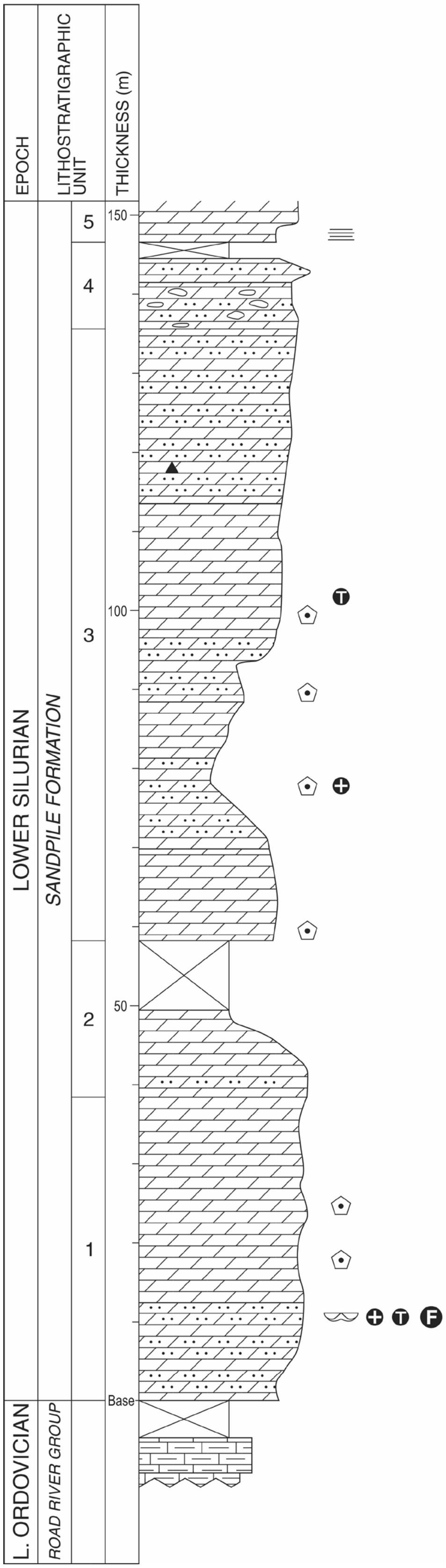
**Unit 7** (376.0–379.0 m): Silty limestone

**Unit 6** (361.0–376.0 m): Shale

**Unit 5** (304.0–361.0 m): See previous page for description

**Figure A14**. **(Cont.)** Headwaters of Joe Poole Creek.

SANDPILE CREEK SECTION




**Unit 5** (146.6–157.3 m): Dolostone; fine to coarse crystalline; light grey, weathers black-grey and yellow; bedding thickness 1 m to over 2 m, some lamination in bottom half of unit

**Unit 4** (135.6–146.6 m): Silty dolostone; very fine to fine crystalline; dark grey and grey, weathers dull brown-grey and grey; bedding thickness 46 cm to 2 m; contains some conglomerate. Float of brown-black paper shale at top of unit

**Unit 3** (58.2–135.6 m): Silty dolostone and dolostone. Silty dolostone: very fine crystalline; light grey, dark grey, blue-grey, dark blue-grey, weathers dark orange-grey, brown-grey, dark grey, blue-grey, and grey with brown stains; bedding thickness over 2 m, at top of unit undulatory laminae present on weathered surfaces, weathers rubbly at top of unit and around 72 m, dolomite stringers common around 113 m; poor dolomite fossils around 76 m. Dolostone: very fine to fine crystalline; grey-black, blue-grey, dark grey and grey, weathers grey, brown-grey, and dark grey; bedding thickness over 2 m, weathers rubbly around 85 m; at 102 m poorly preserved *Favosites*

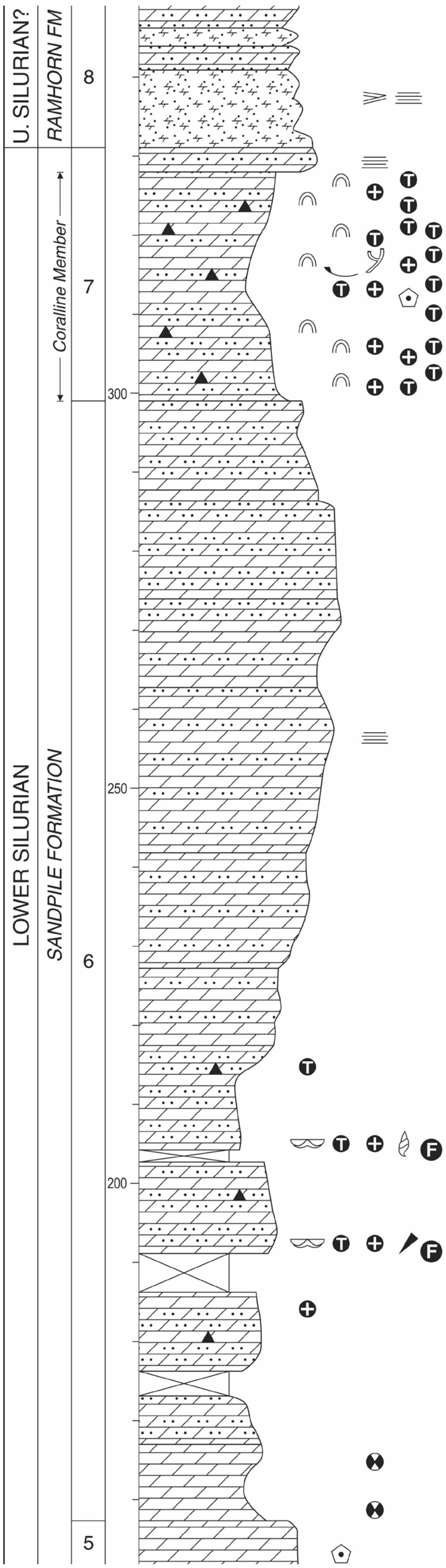
**Unit 2** (38.4–58.2 m): Dolostone; microcrystalline to very fine crystalline; dark grey, and grey-black, weathers light grey; bedding thickness 2–3 m, poorly developed at base of unit; slightly silty at base of unit

**Unit 1** (0.0–38.4 m): Dolostone; microcrystalline to medium crystalline; grey, dark grey, dull dark grey, dark blue-grey, weathers grey, brown-grey, and dark grey; bedding thickness 30 cm to 2 m, poorly developed around 24 m, weathers rubbly at base and top of unit, dolomite stringers throughout; locally silty in bottom third of unit, rare lichens around 14 m
O-45589 (10.7 m)

**Pre-Unit 1:** Covered interval, argillaceous limestone below. Contact not exposed, structurally conformable

**Figure A15.** Sandpile Creek (note Norford, 1962, p. 4; 1965, p. 46, 47).

## SANDPILE CREEK SECTION page 2 of 3




**Unit 8** (331.1–427.0 m): See next page for description

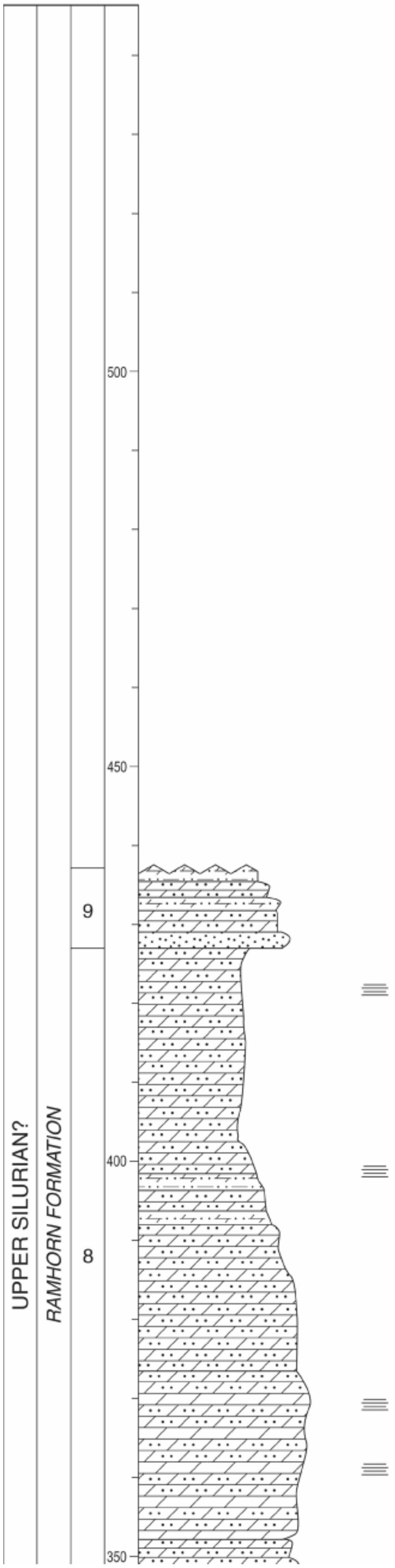
**Unit 7** (299.0–331.1 m): Silty dolostone; very fine crystalline; blue-grey, dark blue-grey, and black-grey, weathers brown-grey, dull brown-grey, light brown-grey, and brown; bedding thickness 90 cm to over 2 m; abundant silicified fossils throughout; locally slightly silty

**Unit 6** (157.3–299.0 m): Silty dolostone and dolostone. Silty dolostone: microcrystalline to fine crystalline; dark grey, dull grey, grey, light grey, and dark dull grey, weathers brown, brown-grey, dark brown-grey, dull brown-grey, light grey, grey, and dull grey; bedding thickness 30 cm to over 2 m, 5 cm thick partings and poorly developed undulatory lamination on weathered surfaces around 164 m, some nodular structures and rubbly weathering around 177 m; contains up to 5% quartz sand at 260–290 m. Dolostone: microcrystalline to fine crystalline; grey, dark blue-grey, blue-grey, dull grey, and dark grey, weathers brown-grey, dull grey, light brown, brown and yellow; bedding thickness 30 cm to over 2 m, poorly developed around 229 m, 3–13 cm partings around 233 m, some 1–5 cm undulatory lamination on weathered surfaces at 238 m, contains 50% white dolomite vugs around 160 m, fine white dolomite vugs at base of unit, weathers rubbly at base of unit
O-45588 (204.2–206.0 m)
O-45586 (191.4–195.1 m)

**Unit 5** (146.6–157.3 m): See previous page for description

**Figure A15. (Cont.)** Sandpile Creek (note Norford, 1962, p. 4; 1965, p. 46, 47).

SANDPILE CREEK SECTION, page 3 of 3

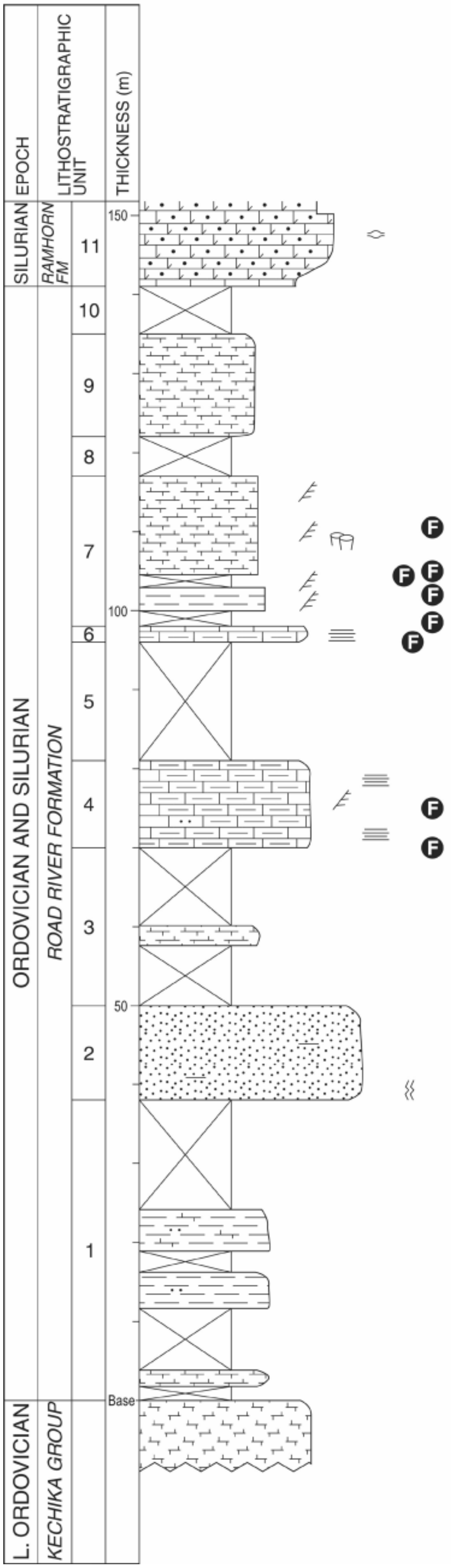



**Unit 9** (427.0–437.1 m): Dolomitic siltstone, very silty dolostone, and quartz sandstone. Dolomitic siltstone: light grey, weathers light brown, lichens present. Very silty dolostone: very fine crystalline; dark grey, weathers light buff to light brown-grey; bedding thickness 15 cm to 1 m. Quartz sandstone: first bed occurs at 427 m. Section continues to 547.4 m where it is faulted against similar rocks of the Ramhorn Formation. No description above 437.1 m

**Unit 8** (331.1–427.0 m): Very silty dolostone, silty dolostone, dolomitic siltstone, and dolomitic sandstone. Very silty dolostone: very fine crystalline; dark grey, light grey, and grey, weathers yellow, pale yellow, light brown, and brown-grey; bedding thickness 15 cm to over 2 m, laminated in some places. Silty dolostone: very fine crystalline; grey, weathers yellowish grey, pale yellowish grey, and pale yellow; bedding thickness 30 cm to over 2 m; poorly preserved coral at 341 m. Dolomitic siltstone: light grey, weathers light brown; lichens present. Dolomitic sandstone: pale yellow, weathers yellow, yellow-brown, and yellowish grey, lichens around 337 m; bedding thickness over 2 m, laminated and crosslaminated; contains quartz sand laminae at bottom of unit

**Figure A15. (Cont.)** Sandpile Creek (note Norford, 1962, p. 4; 1965, p. 46, 47).

## TURNAGAIN RIVER ROOF-PENDANT SECTION




**Unit 11** (141.0–156.0 m): Sandy limestone; light olive-grey, weathers light grey; bedding thickness 2 cm to 1 m, many beds laminated, contains sparse, small quartz nodules; dolomitic, contains abundant very fine- to fine-grained quartz sand. Lower 2/3 of unit poorly foliated subparallel with bedding (perhaps adjacent to a faulted basal contact). Contact with Road River Formation not exposed, may be faulted, because basal sequence of rock differs laterally

**Unit 10** (135.0–141.0 m): Covered interval.

**Unit 9** (122.0–135.0 m): Shale; greyish black, weathers greyish black, light olive-grey, and grey; very fissile; calcareous, very poorly exposed as float in frost-heaved outcrop

**Unit 8** (117.0–122.0 m): Covered interval

**Unit 7** (98.0–117.0 m): Calcareous shale and shale. Calcareous shale in top third of unit: bedding thickness 1–5 cm, somewhat platy, poor fissility parallel to bedding. Shale: dark grey, weathers dull dark grey; bedding thickness 1–3 cm, recessive, mediocre cleavage parallel to bedding; graphitic, silty, interbedded very fissile shales (10%). Unit poorly exposed with frost-heaved outcrops, covered intervals at 100.0–103.5 m, 99.5–99.8 m, and 98.0–98.5 m. Graptolites throughout, including *Cyrtograptus* and *Monograptus;* sponge fragments at 108.5 m

C-83018 (110.5–110.6 m)
C-83016 (105.0–105.3 m)
C-83015 (104.4–104.5 m)
C-83017 (102.0–110.0 m), Float
C-83014 (98.5–98.6 m)

**Unit 6** (96.0–98.0 m): Limestone; microcrystalline to very fine crystalline; dark grey, weathers dull dark grey; bedding thickness around 1 m, some lamination and somewhat platy weathering at top of unit; argillaceous
Fossil sample: C-83013 (96.0–97.0 m), Conodonts (CAI 5)

**Unit 5** (81.0–96.0 m): Covered interval.

**Unit 4** (70.0–81.0 m): Limestone; microcrystalline; dark grey, weathers dull olive-grey and dark grey; bedding thickness 5–50 cm, platy, some beds laminated, lamination reveals shearing and microfolds, cleavage poorly developed; poorly preserved graptolites; argillaceous, locally silty, contains sparse shaly interbeds, bedding attitude 180/12 W. Float and rare outcrop from 70.0–81.0 m
C-83012 (75.0–81.0 m), Conodonts
C-83011 (float 70.0–81.0 m)

**Unit 3** (50.0–70.0 m): Interval mostly covered but with local float of shale, some silty. Outcrop of calcareous shale (57.0–59.0 m): greyish black, weathers dark grey; moderately fissile; graphitic

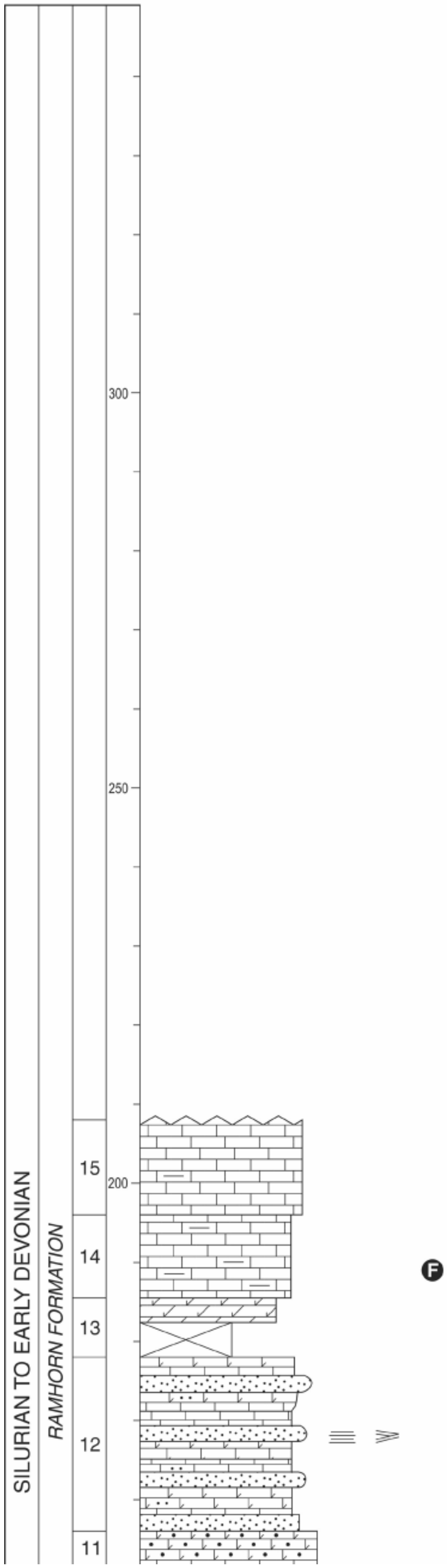
**Unit 2** (38.0–50.0 m): Argillaceous quartz sandstone; very fine to fine grained; dark grey, weathers dull dark yellowish brown, dull olive-grey, off-white; abundant lichens present; bedding thickness 50 cm to 2 m, resistant, poorly developed bedding, contains quartz veins and stringers

**Unit 1** (0.0–38.0 m): Shale; dark grey and greyish black, weathers dark bluish grey, dark grey with dark yellowish orange stains; bedding thickness 0.5–3 cm, recessive, cleavage moderate and parallel to bedding; locally calcareous, locally silty. Unit is poorly exposed; covered intervals at 22–38 m, 14–18 m, 2–11 m, and 0–1 m. Contact with underlying rocks not exposed

**Pre-Unit 1:** Mudstone; dark grey, weathers dull grey and light olive-grey; recessive, thin bedded, locally crenulated; calcareous, bedding attitude 190/15 W

**Figure A16.** Turnagain River Roof-Pendant (note Gabrielse, 1998, p. 121, 133, 134).

TURNAGAIN RIVER ROOF-PENDANT SECTION, page 2 of 2




**Unit 15** (196.0–208.0 m): Limestone; microcrystalline to very fine crystalline; dark grey, weathers dull light grey; bedding thickness 5–30 cm; interbedded with platy limestone (15%)
C-83019 (189.0–201.0 m), Conodonts

**Unit 14** (185.5–196.0 m): Limestone; microcrystalline; dark grey, weathers grey and greyish orange; some beds weather platy

**Unit 13** (178.0–185.5 m): Dolostone; fine to medium crystalline; brownish olive-grey, weathers dull light grey; bedding thickness around 30 cm, recessive; calcareous. Unit largely covered from 178.0–182.7 m

**Unit 12** (156.0–178.0 m): Limestone and interbedded calcareous quartz sandstone and quartzite. Limestone: very fine crystalline with quartz silt and local layers of quartz sand; grey, weathers light grey and very light grey; bedding thickness 3–30 cm; dolomitic. Interbedded calcareous quartz sandstone and quartzite: contains very fine- to coarse-grained quartz sand, subangular to rounded; weathers dull dark grey, covered thickly with lichen; bedding thickness 10–30 cm, mostly laminated, rarely crosslaminated

**Unit 11** (141.0–156.0 m): See previous page for description

**Figure A16. (Cont.)** Turnagain River Roof-Pendant (note Gabrielse, 1998, p. 121, 133, 134).

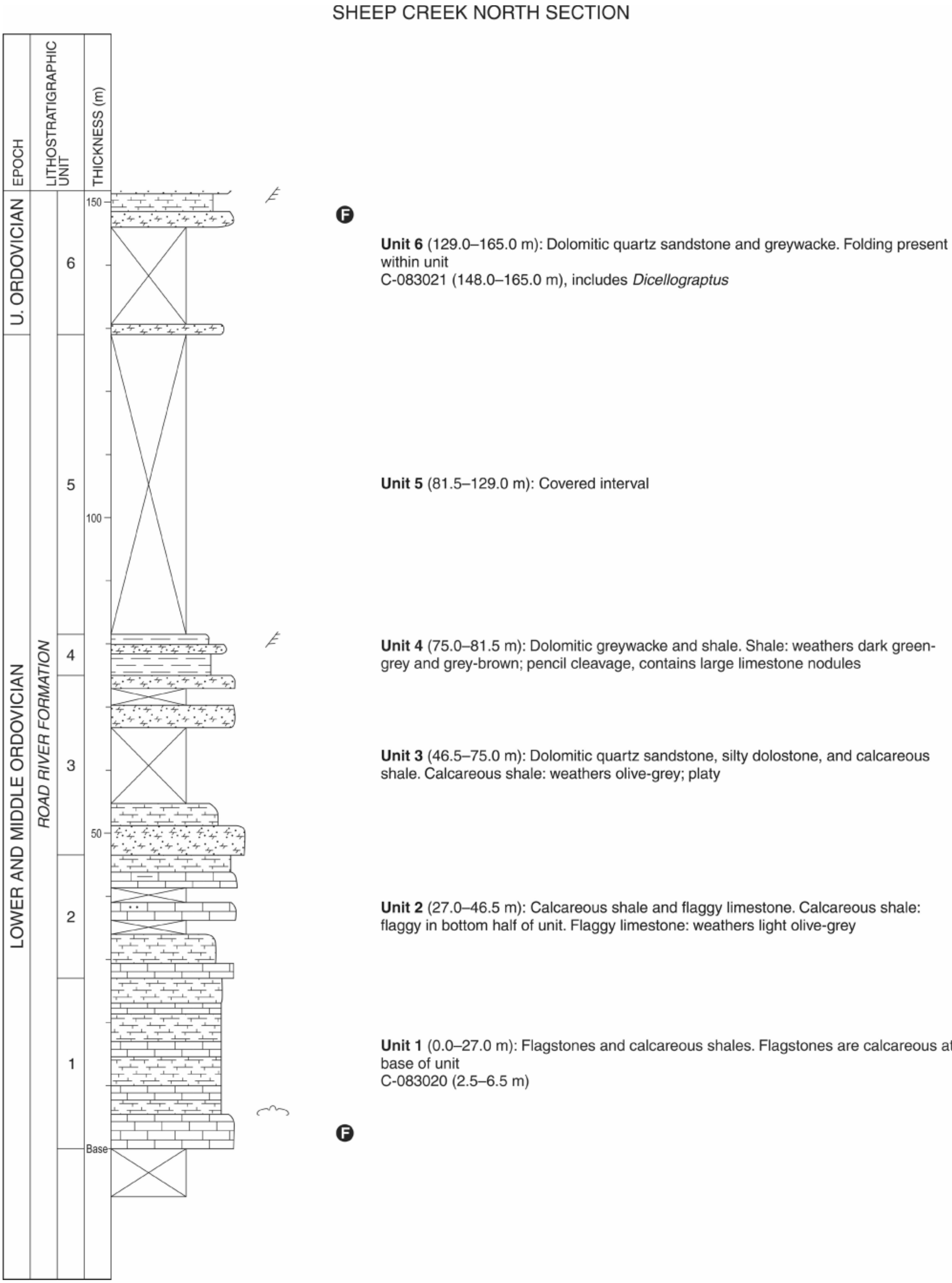
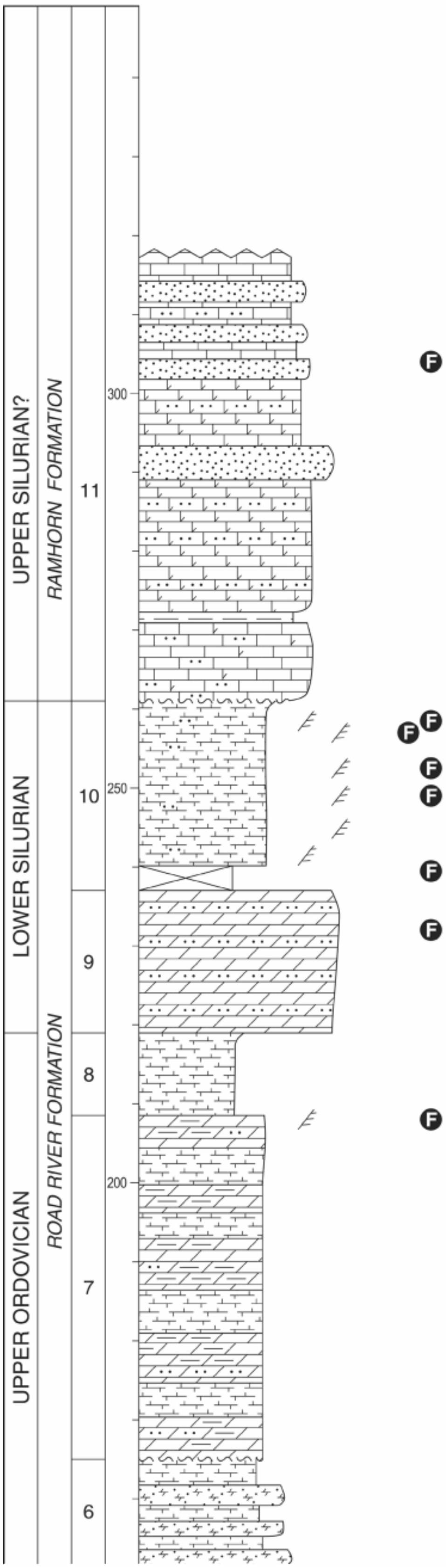



**Figure A17.** Sheep Creek North.

SHEEP CREEK NORTH SECTION, page 2 of 2




**Unit 11** (261.0–315.0 m): Silty limestone, dolomitic limestone, quartz sandstone and shale. Silty limestone: locally dolomitic in bottom half of unit. Top beds in core of syncline. Contact sheared (or unconformity) cuts out 15 cm of beds in 1 m
C-083029 (304.0–310.0 m), Conodont

**Unit 10** (237.0–261.0 m): Silty, calcareous shale
C-083028 (258.5–258.6 m), includes *Cyrtograptus*
C-083027 (257.0–258.0 m)
C-083026 (252.5–253.0 m)
C-083025 (249.0–249.3 m)
C-083024 (239.5–240.0 m)

**Unit 9** (219.0–237.0 m): Silty dolostone. Contact apparently conformable, but contortions below
C-083023 (232.0–237.0 m), Conodont

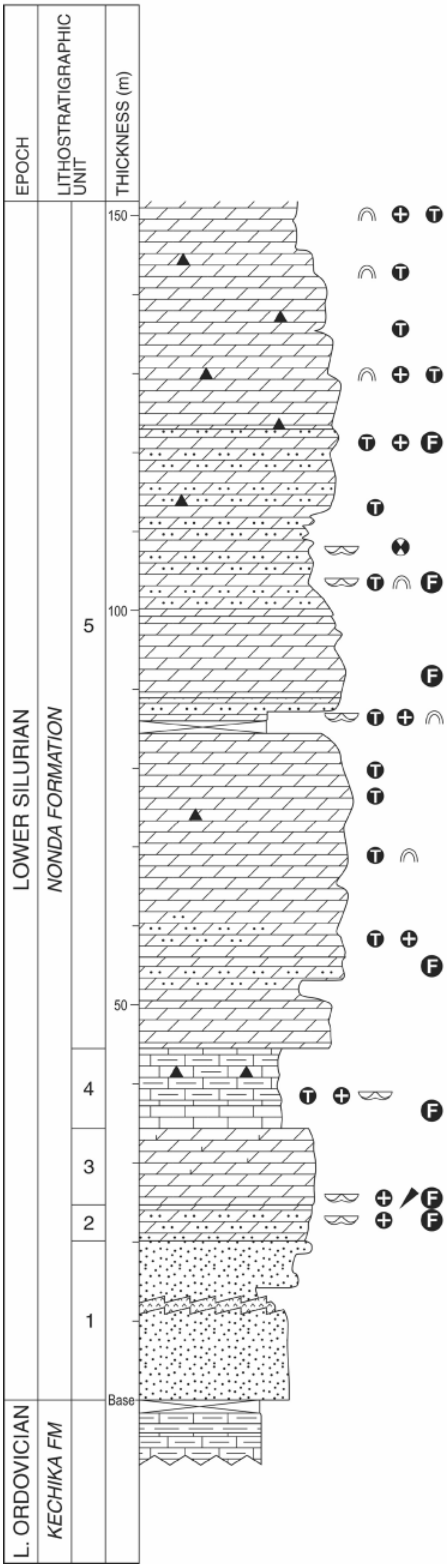
**Unit 8** (208.5–219.0 m): Calcareous shale

**Unit 7** (165.0–208.5 m): Calcareous shale, and locally silty/argillaceous dolostone. Folding present within unit. Faulted basal contact
C-083022 (208.0–208.5 m)

**Unit 6** (129.0–165.0 m): See previous page for description

**Figure A17. (Cont.)** Sheep Creek North.

## HOOLE CREEK SECTION




**Unit 5** (44.5–179.5 m): Dolostone, dolomitic limestone, and silty dolostone. Dolostone: very fine crystalline to fine crystalline; grey and dark grey, weathers dull grey to dull dark grey and dark grey; bedding thickness 5 cm to over 2 m, 3 cm partings at 167 m, contains 5% chert from 139–146 m, dolomite stringers throughout; stromatoporoids abundant at 146 m, *Camarotoechia* and *Syringopora* present at top of unit, *Syringopora* also found around 139 m and 61 m. Dolomitic limestone: very fine crystalline; dull grey, weathers dull grey; bedding thickness 29–61 cm with partings, at 170 m dolomitic vugs and 15% stromatoporoids present, dolomite stringers. Silty dolostone: very fine to coarse crystalline; grey, light grey, dull grey and dull dark grey, weathers grey, and light grey; bedding > 2 m, from 103.6–122.0 m bedding thickness 15–61 cm with 5 cm partings, platy partings around 107 m, from 116–134 m light grey beds occur, 8% light yellow beds occur at 134 m, dolomitic stringers around 55,116, and 134 m, dolomitic vugs present
O-45590 (121.3–123.4 m)
O-45520 (103.6–104.6 m)
O-45592 (91.7–96.0 m)
O-45593 (54.9–59.4 m)

**Unit 4** (34.4–44.5 m): Limestone; very fine crystalline; dark grey, weathers blue-grey and brown; bedding > 2 m, locally argillaceous around 40 m, weathers platy from 43.9–44.5 m, weathers rubbly at bottom of unit; *Favosites* bed at 42.1 m
O-45521 (36.6–44.5 m)

**Unit 3** (24.7–34.4 m): Dolostone; very fine crystalline; dark grey, weathers grey and dark grey; bedding thickness 5–61 cm, red stains present on bedding planes, locally calcareous toward top of unit; *?Stricklandia* present at bottom of unit
O-45595 (25.3–26.5 m)

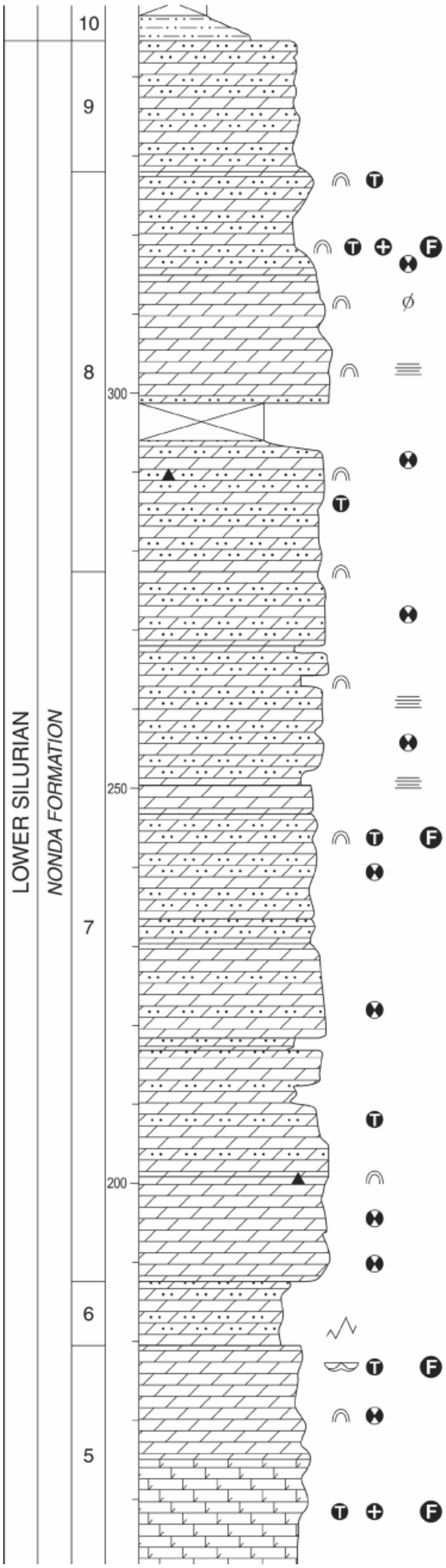
**Unit 2** (20.1–24.7 m): Very silty dolostone; very fine crystalline; brown-tinged light grey, weathers light brown; bedding thickness 30 cm to over 2 m
O-45617 (22.9–23.2 m)

**Unit 1** (0.0–20.1 m): Quartz sandstone, dolomitic sandstone, siltstone, and greenstone. Quartz sandstone: light grey and whitish grey, weathers flesh-grey, rusty brown, and light brown; bedding thickness 30–49 cm. Dolomitic sandstone: light grey, weathers brown-grey to brown. Siltstone: argillaceous. Greenstone sill at 6.1–6.7 m

**Pre-Unit 1:** Argillaceous limestone; very fine crystalline; contains shaly interbeds; contact is hidden and structurally conformable

**Figure A18.** Hoole Creek (note Norford et al., 1967, p. 508).

## HOOLE CREEK SECTION, page 2 of 4




**Unit 10** (344.6–356.8 m): Siltstone; grey and dark grey, weathers buff to buff-grey; bedding thickness 15–20 cm, weathers platy; contact between units 9 and 10 is covered and structurally conformable; locally dolomitic toward top of unit

Unit 9 (328.0–344.6 m): Silty dolostone; very fine crystalline; light brown-grey and grey, weathers light grey, 10% of beds weather grey, rare dark grey weathering beds at 329.5–329.8 m; bedding thickness 15–55 cm, bedding is well developed

**Unit 8** (277.4–328.0 m): Silty dolostone and dolostone. Silty dolostone: very fine crystalline to medium crystalline; dark grey and grey, weathers dull dark grey, grey and light grey, 40–90% light grey weathering beds, 10% dark grey beds at bottom of unit; bedding thickness 30 cm to over 2 m, well-developed bedding at bottom of unit, weathers rubbly around 178 m, dolomitic stringers and vugs. Dolostone: very fine to medium crystalline; grey and brown-tinged dark grey, weathers dark grey, dull grey and dark dull grey; bedding thickness over 2 m, 5% porosity, 20% dark grey weathering beds and 80% light grey weathering beds around 298 m, laminated, dolomite stringers present
O-45525 (318.5–318.8 m)

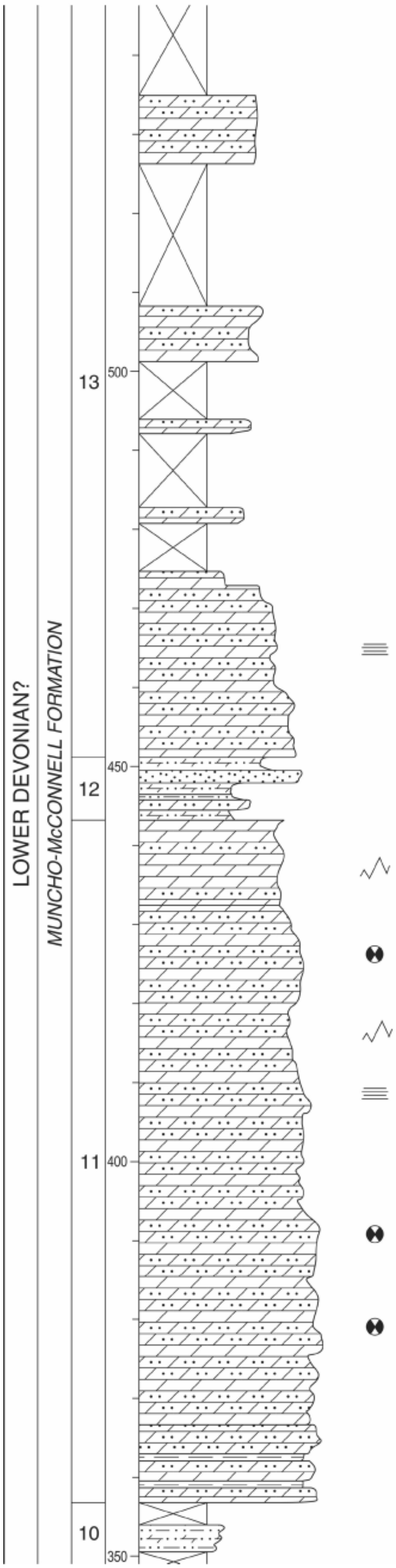
**Unit 7** (187.6–277.4 m): Dolostone interbedded with slightly silty to very silty dolostone. Dolostone: very fine to medium crystalline; dark grey, dark brown-grey and dull grey, weathers dull dark grey; bedding > 2 m, dolomitic vugs and stringers present. Slightly to very silty dolostone: very fine to coarse crystalline; dark grey, grey and light grey, weathers dull dark grey, and light grey to grey; bedding > 2 m, at 264–265 m bedding thickness 15–30 cm, at 254 m bedding thickness 30–60 cm, laminated, dolomitic stringers and vugs
O-45596 (243.8–246.9 m)

**Unit 6** (179.5–187.6 m): Silty dolostone; very fine crystalline; light grey, weathers light grey to light buff-grey; bedding thickness 15–91 cm, well developed bedding, poorly developed stylolites

**Unit 5** (44.5–179.5 m): See previous page for description
O-45524 (176.8-179.8 m)
O-45594 (158.5-167.6 m)

**Figure A18. (Cont.)** Hoole Creek (note Norford et al., 1967, p. 508).

HOOLE CREEK SECTION, page 3 of 4




**Unit 13** (451.1–562.4 m): Silty dolostone; very fine crystalline to fine crystalline; light grey and dark grey, weathers light grey, dull grey and dull dark grey; bedding thickness 15–30 cm, lamination; around 475 m contains 20–60% dark-grey-weathering dolostone beds; 60% light-grey-weathering beds; 324/37 NE at 472 m

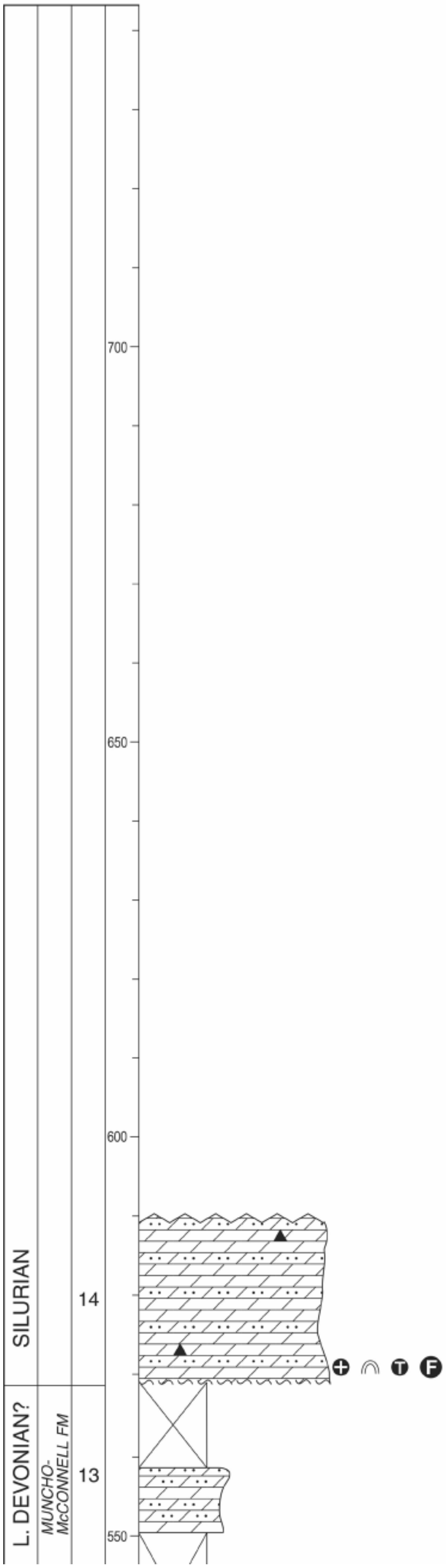
**Unit 12** (443.2–451.1 m): Dolomitic siltstone, silty dolostone, quartz sandstone

**Unit 11** (356.8–443.2 m): Very silty and silty dolostone, dolostone. Dolostone: very fine crystalline; dark grey, weathers dull dark grey; bedding thickness around 61 cm, weathers rubbly, dolomitic stringers. Very silty and silty dolostone: microcrystalline to very fine crystalline; light grey, grey and dark grey, weathers light grey, grey and light buff grey; contains quartz sand at 405 m; 3 cm thick brown shale interbeds at 400 m, 364 m, and at bottom of unit; dark dolostone at 378 m and 360–362 m; 15% dark-grey-weathering dolostone beds at top of unit; well-developed bedding; bedding thickness 10–90 cm; 70–75% light-grey-weathering beds toward bottom and top of unit; 5–50% of beds weather grey or dark grey at middle of unit; dark grey weathering beds at 414–418 m,15 cm thick beds at 401 m; weathers blocky at bottom of unit; some lamination; some dolomitic vugs; stylolites

**Unit 10** (344.6–356.8 m): See previous page for description

**Figure A18. (Cont.)** Hoole Creek (note Norford et al., 1967, p. 508).

HOOLE CREEK SECTION, page 4 of 4

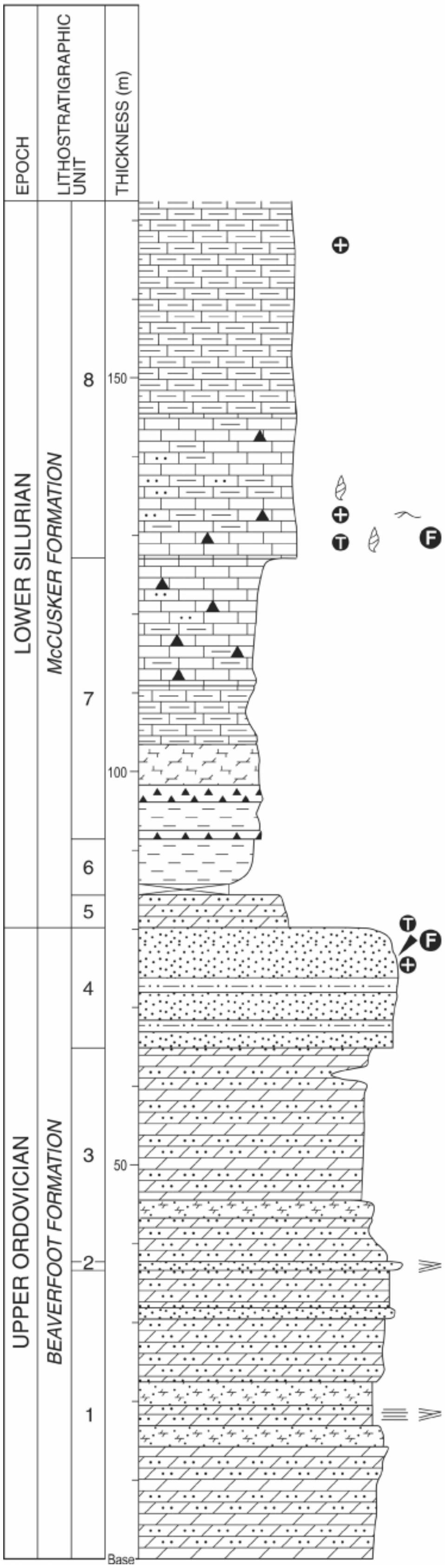



**Unit 14** (562.4 m–end of section): Thrust fault at 569 m dips about 10 degrees NE. Segment from 475–562 m is on adjacent part of ridge with poorly showing outcrop of similar alternating light grey and dark grey weathering dolostone
O-45522 (570.9–589.2 m)

**Unit 13** (451.1–562.4 m): See previous page for description

**Figure A18. (Cont.)** Hoole Creek (note Norford et al., 1967, p. 508).

## SIKANNI CHIEF RIVER SECTION




**Unit 8** (127.1–186.2 m): Upper two-thirds of unit contains argillaceous limestone, lower third of unit contains limestone with interbedded silty and argillaceous layers. Argillaceous limestone; microcrystalline to very fine crystalline; dark grey, weathers yellow-grey and orange-grey; bedding 61 cm to 2 m, 3–8 cm partings, banded and nodular, some lenticular silty partings; 30% very argillaceous limestone around 176 m (upper two-thirds). Limestone; microcrystalline; dark grey, weathers light grey and olive-grey; weathers to layers 3–15 cm thick; interbedded layers of silty limestone and argillaceous limestone; silty limestone is microcrystalline to very fine crystalline, nodular to banded, weathers light grey or yellow-grey; argillaceous limestone weathers yellow-brown; silty layers 3–8 cm thick; locally wispy, light brown argillaceous layers 1–10 cm thick (lower third)
O-64468 (129.8–130.1 m)

**Unit 7** (91.4–127.1 m): Limestone, argillaceous limestone, and mudstone. Limestone: microcrystalline; dark grey, weathers light grey or yellow-grey; bedding thickness 1–15 cm, undulatory bedding; slightly silty. Argillaceous limestone: microcrystalline to very fine crystalline; dark grey, weathers yellow-grey; bedding 1–8 cm, some poorly defined lamination. Mudstone: dark grey, weathers light olive-grey; bedding thickness 1–5 cm; locally shaley, locally calcareous or dolomitic (up to 20% dolomitic mudstone). Unit locally contains 5–25% chert layers

**Unit 6** (84.4–91.4 m): Mudstone; microcrystalline to very fine crystalline; dark grey, weathers green-grey; bedding 8 cm to 1 m, weathers shaly and blocky; slightly dolomitic, slightly silty, some iron stains

**Unit 5** (80.2–84.4 m): Very silty dolostone with 10% quartz sand; impure quartz sandstone

**Unit 4** (64.9–80.2 m): Quartz sandstone, impure quartz siltstone and impure quartz sandstone. Quartz sandstone: fine- to medium-grained; pale orange, weathers very light grey; bedding thickness 38–91 cm. Impure quartz siltstone: bedding 30 cm to 1 m. Impure quartz sandstone: fine- to medium-grained; dark grey and dark brown-grey, weathers light olive-grey
O-64469 (79.9–80.2 m)

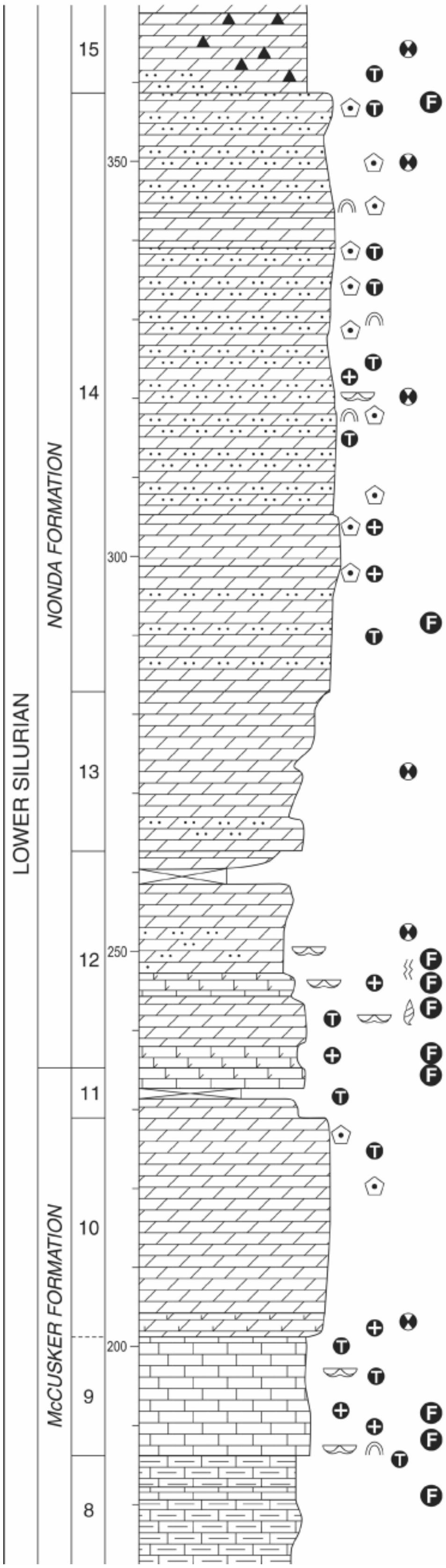
**Unit 3** (37.8–64.9 m): Silty dolostone and dolomitic sandstone. Silty dolostone: very fine crystalline; light green-grey, weathers orange-grey; bedding 61–91 cm, quartz sandstone laminae in some beds, some crossbedding; contains 15% quartz sand. Dolomitic sandstone: brown-grey, weathers orange-grey; bedding: 8–38 cm; 40% medium crystalline dolostone, 60% sandy dolostone (contains 25% quartz sand). Bedding attitude (overturned) at top of unit: 178/58W

**Unit 2** (36.6–37.8 m): Quartz sandstone; very fine- to medium-grained; light grey, weathers off-white or very light grey; crosslaminated, bedding (overturned) 180/50W

**Unit 1** (0–36.6 m): Silty to very silty dolostone and dolomitic sandstone. Silty to very silty dolostone: very fine to coarse crystalline; light grey or pinkish grey, weathers pale yellow-grey or orange-grey; bedding thickness 15–50 cm; contains 5–40% quartz sand; laminated and crosslaminated quartz sandstone present between beds in uppermost quarter of unit. Dolomitic sandstone: fine- to coarse-grained; very pale orange, weathers light orange-grey; bedding thickness 5–61 cm, some lamination and crosslamination; contains 40% medium crystalline dolomite. Lesser, very silty dolostone also present. Similar outcrop continues below 0 m

**Figure A19.** Sikanni Chief River (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

## SIKANNI CHIEF RIVER SECTION, page 2 of 4




**Unit 15** (358.7–388.9 m): Dolostone; very fine to fine crystalline; dark grey, weathers dark grey or dull grey; bedding thickness 30 cm to 2 m, bedding is poorly developed, dolomitic vugs and stringers, rare quartz vugs at 380 m, abundant chert nodules around 219 to 235 m; silty at bottom of unit

**Unit 14** (282.9–358.7 m): Dolostone; very fine to fine crystalline; dark grey, weathers light grey; bedding thickness 3 cm to > 2 m, dolomite stringers and vugs, rare quartz vugs at 310 m and 350 m; abundant echinoderm fragments around 355 m; locally silty in upper two-thirds and at bottom of unit
O-64458 (357.5–358.7 m)
O-64459 (292.6–293.8 m)

**Unit 13** (262.7–282.9 m): Dolostone; very fine to fine crystalline; dark grey, weathers dark grey with reddish-grey stains at bottom third of unit; bedding thickness 66 cm to 1 m, at bottom of unit bedding thickness is around 2 m with 1 to 5 cm partings, some to most beds have poorly developed lamination, fine dolomite stringers and vugs

**Unit 12** (235.3–262.7 m): Dolostone and limestone. Dolostone; very fine crystalline to fine crystalline; dark grey and brown-grey, weathers dark grey and light brown-grey with pale brown stains; bedding thickness 3 cm to 1 m, but is mostly 5–10 cm thick, abundant dolomite veins, stringers, and vugs, rare quartz-filled vugs around 255 m; locally silty, contains rare quartz sand. Limestone: microcrystalline; dark grey, weathers light grey or light brown-grey; bedding thickness 3–30 cm; slightly dolomitic. Base of Nonda Formation delineated by a change in gross weathering colour
O-64460 (249.0–249.6 m)
O-64461 (246.0–249.0 m)
O-64462 (242.9–244.8 m)
O-64463 (237.1–239.0 m)

**Unit 11** (228.9–235.3 m): Dolostone; microcrystalline to very fine crystalline; dark brown-grey, weathers light grey; bedding thickness 3–15 cm
O-64464 (234.4–235.0 m)

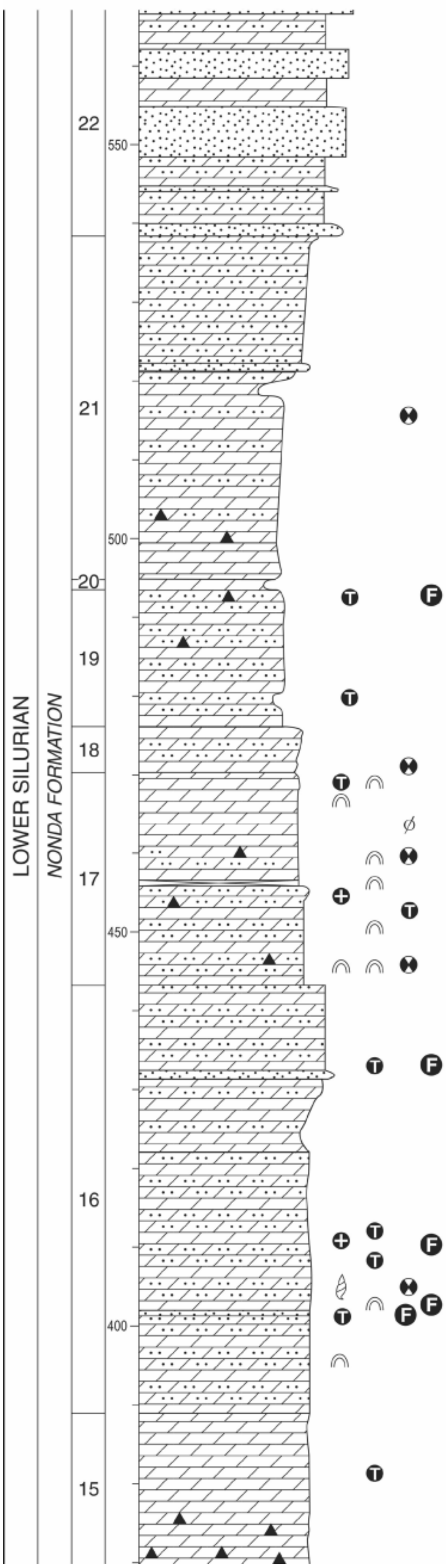
**Unit 10** (201.2–228.9 m): Dolostone; microcrystalline to very fine crystalline; dark grey, dark brown-grey to olive-grey, weathers light grey, blue-grey, or light yellow-grey; bedding thickness 3–91 cm, dolomite stringers, some quartz-filled vugs; contains 10% pellets and quartz sand in beds around 220 m, some beds pass laterally into limestone

**Unit 9** (186.2–201.2 m): Limestone; microcrystalline to very finely crystalline; dark grey, weathers light grey with light orange-grey stains; bedding thickness 3 cm to 2 m with 40% of beds around 30–61 cm thick, 3–10 cm partings, weathers platy to 3–5 cm; gradational contact with unit 10 at 201.2 m, rocks below 201.2 m have more brown weathering colours and some Kechika-like lithologies
O-64465 (191.4–195.7 m)
O-64466 (188.0–191.4 m)

**Unit 8** (127.1–186.2 m)**:** See previous page for description
O-64467 (181.1–183.2 m)

**Figure A19. (Cont.)** Sikanni Chief River (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

SIKANNI CHIEF RIVER SECTION, page 3 of 4




**Unit 22** (538.4–573.8 m): Dolostone and quartz sandstone. Dolostone: microcrystalline to very fine crystalline; dark grey, weathers light grey or brownish yellow-grey; bedding thickness 30 cm to 4 m; locally silty, interbedded with quartz-sandstone layers. Quartz sandstone (567–574 m, 557–564 m, 544–545 m, 539–540 m): very fine- to coarse-grained; off-white to bluish grey, weathers creamy white or light grey to ash-grey; bedding thickness 30 cm to > 2 m, laminated at some levels; bedding is overturned, 170/56W

**Unit 21** (494.8–538.4 m): Very silty dolostone and dolostone. Very silty dolostone: very fine crystalline; light grey, weathers dark grey or grey with olive-grey stains; bedding thickness 30 cm to > 2 m; contains 40–50% fine to coarse-grained quartz sand. Dolostone: very fine crystalline; dark grey, weathers dark and light grey and yellow-brown; bedding thickness 21–46 cm, at 496 m bedding is indistinct locally, dolomite vugs present, rare grey-black chert nodules at 497 m

**Unit 20** (493.5–494.8 m): Dolostone; very fine crystalline; banded grey and pale yellow; bedding thickness 5–15 cm, bedding planes stained reddish brown, grey-black chert nodules present

**Unit 19** (476.1–493.5 m): Silty dolostone; very fine to medium crystalline; dark grey to grey, weathers light grey or brown-grey; bedding thickness 8–23 cm at 479 m and 31 cm to 2 m elsewhere
O-64453 (492.6–493.5 m)

**Unit 18** (470.3–476.1 m): Silty dolostone; medium crystalline; grey, weathers light grey, grey, and dark grey; bedding thickness 30–91 cm

**Unit 17** (443.2–470.3 m): Dolostone and silty dolostone. Dolostone: medium to coarse crystalline; dark grey, weathers grey and dark grey; bedding thicknesses 15 cm to 3 m, about 2% coarse vuggy porosity, white dolomite vugs, veins, and stringers present. Silty dolostone: microcrystalline to medium crystalline; grey and dark grey, weathers dark grey and brown-tinged grey; bedding thickness 30 cm to 3 m, dolomitic vugs make up 5% of rock; contains 5–10% dolomite

**Unit 16** (388.9–443.2 m): Silty dolostone; microcrystalline to very fine crystalline, more than 10% of rock fine crystalline; dark grey, weathers light grey-yellow; bedding thickness 15 cm to 2 m, some poorly developed lamination, irregular quartz-filled vugs; at 431 m, 20 cm thick sandy dolostone bed present (up to 25% quartz sand)
O-64454 (433.1 m)
O-64455 (410.3–416.1 m)
O-64456 (401.4–410.3 m)
O-64457 (402.6–403.6 m)

**Unit 15** (358.7–388.9 m): See previous page for description

**Figure A19. (Cont.)** Sikanni Chief River (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

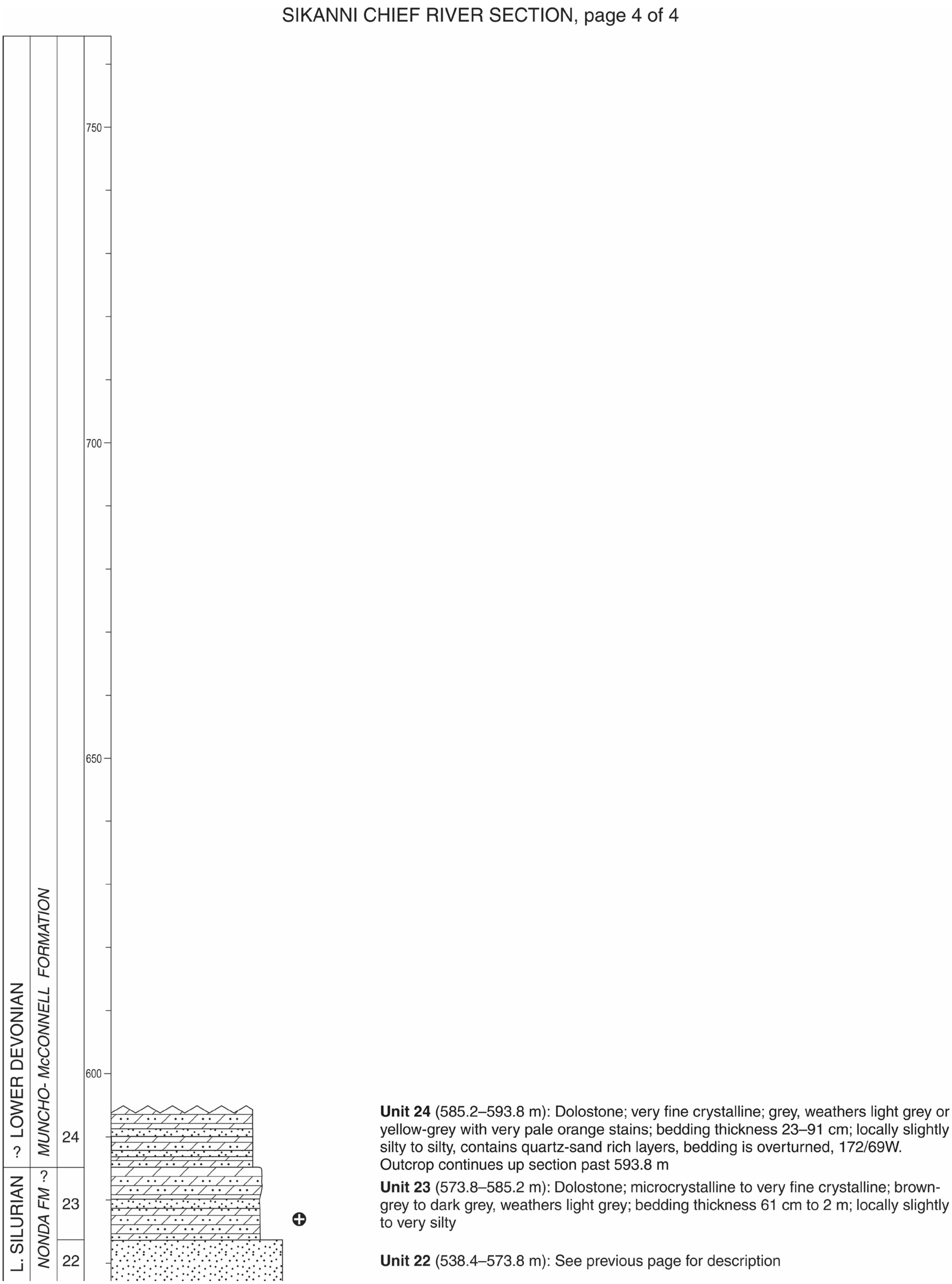
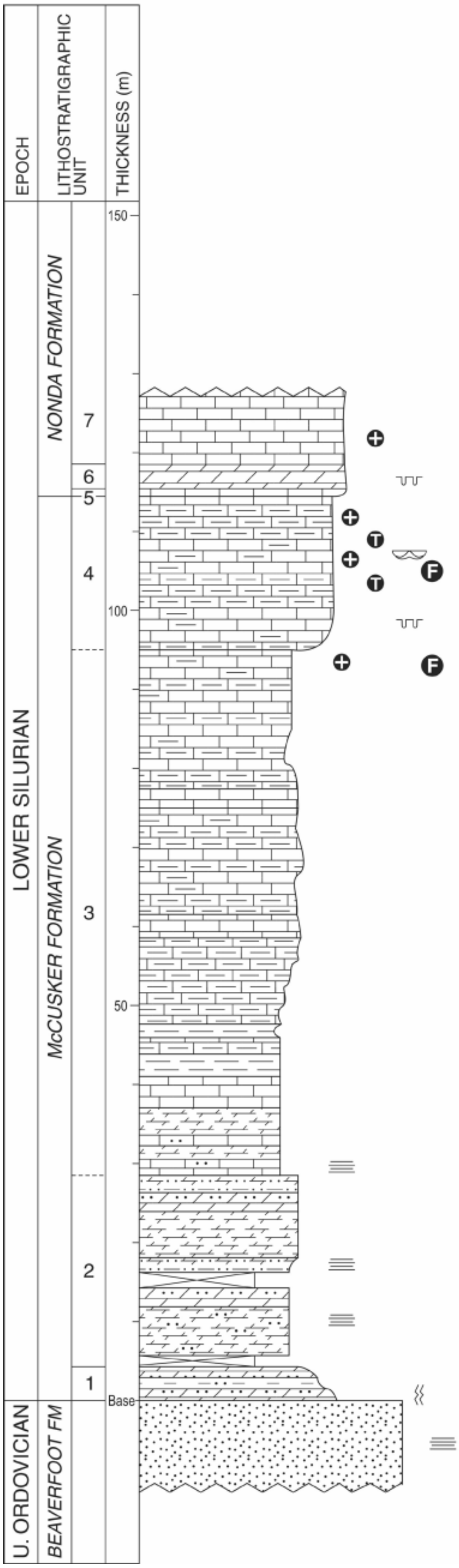



**Figure A19. (Cont.)** Sikanni Chief River (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

SOUTH OF SIKANNI CHIEF RIVER SECTION




**Unit 7** (118.5 m–end): Limestone; microcrystalline to very fine crystalline with sparse shell debris; dark grey and grey, weathers dull light grey; bedding thickness 8–40 cm, well developed, no argillaceous partings

**Unit 6** (115.5–118.5 m): Dolostone; very fine crystalline; light brown-grey, weathers orange-grey; bedding thickness 5–25 cm; upper part of unit with green-grey mottles

**Unit 5** (114.5–115.5 m): Limestone; microcrystalline; grey, weathers dull grey; bedding thickness about 50 cm

**Unit 4** (95.0–114.5 m): Limestone and argillaceous limestone. Limestone (70–100%): microcrystalline to very fine crystalline; brown-grey, weathers dull grey and light dull grey; bedding thickness 2–60 cm; wispy layers of dull yellow-grey-weathering argillaceous dolostone at top of unit, 20% mottles and patches of argillaceous limestone around 104 m. Argillaceous limestone (0–30%): weathers yellow-grey and pale yellow-orange; no cleavage. Subtle concordant contact below Unit 5 delineated above limestone with common, yellow-grey-weathering, wispy layers
C-249882 (105–114 m)

**Unit 3** (28.5–95.0m): Argillaceous limestone, limestone, and shale. Argillaceous limestone (30–90%): microcrystalline; dark grey, weathers, grey, yellow-grey, dull orange-brown; bedding 3–15 cm, cleavage cross-cuts bedding; banded dull grey and pale orange-brown appearance on cleavage surfaces. Limestone (10–70%): microcrystalline; dark grey, weathers dull grey, dull brown-grey; bedding thickness 1–8 cm, some beds are slightly nodular; sparse quartz silt laminae at bottom of unit. Shale (0–40%): dark grey, weathers dull dark grey; bedding thickness 5–10 cm, cleavage not parallel to bedding, fissile around 43 m; locally dolomitic, present in bottom quarter of unit. Gradational contact to more resistant limestones of Unit 4
C-249881 (93.0–93.1 m)

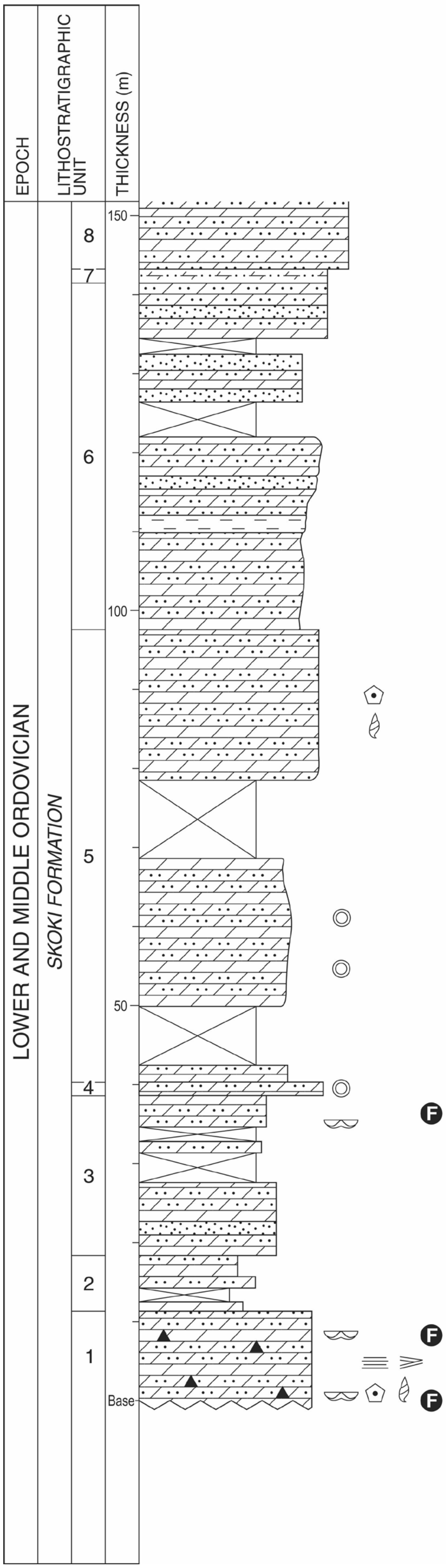
**Unit 2** (4.3–28.5 m): Dolomitic quartz siltstone, very silty dolostone, dolomitic shale, silty dolostone, very silty and calcareous shale. Dolomitic quartz siltstone (30–95%): bedding thickness 1–3 cm, laminated. Very silty dolostone: dark grey, weathers brown-grey; bedding thickness 1–10 cm. Silty dolostone: bedding 2–3 cm; laminated with quartz siltstone. Very silty, dolomitic, and calcareous shale (0–60%): grey-black, weathers dark brown-grey; bedding thickness 2–8 cm, cleavage parallels bedding, fissile; contains 30% interbedded dolomitic quartz siltstone. Gradational contact with Unit 3 picked at zone where there is less quartz siltstone and more limestone

**Unit 1** (0.0–4.3 m): Silty mudstone and silty dolostone. Silty mudstone: dark grey; bedding thickness 3 mm to 2 cm; some quartz silt layers. Silty dolostone: very fine crystalline; dark brown-grey, weathers dull grey and dull brown-grey; bedding thickness 5–6 cm; contains dolomite veins

**Pre-Unit 1:** Quartz sandstone; fine crystalline; dark brown-grey, weathers yellow-brown; bedding 15–60 cm, irregular laminae; slightly dolomitic, dolostones present > 10 m lower in Beaverfoot Formation, weathers grey, bedding thickness 15–50 cm. Contact with Unit 1 concordant and abrupt

**Figure A20.** Sikanni Chief River, south of.

REDFERN MOUNTAIN SECTION




**Unit 8** (143.3–153.3 m): Silty dolostone; weathers pale orange-grey to yellow-grey; bedding thickness 5–61 cm; at 153.3 m irregular silica masses in top 2.4 m of the Skoki Formation. Regional unconformity interpreted between Skoki and Beaverfoot formations

**Unit 7** (141.1–143.3 m): Dolomitic siltstone; weathers olive-grey; bedding thickness 60 mm to 5 cm, flaggy; argillaceous partings

**Unit 6** (97.5–141.1 m): Dolostone, silty dolostone, and quartz sandstone. Dolostone: weathers very pale yellow-brown; bedding thickness 8–46 cm, weathers blocky. Silty dolostone: weathers pale orange-grey to yellow-grey; bedding thickness 5–61 cm, blocky; silty horizons. Quartz sandstone: weathers off-white

**Unit 5** (40.2–97.5 m): Silty dolostone; weathers dull grey and dark grey to light grey, some dark olive, brown-grey-weathering dolostone; bedding thickness 15 cm to 1 m; oncolites fairly common

**Unit 4** (38.7–40.2 m): Silty dolostone; weathers dull grey and light grey to pale yellow brown; bedding thickness 1–5 cm; rare oncolites present

**Unit 3** (18.3–38.7 m): Silty dolostone; weathers dull light grey and yellow-grey; bedding thickness 30–61 cm, weathers blocky
C-078270 (36.3–36.6 m)

**Unit 2** (11.3–18.3 m): Silty dolostone; weathers yellow-grey; bedding thickness 3–10 cm, flaggy

**Unit 1** (0.0–11.3 m): Silty dolostone; weathers pale yellow-brown and light grey; bedding thickness 15–61 cm, laminated, some crosslamination, blocky. Outcrop continues below 0 m
C-078269 (8.2–8.8 m)
C-078268 (0–3.7 m)

**Figure A21.** Redfern Mountain.

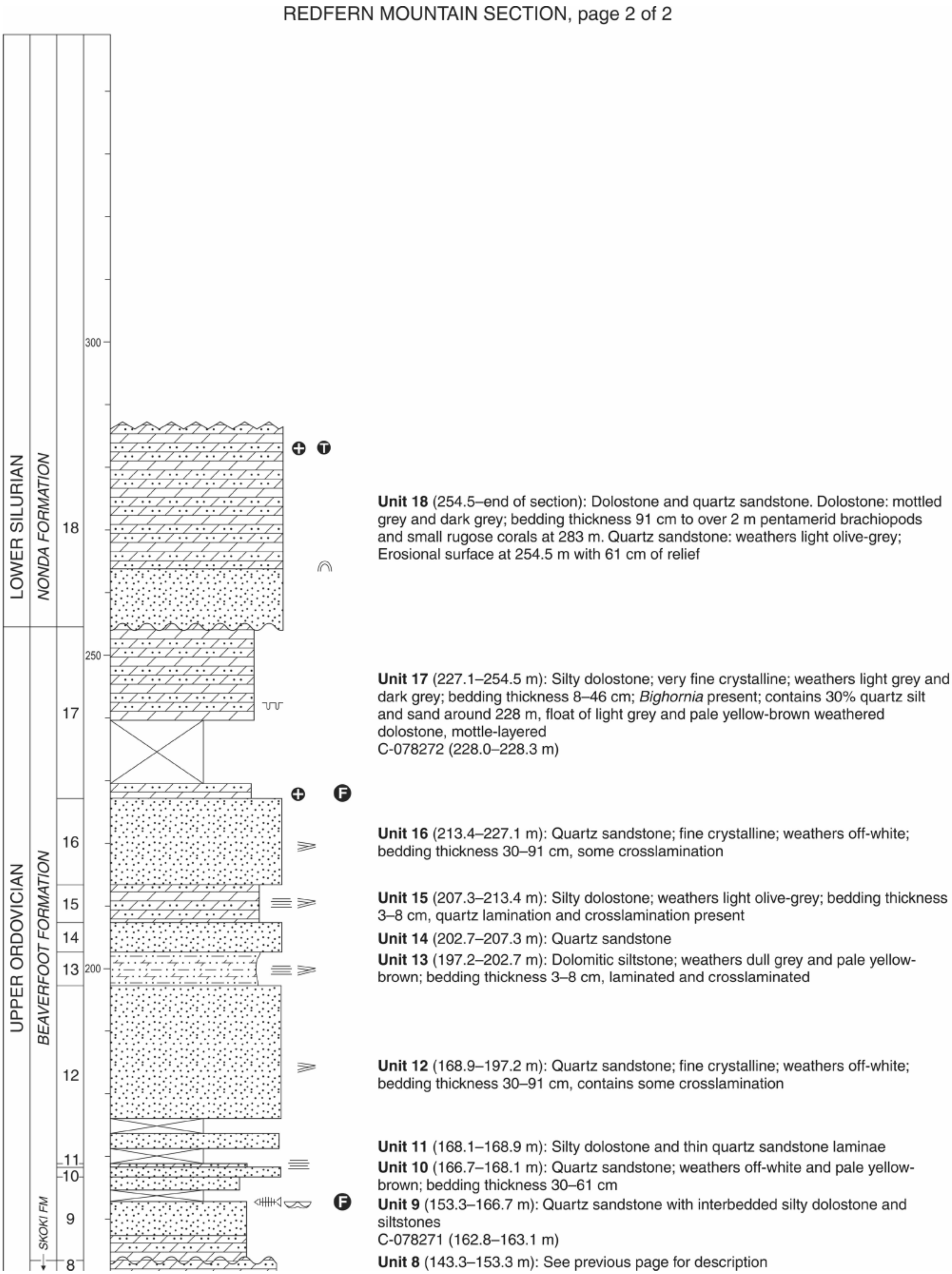
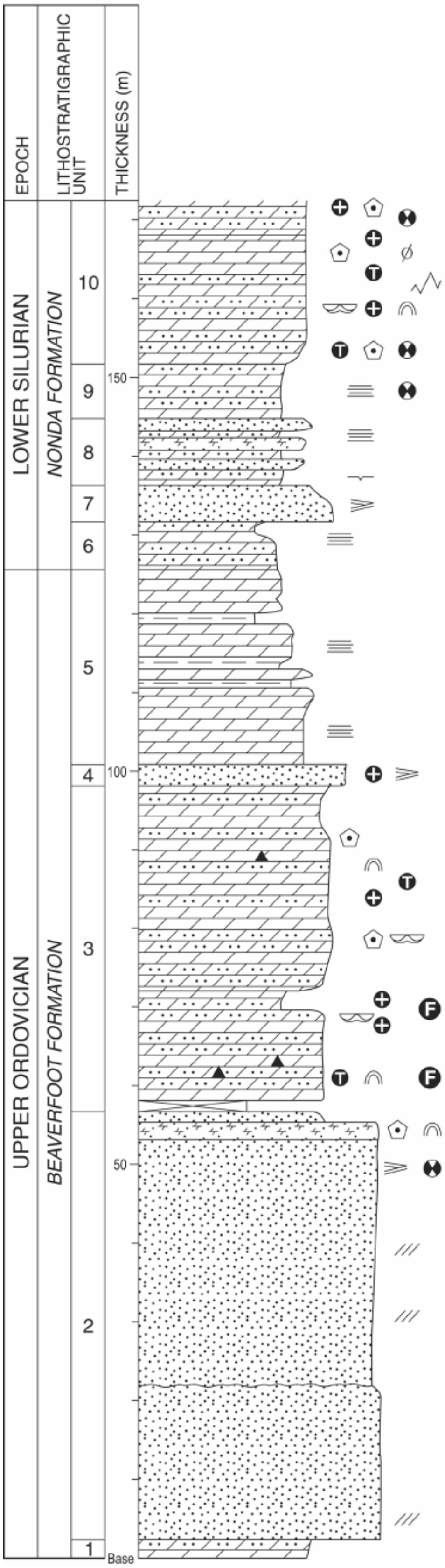



**Figure A21. (Cont.)** Redfern Mountain.

KEILY CREEK SECTION A




**Unit 10** (151.8–194.2 m): Silty dolostone and dolostone. Silty dolostone: very fine to coarse crystalline; dark grey, weathers dull light grey, light olive-grey, and grey with reddish-brown and olive stains; bedding thickness 30 cm to 3 m; around 175 m, echinoderm fragments are locally common as debris, rare dolomite stringers present; around 160 m, pentamerid brachiopods and some styliolitic bedding planes; 5 cm, conglomeratic at bottom of unit; rare dolomite vugs throughout. Dolostone: very fine to fine crystalline; dark grey, weathers dull grey and dull light grey; bedding thickness 90 cm to > 2 m, contains some coarse, vuggy surface porosity, dolomite vugs and stringers present

**Unit 9** (144.8–151.8 m): Silty dolostone; medium crystalline; dark brown-grey, weathers dull dark grey and dull grey; bedding thickness 8–46 cm, mostly laminated, dolomite vugs present

**Unit 8** (136.2–144.8 m): Silty dolostone; very fine to fine crystalline; dark grey, weathers dull grey and dull light grey; bedding thickness 8–30 cm, rudely laminated, mudcracks present in float, weathers slightly blocky; contains quartz sandstone and dolomitic sandstone beds with abrupt bases but grades up into dolostone

**Unit 7** (131.7–136.2 m): Quartz sandstone; medium to coarse grained; pale orange-grey, weathers off-white; bedding thickness 30–90 cm, coarse crosslamination present

**Unit 6** (125.6–131.7 m): Silty dolostone; very fine crystalline; dark grey, weathers dull grey and dull olive-tinged dark grey; bedding thickness 15–30 cm, some lamination present

**Unit 5** (100.9–125.6 m): Dolostone; very fine to fine crystalline; dark grey and dark brown grey, weathers light grey, yellow-grey, light orange-grey, and very light grey; bedding thickness15–60 cm, some lamination in bottom two thirds of unit; contains noncalcareous shale at 118.6 m, shaly dolostone interbeds present at middle of unit

**Unit 4** (98.1–100.9 m): Quartz sandstone; medium grained; very pale orange and dark grey, weathers very light grey and very pale orange; bedding thickness 60 cm to 2 m, crosslaminated

**Unit 3** (56.7–98.1 m): Dolostone and silty dolostone. Dolostone: very fine to medium crystalline; dark grey, weathers light grey; bedding thickness 15 cm to 1 m, rare silicification layers; slightly silty. Silty dolostone: very fine to fine crystalline; dark grey, dark brown-grey, and dark brown-olive grey, weathers light grey, light olive-grey, light brown olive-grey, very pale yellow-brown and similar colours; bedding thickness 15 cm to 2 m; contains 8% quartz silt at bottom of unit, irregular silicification layers at bottom of unit, at 69.8–70.1 m is thin bedded platy dolostone, weathers blocky in bottom half of unit
O-64510 (69.8–70.7 m), from talus
O-64511 (61.0–69.8 m)

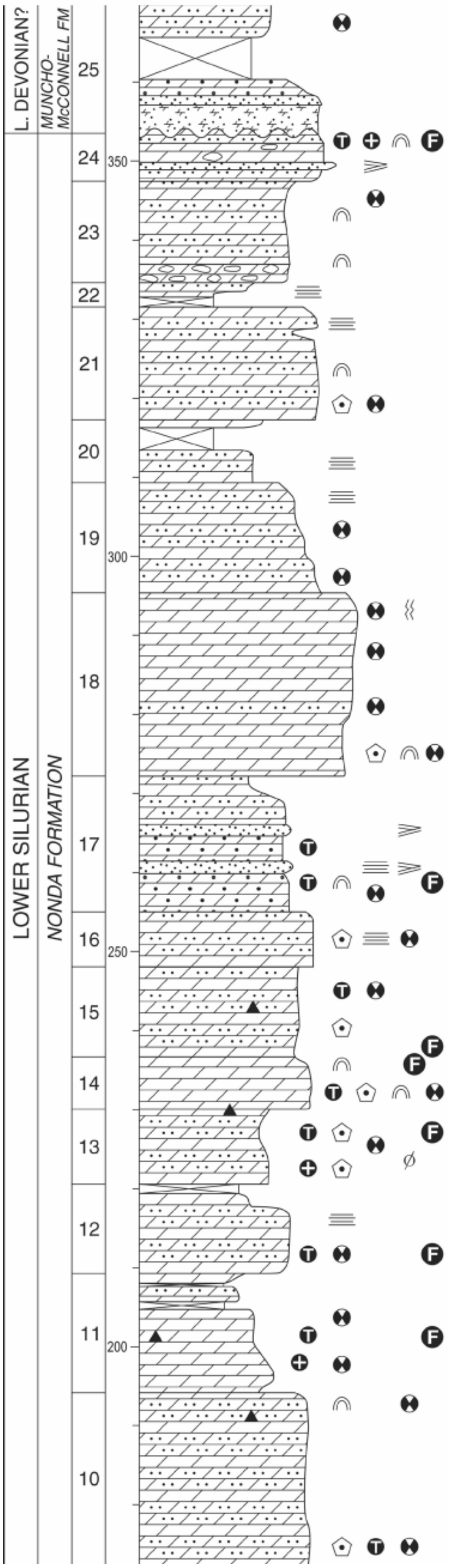
**Unit 2** (2.4–56.7 m): Quartz sandstone; very fine to coarse grained, subangular to subrounded grains; dark grey, very pale orange, and light orange-grey, weathers light grey, light orange-grey, dark orange-yellow, and very pale orange; bedding thickness 3 cm to 6 m, crossbeds and crosslamination; dolomitic quartz sandstone layers and coarse crystalline, dolomite-filled vugs at top of unit; erosion surface at 22 m; bedding attitude at top half of unit is 344/50 NE

**Unit 1** (0.0–2.4 m): Dolostone; brownish dark grey, weathers light grey and very pale orange; bedding thickness 8–60 cm; contains up to 25% quartz sand in many beds; rare, thin quartz sandstone and shaly mudstone

**Pre-unit 1:** Thick covered interval

**Figure A22.** Keily Creek A (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

KEILY CREEK SECTION A, page 2 of 3




**Unit 25:** See next page for description

**Unit 24** (347.5–353.6 m): Dolomitic quartz sandstone; very fine crystalline matrix with medium- to very coarse-grained sand, well-rounded grains; bedding thickness 30–90 cm, crosslaminated; contains quartz silt; quartz sandstone layers, silty dolostone, and rare conglomerate. Concordant but slightly erosional truncation, Unit 24 is lost at base of Unit 25 laterally
O-64503 (352.7–353.1 m)

**Unit 23** (334.7–347.5 m): Silty dolostone; microcrystallline to fine crystalline; dark grey and grey-black, weathers dark grey, dull dark grey, and dark brown-grey; bedding 30 cm to 2 m; interbedded with light grey and grey weathering beds; sparse calcite vugs in top half of unit; dolostone conglomerate at 334.7–335.1 m

**Unit 22** (331.6–334.7 m): Silty dolostone; very fine crystalline; brown-grey, weathers very light brown-grey and very light grey; bedding thickness 8–25 cm, laminated, recessive; contains 10% quartz silt

**Unit 21** (317.3–331.6 m): Silty dolostone; very fine to fine crystalline; dark grey, weathers dull dark grey, dull brown-grey, and dark olive-grey; bedding thickness 30 cm to 1 m, some vague lamination at top half of unit, contains 1–2% calcite vugs at 325.5 m; less resistant silty dolostone bed at 327.2–327.7 m, very fine crystalline, weathers dull grey

**Unit 20** (309.4–317.3 m): Dolostone and silty dolostone. Dolostone: very fine crystalline; olive-grey and dark grey; laminated with very light grey and dark grey weathering laminae. Silty dolostone: very fine crystalline; light brown-grey, weather very light grey; bedding thickness 8–16 cm, poorly developed lamination, recessive; contains 10% quartz silt; no dark dolostone. Undulatory contact with unit 21, possible erosion surface

**Unit 19** (295.4–309.4 m): Silty dolostone; dark brown-grey and brown-grey, weathers light grey and light olive-grey; bedding thickness 30–90 cm; rock contains 15–20% dark grey weathering dolostone interbeds with 5% coarse-crystalline calcite-filled vugs and dolomite stringers in bottom half of unit, in top half of unit some beds have poorly developed lamination

**Unit 18** (272.2–295.4 m): Dolostone and silty dolostone. Dolostone: very fine to fine crystalline; dark grey with brown tinge, weathers dull dark grey and olive-grey; bedding thickness > 2 m, rare dolomite stringers and calcite-filled vugs throughout; at 290.2–290.8 m rock contains 8% coarse-crystalline, calcite-filled vugs and veins; at 282.2–285.3 m contains coarse-crystalline calcite-filled vugs

**Unit 17** (255.1–272.2 m): Sandy dolostone; very fine crystalline; brown-grey, weathers very light grey, light grey, and yellow-grey; bedding thickness 30–90 cm, well-developed; contains 40–50% quartz sand, very fine to coarse, subround to angular grains; rock contains rare sandstone and quartz sandstone layers; at 268.5–269.7 m, very light grey weathering, recessive dolostone; at 269.7–272.2 m, light brown weathering dolostone; quartz sand laminae and crosslamination common; rare calcite-filled vugs
O-64504 (258.8–259.1 m)

**Unit 16** (248.1–255.1 m): Silty dolostone; microcrystalline to very fine crystalline; dark grey, weathers light grey and light olive-grey; bedding 8–46 cm, some beds have poorly developed lamination, very rare calcite-filled vugs present; 346/39 NE

**Unit 15** (236.8–248.1 m): Silty dolostone; very fine crystalline; dark grey, weathers dull grey; bedding > 2 m; sparse, very coarse, calcite-filled vugs; at 236.8–237.3 m, light grey weathering beds with fragments of silicified stromatoporoids
O-64505 (238.0–245.1 m)
O-64506 (236.8–237.1 m)

**Unit 14** (230.1–236.8 m): Dolostone; microcrystalline to very fine crystalline; dark grey, weathers dull dark grey and olive-grey; bedding thickness > 2 m; rock contains 1% very coarse crystalline, calcite-filled large vugs

**Unit 13** (220.7–230.1 m): Silty dolostone; fine crystalline; dark grey and dark brown-grey, weathers dull grey, dull light grey, and light grey; bedding thickness 60 cm to > 2 m; in top half of unit, rock contains 10% echinoderm fragments, 2% pinpoint porosity and 1% coarse crystalline, calcite-filled coarse vugs; in bottom half of unit rock contains quartz sand in some beds and rare, irregular silicification patches
O-64507 (227.1–231.6 m)

**Unit 12** (209.4–220.7 m): Silty dolostone; very fine to fine crystalline; dark grey, weathers grey; bedding thickness 30 cm to > 2 m, from 218.5–219.8 m bedding 8–20 cm with lamination; rare dolomite and calcite vugs and stringers present
O-64508 (211.8–213.7 m)

**Unit 11** (194.2–209.4 m): Dolostone; very fine to fine crystalline; dark grey, weathers dark grey and dull dark grey; bedding thickness > 2 m; very poorly fossilized *Columnaria columbia* at 202.4 m; slightly silty in top half of unit; > 10% irregular, very coarse crystalline, coarse-calcite-filled vugs in top half of unit, about 1% aligned in layers parallel to bedding in bottom half of unit
O-64509 (201.2–242.2 m)

**Unit 10** (151.8–194.2 m): See previous page for description

**Figure A22. (Cont.)** Keily Creek A (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

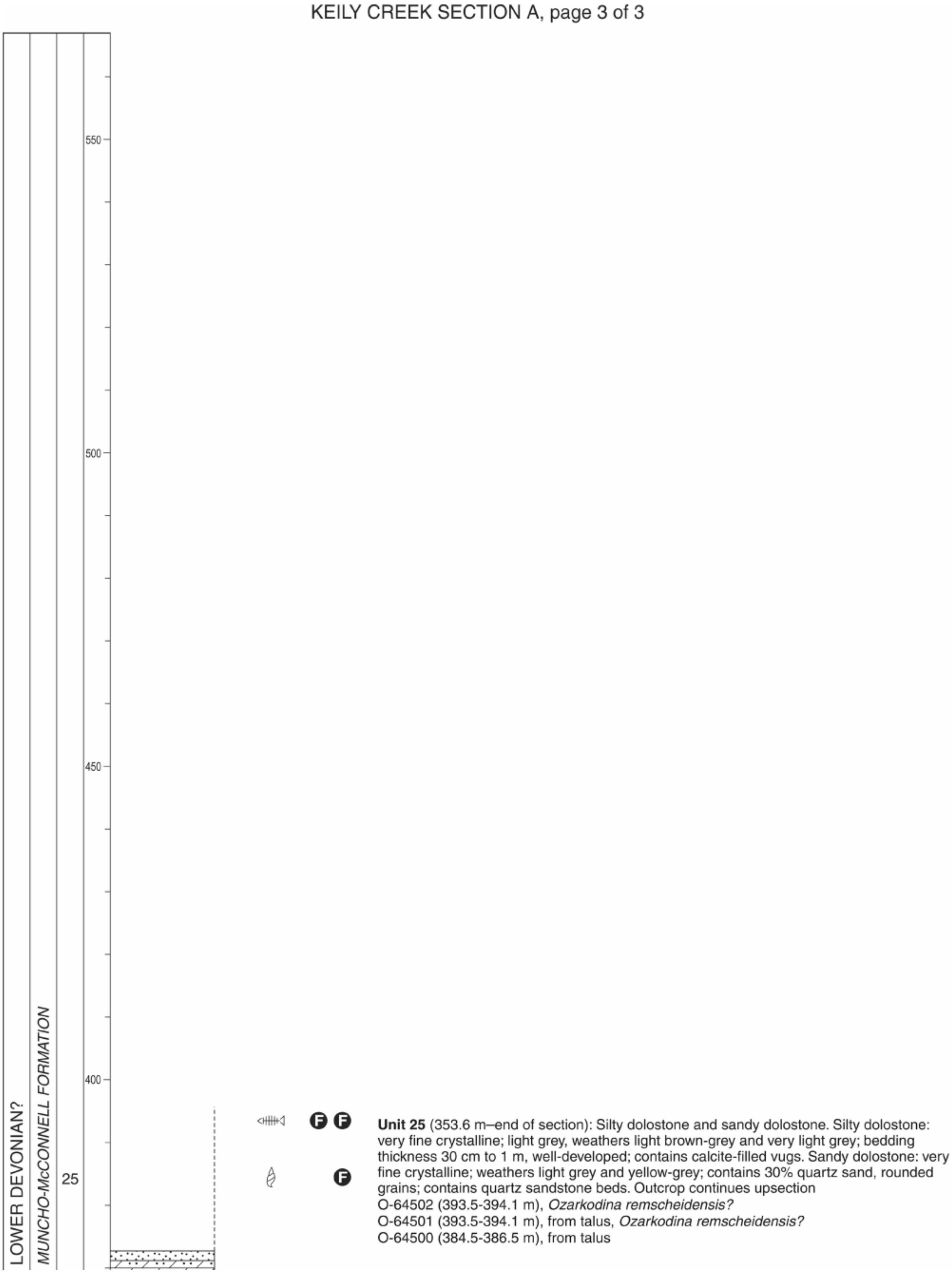
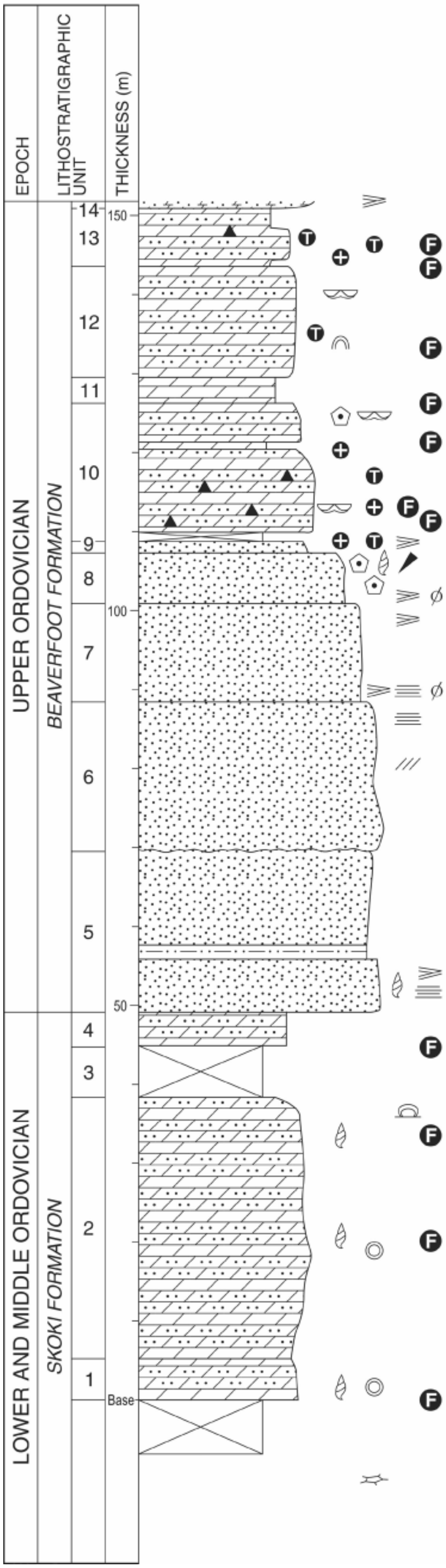



**Figure A22. (Cont.)** Keily Creek A (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

## KEILY CREEK SECTION B




**Unit 14** (150.9–154.2 m): See next page for description

**Unit 13** (143.6–150.9 m): Silty dolostone; very fine to fine crystalline; weathers light grey, dull grey, and light olive-grey; bedding thickness 8–90 cm, weathers rubbly, 5% rubbly weathering intervals at bottom of unit
C-078344 (146.3–147.2 m)

**Unit 12** (129.5–143.6 m): Silty dolostone; very fine crystalline; weathers light grey; bedding thickness 60 cm to 2 m, weathers slightly rubbly
C-078343 (143.3–143.6 m)
C-078342 (133.2–143.6 m), Conodont

**Unit 11** (126.2–129.5 m): Dolostone; microcrystalline to very fine crystalline; weathers light olive-grey and very light grey; bedding thickness 5–15 cm, weathers blocky; 5 cm thick conglomerate at 126.2 m

**Unit 10** (108.8–126.2 m): Silty dolostone and dolostone. Silty dolostone: dark brown-grey, weathers yellow-grey, dull light grey, very pale yellow-brown, and light olive-grey; bedding thickness 30 cm to 3 m, wispy mottles in top third of unit, weathers blocky at bottom of unit. Dolostone (120.4–121.3 m): bedding thickness 3–20 cm with reddish-grey partings, platy weathering; *Bighornia?* present
C-078341 (113.1–125.6 m)
C-078340 (111.3–115.8 m), Conodont

**Unit 9** (107.3–108.8 m): Quartz sandstone; fine crystalline; weathers dull grey; bedding thickness 30–60 cm, some porosity; *Bighornia?* present; bedding attitude 344/49 NE
C-078339 (107.3–108.8 m)

**Unit 8** (100.9–107.3 m): Quartz sandstone; fine to medium grained; weathers pale orange-grey and off-white; bedding thickness 90 cm to 2 m, crosslaminated, some porosity at bottom of unit; at 102.6 m rock is finely conglomeratic

**Unit 7** (88.4–100.9 m): Quartz sandstone; fine to very coarse grained; weathers very pale orange and off-white; bedding thickness 60 cm to 3 m, crosslaminated, 5% porosity and some lamination in bottom half of unit, bedding attitude 344/50 NE

**Unit 6** (69.5–88.4m): Quartz sandstone; very fine to coarse grained; weathers off-white, very pale orange, and reddish brown with orange-grey stains; bedding thickness from 15 cm to 6 m, lamination and crossbeds in top half of unit, crossbeds orientation: 18/65 SE, 15/57 SE, and 25/54 SE; lichens present at bottom half of unit

**Unit 5** (49.1–69.5 m): Quartz sandstone, siltstone, and silty shale. Quartz sandstone: very fine to coarse grained; weathers very pale orange, pale yellow-orange, and light grey with stains; crosslaminated and laminated at bottom of unit; bedding attitude 339/42 NE; lichens present. At 56.7–57.6 m unit is 70% siltstone, 25% quartz sandstone, and 5% silty shale. Erosion surface between Unit 5 and 6 cuts out 60 cm beds laterally

**Unit 4** (44.8–49.1 m): Silty dolostone; microcrystalline to very fine crystalline; weathers light grey; bedding thickness around 60 cm, weathers blocky; contains about 5% coarse-grained quartz sand; shaly mudstone at 48.6–48.8 and 48.9–49.1 m, poorly fissile; concordant contact with Unit 5 above
C-078338 (44.8–49.1 m), Conodont

**Unit 3** (38.4–44.8 m): Covered interval

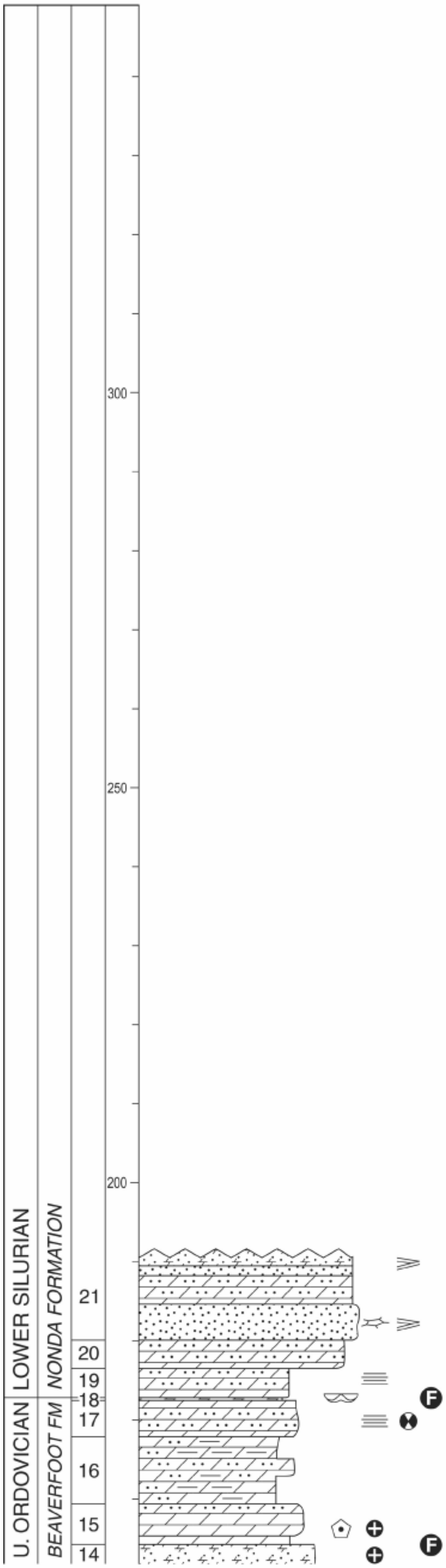
**Unit 2** (5.2–38.4 m): Silty dolostone and dolostone. Silty dolostone: weathers dull brown-grey and pale yellow-brown; bedding thickness 15–60 cm; at 36 m are large stromatolite heads. Dolostone: very fine crystalline; weathers light brown-grey; oncolites are rare past 10.4 m, common around 8.5–10.4 m, and absent from 5.2–8.5 m. Bedding attitude 334/45 NE at bottom of unit
C-078337 (33.5–33.8 m)
C-078336 (20.1 m), Conodont

**Unit 1** (0.0–5.2 m): Silty dolostone; fine crystalline; weathers pale yellow-brown; bedding thickness 60–90 cm; abundant oncolites, some with scraps of shells as nuclei
C-078335 (0.0–5.2 m), Conodont

**Pre-unit 1:** Estimated 15 m covered interval above light grey weathering dolostone of middle member of Skoki; some shrinkage cracks present. Darker weathering dolostone of lower member outcrops westward on ridge

**Figure A23.** Keily Creek B.

KEILY CREEK SECTION B, page 2 of 2




**Unit 21** (180.1–end of section): Interbedded silty dolostone, dolomitic quartz sandstone and quartz sandstone. Silty dolostone: weathers dull grey and dull light grey; crosslaminated. Quartz sandstone: medium to coarse grained; weathers off-white and very pale orange-grey; crosslaminated, very coarse desiccation cracks in quartz sandstone talus. Basal part corresponds to Unit 7 of Keily Creek Section A

**Unit 20** (176.5–180.1 m): Silty dolostone; very fine to medium crystalline; weathers dull, dark grey and yellow-grey; bedding thickness 30 cm to 1 m, resistant

**Unit 19** (172.8–176.5 m): Silty dolostone; very fine crystalline; weathers olive-grey, some beds weather dull olive-grey, light grey, and yellow-grey; bedding thickness around 60 cm, some poorly developed lamination present; abundant pentamerid(?) brachiopods C-078346 (172.8–176.5 m), Conodont

**Unit 18** (172.5–172.8 m): Dolomitic mudstone and argillaceous dolostone; weathers dark reddish brown; bedding thickness about 30 cm

**Unit 17** (167.9–172.5 m): Silty dolostone; very fine crystalline; weathers light grey, light orange-grey, and yellow-grey; bedding thickness around 60 cm, some lamination present, rare quartz-filled vugs

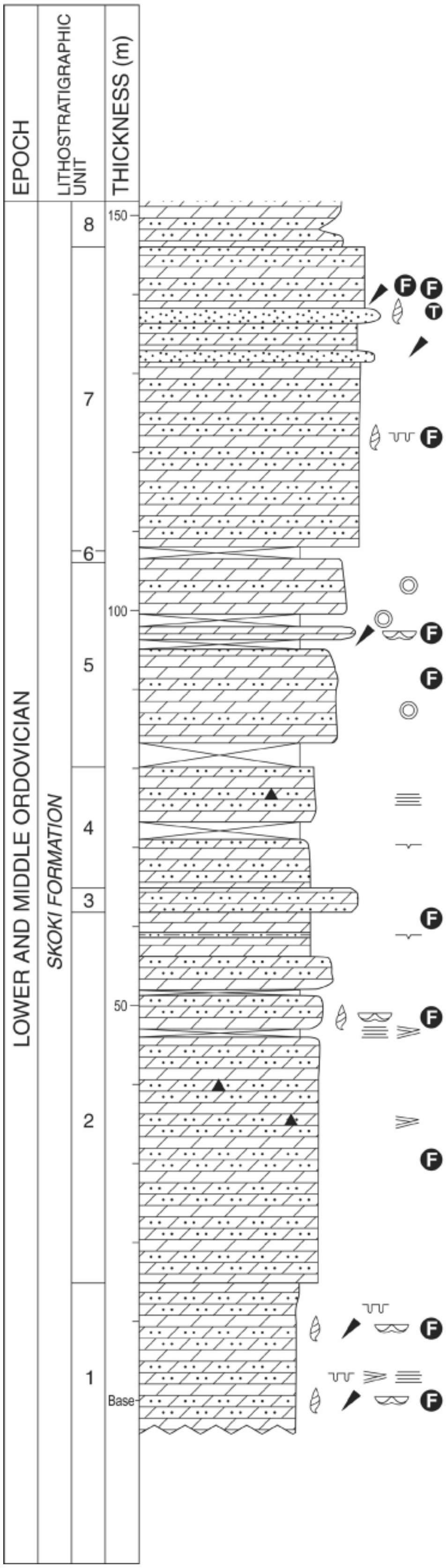
**Unit 16** (159.4–167.9 m): Dolostone; very fine to fine crystalline; weathers yellow-grey and light grey; wavy lamination present; contains some argillaceous dolostone with reddish-brown bedding planes

**Unit 15** (154.2–159.4 m): Dolostone; fine crystalline; weathers light grey and yellow-grey; bedding thickness 5–36 cm, vaguely laminated, some pellets present; slightly silty C-078345 (154.2–161.5 m), Conodont

**Unit 14** (150.9–154.2 m): Dolomitic quartz sandstone and quartz sandstone; weathers light grey, very light grey, very pale orange, and pale orange-grey; bedding thickness around 3 m, some crosslamination; corresponds to Unit 4 of Keily Creek Section A

**Figure A23. (Cont.)** Keily Creek B.

RICHARDS CREEK SECTION




**Unit 8** (146.0–159.4 m): Silty dolostone; very finely crystalline; weathers light grey, light olive-grey and pale yellow-brown, mottling common; bedding thickness 5–30 cm. Contact between Skoki and Beaverfoot formation at 159.4 m

**Unit 7** (107.6–146.0 m): Silty dolostone; very finely crystalline; weathers light grey; some mottling; bedding 30 cm to over 2 m; no oncolites
C-078300 (141.1–142.0 m), Conodont
C-078299 (140.8–143.3 m)
C-078298 (121.9–128.0 m), Conodont

**Unit 6** (106.1–107.6 m): Covered interval

**Unit 5** (80.2–106.1 m): Dolostone; very finely crystalline to finely crystalline; weathers dull grey or dull olive-grey; silty in middle of unit; slightly silty at bottom of unit; bedding thickness 15–61 cm; oncolites common
C-078297 (93.0–97.5 m)
C-078296 (91.4–97.5 m), Conodont

**Unit 4** (64.9–80.2 m): Silty dolostone; very finely crystalline; weathers light grey, dull grey, and yellow-grey; bedding thickness 1–20 cm; some beds laminated; weathers platy; mud cracks

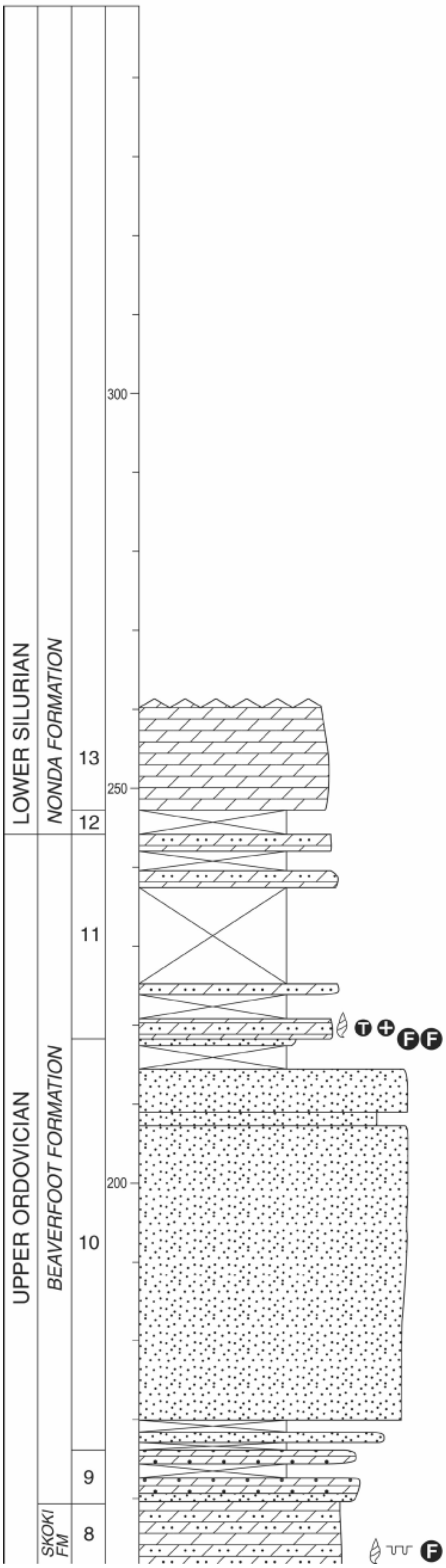
**Unit 3** (62.8–64.9 m): Silty dolostone; weathers very light grey and yellow-grey; bedding thickness 20–61 cm

**Unit 2** (14.9–62.8 m): Silty dolostone and variegated dolostone. Silty dolostone: very finely to finely crystalline; weathers light grey and yellow-grey; bedding thickness 8 cm to 2 m; some cross beds and lamination. Variegated dolostone: very finely crystalline; weathers yellow-grey or very pale brown-grey; bedding thickness 1–5 cm; mud cracks
C-078294 (61.0–67.1 m), Conodont
C-078293 (48.5–49.1 m)
C-078292A (30.5–36.6 m), Conodont

**Unit 1** (0.0–14.9 m): Silty dolostone; very finely crystalline; contains fine quartz silt; weathers yellow-grey, light olive-grey, and dull brown-grey; bedding thickness 8–61 cm; some lamination; rare cross lamination; some mottling; burrows. Poor outcrop continues below zero
C-078292 (9.1–13.7 m)
C-078291 (0.0–6.1 m), Conodont

**Figure A24.** Richards Creek.

RICHARDS CREEK SECTION, page 2 of 2




**Unit 13** (247.2 m–end of section): Dolostone (247.2 m and above); dull dark grey, weathers brown-grey. Float of dark brown-grey weathering dolostone

**Unit 12** (244.1–247.2 m): Covered interval

**Unit 11** (218.2–244.1 m): Silty dolostone; weathers light grey and rubbly; bedding thickness 8–46 cm; *Bighornia*. Contact between Beaverfoot and Nonda formations at 244.1 m
C-078303 (218.2–238.7 m)
C-078302 (218.2–222.5 m)

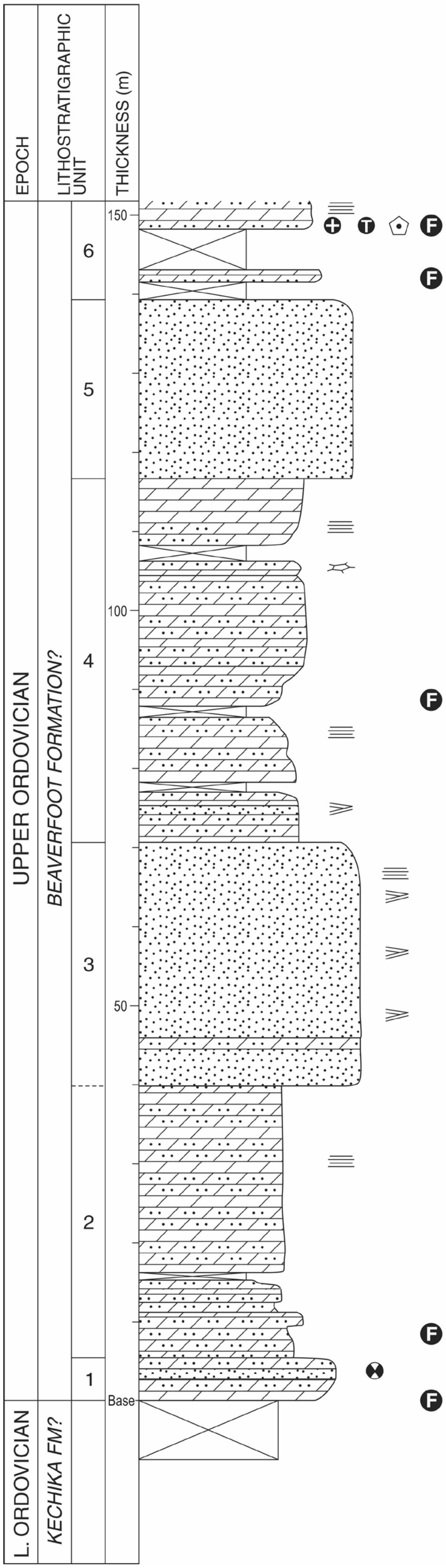
**Unit 10** (166.1–218.2 m): Quartz sandstone; finely to medium crystalline; weathers off-white or pale grey-yellow or orange; bedding thickness 30 cm to 2 m

**Unit 9** (159.4–166.1 m): Sandy dolostone; weathers yellow-grey; bedding thickness 15–30 cm, contains 30% quartz sand

**Unit 8** See previous page for description
C-078301 (153.3–159.4 m), Conodont

**Figure A24. (Cont.)** Richards Creek.

## PROPHET RIVER SECTION




**Unit 6** (139.3–168.2 m): Slightly silty to silty dolostone and dolostone. Slightly silty to silty dolostone: weathers light grey, light olive-grey, and yellow grey; bedding thickness 30 cm to 2 m, weathers blocky at top of unit; *Bighornia?* present; from 157–160 m and 165–167 m, pale yellow-brown-weathering dolostone rubble (from ridge-crest) occurs, quartz silt laminae around 149 m. Dolostone: weathers light grey; karst surface with dolomitic quartz-sandstone crack and fill
C-078331 (148.7–152.4 m)
C-078330 (142.0–152.4 m), Conodont

**Unit 5** (116.7–139.3 m): Quartz sandstone; weathers dark orange-yellow at top of unit, off-white at bottom of unit, lichens present throughout; bedding thickness 60 cm to 3 m; in distant aspect Unit 5 weathers dark yellow-orange with lichens

**Unit 4** (70.7–116.7 m): Dolostone and silty dolostone. Dolostone: very fine crystalline; weathers light grey and yellow-grey; bedding thickness 30–90 cm, weathers blocky, no quartz laminae present; at 105.2 m, a 15 cm thick, platy dolostone bed occurs, weathers pale orange-grey, bedding thickness around 6 mm, desiccation cracks present. Silty dolostone: very fine to medium crystalline; weathers light grey, light olive-grey, very pale yellow-brown, and very pale orange-grey, lichens present at bottom of unit; bedding thickness 15 cm to 2 m, weathers blocky; quartz laminae present in bottom half of unit, at 76.2 m crosslaminated quartz sandstone occurs. Abrupt concordant contact between units 4 and 5
C-078329 (88.7–98.1 m), Conodont

**Unit 3** (39.9–70.7 m): Quartz sandstone; fine- to coarse-grained; weathers off-white, lichens present at top of unit; bedding thickness 30 cm to over 2 m, cross-laminated; at 45 m, 20 cm thick very silty dolostone bed occurs, contains quartz sand

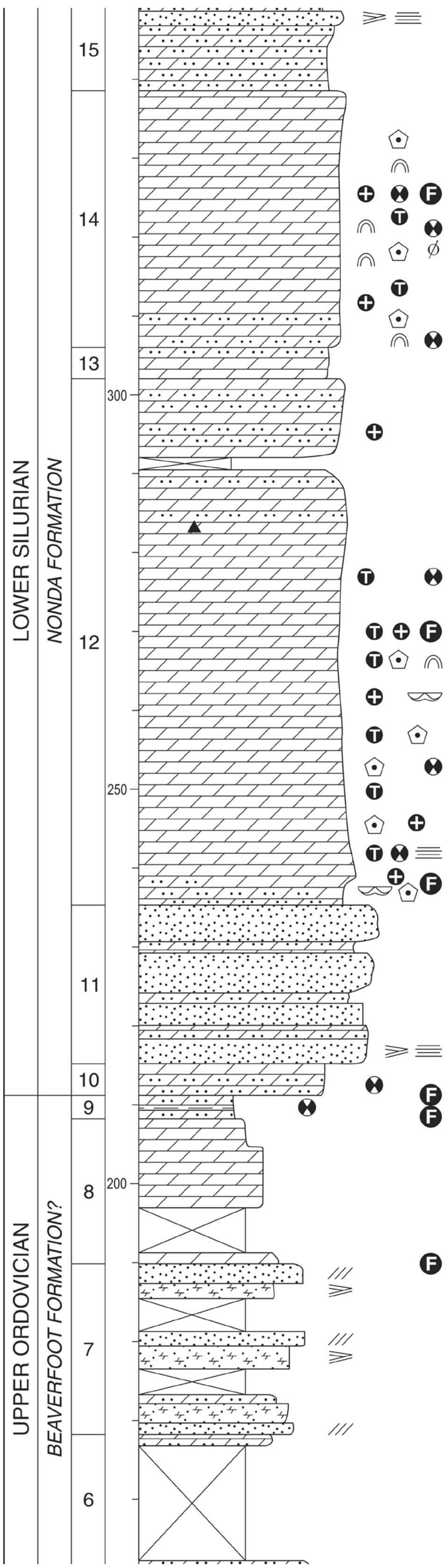
**Unit 2** (5.5–39.9 m): Silty dolostone; fine crystalline; weathers pale orange-grey and very pale yellow-brown; bedding thickness 7–91 cm; contains quartz sand laminae, from 36–39 m; crosslaminated quartz sandstone occurs (30–50% of rock); bottom of unit is very silty, contains up to 20% quartz silt and sand, very silty beds are more resistant, weathers blocky. Contact between units 2 and 3 is gradational
C-078328 (8.5–15.2 m), Conodont

**Unit 1** (0.0–5.5 m): Silty dolostone; very fine to fine crystalline; weathers pale orange-grey; bedding thickness 15–90 cm; contains 10% quartz silt and sand, honeycomb layers of silty material, 10 cm thick quartz sandstone layer at 4.2 m
C-078327 (0.0–5.5 m), Conodont

**Pre-Unit 1:** Covered interval

**Figure A25.** Prophet River (note Section 5 of Cecile and Norford, 1979, p. 221; Norford, 1991, p. 52).

## PROPHET RIVER SECTION, page 2 of 3




**Unit 15** (338.6–354.2 m): Quartz sandstone and very silty dolostone. Quartz sandstone: medium- to coarse-grained; very pale orange, weathers very light grey and orange-grey, lichens present; bedding thickness around 60 cm, laminated and crosslaminated; interbedded with silty dolostone, weathering dull grey and light grey, bedding thickness 30 cm to 1 m. Very silty dolostone: very fine crystalline; brown-grey, weathers dull grey and orange-grey; bedding thickness 30–90 cm, most beds have quartz sand laminae and crosslamination; contains 20% quartz sand and silt. Minor erosion surface at 340 m

**Unit 14** (306.0–338.6 m): Dolostone; very fine to coarse crystalline with microcrystalline matrix; dark grey and dark brown-grey, weathers dull brown-grey, light olive-grey, and light grey; bedding thickness 30 cm to over 2 m, rare dolomite and calcite-filled vugs, drusy cavities around 326 m; rare layers of silicified fossil debris at bottom of unit; locally slightly silty at bottom of unit
O-64513 (325.5–338.6 m)

**Unit 13** (302.0–306.0 m): Slightly silty dolostone; very fine crystalline with microcrystalline matrix; dark grey, weathers dark olive-grey; bedding thickness 8–30 cm, weathers blocky

**Unit 12** (253.3–302.0 m): Dolostone; microcrystalline to medium crystalline; dull grey, dark grey, and dark brown-grey, weathers light grey, dull grey, dull dark grey, dull olive-grey, and similar colors; bedding thickness 15 cm to 2 m, at 235.2–237.1 m quartz sand laminae present within dolostone, rare irregular silicification of rock from 263 m on, 2% coarsely crystalline calcite-filled vugs occur from 290 m on, rare calcite-filled vugs at bottom of unit; pentamerid brachiopods at bottom of unit; locally silty at top of unit, a light-grey-weathering bed occurs at 267.2–269.4 m, bedding attitude around 287 m is 002/41 SE
O-64514 (270.0–272.8 m)
O-64515 (238.0–240.2 m)

**Unit 11** (215.2–235.3 m): Quartz sandstone and dolomitic quartz sandstone. Quartz sandstone: fine- to coarse-grained, well rounded to rounded grains; very light yellow-grey, weathers a creamy yellow-grey to very light orange-grey; bedding thickness 60 cm to 2 m, laminated and crosslaminated; interbedded with dolostone at bottom of unit, dolostone weathers dull grey and dark grey, bedding thickness 15–30 cm. Dolomitic quartz sandstone (225.8–226.7 m): contains 40% fine- to medium-grained, angular to round sand; light brown-grey, weathers yellow-grey; bedding thickness 15–30 cm; interbedded with silty dolostone (weathers dull grey and dull light grey) and quartz sandstone

**Unit 10** (211.2–215.2 m): Silty dolostone; microcrystalline to very fine crystalline; dark grey, weathers dark grey and light grey; bedding thickness 30–90 cm, rare dolomite and calcite-filled vugs
C-078334 (211.2–215.8 m), Conodont

**Unit 9** (208.2–211.2 m): Interbedded silty dolostone, dolostone, argillaceous dolostone, platy dolomitic mudstone and non-calcareous shale. Rocks weather dull grey, yellow-grey, olive-grey, and brown-grey; bedding thickness 8–45 cm, calcite-filled vugs make up to 40% of dark grey silty dolostone; dark grey paper shale at 210.9–211 m

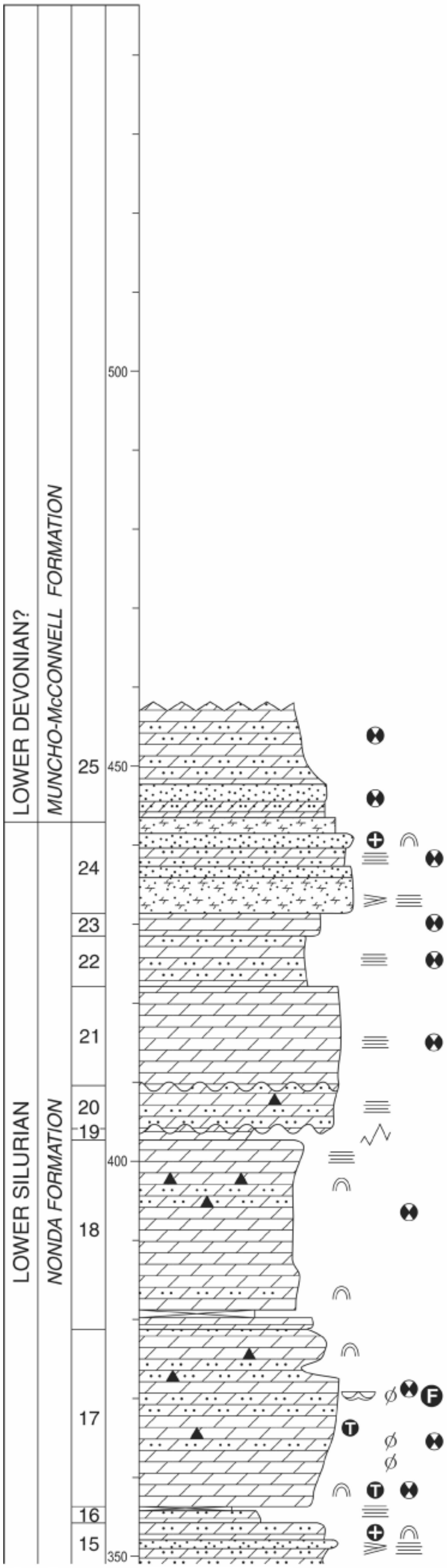
**Unit 8** (189.9–208.2 m): Dolostone; very fine crystalline; weathers light grey, light olive-grey, and dull light olive grey; bedding thickness 15–30 cm, weathers blocky around 198 m, recessive at top of unit; at 197 m, platy pale orange-grey-weathering dolostone occurs with ridge-crest rubble of light grey and light yellow-grey-weathering dolostone
C-078333 (208.5–211.2 m), Conodont

**Unit 7** (168.2–189.9 m): Dolomitic quartz sandstone and quartz sandstone. Dolomitic quartz sandstone: weathers yellow-grey; bedding thickness 30–90 cm, weathers blocky at middle of unit, crosslaminated; monomict dolostone conglomerate occurs at 179 m. Quartz sandstone: weathers yellow-white; bedding thickness 30–90 cm, abundant cross beds
C-078332 (189.9–205.7 m), Conodont

**Unit 6** (139.3-168.2 m): See previous page for description

**Figure A25. (Cont.)** Prophet River (note Section 5 of Cecile and Norford, 1979, p. 221; Norford, 1991, p. 52).

PROPHET RIVER SECTION, page 3 of 3




**Unit 25** (443.5–end of section): Silty dolostone; microcrystalline to very fine crystalline; grey and light olive-grey, weathers light grey, yellow-grey, and very light bluish grey; bedding thickness 30–90 cm, 0.5% small dolomite vugs in top half of unit, 2% coarse crystalline dolomite-filled vugs in bottom half of unit; contains quartz silt and rare rounded quartz sand, in top half of unit layers with floating quartz sand are common, at 443.5–446.8 m quartz sandstone layers and beds, in bottom half of unit some beds have layers of floating rounded quartz sand

**Unit 24** (431.3–443.5 m): Silty dolostone and dolomitic quartz sandstone. Silty dolostone: very fine crystalline; dark brown-grey, weathers olive-grey; bedding thickness around 2 m, dolomite vugs and stringers present; contains quartz silt, contains quartz sandstone beds and laminae. Dolomitic quartz sandstone: very fine crystalline; light brown-grey, weathers light grey and creamy yellowish-grey; bedding thickness 60 cm to 1 m, lamination and crosslamination; quartz sandstone layers present, contains 30% quartz silt and fine- to medium-grained sand with rounded grains

**Unit 23** (428.5–431.3 m): Dolostone; very fine crystalline; dark brown-grey, weathers brown-grey; bedding > 2 m, contains 30% coarsely crystalline dolomite-filled vugs, resulting in mottled effect

**Unit 22** (422.1–428.5 m): Silty dolostone; very fine crystalline; grey, weathers light grey and yellow-grey; bedding thickness 60 cm to 1 m, most beds are laminated, rare coarse dolomite-filled vugs; some beds contain discontinuous patches of monomict breccia (made up of similar rock)

**Unit 21** (409.6–422.1): Dolostone; brown-grey, weathers dull grey, brown-grey, and olive-grey; bedding thickness 30–90 cm, most beds are laminated, irregular silicification layers common around 412.7–413.3 m, at 409.6–412.4 m 5% dolomite stringers and coarse vugs present parallel to bedding; erosion surface above unit 20

**Unit 20** (404.1–409.6 m): Silty dolostone; very fine to fine crystalline; dark grey, weathers creamy light olive-grey; bedding thickness 30 cm to 1 m, well-developed lamination, lenticular chert layers present; erosion surface above unit 19

**Unit 19** (402.8–404.1 m): Dolostone; very fine crystalline; light grey, weathers light yellow-grey; bedding thickness 15–30 cm, weathers blocky, some beds are laminated, stylolites present

**Unit 18** (378.8–402.8 m): Dolostone and silty dolostone. Dolostone: very fine crystalline; dark grey, weathers light olive-grey; bedding thickness 30–60 cm, well defined, finely laminated. Silty dolostone: very fine crystalline with microcrystalline matrix; dark grey, weathers dull dark grey, light grey, and creamy light grey; bedding thickness 20 cm to 1 m, some beds laminated, rare silica stringers; at 392.3–392.6 m and 392.9–393.5 m, beds with abundant silicified stromatoporoids; slightly silty dolostone at bottom of unit, very fine to coarse crystalline, dark brown-grey, weathers light grey, bedding thickness 30 cm to 3 m, interbedded grey and dark grey beds

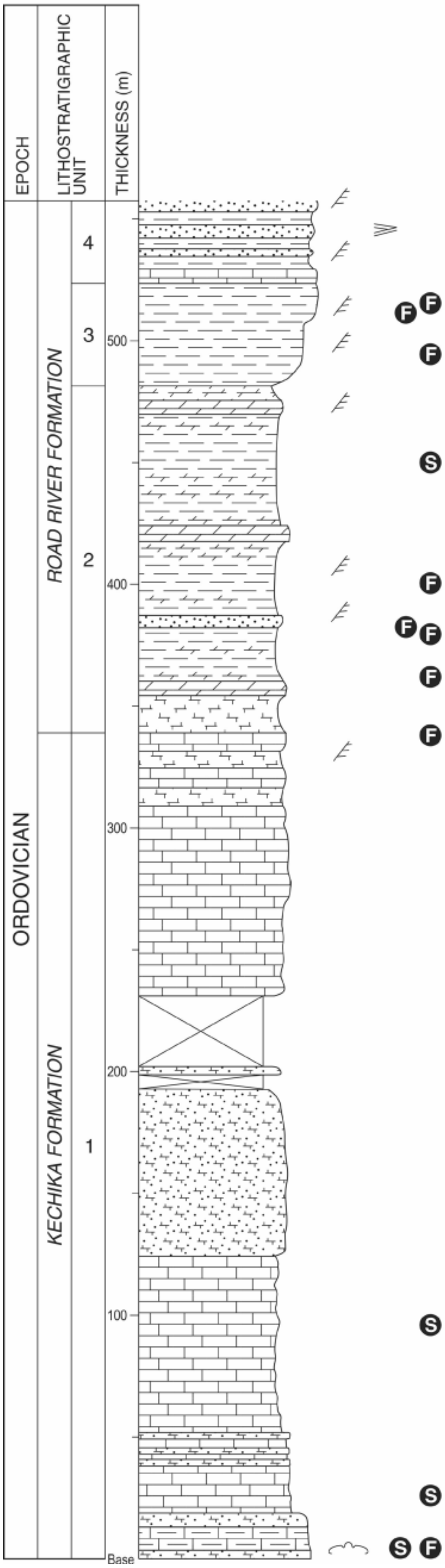
**Unit 17** (356.3–378.8 m): Silty dolostone and dolostone. Silty dolostone: fine to coarse crystalline with microcrystalline matrix; dark grey, weathers dark grey, dull olive-grey, grey, and orange-grey with whitish stains; bedding thickness over 2 m, contains 10% chert nodules at 376–378 m, around 371 m contains 10% dolomite and calcite-filled vugs and 2% drusy cavity porosity, at 364.5–369.4 m single bed has 20% dolomite and calcite-filled vugs and 3% drusy cavity porosity; irregular silicification at top of unit. Dolostone: very fine to fine crystalline; dark grey, weathers dark grey and dull grey with orange-grey stains; bedding thickness 60 cm to over 2 m, at 358.4–361.8 m a bed (over 2 m thick) occurs with 10% dolomite and calcite-filled vugs, at 361.8–363.6 m rock contains 1% drusy cavity porosity, rare calcite and dolomite-filled vugs and dolomite stringers at bottom of unit
O-64512 (370.3–372.1 m)

**Unit 16** (354.2–356.3 m): Silty dolostone; microcrystalline and very fine crystalline; light grey, weathers very light olive-grey; bedding thickness around 90 cm, poorly developed lamination, weathers blocky; contains quartz silt

**Unit 15** (338.6–354.2 m): See previous page for description

**Figure A25. (Cont.)** Prophet River (note Section 5 of Cecile and Norford, 1979, p. 221; Norford, 1991, p. 52).

78-CJA-04




**Unit 4** (523.5–705.0 m): Thick intervals of shale interstratified with quartz sandstone, and dolostone. Shale: grey-black and black, weathers rusty; contains barite at 675 m; recessive in top quarter of unit. Quartz sandstone: fine to medium grained; dark grey and grey, weathers blue-grey and bluish grey-white; well to poorly sorted; massive and blocky; contains silty partings around 400 m; contains large lenses of shale at 580 m; rare ripple cross laminae in bottom third of unit

**Unit 3** (481.5–523.5 m): Shale; weathers rusty and grey
C-078994 (515.5 m)
C-078993 (511.5 m)
C-078992 (494.5 m)
C-078758 (523.5–532.5 m), lithology

**Unit 2** (339–481.5 m): Shale with minor units of dolostone and quartz sandstone. Shale: olive-green, grey and dark grey; locally dolomitic. Dolostone: finely crystalline; grey to dark grey. Quartz sandstone: bluish in color
C-078991 (400.5 m)
C-078990 (382.5 m)
C-078989 (379.5 m)
C-078899 (362 m), Conodont
C-078757 (450–465 m), lithology

**Unit 1** (0–339 m): Limestone, calcarenite, calcilutite, and calcareous mudstone. Limestone: finely crystalline; dark grey to black, weathers grey, dark grey, yellow-orange, and yellow; locally argillaceous, locally phyllitic; pseudo nodules around 27.5–37.5 m; pencil bedding from 51–122 m. Calcareous mudstone: olive-green. Calcarenite: orange, weathers grey; very thick and sparry with abundant bioclastic debris at base of unit. Calcilutite: yellow, weathers grey; thin bedded
C-078898 (338 m), Conodont
C-078897 (3 m), Conodont
C-078756 (310.5–322.5 m)
C-078756A (228 m), lithology
C-078755 (96 m)
C-078754 (26 m)
C-078753 (3 m)

**Figure A26**. 78-CJA-04 (note Section 4 of Cecile and Norford, 1979, p. 221; Norford, 1991, p. 51).

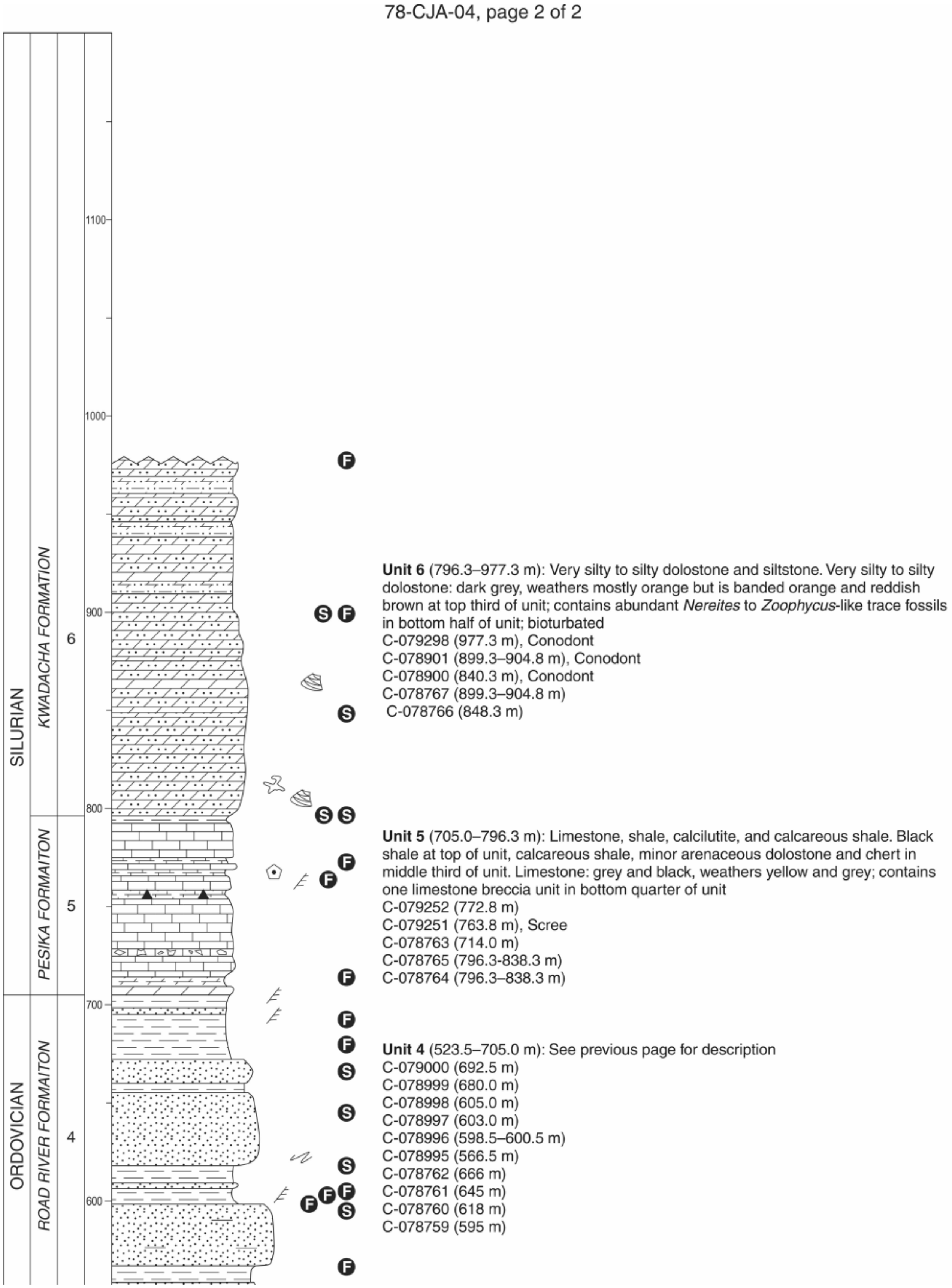



**Figure A26**. **(Cont.)** 78-CJA-04 (note Section 4 of Cecile and Norford, 1979, p. 221; Norford, 1991, p. 51).

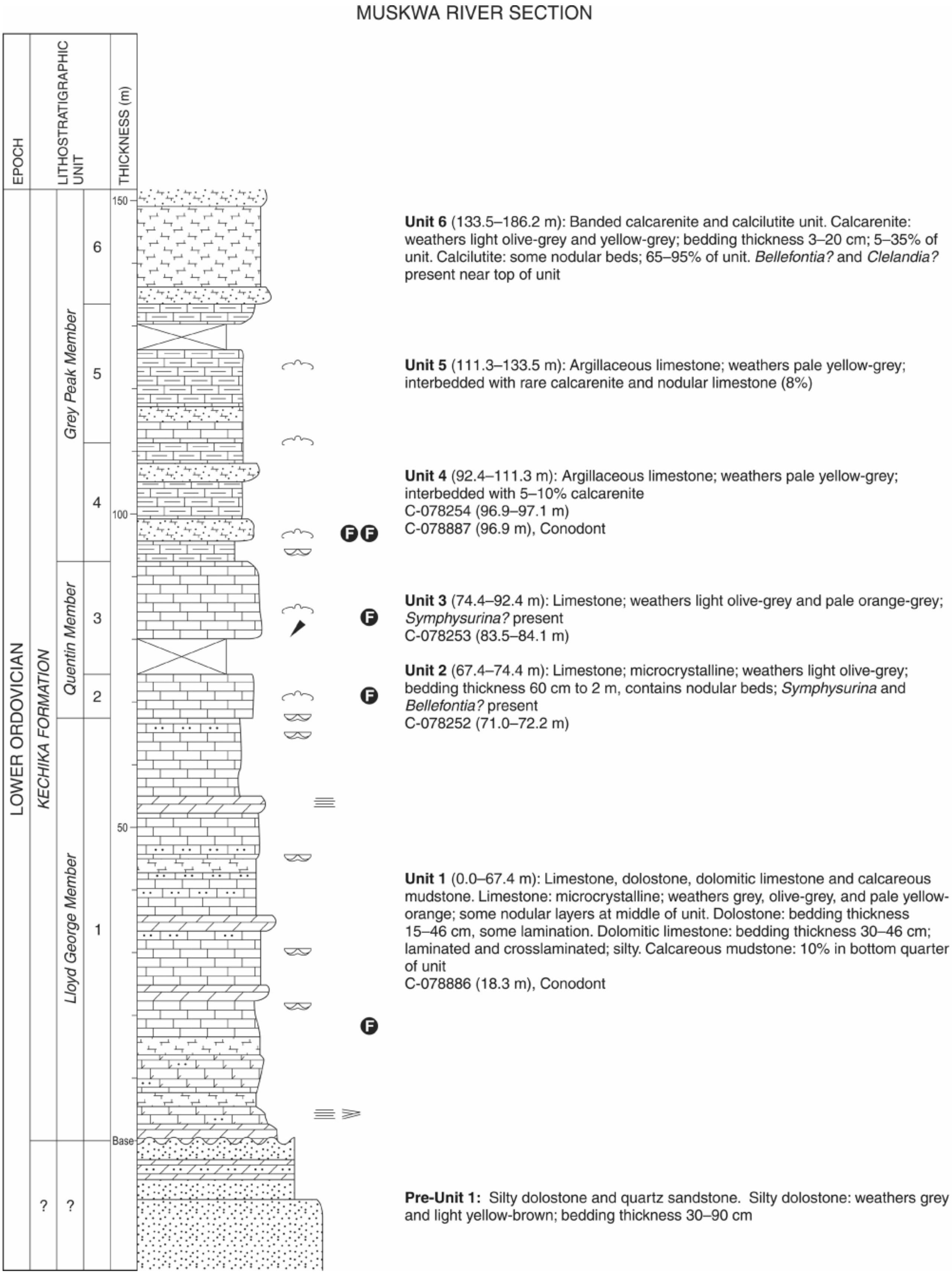



**Figure A27.** Muskwa River (note Section 1 of Cecile and Norford, 1979, p. 221; Norford, 1991, p. 52).

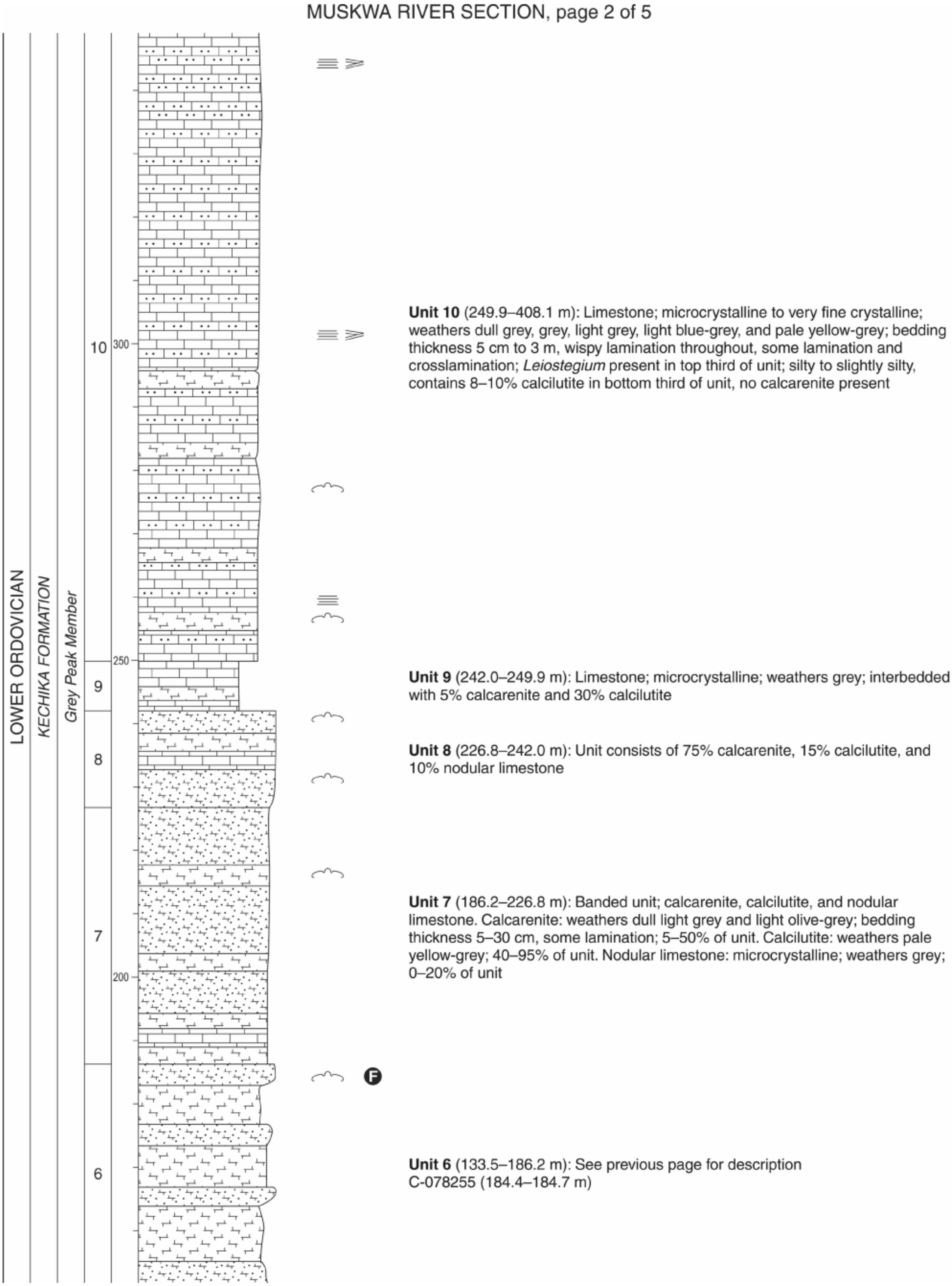
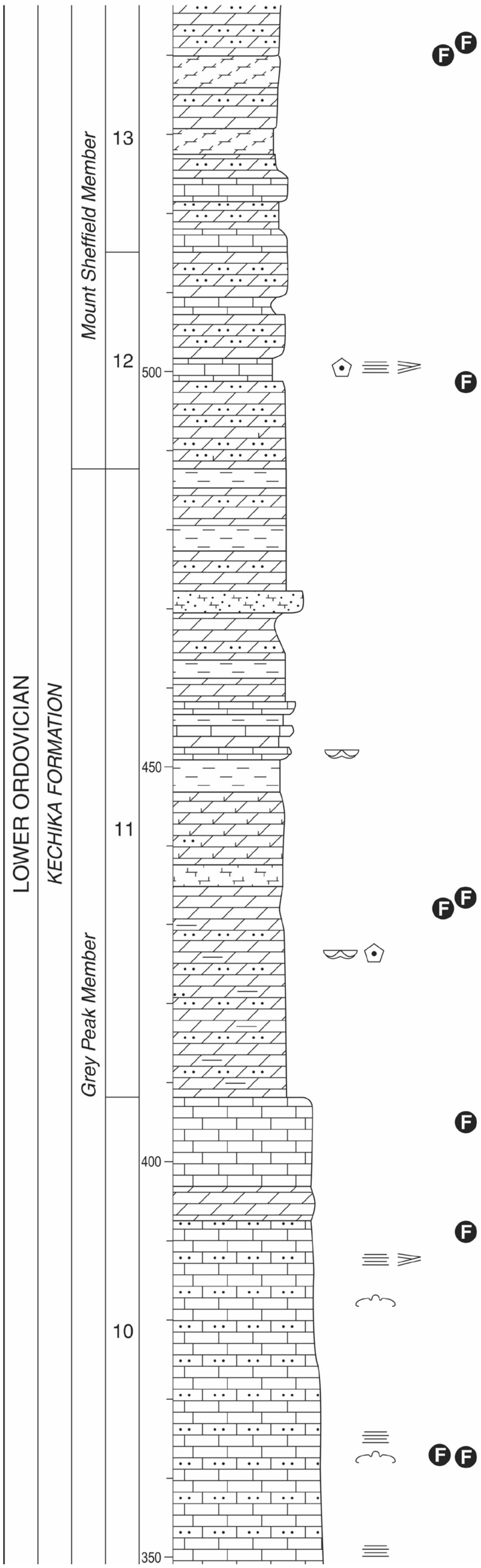



**Figure A27. (Cont.)** Muskwa River (note Section 1 of Cecile and Norford, 1979, p. 221; Norford, 1991, p. 52).

MUSKWA RIVER SECTION, page 3 of 5




**Unit 13** (515.1–566.3 m): Dolostone, very silty dolomitic mudstone, and limestone. Dolostone: weathers orange-grey, pale orange-grey, pale yellow-brown, and light olive-grey; bedding thickness 15–60 cm; irregular silica laminae. Very silty dolomitic mudstone: sparse, nodular; grey-purple partings. Limestone: weathers light grey; bedding thickness 15 cm to 2 m; rare
C-078260 (541.6–541.8 m), Conodont
C-078890 (540.0 m), Conodont

**Unit 12** (487.7–515.1 m): Dolostone; weathers yellow-brown and pale yellow-brown; bedding thickness 1 cm to 2 m, lamination and some crosslamination; feeding trails; contains rare limestone beds
C-078259 (498.7–498.8 m)

**Unit 11** (408.1–487.7 m): Dolostone, mudstone, and calcareous dolostone. Dolostone: weathers dull yellow-brown and dull grey; bedding thickness 15–60 cm, flaggy and laminated; slightly silty at bottom of unit. Mudstone: rare to 20% around 448 m. Calcareous dolostone: weathers dull grey; bedding thickness 30–60 cm, flaggy
C-078258 (433.4–436.5 m)
C-079297 (432.0 m), Conodont

**Unit 10** (249.9–408.1 m): See previous page for description
C-078889 (405 m), Conodont
C-078257 (391.1–391.4 m)
C-078256 (362.7–363.0 m)
C-078888 (363 m), Conodont

**Figure A27. (Cont.)** Muskwa River (note Section 1 of Cecile and Norford, 1979, p. 221; Norford, 1991, p. 52).

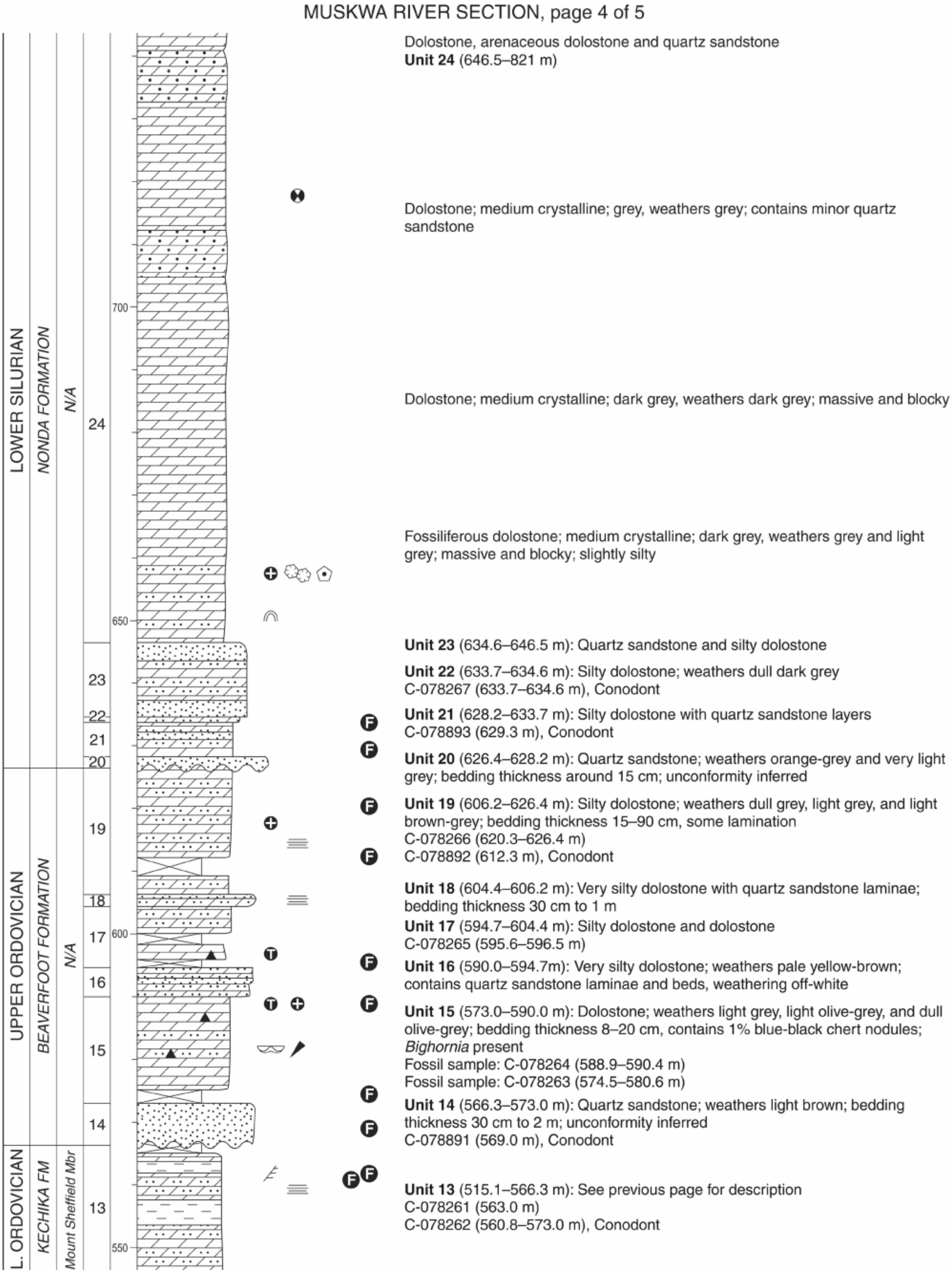



**Figure A27. (Cont.)** Muskwa River (note Section 1 of Cecile and Norford, 1979, p. 221; Norford, 1991, p. 52).

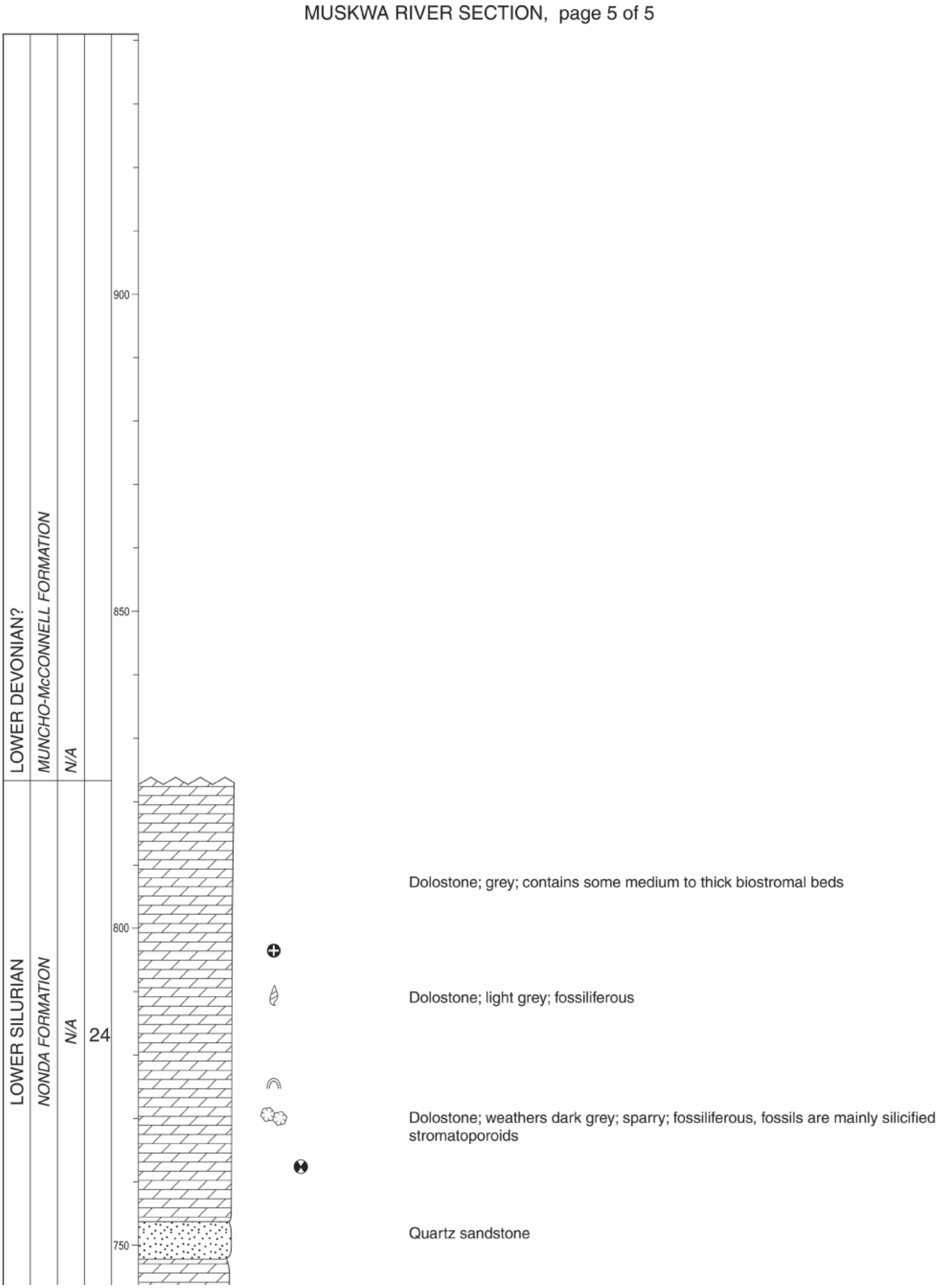
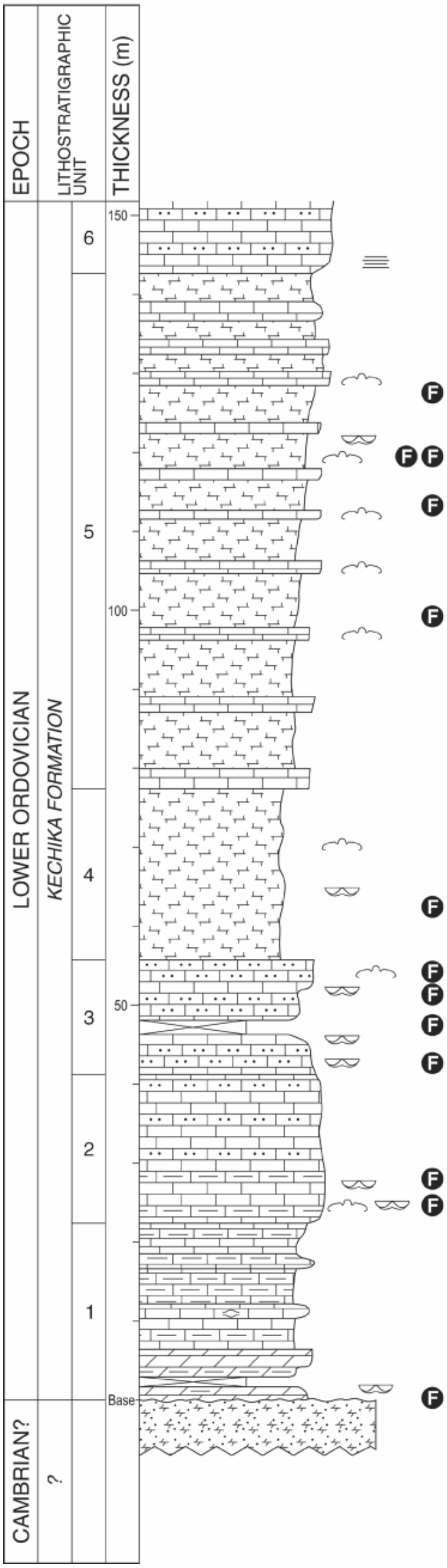



**Figure A27. (Cont.)** Muskwa River (note Section 1 of Cecile and Norford, 1979, p. 221; Norford, 1991, p. 52).

LITTLE LAKE SECTION




**Unit 6** (142.6–291.4 m): See next page for description

**Unit 5** (77.4–142.6 m): Unit 5 (77.4–142.6 m): Calcilutite and limestone. Calcilutite: weathers yellow-grey, pale greenish-yellow, and light grey; bedding thickness 8 cm to 2 m, cleaved at bottom one-sixth of unit, cleavage not parallel to bedding, local nodular patches in middle of unit; *Bellefontia?* present around 113 m. Limestone: microcrystalline to fine crystalline; weathers dull, light olive-grey; limestone beds amount to 1–30%
C-078613 (127.7–128.0 m)
C-078612 (119.5–126.5 m), Conodont
C-078611 (119.5–119.6 m)
C-078610 (113.1–113.2 m)
C-078609 (99.1–111.6 m), Conodont

**Unit 4** (55.8–77.4 m): Calcilutite; weathers yellow-grey; bedding thickness over 2 m, cleaved, cleavage not parallel to bedding; contains < 0.5% limestone bands and lenses, rare calcarenite lenses
C-078608 (62.5–74.4 m), Conodont

**Unit 3** (41.1–55.8 m): Silty limestone; weathers yellow-brown with orange-grey stains; bedding thickness 1 cm to 2 m, weathers blocky
C-078607 (53.3–55.8 m), Conodont
C-078606 (51.8–52.1 m)
C-078605 (47.5–47.9 m)
C-078604 (42.7–43.6 m)

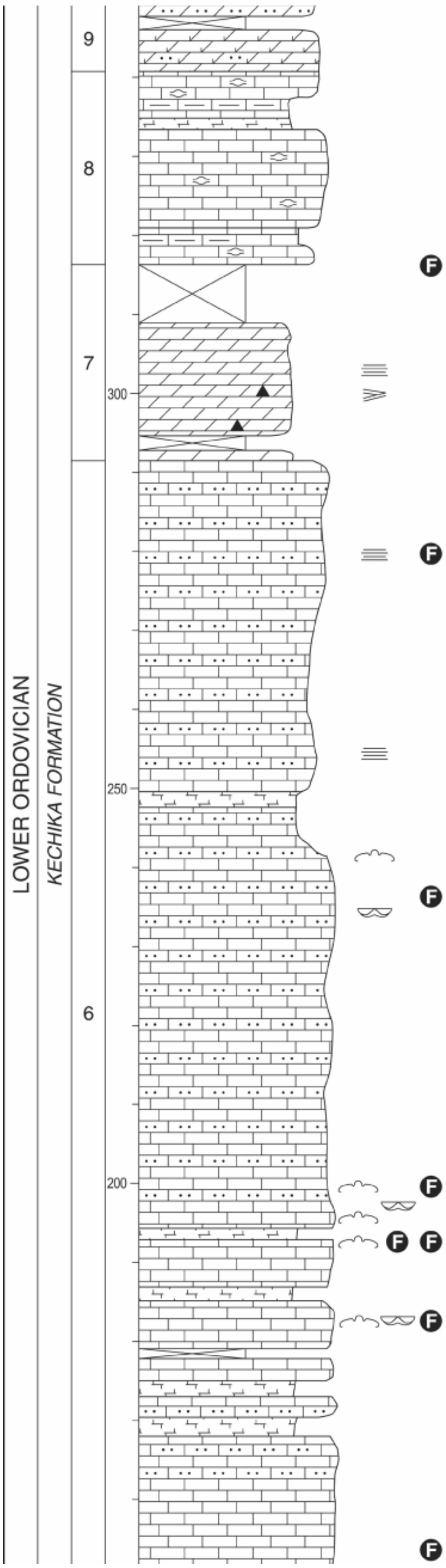
**Unit 2** (22.3–41.1 m): Limestone; very fine crystalline; weathers dull dark grey, dull grey, and yellow-brown; bedding thickness 3–60 cm; *Symphysurina?* present at base of unit; slightly silty in upper half of unit; contains 0–15% nodular beds in lower half of unit; no nodules in upper half of unit
C-078603 (28.0–43.3 m), Conodont
C-078602 (23.2–24.4 m)

**Unit 1** (0.0–22.3 m): Limestone and dolostone. Limestone: very fine crystalline; weathers grey and orange-grey; bedding thickness 15–45 cm; upper two-thirds of unit contains 20% limestone beds and 80% nodular limestone beds; some nodules present around 11 m. Dolostone: very fine crystalline; weathers yellow-orange and yellow-brown; basal erosion surface, 3 cm of relief; locally argillaceous
C-078601 (0.0–24.4 m), Conodont

**Pre-Unit 1** (-7.6–0.0 m): Dolomitic quartz sandstone; weathers light grey and yellow-brown; bedding thickness 30 cm to 1 m

**Figure A28.** Little Lake.

LITTLE LAKE SECTION, page 2 of 3




**Unit 9** (340.8–369.1 m): See next page for description

**Unit 8** (316.1–340.8 m): Limestone; weathers dull brown-olive-grey; bedding thickness 15–46 cm, weathers flaggy, grey nodules present; locally argillaceous and nodular in upper portion of unit
C-078621 (316.1–328.9 m), Conodont

**Unit 7** (291.4–316.1 m): Dolostone; microcrystalline; weathers very light grey and very light yellow-grey; bedding thickness 46 cm to over 2 m, laminated and crosslaminated, scour marks present

**Unit 6** (142.6–291.4 m): Limestone and calcilutite. Limestone: microcrystalline to fine crystalline; dark grey, weathers dull light grey, light grey, and yellow-brown; bedding thickness 3–46 cm, weathers blocky, wispy partings and lamination; locally slightly silty, flat pebble conglomerate present around 155 m. Calcilutite: bedding thickness 15–61 cm
C-078620 (279.8–291.4 m), Conodont
C-078619 (236.2–249.3 m), Conodont
C-078618 (199.6–199.7 m)
C-078617 (192.6–199.6 m), Conodont
C-078616 (192.6–192.9 m)
C-078615 (182.6–182.7 m)
C-078614 (153.0–163.1 m), Conodont

**Figure A28. (Cont.)** Little Lake.

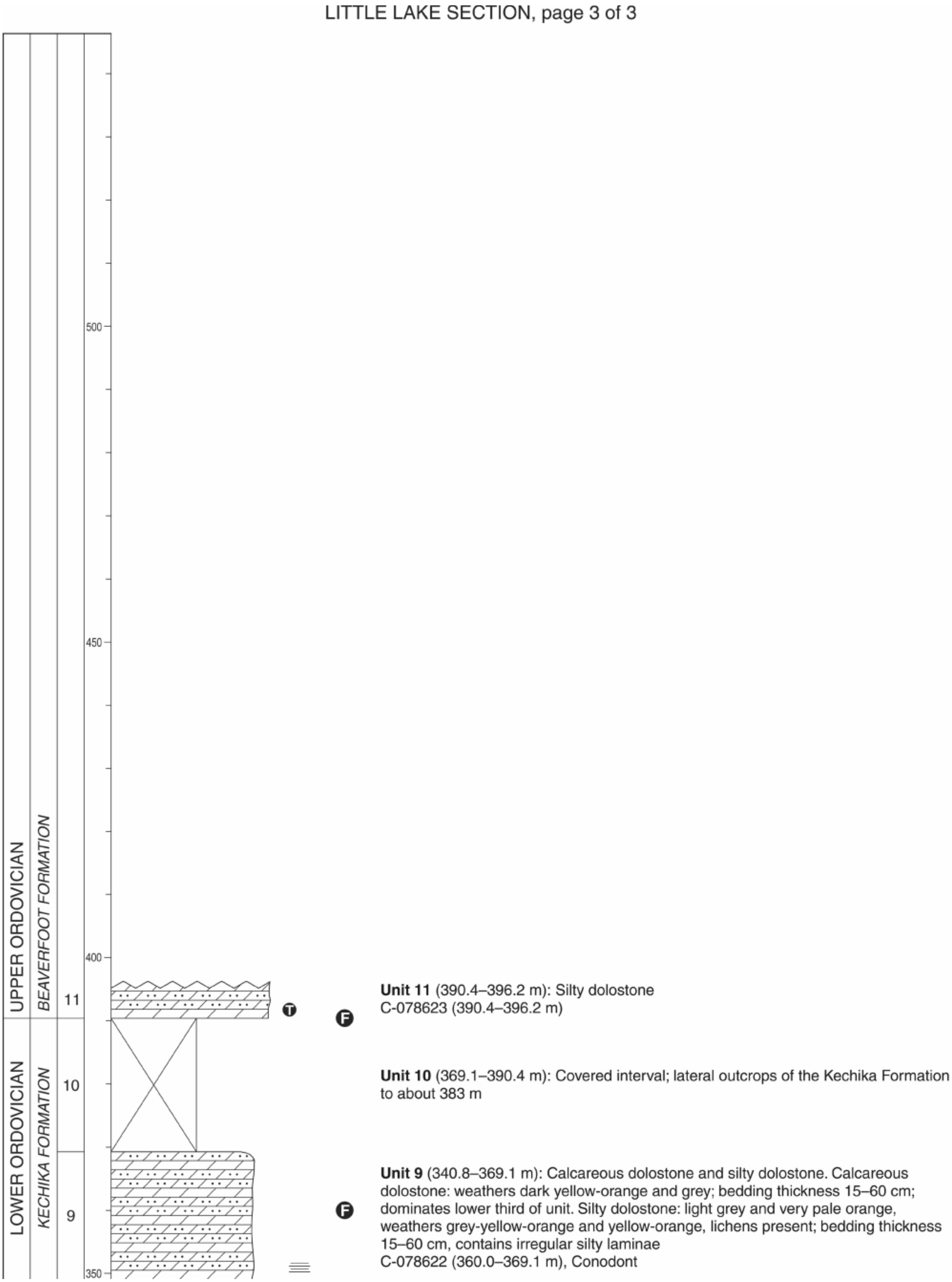
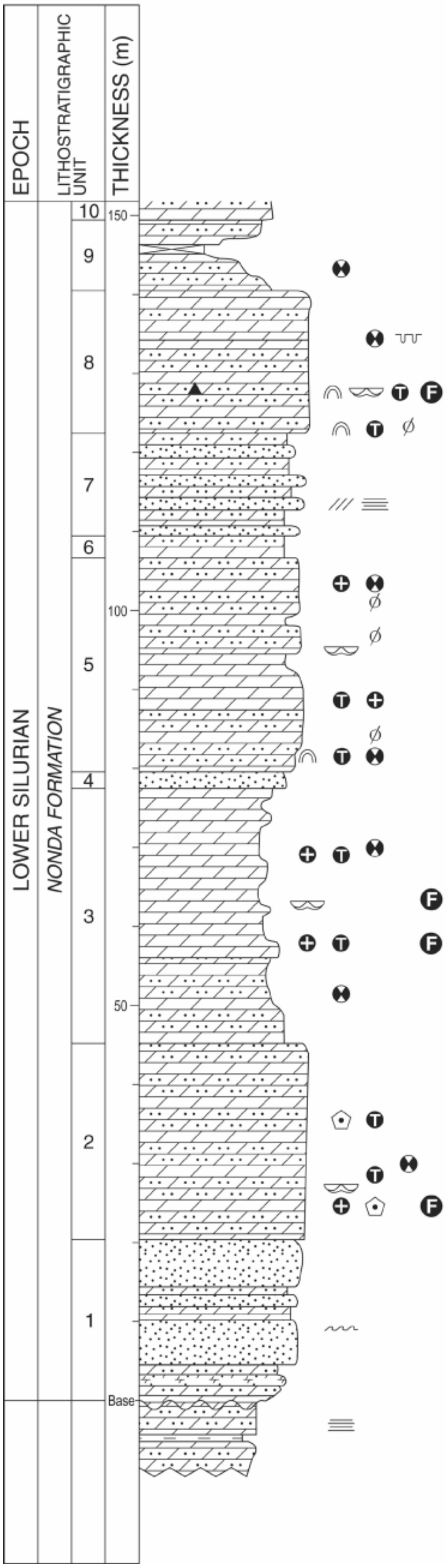



**Figure A28. (Cont.)** Little Lake.

## GATHTO CREEK SOUTH SECTION




**Unit 9** (140.5–149.4 m): Silty dolostone; very fine to fine crystalline; dark brown-grey, weathers olive-grey and blocky; bedding 61–152 cm; rare calcite-filled vugs

**Unit 8** (123.4–140.5 m): Slightly silty and silty dolostone. Slightly silty dolostone: very fine to fine crystalline; dark brown-grey, weathers dark brown-grey, grey and dark grey; bedding 91 cm, poorly mottle-laminated, rare dolostone vugs; from 137.8–138.4 m, irregular silicification of 20% of rock. Silty dolostone: very fine crystalline; dark brown-grey, weathers dull dark grey, grey and olive-grey; bedding: 61–244 cm, rare drusy cavity porosity, dolostone, calcite, and silica-filled vugs common; stromatoporoids common; irregular silicification, contains minor quartz silt
O-64519 (127.7–133.8 m)

**Unit 7** (109.4–123.4 m): Silty dolostone and quartz sandstone. Silty dolostone: very fine crystalline; grey, weathers light grey and grey; bedding 8–46 cm, some beds have poorly developed lamination. Quartz sandstone (109.4–121.3 m): medium to coarse grained, grains well rounded; off-white, weathers off-white and grey-yellow-white, stains; bedding 30–38 cm, rare crossbeds; contains 50% silty dolostone beds, at 117.3 m dolostone makes up 70% of interval

**Unit 6** (106.7–109.4 m): Silty dolostone: very fine crystalline; grey, weathers light grey and grey; bedding thickness 15–183 cm, bedding is well developed

**Unit 5** (79.6–106.7 m): Silty dolostone and dolostone. Silty dolostone: very fine to medium crystalline; dark grey, weathers grey and dull light to dark grey; most bedding over 2 m but ranges from 15–46 cm at 93.3–95.4 m, 5–8 cm at 97.2–97.8 m, and 3–5 cm at 98.1–99.1 m; large coarse crystalline calcite-filled vugs, 2% of rock; drusy cavity porosity, rare to 2% of rock; irregular silicification layers present. Dolostone: very fine to fine crystalline; dark grey, weathers dark grey and dull grey; bedding over 2 m; 3% coarse crystalline calcite-filled vugs; rare drusy cavity porosity; rare irregular silicification, slightly rubbly when well weathered

**Unit 4** (77.4–79.6 m): Quartz sandstone; medium to coarse grained; very light grey, weathers off-white, very light grey and yellow-grey; bedding thickness 15–46 cm, some coarse layering present; unit 4 grades into unit 5

**Unit 3** (45.1–77.4 m): Dolostone; very fine to medium crystalline; dark grey, weathers dark grey, olive-grey, dull grey and dull olive-grey; bedding 5 cm to 2 m and readily weathers to 5–15 cm, some resistant beds, rare calcite stringers and small vugs, from 66.1–67.0 m and at bottom of unit 5% coarse crystalline, calcite-filled vugs, at 70.1 m 2% calcite-filled vugs; locally silty in bottom third of unit; 183/03 NW
O-64520 (63.4–63.7 m)
O-64521 (57.9–59.4 m)

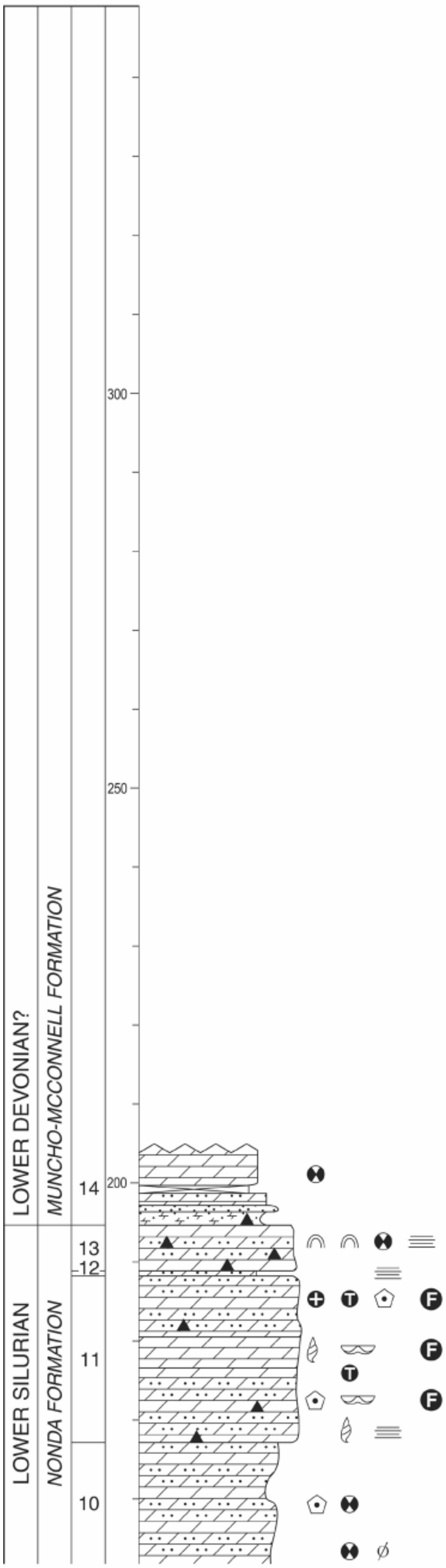
**Unit 2** (20.3–45.1 m): Silty dolostone; very fine to medium crystalline, local microcrystalline matrix around 30.5 m; dark grey, weathers grey, dull grey, dark grey, light grey and olive-grey; bedding thickness 15 cm to over 2 m, bedding tends to be indistinct, sparse calcite-filled vugs; dolomitized pentamerid at 24.7 m
O-64522 (24.7–25.0 m)

**Unit 1** (0.0–20.3 m): Quartz sandstone, slightly silty dolostone and dolostone. Quartz sandstone: very fine to medium grained; very pale orange and pale grey-orange to yellowish white, weathers very pale yellow-brown, off-white and yellow-grey with stains; bedding thickness 10–91 cm; ripple marks at 9.4 m, rare lenses of dolomitic quartz sandstone, rare dolomitic sandstone and dolostone below 14.6 m. Slightly silty dolostone (91 cm to 1.4 m): dark grey, weathers olive-grey; bedding thickness around 46 cm; shaly partings at 1.4 m. Dolostone (0–91 cm): thin dolostone beds 2–15 cm thick; shaly partings thick and thin laterally

Pre-Unit 1: Silty dolostone and shaly mudstone. Silty dolostone: fine to medium crystalline; light grey, weathers light olive-grey; bedding thickness 30–152 cm in some beds, others contain fine lamination with 10% interbedded shaly mudstone. Shaly mudstone: dark grey, weathers dark grey; bedding thickness 5–46 cm, some beds nodular; slightly dolomitic. Contact erosion surface 30 cm deep

**Figure A29.** Gathto Creek South (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

GATHTO CREEK SOUTH SECTION, page 2 of 2




**Unit 14** (194.8–199.0 m): Dolostone; microcrystalline to very fine crystalline with ghosts of coarser crystals; light brown-grey, weathers light grey and light olive-grey; bedding thickness 30–122 cm, unit contains 5% small and angular calcite-filled vugs

**Unit 13** (188.8–194.8 m): Silty dolostone; fine crystalline; grey, weathers dull dark grey and olive-grey; bedding 152–305 cm, rare calcite-filled vugs, contains 8% irregular chert nodules, silicified stromatoporoids at 191.4–194.8 m; contact between units 13 and 14 is not well exposed, concordant, and shows no signs of erosion

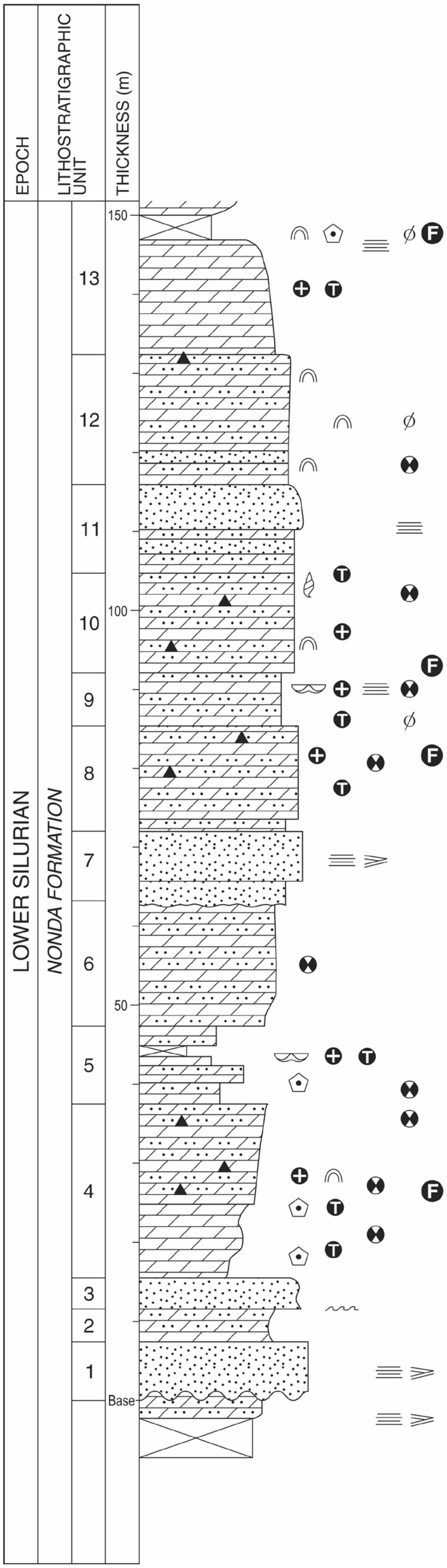
**Unit 12** (188.4–188.8 m): Silty dolostone; very fine crystalline; light brown-grey and very light grey, weathers very light grey; bedding thickness 15–46 cm, laminated, most beds weather blocky; contains minor quartz silt

**Unit 11** (167.0–188.4 m): Dolostone; very fine to fine crystalline, coarse crystalline with very fine crystalline matrix at bottom of unit; dark grey and dark brown-grey, weathers dark grey and dull dark grey; bedding thickness 3 cm to over 2 m, poorly developed bedding at top of unit, 2% chert nodules in lowest bed, poorly developed coarse lamination; irregular silicification, layers of irregular silicification at top of unit, locally silty towards bottom half of unit, coarse-crystalline ghost grains at middle of unit, quartz sand present in dolostone at 177.4 m
O-64518 (172.5–173.4 m)
O-64517 (178.9–182.3 m)
O-64516 (185.3–186.2 m)

**Unit 10** (149.4–167.0 m): Silty dolostone; very fine to fine crystalline; dark grey, weathers dull grey, dull dark grey and olive-grey; bedding 61–183 cm, some beds poorly laminated, sparse coarse-crystalline dolomite and silica-filled vugs, large coarse-crystalline calcite-filled vugs, common dolostone and calcite stringers at 157.0 m, rare drusy cavity porosity; contains quartz silt and coarse-crystalline ghost grains, some irregular silicification

**Figure A29. (Cont.)** Gathto Creek South (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

## TUCHODI RIVER SECTION




**Unit 13** (132.6–152.1 m): Dolostone; very fine to coarse crystalline; grey and dark grey, weathers dull olive-grey and light grey; some beds laminated, some silicification or irregular silicification, very minor drusy cavity porosity from 147.5 m on
O-64524 (147.8–149.7 m)

**Unit 12** (116.7–132.6 m): Silty dolostone; microcrystalline to very fine crystalline; dark grey, weathers dull dark grey and dull dark grey-brown; bedding 91 cm to 4 m, massive bedding present above 121.9 m, irregular silicification common, sparse calcite-filled vugs, drusy cavity porosity ranges from 2 to 3%; stromatoporoids common (5% of rock)

**Unit 11** (105.5–116.7 m): Silty dolostone and quartz sandstone. Silty dolostone: very fine crystalline; bedding thickness around 3 m; contains 15% quartz sand and silt, quartz sand laminae and quartz sandstone, above 108.2 m quartz sandstone occurs with interbeds of silty dolostone. Quartz sandstone: medium- to coarse-grained; pale grey, orange-pink, weathers very light grey and grey-orange with grey orange-pink stains; bedding around 2 m, rare lamination; erosion surface at 110 m

**Unit 10** (92.4–105.5 m): Silty dolostone; very fine to fine crystalline; dark grey, weathers dull grey and dark grey; bedding thickness 60 cm to 1 m, chert nodules greater than 1%, irregular silicification in some beds, at 105.2 m about 3% coarsely crystalline calcite-filled vugs
O-64525 (93.0–99.1 m)

**Unit 9** (85.3–92.4 m): Silty dolostone; fine to medium crystalline; light brown-grey, weathers light grey; bedding 30–90 cm, some beds poorly laminated, irregular silicification, sparse coarse crystalline calcite-filled vugs, local 1% drusy cavity porosity

**Unit 8** (73.9–85.3 m): Silty dolostone; very fine to fine crystalline; light brown-grey and dark grey, weathers dull grey, dark grey and light olive-grey; bedding thickness > 2 m, drusy cavity porosity ranges from 1 to 2%, sparse large coarse crystalline calcite-filled vugs, chert and irregular silicification present, from 82.9 to 85.0 m silicification of approximately 4% of rock, chert nodules 3%
O-64526 (81.7–91.7 m)

**Unit 7** (63.3–73.9 m): Quartz sandstone; fine to coarsely crystalline; off-white, weathers off-white, contains pale yellow-orange stains; bedding thickness > 2 m, from 63.1 to 64.0 m bedding thickness 15–46 cm, rare lamination and very rare crosslamination

**Unit 6** (47.4–63.3 m): Silty dolostone; microcrystalline to very fine crystalline; dark grey, weathers slightly hackly and dull dark grey, grey, light grey and dark brown olive-grey; bedding thickness > 2 m, coarse crystalline calcite-filled irregular vugs present, 38 cm deep erosion surface at 63.3 m

**Unit 5** (37.5–47.4 m): Silty dolostone; fine to medium crystalline; dark brown-grey and grey, weathers olive-grey and dull light olive-grey, beds stained reddish brown; bedding thickness 3–46 cm, most beds weather 3–8 cm, rare coarse crystalline calcite-filled vugs

**Unit 4** (15.5–37.5 m): Silty dolostone and dolostone. Silty dolostone: fine to medium crystalline; dark grey, weathers dull grey and dark grey; bedding thickness 3–10 cm, at 27.1 to 27.4 m large coarse crystalline calcite-filled vugs (2% of unit). Dolostone: fine crystalline; dark grey, weathers dark grey and olive-grey, some bedding planes weather grey-red; bedding thickness 15–61 cm, rare irregular large coarse crystalline calcite-filled vugs
O-64527 (26.5–31.7 m)

**Unit 3** (11.6–15.5 m): Quartz sandstone; fine- to medium-grained; off-white, weathers yellow-grey with orange-grey stains; bedding thickness 30 cm to 2 m, ripple marks at 11.6 m; orientation 338/19 NE

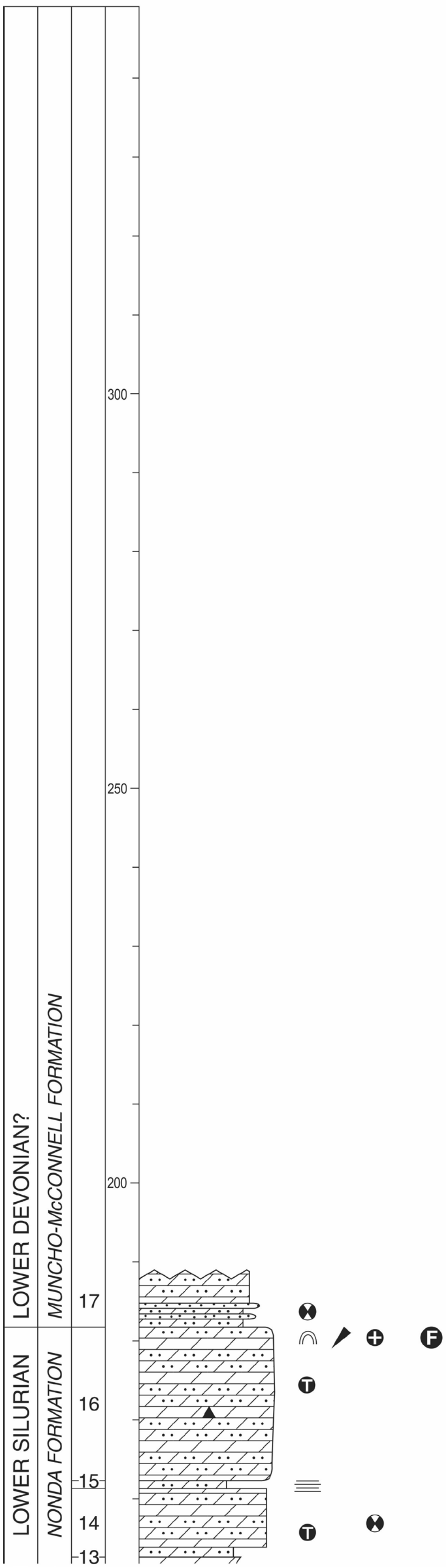
**Unit 2** (7.3–11.6 m): Silty dolostone; fine to medium crystalline; dark grey, weathers dull dark grey and dark olive-grey, displays pale reddish-brown stains; bedding thickness 61–91 cm, weathers slightly rubbly

**Unit 1** (0.0–7.3 m): Quartz sandstone; very fine- to medium-grained; off-white and very pale orange, weathers creamy light orange-grey and displays dark yellow-grey stains; bedding thickness 23 cm to 1 m, some lamination and rare crosslamination; erosion surface at 0 m

**Pre-Unit 1** (-8.0–0.0 m): Very silty dolostone; brownish olive-grey, weathers light olive-grey and yellow-grey; bedding thickness 30–61 cm, some lamination and rare crosslamination. Outcrop continues further down ridge

**Figure A30**. Tuchodi River (note Norford, 1991, p. 52).

TUCHODI RIVER SECTION, page 2 of 2




**Unit 17** (181.7–187.5 m): Silty dolostone; microcrystalline to very fine crystalline; light grey, weathers very light grey and light bluish-grey; bedding 61 cm to 1 m, weathers blocky, fine calcite-filled vugs common; contains 5% quartz silt and sand

**Unit 16** (162.2–181.7 m): Silty dolostone; very fine to coarse crystalline; pale olive-grey and grey, weathers very pale yellow-brown and grey to light grey; bedding thickness 61 cm to over 2 m, some beds have irregular silicification, others laminae of coarse irregular silicification; around 180 m abundant silicification (mostly stromatoporoids). Orientation is 336/21 NE
O-64523 (180.4–181.7 m)

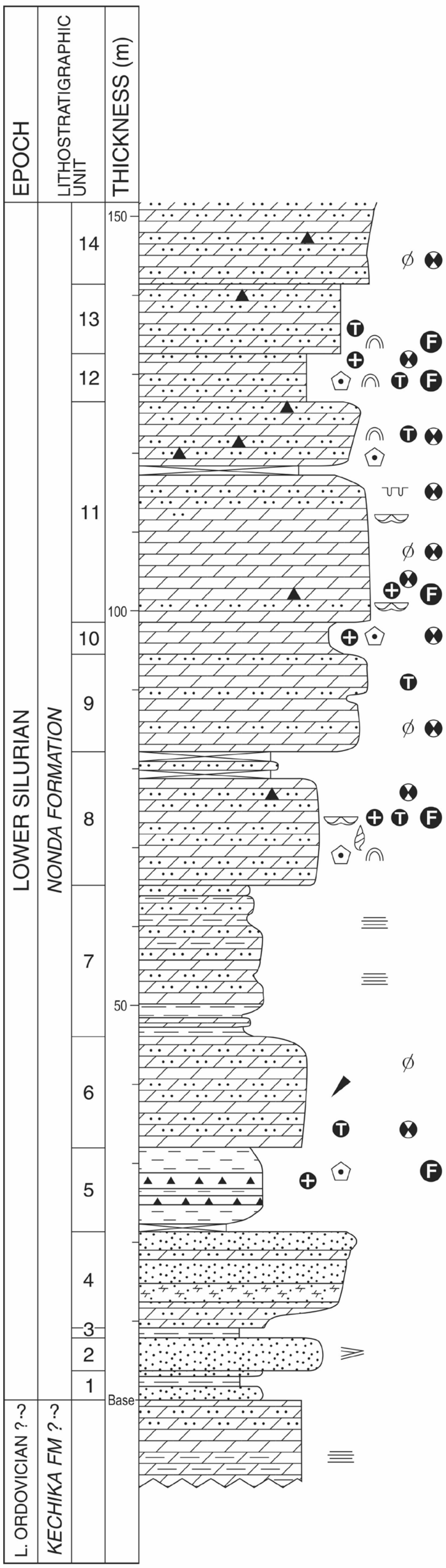
**Unit 15** (161.2–162.2 m): Silty dolostone; very fine crystalline; light grey, weathers light grey and light olive-grey; bedding 10–30 cm, laminated, recessive; quartz siltstone (10%)

**Unit 14** (152.1–161.2 m): Silty dolostone; microcrystalline to very fine crystalline; dark grey, weathers dull dark grey, grey, and light grey; bedding thickness 31 cm to over 2 m, at 157.0 to 158.5 m up to 5% coarse irregular silicification common; recessive dolostone from 152.1 to 152.7 m, weathers dark brown-grey with small dolomite-filled vugs

**Unit 13** (132.6–152.1 m): See previous page for description

**Figure A30**. **(Cont.)** Tuchodi River (note Norford, 1991, p. 52).

## DEVEREUX PEAK SECTION




**Unit 14** (141.4–153.0 m): See next page for description

**Unit 13** (132.6–141.4 m): Silty dolostone; very finely crystalline; dark grey, weathers dull dark grey and grey; bedding thickness 61 cm to 2 m; halysitid corals common
O-64528 (134.1–141.4 m)

**Unit 12** (126.5–132.6 m): Silty dolostone; very finely to finely crystalline; grey, weathers brown-grey; larger ghost crystals; bedding thickness 8–61 cm and 5–46 cm where weathered; rare coarsely crystalline calcite-filled vugs
O-64529 (129.2–132.0 m)

**Unit 11** (98.5–126.5 m): Slightly silty to silty dolostone, dolostone. Slightly silty to silty dolostone: very finely crystalline to coarsely crystalline; dark grey, weathers dull dark grey and dark brownish olive-grey, some beds mottled grey and brown olive-grey; bedding thickness 1–2 m, 15–30 cm where well weathered; rare calcite-filled vugs; coarsely crystalline calcite-filled vugs around 114 m. Dolostone: very finely to finely crystalline; dark grey, weathers dull dark grey; bedding thickness 61 cm to over 2 m; rare coarsely crystalline calcite-filled vugs; contains 1% surface porosity
O-64530 (102.1–106.1 m)

**Unit 10** (94.5–98.5 m): Dolostone; very finely crystalline; dark grey, weathers dark brown-grey; bedding thickness 5–61 cm; rare calcite-filled vugs

**Unit 9** (82.1–94.5 m): Slightly silty to silty dolostone; grey, weathers dull grey and olive-grey with brown stains; fine to medium crystalline; bedding thickness over 2 m, weathers to irregular 5–30 cm partings; rare coarsely crystalline calcite-filled vugs; contains greater than 1% drusy cavities and fine vuggy porosity at 83 m

**Unit 8** (65.2–82.1 m): Silty dolostone; very finely to medium crystalline; dark grey, weathers dull olive-grey, dark grey, dark brown-grey with dark yellow-brown stains; bedding thickness 30 cm to 3 m; rare calcite-filled vugs
O-64531 (73.8–81.4 m)

**Unit 7** (46.0–65.2 m): Silty dolostone and shaly dolostone. Silty dolostone: very finely to finely crystalline; dark grey, weathers dull olive-grey; bedding thickness 30–61 cm; poorly developed coarse lamination; shaly dolostones present around 56 m. Shaly dolostone: dark grey; moderately to poorly fissile

**Unit 6** (32.0–46.0 m): Silty dolostone; fine to coarsely grained; dark grey weathers dull grey; contains minor amounts of quartz sand; quartz sandstone layers at 32–39 m; rare beds weather pale yellow-brown and light orange-grey; bedding thickness 30 cm to over 2 m; weathers rubbly; coarse calcite-filled vugs; contains 1% drusy cavities and coarse vuggy porosity at 44 m

**Unit 5** (21.3–32.0 m): Slightly dolomitic mudstone; microcrystalline to very finely crystalline; dark grey, weathers a dull dark brown-grey; argillaceous dolostone from 31–32 m; bedding over 2 m; off-white dolomite stringers at 23 m; contains 10% argillaceous cherty layers and nodules; no chert nodules above 30 m
O-64532 (29.0–32 m)

**Unit 4** (9.1–21.3 m): Slightly dolomitic quartz sandstone and dolostone**.** Slightly dolomitic quartz sandstone: dark grey, weathers light olive-grey with brown stains; bedding thickness 30–60 cm; cross-laminated. Dolostone: dark olive-grey, weathers dull dark olive-brown; makes up 10% of unit; contains much quartz sand; bedding thickness 8–23 cm; weathers rubbly; recessive and earthy

**Unit 3** (7.9–9.1 m): Shale; dark grey, weathers dark grey and moderate brown; poorly fissile

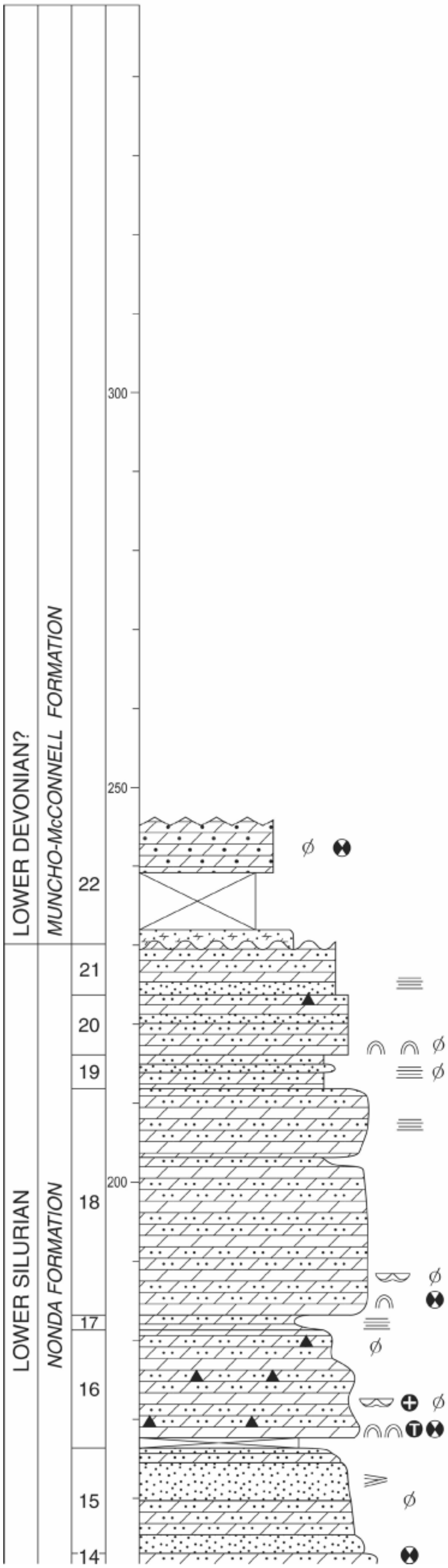
**Unit 2** (3.7–7.9 m): Dolomitic quartz sandstone; very fine to coarse grained; dark grey, weathers yellow-grey, grey-orange and light grey; argillaceous; bedding thickness 30 cm to 2 m; abundant, very coarse cross-lamination

**Unit 1** (0.0–3.7 m): Shale and dolomitic quartz sandstone. Dolomitic quartz sandstone: fine to coarse grained; light grey and dark grey, weathers light grey and dark brown-grey with brown stains; argillaceous; bedding thickness 15–30 cm with argillaceous partings; argillaceous lenses; contains 20% shale with argillaceous quartz sandstone beds 3–5 cm thick at 1.0–1.5 m. Shale (3–4 m). Poorly exposed concordant contact between Kechika and Nonda formations at 0 m

**Pre-Unit 1:** Dolostone, shale and silty dolostone. Silty dolostone: very finely crystalline; dark grey, weathers moderate brown and dark yellow-brown; bedding thickness 20–61 cm; some lamination

**Figure A31**. Devereux Peak (renamed, previously was Mount Stalin North, note Norford et al., 1967, p. 508; Norford 1991, p. 52).

## DEVEREUX PEAK SECTION, page 2 of 2




**Unit 22** (230.1 m–end of section): Sandy dolostone, pebble/cobble conglomerate and dolomitic quartz sandstone. Sandy dolostone: very finely crystalline; grey, weathers yellow-grey and light grey; contains 10% floating quartz sand, coarsely to very coarsely-grained, rounded, contains small calcite-filled vugs; bedding thickness 30–61cm. Basal conglomerate: pebbles and cobbles of silicified stromatporoids derived from Nonda Formation; grey-orange weathering quartz-sandstone matrix; 46–76 cm thick laterally. Erosion surface 5 cm deep below this basal conglomerate. Dolomitic quartz sandstone: light brown-grey, weathers orange-grey; bedding thickness 30–61 cm

**Unit 21** (223.7–230.1 m): Silty dolostone, quartz sandstone. Silty dolostone: fine to medium crystalline; grey, weathers light olive-grey and light grey; irregular silicification in some beds; some beds have poorly developed lamination; bedding thicknesses 30–61 cm. Quartz sandstone (223.7–224 m): quartz sandstone layers from 226.5–226.7 m. Very silty dolostone or dolomitic quartz sandstone from 227.4–228 m

**Unit 20** (216.1–223.7 m): Silty dolostone; very finely to finely crystalline; dark grey, weathers dark grey and dark brown-grey; massive bedding over 2 m; irregular silicification of 10% of rock; stromatoporoids present, 2%; rare drusy cavity porosity from 218–218.5 m; about 50% of unit is made up of quartz sandstone layers

**Unit 19** (211.8–216.1 m): Silty dolostone; very finely to finely crystalline; grey, weathers light grey and light yellow-grey; contains minor irregular silica quartz stringers; at 215 m, thin quartz-sandstone beds and laminae occur; at 211.8–212 m, minor drusy cavity porosity present; bedding thickness 61–91 cm

**Unit 18** (183.2–211.8 m): Silty dolostone and dolostone. Dolostone (201.8–202.4 m): weathers light grey; bedding thicknesses 15–30 cm; well laminated. Silty dolostone: microcrystalline to finely crystalline; dark grey and light grey, weathers dull dark brown-grey, grey, light grey and light olive-grey; bedding thickness over 2 m; poorly developed coarse lamination; silica stringers around 191 m; irregular silicification of 3% of rock; at 187 m, coarsely crystalline calcite-filled vugs occur, 5% of rock

**Unit 17** (181.4–183.2 m): Silty dolostone; very finely crystalline; light brown-grey, weathers light olive-grey; distinct bedding; bedding thickness 15–46 cm; weathers blocky; well laminated; slightly recessive

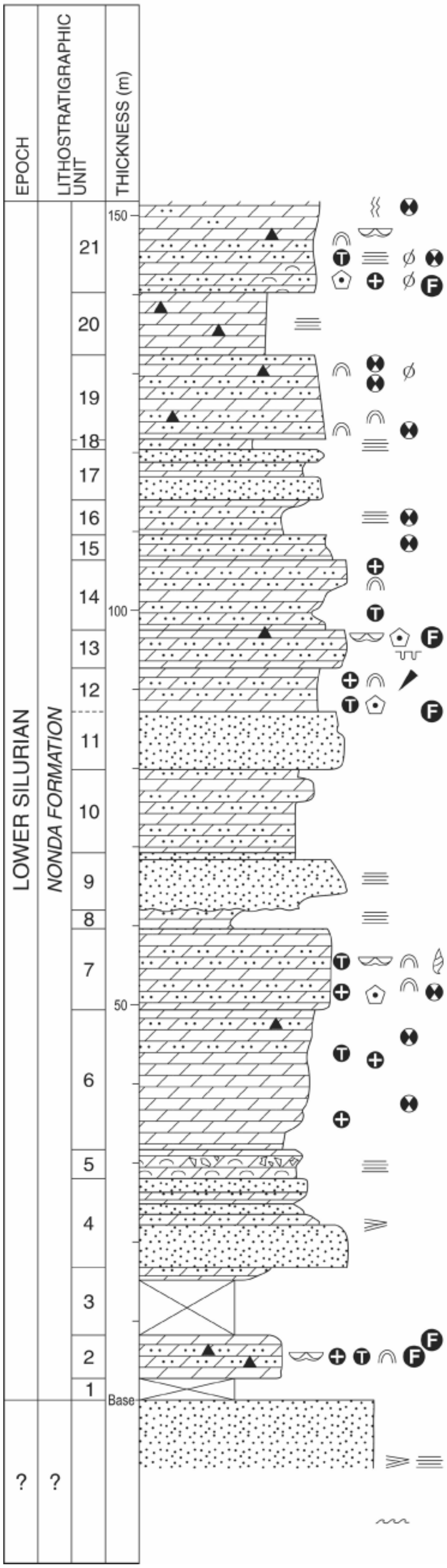
**Unit 16** (166.4–181.4 m): Silty dolostone; finely crystalline; grey or light brown-grey, weathers grey, light grey and pale orange; bedding thickness 2–3 m; at 176 m, chert and silicification make up 25% of rock; at 169–173 m chert and silicification make up 10% of rock; drusy cavity porosity present in 2% of rock; around 168 m, coarsely crystalline large calcite-filled vugs and drusy cavities, 3% of rock; irregular silicification present; from 166.4–169 m stromatoporoids present in 20% of rocks

**Unit 15** (153.0–166.4 m): Quartz sandstone: fine to medium grained; pinkish white and off-white, weathers off-white and yellow-grey; bedding thickness 30 cm to 2 m; rare cross lamination; predominately silty dolostone up to 157 m

**Unit 14** (141.4–153.0 m): Silty dolostone; microcrystalline to medium crystalline; grey, weathers dull grey, dark grey and light grey; bedding thickness 30 cm to 5 m; above 146 m, calcite-filled vugs make up 1% of rock, around 143 m, very large calcite-filled vugs and drusy cavities present, 5% of rock; irregular silicification, 1% of rock; chert nodules, 0.5%

**Figure A31**. **(Cont.)** Devereux Peak (renamed, previously was Mount Stalin North, note Norford et al., 1967, p. 508; Norford 1991, p. 52).

## MOUNT MARY HENRY SECTION




**Unit 21** (140.2–154.2 m): See next page for description
O-64534 (141.1–142.6 m)

**Unit 20** (132.3–140.2 m): Dolostone; very fine to medium crystalline with biogenic debris; dark grey, weathers dull light olive-grey; bedding 5–60 cm, some lamination

**Unit 19** (121.6–132.3 m): Silty dolostone; very fine to medium crystalline; dark grey and dark brown-grey, weathers dull grey, light grey, dull brown-grey, and dark grey; bedding thickness 30 cm to 2 m, coarse crystalline calcite-filled vugs present throughout, rare at bottom of unit; at 131 m, rock contains 5% drusy cavity porosity

**Unit 18** (120.4–121.6 m): Silty dolostone; microcrystalline to very fine crystalline; dark grey, weathers dull light grey and light olive-grey; bedding thickness 5–60 cm, most beds have light grey and dark brown-grey laminae

**Unit 17** (114.0–120.4 m): Quartz sandstone and silty dolostone. Quartz sandstone: fine- to coarse-grained; very light pinkish-grey, weathers greyish-yellow with yellowish-grey stains, lichens present; bedding thickness 20–90 cm, some lamination, no crosslamination present

**Unit 16** (109.6–114.0 m): Silty dolostone; microcrystalline; dark brown-grey, weathers yellow-grey and light olive-grey; bedding thickness 5–90 cm, well developed bedding, some lamination, calcite-filled vugs present; contains 5% quartz sand and silt

**Unit 15** (106.4–109.6 m): Silty dolostone; microcrystalline to very fine crystalline; dark grey, weathers dull grey; bedding thickness 15–90 cm, coarsely crystalline calcite-filled vugs common in some beds

**Unit 14** (97.5–106.4 m): Silty dolostone; microcrystalline to fine crystalline; grey, weathers dull grey and dull light grey; bedding thickness 60 cm to > 2 m; 3% irregular silicification at top of unit; slightly recessive dolostones at 101.5–102.7 m

**Unit 13** (92.7–97.5 m)**:** Silty dolostone; weathers dark grey, some beds are vaguely mottled; bedding thickness > 2 m
O-64535 (96.6–101.5 m)

**Unit 12** (87.2–92.7 m): Silty dolostone; very fine to fine crystalline with coarse crystalline ghost crystals; dark grey, weathers grey and dull light grey; bedding thickness 15–90 cm, some beds weather slightly platy; stromatoporoids common from 90.8–91.4 m; contact between units 11 and 12 is gradational within one bed
O-64536 (87.2–89.9 m)

**Unit 11** (79.9–87.2 m): Quartz sandstone; medium- to coarse-grained, rounded grains; very light creamy grey, weathers very light grey and creamy white, lichens present; bedding thickness 1–2 m, no lamination or crosslamination

**Unit 10** (69.2–79.9 m): Silty dolostone; fine crystalline; dark grey, weathers light grey, dull grey and dark grey; bedding thickness 30–90 cm, some beds weather 5–20 cm, from 69.2–76.2 m bedding thickness is 5–45 cm, from 78.9–79.2 m bedding thickness is 5–20 cm. 5-20 cm

**Unit 9** (62.0–69.2 m): Quartz sandstone; creamy off-white, weathers creamy off-white and pale yellow-grey, lichens present; bedding 30 cm to 2 m, very coarse crossbeds common, some lamination; unit thins laterally; erosional surface, 8 cm deep, between units 8 and 9

**Unit 8** (59.7–62.0 m): Silty dolostone; very fine to fine crystalline; dark brown-grey, weathers grey; bedding 5–30 cm, some beds laminated; some bedding planes stained reddish grey

**Unit 7** (49.4–59.7 m): Silty dolostone; very fine to fine crystalline; dark grey, weathers dull grey and light grey; bedding > 2 m, rare and large calcite-filled vugs

**Unit 6** (31.7–49.4 m): Dolostone; dark grey and grey-black, weathers dull dark grey, grey, dull grey and dull brown-grey; bedding thickness 15–90 cm; slightly silty in top two-thirds of unit; from 32.3-32.6 m dark dull grey, olive-grey-weathering, recessive dolostones; rare, coarsely crystalline, calcite-filled vugs

**Unit 5** (28.0–31.7 m): At 28.2–28.8 m occurs bed with abundant stromatolites and pellets; 28.3–28.8 m is pelletal, 28.8–29.9 m is stromatoltic. Silty dolostone at 30.5 m; laminated. Breccias present. 15 cm deep erosional surface between units 4 and 5

**Unit 4** (16.8–28.0 m): Quartz sandstone; medium- to coarse-grained; creamy light grey, weathers grey, off-white, light orange-grey, and orange grey; bedding 30 cm to 2 m, indistinct, some crosslamination

**Unit 3** (8.2–16.8 m): Silty dolostone; very fine crystalline; dark grey, weathers grey; bedding 30–60 cm; 329/41 NE

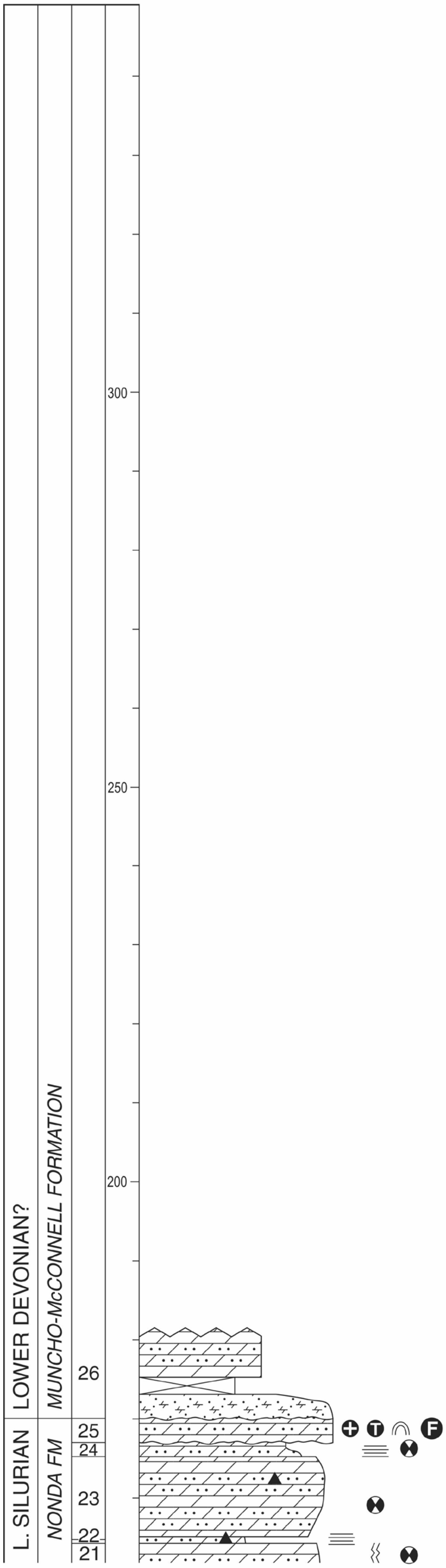
**Unit 2** (2.7–8.2 m): Silty dolostone; very fine crystalline; dark grey, weathers light olive-grey and olive-grey; bedding 15 cm to 1 m; at 7.6–8.1 m irregular silicification of 20% of the bed
O-64538 (7.6–8.2 m)
O-64539 (5.5–7.6 m)

**Unit 1** (0.0–2.7 m): Covered interval

**Pre-Unit 1:** Quartz sandstone; very fine- to fine-grained; pale orange, weathers very pale orange with orange-grey stains, lichens present; bedding thickness 30 cm to 2 m, many beds are laminated but crosslamination is very rare, no crosslamination at top of unit, ripple marks 35 m below base

**Figure A32.** Mount Mary Henry (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

MOUNT MARY HENRY SECTION, page 2 of 2




**Unit 26** (170.1 m– end of section): Silty dolostone and quartz sandstone. Quartz sandstone: fine- to coarse-grained, well rounded grains; light olive-grey, weathers light olive-grey and yellow-grey with orange-grey stains; bedding thickness around 90 cm; slightly dolomitic; erosion surface is slightly leached

**Unit 25** (167.0–170.1 m): Silty dolostone; very fine to fine crystalline; grey, weathers grey and light grey; bedding thickness 60 cm to 1 m; at 168.9–169.5 m, silicified stromatoporoids make up 5% of rock; contains lenses of quartz sandstone; patches of breccia at 167.0–167.9 m. 30 cm deep erosion surface between units 24 and 25
O-64533 (168.9–169.5 m)

**Unit 24** (165.2–167.0 m): Silty dolostone; very fine crystalline; dark grey, weathers light olive-grey, very light olive-grey, and light bluish-grey; bedding thickness 8–20 cm, most beds have dark brown-grey fine laminae, rare small calcite-filled vugs present, recessive; contains very rare quartz silt

**Unit 23** (154.8–165.2 m): Silty dolostone; very fine to fine crystalline; dark grey, weathers dull dark grey and grey; bedding thickness 60 cm to 3 m, dolomite stringers and vugs present

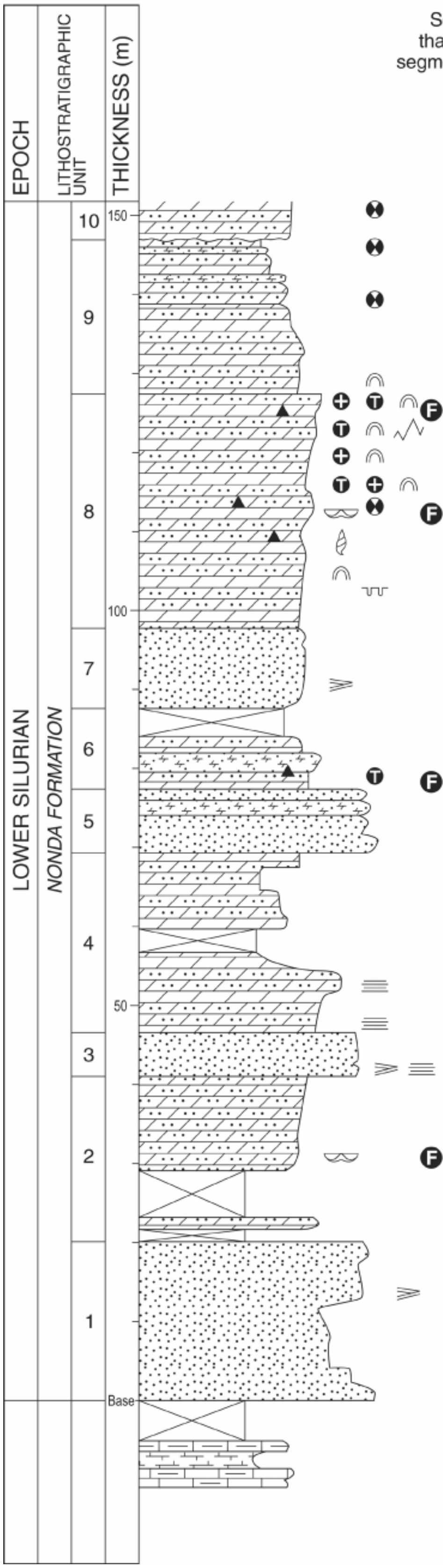
**Unit 22** (154.2–154.8 m): Silty dolostone; microcrystalline to very fine crystalline; dark grey, weathers yellow-grey and light bluish-grey; bedding thickness 5–10 cm; contains minor quartz silt, quartz-silt laminae

**Unit 21** (140.2–154.2 m): Dolostone and silty dolostone. Dolostone (top third of unit): microcrystalline; dark grey, weathers dull grey and light grey; bedding thickness around 5 m; slightly silty; 3 cm thick quartz sandstone layer at 154 m; at 153.9–154.0 m rock contains very large, rounded, nodular chert; rare coarsely crystalline veins and vugs amount to 3% of rock at 149.0–151.2 m. Silty dolostone (bottom two-thirds of unit): medium to coarse crystalline; dark brown-grey, weathers dull dark brown-grey and dark brown-olive grey; bedding thickness > 2 m, some beds are poorly laminated, sparse irregular silicification, some calcite vugs and stringers; rock contains 10% stromatoporoids at 141.1–142.6 m, sparse stromatolites at 140.5 m; contains 1% drusy cavity porosity at 144.8–146.3 m, rare at bottom of unit

**Figure A32. (Cont.)** Mount Mary Henry (note Norford et al., 1967, p. 508; Norford, 1991, p. 52).

## MOUNT ST. GEORGE SECTION

Section was measured in two segments that are about 1 kilometre apart, these two segments are matched here at the top of Unit 7.




**Unit 10** (146.9–196.3 m): See next page for description

**Unit 9** (127.4–146.9 m): Dolostone and dolomitic sandstone. Dolostone: microcrystalline to very fine crystalline; dark dull grey, grey, and light grey, weathers dark grey, grey, and light grey; bedding thickness 30 cm to over 2 m; weathers flaggy at middle of unit, irregular silicification at base of unit, dolomitic vugs present; stromatoporoids or silicified algae in bottom third of unit; locally slightly silty to silty. Dolomitic sandstone: pale yellow, weathers yellow and yellow-grey; bedding thickness 30–60 cm; 90 cm thick; contains rare amethysts

**Unit 8** (97.8–127.4 m): Silty dolostone; very fine crystalline to fine crystalline; grey and dark grey, weathers dull grey and dark grey, mottled at bottom quarter of unit; bedding thickness 30 cm to 2 m, rare stylolites around 121 m, lacks chert nodules around 118 m, dolomite stringers and vugs present; at 114 m a band with *C. magnitubus* present, halysitids and *Favosites* present
O-45559 (125.3–126.5 m)
O-45560 (112.2–115.0 m)

**Unit 7** (87.6–97.8 m): Quartz sandstone and dolomitic sandstone. Quartz sandstone: off-white, weathers yellow-grey, yellow, and white; bedding thickness 15–60 cm, crosslaminated; contains 30–40% dolomitic sandstone; 45 cm thick, quartz sandstone bed within covered interval. Dolomitic sandstone: light grey, weathers grey and yellow-grey; bedding thickness 5–60 cm; contains 40% quartz sandstone

**Unit 6** (77.4–87.6 m): Silty dolostone and dolomitic sandstone. Silty dolostone: very fine crystalline; light grey, weathers grey and dull grey; bedding 30–60 cm, poorly developed, contains silica nodules. Dolomitic sandstone: light grey, weathers light grey; bedding thickness 60 cm to 1 m; silty; 2 m of beds
O-45597 (78.3–80.2 m)

**Unit 5** (69.3–77.4 m): Dolomitic sandstone and quartz sandstone. Dolomitic sandstone: light grey, weathers dark brown-grey; bedding thickness 30–60 cm; contains 20% quartz sandstone. Quartz sandstone: very fine to fine grained, poorly sorted, poorly rounded grains; off-white, weathers whitish grey, lichens present at base of unit; bedding thickness 60 cm to over 2 m; contains rare amethysts

**Unit 4** (46.6–69.3 m): Silty dolostone; very finely to finely crystalline; grey, brown-tinged dark grey, light grey, and dark grey, weathers dull dark grey, dull grey, and black-grey with brown stains; bedding thickness 8 cm to 1 m; contains 1%, rusty-brown-weathering, shaly dolostone interbeds; quartz sand laminae in bottom half of unit; weathers blocky in bottom half of unit

**Unit 3** (41.0–46.6 m): Quartz sandstone; very fine- to medium-grained, well rounded to subangular grains; off-white, weathers grey, lichens present; bedding thickness 8–90 cm, some lamination and crosslamination

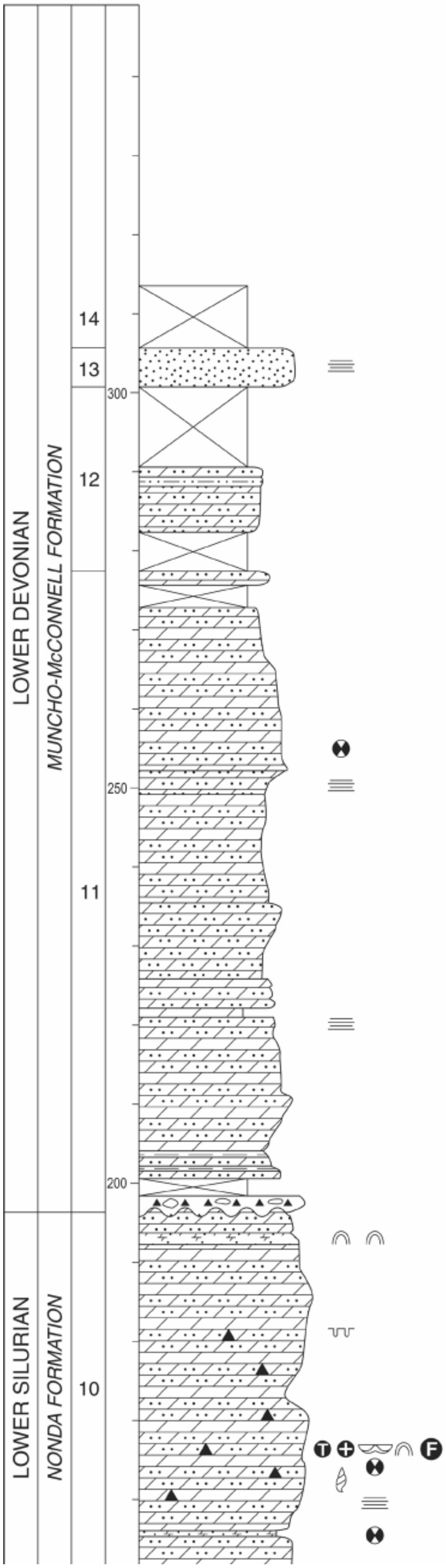
**Unit 2** (20.1–41.0 m): Silty to very silty dolostone; very fine to fine crystalline; dull brown-tinged grey, dull light grey, grey, and dark grey, weathers dull grey, brown-grey, and yellow-grey; bedding thickness 8 cm to 1 m, weathers blocky at top of unit, flaggy in bottom two-thirds of unit; pentamerid and *Stricklandia* at top of unit; black shale talus present in basal covered interval
O-45598 (30.8–35.1 m)

**Unit 1** (0.0–20.1 m): Quartz sandstone; very fine- to coarse-grained, rounded to angular grains, poorly sorted; off-white, grey-white, pale yellow, and light grey, weathers white, and off-white, lichens present; bedding thickness 8 cm to over 2 m, some crosslamination around 12 m; contact talused, but is gross angular unconformity elsewhere, approximately 10°

**Pre-Unit 1:** Argillaceous limestone and calcareous mudstone

**Figure A33**. Mount St. George (note Norford et al., 1967, p. 508).

MOUNT ST. GEORGE SECTION, page 2 of 2




**Unit 14** (305.7–end of section): Large covered interval, above this barren, very-light-grey-weathering dolostones and silty dolostones

**Unit** 13 (300.8–305.7 m): Quartz sandstone; fine- to medium-grained, subangular grains; light yellow, weathers pale yellow and yellow-brown; bedding thickness 60 cm to 1 m, mostly laminated

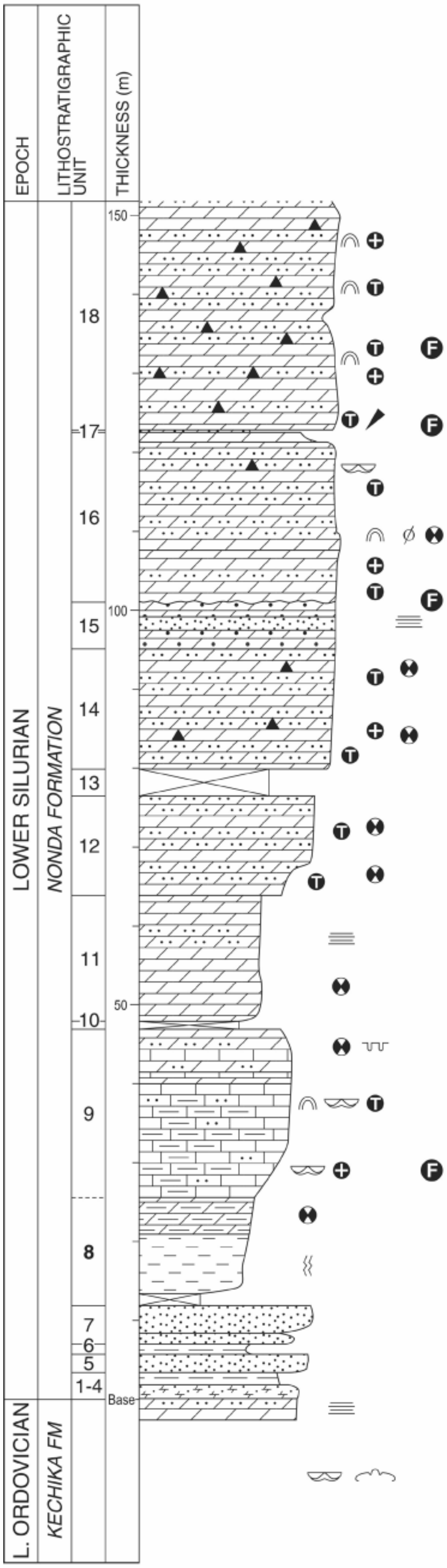
**Unit** 12 (277.4–300.8 m): Very silty dolostone and siltstone. Very silty dolostone: microcrystalline to very fine crystalline; putty-grey, weathers light yellow-grey, and light yellow; bedding thickness 15–90 cm

**Unit 11** (196.3–277.4 m): Silty dolostone; microcrystalline to very fine crystalline; grey, brown-tinged grey, light grey, and brown-dark grey, weathers yellow-grey, light yellow-grey, light grey, grey, and dull grey; bedding thickness 1 cm to over 2 m, locally very silty, laminated in some places, weathers flaggy at top quarter of unit, weathers rubbly around 249 m, dolomitic vugs present; chert-nodule congomerate marks disconformity at base of unit; contains quartz sand at 249 m; contains 5% silty shale interbeds at base of unit, greenish brown, weathers yellow; some recessive chert-nodule interbeds at 220 m; outcrop covered for 30 cm at 217 m

**Unit 10** (146.9–196.3 m): Silty dolostone and dolomitic sandstone. Silty dolostone: microcrystalline to fine crystalline; grey, dark grey, light grey, and brown-grey, weathers grey, dark grey, dull grey, and light grey, mottled grey and dull grey; bedding thickness 30 cm to over 2 m, 5–30 cm bedding sequence for about 90 cm at around 170 m, contains 2% chert nodules at 180 m, contains 2–5% dolomite vugs in bottom third of unit; minor? erosion surface at base of unit; contains 10% quartz sand around 192 m, 90 cm thick sandy dolostone bed at 186 m, some silica lamination around 159 m, irregular silicification at 165 m, irregular silica bodies around 166 m. Dolomitic sandstone near top of unit: brown, weathers dull grey; contains 30% quartz sand O-45558 (166.4–167.3 m)

**Figure A33**. **(Cont.)** Mount St. George (note Norford et al., 1967, p. 508).

## RACING RIVER SECTION




**Unit 18** (122.8–157.0 m): See next page for description
O-64540 (133.2–137.2 m)
O-64541 (123.4–128.0 m)

**Unit 17** (122.5–122.8 m): Dolostone; very fine crystalline; grey, weathers yellow-grey; bedding thickness around 30 cm, recessive; slightly silty

**Unit 16** (101.0–122.5 m): Dolostone and silty dolostone. Dolostone: dark brown-grey and grey, weathers dark grey and dull brown-grey; bedding thickness 15 cm to 3 m, contains rare calcite-filled large vugs and drusy cavities at base of unit, recessive at top of unit; at 103.0–103.9 m a *Columnaria columbia* horizon; some bedding planes stained grayish red at base of unit. Silty dolostone: very fine crystalline; dark grey, weathers dull dark grey and dull grey; bedding thickness > 2 m
O-64542 (101.2–104.9 m)

**Unit 15** (95.1–101.0 m): Sandy dolostone and quartz sandstone beds. Sandy dolostone: very fine to fine crystalline; light grey and light brown-grey, weathers light grey and yellow-grey; thickness 15–46 cm, well developed bedding, most beds have poorly developed laminations with quartz-sand rich layers; contains 30% quartz sand. Quartz sandstone beds (95.1–95.5 m, 97.8–98.3 m, 99.2–99.4 m). Erosion surface at base of Unit 15, 15 cm deep

**Unit 14** (79.9–95.1 m): Silty dolostone; very fine to fine crystalline; dark grey, weathers dark grey and dull dark grey; bedding thickness > 2 m, contains 1% coarse crystalline calcite-filled large vugs, contains 0.5% irregular grey-black-weathering chert nodules

**Unit 13** (76.5–79.9 m): Covered interval

**Unit 12** (63.9–76.5 m): Silty dolostone; very fine to fine crystalline; dark grey, weathers dull dark grey and dull grey with olive-brown stains; bedding thickness 30–90 cm, contains coarsely crystalline calcite-filled large vugs and dolomite stringers

**Unit 11** (47.9–63.9 m): Silty dolostone and dolostone. Silty dolostone: very fine crystalline; dark grey, weathers light olive-grey; at 59.1–59.4 m beds are 30 cm thick and laminated, elsewhere beds weather brown-grey, olive-grey, and platy with thicknesses of 5–30 cm, some beds laminated; some bedding planes stained reddish brown. Dolostone: very fine to fine crystalline; dark grey, weathers dull grey and dull brown olive-grey with brown-grey and orange-grey stains; bedding thickness 30–60 cm, some beds have poorly developed lamination, fine stringers and calcite-filled coarse vugs

**Unit 10** (46.9–47.9 m): Covered interval but covered with dark brown earthy soil, and grey-black shale appears to be present on opposite ridge

**Unit 9** (25.6–46.9 m): Limestone; microcrystalline to very fine crystalline; dark grey and dark brown-grey, weathers grey, dark grey, dull grey, and dull olive-grey; bedding thickness 30 cm to 3 m, some beds weather slightly rubbly, coarse crystalline calcite vugs at top of unit; pentamerid at bottom third of unit; slightly silty throughout, slightly argillaceous in bottom two-thirds of unit, poorly developed bedding and some shaly beds at bottom of unit, partly dolomitized bed with vertical mottles of dolostone at 46.3–46.6 m
O-64543 (29.0–33.5 m)

**Unit 8** (11.9–25.6 m): Very argillaceous dolostone and mudstone. Very argillaceous dolostone: very fine crystalline; brown-grey, weathers dull light grey, grey, yellow olive-grey, and olive-grey; bedding thickness 60 cm to 2 m, weathers to rubbly, nodular, shaly partings, contains coarse crystalline calcite vugs. Mudstone: dark brown-grey, weathers light olive-grey and yellow-grey; irregular and nodular weathering beds, rare calcite veins and stringers; slightly dolomitic. Contact between units 8 and 9 is gradational. Bedding attitude: 147/19 SW

**Unit 7** (7.0–11.9 m): Quartz sandstone; fine- to medium-grained; light grey, weathers light brown-grey with brown and yellow-brown stains; bedding thickness 60 cm to 1 m; contains rare dolomite cement

**Unit 6** (5.8–7.0 m): Shale; dark grey

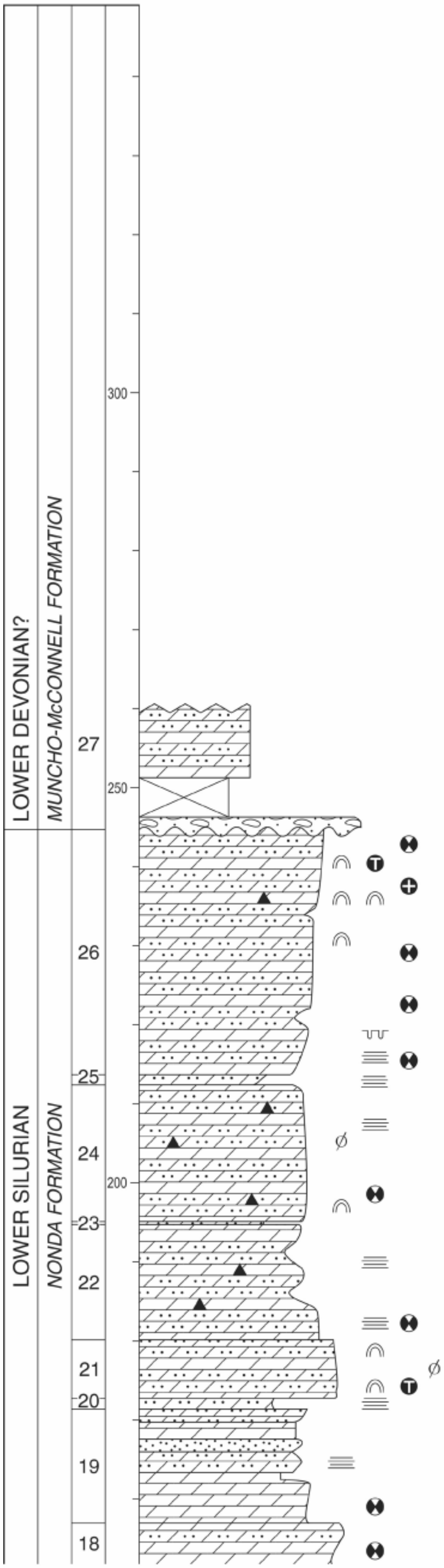
**Unit 5** (3.4–5.8 m): Quartz sandstone; very fine to fine crystalline; dark grey, weathers dull yellow-grey, contains orange-brown impurities; bedding thickness 15–60 cm, poorly developed bedding, rare argillaceous partings

**Units 1–4** (0.0–3.4 m): Unit 1 (0.0–0.5 m): Dolomitic quartz sandstone with irregular dark grey argillaceous partings; bedding thickness 3–15 cm. Unit 2 (0.5–1.2 m): Shale: dark grey; grades up into unit 3. Unit 3 (1.2–1.8 m): Dolomitic quartz sandstone containing 35%, dark grey, shaly mudstone laminae and irregular partings; grades up into unit 4. Unit 4 (1.8–3.4 m): Shale: dark grey

**Pre-unit 1:** Kechika Formation (74 m thick), uppermost beds are silty dolostone. Silty dolostone: very fine to fine crystalline; dark brown-grey and dark grey, weathers dark yellow-orange and yellow-brown; bedding thickness 3–8 cm, irregular lamination. Contact is poorly exposed, apparently concordant. Beds underlain by 77 m of quartz sandstone that rests unconformably on ?Precambrian rocks

**Figure A34.** Racing River (note Norford et al., 1967, p. 508).

RACING RIVER SECTION, page 2 of 2




**Unit 27** (244.8–end of section): Silty dolostone and conglomerate. Silty dolostone: very fine to medium crystalline; grey, weathers light grey and yellow-grey; bedding thickness 8-30 cm, well developed, some beds laminated; contains 5% quartz silt. Conglomerate: 20% medium crystalline quartz sandstone matrix; bedding thickness around 2 m; pebbles and cobbles of chert and silicified stromatoporoids, grades up into quartz sandstone

**Unit 26** (213.7–244.8 m): Silty dolostone and dolostone. Silty dolostone: very fine crystalline to medium crystalline; dark grey and dark brown-grey, weathers dark grey, dull grey, dull brown olive-grey, and dull brown-grey; bedding thickness 30 cm to 3 m, at 142.3–234.7 m bedding thickness 15–46 cm, at 218 m many rocks have coarse poorly developed lamination; contains 20% silicified stromatoporoids at 242.6–242.9 m, 234.7–237.7 m, and 232.3–233.5 m; patches and layers of quartz sand at 239.6 m, irregularly and coarsely mottled in bottom third of unit, contains 3% calcite vugs and stringers at 214.9 m, elsewhere sparse coarse crystalline calcite-filled vugs. Dolostone: microcrystalline to very fine crystalline; dark brown-grey, weathers dull grey and dull brown olive-grey; bedding thickness > 2 m, sparse calcite-filled vugs; 10% irregular silicification at 224.6–224.9 m. Erosion surface below Unit 27 cuts down 1 m in 18 m laterally

**Unit 25** (212.4–213.7 m): Very silty dolostone; microcrystalline to very fine crystalline; dark grey, weathers light grey and yellow-grey; bedding thickness 8–60 cm, some beds laminated

**Unit 24** (195.1–212.4m): Dolostone and silty dolostone. Dolostone: medium crystalline; dark brown-grey, weathers full grey and dark grey; bedding thickness > 2 m, rare lamination on weathered surfaces; contains 3% chert at 202.1–202.2 m, enormous coarse crystalline calcite-lined drusy cavities at 204.8–208.2 m. Silty dolostone: fine crystalline; dark grey, weathers dull dark grey and dark brown-grey; bedding thickness > 2 m, contains 5–8% calcite-filled small vugs and stringers

**Unit 23** (194.8–195.1 m): Very silty dolostone; microcrystalline to very fine crystalline; dark grey, weathers yellow-grey; bedding thickness 8–15 cm; laminated and recessive

**Unit 22** (180.1–194.8 m): Silty dolostone; very fine to fine crystalline; dark grey, weathers dull grey, brown-grey, dark grey, and dull olive-grey; bedding thickness 30 cm to 2 m, some beds laminated, poorly developed lamination at 186.8 m, very rare calcite vugs; no silicification

**Unit 21** (172.8–180.1 m): Silty dolostone; very fine crystalline; dark brown-grey, weathers dull dark grey; bedding thickness > 2 m, sparse drusy cavity porosity at 178.6–179.8 m; contains 3% stromatoporoids; 20% irregular argillaceous silicification of rock

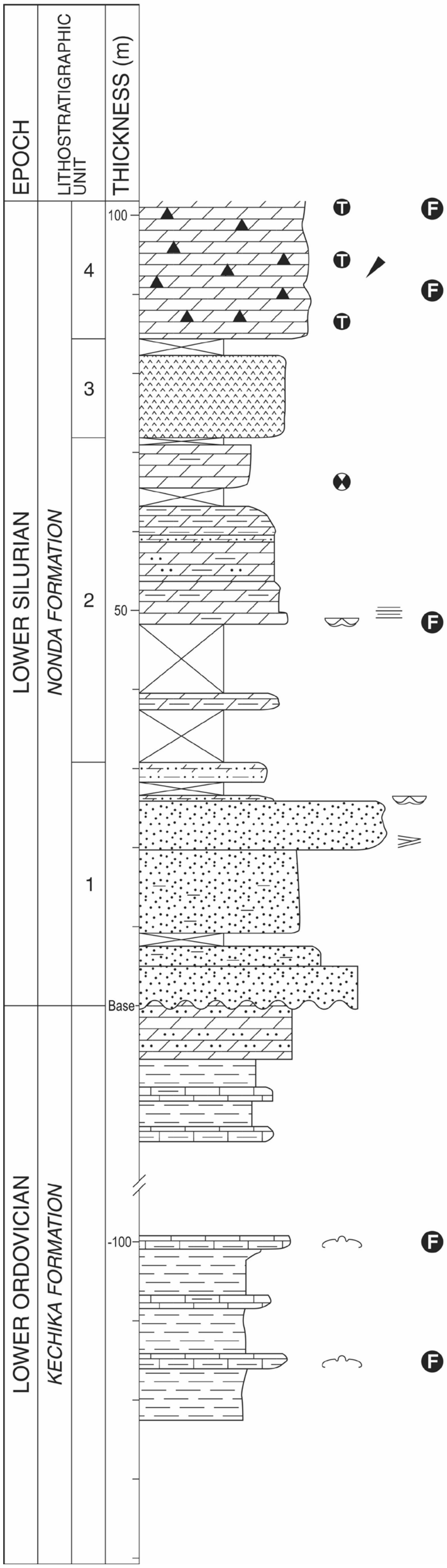
**Unit 20** (171.3–172.8 m): Silty dolostone; very finely crystalline; dark grey, weathers dark dull brown-grey and yellow-grey; bedding thickness 5–20 cm, most beds laminated, barren and recessive, dolomite stringers present

**Unit 19** (157.0–171.3 m): Silty dolostone and dolostone. Silty dolostone: microcrystalline to very fine crystalline; brown-grey, weathers light grey; bedding thickness 15–60 cm, well developed bedding; contains 8% quartz sand, rock contains no quartz sand from 167.3–170.7 m, at 170.7–171.3 m quartz sand makes up 10% of dolostone, quartz sandstone layer within bed at 166.7–166.8 m, very silty dolostone and dolomitic quartz sandstone laminae at 167.3–165.8 m, recessive light-grey-weathering dolostones at 162.5–163.4 m. Dolostone: microcrystalline to very fine crystalline; dark grey, weathers light grey; bedding thickness 30–90 cm, well developed bedding, rare coarse crystalline calcite-filled vugs

**Unit 18** (122.8–157.0 m): Dolostone and silty dolostone. Dolostone: very fine crystalline; dark brown-grey and dark grey, weathers dull dark grey, grey, and dark grey; bedding thickness 30 cm to 3 m, at top of unit rock contains 2% coarse crystalline calcite-filled vugs (leached on weathered surfaces), at 144.8–151.2 m contains 5% irregular silicification and chert nodules; stromatoporoids make up 0.5% of rock at 129.5–131.7 m; slightly silty at top of unit. Silty dolostone: very fine crystalline; dark grey, weathers dark grey and dull grey; bedding thickness 1–3 m, contains 2% irregular chert nodules and silicification; at 137.2–140.2 m, 2–5% of rock with irregular silicification

**Figure A34. (Cont.)** Racing River (note Norford et al., 1967, p. 508).

## LUE CREEK SECTION, SECTION #123




**Unit 4** (84.4–117.3 m): Dolostone; very fine to fine crystalline; grey, and light grey, weathers dark grey, dull grey, dull dark grey, and light grey, mottled around 108 m; bedding thickness 30 cm to over 2 m, chert nodules; *Favosites* and *Cystihalysites* present
O-45526 (100.9–105.5 m)
O-45529 (90.5–91.4 m)

**Unit 3** (71.9–84.4 m): Igneous rock; upper and lower contacts concealed

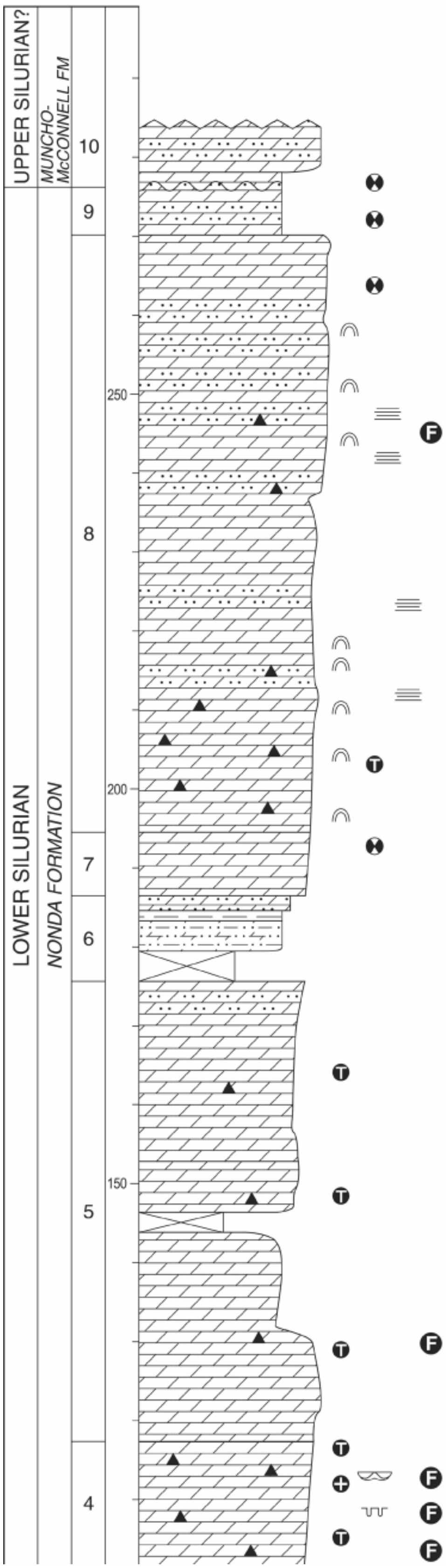
**Unit 2** (30.8–71.9 m): Silty dolostone and argillaceous dolostone. Silty dolostone: very fine crystalline; dull grey, weathers blue-dull grey; bedding thickness 8–90 cm. Argillaceous dolostone: microcrystalline to medium crystalline; dark grey, light grey, and grey, weathers dull dark grey, brown-grey, blue dull-grey, blue brown-grey, and yellow-brown; bedding thickness 5–90 cm, around 48 m some lamination and poorly developed bedding, dolomite stringers and vugs around 66 m; pentamerids present
O-45591 (48.5–49.1 m)

**Unit 1** (0.0–30.8 m): Quartz sandstone and dolomitic siltstone. Quartz sandstone: grey-white, grey, dark grey, and off-white, weathers off-white, yellow, brown-white, yellow-brown, and orange-grey; bedding thickness 60 cm to 3 m; locally argillaceous. Dolomitic siltstone: green-grey, weathers blue-grey and black-grey. Basal erosion surface about 5 cm deep

**Pre-unit 1:** Discontinuous outcrop below zero: silty dolomites at top, underlain by argillaceous limestones, shales, and limestones. Silty dolostone: very fine crystalline; dull dark grey, weathers blue-grey and yellowish-brown; bedding thickness 8–45 cm
O-45534 (-100 m), *Bellefontia* and *Xenostegium*
O-45535 (-115 m), *Bellefontia*

**Figure A35**. Lue Creek.

## LUE CREEK SECTION, page 2 of 2




**Unit 10** (276.1–end of section): Silty dolostone; very fine crystalline; light pink-tinged grey, weathers light grey and light buff; bedding thickness 15–45 cm; erosion surface between Units 9 and 10 is 45 cm deep. Approximate top of exposed outcrop section at about 400 m and is faulted against Nonda Formation rocks

**Unit 9** (270.1–276.1 m): Silty dolostone; very fine crystalline; dull grey and grey, weathers dull grey and buff-grey; bedding thickness over 2 m, calcite vugs throughout

**Unit 8** (194.6–270.1 m): Dolostone and silty dolostone. Dolostone: fine crystalline to coarsely crystalline; grey, light grey, dull dark grey, dark grey, and brown-grey, weathers grey, dull grey, dull dark grey, and dark grey; bedding thickness 30 cm to 3 m, rare lamination around 244 m. Silty dolostone: very fine crystalline to coarsely crystalline; grey, dark grey and light grey, weathers grey, dull grey, and dark grey with stains; bedding thickness 30 cm to 3 m, laminated, calcite vugs around 264 m; abundant stromatoporoids at 250–260 m
O-45530 (245.1–246.3 m)

**Unit 7** (186.5–194.6 m): Dolostone; microcrystalline to very fine crystalline; weathers dark grey and grey; bedding thickness over 2 m, white calcite vugs present

**Unit 6** (175.7–186.5 m): Silty to very silty dolostone and dolomitic siltstone. Silty to very silty dolostone: very fine crystalline; dark grey, weathers grey and dark grey; bedding thickness over 2 m, a few dolomite stringers at bottom of unit. Dolomitic siltstone: light grey, weathers light grey; bedding thickness 30–60 cm

**Unit 5** (117.3–175.7 m): Dolostone; microcrystalline to fine crystalline; dull grey, brown-grey, blue-grey, light grey, and grey, weathers dull brown-grey, dark grey, grey, light grey, and pale yellowish-grey; bedding thickness 30 cm to over 2 m; *Favosites* present; rare, dark dolomite interbeds at bottom third of unit; silty dolostones at top
O-45527 (129.8–132.0 m)

**Unit 4** (84.4–117.3 m): See previous page for description
O-45528 (112.8–118.3 m)
O-45532 (108.2–112.8 m)
O-45531 (103.6–108.2 m)

**Figure A35**. **(Cont.)** Lue Creek.

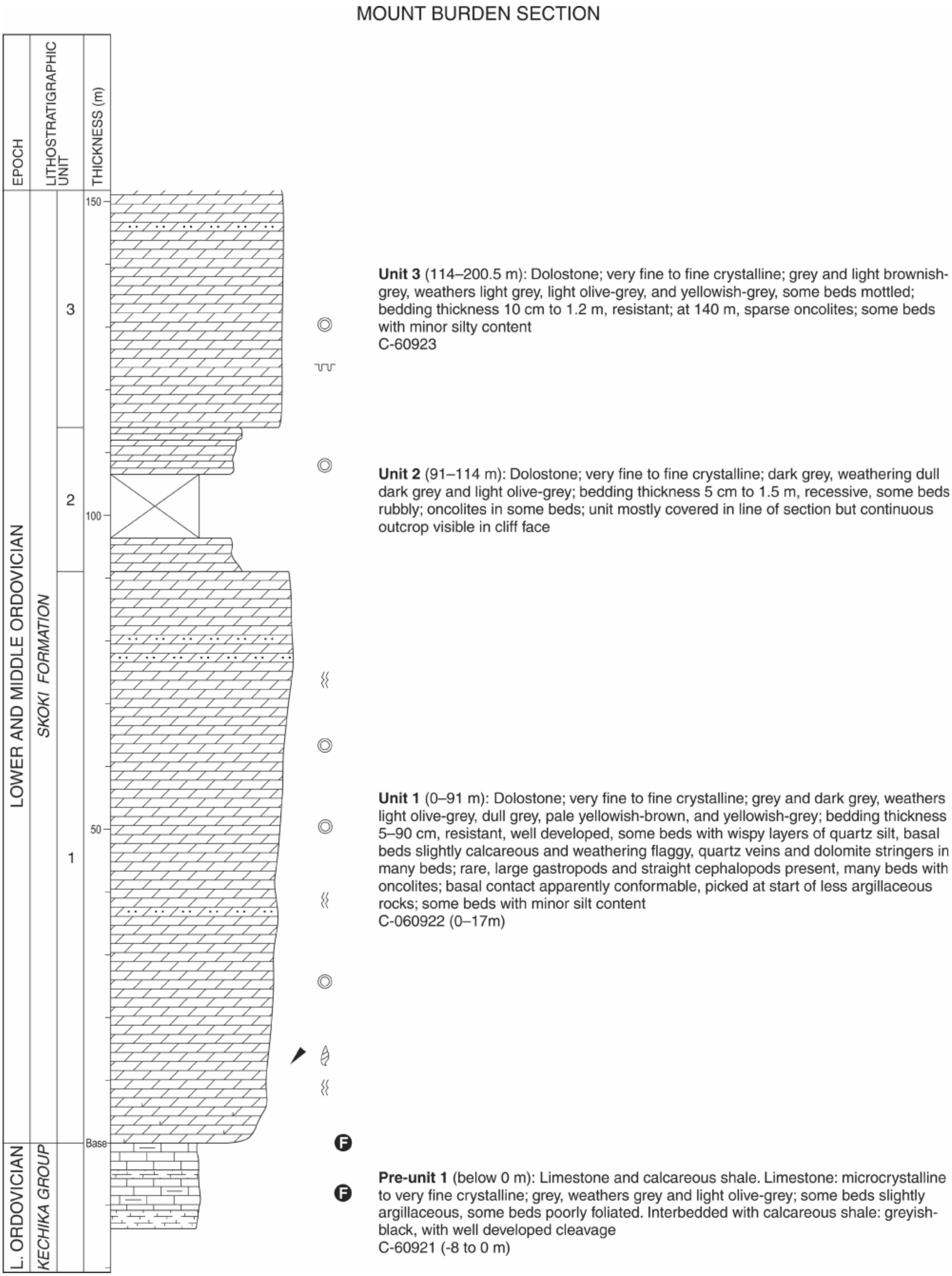
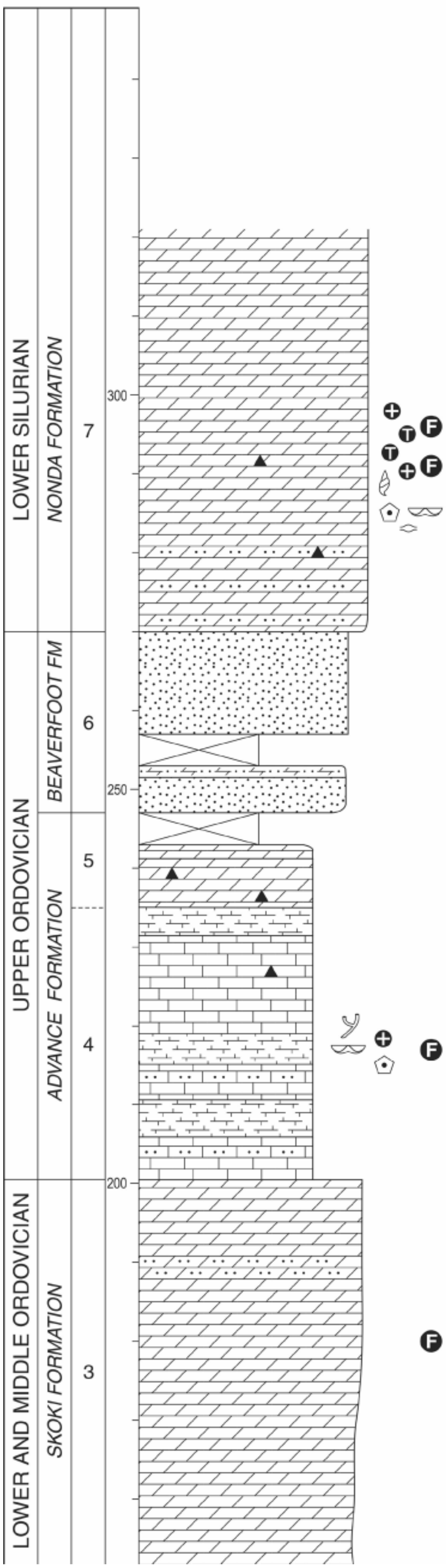



**Figure A36.** Mount Burden (note Norford, 1991, p. 51–52; 1996, p. 7, 15–17).

MOUNT BURDEN SECTION, page 2 of 2




**Unit 7** (270–321 m): Dolostone; extremely fine crystalline; dark grey and brownish olive-grey, weathers light grey, very pale orange, and pale yellowish-brown; bedding thickness 5 cm to 3 m, resistant except at base, some bedding planes stained red, with rare irregular silty partings in upper beds of unit, some beds weather blocky; some beds with minor silty content, contains abundant quartz silt and sand as wispy layers at 269.5–279.5 m, contains 1% shaly interbeds in basal 15 m of unit, contains 1–5% greyish-black chert nodules at 285.5–305.5 m, at 281.5–285.5 m dolostones are light grey, recessive, platy and nodular basal contact concordant, arbitrarily picked above quartz sandstone and sandstone
C-60926 (296–296.5 m)

**Unit 6** (247–270 m): Quartz sandstone, dolomitic quartz sandstone, and dolomitic quartz siltstone. Quartz sandstone and dolomitic quartz sandstone: fine to coarse-grained; olive-grey and very light brownish-grey, weathers light brownish-grey and orange-grey; bedding thickness 5–90 cm, some beds friable; minor shale interbeds. Dolomitic quartz siltstone (251.0–252.5 m): olive-grey, weathers yellowish-brown; thin-bedded. *Receptaculites* sp. at 247.5 m; basal contact concordant but not exposed; covered interval at 252.5–256.5 m

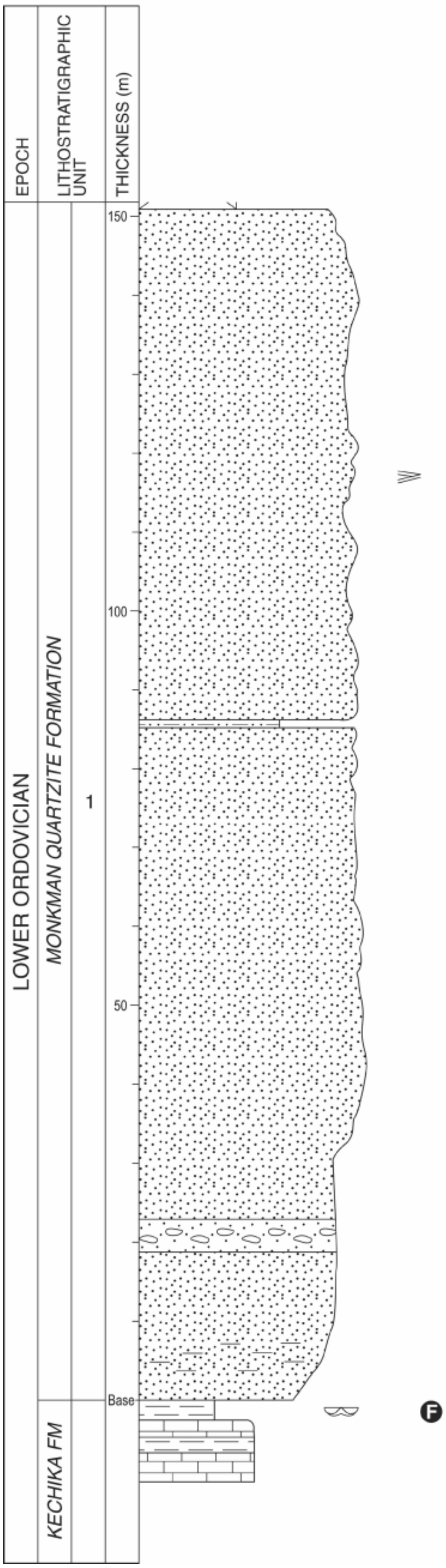
**Unit 5** (235–247 m): Dolostone; extremely fine crystalline; dark grey, weathers light olive-grey, light grey, and very pale yellowish-brown; bedding thickness 5–15 cm, undulatory, some bedding planes have red stains, some beds weather rubbly, at 234.5–235.2 m greyish-black chert nodules common; most beds with silty and argillaceous content, less than 5% shaly interbeds, covered interval at 242.5–246.5 m basal contact gradational with Unit 4

**Unit 4** (200.5–235 m): Limestone and calcareous shale. Limestone: extremely fine crystalline; dark grey, weathers yellowish-grey and olive-grey; bedding thickness 2.5–15 cm, recessive, somewhat nodular; some beds dolomitic, many beds with argillaceous and silty content. Calcareous shale: dark grey and dark olive-grey, weathers dark grey; recessive, at 226.5–228.5 m, preponderant in basal beds, gradually less significant upward and amounting to 3% of uppermost beds. greyish-black chert nodules make up 10% of beds. Basal contact concordant, but not accessible for detailed examination
C-60924

**Unit 3** (114–200.5 m): See previous page for description
C-60923 (180–194 m)

**Figure A36. (Cont.)** Mount Burden (note Norford, 1991, p. 51–52; 1996, p. 7, 15–17).

MOUNT HUNTER SECTION

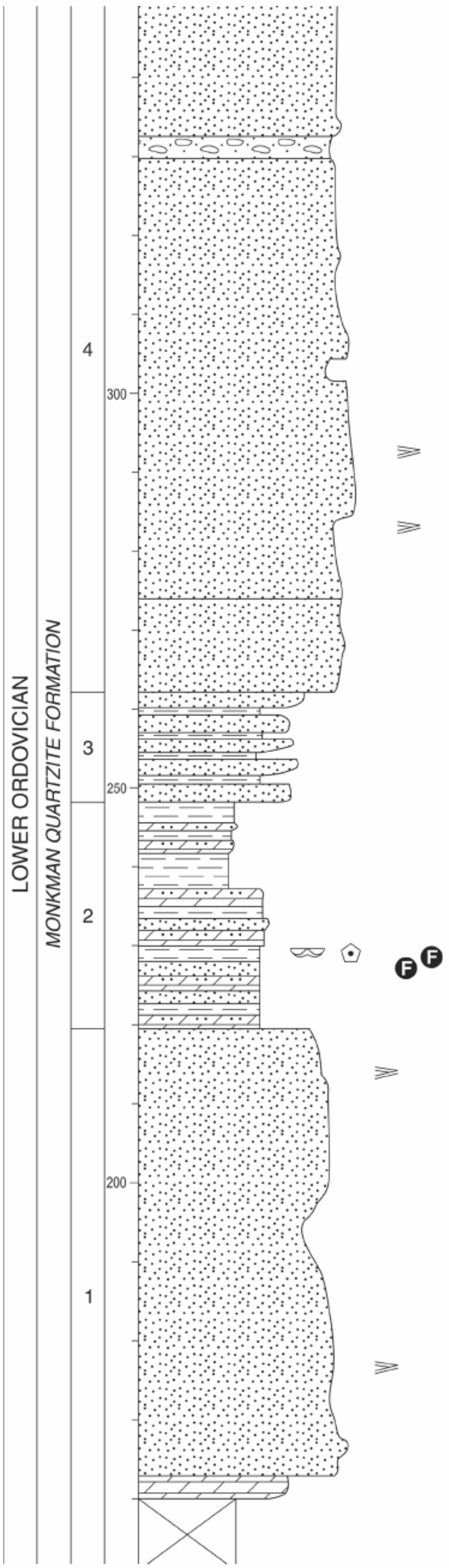



**Unit 1** (0.0-219.5 m): Quartz sandstone, sandstone, dolostone, and argillite. Quartz sandstone: fine- to medium-grained, well rounded and well sorted grains; light brown-grey, light greyish white, off-white, weathers off-white, yellow-brown, brown-white, light brown-grey, light brown-white, lichens around 76 m; bedding thickness 1 cm to 3 m, contains less than 5% shale partings at bottom of unit, rare crosslamination; conglomerate beds around 24 m, 30 cm thick argillite and conglomerate bed at 96 m. Sandstone (218.8–219.5 m): medium- to coarse-grained; weathers light brown; crosslaminated. Dolostone: very fine to fine crystalline; dark grey, weathers grey; bedding thickness 30–90 cm. Basal contact with Pre-Unit 1 conformable

**Pre-Unit 1** (below 0 m): Limestone and shale. Shale: green-grey, weathers brown-grey
O-45285 (-1.5–0 m)

**Figure A37.** Mount Hunter (note Norford 1965, p. 46, 47).

MOUNT HUNTER SECTION, page 2 of 7




**Unit 4** (262.1–463.3 m): Quartz sandstone and siltstone. Quartz sandstone: very fine- to coarse-grained, well rounded and well sorted grains; off-white, light yellow-white, weathers off-white, light orange-brown, and light yellow-grey; bedding thickness 15 cm to >2 m, rare lamination and crosslamination; conglomerates from 332–333 m, interval from 451–457 m is poorly exposed

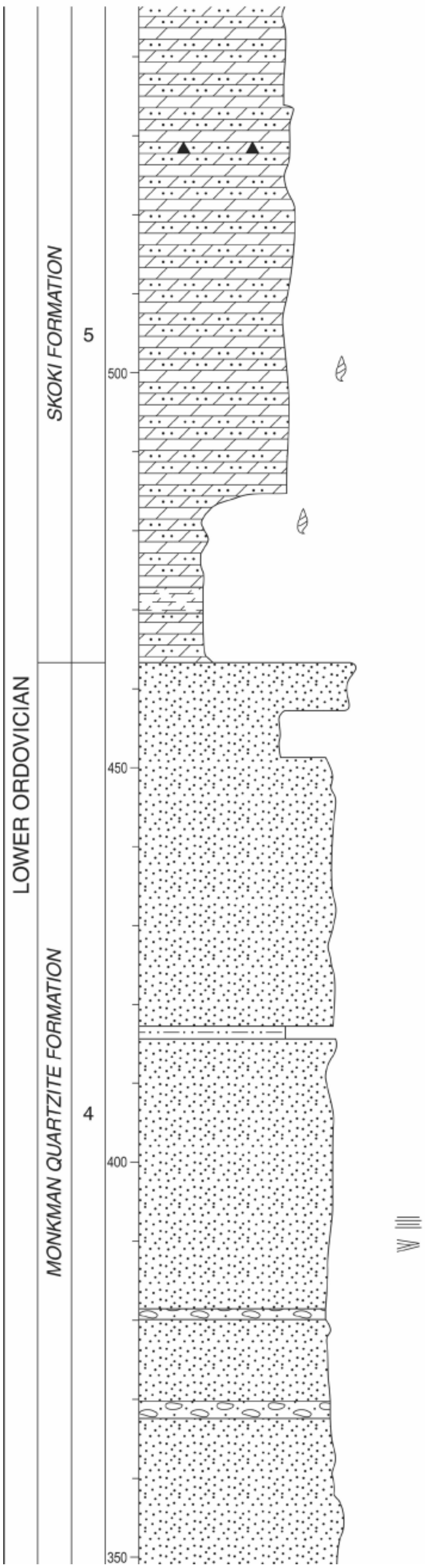
**Unit 3** (248.1–262.1 m): Quartz sandstone and sandstone with shale interbeds. Quartz sandstone: light yellow-grey, weathers light brown and light grey; bedding thickness 15–45 cm; contains up to 5% black shale interbeds. Sandstone: fine- to coarse-grained; light buff, weathers fleshy yellow-brown; contains black shale interbeds

**Unit 2** (219.5–248.1 m): Silty dolostone, shale, and sandstone. Silty dolostone: very fine crystalline; grey, weathers yellow-grey; bedding thickness 15–60 cm, contains argillaceous partings. Sandstone: locally silty
O-45282 (228.6–243.8 m)
O-45283 (227.1–231.6 m)

**Unit 1 (**0.0–219.5 m): See previous page for description

**Figure A37. (Cont.)** Mount Hunter (note Norford 1965, p. 46, 47).

MOUNT HUNTER SECTION, page 3 of 7

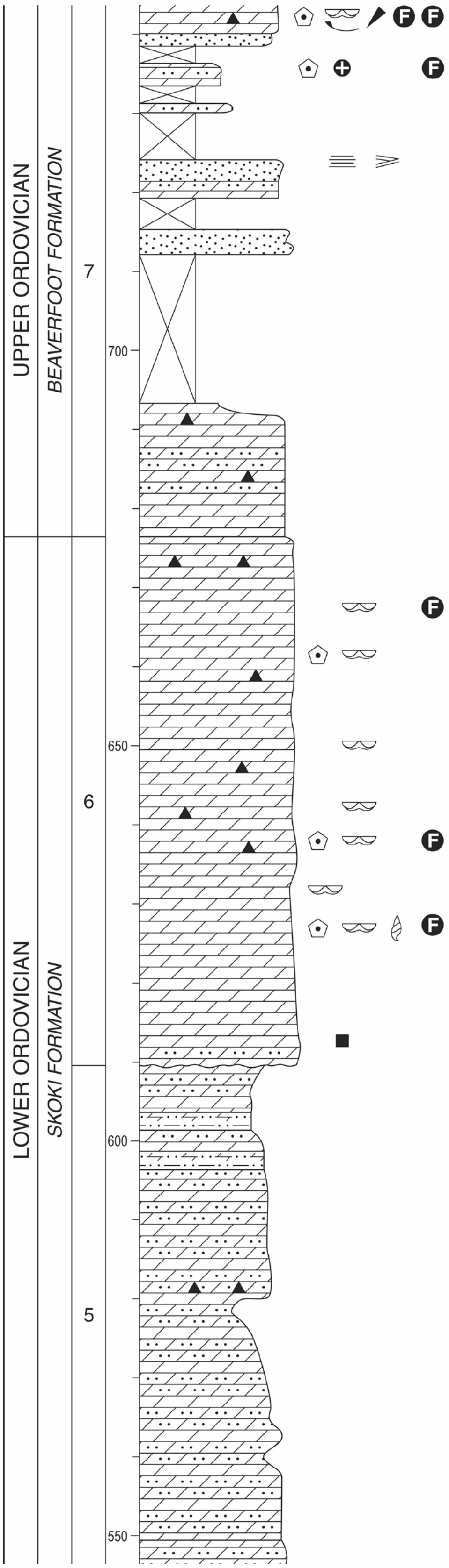



**Unit 5** (463.3–609.6 m): Silty dolostone, siltstone, and dolomitic shale. Silty dolostone: microcrystalline to fine crystalline; dark grey, grey, light grey, and dull grey, weathers yellow-grey, dull grey, dark yellow-grey, and black-grey; bedding thickness 3 cm to 2 m, locally argillaceous, contains some sand grains around 564 m; weathers rubbly from 521–570 m, bedding attitude 123/52W; ghost gastropods at 497 and 512 m, borings immediately beneath erosion surface at top of unit; siltstone: 20% of rock is dolomitic and argillaceous

**Unit 4** (262.1–463.3 m): See previous page for description

**Figure A37. (Cont.)** Mount Hunter (note Norford 1965, p. 46, 47).

MOUNT HUNTER SECTION, page 4 of 7



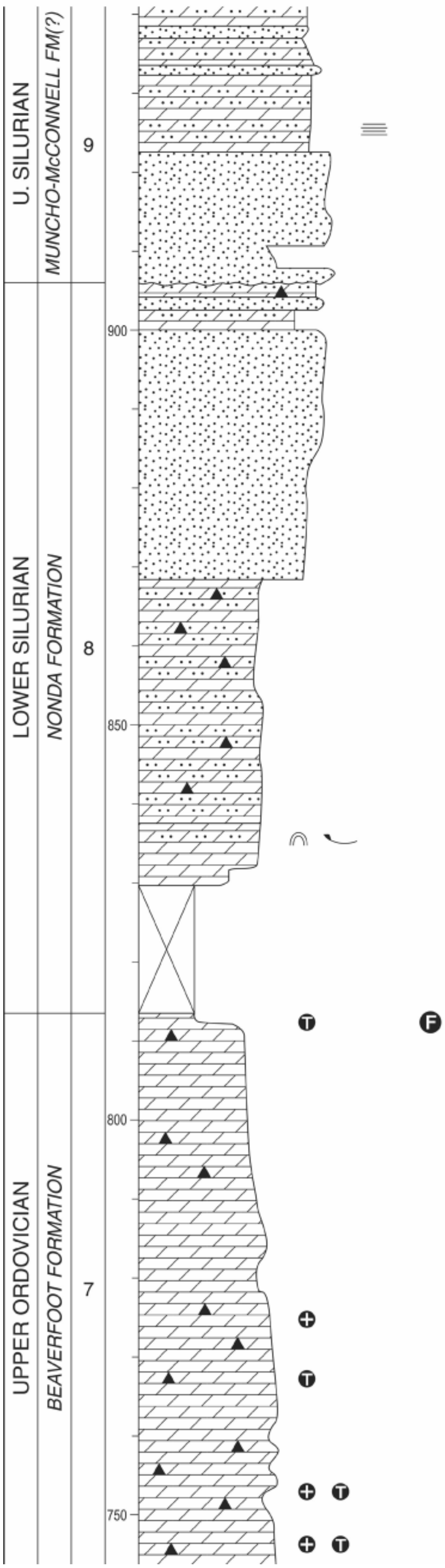

**Unit 7** (676.4–813.5 m): Dolostone, silty dolostone, and quartz sandstone. Dolostone: microcrystalline to fine crystalline; dark grey, grey, light grey, and grey, weathers dull grey, light grey, grey, and light yellow-grey; bedding thickness 9 cm to 2 m, well developed at base of unit; contains up to 10% chert around 747 m. Silty dolostone: microcrystalline to fine crystalline; grey, weathers dull grey and light yellow-grey; bedding thickness 3–30 cm; well-preserved echinoderm fragments; contains rare chert around 684 m. Quartz sandstone: white-grey, weathers light yellow-grey, and off-white; bedding thickness 9–30 cm, common lamination and cross lamination; contains some dolomite/silica cement. Black shaly talus on adjacent ridge
O-45279 (742.2–745.2 m), includes *Aulacera* and *Lobocorallium*
O-45519 (742.2–745.2 m), includes *Aulacera* and *Lobocorallium*
O-45513 (735.8–736.4 m), includes *Pleurocystites*

**Unit 6** (609.6–676.4 m): Dolostone; microcrystalline to fine crystalline; grey, light grey, and dark grey, weathers grey and yellow-grey; bedding thickness 30 cm to >2 m, weathers to thin beds around 646 m, <20 cm deep; slightly silty at bottom of unit, contains rare chert (<1%), contains pockets with pyrite at base of unit. Basal erosion surface with Unit 5 about 20 cm deep
O-45284 (667.5–672.1 m)
O-45515 (637.0–641.6 m), includes *Orthambonites* and *Blastoidocrinus*
O-45514 (627.3–630.3 m), includes *Orthambonites* and *Blastoidocrinus*

**Unit 5** (463.3–609.6 m): See previous page for description

**Figure A37. (Cont.)** Mount Hunter (note Norford 1965, p. 46, 47).

MOUNT HUNTER SECTION, page 5 of 7



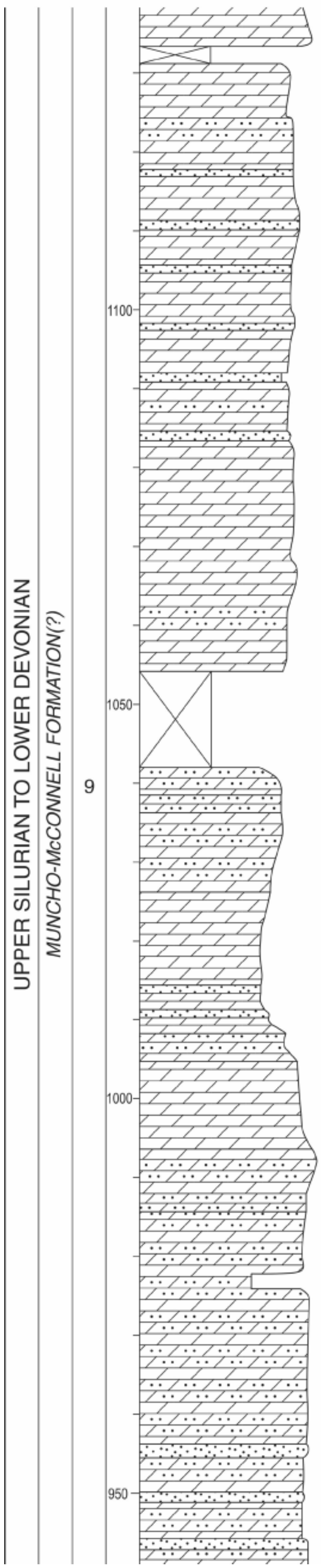

**Unit 9** (906.0–1474.6 m): See next page for description

**Unit 8** (813.5–906.0 m): Silty dolostone, dolostone, quartz sandstone, and sandstone. Silty dolostone: microcrystalline to very fine crystalline; grey, and dark grey, weathers yellow-grey, dull grey, light grey, and light yellow-grey; bedding thickness 9–90 cm; 15 cm deep erosion surface at 906 m. Dolostone: microcrystalline to very fine crystalline; grey and dark grey, weathers light yellow-grey, grey, and light grey; bedding thickness 15–90 cm; slightly silty around 838 m. Quartz sandstone: fine- to medium-grained; light yellow-white and off-white, weathers off-white and white; bedding thickness 30 cm to 3 m; contains rare amethysts (up to 1%). Sandstone: light grey, weathers yellow-grey and brown-grey; bedding thickness 15–45 cm, laminated and crosslaminated

**Unit 7** (676.4–813.5 m): See previous page for description
O-45281 (812.3 m)

**Figure A37. (Cont.)** Mount Hunter (note Norford 1965, p. 46, 47).

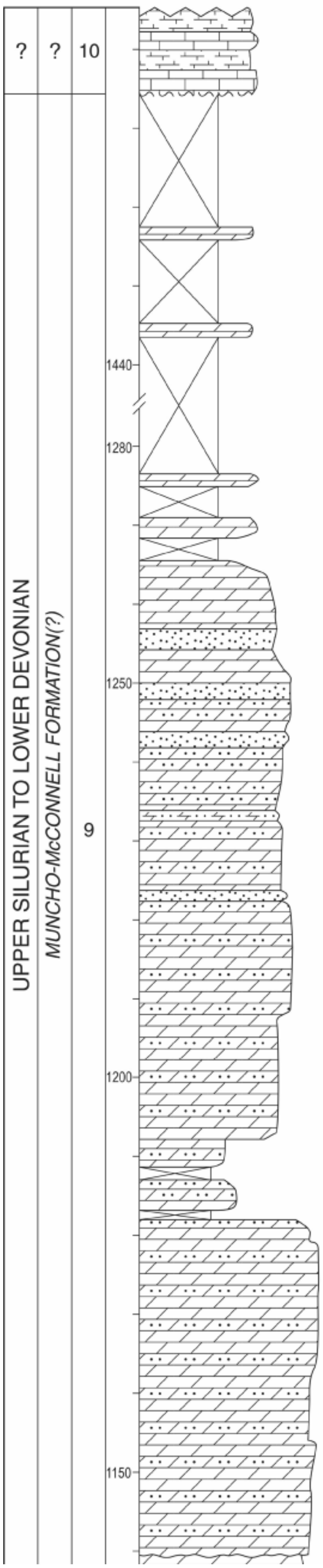
MOUNT HUNTER SECTION, page 6 of 7




**Unit 9** (906.0–1474.6 m): Silty dolostone, dolostone, and dolomitic siltstone. Silty dolostone: microcrystalline to fine crystalline; light grey, grey, dark grey, weathers light grey, light yellow-grey, white-grey, yellow-grey, and yellow-brown; bedding thickness 15 cm to >2 m; contains 2–40% sandstone beds, up to 5% dark grey dolostone beds around 1213 m. Dolostone: microcrystalline to fine crystalline; light grey, dark grey, grey, light brown-grey, weathers light grey, dull grey, yellow-grey, and white-grey; bedding thickness 8 cm to 3 m; contains 5–15% sandstone beds, very fine- to coarse-grained quartz sand makes up 70% of rock at 1087 m, at 1158 m rock contains up to 5% sand grains, 3 cm deep erosion surface at 1145 m. Dolomitic siltstone: light grey, weathers light yellow-grey; bedding thickness 9–30 cm. Large covered interval from 1276.5–1474.6 m, represented by outcrop for most of interval, in low ridge near valley floor

**Figure A37. (Cont.)** Mount Hunter (note Norford 1965, p. 46, 47).

MOUNT HUNTER SECTION, page 7 of 7




**Unit 10** (1474.6 end of section): Calcareous shale, limestone, and phyllites. Thrust fault postulated at 1474.6 m

**Unit 9** (906.0–1474.6 m): See previous page for description

**Figure A37. (Cont.)** Mount Hunter (note Norford 1965, p. 46, 47).

# An unnamed Proterozoic map unit, Pool Creek map area (NTS 95-C/5), southeasternmost Yukon

R.B. MacNaughton[1]

*MacNaughton, R.B., 2017. An unnamed Proterozoic map unit, Pool Creek map area (NTS 95C/5), southeasternmost Yukon; in Central Foreland NATMAP Project: Proterozoic to Devonian stratigraphic sections in British Columbia and Yukon, (ed.) L.S. Lane and R.B. MacNaughton; Geological Survey of Canada, Bulletin 603, p. 205–222. https://doi.org/10.4095/299867*

**Abstract:** An unnamed map unit in central Pool Creek map area (NTS 95-C/5) is dominated by green-weathering argillite with lesser sandstone and breccia. The map unit rocks were hornfelsed during emplacement of the Pool Creek syenite at ca. 640 to 650 Ma and thus it is Neoproterozoic or older. A detailed measured section through part of the unit documented three facies associations (FAs). The 'argillite FA' is dominated by hornfelsed siltstone and shale, with minor sandstone. Volumetrically, it is the most signiflcant of the three facies associations. The 'argillite and sandstone FA' contains the same rock types but a greater proportion of sandstone. Both facies associations were probably deposited mainly from turbidity currents, with lesser input from hemipelagic processes and sandy debris flows. In contrast, the 'breccia FA' consists of intraformational to basalt-clast breccia. It records deposition from debris flows. Soft-sediment deformation, including large-scale slump folding, is prevalent throughout the measured interval. The map unit was deposited on a deep-marine slope.

**Résumé :** Dans la partie centrale de la région cartographique de Pool Creek (feuillet 95-C/5 du SNRC), une unité cartographique non dénommée est composée principalement d'argilite à patine d'altération de couleur verte et d'une quantité moindre de grès et de brèche. Les roches de l'unité cartographique ont été transformées en cornéennes lors de la mise en place de la syénite de Pool Creek vers 650–640 Ma; cette unité date donc au moins du Néoprotérozoïque. Une coupe mesurée à l'échelle du détail qui recoupe une partie de l'unité rend compte de trois associations de faciès. L'« association de faciès à argilite » se compose surtout de siltstone et de shale ainsi que d'une faible quantité de grès transformés en cornéennes. D'un point de vue volumétrique, il s'agit de l'association de faciès la plus importante. L'« association de faciès à argilite et à grès » contient les mêmes types de roche, mais avec une plus grande proportion de grès. Le dépôt de ces deux associations de faciès s'est probablement effectué en grande partie par des courants de turbidité et, dans une moindre mesure, par des processus hémipélagiques et des coulées de débris sableuses. En revanche, l'« association de faciès à brèche » est constituée de roches fragmentaires allant d'une brèche intraformationnelle à une brèche à clastes de basalte. Le dépôt de ces roches se serait effectué par des coulées de débris. Dans tout l'intervalle mesuré, on constate l'existence généralisée d'une déformation de sédiments meubles, qui s'exprime notamment par des plis de glissement à grande échelle. L'unité cartographique s'est déposée sur un talus en milieu marin profond.

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# INTRODUCTION

This contribution provides detailed log and photographic documentation of a measured section through part of an argillite-dominated succession in Pool Creek map area (NTS 95-C/5; Figure 1). Douglas and Norris (1959; *see also* Douglas, 1976) recognized a map unit dominated by green-weathering argillite (their map unit 1) that was tentatively interpreted to be of Proterozoic age, possibly Helikian. During 2000–2001, mapping carried out by L.C. Pigage and T.L. Allen of the Yukon Geology Program (now the Yukon Geological Survey) as part of the Central Foreland NATMAP Project, clarified the distribution of this unit (Fig. 2) and its stratigraphic context (Allen et al., 2001; Pigage and Allen, 2001; Fallas et al., 2004). The unit is unnamed; herein, it is referred to as the 'argillite unit.'

The unit is best exposed along a ridge that lies above the treeline in the central part of Pool Creek map area (Fig. 3). As part of the mapping effort in this map area during 2000, the author spent two days measuring a detailed stratigraphic section (Fig. 4) through a reasonably well exposed part of the unit. A preliminary version of this stratigraphic section, without detailed notes, was published by Allen et al. (2001).

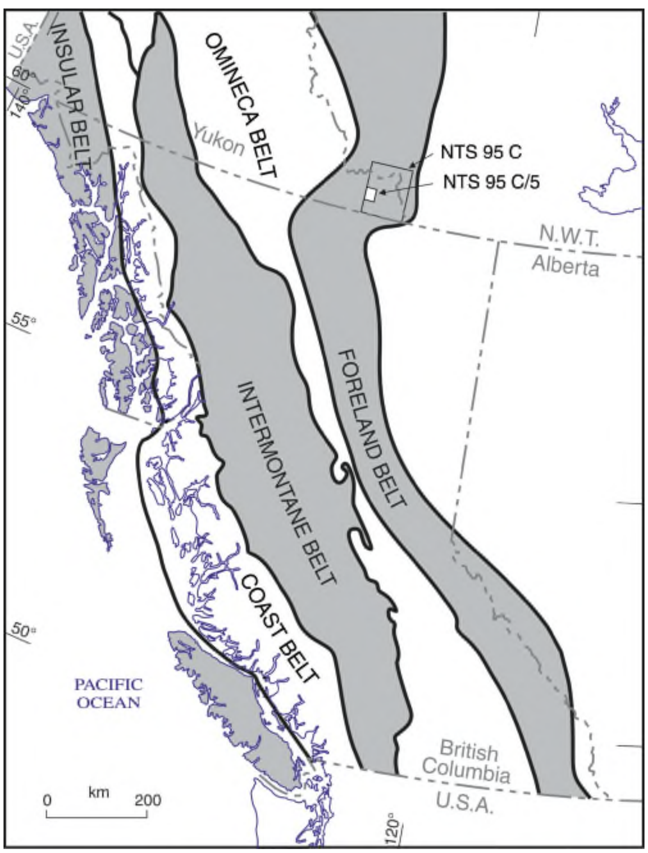



**Figure 1.** Position of study area within the Cordilleran foreland belt. La Biche River (NTS 95C) and Pool Creek (NTS 95C/5) map areas are labelled.

More recently, a detailed account of the sedimentology and regional significance of the argillite unit (MacNaughton et al., 2017) was based in large part on data from this section.

The base of the argillite unit has not been observed. The argillite unit is overlain by the Crow Formation (Pigage, 2009), a sandstone-dominated map unit that has yielded Tremadocian (Early Ordovician) to early Whiterockian (early Middle Ordovician) conodonts (GSC loc. C-417068; McCracken, 2003). Bedding in the argillite unit dips moderately to the northeast and southeast, defining a broad, open synform that plunges to the east-southeast (Fig. 2), whereas bedding in the overlying map unit dips roughly eastward (Fallas et al., 2004). Thus, the upper contact of the argillite unit is apparently an angular unconformity.

# AGE OF THE ARGILLITE UNIT

The Proterozoic age tentatively assigned to this unit by Douglas and Norris (1959) was based on lithological similarity between the unit and Proterozoic formations in Alberta, particularly the Appekunni Formation (Willis, 1902). Subsequent work has provided a more robust basis for dating the succession. An intrusion of unfoliated, coarsely crystalline nepheline syenite, known informally as the Pool Creek syenite (Harrison, 1982), crops out immediately north of the argillite unit (Fig. 2). Zircons from the Pool Creek syenite have yielded isotopic U/Pb dates that cluster around 640 to 650 Ma (Pigage and Mortensen, 2004). Both the argillite unit and an adjacent unit of Proterozoic sandstone and siltstone (Fig. 2; Fallas et al., 2004; Pigage 2009) have been hornfelsed. In addition, xenoliths of laminated argillite, which may have been derived from the argillite unit, have been observed within the Pool Creek syenite (D.W. Morrow, pers. comm., 2004). The nearby emplacement of an Eocene syenite seems not to have caused hornfelsing, because adjacent ?Cambrian–Ordovician and younger map units are unaffected. Thus the argillite unit is older than the Pool Creek syenite and must be of Neoproterozoic age or older. Detrital zircon data and lithostratigraphic considerations suggest that the argillite unit is correlative with the lower Windermere Supergroup (Pigage, 2009), possibly with non-glacial units of the Hay Creek Group (MacNaughton et al., 2017).

# LOCATION AND METHODOLOGY

The section (section MWB-00–21; Fig. 4, 5) was measured by Jacob's staff and was subdivided into units based on gross-scale variations in lithology. The base of the section is at co-ordinates 345620 E, 6695764 N (all co-ordinates given in this report are in UTM NAD 83). From its base, the section followed an irregular track to the southeast along the ridge, ending at co-ordinates 345903 E, 6695412 N. The quality of the outcrop was highly variable along the ridge and the section contained numerous covered or poorly exposed

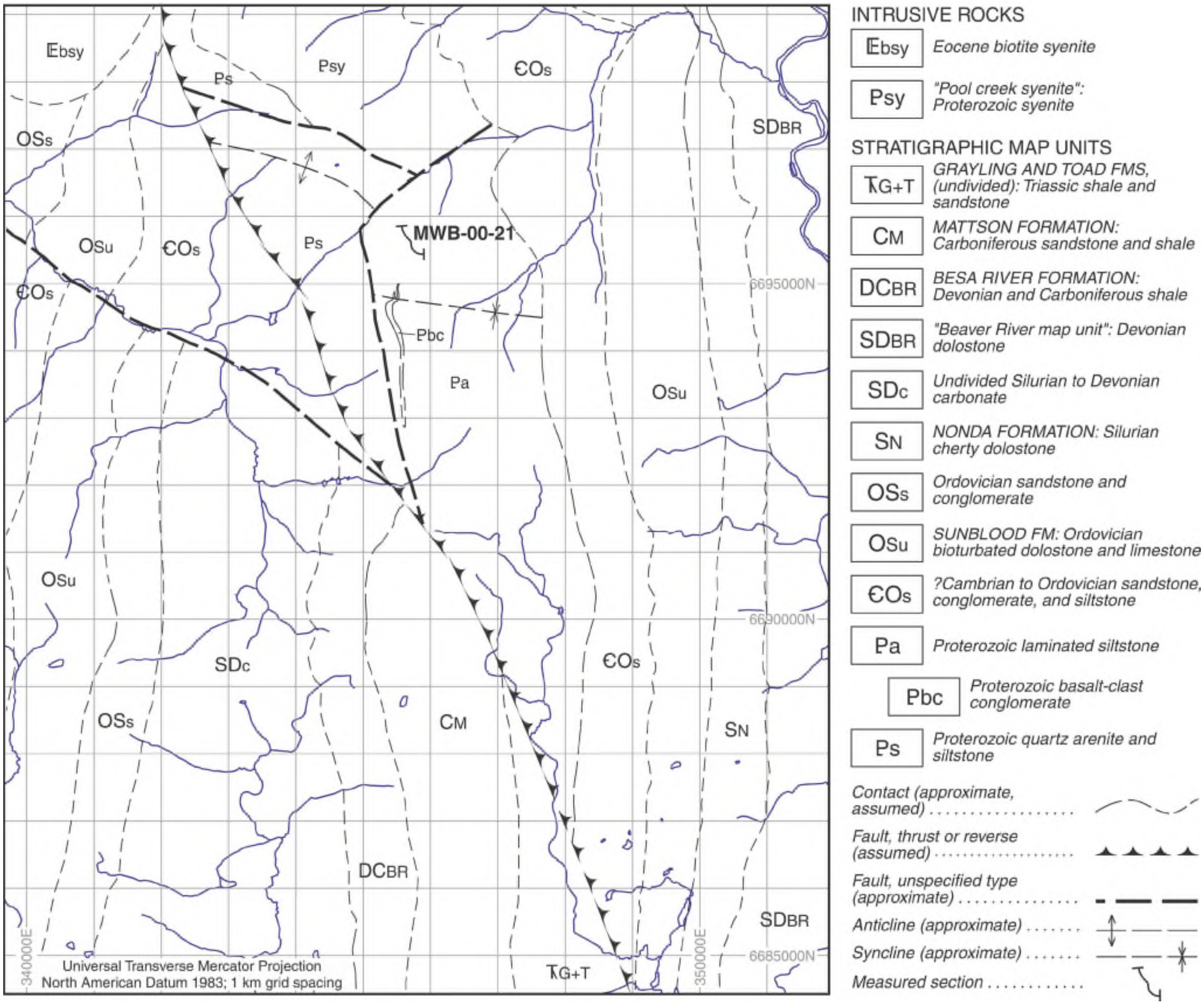



**Figure 2**. Simplified geological map of part of central Pool Creek map area; trace of section MWB-00-21 is labelled. The argillite unit is labelled as map unit Pa. Map unit Pbc is a locally mappable, red-weathering, basalt-clast conglomerate, possibly a submarine channel fill, which occurs within the argillite unit but was not encountered along the track of the measured section. Map modified after Pigage and Allen (2001) and Fallas et al. (2004).

**Figure 3**. Photograph of ridge along which section was measured. Oblique aerial view, looking westward. 2010-071

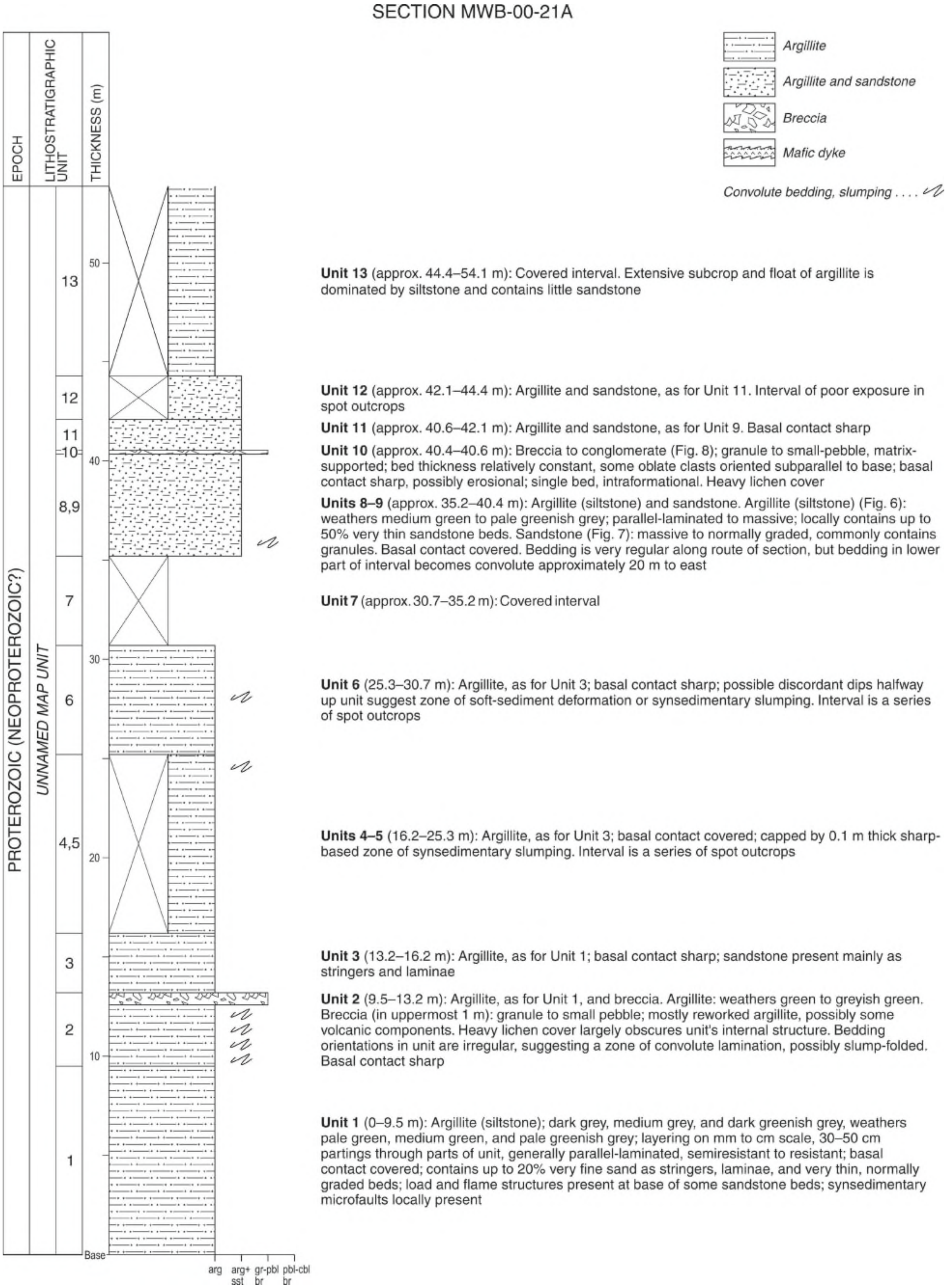
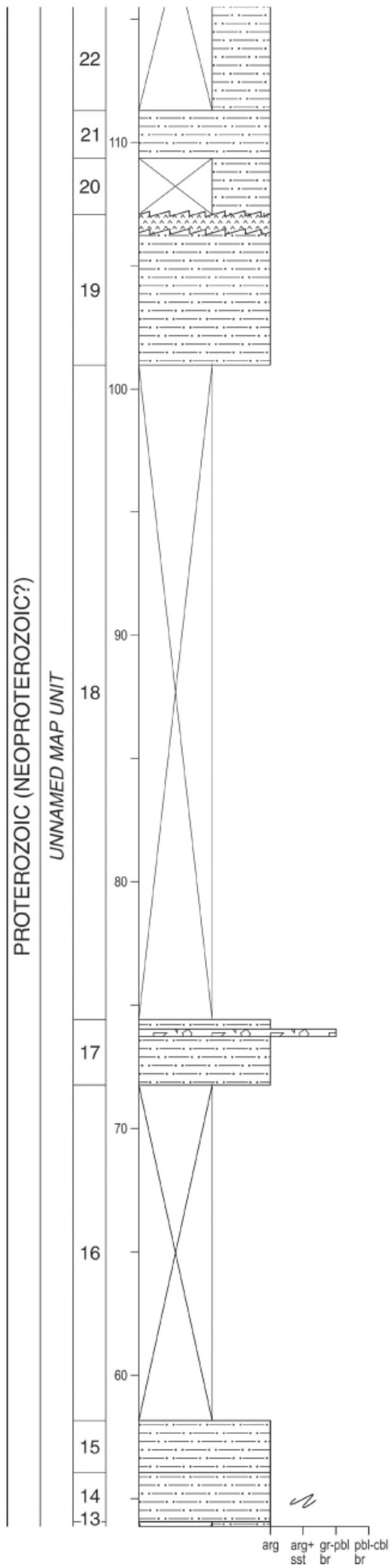



**Figure 4a.** Measured section (MWB-00–21A) through lower part of exposure of the argillite unit. Thicknesses for units 1 to 6 are considered accurate; those for units 7 to 30 should be considered approximate.

SECTION MWB-00-21A, continued




**Unit 22** (approx. 111.3–123.2 m): Covered interval. Argillite exposed in rare spot outcrops

**Unit 21** (approx. 109.3–111.3 m): Argillite; basal contact covered. Exposed in semiresistant outcrops

**Unit 20** (approx. 107.0–109.3 m): Argillite. Interval of poorly exposed spot outcrops

**Unit 19** (approx. 101.0–107.0 m): Argillite (siltstone); weathers light to medium green to greenish grey, locally weathers dark green; parallel-laminated; basal contact covered; contains normal-graded laminae and rare very thin beds of sandstone. Section is cut by NE–SW-trending mafic dyke at top of interval

**Unit 18** (approx. 74.5–101.0 m): Covered interval

**Unit 17** (approx. 71.8–74.5 m): Argillite and breccia. Argillite: contains minor sandstone. Breccia (approx. 0.5 m below top of unit): granule and small pebble size clasts; 0.2–0.3 m thick, massive; sharp-based; clast lithologies include intraclastic siltstone and mudstone, minor quartz sandstone, possibly very small clasts of mafic volcanic material. Basal contact covered

**Unit 16** (approx. 58.2–71.8 m): Covered interval

**Unit 15** (approx. 56.1–58.2 m): Argillite; basal contact gradational; contains < 20% sandstone as stringers or laminae, lithologically very similar to Unit 14 but lacks discordant dips

**Unit 14** (approx. 54.1–56.1 m): Argillite; basal contact covered; dominated by siltstone with lesser sandstone, locally convolute to discordant dips suggest presence of slumped intervals

**Unit 13** (approx. 44.4–54.1 m): Covered interval. Extensive subcrop and float of argillite is dominated by siltstone and contains little sandstone

**Figure 4b.** Measured section (MWB-00–21A) through lower part of exposure of the argillite unit. Thicknesses of numbered units should be considered approximate.

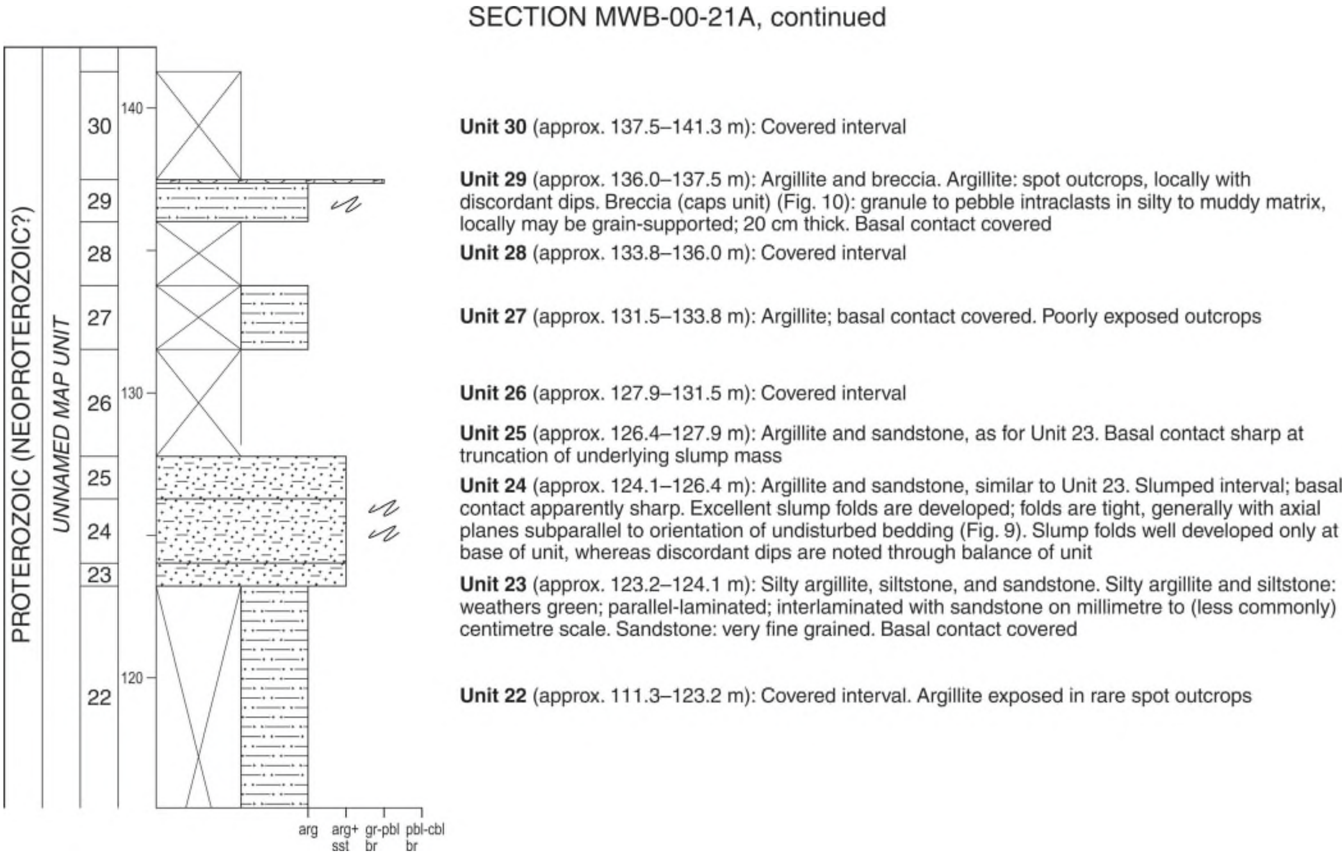



**Figure 4c.** Measured section (MWB-00–21A) through lower part of exposure of the argillite unit, continued. Thicknesses of numbered units should be considered approximate.

intervals. Additionally, even intervals of continuous outcrop were affected by very heavy lichen cover. It was necessary to offset the section track slightly several times, either by tracing bedding surfaces or by means of compass bearings. None of these offsets were sufficiently large to necessitate breaking the section into segments. Only two days were available to measure the section, necessitating rapid work. As a result, some unit descriptions are brief. Where intervals were better exposed, more detailed descriptions were recorded.

As a result of problems with the measurement of unit thicknesses in the lower part of MWB-00–21, the section is presented as two segments. The lower segment (MWB-00–21A) represents approximately 141.7 m of strata and is of reconnaissance quality. Thicknesses in the basal interval of the section (units 1–6; 30.7 m) are considered reliable. However, unit thicknesses through the balance of this segment are approximate. This part of the section should be used only as a guide to lithological composition and succession. The upper segment, MWB-00–21B, is 122.8 m thick. This thickness value is considered reliable within expected variation for a measured section. There is no unmeasured interval or offset of the section track associated with the break between the two segments. Unit numbers continue in series from MWB-00–21A into MWB-00–21B but, for accuracy, the running tally of unit thicknesses has been reset to 0 m at base of MWB-00–21B.

## DESCRIPTION OF SECTION

The detailed section from the argillite unit is presented in Figure 4 and 5. Figures 6 to 21 provide photographs of outcrops and polished slabs; references to these figures are found in Figures 4 and 5. The section comprises three facies associations (FAs), i.e. groupings of facies that are genetically related and that have some environmental significance (Collinson, 1969). The first, referred to in Figure 4 and 5 as the 'argillite FA,' is dominated by interlaminated to interbedded shale and siltstone that weather medium to dark green (shale) and pale green to greenish grey (siltstone). These lithofacies are massive, normal graded, or faintly parallel laminated. Laminae and very thin beds of very fine-grained sandstone are a minor component. The argillite FA corresponds to 'Facies association 1 (argillite)' in the sedimentological study of MacNaughton et al. (2017). (Note that those authors also subdivided their facies associations into several component lithofacies of mudstone, siltstone, and sandstone.)

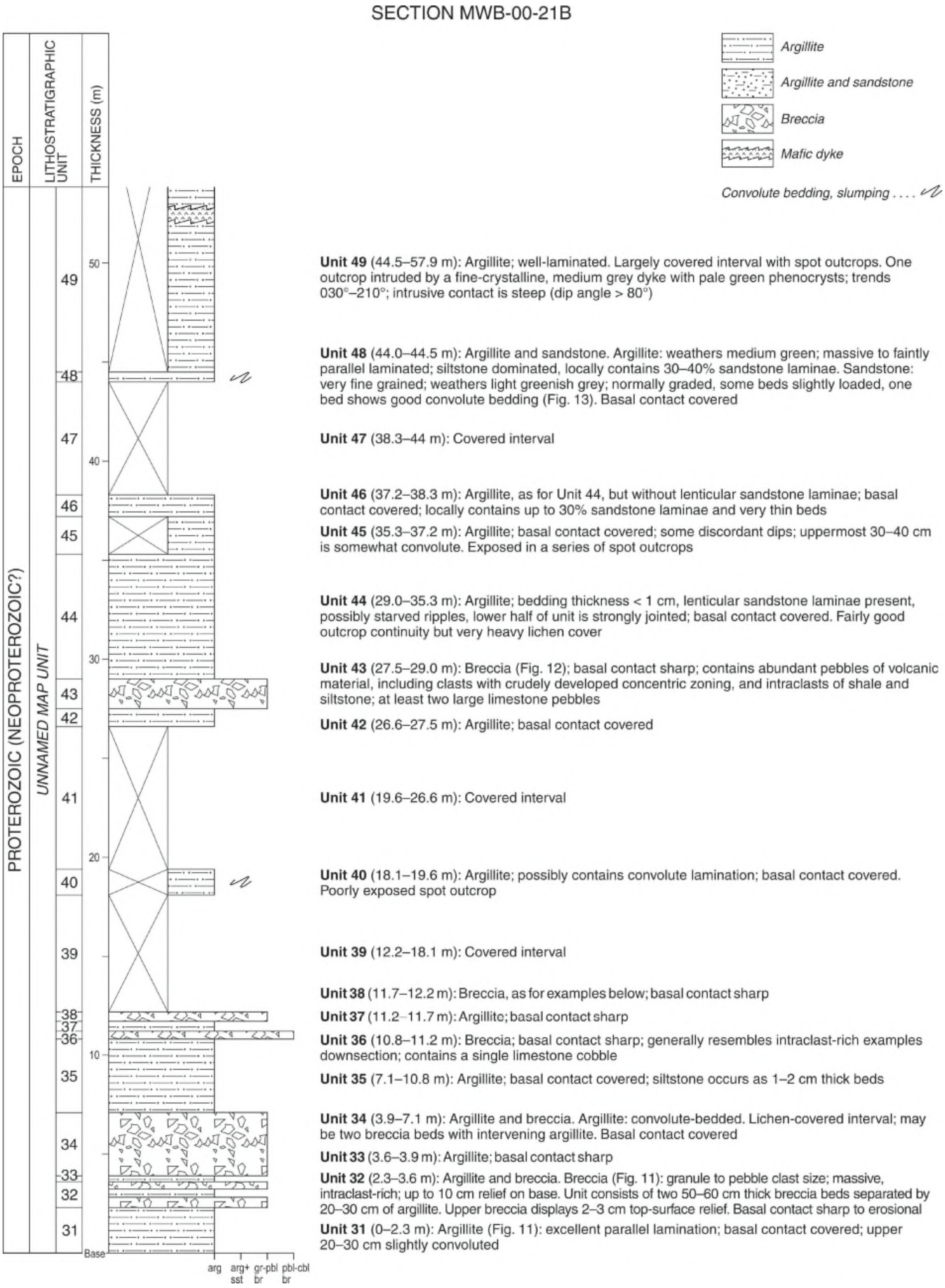
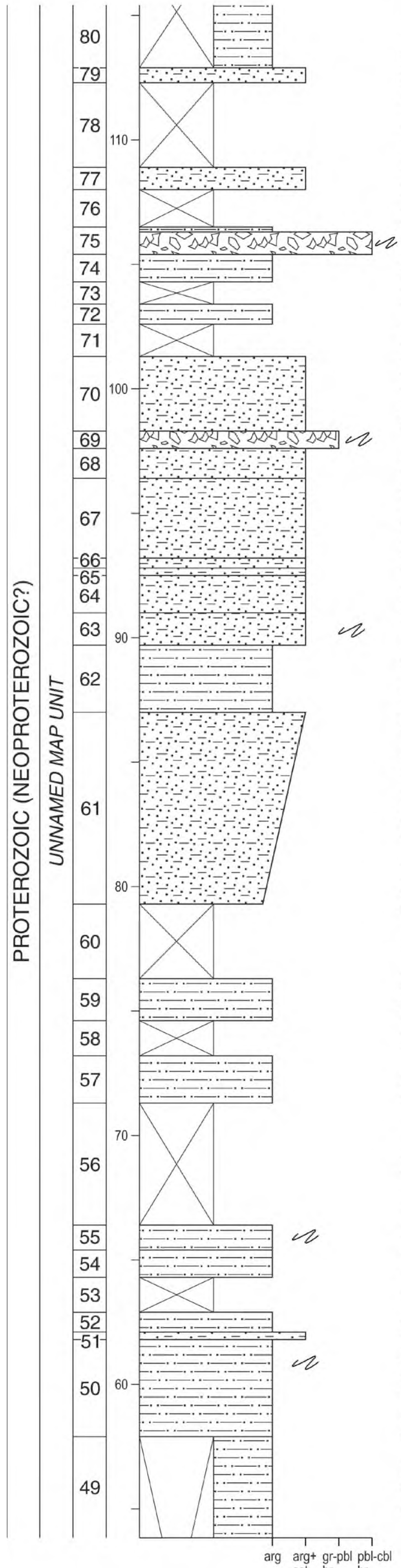



**Figure 5a.** Measured section (MWB-00–21B) through upper part of exposure of the argillite unit. Segment MWB-00–21B continues upsection without interruption or change in unit numbering from the top of MWB-00–21A. Running tally of unit thicknesses has been reset to 0 m at base of MWB-00–21B.

SECTION MWB-00-21B, continued




**Unit 80** (112.9–117.4 m): Argillite. Occurs as rare spot outcrops in mostly covered interval

**Unit 79** (112.3–112.9 m): Argillite and sandstone. Sandstone (up to 50% of unit): very fine grained; thin-bedded, massive to (possibly) normal graded. Basal contact covered

**Unit 78** (108.9–112.3 m): Covered interval

**Unit 77** (108.0–108.9 m): Argillite and sandstone. Sandstone: very fine grained; weathers buff; 0.2 m thick, massive, caps argillite. Basal contact covered

**Unit 76** (106.5–108.0 m): Covered interval

**Unit 75** (105.4–106.5 m): Breccia and argillite. Breccia: granule to pebble clast size; single bed dominates lower 0.9 m of unit, intraformational; basal contact sharp; contains volcanic granules and small pebbles, scattered pebbles of limestone and other calcareous material; carbonate clasts strongly weathered, some resemble sheath folds. Breccia locally passes upward into zones of contorted argillite. Breccia is sharply overlain by 0.2 m of undisturbed argillite

**Unit 74** (104.3–105.4 m): Argillite, as for Unit 70; basal contact covered

**Unit 73** (103.4–104.3 m): Covered interval

**Unit 72** (102.6–103.4 m): Argillite, as for Unit 70; basal contact covered

**Unit 71** (101.3–102.6 m): Covered interval

**Unit 70** (98.3–101.3 m): Argillite and sandstone, similar to Unit 68 but with only 30–40% sandstone. Basal contact sharp. Heavy lichen cover (Fig. 20)

**Unit 69** (97.6–98.3 m): Breccia; granule to pebble clast size; massive, intraformational; basal contact sharp, irregular; contains abundant volcanic granules and small pebbles, rare carbonate pebbles with relict microbial textures (Fig. 19a); some pebbles very strongly weathered; zones of contorted argillite. Interval passes laterally (over ~10 m) into undisturbed argillite, which in turn passes (over ~20 m) into a zone with abundant intraformational truncation surfaces (Fig. 19b)

**Unit 68** (96.4–97.6 m): Argillite and sandstone, similar to Unit 67 but with sandstone mostly as laminae < 5 mm thick. Basal contact gradational. Lichen cover very heavy

**Unit 67** (93.2–96.4 m): Argillite and sandstone. Sandstone (40–50%): very fine grained; very thin beds, very rare current ripples atop some beds. Unit laminated, with 30–40 cm partings. Basal contact sharp

**Unit 66** (92.8–93.2 m): Argillite and sandstone, as for Unit 64 (Fig. 18). Sandstone: excellent normal grading, possibly also inverse grading. Basal contact sharp

**Unit 65** (92.5–92.8 m): Argillite and sandstone, as for Unit 64 but with some laterally discontinuous slumped to convolute-bedded intervals, which disappear to the east over 3–4 m; basal contact gradational

**Unit 64** (91.0–92.5 m): Argillite and sandstone (Fig. 17a), as for Unit 63 but unslumped. Sandstone: diffuse parallel lamination (Fig. 17a, b). Basal contact sharp

**Unit 63** (89.7–91.0 m): Argillite and sandstone. Sandstone: bedding up to 3 cm thick, locally contains granules. Basal contact sharp. Unit has very well-developed slump folding (Fig. 16), possible slump mass?

**Unit 62** (87.0–89.7 m): Argillite; basal contact covered. Heavy lichen cover

**Unit 61** (79.3–87.0 m): Argillite and sandstone. Sandstone (locally to ~50%): very fine grained; beds very thin to thin; massive to normal graded, centimetre-scale partings and a thicker, decimetre-scale parting. Basal contact covered. Like Unit 59 at base, but becomes somewhat sandier upsection

**Unit 60** (76.3–79.3 m): Covered interval

**Unit 59** (74.4–76.3 m): Siltstone and shale, siltstone, and sandstone. Siltstone and shale: weathers dark green. Siltstone: weathers pale green to greenish grey. Sandstone (10–20% of unit): very fine grained; weathers pale greenish grey. Basal contact covered

**Unit 58** (73.2–74.4 m): Covered interval

**Unit 57** (71.3–73.2 m): Argillite; basal contact covered; very fine sand comprises < 10% of unit as stringers

**Unit 56** (66.4–71.3 m): Covered interval

**Unit 55** (65.4–66.4 m): Argillite; basal contact sharp; very fine sand (Fig. 15) comprises < 10% of unit as wispy stringers and rare very thin beds

**Unit 54** (64.3–65.4 m): Argillite; convoluted to slumped; basal contact covered; locally sandy, local intraformational brecciation. Heavy lichen cover

**Unit 53** (62.9–64.3 m): Covered interval

**Unit 52** (62.1–62.9 m): Argillite; basal contact sharp

**Unit 51** (61.8–62.1 m): Sandstone; very fine grained; dark to medium grey, weathers pale greenish grey; very thin beds, amalgamated, massive; basal contact sharp and erosional; locally contains dark grey mud clasts (Fig. 14a, b, c)

**Unit 50** (57.9–61.8 m): Argillite; strongly fractured; basal contact covered; uppermost few centimetres of unit show convolution beneath overlying sandstone bed (Fig. 14a)

**Unit 49** (44.5–57.9 m): Argillite; well-laminated. Largely covered interval with spot outcrops. One outcrop intruded by a fine-crystalline, medium grey dyke with pale green phenocrysts; trends 030°–210°; intrusive contact is steep (dip angle > 80°)

**Figure 5b**. Measured section (MWB-00–21B) through upper part of exposure of the argillite unit, continued. Segment MWB-00–21B continues upsection without interruption or change in unit numbering from the top of MWB-00–21A. Running tally of unit thicknesses has been reset to 0 m at base of MWB-00–21B.

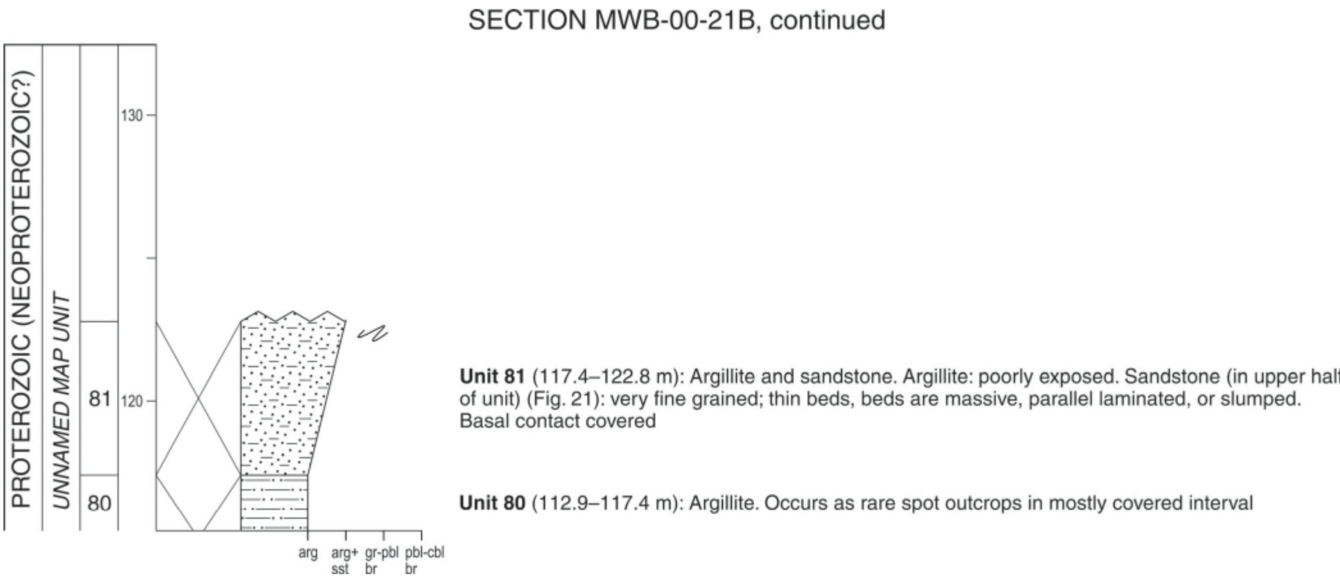



**Figure 5c.** Measured section (MWB-00–21B) through upper part of exposure of the argillite unit, continued. Segment MWB-00–21B continues upsection without interruption or change in unit numbering from the top of MWB-00–21A. Running tally of unit thicknesses has been reset to 0 m at base of MWB-00–21B

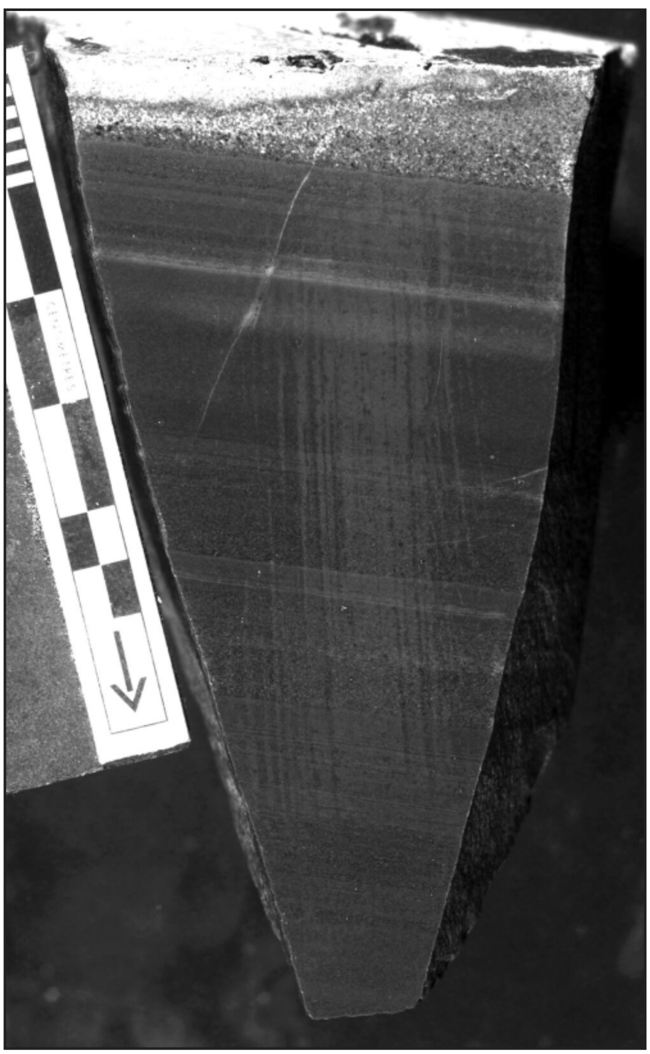


**Figure 6.** Unit MWB-00–21A-8: Normal-graded siltstone and mudstone with an overlying, sharp-based bed of sandstone. Centimetre scale bar. In Figures 6 to 21, beds young to top of all photographs, unless otherwise indicated. 2010-072

**Figure 7.** Unit MWB-00–21A-8: Block of local float showing normal-graded beds of very fine-grained sandstone, with interbeds of siltstone and shale. Hammer for scale. 2010-073

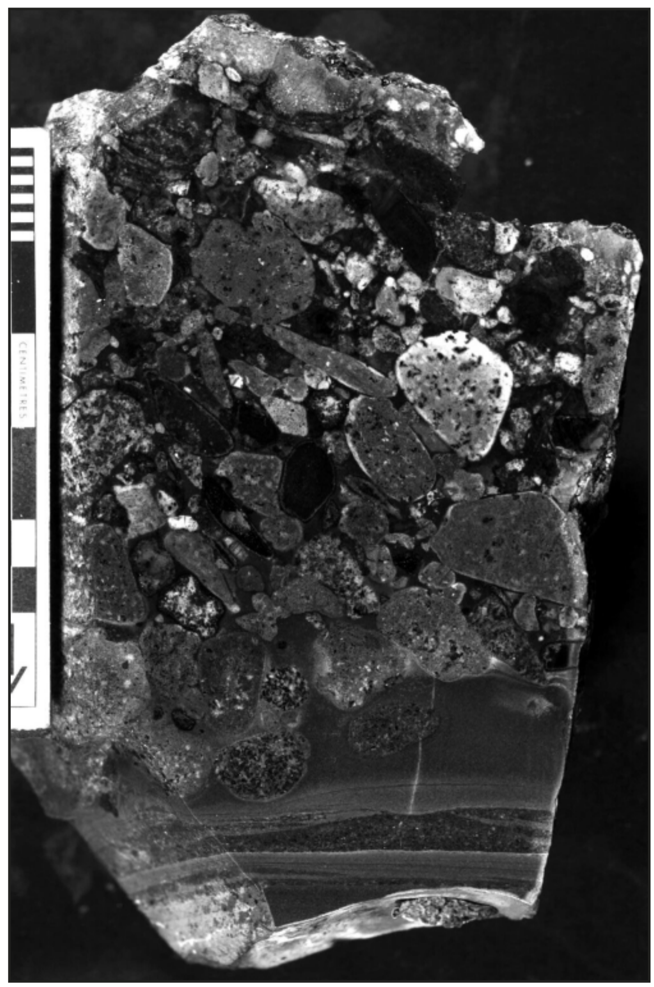


**Figure 8.** Unit MWB-00–21A-10: Polished slab of conglomerate rich in volcanic clasts. Specimen preserves contact between conglomerate and underlying siltstone and mudstone. Centimetre scale bar. 2010-074

**Figure 9.** Well developed, tight to isoclinal slump folds in argillite FA at base of unit MWB-00–21A-24. Hammer for scale. 2010-075

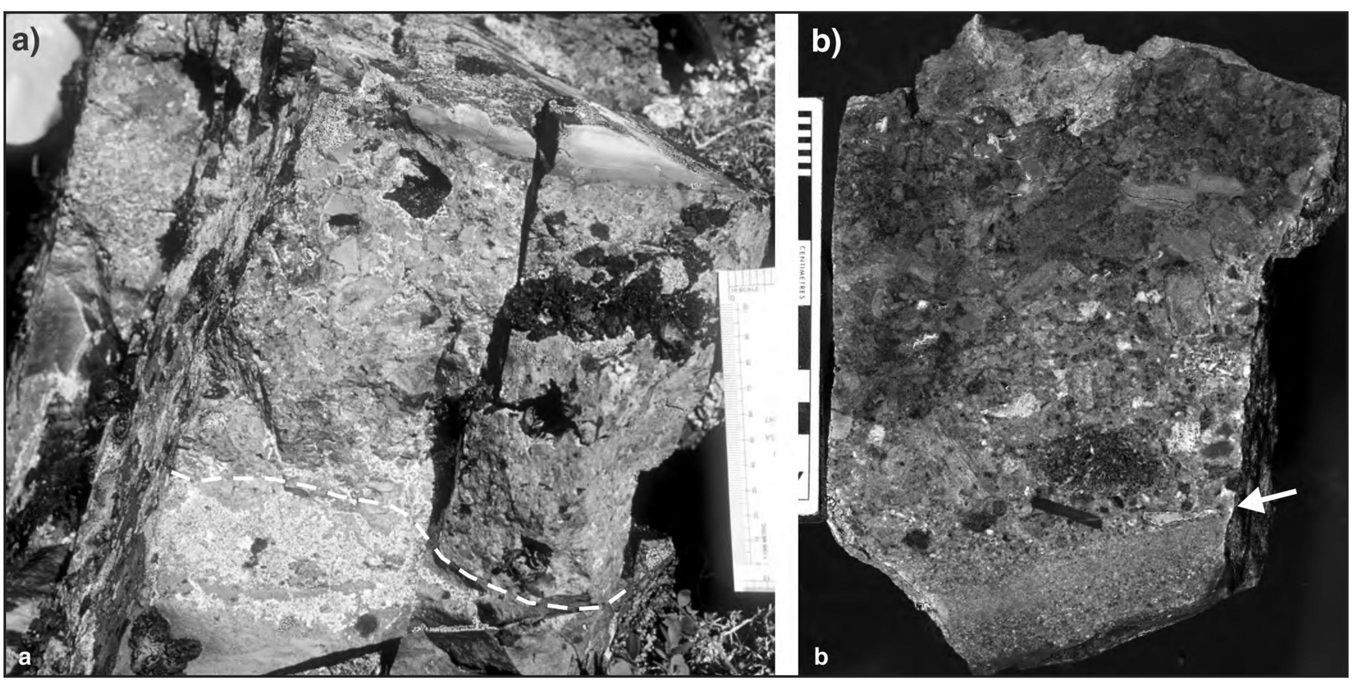



**Figure 10**. Unit MWB-00–21A-29: Breccia FA in erosional contact with underlying argillite FA. **a)** Outcrop photograph of contact (dashed line). Centimetre-scale bar. 2010-076A **b)** Polished slab that contains contact (arrow). Centimetre-scale bar. 2010-076B

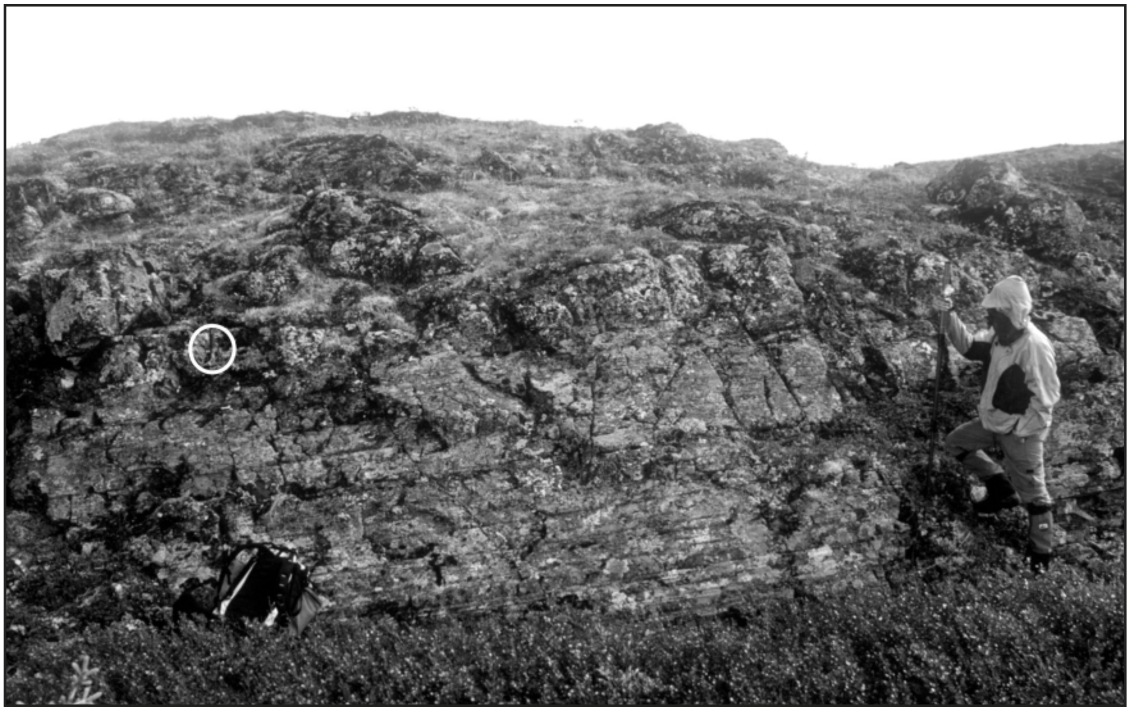


**Figure 11.** Units MWB-00B-31, 32: Argillite FA with well developed, regular bedding, overlain by breccia FA in which bedding is much less regular. Hammer (circled) is placed at base of flrst breccia bed. Jacob's staff is 1.5 m long. 2010-077

**Figure 12.** Polished slab of a specimen of volcanic-clast-rich breccia FA from unit MWB-00–21B-43. Note unusual concentric zoning of clast along top edge of specimen. Centimetre-scale bar. 2010-078

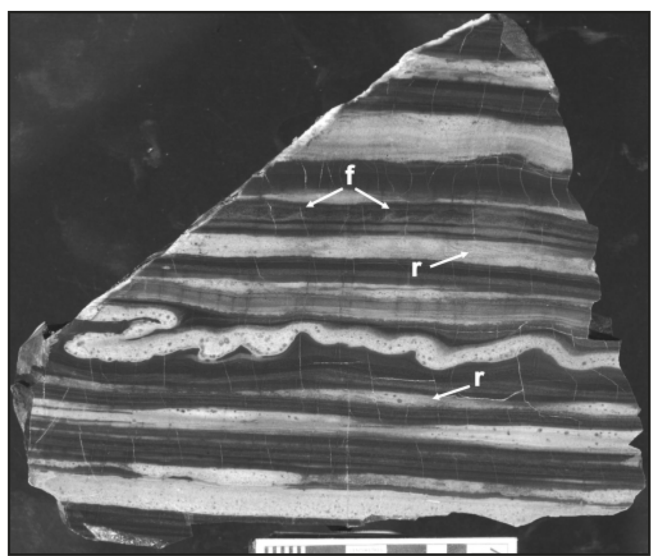



**Figure 13.** Unit MWB-00–21B-48: Polished slab of interlaminated shale, siltstone, and sandstone. Note prominent convolute bedding, also faintly preserved ripple crosslamination (r) and flame structures (f). Centimetre-scale bar. 2010-079

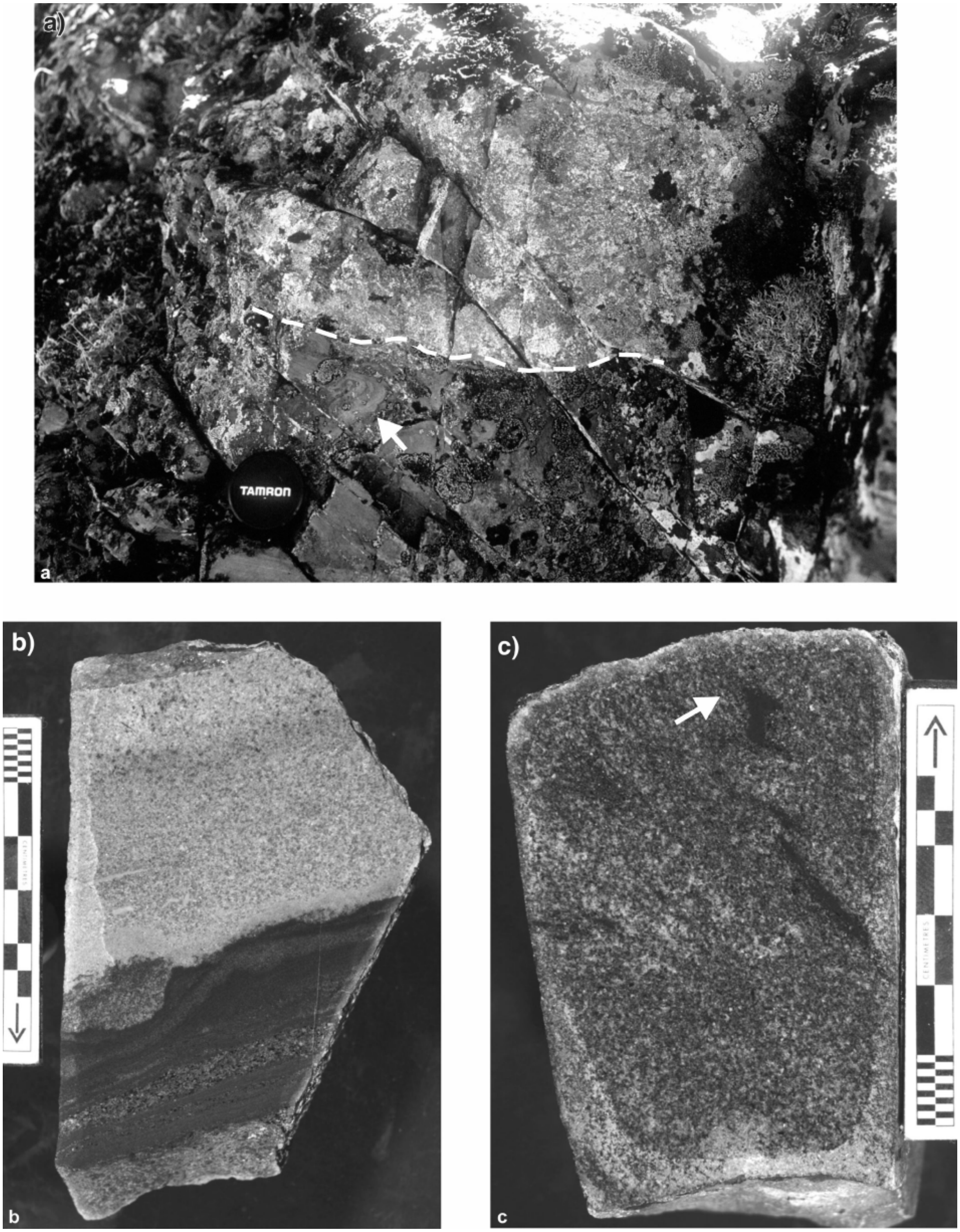



**Figure 14.** Units MWB-00–21B-50, 51. **a)** Field photograph of unit 51 (fine-grained sandstone) in erosional contact (dashed line) with underlying, convolute-bedded argillite facies (unit 50). Arrow points to convolute bedding. Lens cap for scale. 2010-080A **b)** Polished slab of specimen displaying contact between unit 50 (shale, siltstone, and sandstone) and unit 51 (massive sandstone). Centimetre-scale bar. 2010-080B **c)** Close-up view of polished slab of sandstone from within unit 51. White arrow points in younging direction. Note deformed shale chips. Centimetre-scale bar. 2010-080C

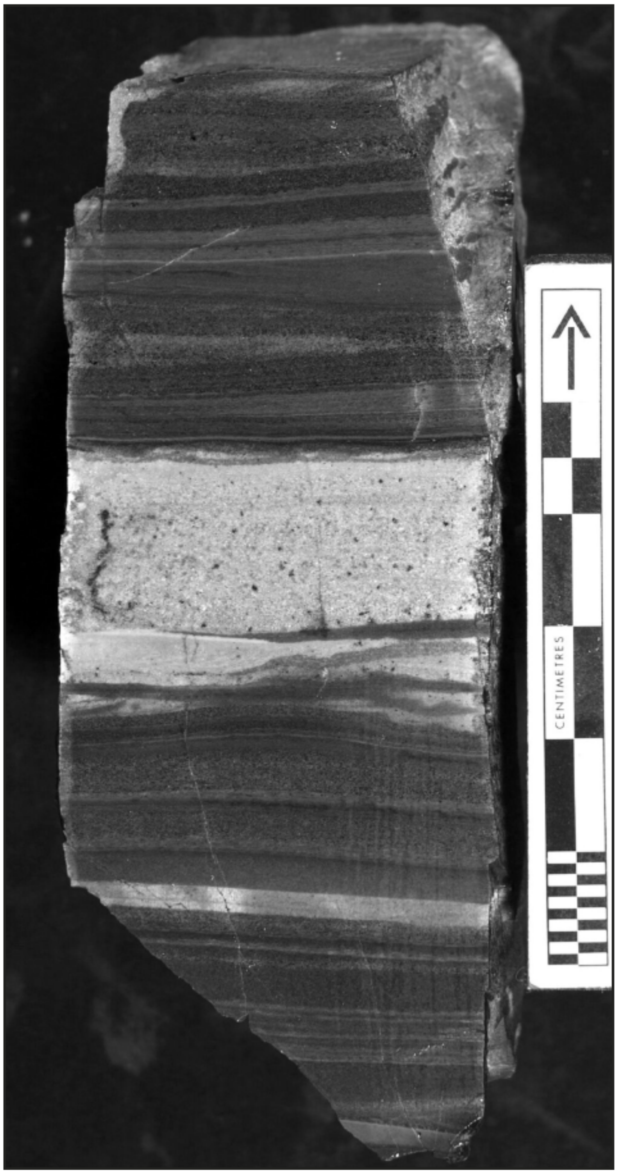



**Figure 15.** Unit MWB-00–21B-55: Normal-graded packets of siltstone and shale, with minor sandstone. Sandstone bed crossing middle of specimen is sharp based, with a massive lower division and an upper division displaying diffuse parallel lamination; it may be a thin turbidite. Note ripple crosslamination in sandstone immediately beneath this bed. Centimetre-scale bar. 2010-081

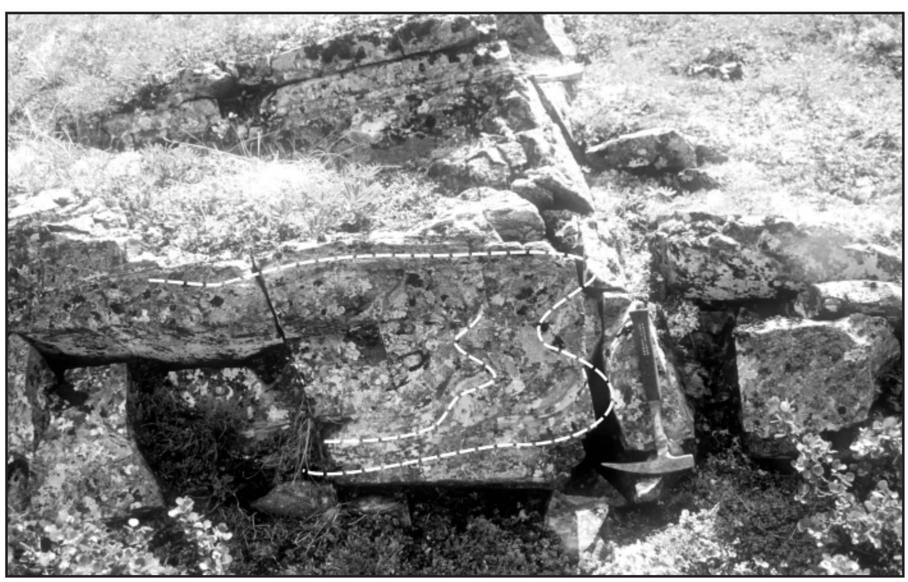


**Figure 16.** Unit MWB-00–21B-63: Slump folding (outlined by dashed line) developed in argillite FA. Hammer for scale. 2010-082

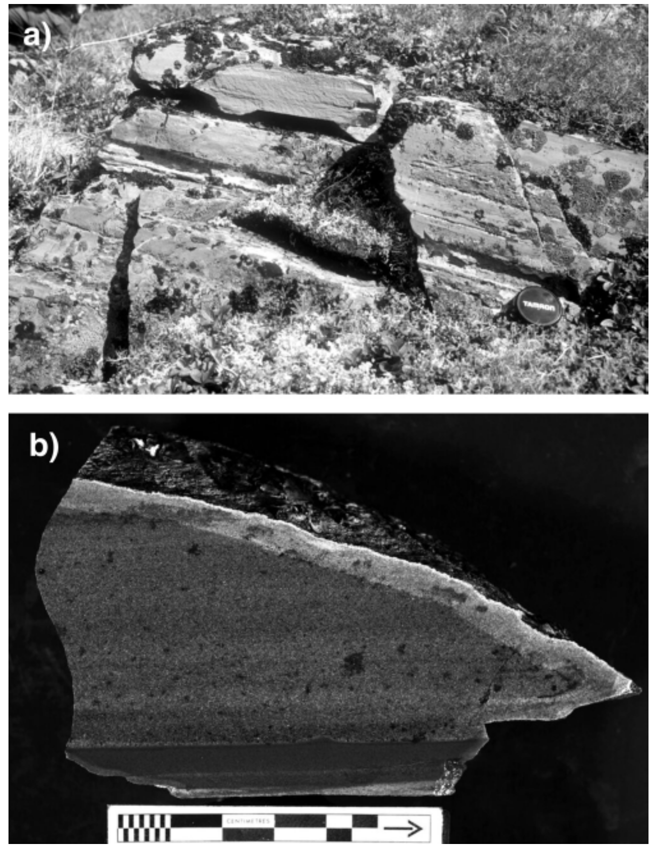


**Figure 17.** Unit MWB-00–21B-64. 2010-083A **a)** Outcrop photograph of well bedded sandstone with parallel lamination. Lens cap for scale. **b)** Polished slab of sandstone illustrating subtly developed parallel lamination. Centimetre-scale bar. 2010-083B

**Figure 18.** Interlayered shale, siltstone, and normally graded sandstone in unit MWB-00–21B-66. Lens cap for scale. 2010-084

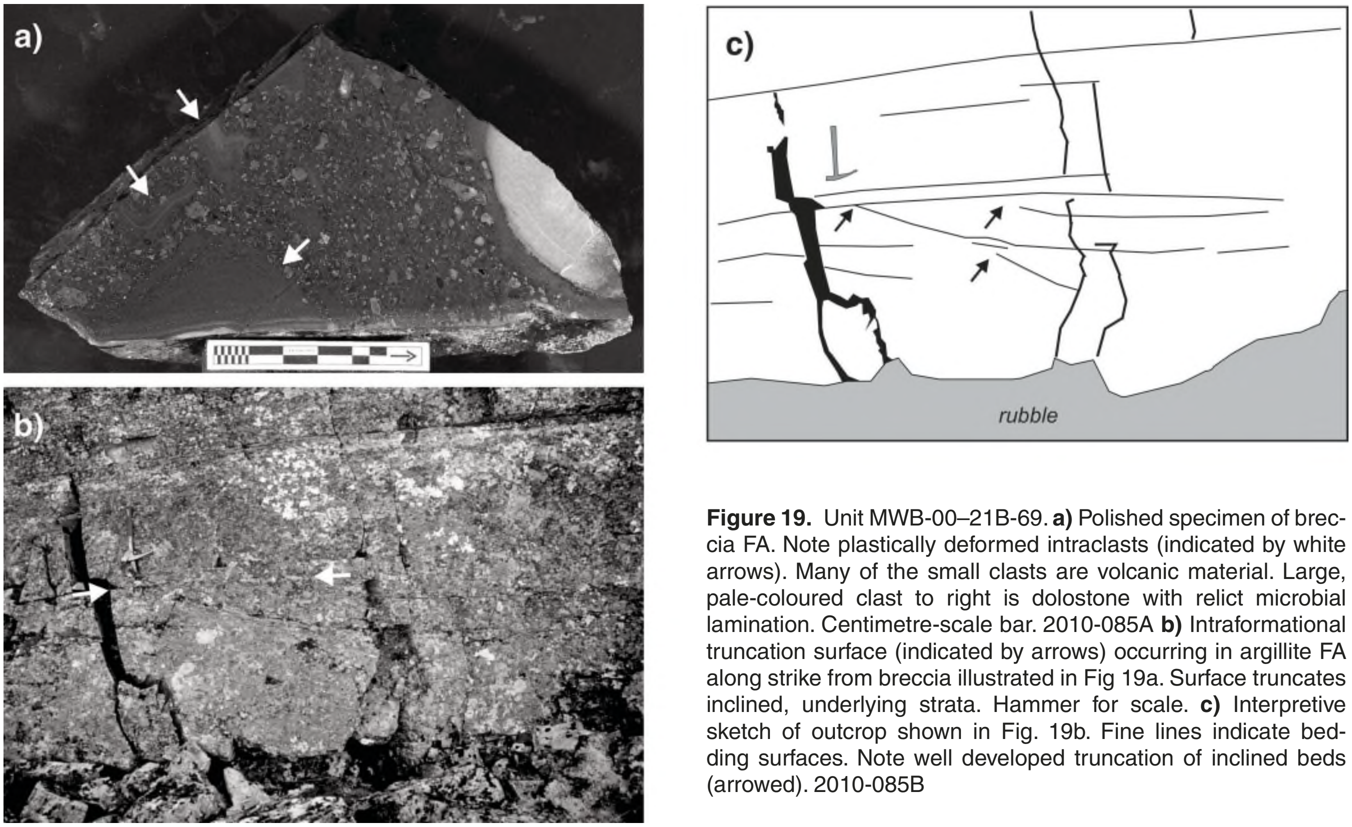



**Figure 19.** Unit MWB-00–21B-69. **a)** Polished specimen of breccia FA. Note plastically deformed intraclasts (indicated by white arrows). Many of the small clasts are volcanic material. Large, pale-coloured clast to right is dolostone with relict microbial lamination. Centimetre-scale bar. 2010-085A **b)** Intraformational truncation surface (indicated by arrows) occurring in argillite FA along strike from breccia illustrated in Fig 19a. Surface truncates inclined, underlying strata. Hammer for scale. **c)** Interpretive sketch of outcrop shown in Fig. 19b. Fine lines indicate bedding surfaces. Note well developed truncation of inclined beds (arrowed). 2010-085B


**Figure 20.** Unit MWB-00–21B-70: Argillite and sandstone FA. Darker layers are shale and siltstone; paler layers are very flne-grained sandstone. Lens cap for scale. 2010-086

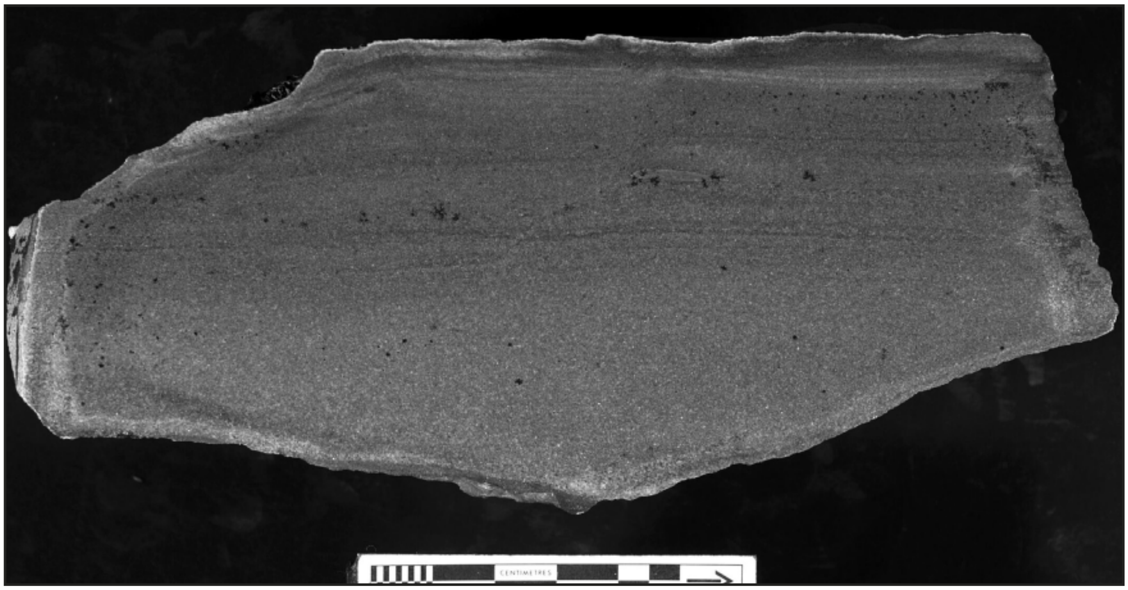


**Figure 21.** Unit MWB-00–21B-81: Polished slab of sandstone, displaying massive lower division and parallel-laminated upper division. Slight disruptions of laminae near top of specimen may be dewatering-related dish structures. Centimetre-scale bar. 2010-087

A second facies association, the ‘argillite and sandstone FA’ (Figures 4 and 5), contains the same lithofacies and displays similar colour variations, but sandstone accounts for up to 50 per cent of this facies association. Shale and siltstone are proportionally less abundant. The sandstone is very fine grained, locally with rare granule-bearing beds, and is very thin to thin bedded or, rarely, medium bedded. Sandstone beds in both facies associations show sharp or erosional bases and are commonly normally graded with rare parallel lamination or current-ripple crosslamination. The argillite and sandstone FA corresponds to ‘Facies association 2 (argillite and sandstone)’ in the sedimentological study of MacNaughton et al. (2017).

Slump-folded horizons, intraformational truncation surfaces, and convolute bedding are typical of the argillite FA and the argillite and sandstone FA. Beds preserving these features were treated by MacNaughton et al. (2017; see their Fig. 3) as their ‘Facies association 3 (chaotically bedded strata).’

The third facies association (‘breccia FA’; Figures 4 and 5) encompasses breccia beds consisting of granules, pebbles, and (less commonly) cobbles, in a sandy to muddy matrix. Clasts are angular to subrounded. Beds are commonly matrix-supported, though grain-supported examples were also observed. Upper-surface relief is locally present upon breccia beds. In some cases, oblate clasts are oriented subparallel to bedding, but the beds are otherwise massive. Clast composition is highly variable from bed to bed, with some beds apparently dominated by intraformational clasts of argillite and others containing abundant fragments of allochthonous volcanic material. Thin-section analyses and geochemical data indicate that the volcanic clasts are predominantly basaltic (Pigage and MacNaughton, 2004; Pigage, 2009; MacNaughton et al., 2017). Rare dolostone clasts also occur; such clasts generally preserve microbial lamination. The breccia FA corresponds to ‘Facies C.1: matrix-rich conglomerate’ in the sedimentological study of MacNaughton et al. (2017).

The argillite FA is most significant volumetrically and is especially dominant in the lower segment of the section. Sandier intervals are common in the following intervals: units 8 to 12, 23 to 25, and 61 to 81. In addition, the argillite FA is itself somewhat sandier in the upper part of the section. Breccia beds occur sporadically throughout the section, but are particularly common in the interval from unit 29 to unit 43.

At two levels in the section (units 19 and 49), steeply dipping, finely crystalline to aphanitic, basaltic dykes were observed to cut the argillite strata. Both dykes trend approximately northeast-southwest. Similar dykes were reported from Pool Creek map area by Allen et al. (2001).

It should be noted that MacNaughton et al. (2017) documented additional lithofacies from the argillite unit that are not represented in the present measured section. These included clast-supported conglomerate preserved in a submarine channel (their Facies C.2), as well as poorly exposed carbonate lithofacies.

## ORIGIN OF SUCCESSION

Only a brief summary of the sedimentology of the argillite unit will be presented here. Allen et al. (2001) presented a preliminary discussion, and a detailed account has recently been published (MacNaughton et al., 2017).

Allen et al. (2001) considered that sandstone beds in the argillite unit preserved characteristics that could be consistent with an origin either as thin-bedded turbidites or as distal tempestites, and on that basis suggested that the succession was deposited on the uppermost continental slope or at the slope-shelf transition. However, the more detailed study of MacNaughton et al. (2017) confirmed that all lithofacies in the argillite unit were consistent with deposition in a slope setting. Mudstone and siltstone beds were interpreted to record deposition from dilute turbidites, possibly with input from hemipelagic deposition. Sandstone beds preserve evidence for deposition by turbidity currents (indicated by recognizable Bouma sequences) and sand-rich debris flows (indicated by massive beds with a swirled depositional fabric). Breccia beds display characteristics indicating deposition from debris flows, including a massive, unsorted, commonly matrix-supported character, as well as the local presence of upper-surface relief. The prevalence of slump folding, intraformational truncation surfaces, and intraclast-rich debris flows provides strong evidence for a slope depositional setting, as does the presence of a mappable submarine channel (not documented in the measured section; but *see* MacNaughton et al., 2017).

## CONCLUSIONS

A measured section through a hornfelsed, argillite-dominated map unit in Pool Creek map area (NTS 95C/5) can be subdivided into three facies associations. Two facies associations consist of shale, siltstone, and sandstone in varying proportions and were deposited primarily by turbidity currents, with lesser input from sandy debris flows and hemipelagic deposition. A breccia facies association is variably dominated by intraformational or volcanic clasts and records deposition from debris flows. Slump folding is a prevalent feature of the succession, indicating deposition in a slope setting. The map unit was hornfelsed during the emplacement of the 640–650 Ma Pool Creek syenite and thus is of Neoproterozoic age or older and probably correlative with the lower part of the Windermere Supergroup.

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Staff of the Yukon Geology Program (Lee Pigage, Tammy Allen, and Anna Fonseca) kindly shared their camp during fieldwork. Pigage and Allen are thanked for their ongoing interest and shared observations. Jordin Barclay and Michael Hearn assisted with section measuring. Helicopter support was provided by Talon Helicopters. The following persons assisted with preparation of the line drawings: Sylvia Leong, Dave Sargent, Joanna Palmer, Karen Fallas, and Steven Hinds. Melissa Peterson and Chris Cecile prepared the polished slabs and Bryan Rutley photographed the resulting samples. Larry Lane and Darrel Long reviewed the manuscript. Copyediting was done by Jo Gray and Alison Weatherston.

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# Lower and Middle Devonian outcrop stratigraphy of northeast British Columbia

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**Abstract:** Presqu'ile Barrier reef strata are documented in six measured sections from southern Trutch and Halfway River map areas, Rocky Mountain Thrust Belt, northeastern British Columbia. They contain abundantly stromatoporoidal strata as young as mid-Givetian. Presqu'ile Dolomite is commonly developed in large masses within thick 'Upper Chinchaga to Slave Point Undivided' limestone successions in outcrop. Less extensive, white, hydrothermal dolospar is developed within relatively thin Dunedin Formation strata, particularly in slope settings immediately basinward of the Presqu'ile Barrier reef complex. Manetoe Dolomite occurs within Dunedin strata, even in northernmost sections. The Dunedin Formation's basal unconformity and its diachronous and gradational upper contact with the Besa River Formation are confirmed and documented. Lower to Middle Devonian siliciclastic units occur within the Laurier Embayment, a broad bypass channel through the Presqu'ile Barrier reef complex. Extensive Presqu'ile Dolomite occurs south of Laurier Embayment, similar to that in the nearby Clarke Lake gas field.

**Résumé :** Les strates du récif barrière de Presqu'ile sont décrites à l'aide de six coupes mesurées situées dans les régions cartographiques de Trutch Sud et de Halfway River, au sein de la zone de chevauchement des Rocheuses, dans le nord-est de la Colombie-Britannique. Elles renferment une abondance de strates à stromatopores, dont certaines ne remontent qu'au Givétien moyen. En affleurement, la Dolomie de Presqu'ile se manifeste généralement sous forme de grandes masses au sein d'épaisses successions de calcaire « de l'intervalle indivisé s'étendant de la partie supérieure de la Formation de Chinchaga à la Formation de Slave Point ». De la dolosparite hydrothermale de couleur blanche, moins répandue, s'est formée à l'intérieur de strates relativement minces de la Formation de Dunedin, surtout dans des milieux de talus juste au large du complexe de récif barrière de Presqu'ile. La Dolomie de Manetoe est encaissée dans les strates de la Formation de Dunedin, et ce, même dans les coupes les plus au nord. La discordance formant la base de la Formation de Dunedin et le contact supérieur diachronique et progressif de celle-ci avec la Formation de Besa River sus-jacente ont été confirmés et documentés. Des unités silicoclastiques du Dévonien inférieur et moyen sont présentes dans le rentrant de Laurier, un large chenal de dérivation recoupant le complexe de récif barrière de Presqu'ile. Au sud du rentrant de Laurier, la Dolomie de Presqu'ile couvre une vaste étendue, de façon semblable à ce que l'on observe dans le champ gazier de Clarke Lake situé à proximité.

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# INTRODUCTION

Devonian strata in northeast British Columbia comprise one of the most extensive and well exposed Devonian successions in the world and are the host to numerous economic deposits of oil, gas, lead, zinc, and sulphur (Morrow and Geldsetzer, 1988). The Clarke Lake Gas Field, shown in Figure 1, is typical of many gas fields hosted in the Devonian succession of Keg River to Slave Point formational platform-edge carbonate deposits that form the Presqu'ile Barrier in northeastern British Columbia (Fig. 1; Meijer-Drees, 1993, 1994; Bebout and Maiklem, 1973; Morrow et al., 2002). The Presqu'ile Barrier reef complex across northeast British Columbia occupies the southeastern part of a broad paleogeographic or paleotectonic feature termed the MacDonald Platform (Gabrielse, 1967; Morrow and Geldsetzer, 1988). The MacDonald Platform comprises the entire area of lower Paleozoic shallow-water carbonate shelf deposits across northeastern British Columbia north of the Peace River Arch (Cecile et al., 1997) or north of about 56° latitude (Fig. 1).

Devonian strata in the subsurface of northeastern British Columbia have been more intensively studied than correlative strata exposed in the mountain belt west of the prolific Devonian gas fields. The absence of detailed studies of surface stratigraphy can be attributed to the inaccessibility of surface exposures of Devonian strata, which can generally be reached only by helicopter. Recently, however, petroleum exploration has targeted subsurface Devonian strata in the mildly deformed foothills region of the Rocky Mountains Thrust Belt in northeast British Columbia. This has provided

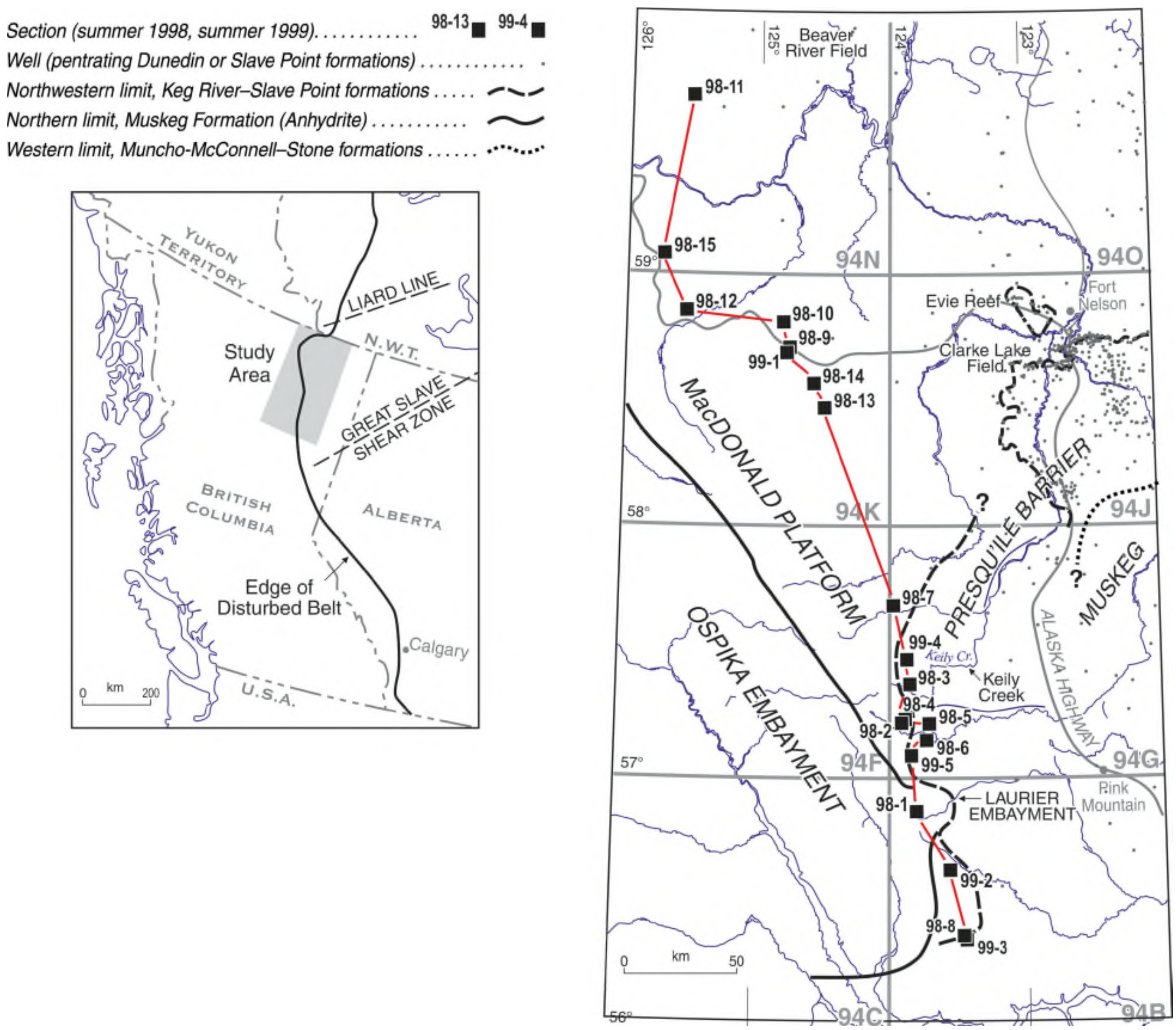



**Figure 1.** Locations of measured sections by section number. Line of cross-section for Figure 4 passes through all sections northwestward from Section MTA-99-3 in the Halfway River map area to Section MTA-98-11 in the Toad River map area. Muncho-McConnell-Stone limit of Ospika Embayment is *from* Thompson (1989). Laurier Embayment is *after* Davies (1997). The Liard Line and Great Slave Shear Zone (Cecile et al., 1997) are shown in the inset index map.

the impetus for a more detailed study of exposed Devonian strata. During this study, data and samples from Lower and Middle Devonian formations were collected from four 1:250 000 map areas: Halfway River (94B), Trutch (94G), Tuchodi Lakes (94K), and Toad River (94N). Twenty stratigraphic sections were measured through Devonian strata exposed in a narrow, sinuous outcrop belt along the Front Ranges of the Rocky Mountains in these map areas (Fig. 1 and Tables 1, 2, 3; see Figures 11–30 for complete section descriptions).

## Purpose and objective

The purpose of this study was to gain more detailed lithostratigraphic and biostratigraphic information about Devonian strata exposed along the Rocky Mountain Thrust Belt of northeast British Columbia, primarily in support of exploration for hydrocarbon resources hosted in these strata. The primary objective was to present these data in a coherent manner as a series of measured stratigraphic sections with accompanying biostratigraphic information and to verify and further develop the presently understood stratigraphic relationships within these strata (e.g. Taylor and MacKenzie, 1970) as well as with respect to overlying and underlying strata. A related objective was to identify potential gas and oil reservoir rock in Devonian strata exposed along this part of the Rocky Mountain Thrust Belt.

## Previous work and stratigraphic nomenclature

Detailed geological information about the Devonian stratigraphy of northeastern British Columbia was not published until after the construction of the Alaska Highway. Williams (1944), in an early reconnaissance geological survey, reported on the widespread distribution of Devonian strata along the highway. Laudon and Chronic (1949) applied a modified formational nomenclature from the Mackenzie River area to this succession. They proposed two new names for the lowermost Devonian strata—the Muncho and McConnell formations—and referred overlying carbonate-dominated strata to the Ramparts Formation. Black shale capping the section was assigned to the Fort Creek Formation. The type area of both the Ramparts and Fort Creek (abandoned) formations are in the northern District of Mackenzie (Kindle and Bosworth, 1921).

This stratigraphy underwent revision in the early 1960s when Kidd (1962) reassigned the shale-dominated succession formerly placed in the Fort Creek Formation by Laudon and Chronic (1949) to a new unit, the Besa River Formation. This was partly because the term ‘Fort Creek Formation’ as a formal stratigraphic unit had already been abandoned (Hills et al., 1981, p. 65). By 1966, when outcrops in the Rocky Mountains were re-examined during the Geological Survey of Canada’s Operation Liard, Taylor and MacKenzie (1966, 1970) realized that previous correlations were not adequate and redefined the Lower and Middle Devonian

**Table 1.** Location data for sections (UTM Zone 10V eastings and northings; NAD 83).

| Section name | NTS map area | Easting (base in metres) | Northing (base in metres) | Easting (top in metres) | Northing (top in metres) | Airphoto number |
|---|---|---|---|---|---|---|
| MTA-98-1 | 94-B | 457000 | 6306250 | 456450 | 6305750 | A17136-81 |
| MTA-98-2 | 94-G | 446000 | 6343000 | 446750 | 6342700 | A17163-156 |
| MTA-98-3 | 94-G | 448475 | 6360100 | 448100 | 6360600 | A17163-157 |
| MTA-98-4 | 94-G | 446150 | 6343600 | 446750 | 6343500 | A17163-156 |
| MTA-98-5 | 94-G | 456500 | 6341350 | 456000 | 6341250 | A17163-89 |
| MTA-98-6 | 94-G | 455250 | 6334150 | 454850 | 6333750 | A17163-87 |
| MTA-98-7 | 94-G | 442000 | 6394200 | 442800 | 6394250 | A17164-40 |
| MTA-98-8 | 94-B | 471150 | 6248200 | 472250 | 6248250 | A17165-93 |
| MTA-98-9 | 94-K | 397400 | 6508250 | 396000 | 6506500 | A1169-143 |
| MTA-98-10 | 94-K | 395300 | 6520000 | 395800 | 6521000 | A11613-34 |
| MTA-98-11 | 94-N | 357300 | 6621050 | 358500 | 6620900 | A19440-69 |
| MTA-98-12 | 94-K | 352450 | 6526300 | 352000 | 6525950 | A11609-38 |
| MTA-98-13 | 94-K | 412450 | 6482000 | 413000 | 6482500 | A11634-53 |
| MTA-98-14 | 94-K | 408000 | 6492750 | 408500 | 6493400 | A11613-285 |
| MTA-98-15 | 94N | 342800 | 6552500 | 343000 | 6552250 | A18177-30 |
| MTA-99-1 | 94-K | 396000 | 6506500 | 395400 | 6505750 | A11609-143 |
| MTA-99-2 | 94-B | 465050 | 6276750 | 465700 | 6277000 | A17163-45 |
| MTA-99-3 | 94-B | 472000 | 6246250 | 471800 | 6246800 | A17165-93 |
| MTA-99-4 | 94-G | 447300 | 6369850 | 446300 | 6369250 | A17163-149 |
| MTA-99-5 | 94-G | 448900 | 6327600 | 449450 | 6328000 | A17163-160 |

**Table 2.** Age determinations from fauna in measured sections MTA 98-1 to MTA-98-15, and MTA-99-1 to MTA-99-5*.

| Section | GSC sample C-number | Unit (metres above base of section) | Description (formation or equivalent) | Age (conodont determinations except for a brachiopod determination from sample C-406029) |
|---|---|---|---|---|
| MTA-98-1 | C-254917 | N/A (209.5) | Base of Besa River Formation immediately overlying Section MTA-98-1 (Besa River) | *ensensis* Zone to mid-Middle varcus Subzone (latest Eifelian to mid-Givetian, Middle Devonian) |
| MTA-98-2 | C-254918 | 1 (14.5) | Below contact between Nonda and Muncho-McConnell formations (Nonda) | Middle Ordovician to Middle Devonian (likely Silurian) |
| | C-254919 | 19 (281.9) | Top unit of the Muncho-McConnell Formation (Muncho-McConnell) | Barren |
| MTA-98-3 | C-254920 | Top of Nonda | Contact between the Nonda and Muncho-McConnell formations strati-graphically below base of section MTA-98-3 (Nonda) | Barren |
| | C-254921 | 6 (57.0) | Finely comminuted shell hash in grey argillaceous dolomitic lime mudstone (Stone) | Barren |
| | C-254922 | 15 (126.5) | Crinoid dolowackestone (Upper Chinchaga to Slave Point Undivided) | *costatus* or *ensensis* Zone to Upper varcus Subzone (mid-Eifelian to mid-Givetian, Middle Devonian) |
| | C-254923 | 18 (167.0) | Stromatoporoidal boundstone?? (Upper Chinchaga to Slave Point Undivided) | Barren |
| | C-254924 | 23 (240.5) | Top of unit (Upper Chinchaga to Slave Point Undivided) | Barren |
| | C-406029 | 23 (219.5) | Base of unit – *Stringocephalus* sp. (Upper Chinchaga to Slave Point Undivided) | Givetian, late Middle Devonian |
| MTA-98-4 | C-254925 | 12 (220.5) | Top of unit at hardground (Dunedin) | Barren |
| | C-254926 | 14 (241.5) | Shaly interval between two resistant mudstone beds (Dunedin) | Barren |
| | C-254927 | 20 (285.0) | Horn corals, crinoids - above top of bioherm (Dunedin) | *ensensis* Zone to Lower *varcus* Subzone (latest Eifelian to early Givetian, Middle Devonian) |
| | C-254928 | 22 (304.5) | Near the top of the unit, at contact with the Besa River Formation (Dunedin) | *ensensis* Zone to Lower *varcus* Subzone (latest Eifelian to early Givetian, Middle Devonian) |
| MTA-98-5 | C-254929 | 12 (201.0) | Thin, wavy-bedded interval (Upper Chincha-ga to Slave Point Undivided) | Barren |
| | C-254930 | 18 (262.5) | Stromatoporoid bed (Upper Chinchaga to Slave Point Undivided) | possibly Ordovician to Middle Devonian (McCracken, pers. comm.) |
| | C-254931 | 21 (282.3) | Stromatoporoid trash layers (Upper Chinchaga to Slave Point Undivided) | Barren |
| | C-254932 | 22 (302.0) | Stromatoporoid debris beds with shells and crinoids (Upper Chinchaga to Slave Point Undivided) | Barren |
| MTA-98-8 | C-254933 | 9 (228.6) | Rippled dolostone (Dunedin) | Barren |
| | C-254934 | 13 (265.6) | Bioclastic fioatstone with shells, crinoids and corals (Dunedin) | Missing from the collections |
| MTA-98-9 (Section MTA-99-1 includes a re-measured Dunedin section at this location) | C-254944 | 18 (544.4 | Dark grey lime mudstone at Base of Dunedin — see Section MTA-99-1 (Dunedin) | Barren |
| | C-254945 | 23 (628.1) | Contact between the Dunedin and Besa River formations — see Section MTA-99-1 (Dunedin) | *ensensis* Zone to mid-Middle *varcus* Subzone (latest Eifelian to mid-Givetian, Middle Devonian) |

**Table 2.** (Cont.)

| Section | GSC sample C-number | Unit (metres above base of section) | Description (formation or equivalent) | Age (conodont determinations except for a brachiopod determination from sample C-406029) |
|---|---|---|---|---|
| MTA-98-10 | C-254935 | 3 (55.6) | Base of the Dunedin Formation (Dunedin) | Barren |
| | C-254936 and C-254937 | 8 (145.5) | Shelly bed (Dunedin) | *ensensis* Zone to Middle *varcus* Subzone (latest Eifelian to mid-Givetian, Middle Devonian) |
| | C-254938 | 10 (285.0) | Contact between the Dunedin and Besa River formations (Dunedin) | *ensensis* Zone to mid-Middle *varcus* Subzone (latest Eifelian to mid-Givetian, Middle Devonian) |
| MTA-98-11 | C-254939 | 17 (519.0) | Upper Dunedin Formation (Dunedin) | Barren |
| MTA-98-12 | C-254940 | 13 (264.8) | Recessive, with some fauna, about 20–30 m to Besa River Formation (Dunedin) | Barren |
| MTA-98-13 | C-254941 | 21 (421.2) | Lumpy bedded upper part of unit (Dunedin) | *ensensis* Zone to mid-Middle *varcus* Subzone (latest Eifelian to mid-Givetian, Middle Devonian) |
| MTA-98-14 | C-254942 | 11 (274.3) | Contact between Dunedin and Stone formations (Dunedin) | Barren |
| | C-254943 | 15 (439.4) | Contact between Dunedin and Besa River formations (Dunedin) | *kockelianus* Zone to mid-Middle *varcus* Subzone (late Eifelian to mid-Givetian, Middle Devonian) |
| MTA-99-1 | C-254972 | 2 (4.0) | 1.0 m above base of the Stone Formation (Dunedin) | Barren |
| | C-254973 | 6 (44.4) | Top of the unit (Dunedin) | Barren |
| | C-254974 | 13 (160.0) | Thin coralline bed (Dunedin) | Barren |
| | C-254975 | 15 (188.3) | Top bed with coral heads (Dunedin) | *ensensis* Zone to mid-Middle *varcus* Subzone (latest Eifelian to mid-Givetian, Middle Devonian) |
| | C-254976 | 16 (192.3) | From concretion in the Besa River Formation (Besa River) | *ensensis* Zone to mid-Middle *varcus* Subzone (latest Eifelian to mid-Givetian, Middle Devonian) |
| MTA-99-2 | C-254977 | 2 (11.5) | Burrow-mottled dolomitized mudstone (Stone) | Indeterminate |
| | C-254978 | 9 (205.0) | Top of thick and resistant bed (Upper Chinchaga to Slave Point Undivided) | Barren |
| MTA-99-3 | C-254979 | 2 (41.5) | Stromatoporoids and corals in thick beds (Upper Chinchaga to Slave Point Undivided) | Barren |
| | C-254980 | 5 (87.25) | Sample in dominant lithology of unit (Upper Chinchaga to Slave Point Undivided) | *ensensis* Zone - Upper *varcus* Subzone (latest Eifelian to mid-Givetian) |
| | C-254981 | 9 (260.25) | Argillaceous crinoidal limestone (Upper Chinchaga to Slave Point Undivided) | Barren |
| MTA-99-4 | C-254982 | 1 (3.0) | Top bed with coral and stromatoporoid boundstone (Nonda) | Late Llandovery-early Wenlock (Early Silurian) |
| | C-254983 | 18 (582.75) | Bioclastic wackestone to fioatstone (Upper Chinchaga to Slave Point Undivided) | Indeterminate |
| MTA-99-5 | C-254984 | 7 (188.0) | Fossiliferous bed at the top of the Dunedin Formation (Dunedin) | upper *ensensis* Zone to Middle *varcus* Subzone (latest Eifelian to mid-Givetian, Middle Devonian) |
| *McCracken (2000a, b) and Norris (1998) | | | | |

**Table 3.** Section names and formation thicknesses*.

| Section name | Nonda | Muncho McConnell | Wokkpash | Stone | Dunedin (DQS map unit in MTA-98-1) | Upper Chinchaga to Slave Point Undivided | Besa River |
|---|---|---|---|---|---|---|---|
| MTA-98-1 | | | | | 209.0+ | | 0.5+ |
| MTA-98-2 | 15.0+ | 267.0 | | 100.5+ | | | |
| MTA-98-3 | | 6.0+ | | 105.5 | | 129.0+ | |
| MTA-98-4 | | | | 199.5+ | 108.0 | | 0.5+ |
| MTA-98-5 | | | | 5.0+ | | 306.8+ | |
| MTA-98-6 | | | | 49.5+ | | 451.5+ | |
| MTA-98-7 | | | | 10.5+ | 124.5 | | 0.5+ |
| MTA-98-8 | | 0.5+ | | 223.5 | 55.5 | | 0.5+ |
| MTA-98-9 | | 20.8+ | 49.4 | 481.9 | 0.5+ | | |
| MTA-98-10 | | | | 55.5+ | 227.5 | | 0.5+ |
| MTA-98-11 | | | | 33.0+ | 490.5+ | | |
| MTA-98-12 | | | | 1.3+ | 263.5 | | 0.5+ |
| MTA-98-13 | | 0.5+ | 41.6 | 228.8 | 169.0 | | 0.5+ |
| MTA-98-14 | | 0.5+ | 50.7 | 184.6 | 204.1 | | 0.5+ |
| MTA-98-15 | | | 2.6 | 1386.6 | 105.4+ | | |
| MTA-99-1 | | | | 3.0+ | 185.3 | | 6.0+ |
| MTA-99-2 | | | | 13.0+ | | 214.5 | 0.5+ |
| MTA-99-3 | | | | 0.5+ | | 260.25 | 0.5+ |
| MTA-99-4 | 36.75+ | 142.5 | | 199.5 | | 238.5+ | |
| MTA-99-5 | | | | 4.5+ | 163.5 | | 0.5+ |

*Thickness in metres. Incomplete thicknesses denoted with a plus (+) sign

outcrop stratigraphy in northeast British Columbia. They were unable to discern signiflcant differences between the Muncho and McConnell formations and, because of this, combined them into a single unit, the Muncho-McConnell Formation. Taylor and MacKenzie (1966) flrst recognized a distinctive sandy unit, the Wokkpash Formation, as occurring within the thick Lower Devonian dolomite succession. Finally, they separated the Ramparts Formation of Laudon and Chronic (1949) into the dolostone-dominated Stone and limestone-dominated Dunedin formations of late Early and early Middle Devonian age. Taylor and MacKenzie (1970) noted, however, that the Dunedin Formation underwent a facies change to more reefal character south of Keily Creek in the Trutch map area. Thompson (1989) recognized that thicker sections of Dunedin exposed in the mountains of the Halfway River map area correlated with several Middle Devonian formations (Pine Point, Sulphur Point, Watt Mountain, and Slave Point) mapped extensively in the subsurface immediately east of the mountain belt. Previously Macqueen and Taylor (1974) and Macqueen and Thompson (1978), using the surface-to-subsurface correlations of Grifﬂn (1967), had also identifled the dominantly subsurface Pine Point and Slave Point formations within thicker ‘Dunedin’ successions. Throughout the 1970s, there was further reflnement and identiflcation of more local facies variations within Middle Devonian strata of the mountains (Macqueen and Taylor, 1974; Taylor et al., 1975; Morrow, 1978).

The stratigraphic nomenclature used in this study (Fig. 2) follows that of previous workers who correlated the anomalously thick ‘Dunedin’ successions mapped in the Trutch and Halfway River map areas with a succession of Middle Devonian formations in the subsurface. However, the term ‘Pine Point Formation (Group)’ is not used here because of the wide variance in its deflnition and usage. The reader is referred to Hills et al. (1981, p. 140) and Morrow et al. (2002) for a more detailed discussion of the term ‘Pine Point Formation’. For example, the Pine Point Formation was originally deflned (Cameron, 1918) to include strata that are part of what is now known as the Lonely Bay Formation and the Bituminous Limestone and Shale members of Norris (1965). Norris (1965) redeflned the unit to include all these strata above the Chinchaga Formation plus younger strata up to the base of the Sulphur Point Formation and including the forereef argillaceous strata of the Buffalo River Member and a tongue of the Horn River Formation. Skall (1975) elevated the Pine Point Formation to group status but excluded Lower Keg River Member strata above the Chinchaga Formation,

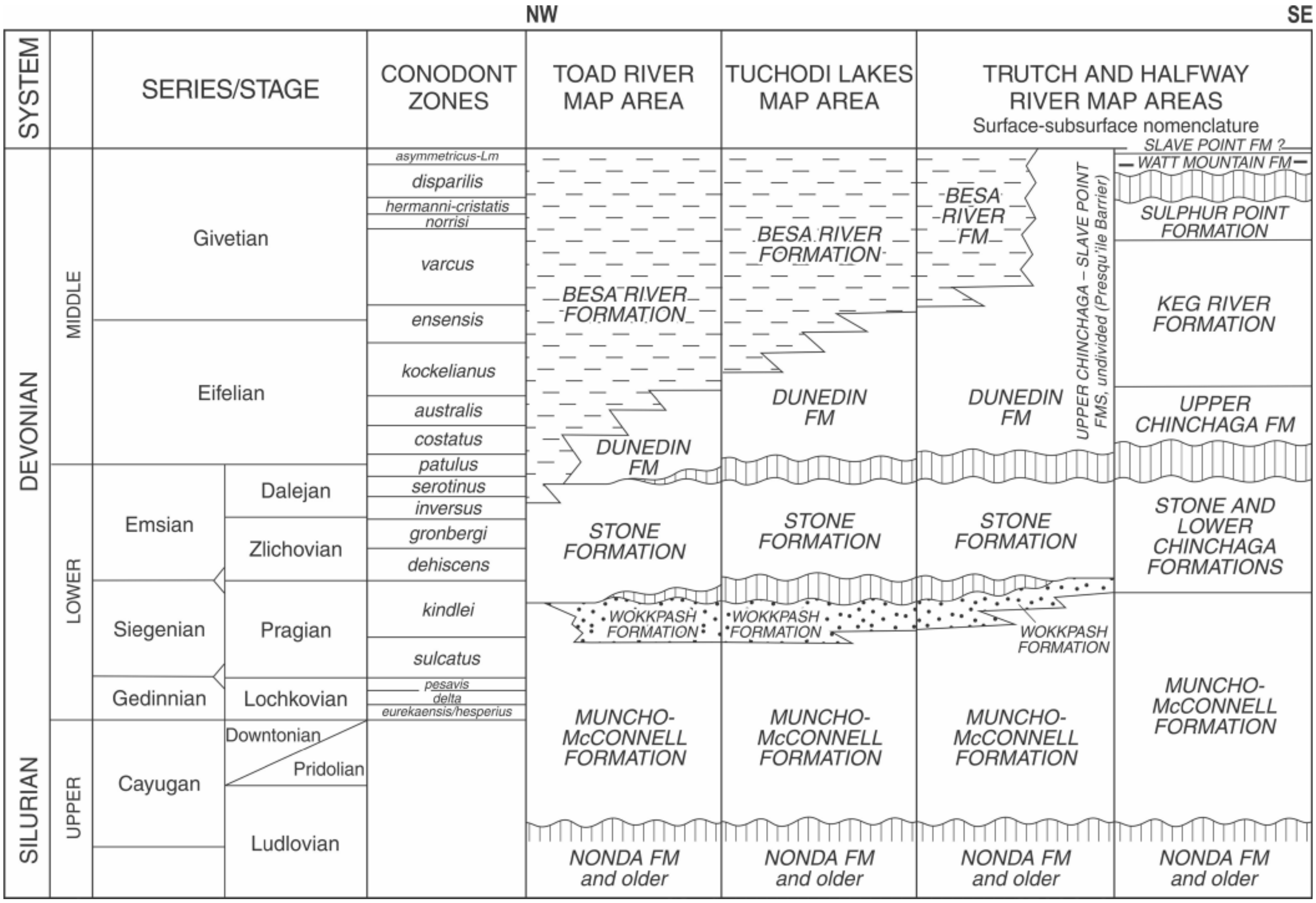



**Figure 2.** Stratigraphy of northeast British Columbia within the study area. An informal unit recognized here is the 'Upper Chinchaga to Slave Point Undivided'. These strata have been mapped as Dunedin Formation (Thompson, 1989), but are the surface exposure of the thick Presqu'ile Barrier reef complex that is developed throughout northeast British Columbia. This unit is formed largely, but perhaps not completely, of strata equivalent to the Keg River Formation and the upper part of the Chinchaga Formation. Lower and Middle Devonian conodont zonation is from Johnson et al. (1985).

although these were formerly included in the Pine Point. These are only a few of the many different usages that have been applied to the term 'Pine Point'.

A more recent use of the name 'Pine Point' in a major formal publication that focused on Devonian stratigraphy, is as an informal lithostratigraphic unit, the 'Pine Point dolostone' described in the region of the Northwest Territories near and at the former Pine Point minesite (Meijer Drees, 1993). Such a term cannot be used in this study because equivalent strata at the front of the Presqu'ile Barrier in northeast British Columbia contain a large proportion of limestone in addition to the flne-crystalline dolostone characteristic of the 'Pine Point dolostone' at Pine Point in the Northwest Territories (Meijer Drees, 1993).

This study follows the suggestion of Morrow et al. (2002) that the well-deflned subsurface stratigraphic succession of Chinchaga (Upper and Lower members), Keg River (Lower and Upper Members), Sulphur Point, and Watt Mountain formations be used in place of the poorly deflned Pine Point Formation wherever possible. There is, however, a need to recognize that most of the thick 'Dunedin' sections that include these strata cannot be subdivided lithostratigraphically. This is primarily because of the absence of the distinctive green shale marker of the Watt Mountain Formation, which permits separation of the Slave Point Formation from underlying pre-Slave Point middle Devonian strata. Consequently, an informal stratigraphic unit, the 'Upper Chinchaga to Slave Point Undivided' (Fig. 2), is used here to indicate an undivided succession ranging in age from late Eifelian (Upper Chinchaga equivalent) to middle Givetian (Watt Mountain equivalent) or even to late Givetian (Slave Point equivalent).

## METHODOLOGY

The material presented here formed part of a Master of Science degree submitted by L.M. Nadjiwon to the University of Waterloo, under the supervision of M. Coniglio at the

University of Waterloo. Fieldwork was conducted during the summers of 1998 and 1999. Twenty stratigraphic sections were measured through Lower and Middle Devonian strata (Fig. 1). Lithological descriptions for carbonates follow the classification of Dunham (1962), and modifications by Embry and Klovan (1971). Descriptions for siliciclastic rocks follow the classification of Folk (1974). Bed thickness and bedding-style terminology follows Ingram (1954) and Kahle and Floyd (1971). Breccia fabric descriptions follow Morrow (1982). Field descriptions were supplemented with thin-section examination, as outlined by Flügel (1982), for selected samples.

The Alaska Highway runs through the study area, though access to all but two field sections (Sections MTA-98-9 and MTA-99-1) was by helicopter. Strata were measured with a 1.5 or 1.3 m long Jacob's staff. Units within each formation were recognized on the basis of changes in lithology, fresh and weathered colour, weathering pattern, bedding, sedimentary structures (e.g. mudcracks), fossil content, and postdepositional alteration (e.g. dolomitization, brecciation, and mineralization).

## PALEOGEOGRAPHIC AND DEPOSITIONAL SETTING

Northeastern British Columbia, as part of Western Canada, was within tropical to subtropical latitudes throughout Middle Devonian time, with the paleoequator near the latitude of Great Slave Lake and inclined approximately 30° to the present parallels of latitude (Morrow and Geldsetzer, 1988). Open ocean lay to the west and north, and transgressions are interpreted to have progressed from northwest to southeast (Morrow and Geldsetzer, 1988). The study region is included in the Macdonald Block, bordered to the north by the Liard Line (Fig.1, 3) and to the south by the Great Slave Lake Shear Zone, (Fig. 1) both of which are basement features (Cecile et al., 1997). The MacDonald Platform, which occupies most of the study area (Fig. 3), was a region of dominantly shallow-water carbonate deposition.

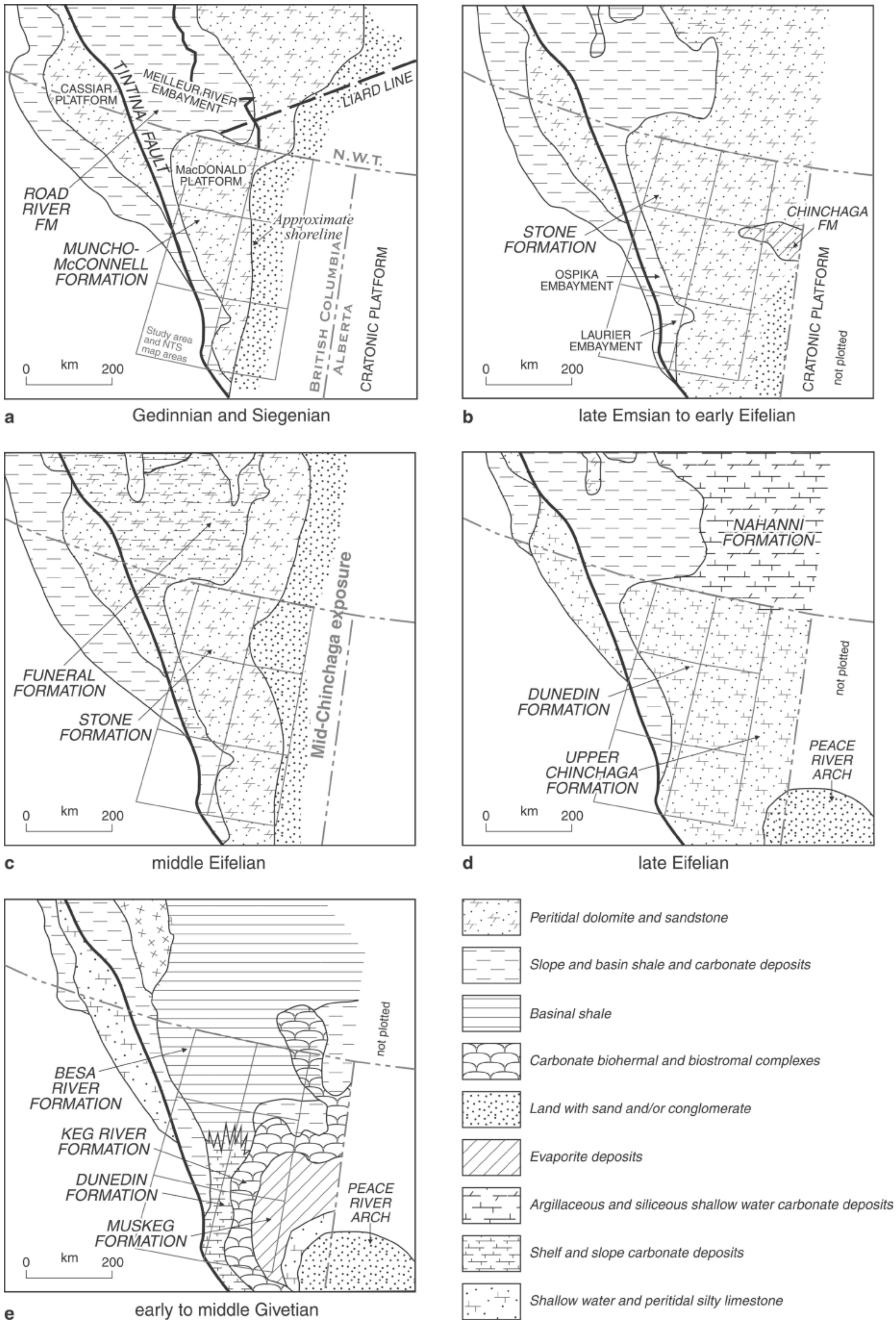
The discussion that follows and the maps shown in Figure 3 are based almost entirely on Morrow and Geldsetzer (1988). The paleogeographic maps of Figure 3 have not been restored palinspastically. A major structural discontinuity, the Tintina Fault (Fig. 3), separates the 'in place' Devonian east of Tintina from dextrally transported Devonian strata, including the tectono-sedimentological feature known as the Cassiar Platform (Fig. 3a), on the west side of the Tintina Fault.

Devonian sedimentation in Western Canada took place within two major provinces: the Continental Shelf and Cratonic Interior (Morrow and Geldsetzer, 1988). A thick sequence of marine sediments accumulated within the Continental Shelf tectono-sedimentological province, which is divided into inner and outer parts (Morrow and Geldsetzer, 1988). Shallow-marine carbonate deposits are characteristic of the Inner Shelf, whereas the Outer Shelf is characterized by resedimented slope and basin carbonate, siltstone, and shale that were deposited in marine basins and troughs bordering the west side of the Inner Shelf. Nineteen of the twenty stratigraphic sections described here are on the MacDonald Platform (Fig. 1), which is part of the Inner Continental Shelf tectono-sedimentological province of Morrow and Geldsetzer (1988). One stratigraphic section (Fig. 1), of slope and basin siliciclastic strata, is located in the Laurier Embayment, a part of the larger Ospika Embayment, both of which are part of the Outer Continental Shelf tectono-sedimentological province of Morrow and Geldsetzer (1988).

The Cratonic Platform tectono-sedimentological province (Morrow and Geldsetzer, 1988; Fig. 3a) lies east of MacDonald Platform. The Cratonic Platform contains a much thinner accumulation of shallow- to restricted-marine sediments. The Cratonic Platform was separated from the Continental Shelf tectono-sedimentological province by a 'hinge line' (Morrow and Geldsetzer, 1988; Griffin, 1967) across which the rate of Devonian subsidence abruptly increased westward. No measured stratigraphic sections of this study fall within the Cratonic Platform.

Several major western Canadian Devonian paleogeographic features affected sedimentation in northeast British Columbia. The Peace River Arch (Fig. 3), along the west edge of the Cratonic Platform Province in south-central British Columbia, was intermittently active throughout Devonian time, undergoing uplift and depression throughout the Devonian, and contributing clastic sediments during times of marine regression (Morrow and Geldsetzer, 1988; Cecile et al., 1997). To the north of this arch lay the MacDonald Shelf, which during the Devonian was an open-marine platform (MacDonald Platform) facing the Ospika Embayment and Meilleur River Embayment shale basins to the west and northwest, respectively (Fig. 3a; Morrow and Geldsetzer, 1988). A southern extension of the Kechika Trough, the Ospika Embayment (Fig. 1, 3), contained several re-entrants that extended into the MacDonald Shelf, or Platform (Ross et al., 1993), which accumulated basinal sediments until final filling in the early Middle Devonian. One of these is the 30 km wide Laurier Embayment (Fig. 1; Davies, 1997) situated in the northern part of the Halfway River map area.

**Figure 3.** Generalized paleogeographic maps of Lower and Middle Devonian facies distributions west of 120°W longitude. *Modified from* Morrow and Geldsetzer (1988). Outline of study area is superimposed on these maps.



CASSIAR PLATFORM
TINTINA FAULT
MEILLEUR RIVER EMBAYMENT
LIARD LINE
N.W.T.
MacDONALD PLATFORM
ROAD RIVER FM
Approximate shoreline
MUNCHO-McCONNELL FORMATION
BRITISH COLUMBIA
ALBERTA
CRATONIC PLATFORM
Study area and NTS map areas
0 km 200
a
Gedinnian and Siegenian
STONE FORMATION
CHINCHAGA FM
OSPIKA EMBAYMENT
LAURIER EMBAYMENT
CRATONIC PLATFORM
not plotted
0 km 200
b
late Emsian to early Eifelian
Mid-Chinchaga exposure
FUNERAL FORMATION
STONE FORMATION
0 km 200
c
middle Eifelian
NAHANNI FORMATION
not plotted
DUNEDIN FORMATION
UPPER CHINCHAGA FORMATION
PEACE RIVER ARCH
0 km 200
d
late Eifelian
not plotted
BESA RIVER FORMATION
KEG RIVER FORMATION
DUNEDIN FORMATION
MUSKEG FORMATION
PEACE RIVER ARCH
0 km 200
e
early to middle Givetian
Peritidal dolomite and sandstone
Slope and basin shale and carbonate deposits
Basinal shale
Carbonate biohermal and biostromal complexes
Land with sand and/or conglomerate
Evaporite deposits
Argillaceous and siliceous shallow water carbonate deposits
Shelf and slope carbonate deposits
Shallow water and peritidal silty limestone

East of the MacDonald Platform, across the Cratonic Platform Province, lay a shallow basin of restricted-marine circulation, the evaporitic Elk Point Basin (Maiklem, 1971). This continental interior basin extended as far south as North Dakota at the time of maximum Devonian marine incursion during the late Givetian (Braun et al., 1988).

Devonian strata in northeast British Columbia (Fig. 3) were deposited during the Kaskaskia Transgression (Sloss, 1963). This continent-wide transgression began in the latest Silurian, as recorded by the Muncho-McConnell Formation (Fig. 3a), and ended in the latest Famennian with deposition of the Exshaw Shale (Morrow and Geldsetzer, 1988). Several minor regressions, for example the middle Eifelian regression (Fig. 3c), which resulted in the mid-Chinchaga detrital break, punctuated the overall transgressive event. Following the Eifelian regression, the Devonian sea advanced all the way to North Dakota and filled the Elk Point Basin (Moore 1988; Fig. 3d). In mid-Givetian time, the western portion of the MacDonald Shelf underwent accelerated subsidence and the shale-carbonate facies transition shifted abruptly eastward (Fig. 3e). This marked the end of Dunedin Formation deposition and coincided with the development of a carbonate barrier complex, the Presqu'ile Barrier reef complex. This complex formed at the northern edge of the Elk Point Basin as a stable carbonate barrier, or, in other words, as a reef-rimmed cratonic basin margin, called variously the Keg River-Slave Point Barrier (Fig. 3e), or 'Presqu'ile Barrier' (Morrow and Geldsetzer, 1988) of the Elk Point Basin. This reef complex served as an effective barrier to marine circulation between the Elk Point Basin and the open ocean to the northwest until early Frasnian time. An abrupt transgression drowned the reef complex and deeper marine sedimentation was established, including deposition of the Besa River and Hay River formation shales as part of the continent-wide 'Taghanic Onlap' (Braun et al., 1988) Late Devonian marine transgression and basinal shale deposition.

# BIOSTRATIGRAPHY AND FORMATION AGES

## Previous studies

Devonian strata of northeastern British Columbia contain few age-diagnostic macrofaunas. Macrofaunas with age significance identified in previous studies include fish fragments considered to be Early Devonian (R. Thorsteinsson, pers. comm. 1998) reported from two localities in the Muncho-McConnell Formation (Taylor and MacKenzie, 1970). The crinoid *Gasterocoma bicaula* (Johnson and Lane, 1969), with its distinctive ossicles containing two axial canals, is diagnostic of the upper Lower Devonian (late Emsian) to lower Middle Devonian (middle Eifelian) (Dunn and Kendall, 1978). A. W. Norris (pers. comm. *in* Taylor and MacKenzie, 1970) described two-holed crinoids from strata 225 m from the base of the Dunedin in the Caribou Range (Toad River map area). Previous work (Taylor and MacKenzie, 1970) indicated that the Dunedin top is diachronous based upon brachiopod determinations. In the Caribou Range to the north, the top beds contain *Schuchertella* cf. *S. adoceta*, which is Eifelian in age. In the central areas, top beds contain the Givetian brachiopods *Leiorhynchus castanea*, whereas in the south (94B), they contain *Hadrorhynchia sandersoni* and *Halloceras logani*, both indicative of late Givetian strata. Chatterton (1978), based on conodont determinations, found the age of the Dunedin near its northern limit to be no younger than early to middle Eifelian.

At Mount Jane Smith (59°N, 126°07´W) along the northwestern limit of Dunedin exposure immediately west of the Toad River map area, a conodont collection taken from the Dunedin Formation 30 m beneath its upper contact indicates that the Dunedin Formation at this locality is no younger than earliest Eifelian (Chatterton, 1978). This is older than the latest Eifelian to mid-Givetian age for the upper contact of the Dunedin Formation at its type section in Section MTA-99-1 (Table 2). These data corroborate the previously suggested diachronous nature of the upper Dunedin contact (Taylor and MacKenzie, 1970).

# BIOSTRATIGRAPHIC DATA OF THIS STUDY

## Introduction

Conodonts represent the most generally useful means for biostratigraphic zonation of Devonian carbonate rocks worldwide (Johnson et al., 1985). Forty-two (42) conodont samples were collected during this study and seventeen of these yielded identifiable conodonts (Table 2). Collections were made preferentially from beds near the upper and lower contacts between formations. Conodont samples were processed and analyzed by A. D. McCracken (2000a, b). Most of these were collected from the Dunedin Formation (22 samples) and the Upper Chinchaga to Slave Point Undivided (13), with the remainder from the Stone (2), Muncho-McConnell (1), Nonda (2) and Besa River (2) formations.

Abundant macrofauna were observed in many of the stratigraphic sections measured in this study, but only one of these (*Stringocephalus* sp.) has stage-specific age significance (Sample C-406029 in Section MTA-98-3).

## Nonda Formation

The uppermost bed of the Nonda Formation beneath the Devonian succession at Keily Creek in the Trutch map area (Section MTA-99-4) is firmly dated as late Llandovery to early Wenlock, or Early Silurian in age (Table 2) in agreement with previous work, summarized in Norford (1997).

Norford (1997) indicated that the beds immediately below the erosional top surface of the Nonda Formation fall within an age range of late Llandovery to early Wenlock throughout northeast British Columbia.

## Muncho-McConnell Formation

No new faunal age dates for the Muncho-McConnell Formation were obtained during this study. Norford (1997) indicated a latest Wenlock age for the base of the Muncho-McConnell throughout northeast British Columbia.

## Stone Formation

As with the Muncho-McConnell Formation, no new age dates were obtained for the Stone Formation during this study. Previous work (e.g. Chatterton, 1978) has indicated a Siegenian to Emsian age for the Stone Formation in northeast British Columbia.

## Dunedin Formation

All Dunedin conodont determinations were from the upper parts or uppermost beds of the Dunedin Formation. Almost all these yielded conodonts representing the *ensensis* Zone to Lower or Middle *varcus* Subzone, indicating the latest Eifelian to early Givetian of the Middle Devonian (Table 2). One sample (C-254943 in Table 2) yielded conodonts indicative of the *kockelianus* Zone to Middle *varcus* Subzone, which ranges from late Eifelian to mid-Givetian in age.

Dunedin strata also contain some age-significant macrofauna. Crinoid ossicles with two axial canals were identified in Section 11 (Caribou Range in the Toad River map area) at 70 m above the base of the Dunedin Formation. This suggests that the lower part of the formation is late Emsian to early Eifelian in age in the northern sections of the study region, confirming the results of previous workers (Taylor and MacKenzie, 1970; Morrow, 1978).

## Upper Chinchaga to Slave Point Undivided

Conodont samples from the Upper Chinchaga to Slave Point Undivided yielded age determinations similar to those of the Dunedin Formation, ranging from the *costatus* Zone to the Upper *varcus* Subzone (Table 2). This indicates a mid-Eifelian to mid-Givetian age range (Table 2). However, it is of interest to note that the youngest age (Upper *varcus* Subzone) is slightly younger than the youngest determinations (Middle *varcus* Subzone) from the Dunedin Formation as well as those (Middle *varcus* Subzone) from the basal beds of the Besa River Formation above the Dunedin Formation at its type section (MTA-99-1). Consequently, the Upper Chinchaga to Slave Point Undivided includes strata that are age-equivalent to uppermost Keg River Formation and possibly younger (Johnson et al., 1985).

Large terebratulid brachiopods identified as *Stringocephalus* sp. (Norris, 1998), diagnostic of the Givetian Stage or Age (Crickmay, 1960), were found in reef-like buildups 20 m from the top of the Dunedin/Keg River at Section MTA-98-3. Similar brachiopods (not formally identified) were found near the top of Section 19.

## Besa River Formation

The two conodont determinations obtained from samples from basal Besa River beds in Sections MTA-98-1 and MTA-99-1 were both indicative of the *ensensis* Zone to mid-Middle *varcus* Subzone, or a latest Eifelian to mid-Givetian age range.

## Dolomitic quartz sandstone map unit (Unit Dqs)

The Besa River in Section MTA-98-1 conformably overlies the ‘dolomitic quartz sandstone map unit’ in the Laurier Embayment. This is consistent with the perception that the ‘dolomitic quartz sandstone map unit’ is at least partly coeval with deposition of the Dunedin Formation and the Upper Chinchaga to Slave Point Undivided, but no fauna were collected from this unit to confirm this interpretation.

# STRATIGRAPHY OF THE STUDY AREA

## Introduction

Devonian stratigraphy within the two northern map areas (Toad River and Tuchodi Lakes) differs markedly from that within the two southern map areas (Trutch and Halfway River; Fig. 2, 4), where some sections include strata equivalent to formations, such as the Keg River and Sulphur Point formations that are mapped throughout the subsurface to the east of the outcrop belt. Lower Devonian formations are present across the study area but tend to be markedly thicker to the northwest (Fig. 4). A marked basinal re-entrant filled with a siliciclastic succession occurs along the Devonian shelf edge in the Halfway map area. This has been termed the Laurier Embayment (Fig. 1, 4; Davies, 1997). Strata occupying this embayment are age-equivalent to the Silurian to Middle Devonian, carbonate-dominated shelf platform succession bordering the embayment, and have been described and informally named by Thompson (1989; Fig. 4, 5).

The Upper Chinchaga to Slave Point Undivided and the Dunedin Formation were the primary research subjects of a Master thesis (Nadjiwon, 2001) using the outcrop

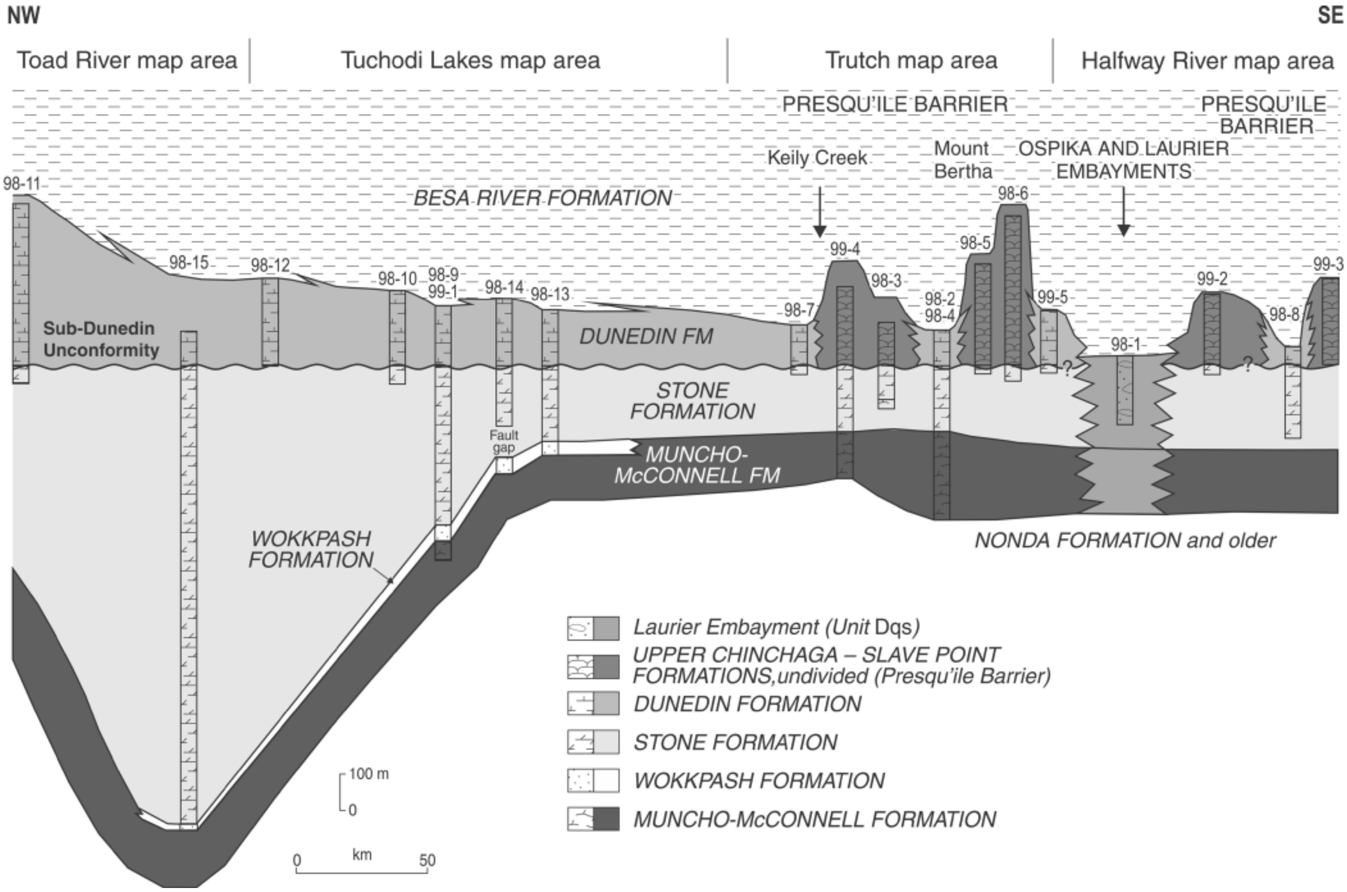



**Figure 4.** Generalized cross-section of the study area, illustrating the relationships between the formations and thickness changes within them. Section datum is the top of the Stone Formation and the line of section is shown on Figure 1.

stratigraphic data provided by this study. A more complete summary of sedimentological and diagenetic findings for these formations is planned for future publications.

## Dolomitic quartz sandstone unit (Dqs)

The Middle Devonian dolomitic quartz sandstone unit (Dqs) was measured in only one incomplete section (Fig. 5; MTA-98-1) of the uppermost map unit of the basinal lower Paleozoic siliciclastic succession within the Laurier Embayment (Fig.1; Thompson, 1989). The latest Eifelian to mid-Givetian age of Besa River limestone and shale immediately overlying this unit in Section MTA-98-1 (Table 2), as mentioned previously, is consistent with Thompson's (1989) correlation of the Dqs map unit with Dunedin strata flanking the Laurier Embayment. Also, the presence of eroded breccia fragments of grey dolostone in unit 2 of Section MTA-98-1 that resemble dolostone of the Stone Formation may indicate that much of the Dqs map unit is formed of deposits shed into the embayment during the period of erosion of the surrounding MacDonald Platform that followed deposition of the Stone Formation.

## Muncho-McConnell Formation

The oldest Devonian unit is the Muncho-McConnell Formation, originally named by Taylor and MacKenzie (1970) describing an approximately 60 to 350 m thick succession of homogeneous, colour-banded, medium to light grey, medium- to thick-bedded, fine-crystalline to aphanitic dolostone. Recessive, faintly yellow-weathering, silty to sandy, laminated dolostone intervals impart a somewhat 'ribbed' appearance in outcrop to the Muncho-McConnell (Fig. 6a, 7a). The two complete sections of Muncho-McConnell measured as part of this study were 267.0 m in Section MTA-98-2, and 142.5 m in Section MTA-99-4 (Fig. 1, Table 3). The Muncho-McConnell overlies the dark grey, more resistant, Silurian Nonda Formation (Fig. 2, 4, 6a and 7a; Norford et al., 1966) with a low-relief, and abruptly unconformable contact (Fig. 8a) across the study area.

Because of the paucity of data, determination of facies changes within the Muncho-McConnell across the study region is difficult. Overall, it is very fine-crystalline dolomite, probably originally deposited as a mudstone. There are numerous silty and sandy intervals as laminae and lenses (Fig. 8b). Dominant sedimentary structures are laminae (many likely microbial), fenestral fabric, and local channels and scour features, some of which are half a metre in



**Figure 5.** Outcrop photographs at or near Section MTA-98-1 near Robb Lake. **a)** View to the south of the east-west ridge immediately south of Section MTA-98-1. This shows part of the siliciclastic lower Paleozoic succession that fills the Laurier Embayment (*see* Fig. 1). 2010-056 **b)** Hummocky trough-crossbedding in dolomite-cemented quartzarenite sandstone of unit 2 in Section MTA-98-1. Jacob's staff for scale. 2010-057

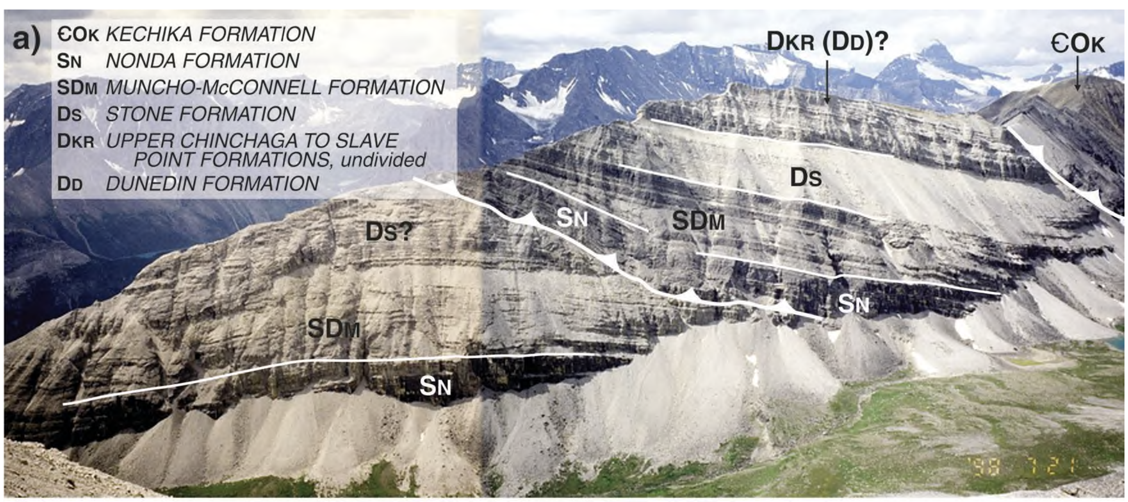




**Figure 6.** Outcrop photographs at or near Section MTA-98-3 north of Redfern Lake. **a)** Panoramic view to the south of several thrust panels immediately south of Section MTA-98-3. 2010-058 **b)** Close-up view of the large terebratulid brachiopod *Stringocephalus* sp. in unit 23 of Section MTA-98-3. Brachiopod shells shown are about 10 cm in length. 2010-059

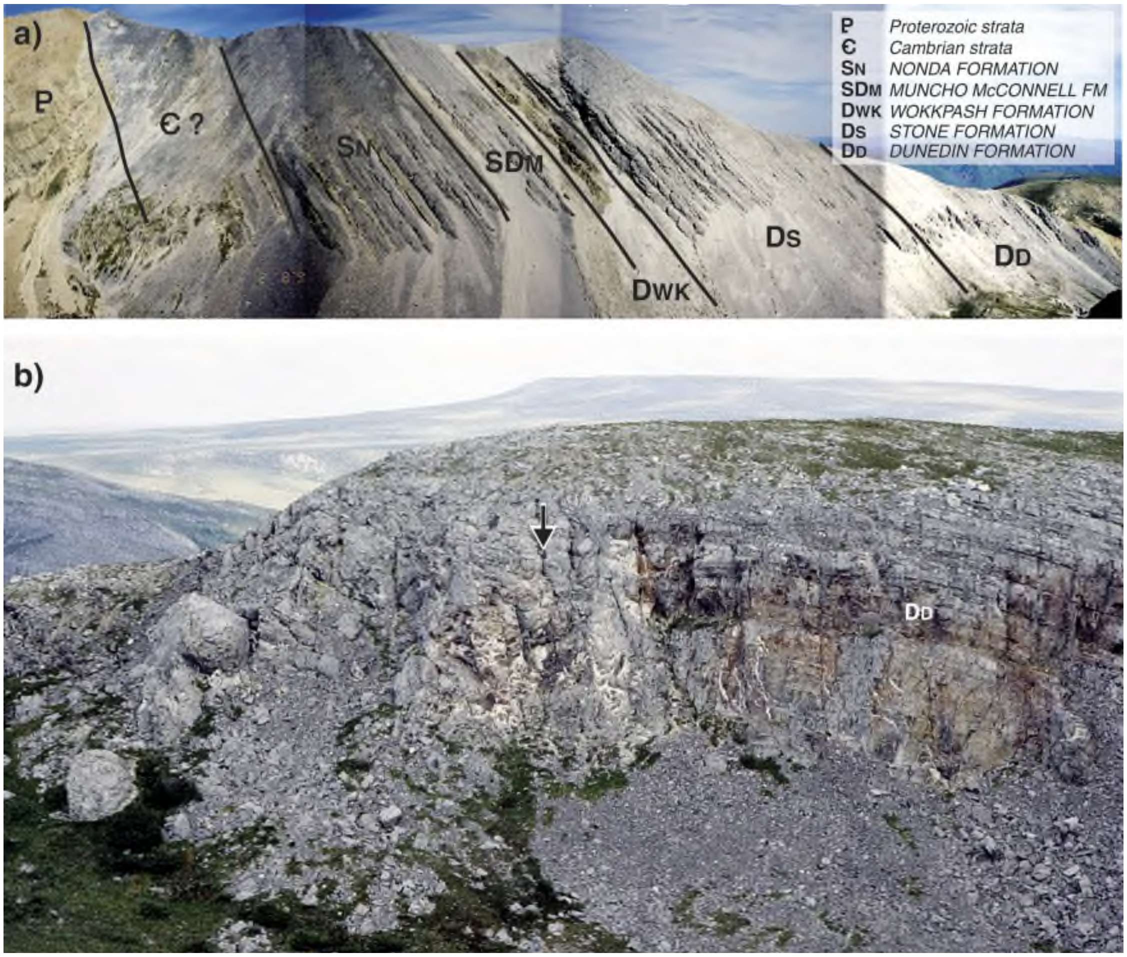



**Figure 7.** Outcrop photographs at Sections MTA-98-11 and MTA-98-13. **a)** View to the north from Section MTA-98-13 of the lower Paleozoic succession near Mount Mary Henry. 2010-060 b**)** View to the north of a small hill, about 15 to 20 m high, formed of bedded limestone near the top of the Dunedin Formation immediately north of Section MTA-98-11. A large, white calcite- and/or dolospar-cemented body of rubble and mosaic breccia is exposed (arrow). Larger breccia blocks are estimated to be about a metre across. 2010-061

amplitude. Visible fauna are seen only in Section MTA-98-2, as stromatoporoids within small biostromes near the base of the formation. This same section is also the most siliciclastic. In general, this formation was deposited in a peritidal environment but Section MTA-98-2 shows some evidence of occasional deposition in a subtidal to open-marine environment, perhaps because of its relative proximity to the Laurier Embayment (Fig. 4).

## Wokkpash Formation

North of Keily Creek (Fig. 1) the Muncho-McConnell Formation is conformably overlain by a succession of nearshore, crossbedded, dolomitic, cream- to yellowish-orange-weathering, white quartz arenite of the Wokkpash Formation, which is reported to range in thickness from about 40 to about 125 m (Fig. 2; Taylor and MacKenzie, 1970). Strata of this formation are included within four sections of the two northern map areas (Table 3). Three complete Wokkpash sections ranging in thickness from 41.6 to 50.7 m were measured (Table 3, Fig. 7a). The Wokkpash Formation is unconformably overlain by the Stone Formation (Taylor and MacKenzie, 1970; Fig. 2). The Wokkpash was not identified in the southern part of the Trutch map area or in the Halfway River map area, consistent with the observations of Taylor and MacKenzie (1970) (Fig. 4). The dominant lithology is sandstone, with dolomitic sandstone in Section MTA-98-13, the southernmost exposure of the formation. Much of the sandstone contains silty layers.

Overall, the formation contains sedimentary structures indicative of deposition within a shallow-marine foreshore to nearshore environment with moderate to high energy levels, such as a barrier bar complex. These features include scour-and-flll bedding (Fig. 8b), crossbedding, and current laminae. There are also soft-sediment deformation structures, including flame and ball-and-pillow structures.

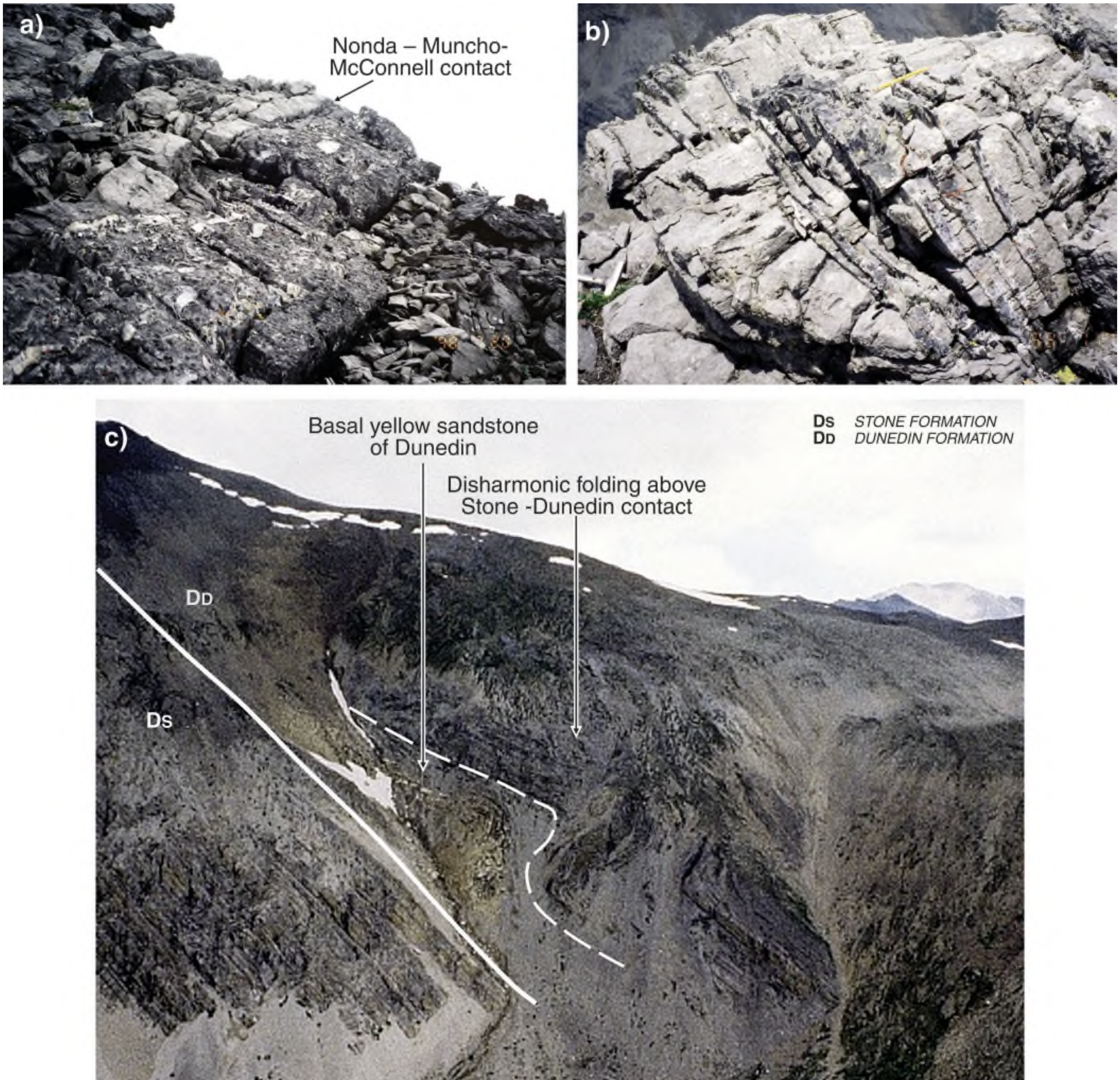



**Figure 8.** Outcrop photographs at or near Section MTA-98-2 south of Colledge Lake. **a)** Contact between Nonda and Muncho-McConnell formations at the top of unit 1 in Section MTA-98-2 (arrow). The contact is erosional, with up to 20 cm of relief. The highly fossiliferous bed below the contact is approximately 50 cm thick. 2010-062 **b)** Lenticular silicified sand lenses within the dolostone of unit 5 in Section MTA-98-2. 2010-063 **c)** View to the north from Section MTA-98-2 across the valley of Section MTA-98-4 showing disharmonic folding (outlined for emphasis) at the Stone-Dunedin contact. Detachment has occurred at the base of the yellow sandy beds of the Dunedin. 2010-064

## Stone Formation

The Stone Formation conformably overlies the Muncho-McConnell Formation south of Keily Creek and the Wokkpash Formation north of Keily Creek (Fig. 4). The Stone Formation is a succession of northward-thickening, shallow-marine dolostones estimated to range from 150 to 650 m in thickness (Taylor and MacKenzie, 1970). North of the type section (in Section MTA-98-9), the thickness of the Stone Formation increases more markedly. The seven complete Stone sections measured in this study range in thickness from 105.5 to 1386.6 m (Table 3). The anomalously thick Stone Formation in Section MTA-98-15 may be structurally thickened. South of Keily Creek, where the Wokkpash is absent, the Stone Formation appears to overlie the Muncho-McConnell conformably.

The dominant rock types of the formation are dolostone and silty to sandy dolostone. The dolostone is generally fine crystalline, originally a mudstone, and contains features such as colour banding, laminae, fenestral fabric, mudchip breccias within laminated units, scour and channel fills, and rare teepee structures, mudcracks, burrows, and stromatactis-like features. Bioclasts are rare, and include amphiporids in Sections MTA-98-15 and MTA-99-4, finely comminuted skeletal debris, corals, and bivalve shells in Section MTA-98-3, stromatolites and comminuted shell hash in Section MTA-98-2, and comminuted shell hash in Section MTA-99-2. Mature quartz sand appears within the formation in the more southerly sections of the Tuchodi Lakes map area as sandy laminae and crossbeds, and in sandy and silty lenses, stringers, and thin beds. Thick pods and beds of particulate rubble pack- and float breccias are found in the middle portions of the Stone Formation in the central portions of the study area, in the same sections in which siliciclastic content first becomes apparent in outcrop. The breccias are composed of rounded to angular mud intraclasts floating in a darker mudstone matrix. These breccias are found in Sections MTA-98-13, 98-14, and 99-4. The breccias can be contained within one or several beds, or may even cut perpendicularly through bedding.

The upper contact of the Stone Formation with the Dunedin Formation is clearly unconformable at several sections, including MTA-98-15, 98-10, 99-1, 98-13, 98-14, and 98-7. This contact appears as a weathered surface with orange to red mud infiltrating the karst surface, or as a wavy unconformity with a relief of up to 50 cm. The contact between the Stone and Upper Chinchaga to Slave Point Undivided is not as clearly unconformable in the outcrop localities studied.

There are several different types of postlithification breccias and other diagenetic features within the Stone Formation. Breccias associated with tectonism and faulting are found in Sections MTA-98-15 and MTA-98-14, as calcite-cemented rubble to mosaic packbreccias. In Sections MTA-98-9 and MTA-98-10 there are rubble and mosaic pack breccias showing clear solution collapse, cemented by barite and minor calcite. This breccia extends upward into the Dunedin Formation at Section MTA-98-10. Calcite-cemented collapse rubble breccia is bound in the basal units of Sections MTA-98-25 and MTA-99-4. The only dolomite-cemented breccias are found within Section MTA-99-2, which has saddle-dolomite-cemented collapse breccia clearly associated with the overlying hydrothermal dolomitization of the Upper Chinchaga to Slave Point Undivided at that location.

## Dunedin Formation

The overlying Dunedin Formation, a succession of open-marine, shelfal argillaceous limestone (Taylor and MacKenzie 1970), was deposited north of Keily Creek and generally north and west of the Presqu'ile Barrier reef complex (Bassett and Stout, 1967). The 'Presqu'ile Barrier' (Meijer Drees, 1994) is a paleogeographic feature that coincides with the northwest limit of the combined Keg River and Slave Point formations mapped both on the surface and in the subsurface (Fig. 1). The Dunedin Formation was reported to range in thickness from about 140 to about 350 m in outcrop exposures in northeast British Columbia (Taylor and MacKenzie, 1970). The nine complete Dunedin successions measured in this study range in thickness from 55.5 to 263.5 m (Table 3). There is a general northwestward increase in Dunedin thickness to a maximum measured incomplete thickness of 490.5 m in Section MTA-98-11 (Fig. 4). The thinnest Dunedin successions, at sections MTA-98-4, MTA-98-7, and MTA-98-8, occur immediately adjacent to the Presqu'ile Barrier represented by the relatively thick Upper Chinchaga to Slave Point Undivided succession (Fig. 4).

The darker open-shelf limestone of the Dunedin rests abruptly and unconformably on lighter coloured dolostone of the underlying Stone Formation (Fig. 4, 9a) in the Tuchodi Lakes and Toad River map areas (Morrow, 1978). In the Trutch and Halfway River map areas south of Keily Creek (Fig. 1, 4) the basal Dunedin beds of orange and yellow dolomitic siltstone and sandstone up to 20 m thick overlie the erosional unconformity surface at the top of the Stone Formation. In some areas, this surface has structural expression as a minor décollement with small detachment folds developed in overlying Dunedin strata (Fig. 8c). The upper contact of the Dunedin with the overlying dark grey and black shale of the Besa River Formation is gradational over several metres (Fig. 9b). This interpretation of a gradational upper contact is corroborated by conodont age determinations from samples immediately above and below the upper Dunedin contact at the Dunedin type section (Taylor and MacKenzie, 1970) in Section MTA-99-1 (Table 2). Conodont determinations from these samples (C-254975 and C-254976 in Table 2) indicate that both the basal Besa River strata and the uppermost Dunedin strata in this section fall within the *ensensis* Zone to mid-Middle *varcus* Subzone. This indicates a latest Eifelian to mid-Givetian Middle Devonian age for the entire stratigraphic interval containing these faunas at the Dunedin type section.

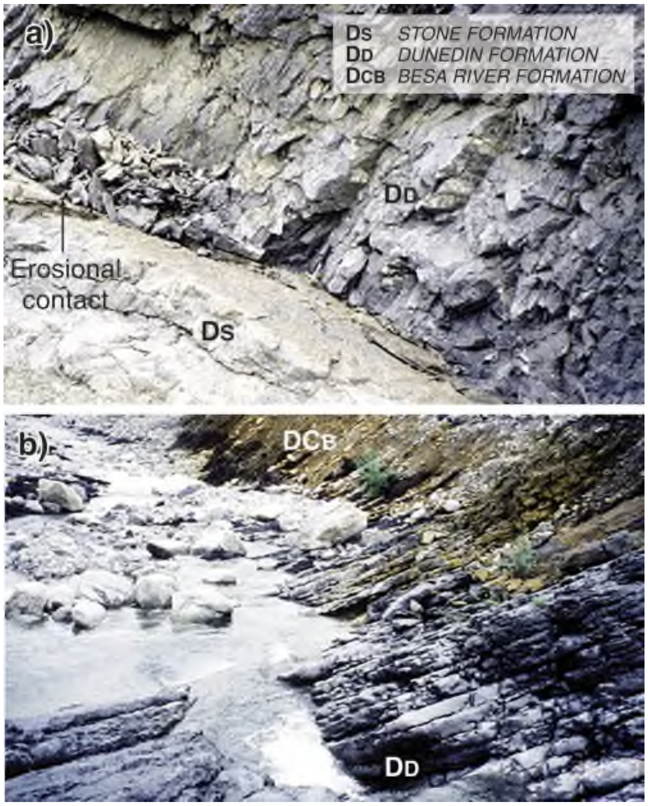



**Figure 9.** Outcrop photographs at Section MTA-98-10. **a)** Sharp, erosional contact of medium to dark bluish grey Dunedin limestone on light grey dolostone of the Stone Formation (arrow). 2010-065 **b)** Upper gradational contact of the Dunedin Formation to Besa River Formation in Section MTA-98-10, where thin-bedded Dunedin limestone passes upward to grey Besa River shale. 2010-066

The Dunedin Formation was deposited almost entirely as limestone except for basal beds that are commonly peritidal synsedimentary dolostone. A minor percentage of dolomite also occurs as irregular matrix replacement throughout the formation, appearing as micrometre-scale euhedral to subhedral rhombs generally associated with peritidal deposits. Section MTA-98-7 contains a higher proportion of dolomitic limestone than other sections. This may be a consequence of its relatively landward position on MacDonald Platform (Fig. 1, 4).

Typical rock types include mudstone, wackestone and packstone, with some grainstone and floatstone. Many of the units contain peloids. Amphiporid rudstones are also found as small beds throughout the formation. There are some rare silty intervals, preserved as laminae and lenses, which occur in Section MTA-99-1 and in Dunedin sections south of MTA-99-1. Typical sedimentary structures include bioturbation and burrows, laminae, microbial-mediated laminae, fenestral fabric, scour-and-fill laminae, colour laminae, mudcracks, sedimentary breccias of mudchip intraclasts, and rare crossbedding. Some bioclasts found include ostracodes, brachiopod and gastropod shell fragments, crinoids, hemispheroidal stromatoporoids, and also amphiporids, corals, calcispheres, charophyte oogonia, trilobite fragments, echinoderm fragments, finger and laminar stromatoporoids, and stromatolites. Bryozoans are found in the most southern sections (MTA-98-13 and MTA-98-7). The middle third of Section MTA-98-10 contains within peloidal bioclastic grainstone small, shallowing-upward cycles that end at possible hardground surfaces and have basal scour features.

Overall, the formation appears to have been deposited during a transgressive event. The basal units are generally shallow open marine in nature, and are followed by strata indicating fluctuating peritidal and shallow subtidal marine depositional environments. Upward through the formation the proportion of subtidal and open-marine strata increases and the peritidal strata decrease. Section MTA-98-11 is the farthest northerly measured section, and also the thickest. Within the basal 200 m of the section there are numerous irregular crinoidal grainstone and floatstone beds alternating with mudstone. These are interpreted as crinoidal and bioclastic shoals forming on the northern edge of the MacDonald Platform during initial Dunedin Formation deposition. Nodular black chert and silicified bioclasts are commonly found within the uppermost 100 m of the formation in many sections.

A breccia pipe occurs in the upper part of Section MTA-98-11, cemented by very coarse-crystalline calcite and silica, with large angular clasts (Fig. 7b). As previously mentioned in the discussion of the Stone Formation, the lower half of Section MTA-98-10 contains a great thickness of barite- and calcite-cemented mosaic to rubble floatbreccia (Morrow, 1982) of probable solution-collapse origin.

## Upper Chinchaga to Slave Point Undivided

Dunedin Formation strata mapped near the Presqu'ile Barrier are age-equivalent to the Upper Chinchaga Member and the lower part of the Keg River Formation (Lower Keg River Member) in the subsurface (Fig. 2). As discussed previously, surface exposures of anomalously thick successions mapped as 'Dunedin' in the southern Trutch and Halfway River map areas have been designated here as the 'Upper Chinchaga to Slave Point Undivided'. This unit forms the outcrop continuation of the subsurface Presqu'ile Barrier (Fig. 10a) in these map areas (Fig. 1, 2). This informal name is applied to strata previously mapped as Dunedin Formation in the Halfway River map area by Thompson (1989). Thompson (1989) recognized that the thicker Dunedin outcrop successions in this map area included packages of strata correlative with, and individually recognizable in outcrop as, correlatives of the subsurface Pine Point, Sulphur Point, Watt Mountain, and Slave Point formations (Fig. 19 *in* Thompson, 1989). This detailed subdivision of thick Dunedin successions in the Trutch and Halfway River map areas was not recognizable in 'Dunedin' successions examined during this study, primarily because the distinctive


**Figure 10**. Outcrop photographs at or near Section MTA-98-5. **a)** View to the north of Mount Bertha. 2010-067 **b)** Section MTA-98-5 on the north side of Mount Bertha. A large, subvertical body of dolomitized and white dolospar-cemented mosaic breccia (unit 10) lies between the arrows. Strata around this body are undolomitized limestone or unbrecciated bedded dolostone (see Section MTA-98-5). 2010-068 **c)** Large, hemispheroidal and domal stromatoporoids in the 'Upper Chinchaga to Slave Point Undivided' strata in unit 18 of Section MTA-98-5. These reefal, stromatoporoid-dominated beds form the prominent line of light grey cliffs along the upper part of the 'Upper Chinchaga to Slave Point undivided' in Figure 10a. Jacob's staff for scale. 2010-069 **d)** Dolospar-cemented brecciated dolostone of unit 10 in this section. Hammer for scale. 2010-070

green shale marker of the Watt Mountain Formation was not observed. However, the presence of charophyte oögonia in unit 21 of Section MTA-98-3 in the upper part of the Upper Chinchaga to Slave Point Undivided may indicate that unit 21 is age-equivalent to Watt Mountain strata farther east (Morrow et al., 2002). Watt Mountain strata are characterized by an abundance of charophyte oögonia indicating a fresh- to brackish-water environment (Meijer Drees, 1993). It is not certain, however, how much, if any, of the Upper Chinchaga to Slave Point Undivided is younger than the Keg River Formation.

The Upper Chinchaga to Slave Point Undivided limestone was affected by hydrothermal dolomitization following burial (*see* Presqu'ile and Manetoe dolomites, below). There is some matrix dolomitization of micrometre-scale euhedral to subhedral dolomite rhombs within the limestone intervals.

Siliciclastic deposits are found at the base of the Dunedin Formation in sections MTA-98-4 and MTA-99-5 and at the base of Upper Chinchaga to Slave Point Undivided strata in sections MTA-99-2 and MTA-99-4. These basal units are pure quartz arenite grading to silty dolostone in the north, and become a silty dolomite farther to the south. These units may represent shoreface deposition attendant upon southward marine transgression across MacDonald Platform after subaerial exposure of the Stone Formation.

Diverse rock types occur throughout the Upper Chinchaga to Slave Point Undivided, from mudstone to bioclastic rudstone. Sedimentary structures include laminae, burrowing and bioturbation, mud intraclasts and sedimentary breccias, fenestral fabric, microbial laminae, current ripples, crossbedding and crosslamination, and stromatactis (Flügel, 1982). Bioclasts include brachiopod and gastropod shells, ostracodes, echinoderm fragments, bryozoans, corals, hemispheroidal and laminar stromatoporoids, crinoids, amphiporids, trilobites, sponges, algae, and calcispheres.

Most of the Upper Chinchaga to Slave Point Undivided was deposited in and around a reef or biostromal complex. Alternation of back-reef restricted lagoons, reef-core stromatoporoidal (Fig. 10c) and coral rudstones, and forereef, bioclast-rich debris beds are common. This facies mosaic was developed on an open-marine subtidal platform of mudstone and bioclastic wackestone, or upon a siliciclastic shoreface. The outcrop belt runs approximately parallel to the strike of the reef front, but there are some sections that contribute an east-west component to the complex. The Upper Chinchaga to Slave Point Undivided in Sections MTA-98-5 and MTA-98-6 are positioned east of the Dunedin Formation in Section MTA-98-4, and there is a distinct difference in the appearance of the sections. The easterly Upper Chinchaga to Slave Point Undivided sections are much thicker, and contain back-reef lagoon and reef core sediments, whereas the westerly Dunedin section contains open-marine and off-reef debris beds and biostromes. Another example is seen between Sections MTA-98-8 and MTA-99-3 (Fig. 4). These sections are separated by only one mountain ridge, and are about 2 km apart, but display very different thicknesses and facies development within the strata mapped entirely as "Dunedin Formation" (Thompson, 1989) in both sections. The Upper Chinchaga to Slave Point Undivided in Section MTA-99-3 is thick, and contains thick stromatoporoidal boundstones and other reefal facies not typical of the Dunedin Formation in its type area farther north, whereas the Dunedin in Section MTA-98-8 is much thinner and contains forereef, slope-deposited, and open-marine strata.

Dolomitization, as part of the Presqu'ile Dolomite, occurs throughout the formation as a result of hydrothermal alteration (Fig. 10b). Associated fabrics include rubble and mosaic float- and packbreccias, zebra fabrics, and saddlerized salt-and-pepper (Fig. 10d). Many of the coarser breccias have later calcite and quartz cements in open vugs and veins. Some vugs contain a final lining of a bituminous substance. As with the Dunedin Formation, silicification commonly occurs within the top 100 m of the formation as chert nodules and lenses and silicification of bioclasts.

## Besa River Formation

The Besa River Formation represents the onset of southeastward marine transgression and basinal shale deposition progressively across the MacDonald Platform toward the Presqu'ile Barrier during Eifelian time and over the Presqu'ile Barrier in Givetian time (Fig. 1, 2, 4).

The contact between the Besa River shale and the underlying Dunedin Formation or Upper Chinchaga to Slave Point Undivided can be abrupt (as at Section MTA-99-1), gradational, or interfingering (Sections MTA-98-10 and 98-8; Fig. 9b). Exposures of Besa River Formation were not measured formally, except at Section MTA-99-1 where its basal 6 m were described. It consists of noncalcareous, recessive, platy, shale. There are lime mudstone concretions, up to 1 m in length, within the lowermost beds.

## Presqu'ile and Manetoe dolomites

Presqu'ile Dolomite is a postdepositional diagenetic replacement facies that is superimposed on the Middle Devonian carbonate depositss of the Presqu'ile Barrier reef complex along its entire length. Presqu'ile Dolomite has extensive lateral development within the Sulphur Point Formation, but is also extensively developed within the overlying Slave Point and underlying Keg River formations along the margin of the Presqu'ile Barrier in the Northwest Territories (Meijer Drees, 1993) and in northeast British Columbia (Griffin, 1967). This diagenetic dolomite forms the host rock for most of the prolific Devonian gas reservoirs of northeast British Columbia, including the large Clarke Lake gas field shown in Figure 1. Typically, Presqu'ile Dolomite occurs as large masses of dolomitized carbonate characterized by a large proportion of white, coarse-crystalline 'saddle dolomite' as massive replacements, as dolospar-cemented breccias, as dolospar-filled vugs, or as zebra dolomite—a more or less regular alternation of white dolospar and grey host carbonate in a centimetre-scale, colour-banded fabric (Beales and Hardy, 1980).

Large masses of this type of replacement (*sensu lato*) dolomite occur in the Upper Chinchaga to Slave Point Undivided in five sections (MTA-98-5, MTA-98-6, MTA-99-2, MTA-99-3, and MTA-99-4) and smaller amounts occur in the Dunedin Formation in three sections (MTA-98-4, MTA-98-8, and MTA-99-5). All these outcrop occurrences of Presqu'ile Dolomite are restricted to the region south of Keily Creek (Fig. 4). In other words, Presqu'ile Dolomite in Dunedin strata is developed in close proximity to the Presqu'ile Barrier, represented by the Upper Chinchaga to Slave Point Undivided successions (Fig. 4).

There are wide variations in textural development of these outcrop occurrences of Presqu'ile Dolomite. However, there are two contrasting styles of Presqu'ile Dolomite emplacement or dolomitization. One style occurs solely, albeit spectacularly, in Section MTA-98-5. Here, a large, subvertical body, about 100 m wide, of white, dolospar-cemented rubble and mosaic breccia has intersected the stratigraphy at a high angle (Fig. 10b) and individual beds display numerous dolomite-cemented fracture fillings subparallel and subperpendicular to bedding (Fig. 10d). All other occurrences are less obviously associated with fracture fillings and are instead wholesale replacements of skeletal lime grainstone, packstone, and wackestone (Nadjiwon, 2001).

# SUMMARY DESCRIPTIONS OF STRATIGRAPHIC SECTIONS

## Section MTA-98-1

This section (Fig. 11), southeast of Robb Lake in the Halfway River map area, is the only one representing the Ordovician to Devonian feature known as the Laurier Embayment. The section was rubbly with few in-place outcrops, and determination of exact thicknesses quite difficult. A 209 m section (Fig. 5) was measured within the dolomitic quartz sandstone (Dqs) map unit, and extended to the upper contact with the Besa River Formation. The degree of textural sedimentary maturity in terms of grain sorting and rounding in this map unit increases uniformly upsection. The basal unit is an impure quartz arenite, fine-grained sandstone containing possible resedimented, crinoid-ossicle-rich turbidites or grain-flow beds, probably deposited within a deeper marine environment below effective wave base. This unit is overlain by a more mature quartz arenite with polished quartz grains. It also contains wavy bedding, some dolomite intraclasts, and some large, metre-high sets of trough cross-bedding, indicating deposition in shallower water than the underlying unit. The uppermost unit is another pure quartz arenite, silica cemented and massive to wavy bedded, with only one bed of dolomitic sandstone near the base of the unit.

This section represents deposition in a moderate-depth marine environment grading upward to a shallow-water near-shore environment. This could be due to progressive filling of the Laurier Embayment after it formed in Late Silurian time (Thompson, 1989). The overlying beds of the Besa River Formation indicate that the Dqs map unit represents the final filling of the Ospika River Embayment re-entrant.

## Section MTA-98-2

Section MTA-98-2 (Fig. 12), south of Colledge Lake in the Trutch map area, includes uppermost Nonda Formation dolostone, and complete Muncho-McConnell and Stone formational successions. The upsection continuation of this succession into the overlying Dunedin Formation is along a ridge immediately north of this section (Section MTA-98-4). One conodont sample of Silurian age was collected at the top of the Nonda Formation. This section represents the southernmost complete section of the Muncho-McConnell Formation measured in this study.

Basal silty dolostone beds of the Muncho-McConnell Formation unconformably overlie the Nonda Formation with erosional relief here (Fig. 8). The Muncho-McConnell consists generally of dolostone and silty dolostone, with local sandstone laminae, beds, and units, increasing in frequency in the middle of the formation where some thick quartz sandstone beds occur. Near the base of the formation are some stromatoporoid-rich sections that are likely biostromal. As sand content increases upward, faunal content and incidence of biostromal features decreases. Overall, this formation was deposited within a shallow-marine environment with low to moderate energy levels. The influx of siliciclastic deposits caused most fauna to disappear by the middle of the time of Muncho-McConnell deposition, but with the return of carbonate sedimentation during Stone Formation deposition they quickly returned.

The Stone Formation here is a uniform light grey dolostone with a basal unit of yellow sandy dolostone. Overall, Stone strata are rather featureless alternations of medium to thick, light grey intervals alternating with yellow dololaminites, with scattered sand stringers within planar beds. There is no visible fauna. This formation likely formed in quiet, shallow water in a restricted-marine, possibly intertidal to lower tidal flat setting. Quartz silt and sand may be eolian.

## Section MTA-98-3

This ridge section (Fig. 13) lies immediately north of Redfern Lake in the Trutch map area. It includes strata of the Stone Formation and the Upper Chinchaga to Slave Point Undivided. The upper contact with the Besa River Formation is not exposed.

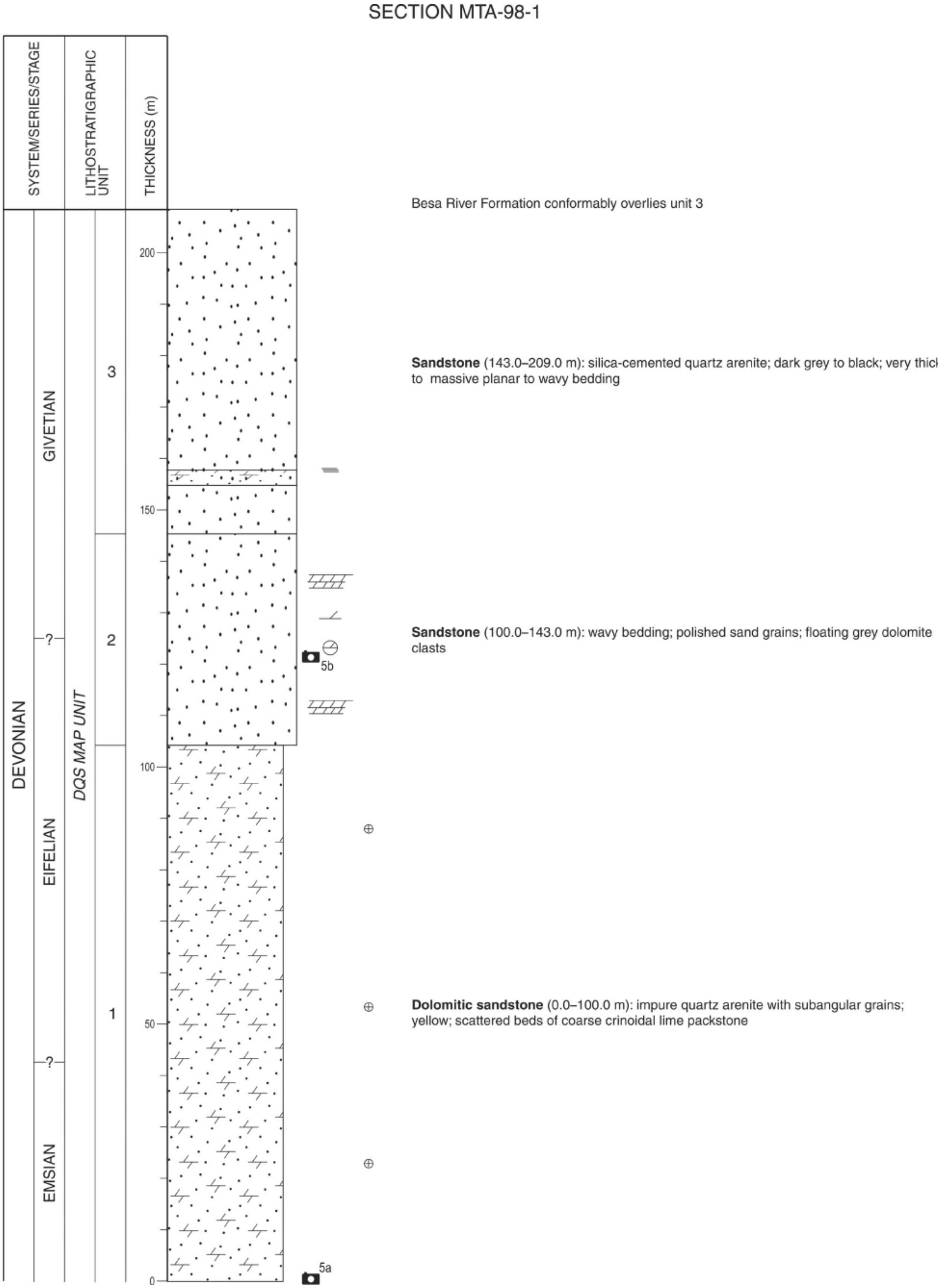



**Figure 11.** Columnar section for Section MTA-98-1. This figure also includes a legend for symbols used in the columnar sections illustrated in Figures 11 to 30 inclusive.

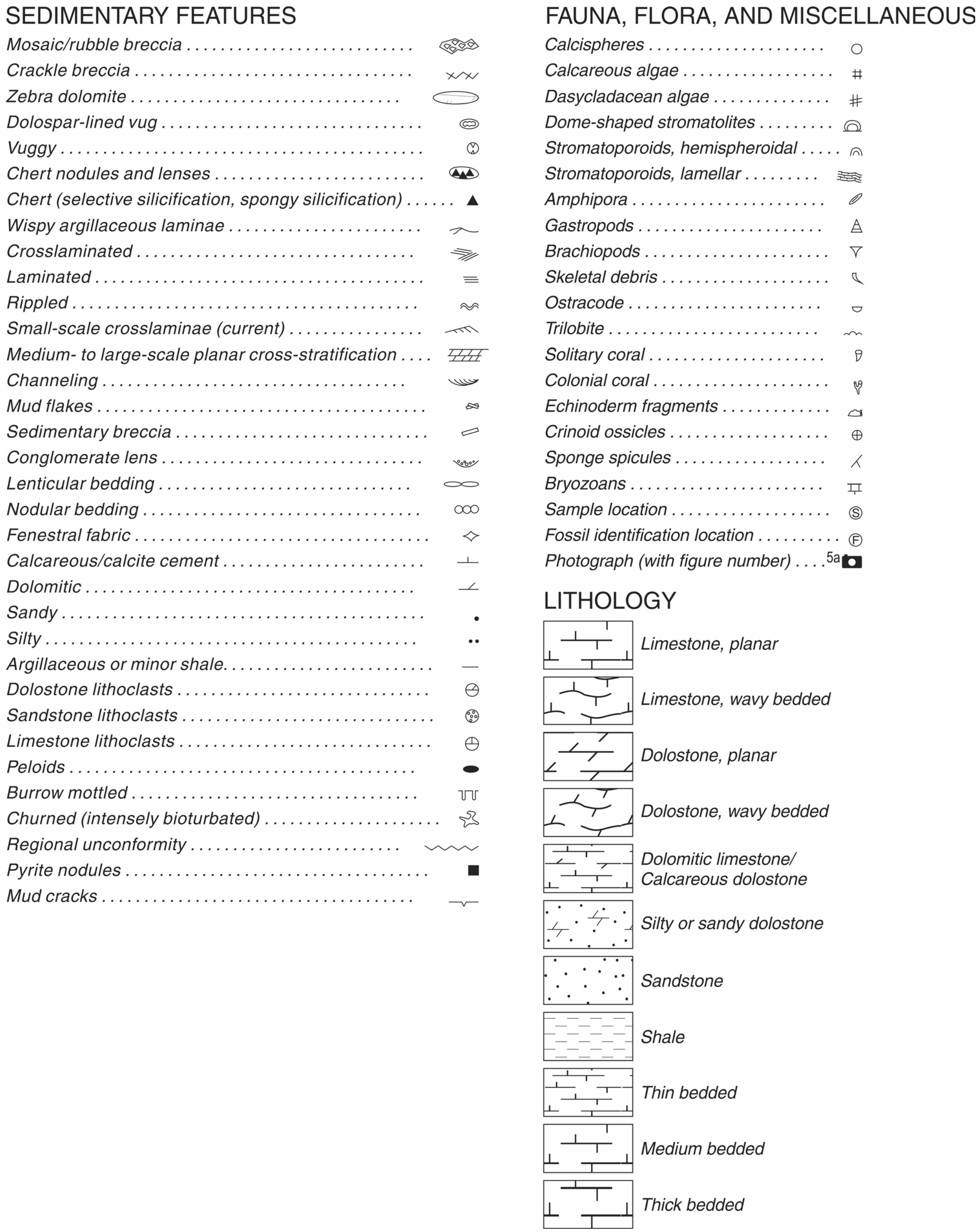



**Figure 11.** (Cont.)

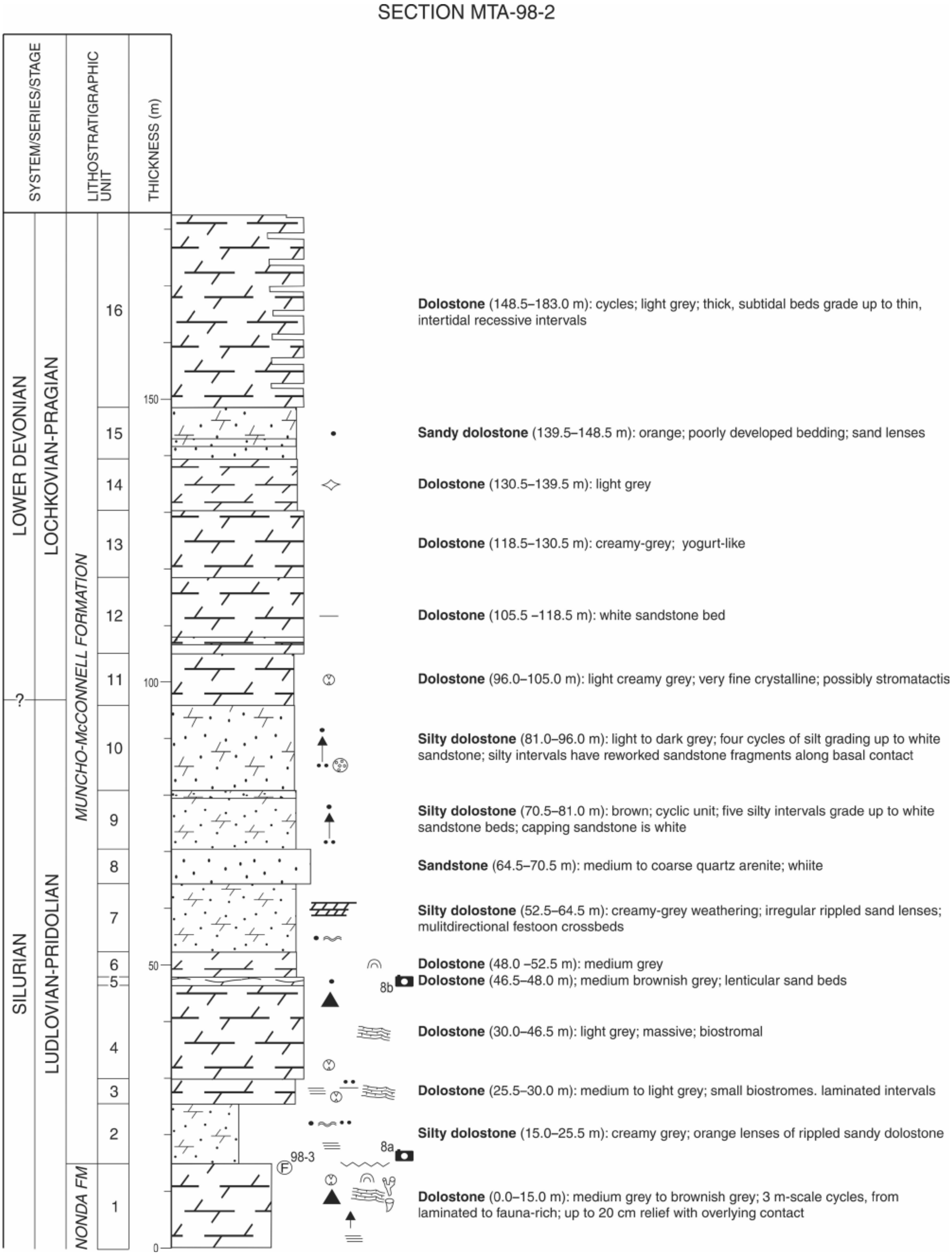



**Figure 12.** Columnar section for Section MTA-98-2.

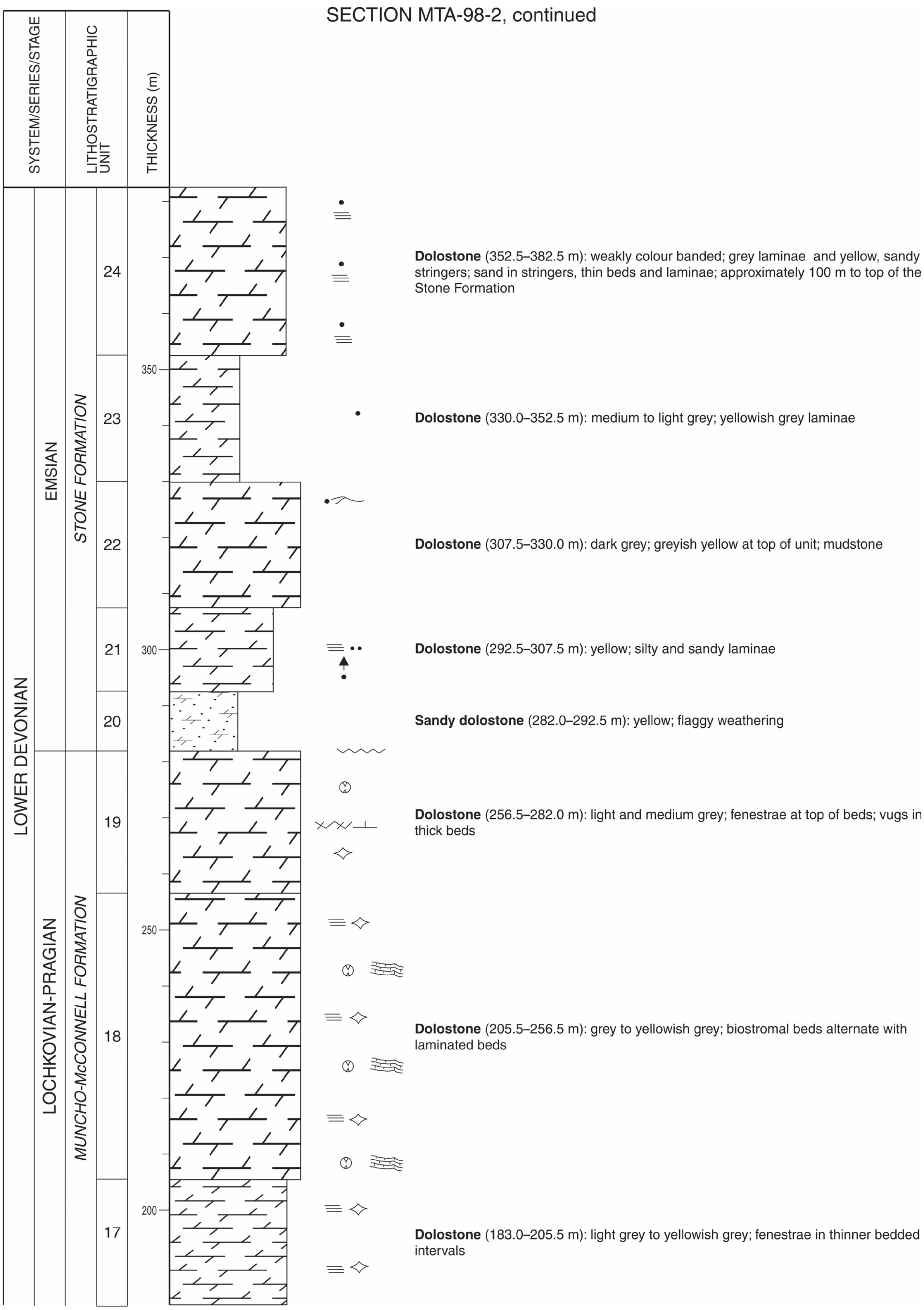



**Figure 12.** (Cont.)

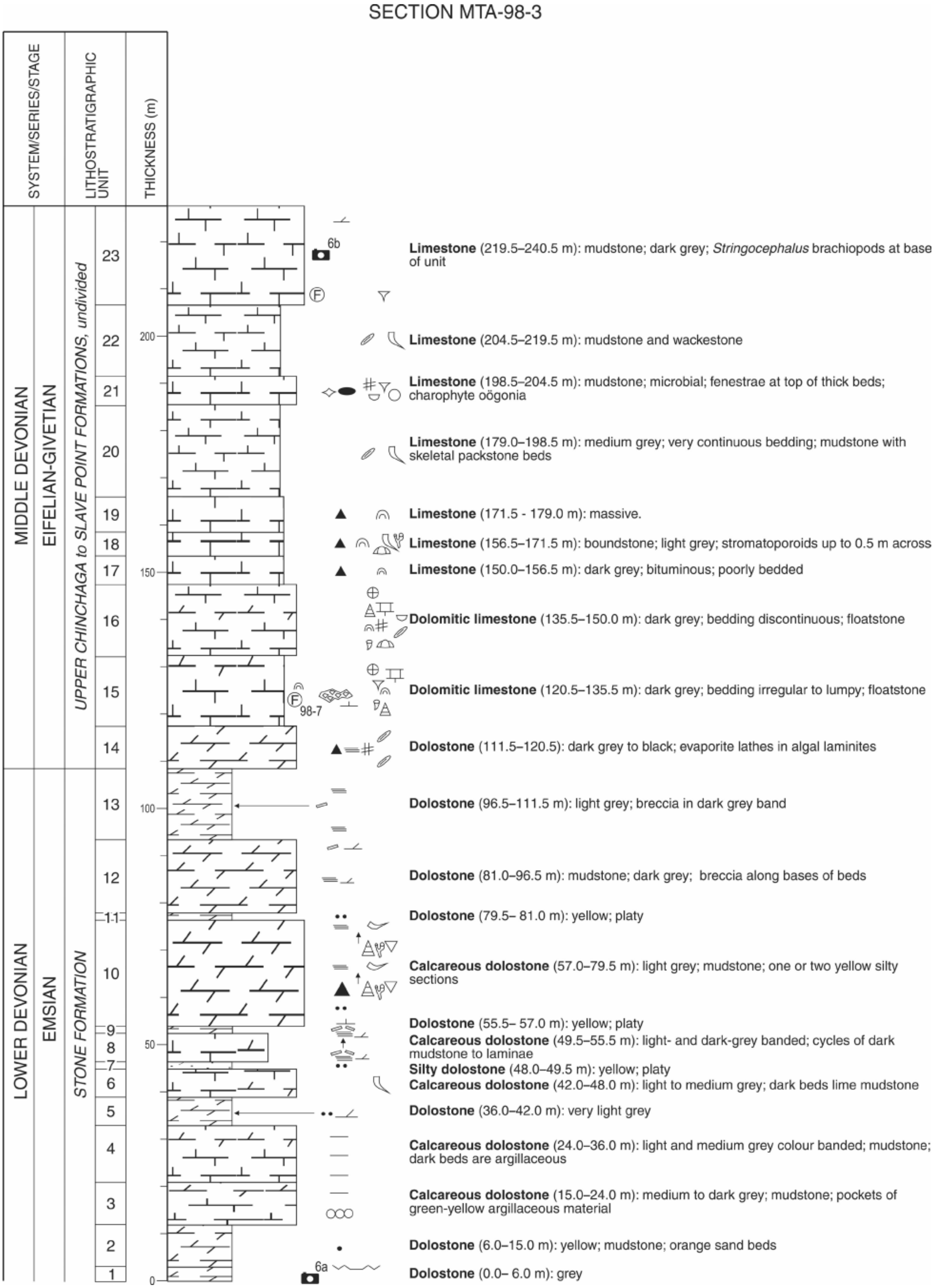



**Figure 13.** Columnar section for Section MTA-98-3.

The Stone Formation is dominantly dolomudstone to calcareous dolostone, with some silty intervals. The basal unit contains sand beds within a dolomudstone. Most beds are featureless, with some nodular bedding and argillaceous units near the base. In the middle and upper parts of the formation, laminated beds are common, as well as sedimentary breccias with mud intraclasts. One bioclastic unit is found in the middle of the formation, with gastropods, brachiopods, and corals. Otherwise visible bioclasts are rare, generally occurring as finely comminuted shell debris. Deposition probably occurred in low- to moderate-energy, shallow subtidal to peritidal environments. The prevalence of yellow intervals of platy and silty dololaminite with common mudchip breccias indicates that peritidal deposition was the norm. The admixture of yellow argillaceous material may have been eolian.

The contact between the Stone Formation and the Upper Chinchaga to Slave Point Undivided occurs above a recessive dolomudstone unit, and shows a marked change in lithology, although there is no direct evidence of an unconformity between the formations here. The basal units are dolomitized, with evidence of hydrothermal dolomitization possibly associated with coarse-crystalline, calcite-cemented collapse rubble breccias. The basal unit of the Stone and the Upper Chinchaga to Slave Point Undivided is composed of shallow-water microbial and algal laminites with amphiporid beds and evaporite minerals. Stromatoporoid floatstone to boundstone with a skeletal grainstone and packstone matrix overlies this, and comprises the remainder of the lower half of the formation. This stromatoporoid boundstone forms large, 15 m thick, light-coloured reef masses with darker flank beds dipping away from individual reef mounds, visible on nearby cliff faces (Fig. 6a). Some beds may have been hydrothermally dolomitized and are partly silicified. The upper units of the formation are skeletal packstone to mudstone. The Upper Chinchaga to Slave Point Undivided probably represents progradation of a reef complex, with the lowest units consisting of back-reef amphiporid lagoons, followed by some floatstone shoals, followed by stromatoporoid boundstone. This boundstone is capped by darker, more open-marine, open-shelf, or deeper marine lagoonal, fossiliferous lime mudstone containing amphiporids, the robust brachiopod *Stringocephalus* sp. and other skeletal debris (Fig. 6b).

## Section MTA-98-4

Section MTA-98-4 (Fig. 14) was measured on a small ridge just north of Section MTA-98-2 near Colledge Lake in the Trutch map area, and contains the upper portion of the Stone Formation and the Upper Chinchaga to Slave Point Undivided, including its upper contact with the Besa River Formation.

The Stone Formation is dolostone with silty to sandy intervals throughout. Silt and sand occur as stringers, thin beds, and disseminated as floating grains throughout the formation. The most common sedimentary structures are rippled bed partings and laminae. There are some higher energy features near the top of the formation, such as current laminae and thick crossbeds. Bioclastic content is fairly low, with some intervals of packstone to wackestone with bioclastic fragments, and one unit (5) with stromatolites in the lower beds.

Generally, this formation was deposited in low- to moderate-energy, very shallow-water and restricted subtidal to peritidal environments as indicated by mudcracks and some pseudomorphs after gypsum. The higher energy, crossbedded intervals may reflect tidal current and channel activity related to the proximity of this section to the Laurier Embayment.

The Upper Chinchaga to Slave Point Undivided directly overlies the Stone Formation with a striking, yellow-to-orange weathering, recessive, silty to sandy, 21 m thick interval resting abruptly on a very-light-grey- to white-weathering, thick-bedded Stone Formation dolostone. The Upper Chinchaga to Slave Point Undivided grades from silty and sandy at the base, with little to no bioclastic content, to highly bioclastic and biostromal at its top. Near the base, peritidal deposition is indicated by fenestrae, microbial laminae, and mudclast sedimentary breccias. Colour-banded units above this contain resedimented mudchip breccias and skeletal debris in medium beds capped by rippled lime siltstone rhythmically alternating with thin, recessive, shaly intervals. These beds may represent open-marine slope deposition. The presence of amphiporid rudstone beds within some of these units indicates probable deposition within a shallow back-reef lagoon. Above these beds, bioclastic content increases abruptly within a resistant, light coloured, stromatoporoid-bearing biostromal unit. This is overlain by a mudstone and skeletal wackestone with a diverse fauna (corals, crinoids, bryozoans, ostracodes, trilobites and brachiopods), indicating deposition in a more normal, open-marine environment than those below the biostrome.

White dolospar-cemented breccias, vug-fillings, and dolomitization of the Presqu'ile Dolomite occur in the biostromal units and in some mudstone beds lower in the section.

## Section MTA-98-5

This section (Fig. 15) includes strata of the uppermost part of the Stone Formation on the northeast side of Mount Bertha (Fig. 10) in the Trutch map area, and continues upward through the Upper Chinchaga to Slave Point Undivided. The upper contact with the Besa River Formation is not exposed.

The lower part of the Upper Chinchaga to Slave Point Undivided contains dark, bioturbated dolomudstone and dolowackestone and scattered thick beds with abundant stromatactis. These strata were probably deposited subtidally at moderate water depths below active wave base. Biostromal limestone units containing large stromatoporoids overlie

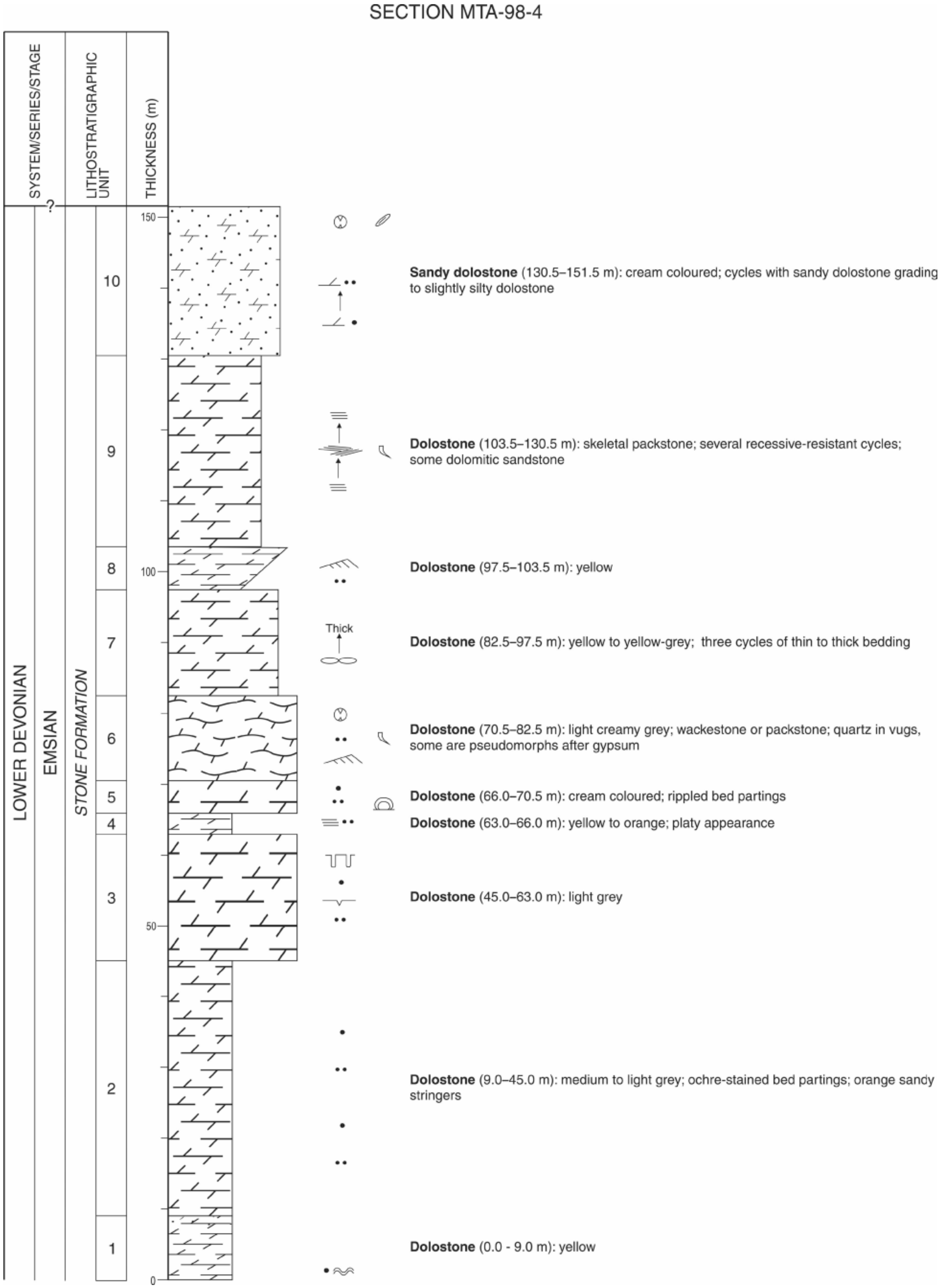



**Figure 14.** Columnar section for Section MTA-98-4.

SECTION MTA-98-4, continued

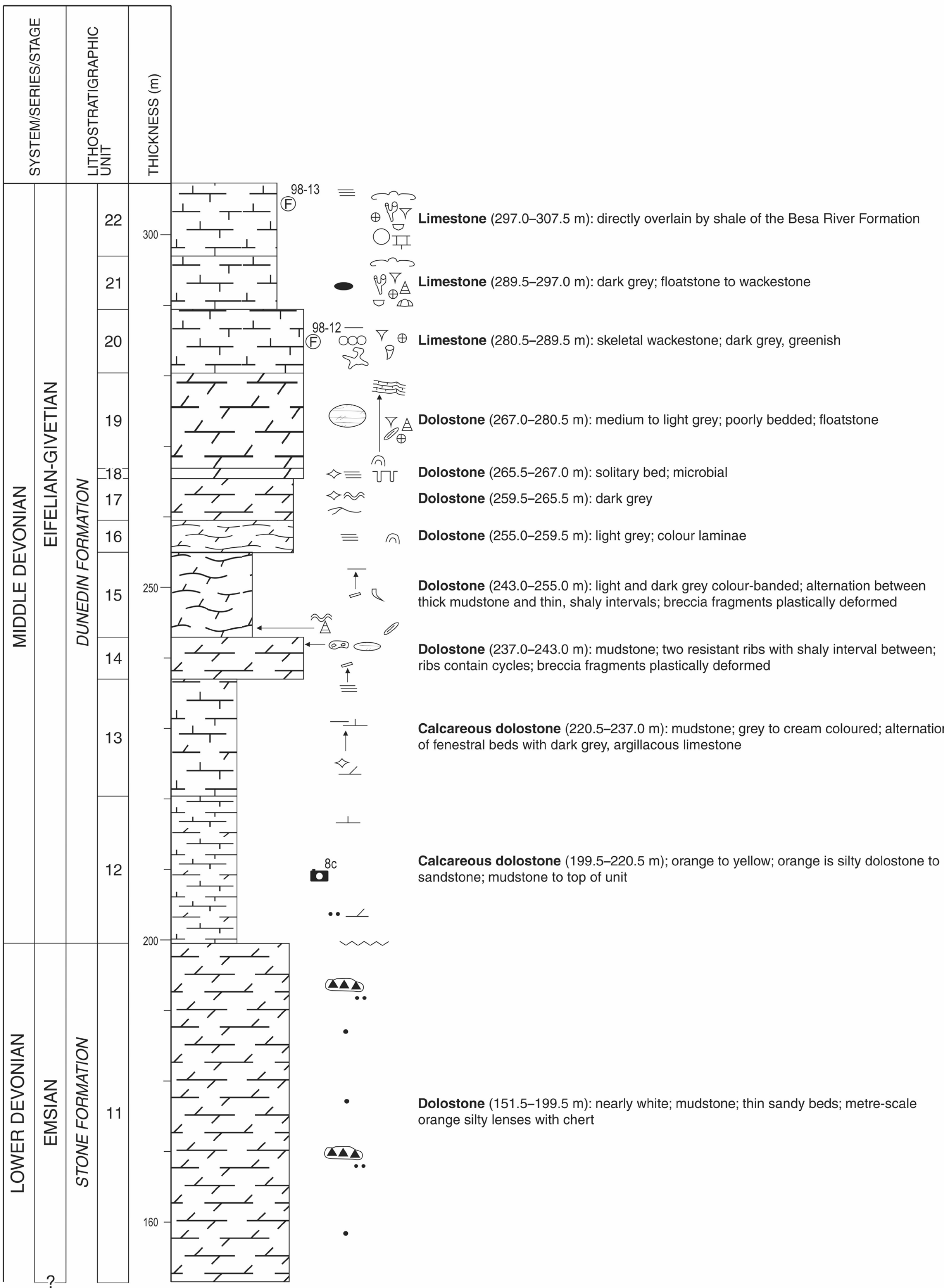



**Figure 14.** (Cont.)

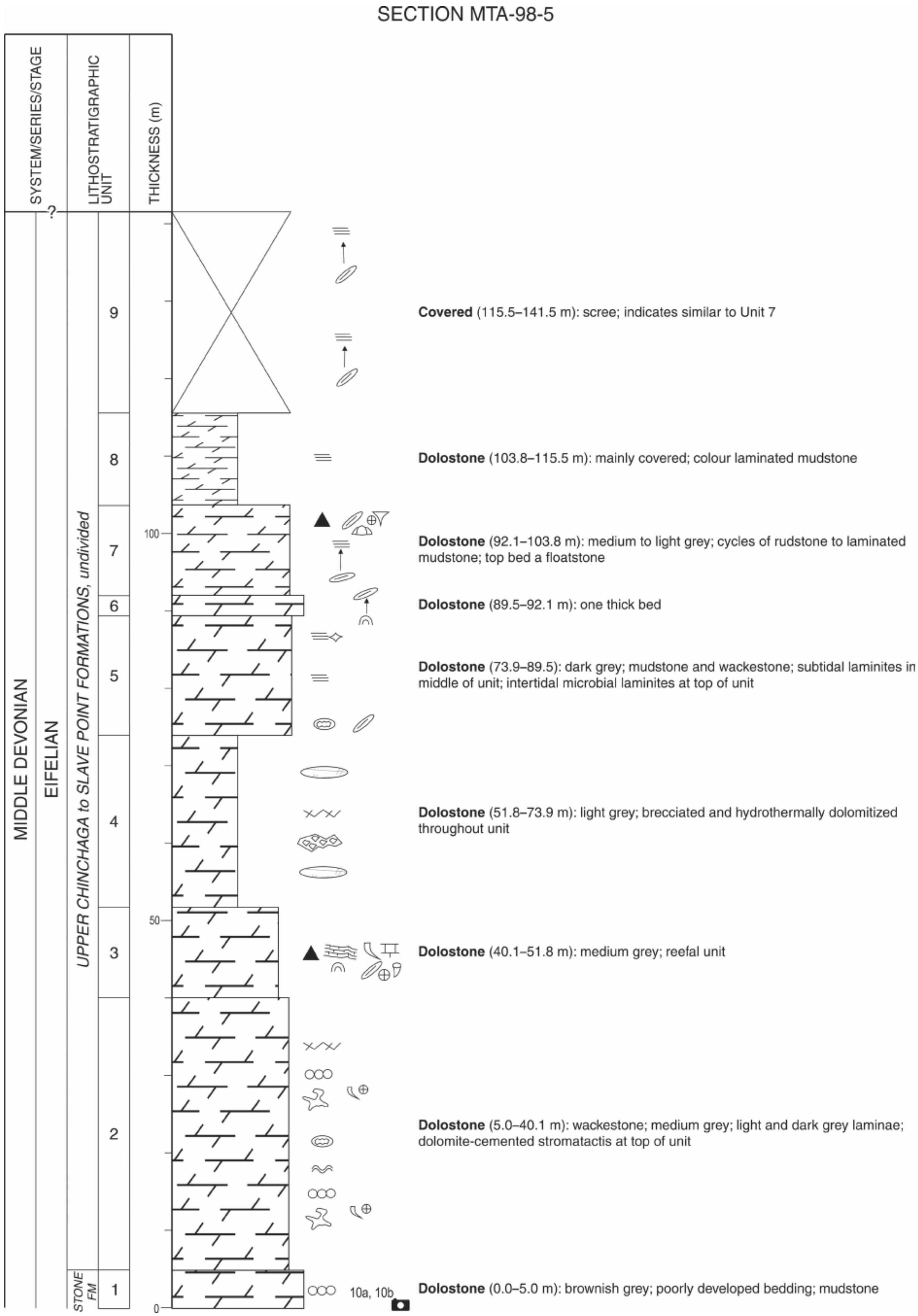



**Figure 15.** Columnar section for Section MTA-98-5.

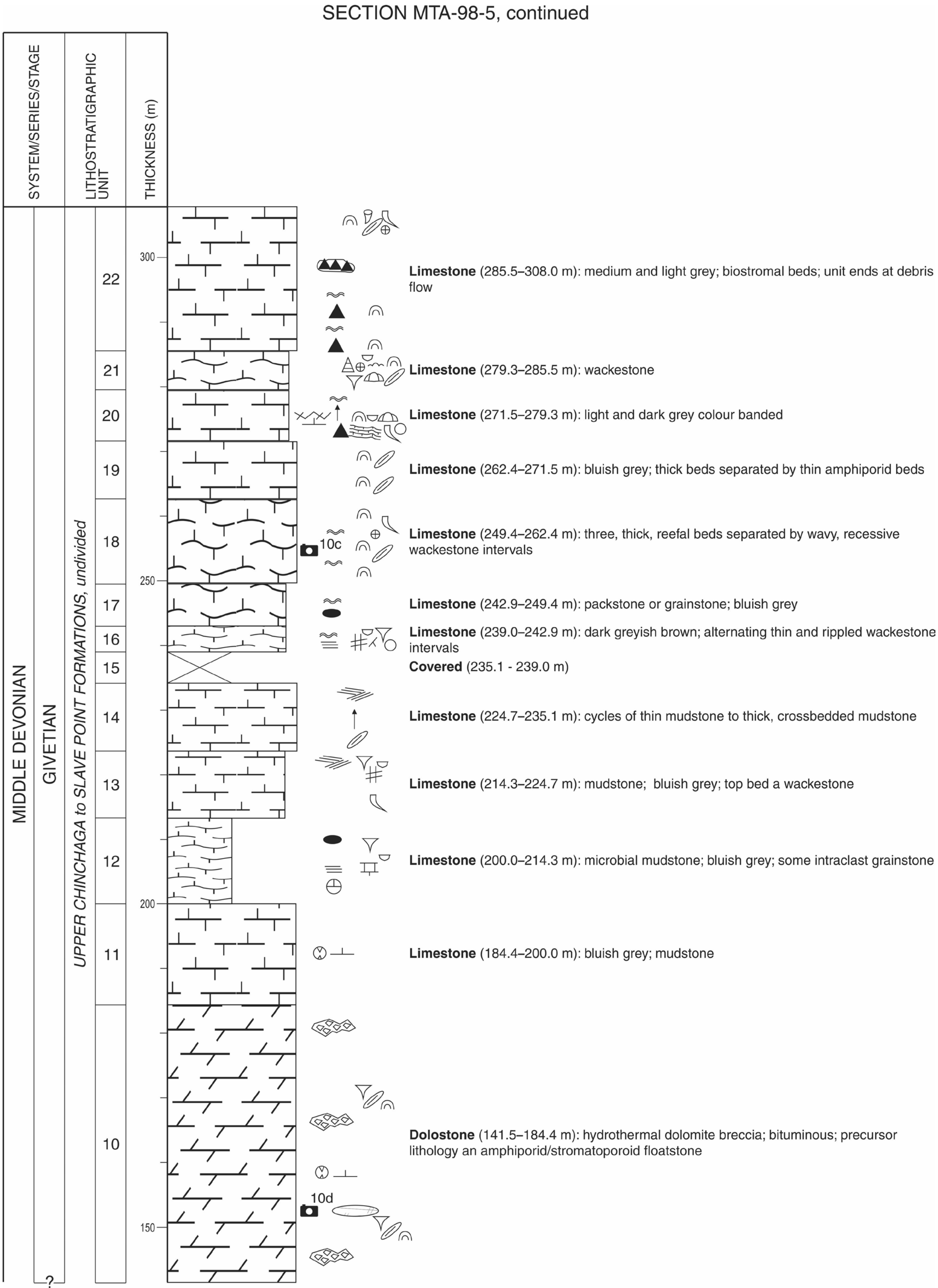



**Figure 15.** (Cont.)

these deeper water deposits. Scattered amphiporid-bearing lime rudstone and floatstone beds indicate close association with a restricted lagoon. The next few units were deposited in this lagoonal environment, with amphiporids, microbial laminites and fenestral fabrics. This pattern of alternating biostromal and amphiporid-rich beds continues upward to the top of the section. The entire section was probably deposited near the back edge of the reef complex, fluctuating between reefal/biostromal and back-reef lagoon facies.

This section is dominantly altered by hydrothermal dolomitization. Many of the internal textures and sedimentary structures were obliterated by the coarse recrystallization in a subvertically oriented body of a spectacular, 100 m wide, hydrothermally dolomitized white dolospar-cemented breccia with abundant zebra fabric (Presqu'ile Dolomite). The upper part of the Upper Chinchaga to Slave Point Undivided was not altered by the dolomitization.

## Section MTA-98-6

This section (Fig. 16) is located on a mountain immediately south of Mount Bertha and Section MTA-98-5. The section was measured from the uppermost beds of the Stone Formation through the Upper Chinchaga to Slave Point Undivided to within approximately 50 m of its upper contact with the Besa River Formation. The short interval of measured Stone Formation is yellow- to light greyish-brown-weathering, medium- to thick-bedded silty dolostone containing some dololaminite and mudchips indicating restricted peritidal deposition.

The contact between the Stone Formation and the Upper Chinchaga to Slave Point Undivided is abrupt but not obviously unconformable. The lowermost two units indicate a subtidal depositional environment, with mudstone and wackestone and a biostromal mound with stromatactis and laminar stromatoporoids. This is followed by an alternation of reefal and/or biostromal units and backreef lagoonal to restricted-marine units. The reefal units are formed of stromatoporoidal rudstone to floatstone, capped by laminated mudstone. The restricted-marine to lagoonal units contain amphiporid rudstone (locally crossbedded), microbial laminae, and some sedimentary breccias. Generally, this section is similar to Section MTA-98-5, with open-marine carbonate passing upward to reefal to backreef facies. As with Section MTA-98-5, much of this section has been altered by hydrothermal dolomitization of the Presqu'ile Dolomite, with associated white dolospar-cemented rubble brecciation and destruction of many original characteristics of the units.

## Section MTA-98-7

This section (Fig. 17) was measured immediately north of Prophet Creek in the Trutch map area, and contains strata of the uppermost Stone Formation and the Dunedin Formation. The section is located immediately north of the Dunedin to Upper Chinchaga to Slave Point Undivided transition at the edge of the Presqu'ile Barrier (Fig. 1, 4).

The top 10 m of Stone Formation is featureless lithographic dolomitic limestone. There are no visible bioclasts. The upper contact with the Dunedin Formation is an erosion surface exhibiting brecciation and solution collapse, and extensive silicification in strata immediately below the unconformable contact.

The basal unit of the Dunedin Formation is open-marine bioclastic wackestone. Overlying strata are formed of intervals of resistant, medium- and wavy-bedded skeletal lime wackestone/packstone interbedded with recessive, silty, calcareous dololaminite. This indicates an alternation of open-marine, shallow subtidal and restricted peritidal environments. The upper part of the section contains charophyte oögonia and fenestral fabric, indicating deposition within a brackish water environment, likely a pond, which may have formed on the tidal flat surface.

## Section MTA-98-8

This section (Fig. 18) lies north of Nabesche River in the Halfway River map area. The section contains strata of the Stone Formation and a complete, albeit thin, Dunedin Formation succession up to its contact with the overlying Besa River Formation.

The Stone Formation has a dominant lithology of dolostone to sandy dolostone. The most common sedimentary structures are laminae within dolomitic mudstone, sandy stringers and laminae, and numerous channel fills. Microbial-mediated laminae are definitively found only in the uppermost unit of the formation. No bioclasts were observed.

Sedimentary structures indicate deposition under restricted subtidal and peritidal conditions. The abundance of channel fills is atypical of the Stone Formation. One possible explanation is that these represent tidal channels. Perhaps the proximity of this section to the Laurier Embayment is a factor that favoured more vigorous development of tidal channels in lower shoreface environments adjacent to tidal flats.

The Dunedin Formation overlies the Stone Formation with a sharp, but not well exposed contact. Above a basal unit, thin interval of thin-bedded lime mudstone, the formation becomes a highly bioclastic, skeletal wackestone and packstone exhibiting thin to thick, graded bedding. This interval exhibits very great faunal diversity (crinoid, coral, brachiopod, amphiporid, ostracode, and bryozoan fragments). These units are overlain by an interval of coralline and lamellar stromatoporoid floatstone with a more restricted fauna. A unit transitional to the Besa River Formation, a crinoid-peloid floatstone, caps the succession.

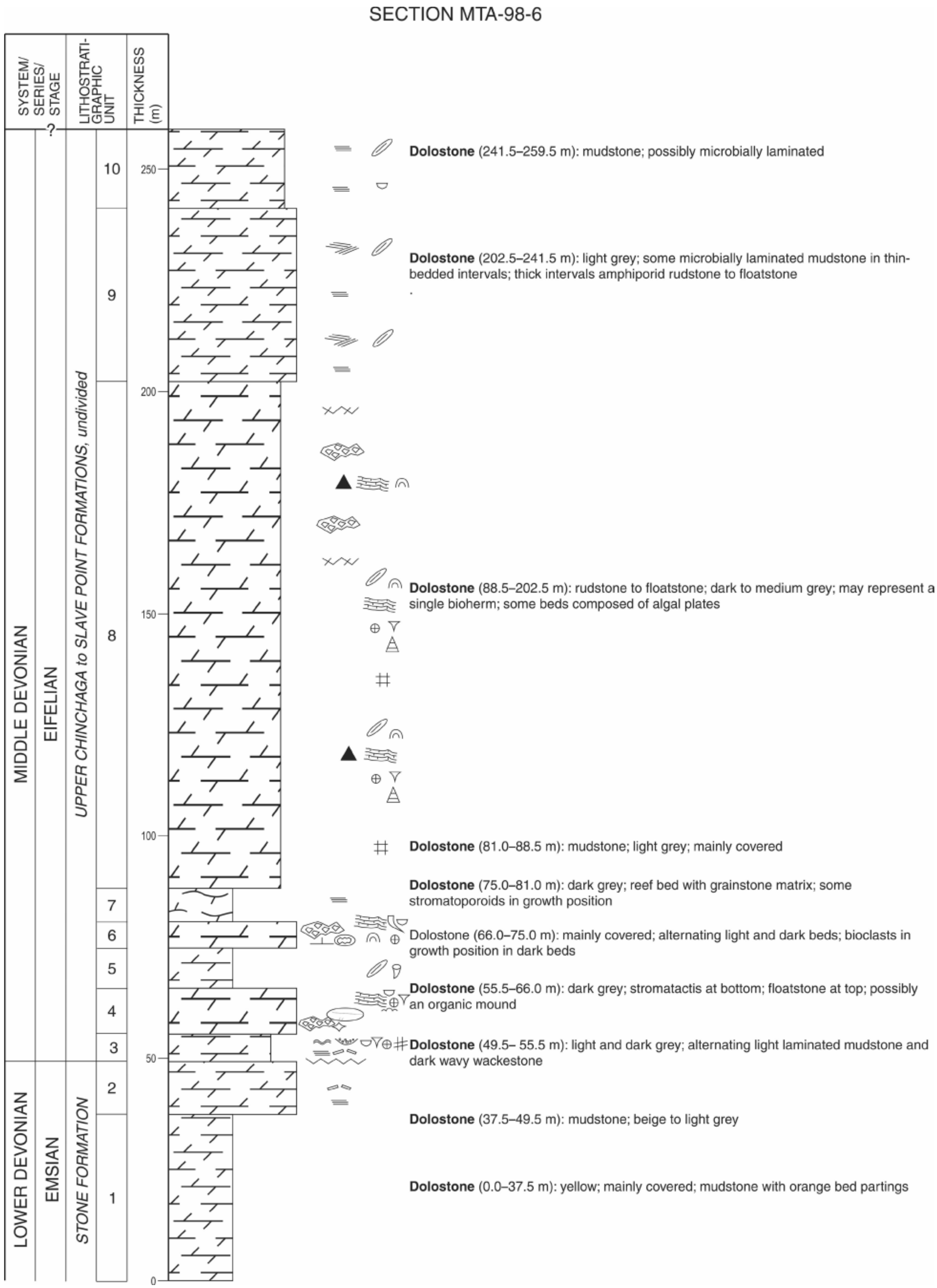



**Figure 16.** Columnar section for Section MTA-98-6.

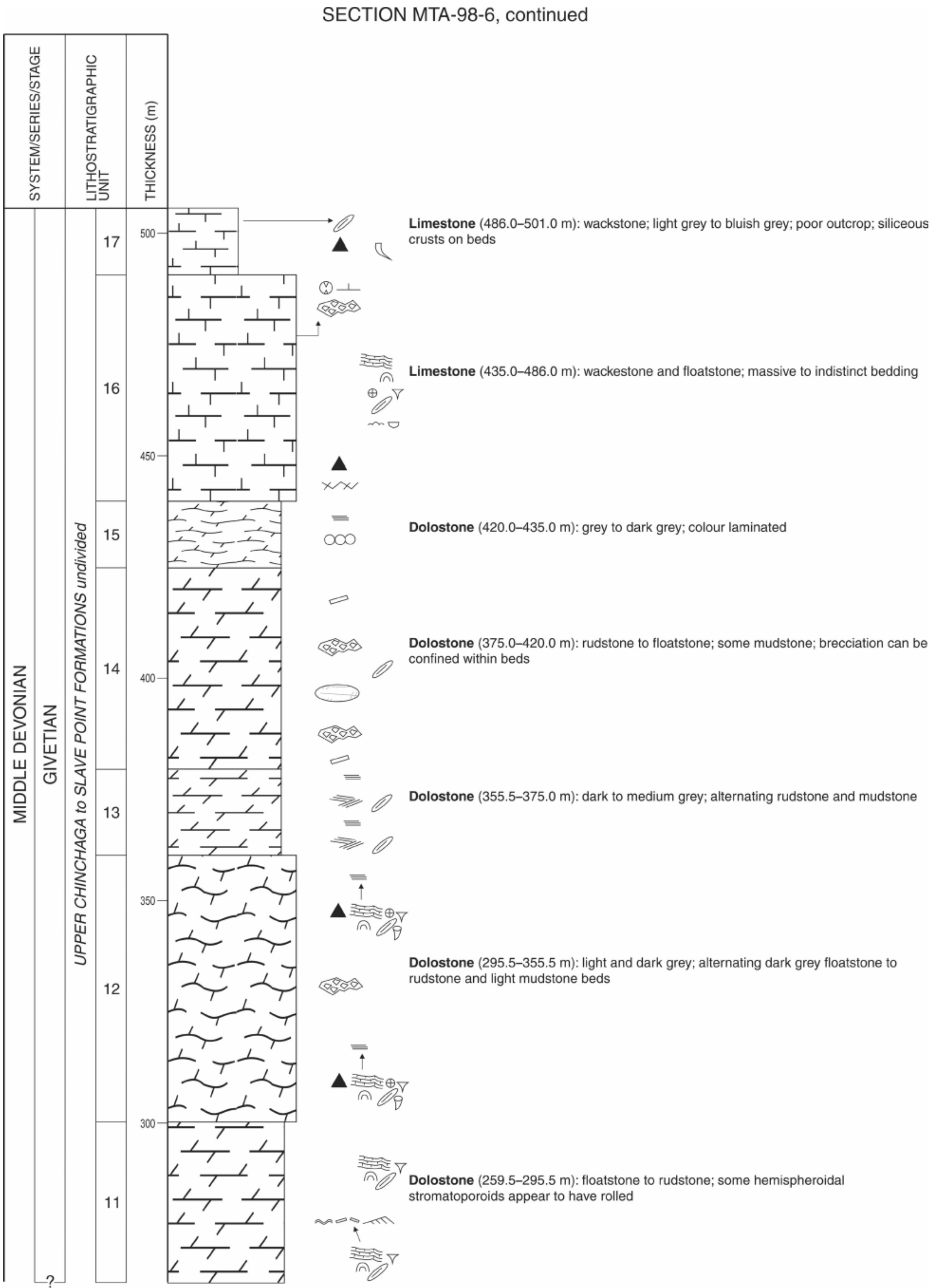



**Figure 16.** (Cont.)

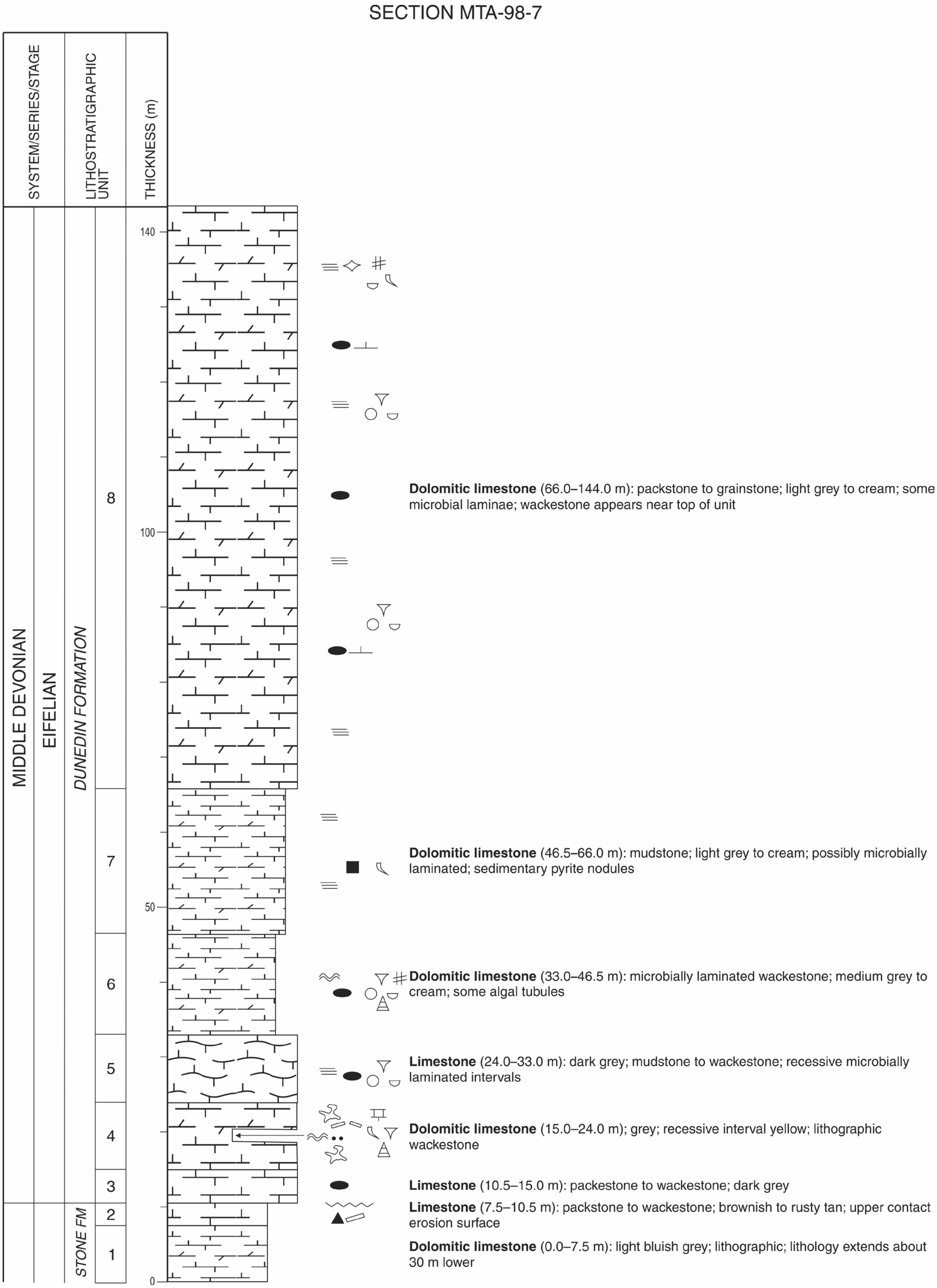



**Figure 17.** Columnar section for Section MTA-98-7.

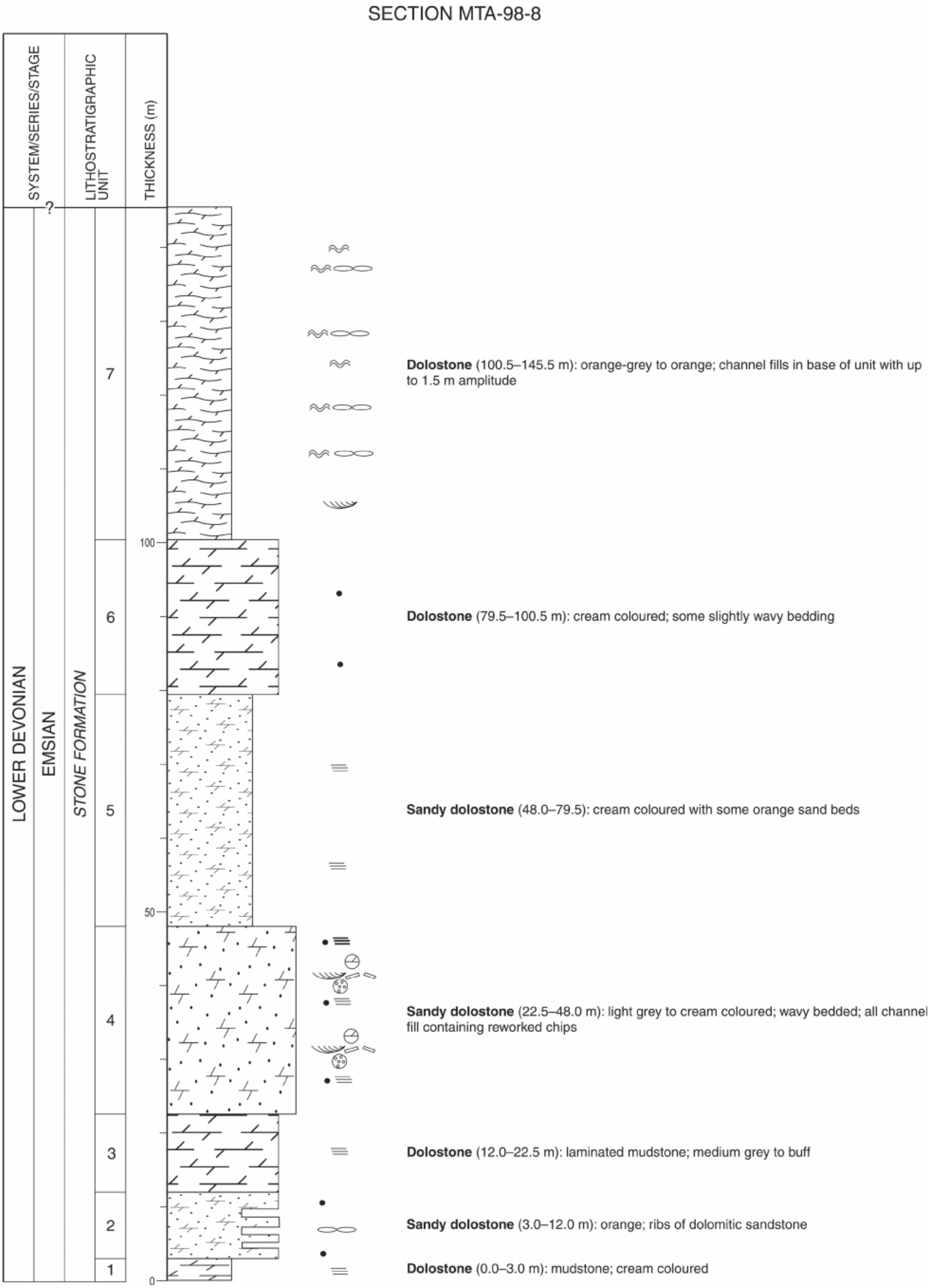



**Figure 18.** Columnar section for Section MTA-98-8.

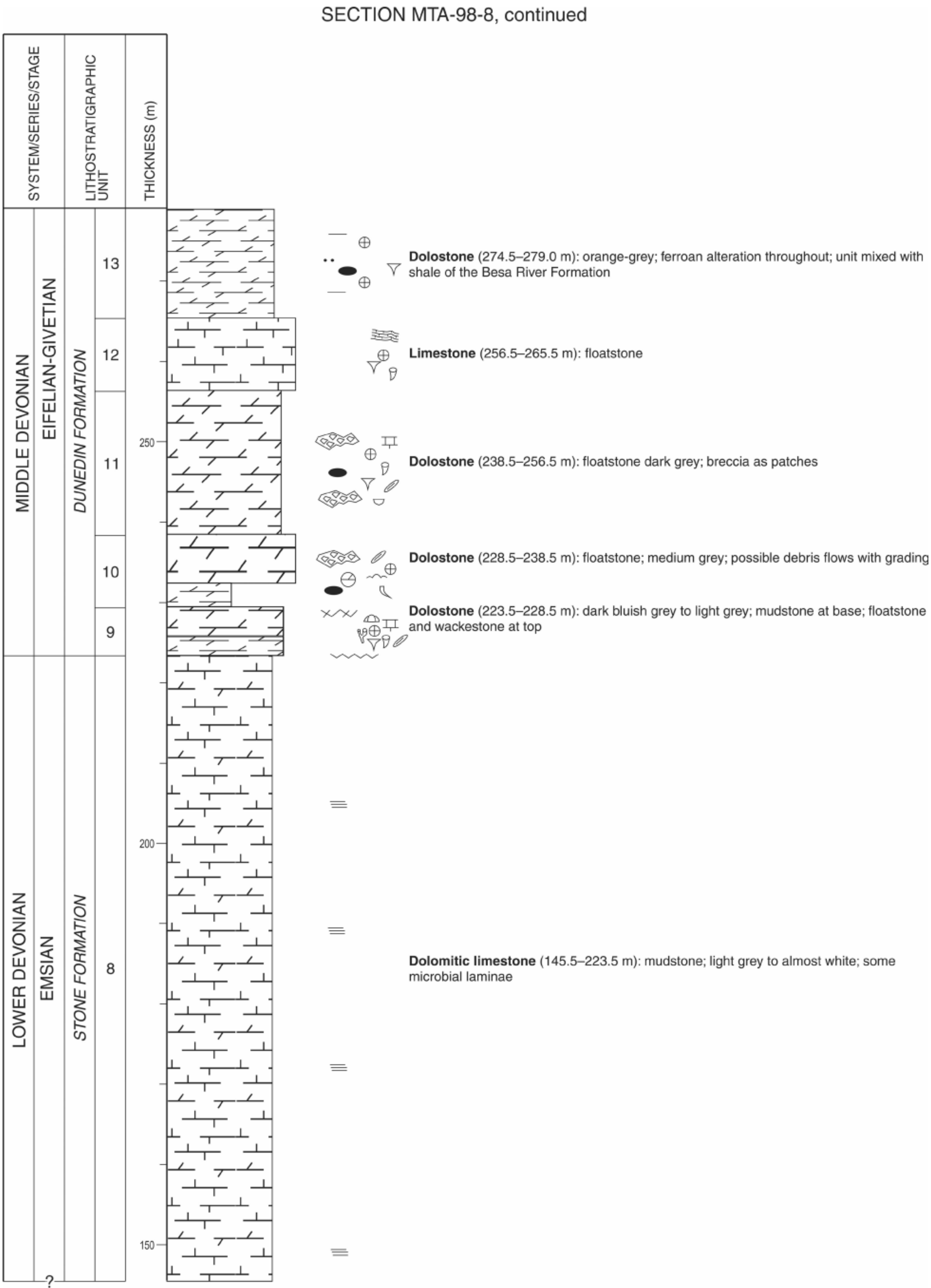



**Figure 18.** (Cont.)

The bottom three units of the formation show indications of slope deposition in a forereef position, including rounding of bioclasts and grading of bioclasts and intraclasts within beds. The lamellar stromatoporoid beds with low faunal diversity may indicate deposition in a reef front or upper forereef slope position.

## Section MTA-98-9

This section (Fig. 19) extends along 110 Creek in the Tuchodi Lakes map area. The section contains strata of the uppermost Muncho-McConnell Formation, and the Wokkpash and Stone formations. The overlying Dunedin Formation is described separately as Section MTA-99-1. This section includes the type section of the Stone Formation.

The top 20.8 m of the Muncho-McConnell Formation were measured. They consist dominantly of cream- to yellow-weathering dolomudstone and silty dolostone, with flne laminae and laminar fenestral fabric. No bioclasts were visible. These features indicate deposition within a low-energy and restricted peritidal environment.

The Wokkpash Formation is composed of sandstone, with dolomite and silica cements. The basal unit is laminated to wavy thin bedded, but the upper units are thickly crossbedded with some soft-sediment deformation features, including ball-and-pillow structures. Overall, the sandstone is fairly mature. The formation was likely deposited in a shallow, nearshore-marine environment, with high current energy. The large-scale, metre-thick crossbeds may have developed in an offshore barrier bar setting. The upper contact with the Stone Formation is sharp, but not well exposed.

The Stone Formation is relatively thick here, and is dolostone throughout. The lithology is dominantly dolomudstone, laminated and fenestral in places. Some sandy stringers occur in the basal units of the formation. Overall, the formation appears monotonous, with medium to thick beds of laminated to massive mudstone punctuated locally with fenestral intervals and scour and channel features. This formation was likely deposited within a restricted subtidal to intertidal environment, under low-energy conditions occasionally punctuated with higher energy events causing channelling and scouring. Much of the upper portions of the formation have been disturbed by postlithiflcation brecciation, with cementation by megacrystalline white calcite and barite. The upper contact with the Dunedin Formation is sharp, wavy, and slightly unconformable.

## Section MTA-98-10

This section (Fig. 20) extends along Snake Creek in the Tuchodi Lakes map area (94K). The section includes strata from the uppermost Stone Formation and the Dunedin Formation up to the contact between the Dunedin and Besa River formations.

The Stone Formation is dominantly dolomudstone to dolowackestone. The presence of laminar fenestral fabric, thinly laminated dololaminite and teepee structures indicates that deposition occurred in a restricted peritidal environment. Much of the formation has been affected by spectacular postlithiflcation brecciation and cementation by megacrystalline calcite and barite with individual crystals up to a metre in length, and has been crosscut by calcite and barite veins.

The contact between the Stone Formation and the overlying Dunedin Formation is wavy and unconformable, and the upper bed of the Stone Formation is karsted and mud cracked with ochre staining. The Dunedin Formation is largely limestone, with the basal unit above the Stone-Dunedin unconformity dolomitized. Most of the formation consists of mudstone and wackestone, with some intervals of grainstone in the middle third. Cycles consisting of thick beds scoured into the top of the underlying cycle, with scours fllled with laminated sediment, are found within the grainstone in the middle third of the formation. There are also small, shallowing-upward cycles with pinkish hardground tops within the grainstone interval. Rare horizons of small, hemispheroidal stromatoporoids are found within the top third of the formation. Overall, the formation appears to have been deposited within alternating subtidal and peritidal environments. The presence of charophytes in the lower part of the Dunedin Formation may indicate some brackish-water influence in an overall peritidal setting (*see* Morrow, 1978). The upper contact with the Besa River Formation appears to be transitional, with some shale alternating with limestone in the upper beds of the formation. This formation underwent postlithiflcation brecciation and collapse similar to the Stone Formation, but on a much larger scale, with some blocks metres in length. Breccias are cemented by megacrystalline barite with subordinate calcite.

## Section MTA-98-11

This northernmost section (Fig. 21) of the study extends across the southern end of the Caribou Range in the Toad River map area. This section includes the uppermost beds of the Stone and the Dunedin formations. The contact with the Besa River Formation is covered and occurs approximately 40.0 m above the top of the section. Crinoids with two axial canals were found between 102.0 and 222.0 m, indicating an age of latest Emsian to earliest Eifelian for the lower Dunedin strata. The Stone Formation consists of dolomudstone to dolowackestone with some laminae and synsedimentary breccias of mudclasts, likely deposited within a restricted- marine, peritidal setting.

Section MTA-98-11 includes the thickest Dunedin succession of this study. The formation is limestone throughout, except for a basal dolostone unit. The dominant lithology is mudstone to wackestone, with some floatstone to packstone units composed of crinoids. Many of the crinoid intervals

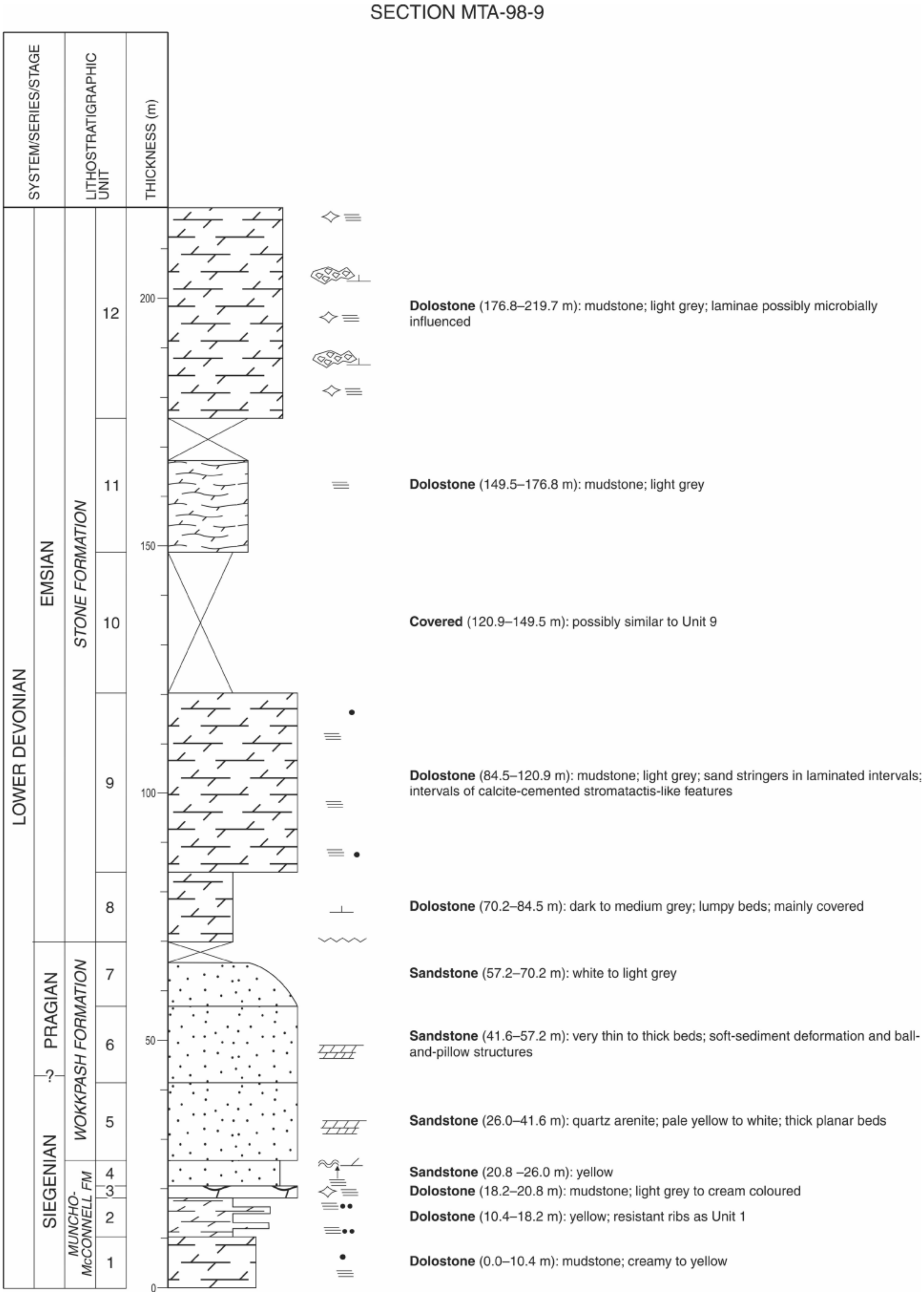



**Figure 19.** Columnar section for Section MTA-98-9.

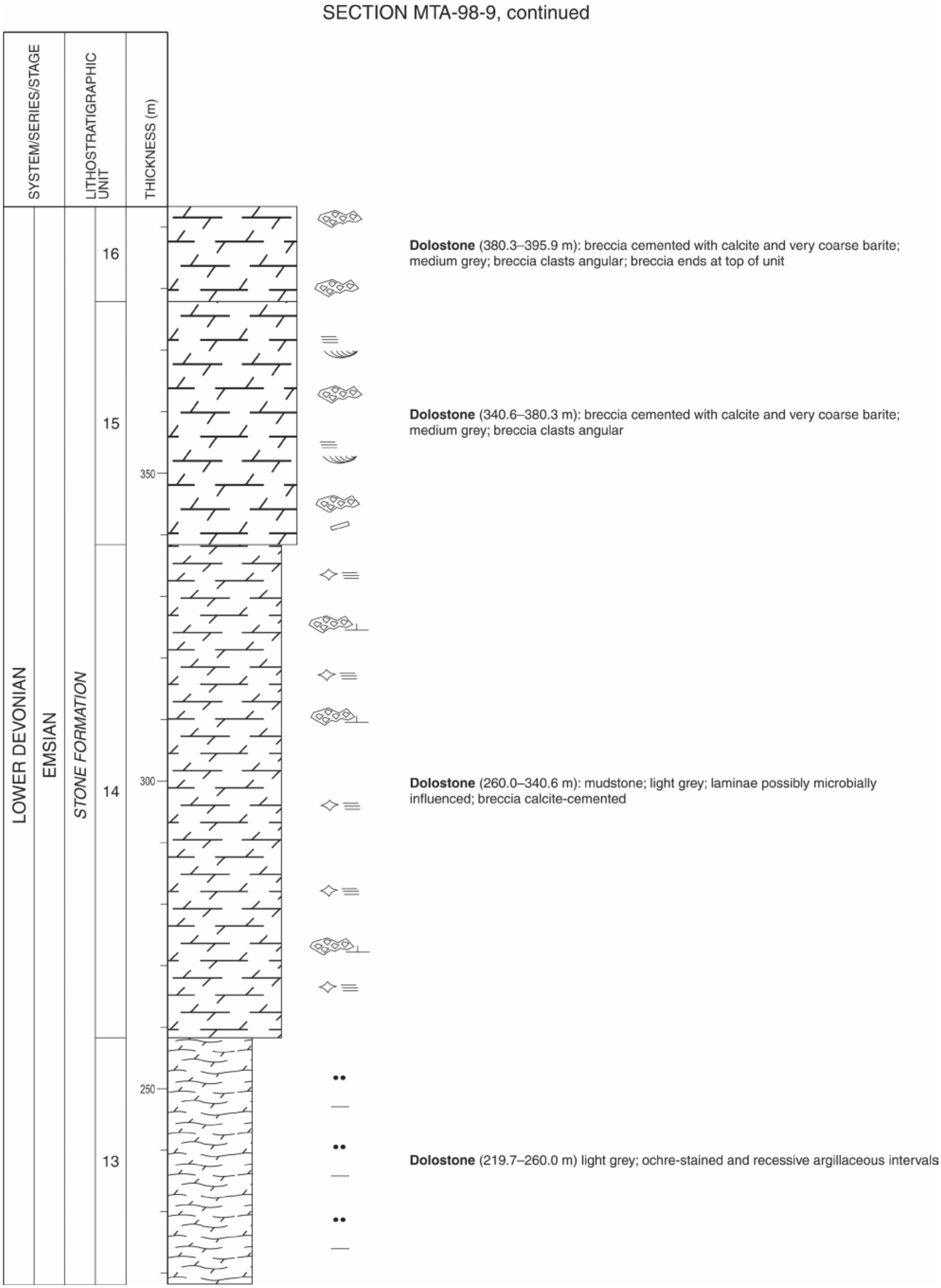



**Figure 19.** (Cont.)

SECTION MTA-98-9, continued

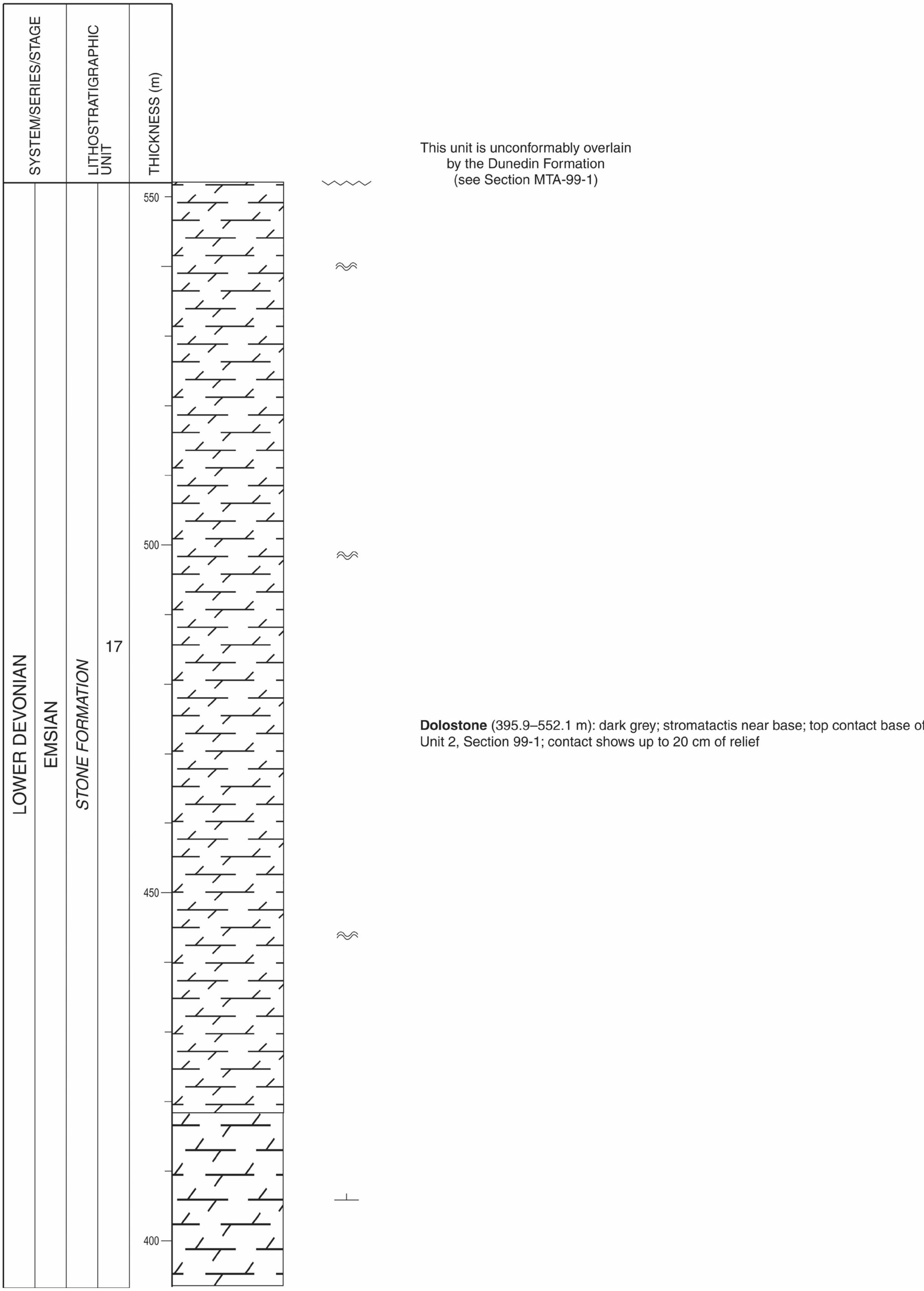



**Figure 19.** (Cont.)

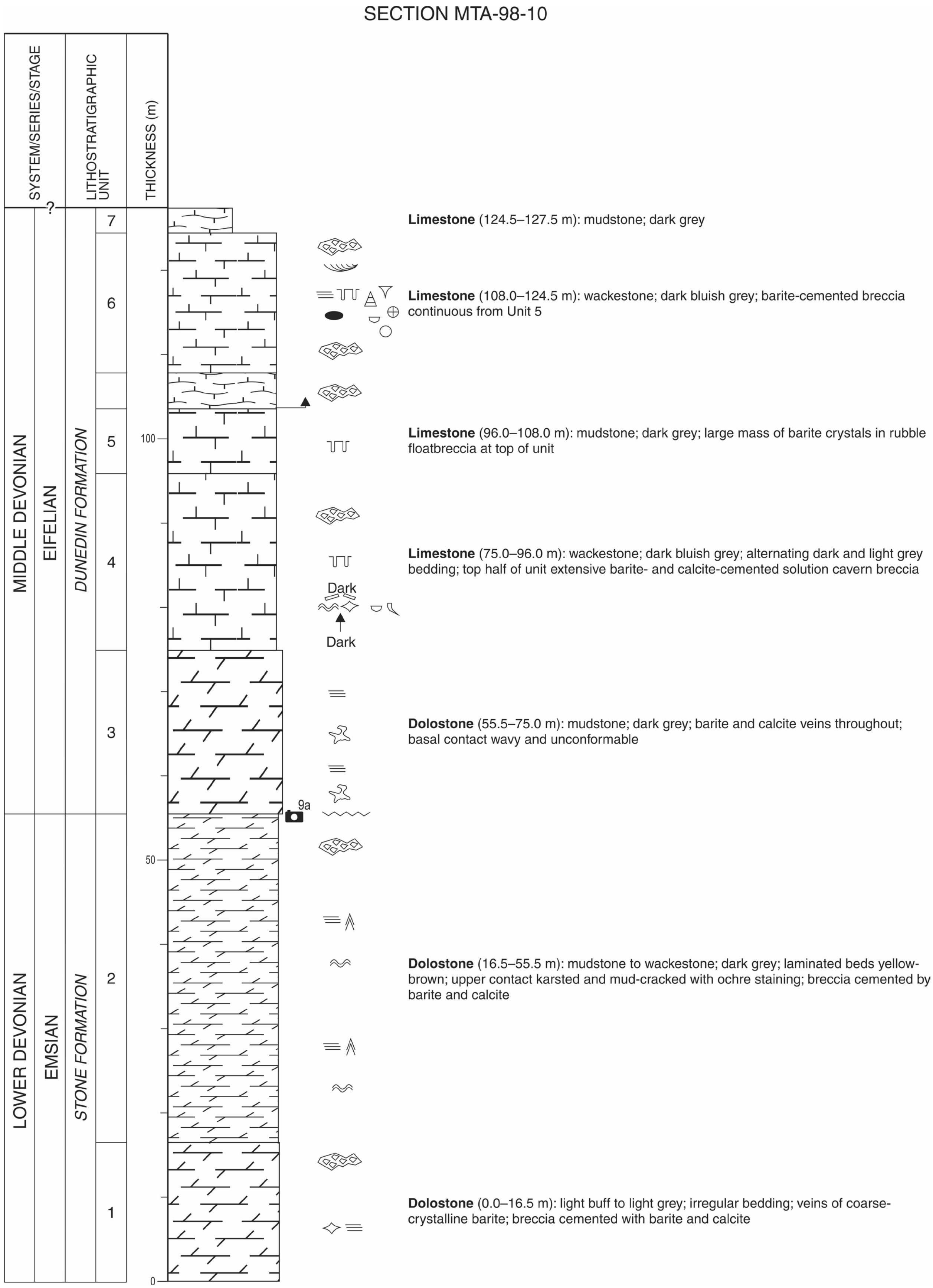



**Figure 20.** Columnar section for Section MTA-98-10.

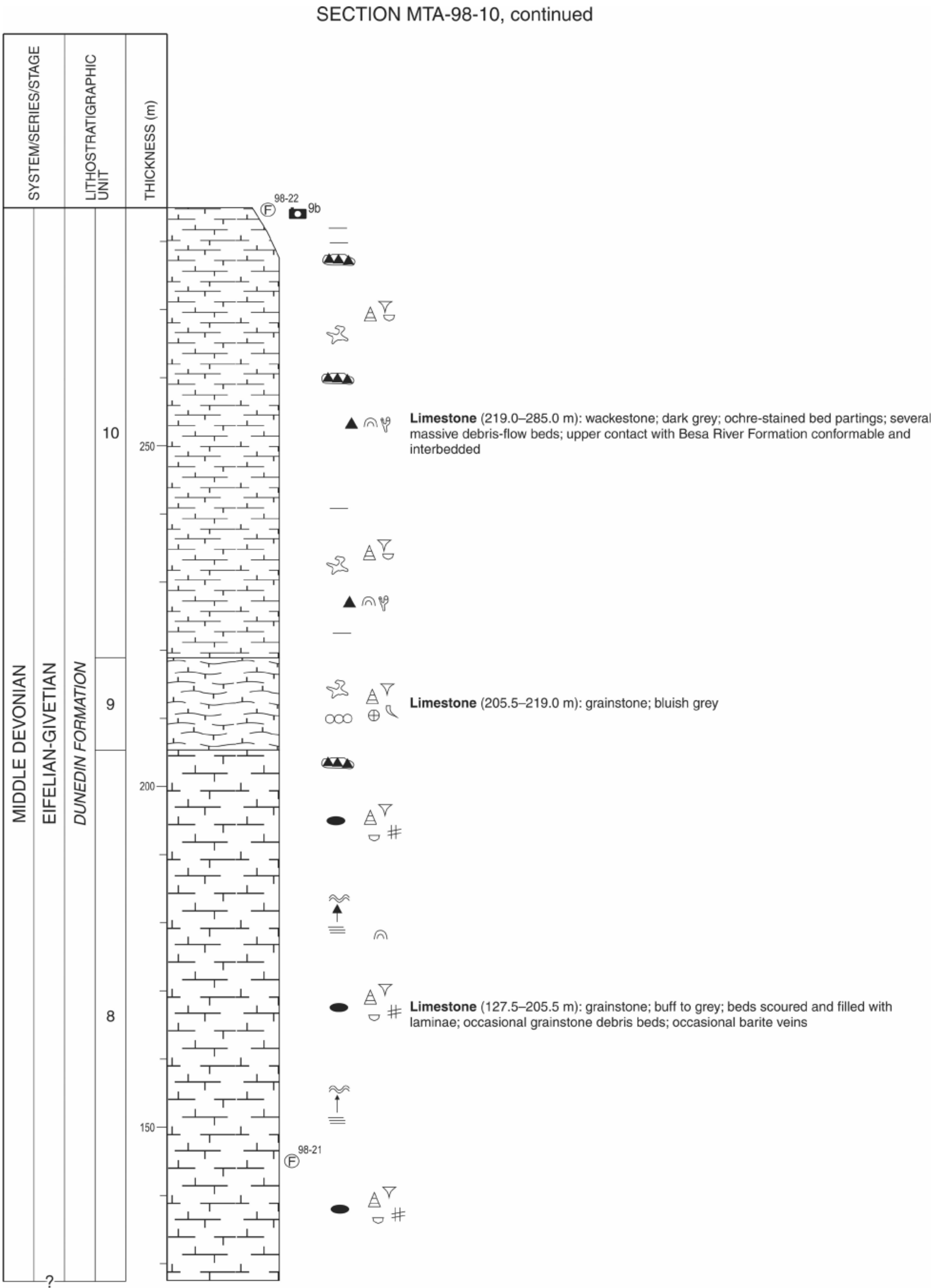



**Figure 20.** (Cont.)

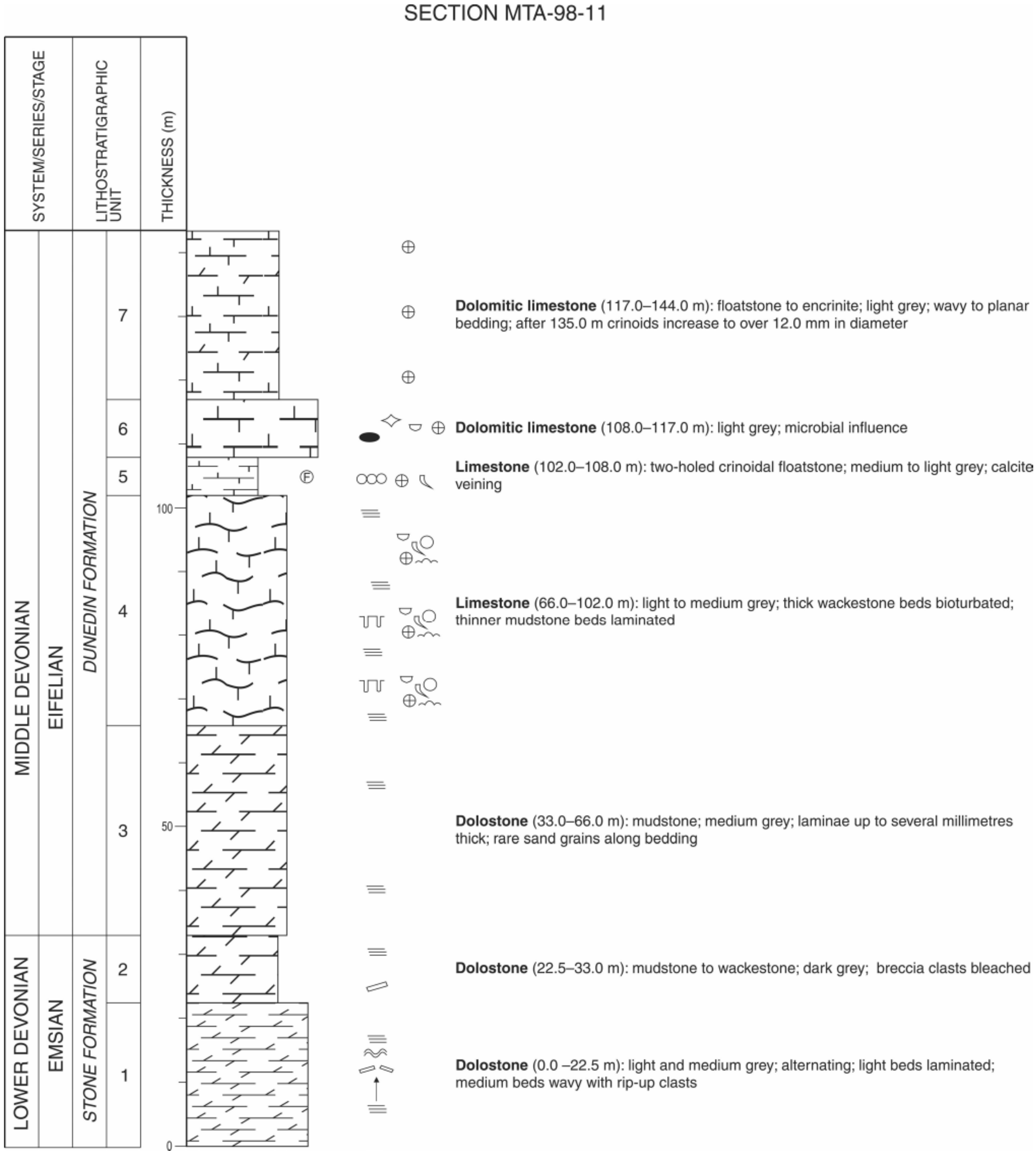



**Figure 21.** Columnar section for Section MTA-98-11.

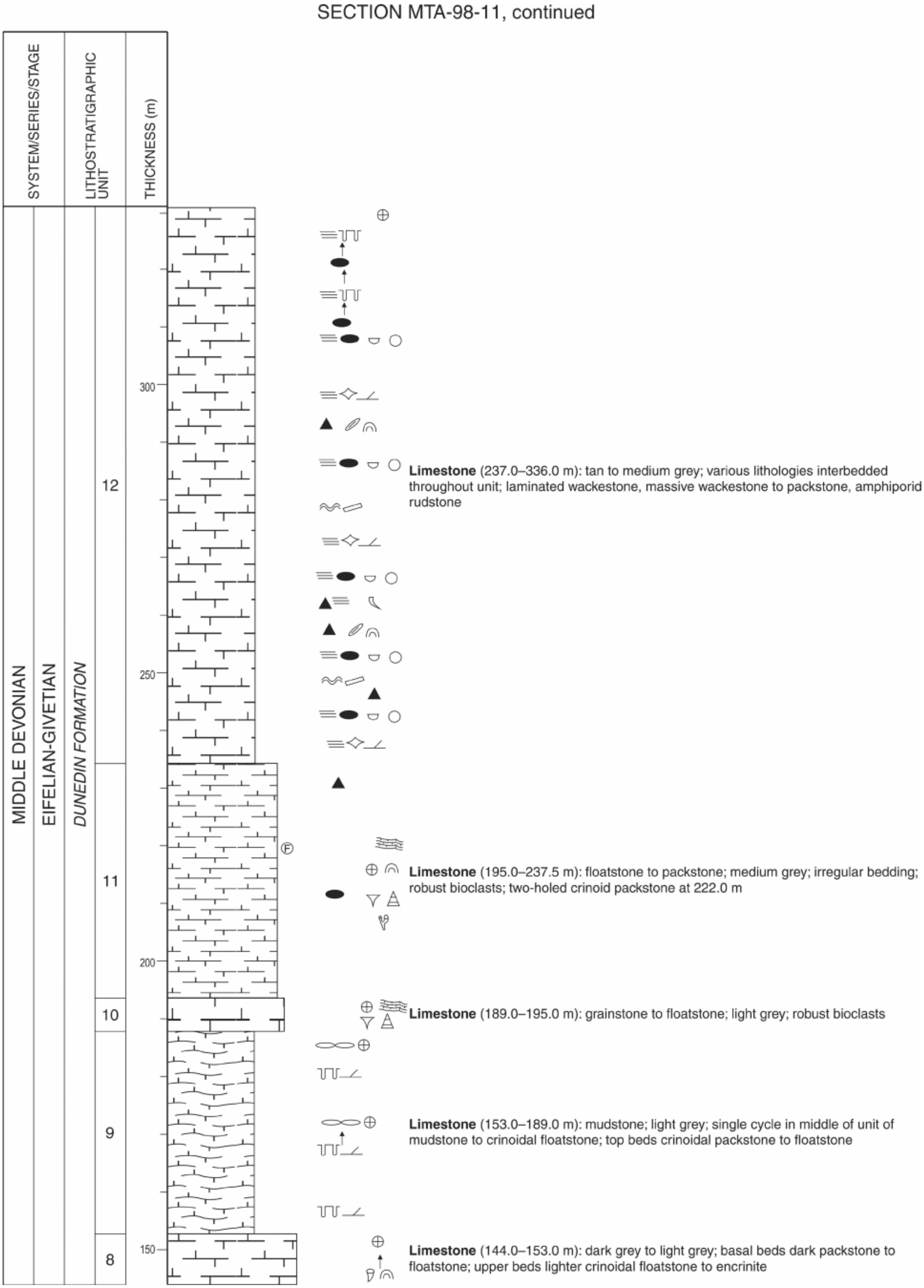



**Figure 21.** (Cont.)

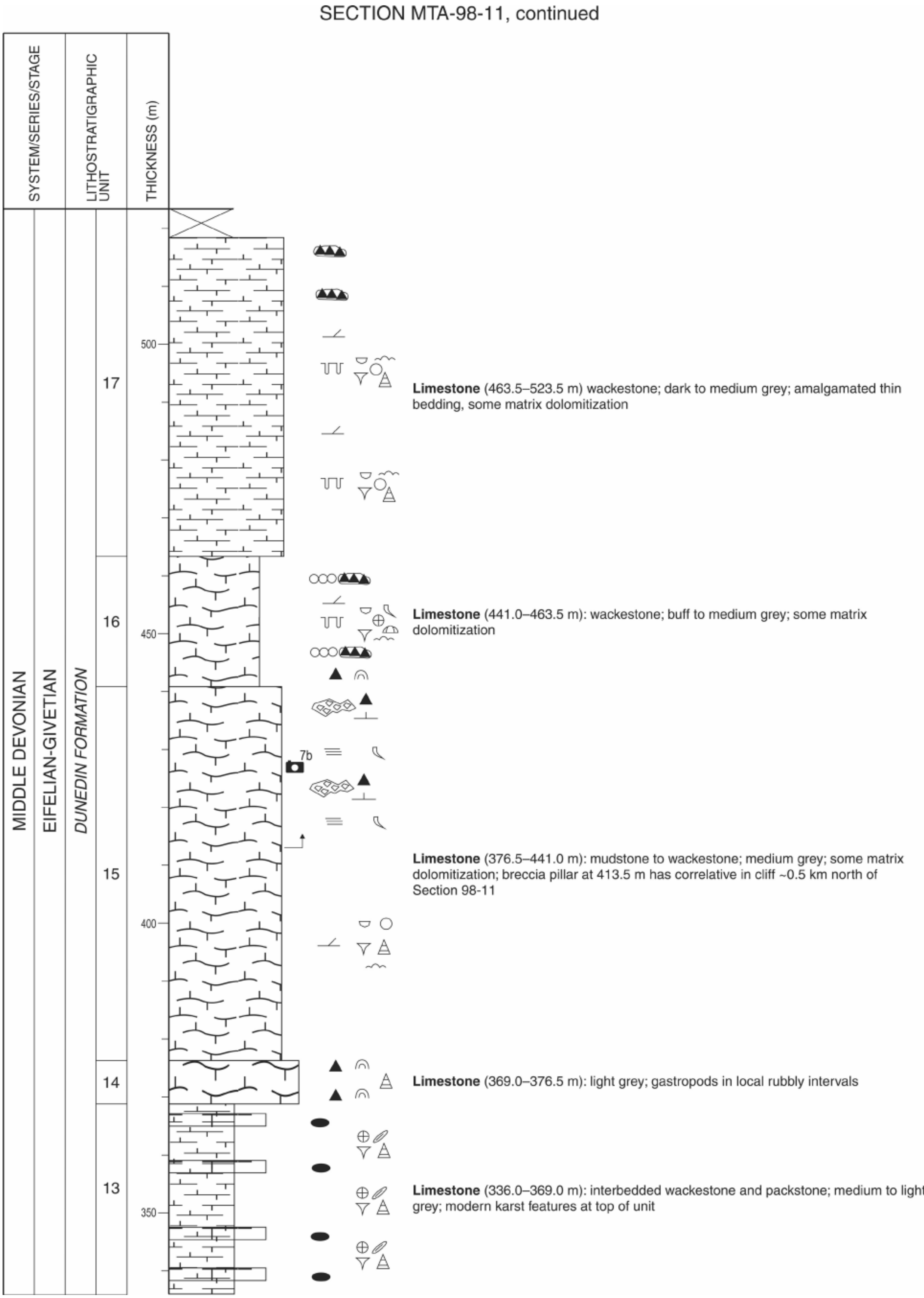



**Figure 21.** (Cont.)

are associated with robust bioclasts, with the crinoid ossicles themselves reaching over 12.0 mm in diameter, indicating deposition in a higher energy environment. Some amphiporid rudstone to packstone is found within the mudstone and wackestone intervals, indicating deposition in a more sheltered and brackish environment. The Dunedin Formation in this section indicates deposition in an open-marine to subtidal environment, with some crinoidal and bioclastic shoals near the base of the formation. Occasional peritidal and lagoonal environments are indicated, possibly occurring behind the crinoidal shoals.

There is one area affected by brecciation, with a large pillar of calcite-cemented rubble to mosaic pack breccia occurring around 410.0 to 440.0 m. In addition, there is abundant silicification in the upper 100.0 m of the formation. A large outcrop half a kilometre north of this section displays the upper part of a similar, but larger, probably calcite-cemented breccia body (Fig. 7b).

## Section MTA-98-12

This section (Fig. 22) extends up the nose of a ridge at the south end of the Sentinel Range in the Tuchodi Lakes map area. It includes strata from the uppermost beds of the Stone Formation and the Dunedin Formation. The contact with the overlying Besa River Formation is covered, and occurs approximately 25.0 m above the top of the section.

Only 1.3 m of Stone Formation was measured in this section, consisting of thinly laminated dolostone with some fenestral fabric, likely deposited within a peritidal environment. The contact with overlying Dunedin strata is sharp but not well exposed.

The Dunedin Formation is dominantly limestone, with dolostone occurring only in the lowermost unit of the formation. The dominant lithology is peloidal mudstone to wackestone, with some rare packstone and bioclastic floatstone intervals. There is an interval with scour-and-fill bedding near the base of the formation, and one thick bed of stromatolites at the base of the formation. Faunal diversity tends to increase slightly upsection. Uppermost beds contain corals and stromatoporoids. The formation was likely deposited initially in a restricted-marine, peritidal setting, which became slightly more open marine and subtidal.

## Section MTA-98-13

This section (Fig. 23) lies east of Mount Mary Henry in the Tuchodi Lakes map area. This section includes strata of the Wokkpash, Stone, and Dunedin formations, up to the upper contact of the Dunedin Formation with the Besa River Formation.

The lower contact between the Wokkpash and Muncho-McConnell formations is not exposed. The Wokkpash Formation consists of dolomite-cemented sandstone to sandy dolostone. The first unit is fairly massive, with some quartz arenite bands near the base and laminae near the top. Some laminae are reworked into chips aligned along bedding. There are also some low-angle crossbeds. The upper unit contains lenticular bedding and appears bioturbated. There are no visible bioclasts. The formation was likely deposited within a high- to moderate-energy, foreshore marine environment, perhaps offshore from barrier bars. The upper contact with the Stone Formation is sharp but not well exposed.

The Stone Formation is uniformly dolostone with some silty and sandy dolostone. The lithology is generally sandy dolomudstone and wackestone. The dominant sedimentary structures are laminae, fenestral fabric, and mudchips, and crossbedding in the sandstone beds. There are very few visible bioclasts, but there are some amphiporid-bearing beds near the middle of the formation. This formation was likely deposited in a low-energy peritidal environment that included times of higher energy, possibly storms, when intraclast breccias formed. Sandstone and occasional channel deposits were deposited during times of deeper water and higher energy. The contact between the Stone and Dunedin formations is sharp but not obviously unconformable.

The Dunedin Formation consists of limestone with some rare dolostone. The dominant lithologies are mudstone, wackestone, and peloidal packstone. Some grainstone is found near the top, containing a moderately diverse ostracode, brachiopod and crinoid fauna, and dasycladacean algae, the only visible fauna in the formation. Deposition took place mainly within a restricted peritidal to shallow subtidal environments. Silicification and barite veining occurs near the base of the formation.

## Section MTA-98-14

This section (Fig. 24) lies near the North Tetsa River in the Tuchodi lakes map area, and includes strata of the Wokkpash, Stone, and Dunedin formations. The section base is at the contact between the Muncho-McConnell and Wokkpash formations, and the top is at the contact between the Dunedin and Besa River formations.

The Wokkpash Formation is composed of yellow and orange weathering, thin- to medium–bedded, silty and sandy dolostone, dolomite-cemented sandstone, and dolostone, with a few, massive, white, quartzarenite beds. It rests with an abrupt contact on the more resistant dolostone of the Muncho-McConnell Formation. There are no visible bioclasts. Mudcracks and fenestral fabric occur near the top of the formation. This formation was likely deposited within a shallow nearshore to shoreface marine environment,

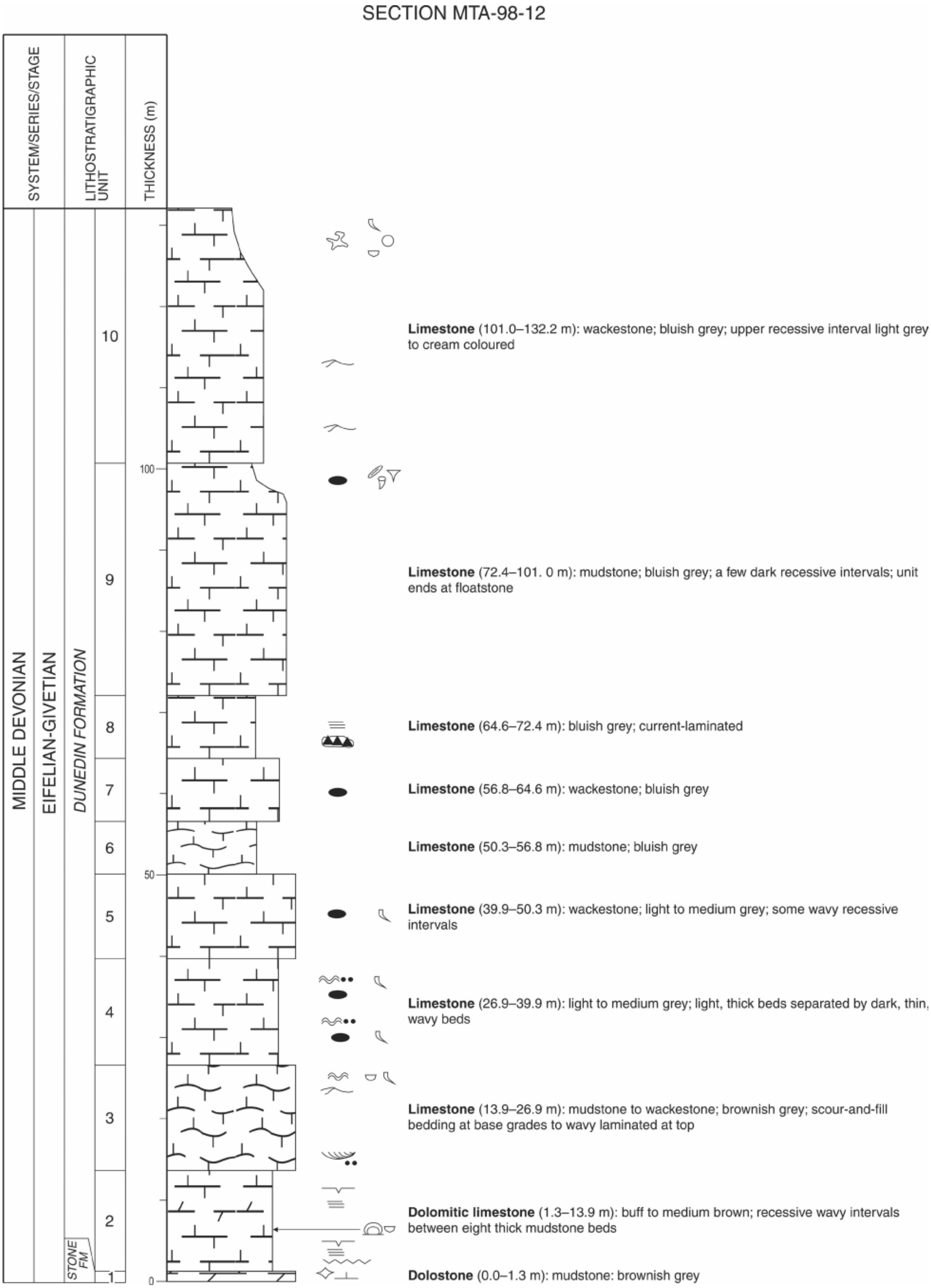



**Figure 22.** Columnar section for Section MTA-98-12.

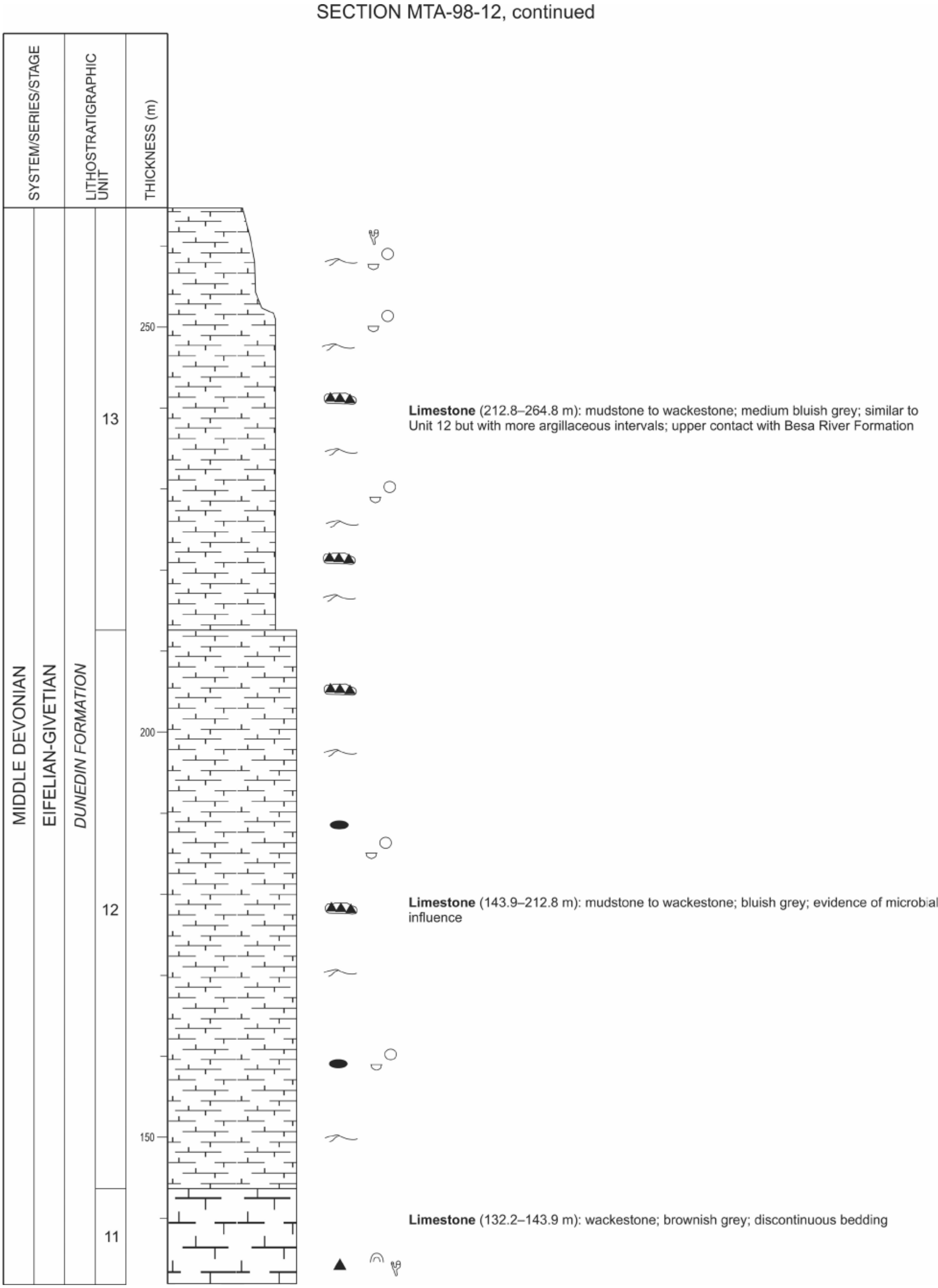



**Figure 22.** (Cont.)

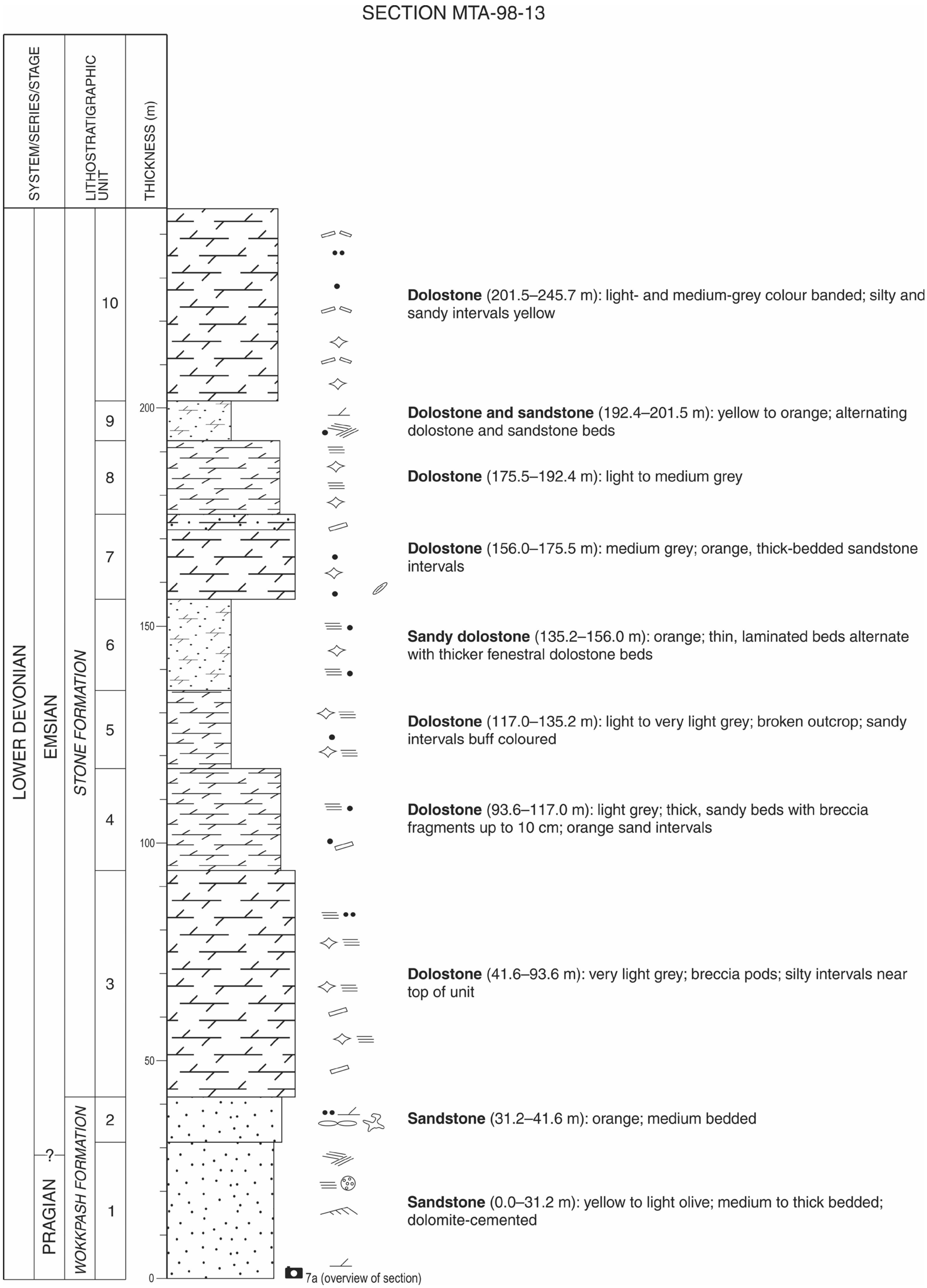



**Figure 23.** Columnar section for Section MTA-98-13.

SECTION MTA-98-13, continued

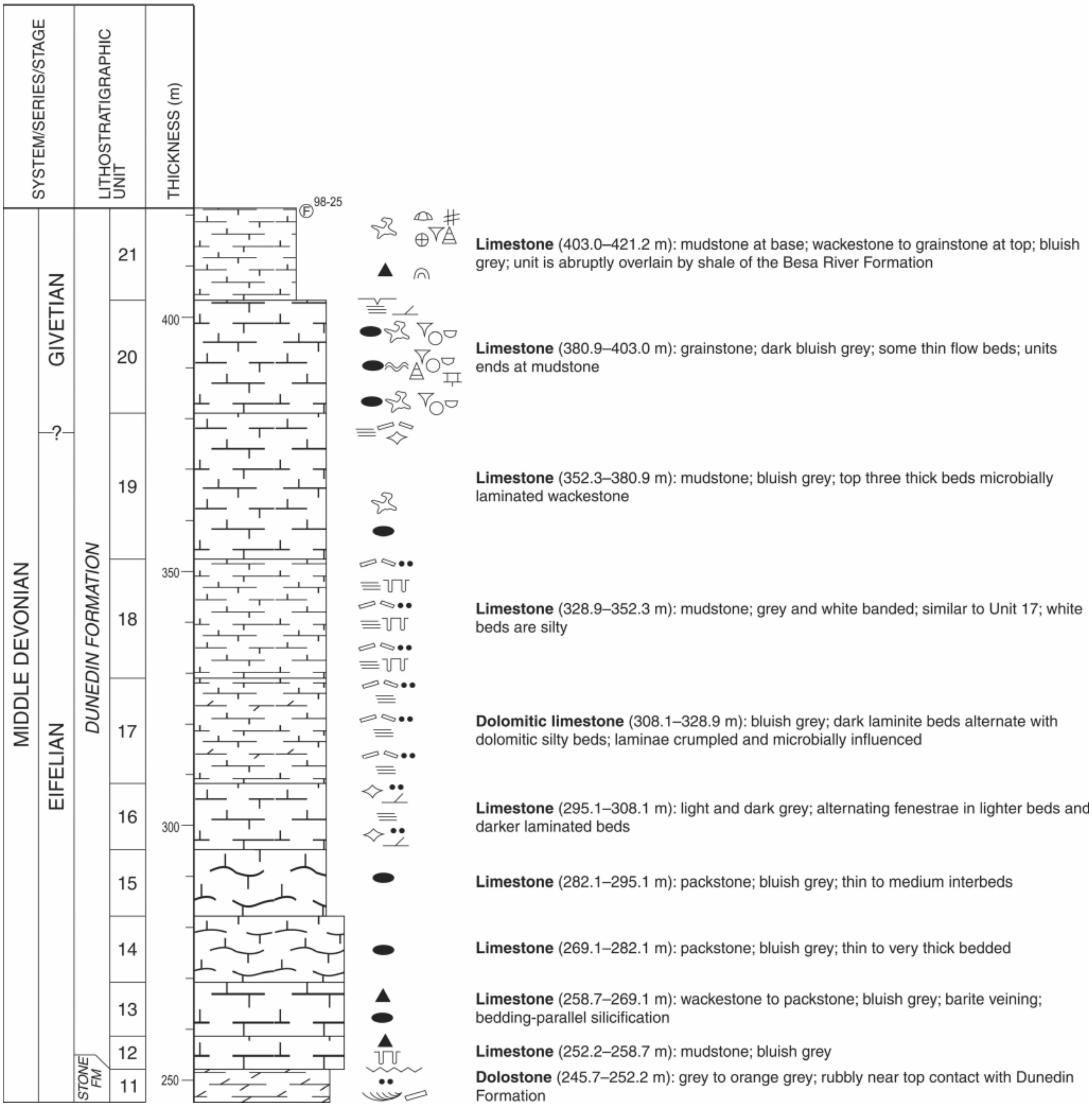



**Figure 23.** (Cont.)

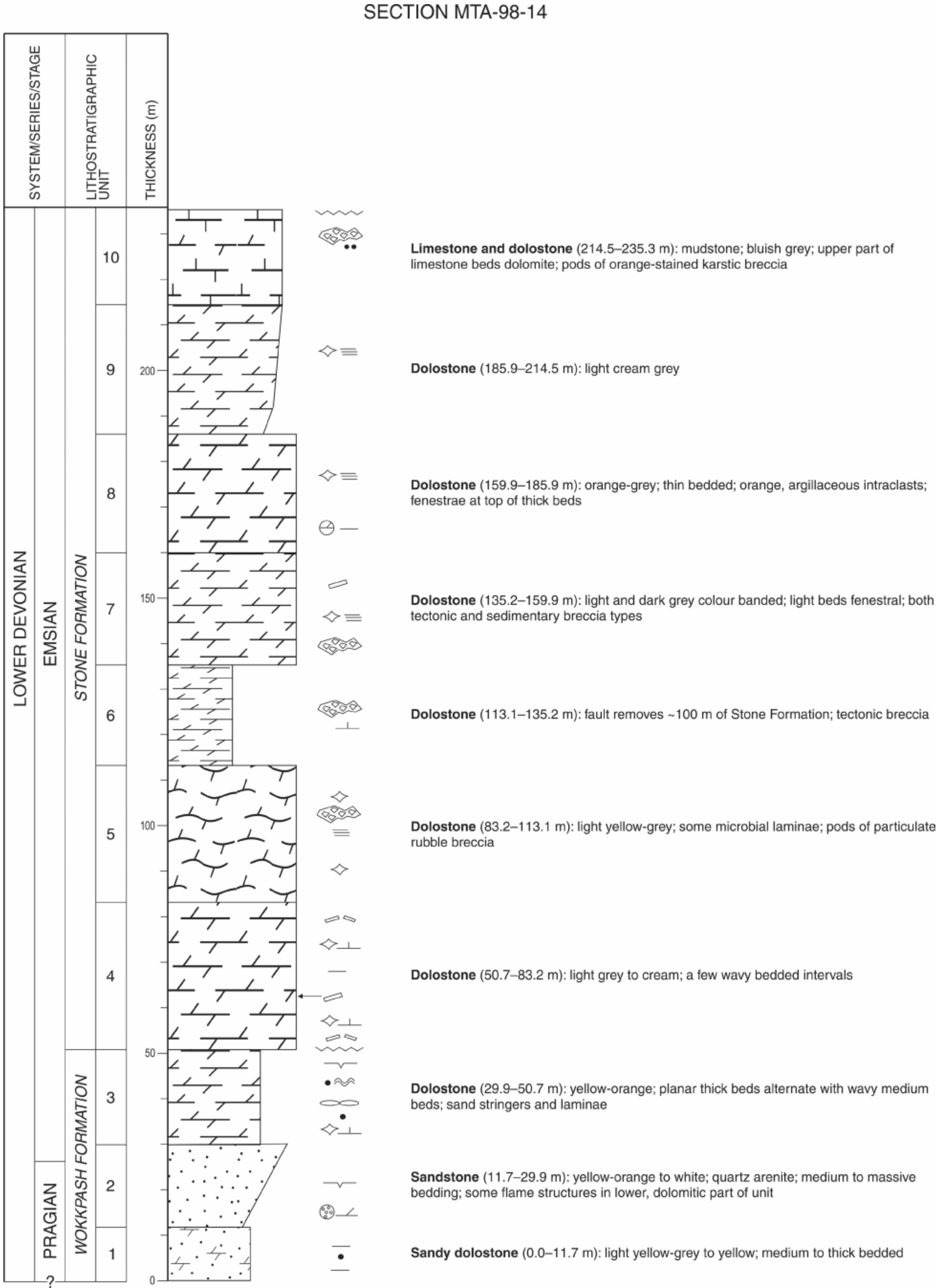



**Figure 24.** Columnar section for Section MTA-98-14.

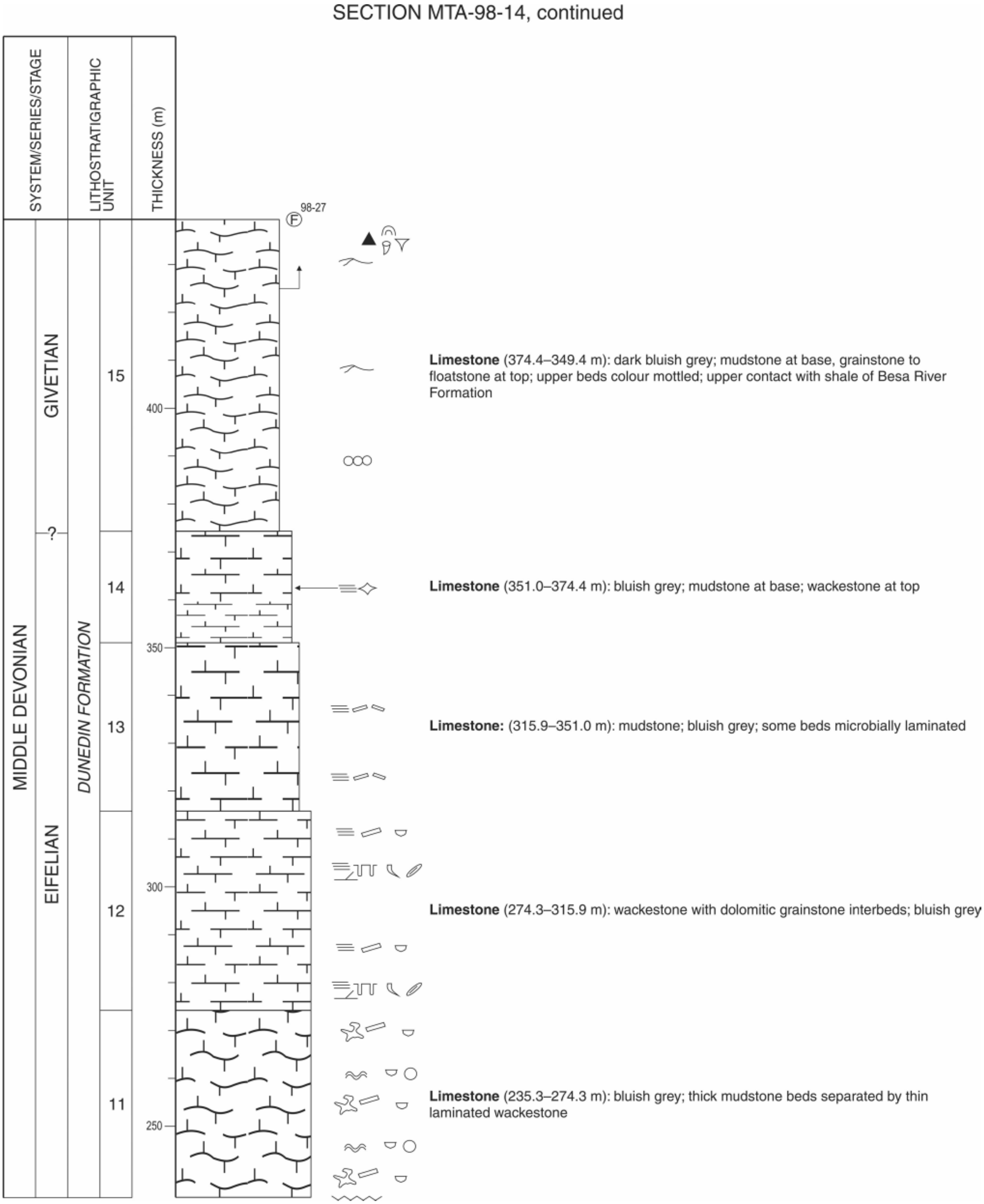



**Figure 24.** (Cont.)

possibly farther from the sediment source and depositionally more updip than other, cleaner, Wokkpash sections measured to the north.

The Stone Formation is composed largely of thick-bedded, cream-coloured dolostone, alternating with dolomudstone and dololaminite. Fenestral fabrics are abundant in the thinner bedded dololaminite. The Stone Formation rests with a sharp contact on the underlying Wokkpash. There are pods of breccia near the base of the formation that are associated with a fault, which cuts approximately 100 m of strata from the formation. Lenses of sedimentary breccias are also abundant. Many of these are lenses of reworked mudchips as intraclasts. The Stone Formation at this location was likely deposited in a tidal-flat-dominated peritidal environment, which was disrupted fairly often by higher energy events, possibly storms, which generated mudchip breccias. The contact between the Stone Formation and the overlying Dunedin Formation limestone occurs at a corroded, orange-stained, paleokarst surface, indicating exposure and the development of an unconformity. The upper beds of the Stone Formation contain pods of silty material that are likely a paleo terra rossa that may have formed in response to a period of subaerial exposure following Stone Formation deposition.

The Dunedin Formation is composed of peloidal lime mudstone and wackestone and local laminated grainstone with a rather depauperate fauna dominated by ostracodes and rare amphiporids. The top beds of the formation are a silicified fossiliferous grainstone to floatstone with a more diverse, open-marine fauna of corals, brachiopods, and hemispheroidal stromatoporoids. Overall, the formation was likely deposited within a peritidal and subtidal, slightly restricted and low-energy marine environment. The laminated grainstone may have been deposited within small, higher energy channels that cut through tidal flats or as occasional storm washover deposits on tidal flats.

## Section MTA-98-15

This section (Fig. 25) was measured along a ridge a few kilometres northeast of Muncho Lake in the Toad River map area. The section includes the uppermost beds of the Wokkpash Formation, the Stone Formation, and part of the Dunedin Formation. The Stone Formation at this location is very thick in comparison with other sections; this may be due to fault repetition, though no faults were obvious during measurement of the section.

The Wokkpash Formation in this section is a yellow sandy dolostone with some sand chips. The contact with the overlying, more resistant Stone Formation is abrupt but not well exposed.

The Stone Formation is dolostone, mainly dolomudstone to dolowackestone, with some thick-bedded, more resistant intervals containing amphiporid floatstone beds throughout. Thinner dololaminite beds commonly exhibit fenestral fabric and tend to occur in repetitious alternations with medium- to thick-bedded dolostone. Deposition probably occurred in a somewhat restricted, shallow subtidal and peritidal environment. The upper contact of the Stone Formation with the overlying Dunedin Formation is sharp and irregular with a strongly karsted appearance. Orange mud infiltrates uppermost Stone strata immediately beneath this erosional surface.

The Dunedin Formation is dominantly limestone, with fossiliferous mudstone and skeletal wackestone as the dominant lithologies. The basal unit contains laminae and fenestral fabric. The uppermost measured unit displays 4 m thick cycles, consisting of burrowed skeletal wackestone grading up to peloidal skeletal packstone and floatstone. The formation was deposited initially within a low-energy peritidal environment, grading upsection to strata indicating a low- to moderate-energy shallow subtidal, to more open-marine environment.

## Section MTA-99-1

This section (Fig. 26) extends along 110 Creek in the Tuchodi Lakes map area. It includes the type section of the Dunedin Formation as well as strata of the underlying Stone Formation and overlying Besa River Formation.

The Dunedin Formation is dominantly limestone, with a basal interval of dolomitic limestone. The contact between the Stone and Dunedin formations occurs at a scalloped surface with up to 50 cm relief, indicating an erosional unconformity. The predominant lithology is fossiliferous mudstone to skeletal wackestone, with some skeletal packstone and floatstone intervals. Faunas are moderately diverse and dominated by ostracodes and brachiopods. Large favositid and hexogonarid corals were observed only along the uppermost Dunedin bed surface immediately beneath Besa River shale. Reddish-orange-stained hardgrounds are scattered throughout. The formation was likely deposited within a subtidal, slightly restricted-marine shelf environment that became more open marine upsection. The upper contact with the Besa River Formation is abrupt and apparently conformable.

## Section MTA-99-2

This section (Fig. 27) extends along the nose of a ridge north of Lapierre Creek in the Halfway River map area. The section includes uppermost strata of the Stone Formation, and the complete Upper Chinchaga to Slave Point Undivided up to its contact with the overlying Besa River Formation. Strata of this section are strongly overprinted by the Presqu'ile Dolomite.

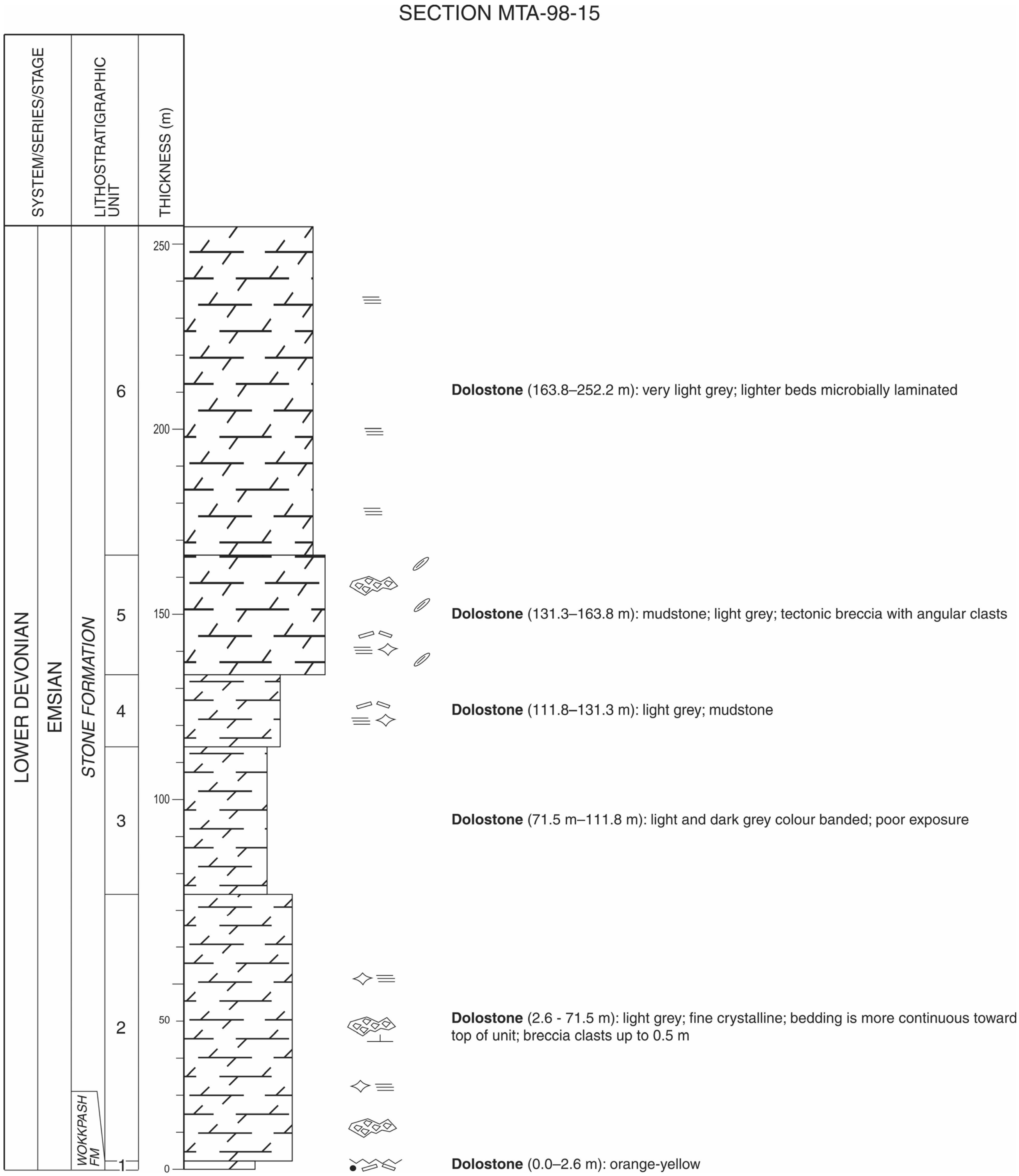



**Figure 25.** Columnar section for Section MTA-98-15.

SECTION MTA-98-15, continued

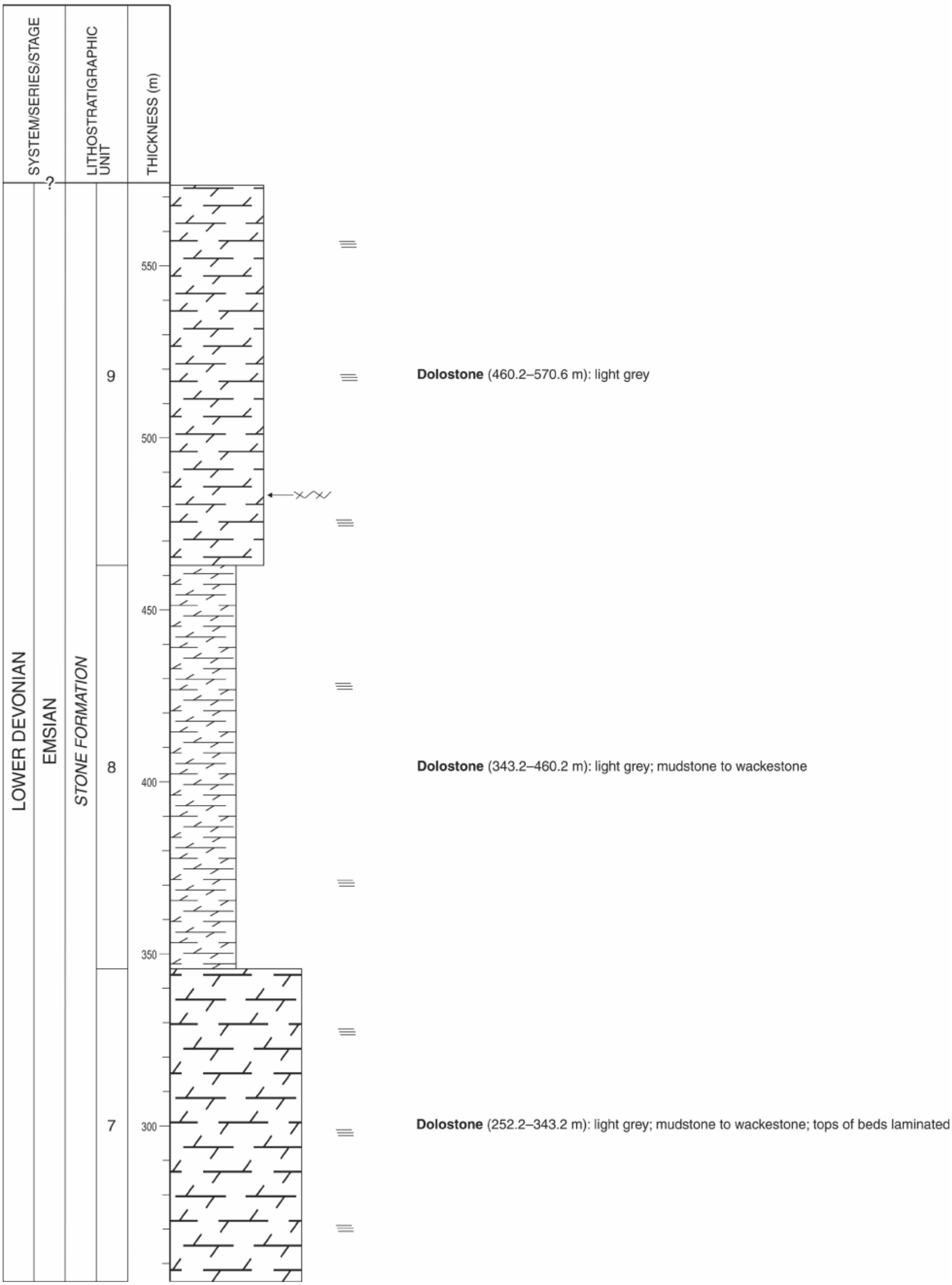



**Figure 25.** (Cont.)

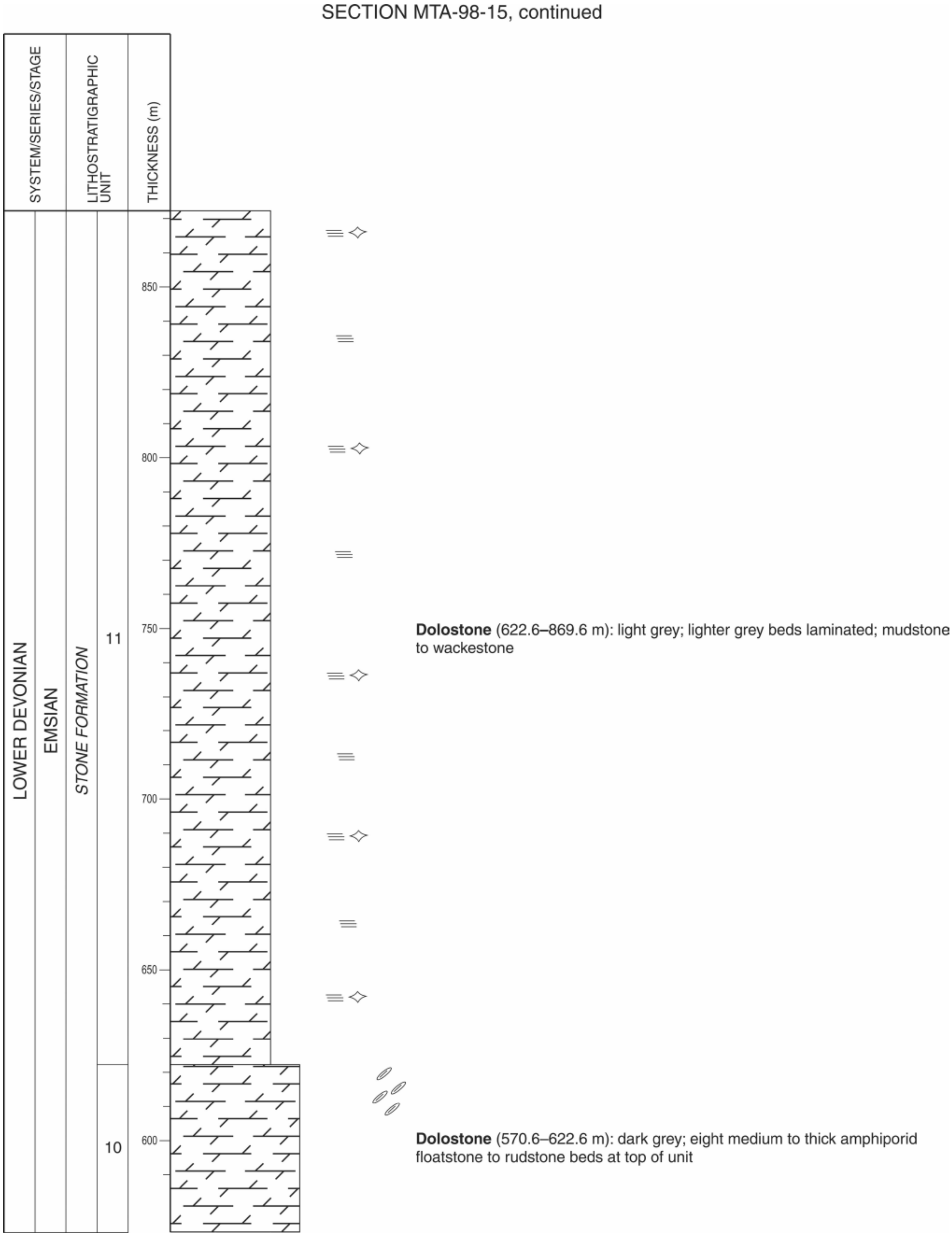



**Figure 25.** (Cont.)

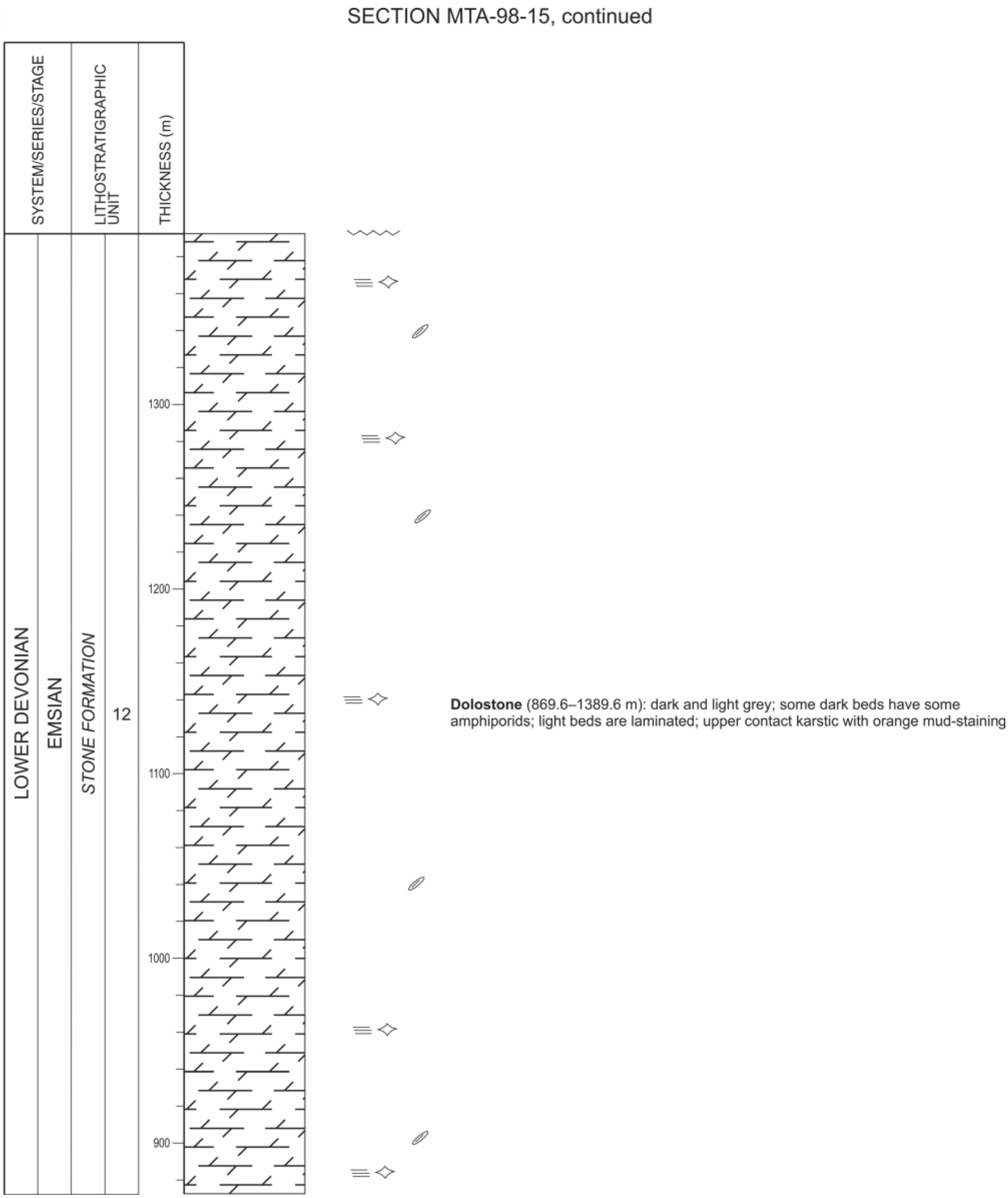



**Figure 25.** (Cont.)

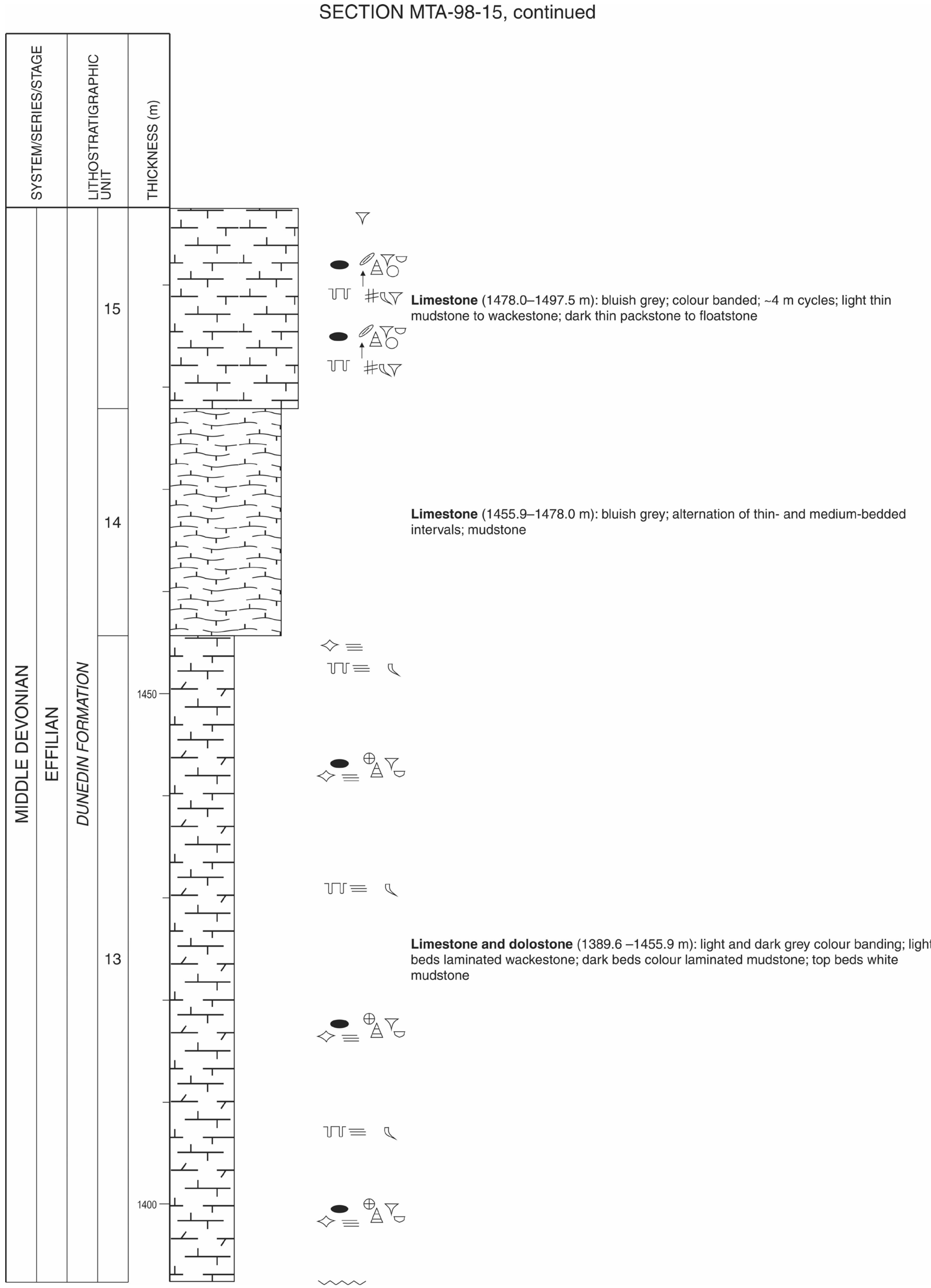



**Figure 25.** (Cont.)

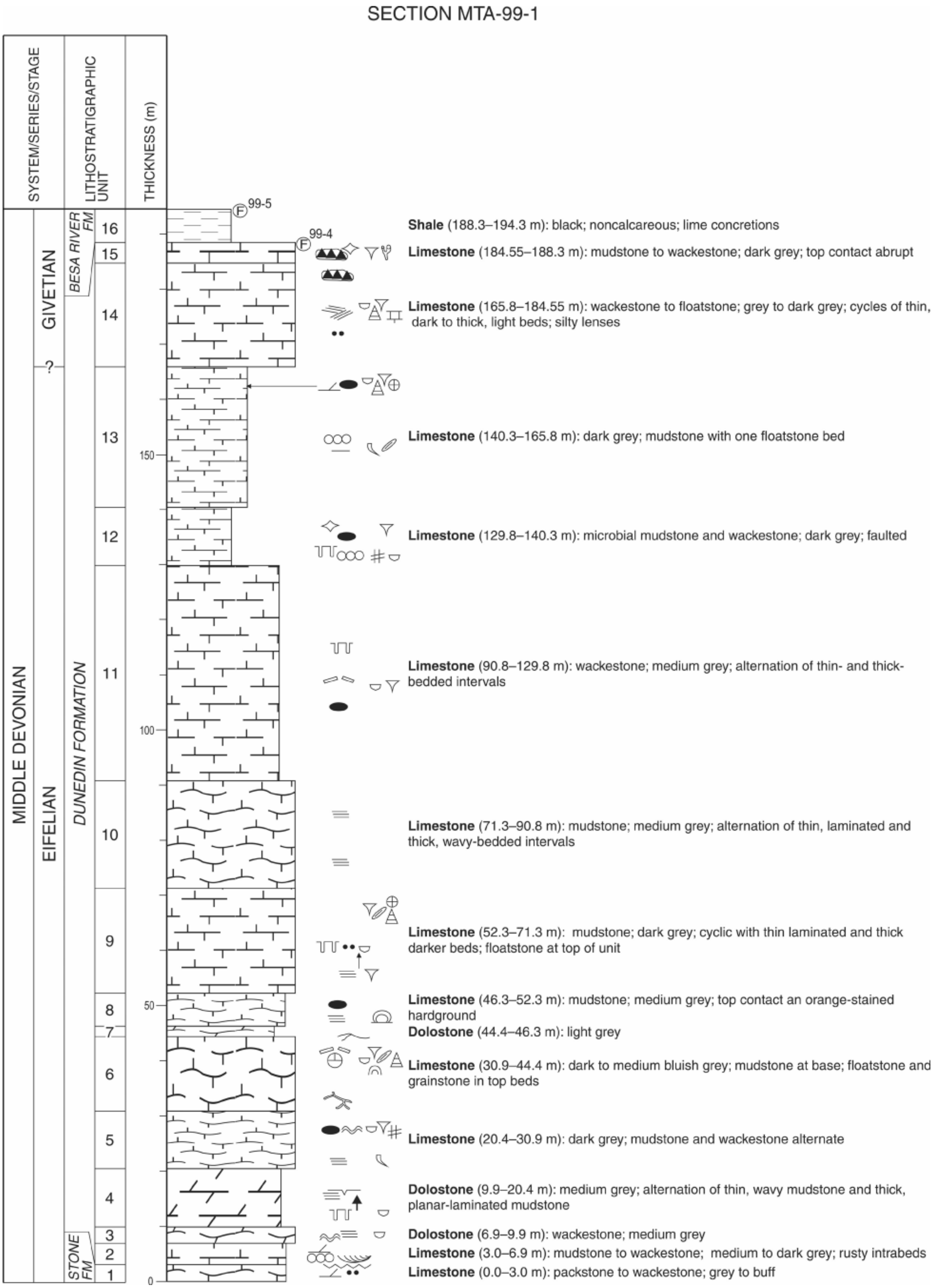



**Figure 26.** Columnar section for Section MTA-99-1.

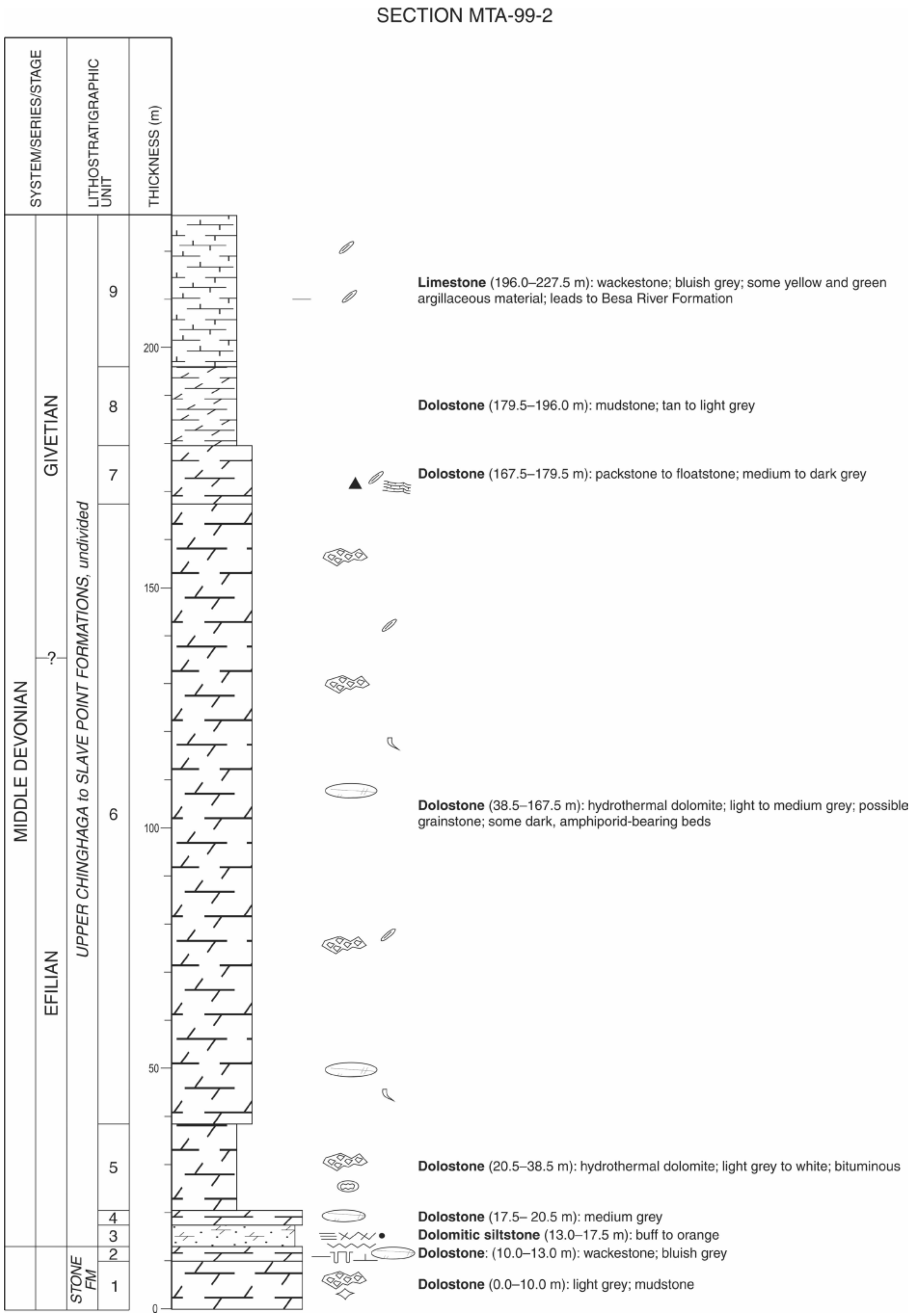



**Figure 27.** Columnar section for Section MTA-99-2.

The Stone Formation is dolostone and mudstone to argillaceous wackestone. Fenestral fabric and burrows can be seen through intense hydrothermal dolomitization and associated brecciation.

The basal 165 m of the Upper Chinchaga to Slave Point Undivided also underwent intense brecciation and hydrothermal dolomitization associated with development of the Presqu'ile Dolomite, and little indication of the original sedimentary structures and lithology remain. The basal unit is dolomitic siltstone to sandstone, which is then overlain by apparent grainstone. Original lithologies and sedimentary structures can still be determined within the upper 70 m, though also altered. These upper beds alternate between mudstone and amphiporid rudstone with some silicified lamellar stromatoporoids. An uppermost interval of slightly argillaceous, tan lime mudstone caps the Upper Chinchaga to Slave Point Undivided and underlies the upper conformable contact with the Besa River Formation. Because of the alteration, very little can be determined as to the depositional environment, but there are indications that deposition occurred within and around a reef complex.

## Section MTA-99-3

This section (Fig. 28) extends along the nose of a ridge north of Nabesche River in the Halfway River map area. The section includes strata of the Upper Chinchaga to Slave Point Undivided.

The formation is dominantly limestone, with the middle third partly altered to hydrothermal dolomite of the Presqu'ile Dolomite. The lower part is dominantly fossiliferous mudstone to skeletal wackestone, with some amphiporids, followed by bioclast-rich floatstone. This small interval was then followed by more wackestone and packstone with local amphiporid floatstone to rudstone beds. The hydrothermal dolomitization with attendant textural obliteration makes the next intervals along the line of section difficult to interpret, but strata exposed along strike farther down the slope were not as intensely altered. Here there are very thick intervals of hemispheroidal stromatoporoid boundstone. The upper portions of the unit, following the dolomitized intervals, are skeletal grainstone and mudstone intercalated with amphiporid rudstone and floatstone.

Deposition began in a subtidal to open-marine setting, followed by development of biostromes or even reefs (i.e. bioherms). This was then replaced by back-reef lagoonal deposition and low faunal diversity, but with numerous amphiporid beds. Reefal stromatoporoid boundstone was then deposited, followed by yet another amphiporid-rich lagoonal interval. Thin-bedded lime mudstone above this leads upsection to the shale of the Besa River Formation.

## Section MTA-99-4

This section (Fig. 29) extends along a ridge immediately south of Keily Creek in the Trutch map area. The section starts within the Silurian Nonda Formation, leads through the Muncho-McConnell and Stone formations, and into the basal beds of the Upper Chinchaga to Slave Point Undivided.

The uppermost Nonda Formation is dolostone and silty to sandy dolostone with boundstone of hemispheroidal stromatoporoids and corals, mudcracked mudstone, and alternating bands of lamellar stromatoporoids and quartzarenite beds. The contact between the Nonda and Muncho-McConnell formations occurs at an unconformity, marked by a silcrete horizon.

The Muncho-McConnell Formation is yellow and orange weathering dolostone to sandy dolostone, with laminae and fenestral fabric in mudstone and silty to sandy mudstone. There is no visible fauna within the formation. Overall, it appears the formation was deposited within a carbonate peritidal setting, which at times had a high siliciclastic input.

The Stone Formation is all light grey dolostone as mudstone and argillaceous or sandy mudstone. Other than a few amphiporid rudstone intervals within Unit 12, there are no visible bioclasts. Sedimentary breccias are found in thick sections of rubble to mosaic floatbreccia with light mudstone clasts in a darker mudstone matrix. The clasts are centimetre scale, with sharp, angular outlines. This formation contains postdepositional rubble breccias cemented by calcite near the base, and vugs filled with megacrystalline calcite at the top. This formation was likely deposited within subtidal and peritidal environments with occasional higher energy episodes (e.g. storms) forming the sedimentary breccias.

The lower part of the Upper Chinchaga to Slave Point Undivided is composed of dolostone, changing upward to limestone. The basal unit, overlying an abrupt, possibly unconformable, contact with the underlying Stone Formation, is a distinctive, yellow-weathering, recessive quartz arenite that grades upward to silty dololaminite. This is followed by a thick interval of fossiliferous mudstone and skeletal wackestone. The uppermost two units are composed of massive bioclastic grainstone beds. This formation contains some Presqu'ile Dolomite near the base, but the upper units are undolomitized. Deposition likely started in a shoreface, siliciclastic-dominated environment, followed by more open-marine, subtidal conditions. Finally, a biostromal or reef complex formed on this open-marine platform. The uppermost part of the Upper Chinchaga to Slave Point Undivided is not exposed here.

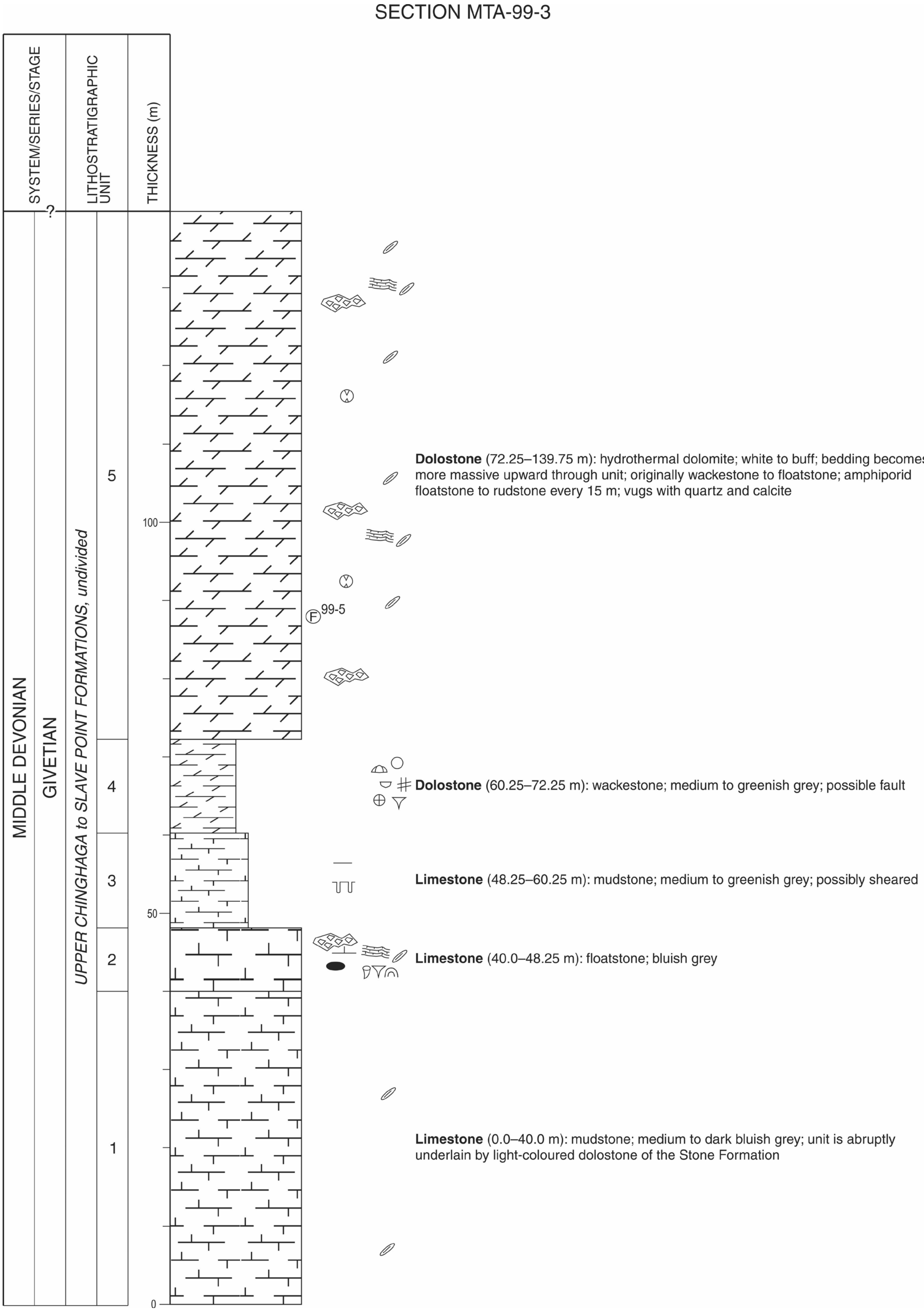



**Figure 28**. Columnar section for Section MTA-99-3.

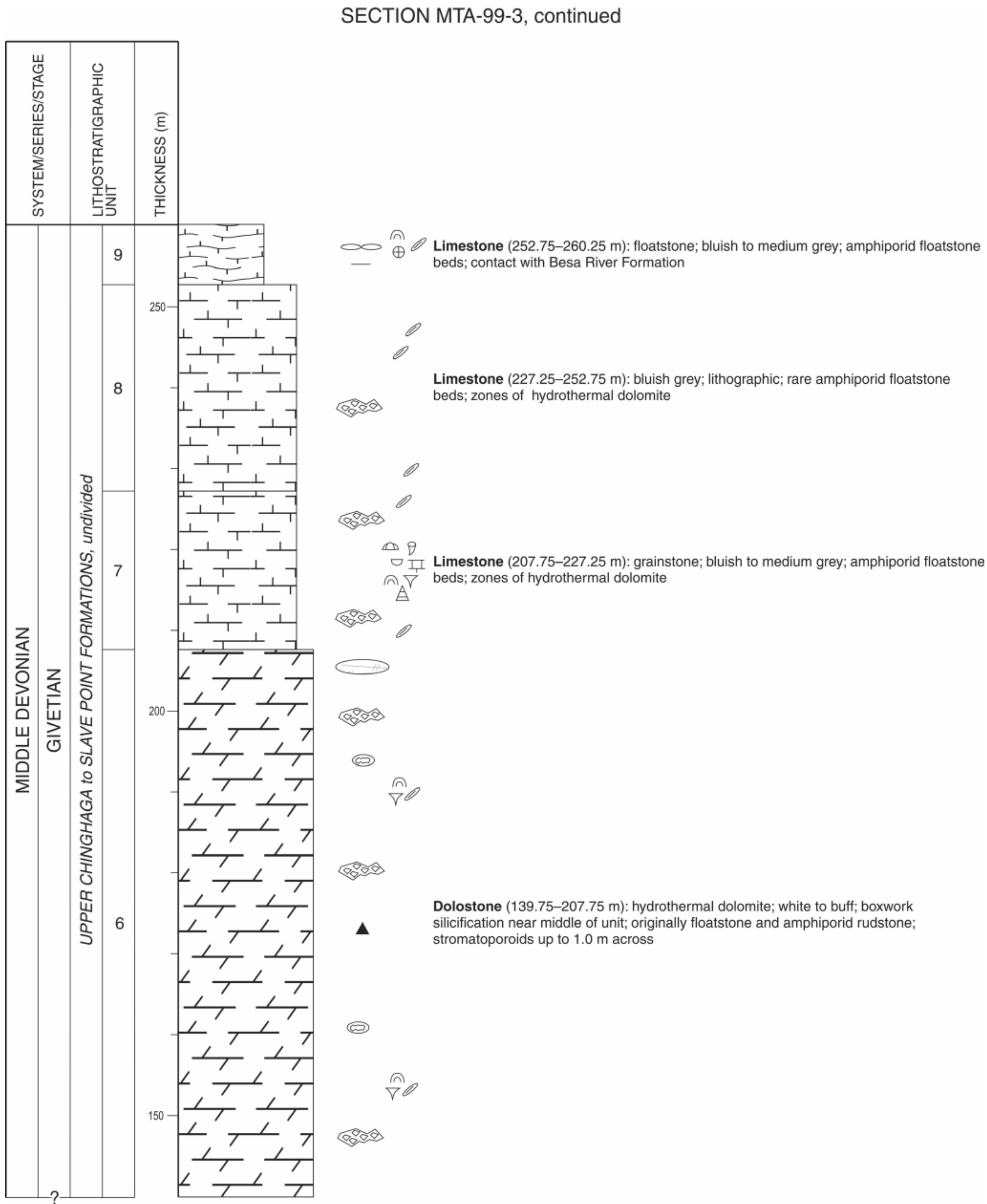



**Figure 28**. (Cont.)

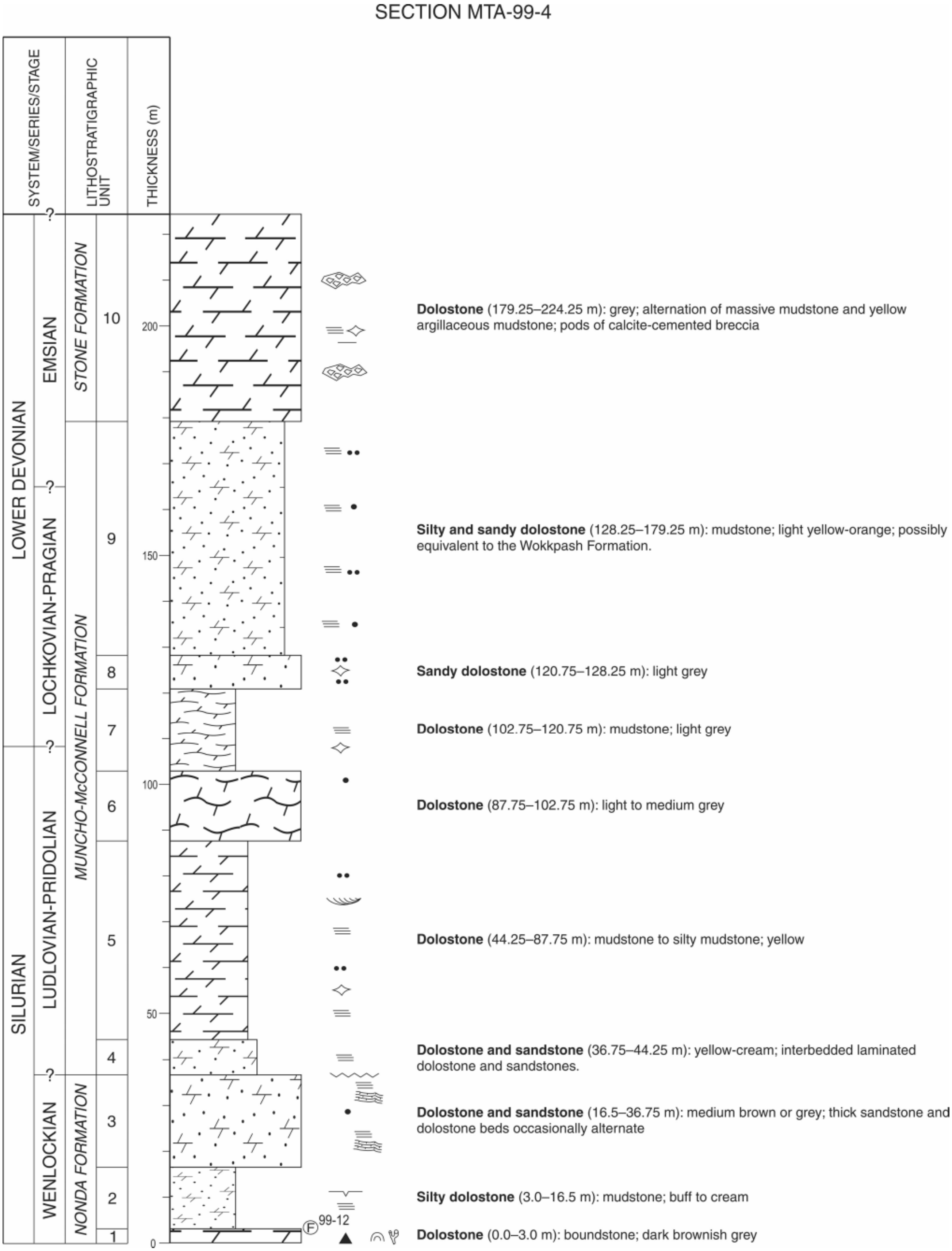



**Figure 29.** Columnar section for Section MTA-99-4.

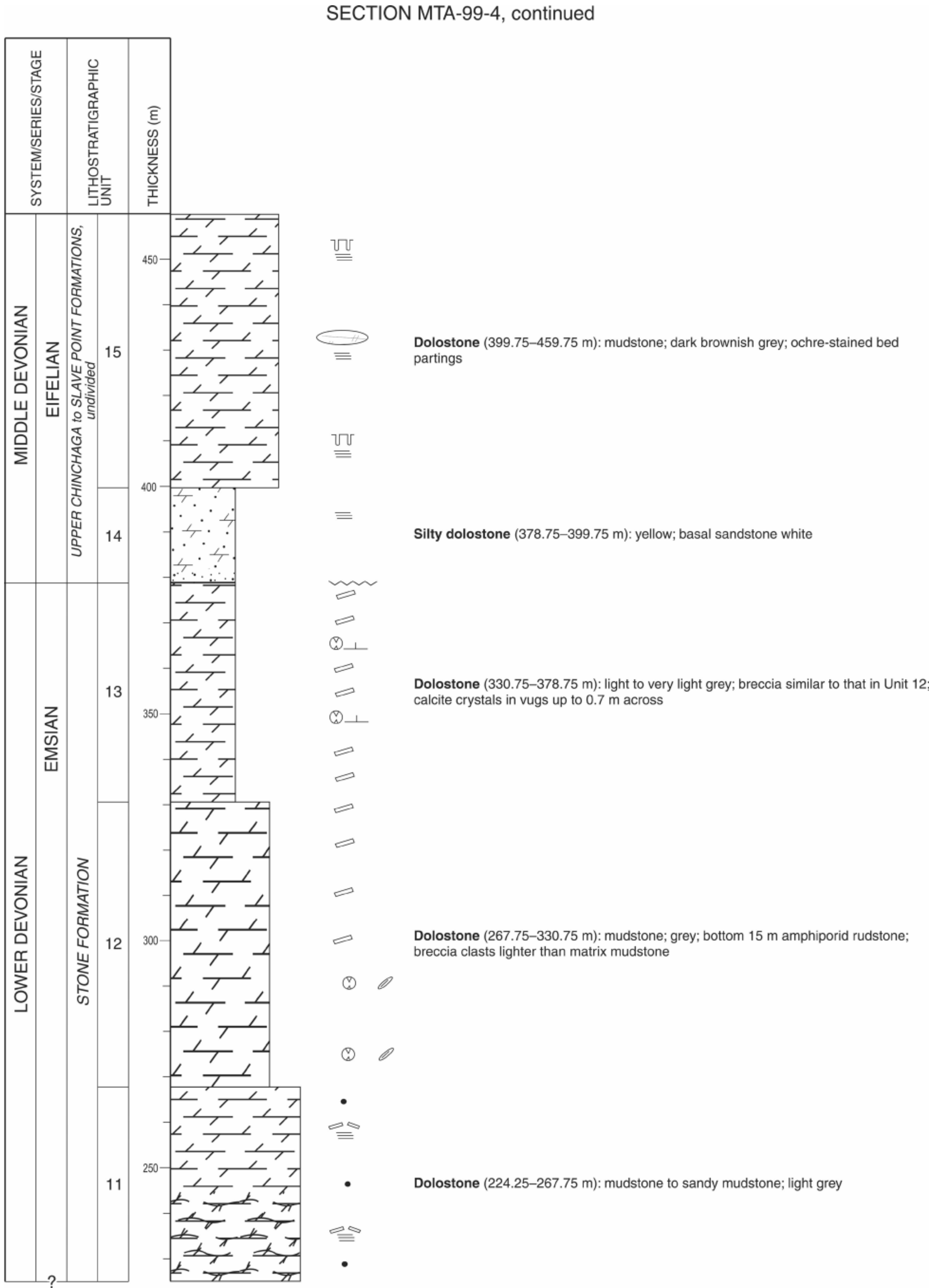



**Figure 29.** (Cont.)

## Section MTA-99-5

This section (Fig. 30) was measured directly east of Mount McCusker in the Trutch map area. The section was measured from the top beds of the Stone Formation upward to the contact between the Upper Chinchaga to Slave Point Undivided and the Besa River Formation. A radical change in dip within the top unit indicates that it may be structurally separated from the underlying units by an eastward-verging thrust.

The uppermost Stone Formation is an argillaceous dolostone with silty and sandy laminae. There is a sharp, but not obviously unconformable, contact between the Stone and the overlying Upper Chinchaga to Slave Point Undivided.

The basal unit of the Upper Chinchaga to Slave Point Undivided is a thin-bedded argillaceous dolostone. It is followed by a thick section of alternating amphiporid floatstone and grainstone beds displaying bed-parallel orientation of bioclasts with high faunal diversity. This is overlain by another thick interval of mudstone and skeletal packstone and floatstone without the intervening amphiporid floatstone

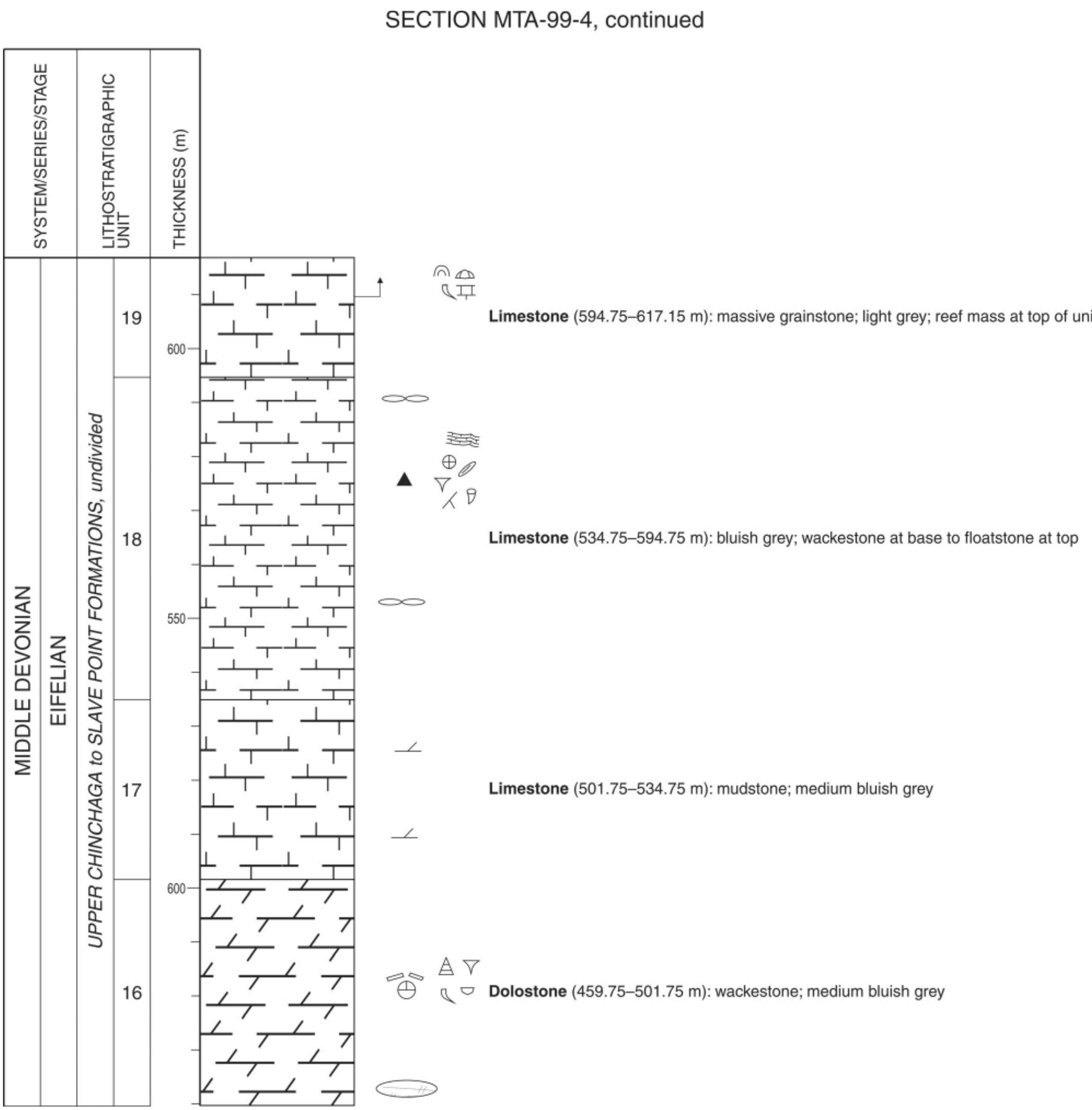



**Figure 29.** (Cont.)

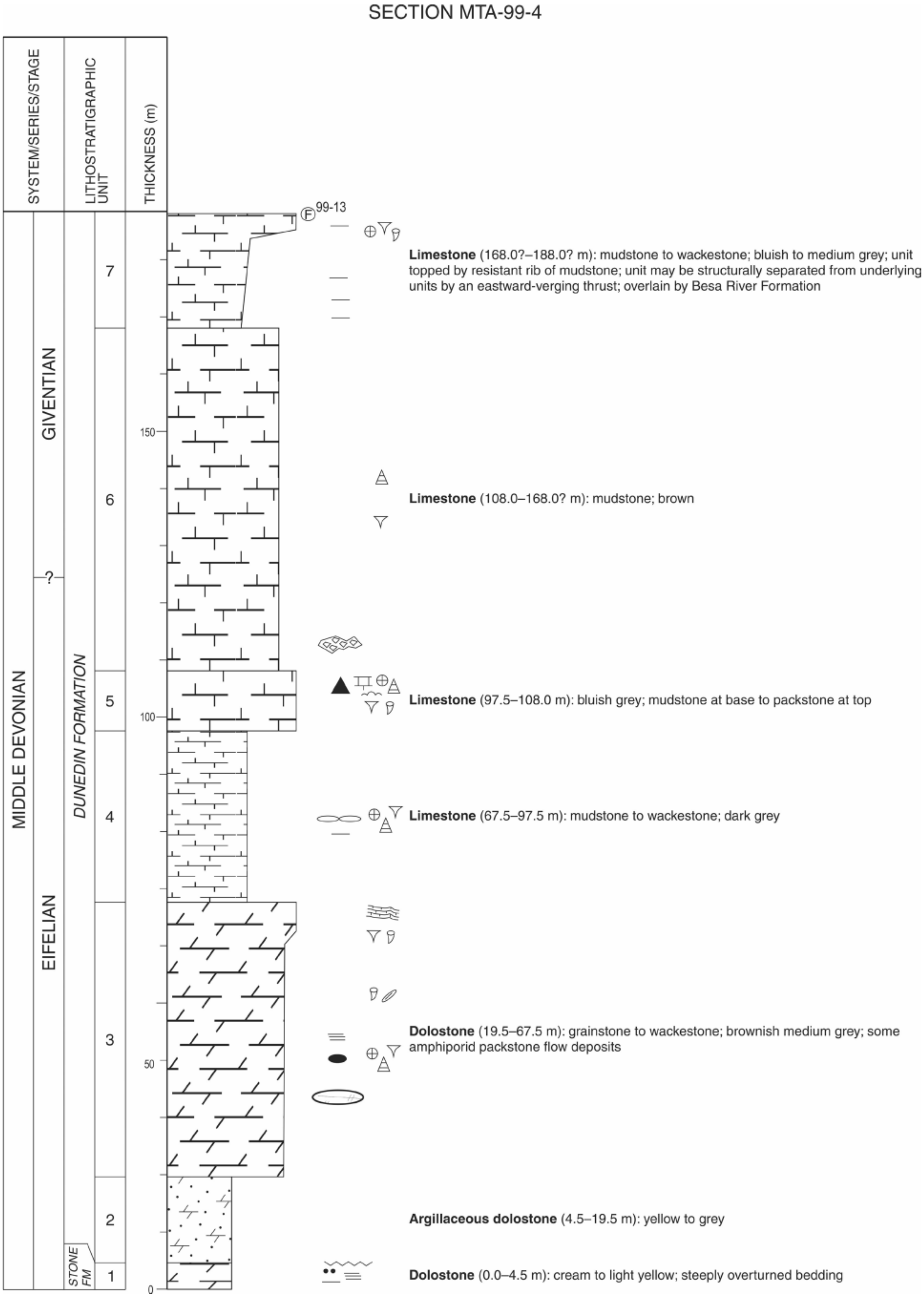



**Figure 30.** Columnar section for Section MTA-99-5.

intervals. This passes upward to fairly monotonous and nondescript mudstone including some intervals with high bioclast content.

Deposition of the section began in a shoreface setting, followed by a forereef submarine slope setting resulting in numerous coarse-skeletal grainflow, debris flow and/or turbidite deposits. The argillaceous skeletal wackestone and lime mudstone at the top of the Upper Chinchaga to Slave Point Undivided here may represent an upward transition to Besa River shale.

## CONCLUSIONS

Important conclusions of this study include the following:

1) The presence of strata that can be included within the Presqu'ile Barrier reef complex of the subsurface has been documented in six measured outcrop sections from the southern Trutch map area and from the Halfway River map area. These sections contain abundantly stromatoporoidal strata as young as mid-Givetian, and may even include strata that are age-equivalent to the Watt Mountain or Slave Point formations.

2) Presqu'ile Dolomite is commonly developed in large masses within the thick 'Upper Chinchaga to Slave Point Undivided' limestone successions of the Presqu'ile Barrier in outcrop. Similar, but less extensive bodies of white hydrothermal dolospar are developed within Dunedin Formation strata, particularly in faunal-rich, slope-deposited successions adjacent to Presqu'ile Barrier sections. However, white dolospar, or calcite-cemented breccias (Manetoe Dolomite) occur within Dunedin strata even in northernmost sections.

3) The previously described bounding stratigraphic relationships of the upper and lower contacts of the Dunedin Formation have been confirmed. More documentation has been obtained concerning the basal unconformity of the Dunedin and of the diachronous and gradational upper Dunedin contact with the Besa River Formation.

4) The presence of Lower to Middle Devonian siliciclastic units within the postulated Laurier Embayment has been confirmed. Particularly extensive masses of Presqu'ile Dolomite occur in Presqu'ile Barrier successions of 'Upper Chinchaga to Slave Point Undivided' strata on the south side of Laurier Embayment.

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