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**New biostratigraphic data from the northern Canadian Cordillera, British Columbia and Yukon — an update on the Mesozoic Stratigraphy activity of the GEM-GeoNorth program**

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## Introduction

The Mesozoic Stratigraphy Activity of the Western Priority Area of the GEM GeoNorth Program was initiated in 2020 to provide new stratigraphic data for the Mesozoic of the northern Canadian Cordillera. The GEM GeoNorth Program itself aims to increase the level of baseline geological knowledge in Canada's north, and to provide geoscience data for sustainable resource development in the context of a changing climate. As such, the Mesozoic Stratigraphy Activity provides new paleontological and geochronological data for a crucial time period in the tectonic and metallogenic history of the northern Canadian Cordillera.

The Late Triassic-Early Jurassic was an important time in the history of the northern Cordillera, as widespread ore deposits developed within volcano-sedimentary strata on the allochthonous terranes prior to their accretion onto the Laurentian margin. However, the exact timing of many of these metallogenic and tectonic events are poorly constrained to date, due to the limitations of previous low-resolution stratigraphic data; thus, efforts to better understand the age and environments of ore body emplacement are severely hampered. The development of a stratigraphic framework for the northern

Cordillera for this time period will help to constrain the age of host strata of Late Triassic-Early Jurassic ore deposits, elucidate the relationship between the ore deposits and the surrounding rocks, and inform future studies of prospectivity elsewhere in the Cordillera.

The present report summarizes the results of three completed studies that were conducted under the auspices of the ongoing Mesozoic Stratigraphy Activity. The locations of these studies are indicated in Figure 1. Several studies are ongoing, and will be reported on when the Activity concludes in 2025.

**New Data**

*1 – Summary of new and existing conodont data from the northern Stikine Terrane (Golding and Lei)*

The most recent summary of conodont data from the northern Stikine Terrane was presented by Golding et al. (2017), encompassing 357 archival samples from the Laberge (105 E), Whitehorse (105 D), Teslin (105 C), Skagway (104 M), Atlin (104 N), Tulsequah (104 K), Dease Lake (104 J), Cry Lake (104 I), Telegraph Creek (104 G), Spatsizi River (104 H), Iskut River (104 B), and Bowser Lake (104 A) map sheets of northwestern British Columbia and southwestern Yukon. Since the publication of this dataset, 48 new productive conodont samples from the northern Stikine terrane have been collected by the authors of this report and collaborators at the British Columbia Geological Survey and the Yukon Geological Survey. The conodont faunas from these samples are shown in Table 1. The samples come from the Lewes River Group in the Laberge and Whitehorse map areas; from the Stikine assemblage in the Dease Lake map area; and from the Sinwa Formation in the Cry Lake, Skagway, and Tulsequah map areas. Some of the samples collected from the Sinwa Formation at Mt. Sinwa have previously been reported by Mihalynuk et al. (2017) and Lei et al. (2022), those from the Lewes River Group in the Laberge map area were reported by Bordet (2018), and the conodont data from the Stikine assemblage in the Dease Lake map area were incorporated in the BCGS map of the area by van Straaten et al. (2022). However, many of the new samples have yet to be fully reported.

In addition to these samples, the conodont data set for the northern Stikine Terrane has been expanded to include new and archival samples from the Nass River (103 P) map area. The data from this map area is presented in Table 2. These samples are derived from the Stuhini Group, the Hazelton Group, and the Bowser Lake Group. Some of these samples have previously been referenced in publications (Cordey et al., 1992); however, many have only been described in internal paleontological reports (herein prefaced MJO- or OF- ) and lab processing records. Re-examination of the archival conodont samples has in many instances necessitated the revision of species identifications and stratigraphic age assignments, reflecting developments in conodont taxonomy and biostratigraphy since the time of writing of the original paleontological reports by M.J. Orchard. The revised conodont faunas and stratigraphic ages are also recorded in Table 2.

The revised stratigraphic ages from in situ limestone beds confirm a Late Triassic (late Norian – Rhaetian) age for part of the Hazelton Group (C-178052; C-210400; C-211185) in the Nass River area, as proposed previously in the Iskut River area by Nelson et al. (2018). The revision of conodont taxonomy and stratigraphic ranges has led to the first recognition of Rhaetian strata in the Nass River area (C-178198); this sample was considered to come from the Hazelton Group by Cordey et al. (1992), although Miller et al. (2020, 2023) suggest that rocks in this region may belong to megaclasts of the newly defined Kinskuch conglomerate. Older Triassic ages recorded within the Hazelton Group (Carnian – middle Norian) may come from samples that were actually collected from an older stratigraphic unit; comments by the original collectors of these samples, recorded in unpublished paleontological reports, suggest that this may be the case, although they do not name the older unit(s). The Permian age (Artinskian) within the Hazelton Group results from the processing of cobbles within conglomerate, which contained conodonts older than the depositional age of the group.

The Late Triassic (late Carnian – Rhaetian) age of conodonts from the Stuhini Group in the Nass River area is consistent with previous estimates for the age of this unit (Golding et al., 2017). However, taxonomic re-assessment has allowed the age of some samples to be determined more precisely. For example, the newly recognized species *Ancyrogondolella diakowi* and *Ancyrogondolella transformis* in sample C-210381 date this sample to the early part of the middle Norian (~217 – 217.5 Ma; Ogg et al., 2020), rather than more broadly middle Norian (~214 – 217.5 Ma; Ogg et al., 2020). Conodonts from clasts in the Bowser Lake Group (C-057732; C-087732; C-087742) are primarily Permian, except for one sample which is late Carnian – Rhaetian in age.

New species recovered from the Sinwa Formation include a rich fauna dominated by *Mockina englandi*, *Mockina carinata*, *Mockina bidentata*, and morphotypes of *Mockina mosheri*, indicating an age range for this formation of middle Norian to Rhaetian. Ages for some of these collections have been further supported by carbon isotope measurements (Lei et al., 2022), although the ages recorded herein are consistent with previous estimates for the age of the formation (e.g. Gabrielse, 1998; Mihalynuk et al. 2017). The Rhaetian conodont *Misikella posthernsteini*, proposed as the index species for defining the base of the Rhaetian stage (Krystyn et al., 2007; Rigo et al., 2016) has been recovered for the first time in the Stikine Terrane; this represents only the fourth occurrence of this species in North America (Carter and Orchard, 2007). Contemporaneous faunas from the Aksala Formation of the Lewes River Group in Yukon are less diverse than those of the Sinwa Formation, and are restricted to late Norian – Rhaetian ages, which is also consistent with previous estimates for the age of these rocks (e.g. Hart, 1997; Lowey et al., 2009; Bordet, 2018).

*2 – New radiolarian data from the Blackwater River Section (Cordey)*

Archival radiolarian samples have been processed from the Blackwater River section in the Prince George (093 G) map area (Cordey, 2020). This section is part of a grey ribbon chert succession exposed along the banks of the Blackwater River at the intersection with the Blackwater Road linking Punchaw Lake to Quesnel (Fig. 2). The cherts have been sampled along the north bank of the river.

Previous test samples revealed that a ~ 20 m succession (estimated thickness without folds, Fig. 3), starting under the Blackwater bridge and continuing to the east, contained Middle Triassic and Early Jurassic radiolarian faunas (Cordey and Struik, 1996; Cordey, 2020). This suggested that a Triassic-Jurassic boundary was present in the section, leading to a more detailed sampling. This report documents the radiolarian faunas extracted and identified from a selection of 15 samples (Table 3). The biostratigraphic correlations are based on the Mesozoic catalogue of O'Dogherty et al. (2009) and the biozonation of Carter et al. (2010).

The results confirm that Middle-Late Triassic, Late Triassic, and Early Jurassic radiolarian cherts are present in the section (Fig. 3). The Triassic ages are found in the first 8 meters while the Early Jurassic ages are present in the remaining 12 meters. However, the chronological succession of the radiolarian faunas is not entirely consistent: some ages are inverted, in both the Triassic (ex: 21 and 23 are younger than 25 and 28) and the Jurassic (41 is older than 36) segments. Also, neither Rhaetian nor strictly Hettangian faunas have been found. Although the Triassic-Jurassic boundary may be present between samples 29 and 30, the results suggest that the section underwent some tectonic disruption (e.g., cryptic flat 'chevron' folding, faulting).

The chert succession exposed further east along the northern riverbank has not been dated yet and could be the target of future investigations.

*3 – New biostratigraphic data from the Bowser and Sustut basins (Golding and Bringué)*

The activity has investigated the potential palynological (dinoflagellate cyst) and micropaleontological (conodont) content of archival samples collected from the Bowser and Sustut basins (British Columbia) and adjacent areas for improved age constraints and correlations with existing macrofossil (ammonite, bivalve) biostratigraphic data. Samples were selected from existing collections at GSC-Calgary and GSC-Vancouver, and obtained from the sedimentary matrix associated with macrofossil specimens to optimize direct correlation. For palynological samples, we targeted localities with the lowest thermal maturity documented in the area (Evenchick, pers. comm.; Stasiuk et al. 2005).

Samples come from several sections throughout and adjacent to the Bowser and Sustut basins, including: Snippaker Mountain (C-101262, C-101284, C-177387); Treaty Ridge (C-201610, C-201611); Argillite Creek (C-201434, C-201435); Eskay Creek (C-201622); and Jurassic Ridge (O-85376); as well as from several unnamed sections and isolated spot collections.

The Snippaker Mountain section (Fig. 4) is located in the northwest corner of the Iskut River (104 B) map area, near to the Alaska border (Fig. 1). It was first logged during regional mapping of the Iskut area (Lefebure and Gunning, 1989; Anderson and Thorkelson, 1990; Alldrick et al., 1990) by Metcalfe and Moors (1993), who noted the presence of a fossiliferous wacke within the Stuhini Group exposed on the mountain. This unit has been dated using ammonoid fossils as Rhaetian, encompassing the Amoenum and Crickmayi ammonoid zones (Nadaraju and Smith 1992a, b; Nadaraju, 1993; Nadaraju and Lewis, 2001), and was recently re-assigned to the Snippaker unit of the Jack Formation (Hazelton Group) by Nelson et al. (2018).  A total of three conodont samples were collected from the matrix of macrofossil samples from the Rhaetian part of the section; however, all of these samples were barren.

The Treaty Ridge section (not to be confused with the Treaty Glacier section of Nelson and Kyba, 2014), located in the vicinity of Treaty Glacier in the Iskut River Map area, exposes Toarcian to Bathonian sediments of the Hazelton Group. First investigated by Lewis et al. (1993), the section has yielded abundant macrofossils (Nadaraju and Smith, 1992a, b; Nadaraju, 1993; Nadaraju and Lewis, 2013). The Eskay Creek section, also located in the Iskut River map area, has been part of numerous studies of the Au-Ag-rich Eskay Creek volcanogenic massive sulphide deposit (e.g. Barresi et al., 2005; Barrett and Sherlock, 1996; Bartsch, 1993; Childe, 1996; Ettlinger, 1992; Roth et al., 1999; Roth, 2002; Sherlock et al., 1994, 1999; MacDonald et al., 1996; Gagnon et al., 2012). The oldest part of the section consists of

Pliensbachian volcanics, overlain by a mudstone unit that has previously yielded Aalenian to Early Bajocian radiolaria (Nadaraju, 1993). Higher parts of the section contain Early Bajocian bivalves (in the Quock Formation; Roth, 2002) and late Bathonian to early Callovian ammonoids (Bowser Lake Group; Evenchick et al., 2001; Roth, 2002).

The palynological material recovered from the Treaty Glacier and Eskay Creek sections and other locations in the Bowser and Sustut basins was highly degraded and thermally mature, and only one confirmed dinoflagellate cyst specimen was observed on the 37 slides (19 samples) analysed (Table 4). The dinoflagellate cyst in the sample from the Eaglenest Creek area is likely Bathonian to Oxfordian, which is consistent with previous estimates for the age of this sample (late Oxfordian), based on unpublished macrofossil determinations. However, dinoflagellate cyst-based age determinations overall are inconclusive, even in these carefully selected samples, which confirms the limited potential for dinoflagellate cyst recovery in the Bowser and Sustut basins. Some pollen grains and spores are, however, better represented and/or preserved in some samples and might show better potential for future study.

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**Tables are available separately and are included in the .zip file.**

**Table 1 –** Sample table recording new conodont collections from the northern Stikine terrane.

**Table 2 –** Sample table recording the reported and revised conodont faunas and stratigraphic ages of archival samples from the northern Stikine terrane in the Nass River (103 P) map area.

**Table 3 –** Sample table recording radiolarian faunas recovered from the Blackwater section in the Prince George (093 G) map area and their stratigraphic ages.

**Table 4 –** Sample table recording palynological samples from the Bowser and Sustut basins, and the age estimates based on dinoflagellate cysts.

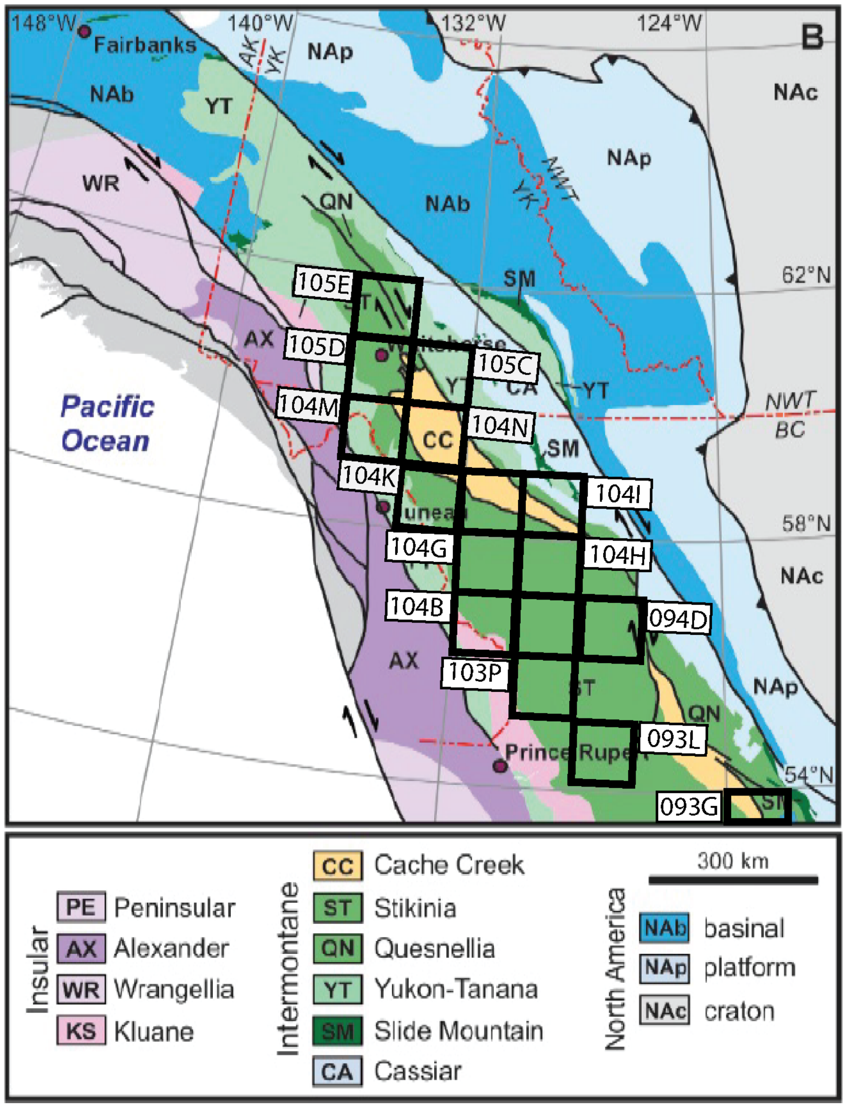


**Figure 1 –** Terrane map of northern British Columbia and southern Yukon, showing the locations of the map sheets from which the samples discussed in this report are derived: Laberge (105 E), Whitehorse (105 D), Teslin (105 C), Skagway (104 M), Atlin (104 N), Tulsequah (104 K), Dease Lake (104 J), Cry Lake (104 I), Telegraph Creek (104 G), Spatsizi River (104 H), Iskut River (104 B), Bowser Lake (104 A), Nass River (103 P), McConnell Creek (094 D), Smithers (093 L), and Prince George (093 G). Modified from Colpron and Nelson (2011).

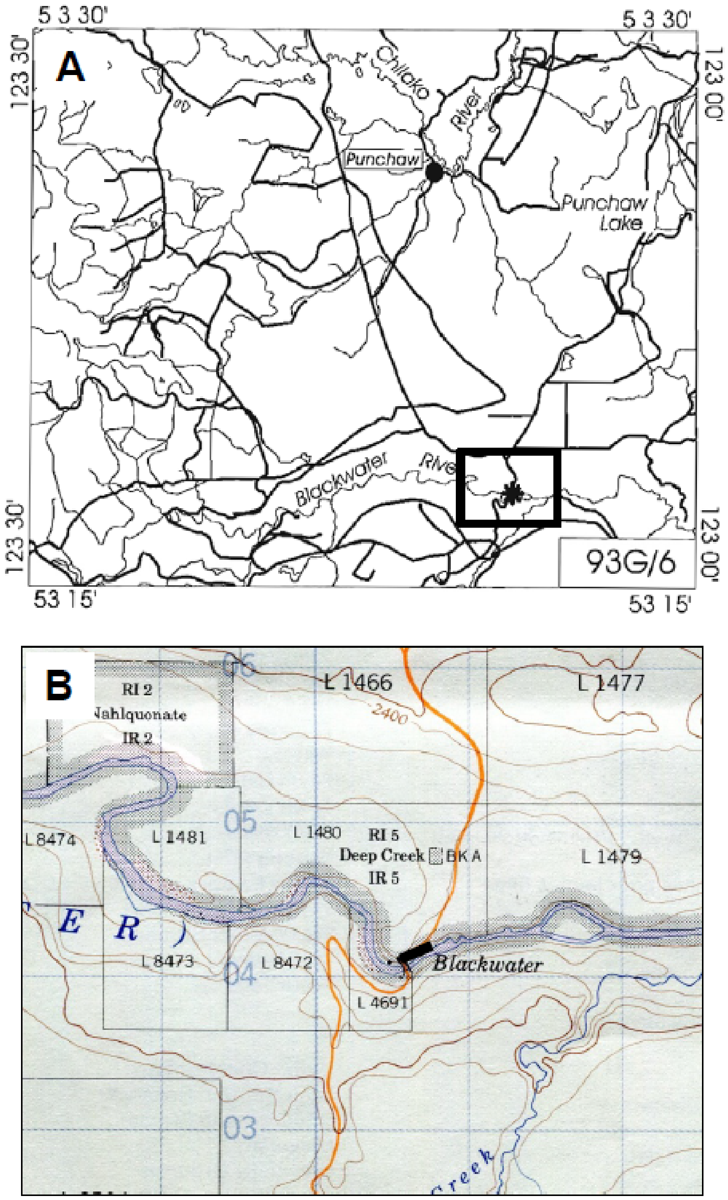


**Figure 2 –** Location of the Blackwater section (UTM 490518.55E; 5904281.50N). **A**: extract of Punchaw Lake map area (93G/8) reproduced from Cordey and Struik (1996); the section (star) is located at the intersection between the Blackwater River and the road from Punchaw Lake to Quesnel. **B**: enlargement (rectangle in **A**) and location of section along the north bank of the Blackwater River, starting from the bridge.

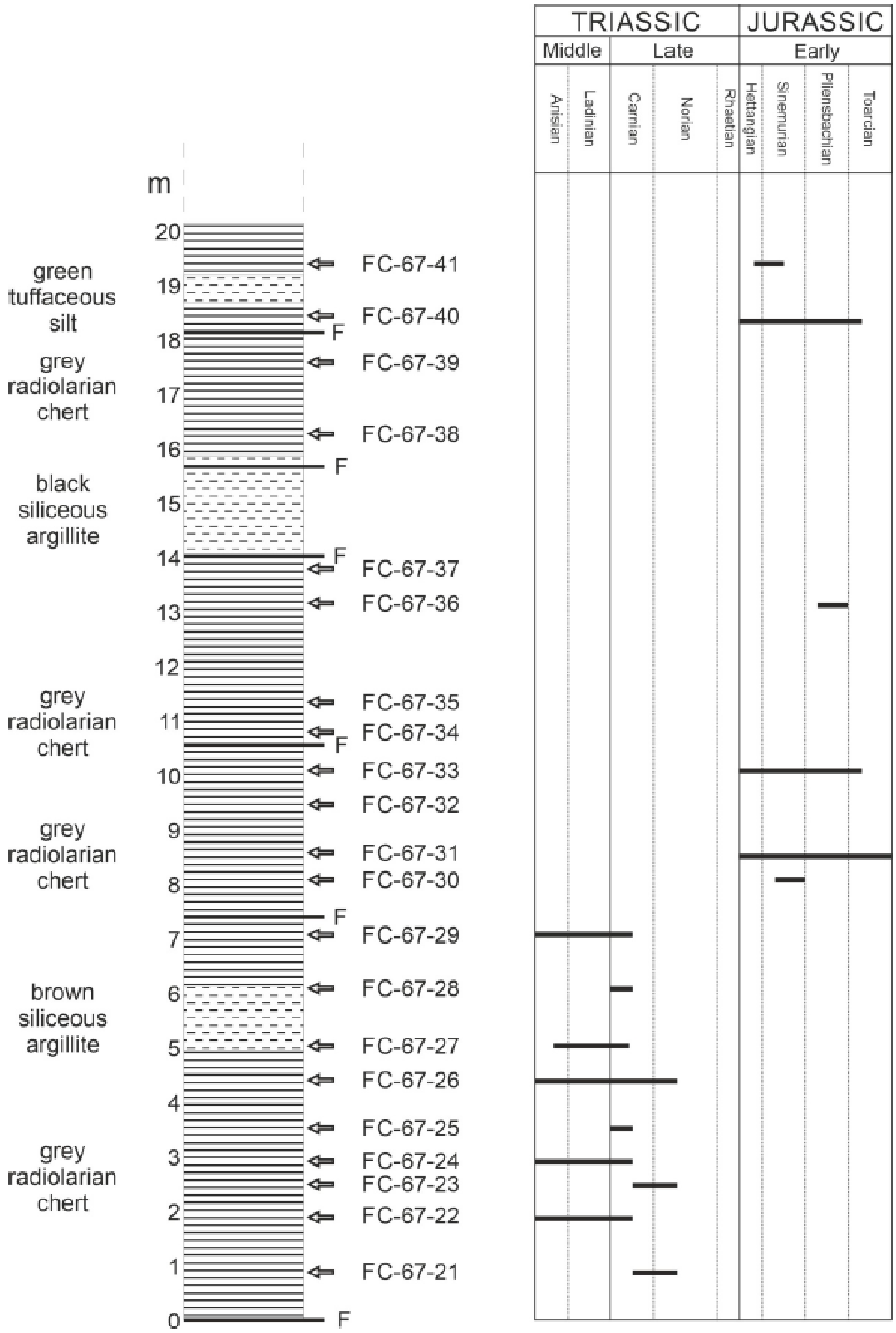


**Figure 3 –** Middle-Late Triassic to Early Jurassic segment of the Blackwater section (UTM 490518.55E; 5904281.50N), with samples and ages based on radiolarians.

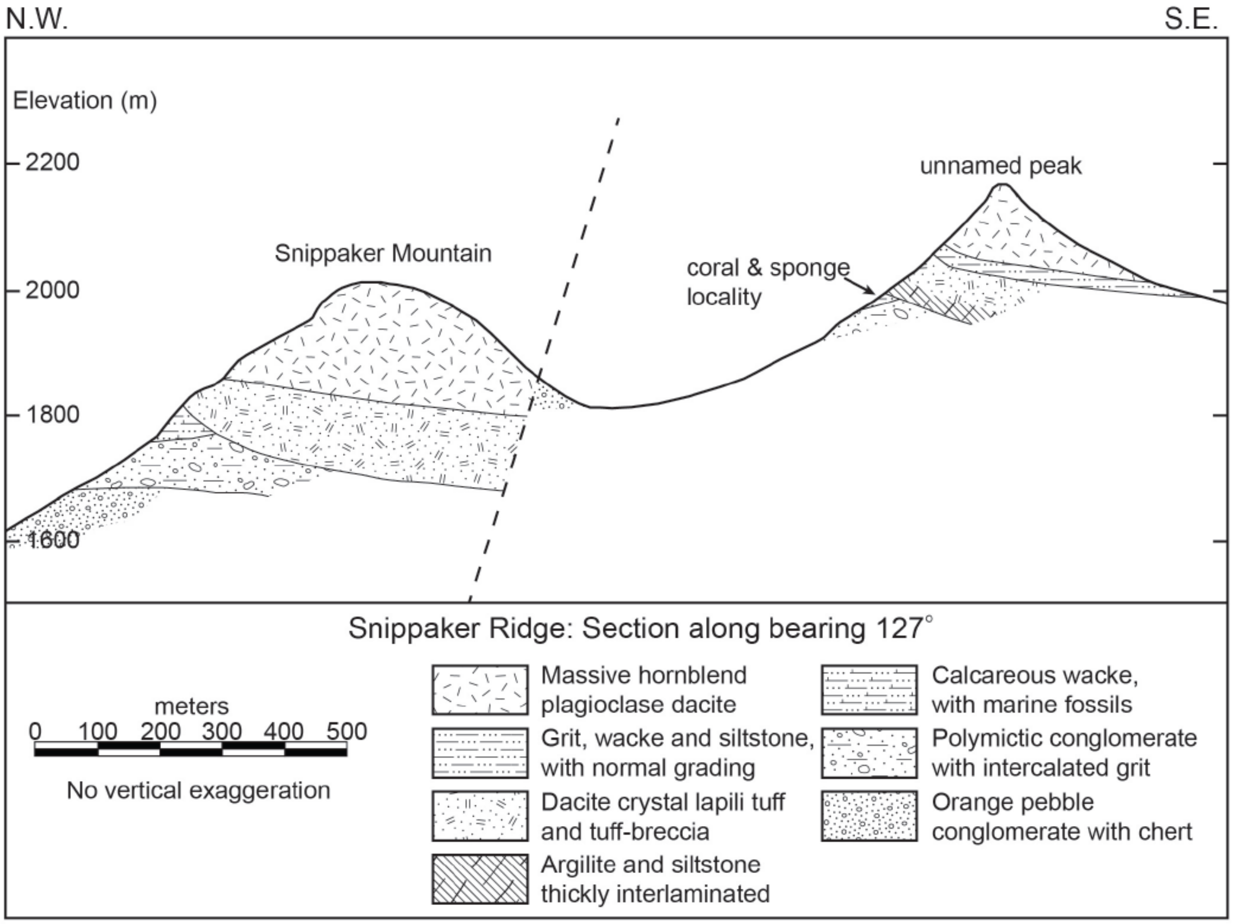


**Figure 4 –** Profile of Snippaker Mountain, showing the location of conodont samples discussed in this report, and the macrofossil samples described by Nadaraju (1993). Modified from Metcalfe and Moors (1993).