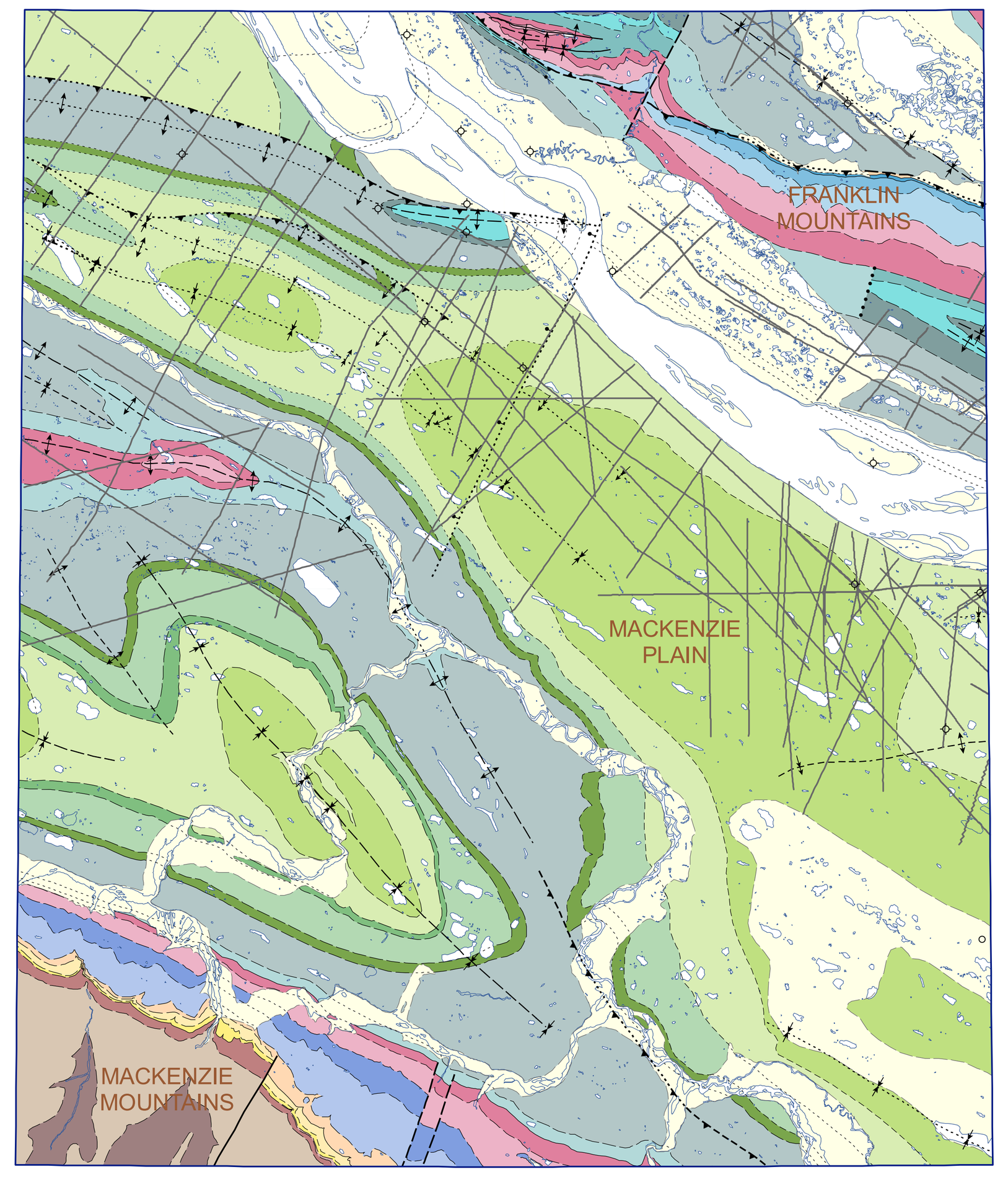


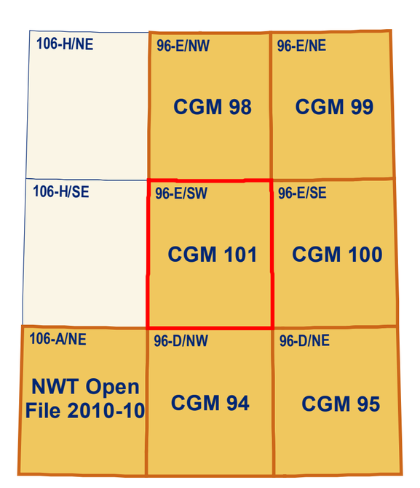
Figure 1. Southwest Norman Wells map area (NTS 96-E/SW) showing seismic lines on record with the National Energy Board that were used to augment the bedrock geology interpretation. Line names are provided in the data files.

Abstract

The southwest quadrant of Norman Wells map area (NTS 96-E) covers parts of the Franklin Mountains, Mackenzie Plain, and Mackenzie Mountains, Northwest Territories. The area varies from low-lying forested plain to alpine mountainous terrain, with bedrock exposures concentrated in the mountains on either side of the Mackenzie River. The geological interpretation in poorly exposed portions of the Mackenzie Plain has been enhanced by examination of public-domain seismic-reflection lines, archived with the National Energy Board. Cordilleran deformation from the southwest has uplifted Proterozoic and/or Paleozoic strata along reverse or thrust faults, and anticlinal folds in both the Mackenzie and Franklin mountains. The intervening Mackenzie Plain is dominated by folded and faulted Devonian and Cretaceous siliciclastic strata that have largely been planed off by glacial activity. The lack of surface exposure of Proterozoic strata in the Norman Range indicates this interval is not involved in Franklin Mountain structures, in contrast to the Mackenzie Mountains. An unconformity at the base of Upper Cretaceous strata cuts more deeply into underlying strata to the northeast, a reflection of uplift along the Keele Arch before deposition of the Slater River Formation. Exploration by petroleum companies in the area has typically targeted potential reservoirs in buried Devonian strata.

Résumé

Le quadrant sud-ouest de la région cartographique de Norman Wells (SNRC 96-E) couvre des parties des monts Franklin, de la plaine du Mackenzie et des monts Mackenzie (Territoires du Nord-Ouest). La région passe d'une basse plaine boisée à des terrains montagneux alpins, où les affleurements du socle rocheux sont concentrés dans les montagnes, de part et d'autre du fleuve Mackenzie. Dans les parties moins bien exposées de la plaine du Mackenzie, l'interprétation géologique a été améliorée par l'examen de profils de sismique-réflexion du domaine public, archivés par l'Office national de l'énergie. La déformation cordillérienne en provenance du sud-ouest a soulevé les strates du Protérozoïque ou du Paléozoïque le long de failles inverses ou de failles de chevauchement, ainsi que par le jeu de plis anticlinaux dans les monts Mackenzie et les monts Franklin. Le sous-sol de la plaine du Mackenzie, en position intermédiaire, est formé en prédominance de strates silicoclastiques du Dévonien et du Crétacé, déformées par des plis et des failles, qui ont été en grande partie aplanies par l'activité glaciaire. L'absence d'affleurements de strates du Protérozoïque dans le chaînon Norman indique que cet intervalle n'a pas été repris dans les structures des monts Franklin contrairement à celles des monts Mackenzie. Une discordance à la base de la succession du Crétacé supérieur s'enfonce plus profondément dans les strates sous-jacentes, au nord-est, ce qui témoigne du soulèvement le long de l'arche de Keele avant le dépôt de la Formation de Slater River. L'exploration par les compagnies pétrolières dans la région a de manière caractéristique ciblé de possibles réservoirs dans la succession enfouie du Dévonien.



National Topographic System reference and index to adjoining published Geological Survey of Canada maps

Cover illustration
View looking west at Franklin Mountain Formation dolostone in the hanging wall of the Norman Range Thrust. Mackenzie River and Mackenzie Plain can be seen beyond the Norman Range, with the Mackenzie Mountains in the left distance. Photograph by K. Fallas. 2012-139

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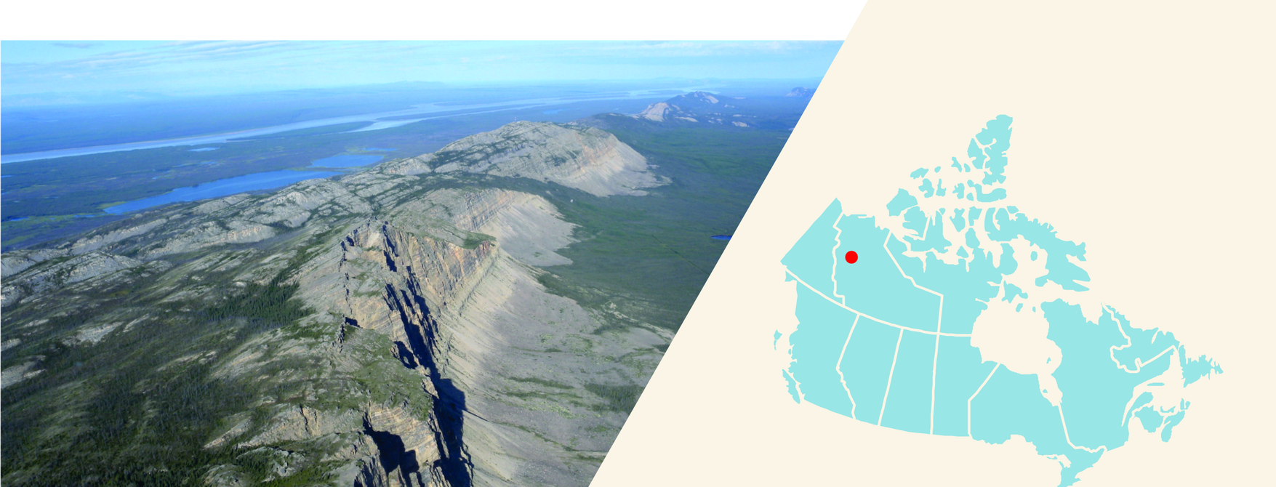
CANADIAN GEOSCIENCE MAP 101

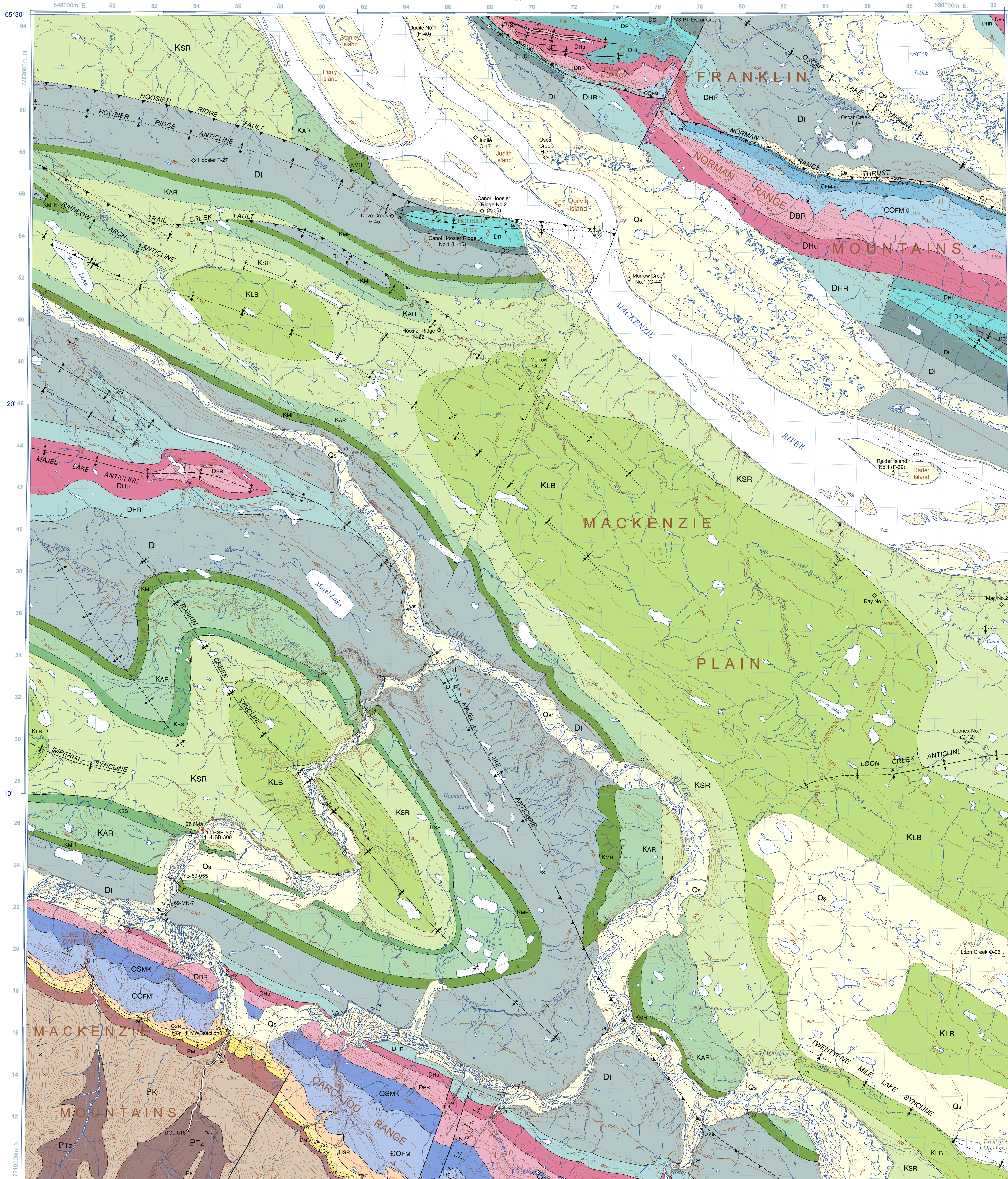
GEOLOGY

NORMAN WELLS (SOUTHWEST)

Northwest Territories

1:100 000





QUATERNARY

Qs — **Quaternary sediment:** mud, sand, and gravel: unconsolidated.

LATE CRETACEOUS

KLB — **Little Bear Formation:** sandstone: lithic wacke to quartz arenite and chert arenite, mottled grey, greenish-grey, brown, or rusty, thin- to thick-bedded, typically friable and porous, crossbedded, laminated, ripple marks, graded bedding, locally bioturbated; interbedded with mudstone and shale: somewhat silty, dark grey to brown or black, crumbly and soft, minor sideritic concretions; and minor coal.

KSR — **Slater River Formation:** shale and mudstone: dark brown to dark grey, black, or rusty-brown, soft, crumbly, and fissile, sideritic concretions common, rare fish scales; minor bentonite and ash tuff: white to yellow, pale green, or orange-brown; and minor sandstone: lithic wacke, brown, grey, or rusty, very thin- to thin-bedded, crosslaminated, and bioturbated.

EARLY CRETACEOUS

KSS — **Sans Sault Member:** sandstone: lithic to quartz arenite or subarkose, very fine- to fine-grained, grey or brown, very thin- to medium-bedded, locally laminated or crossbedded, bioturbation not unusual; interbedded with shale: silty, can be calcareous or gypsiferous, dark grey to black, weathers rusty-grey or brown, rare bivalves.

KAR — **Arctic Red Formation:** shale and mudstone: locally gypsiferous, dark grey, weathers grey and rusty, variably fissile and soft, sideritic concretions fairly common.

KMH — **Martin House Formation:** sandstone: quartz arenite, variably glauconitic, locally conglomeratic, beige to light grey, thin- to thick-bedded, crossbedded, friable, trace fossils common; interbedded with shale or mudstone: medium to dark grey, weathers grey or rusty-brown, proportion of shale and mudstone increases upsection.

DEVONIAN

DI — **Imperial Formation:** shale: locally silty, dark grey to greenish-grey, fissile; interbedded with siltstone: locally micaceous or calcareous, greenish-grey to purplish-brown, laminated, bioturbated; and sandstone: lithic wacke to quartz arenite, micaceous, locally calcareous or glauconitic, grey to greenish-grey or brown, very thin- to medium-bedded, laminated and crosslaminated, abundant and diverse trace fossils; and minor limestone: bioclastic, grey to brown or orange, diverse fossil assemblage. Includes Jungle Ridge Member, comprising limestone: lime mudstone, silty, grey, weathers light yellow, very thin- to thin-bedded, laminated, shale partings, and rare fossils.

Horn River Group (Hare Indian, Ramparts, and Canol formations)

DHR — **Horn River Group:** shale: carbonaceous or petroliferous, calcareous to siliceous, locally silty, dark grey or black, weathers grey, black, brown, or rusty, locally fossiliferous; minor limestone: dark grey with tentaculitids, interbedded with shale at base of unit; cream to light grey stromatoporoid limestone (Ramparts Formation) may be present in the middle of the unit.

DC — **Canol Formation:** shale: siliceous, sulphurous, petroliferous, dark grey to dark brown or black, weathers grey, brown, or yellow, with pink or red patches where burnt and/or oxidized, laminated to very thin-bedded, platy, locally semiresistant.

DR — **Ramparts Formation:** limestone: wackestone to grainstone or rudstone, petroliferous, cream, beige, or light grey, weathers to light shades of grey, brown, yellow, and orange, medium- to very thick-bedded, very fossiliferous (stromatoporoids dominate).

DHI — **Hare Indian Formation:** shale: carbonaceous, calcareous, black, fissile, may contain tentaculitids or other fossils; interbedded with minor limestone: dark grey to black, thin-bedded, tentaculitids common. Basal Bluefish Member is calcareous and fossiliferous, unit becomes less carbonaceous, less calcareous, less fossiliferous, and increasingly silty upsection.

DHu — **Hume Formation:** limestone: wackestone to grainstone, floatstone, medium to dark grey or brownish-grey, typically weathers light grey, thin- to very thick-bedded, parallel to irregular or nodular bedded, fossiliferous with abundant and diverse assemblage. Unit is thicker bedded and cliff-forming in upper part.

DBR — **Bear Rock Formation:** limestone breccia: variably dolomitic and petroliferous, angular clasts range from granule- to boulder-sized, greyish-brown to grey, weathers light grey, vuggy, massive and rubbly with rare bedded intervals of laminated carbonate, tends to form hoodoos.

ORDOVICIAN TO SILURIAN

OSMK — **Mount Kindle Formation:** dolostone: dolowackestone to dolopackstone and dolofloatstone, siliceous and cherty, light to dark grey or brownish-grey fresh and weathered surfaces, thin- to very thick-bedded, vuggy, recrystallized, bioturbated, and fossiliferous (mainly silicified corals, crinoids, orthocone cephalopods, and stromatoporoids).

CAMBRIAN TO ORDOVICIAN

ЄOFM — **Franklin Mountain Formation:** dolostone: dolomudstone to dolograinstone, locally calcareous or cherty, grey, cream, or light brown, weathers light grey, yellowish-grey, or orange, very thin- to thick-bedded, typically recrystallized, locally vuggy, stromatolitic, bioturbated, oolitic, crossbedded, or intraclast-bearing; minor shale: greenish-grey or red, fissile, and laminated; and sandstone: lithic wacke to quartz arenite, dolomitic, cream to orange, red, or brown, weathers light orange to red, very thin- to medium-bedded, crossbedded, ripple marks, and bioturbated. Shale and sandstone found in basal part of unit. Alternation, at 1–2 m intervals, of ooid dolograinstone with dolomudstone produces a locally prominent striped appearance in the middle part of the unit.

ЄOFM-u — **Franklin Mountain Formation, upper member:** dolostone: crystalline dolostone, commonly cherty and siliceous, cream to beige or grey, weathers white to light grey, very thin- to thick-bedded, vuggy and nodular, locally stromatolitic, bioturbated, intraclast-bearing, or oolitic.

CAMBRIAN

ЄFM-m — **Franklin Mountain Formation, middle member:** dolostone: dolomudstone to dolograinstone, rarely calcareous or cherty, light grey to cream or beige, weathers light yellowish-grey to orange-brown, thin- to thick-bedded, typically recrystallized obliterating primary textures, locally vuggy, stromatolitic or thrombolitic, bioturbated, oolitic, crossbedded, or intraclast-bearing; rare shale partings. Alternation, at 1–2 m intervals, of ooid dolograinstone with dolomudstone produces a locally prominent striped appearance.

ЄFM-l — **Franklin Mountain Formation, lower member:** dolostone: dolomudstone, locally calcareous or silty, rare detrital chert grains, grey to greenish-grey or brown, weathers pale yellow to grey or orange-brown, very thin- to medium-bedded, parallel-laminated, locally includes intraclast rudstone, locally stromatolitic or bioturbated; interbedded with shale: dolomitic and silty, varicoloured, laminated, and fissile.

ЄSR — **Saline River Formation:** shale: silty, grey, red, or green, fissile, minor salt casts, desiccation cracks, and horizontal burrows; evaporite: gypsum, anhydrite, or halite, white and grey to pink or red, very thin- to thin-bedded, bedding typically disturbed and chaotic, dominates middle part of unit; minor dolostone: dolomudstone to dolograinstone, grey to yellow, green, or orange, locally intraclast-bearing, oolitic, stromatolitic; and sandstone: lithic wacke to quartz arenite, calcareous or dolomitic, can be conglomeratic, varicoloured, parallel- and crosslaminated, ripple marks, rip-up clasts, and possible trace fossils.

ЄCp — **Mount Cap Formation:** shale: locally silty or dolomitic, dark grey to brown or black, fissile, may contain horizontal burrows, trilobites, and brachiopods, dominates upper part of unit; limestone or dolostone: mudstone to wackestone and bindstone, locally silty, medium to dark grey, weathers orange-brown, parallel to nodular bedded, intraclast-bearing, stromatolitic, bioturbated, few trilobites or brachiopods; and sandstone: quartz wacke to quartz arenite, calcareous and glauconitic, grey to greenish-grey, brown, or orange, very thin- to thick-bedded, trace fossils abundant.

ЄCk — **Mount Clark Formation:** sandstone: quartz arenite, locally glauconitic, very fine- to coarse-grained, can be conglomeratic at base of unit, white to tan or grey, weathers white to grey or brown, very thin- to thick-bedded, parallel-bedded to crossbedded, horizontal and vertical burrows locally abundant, but of low diversity; minor shale or siltstone: grey.

NEOPROTEROZOIC (Tonian to Cryogenian)

Mackenzie Mountains Supergroup (Tsezotene Formation and Katherine Group)

Katherine Group (Eduni, Tawu, Grafe River, Etagochile, Shattered Range, McClure, and Abraham Plains formations)

PAP — **Abraham Plains Formation:** sandstone: quartz arenite, hematitic, cream to brown, light grey, orange, pink, or maroon, thin- to very thick-bedded, well cemented, parallel-bedded and crossbedded, crosslaminated, ripple marks, rip-up clasts; interbedded with minor conglomerate: granule to pebble, white to orange-brown, pink, red, or purple, massive to crossbedded; and siltstone: locally shaly or micaceous, maroon or green, very thin-bedded, and crosslaminated.

PM — **McClure Formation:** shale: locally dolomitic or silty, grey, rusty-brown, green, and maroon, fissile, desiccation cracks; interbedded with dolostone: commonly cherty, silty, or sandy, medium grey, weathers to orange or orange-brown, very thin- to thick-bedded, typically stromatolitic, pisolitic, oolitic, intraclast-bearing, and parallel- or crosslaminated; and sandstone: lithic wacke to quartz arenite, can be micaceous, hematitic, or dolomitic, cream to brown, grey, red, or purple, very thin- to medium-bedded, crosslaminated, ripple marks, rip-up clasts, sole marks, and desiccation cracks.

PK-l — **Katherine Group, lower part:** Eduni, Tawu, Grafe River, Etagochile, and Shattered Range formations: sandstone: quartz arenite, locally hematitic or micaceous, locally conglomeratic, white to light grey, pink, brown, or orange, very thin- to very thick-bedded, well cemented, parallel- and crossbedded, ripple marks, rip-up clasts, and desiccation cracks; interbedded with minor shale: silty, greenish-grey to pink or red, fissile, desiccation cracks; and dolomudstone: may be calcareous, grey to orange or red, medium-bedded, parallel-laminated, and intraclast-bearing. Shale and carbonate dominate in the Tawu and Etagochile formations.

PTz — **Tsezotene Formation:** shale: micaceous, silty in places, grey, maroon, or green, fissile, minor desiccation cracks; interbedded with sandstone: lithic wacke to quartz arenite, micaceous, locally conglomeratic, varicoloured, typically weathers brown or orange-brown, thin- to thick-bedded, parallel-bedded, crossbedded, and crosslaminated, rip-up clasts, ripple marks; minor dolostone: dolomudstone to dolograinstone, calcareous, grey to greenish-grey, weathers beige to orange-brown, thin- to thick-bedded, laminated, minor salt casts and ooids.

Geological contact
- Defined
- Approximate
- Inferred
- Concealed
- Nomenclature change

Drift contact
- Approximate

Fault, hanging wall undefined (steep dip)
- Defined
- Approximate
- Concealed

Normal fault, symbol on hanging-wall side
- Concealed

Thrust fault, symbol on hanging-wall side
- Approximate
- Inferred
- Concealed

Anticline, upright
- Defined
- Approximate
- Inferred
- Concealed

Syncline, upright
- Defined
- Approximate
- Inferred
- Concealed

Monocline, anticlinal bend, shorter arrow on steeper limb
- Inferred
- Concealed

Monocline, synclinal bend, shorter arrow on steeper limb
- Concealed

Visited outcrop, no measurements

Outcrop observed remotely from ground or air

Bedding strike and dip, inclined, upright
- 5 — Evidence for younging direction known
- 12 — No evidence for younging direction
- 17 — No evidence for younging direction, estimated measurement

Fossil locality

96.7Ma — Radiometric age

DGL-016 — Measured stratigraphic section with name of section

Petroleum well with well name
- Ray No. 1 — Dry and abandoned
- Loon Creek O-06 — Unknown status

NOTES

The authors have updated and revised map unit terminology from the Operation Norman map (Aitken and Cook, 1976). In general, terminology for Cambrian units is that of Dixon and Stasiuk (1998) with modifications by Fallas and MacNaughton (2012), Silurian and Devonian usage follows that of Morrow (1991), and Cretaceous to Paleocene formation names are those of Dixon (1999). Neoproterozoic to Ordovician units have recently undergone revision to their terminology, as outlined below.

Recent stratigraphic work in the Mackenzie Mountains has formalized the Mackenzie Mountains Supergroup and revised its formation-level nomenclature. Within the Katherine Group, the Eduni, Tawu, Grafe River, Etagochile, and Shattered Range formations of Long and Turner (2012) correspond to the lower part of the Katherine Group as shown on the GSC maps for Carcajou Canyon (Aitken et al., 1974) and Norman Wells (Aitken and Cook, 1976), and to the K1 to K5 divisions of Aitken et al. (1978) and Long et al. (2008). Delineation of these new formations depends on the ability to recognize the recessive Tawu and Etagochile formations. These formations are seldom exposed in the mapping area and so the five lower formations of the Katherine Group were grouped during mapping. The McClure and Abraham Plains formations correspond to the upper Katherine Group on the Carcajou Canyon (Aitken et al., 1974) and Norman Wells (Aiken and Cook, 1976) maps, and to the K6 and K7 divisions of Aitken et al. (1978) and Long et al. (2008).

Previous work by the Geological Survey of Canada in the Norman Wells map area (Aitken and Cook, 1976) subdivided the Cambro-Ordovician Franklin Mountain Formation into three informal units. In ascending order they are: Cyclic member, Rhythmic member, and Cherty member (Norford and Macqueen, 1975). On the present maps, these older unit names correspond, in ascending order, to informal lower, middle, and upper members of the Franklin Mountain Formation. These lower, middle, and upper members correspond to the units 1, 2, and 3 of the Franklin Mountain Formation described by Turner (2011).

For detailed information on surficial deposits, here shown as "Quaternary sediment", *see* Duk-Rodkin (2002).

The names Norman Range Thrust, Hoosier Ridge Fault, Trail Creek Fault, Oscar Lake syncline, Hoosier Ridge anticline, Majel Lake anticline, Rankin Creek syncline, Loon Creek anticline, and Twentyfive Mile Lake syncline have been introduced to facilitate discussion of these structural features. The names Rainbow Arch anticline and Imperial syncline are extended from the adjoining Sans Sault Rapids map area (Aitken and Cook, 1979). Cordilleran deformation in this map area has generated folds and thrust faults interpreted to be detached within Proterozoic strata within the Mackenzie Mountains in the southwest corner, and stepping up into Cambrian or Devonian strata to the northeast (Cook and MacLean, 1999).

Coverage of public-domain seismic-reflection data used to augment the map compilation and constrain stratigraphic relationships is shown in Figure 1. Surface and subsurface stratigraphic relationships within this map area are shown schematically in Figure 2.

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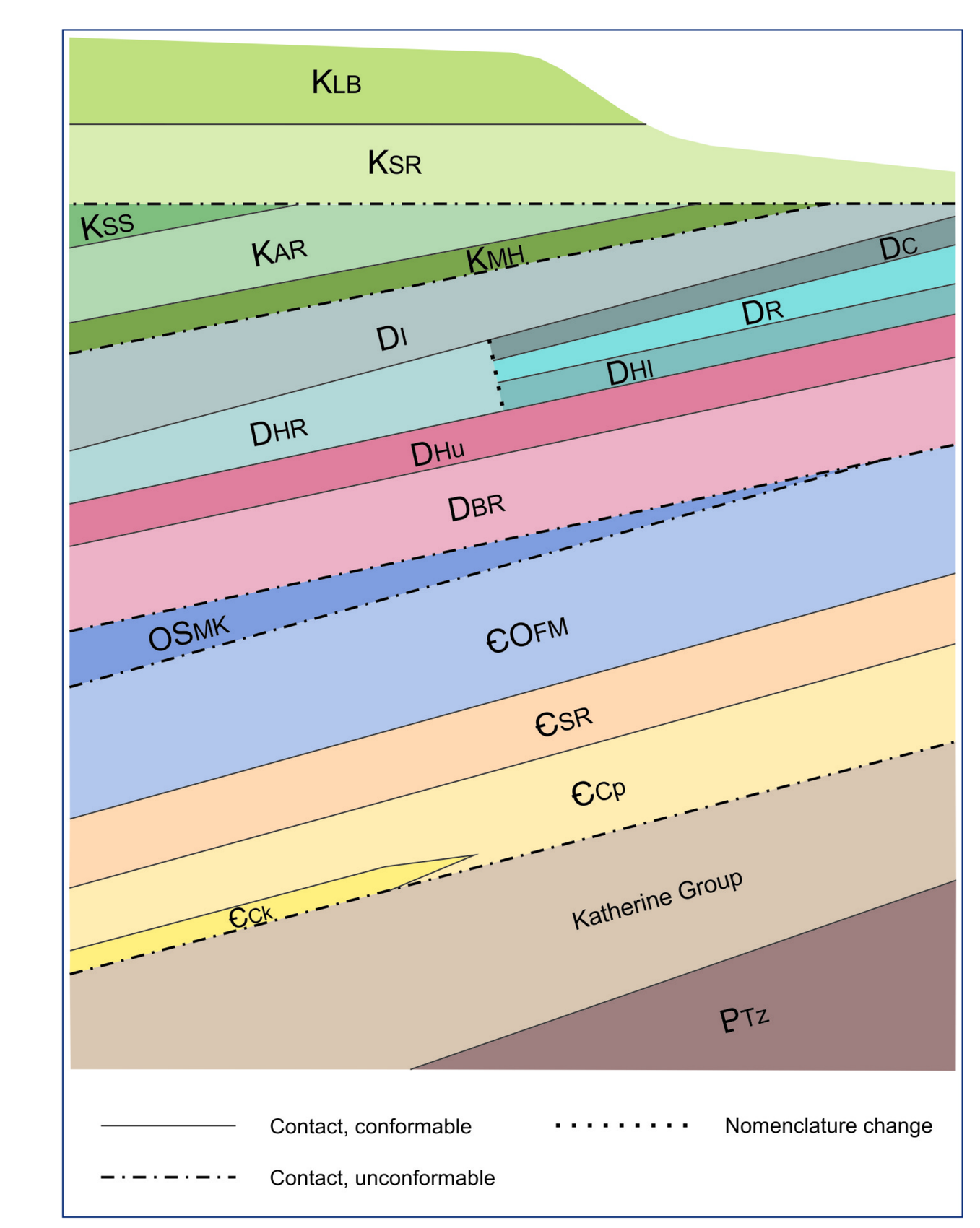

Figure 2. Schematic stratigraphic relationship diagram for southwest Norman Wells map area (NTS 96-E/SW). Thinning or removal of map units beneath erosional unconformities reflects tectonic activity adjacent to the Keele Arch from the Paleozoic to the Cretaceous.

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Canadian Geoscience Maps

Authors: K.M. Fallas, R.B. MacNaughton, B.C. MacLean, and T. Hadlari

Geological compilation by K.M. Fallas, R.B. MacNaughton, B.C. MacLean, and T. Hadlari, 2011–2012

Geological field observations by K.M. Fallas, R.B. MacNaughton, D. Midwinter, T. Hadlari, R. Lemiski (Northwest Territories Geoscience Office), J. Powell (University of Ottawa), 2009–2011, C.J. Yorath, M.E. Ayling, J.D. Aitken, D.G. Cook, and H. Balkwill, 1968–1969

Seismic data interpretation by B.C. MacLean, 2010–2012. Stratigraphic sections measured by T. Hadlari, R.B. MacNaughton, M. Sommers, B. Pratt (University of Saskatchewan), R. Acker, S. Hubbard (University of Calgary), 2009–2011, C.J. Yorath, W.S. Mackenzie, A.E.H. Pedder, and J.L. Usher, 1969

Geomatics by K.M. Fallas, P. Dhesi, S.D. Orzeck, and N. Raska

GEOLOGY

NORMAN WELLS (SOUTHWEST)

Northwest Territories

1:100 000

2 0 2 4 6 8 km

Cartography by P. Dhesi and S.D. Orzeck

Scientific editing by E. Inglis

Joint initiative of the Geological Survey of Canada and the Northwest Territories Geoscience Office, conducted under the auspices of the Mackenzie Delta and Corridor Project as part of Natural Resources Canada's Geo-mapping for Energy and Minerals (GEM) Program.

Logistical support provided by the Polar Continental Shelf Program as part of its mandate to promote scientific research in the Canadian North. PCSP 02509, 01310, and 00411.

Map projection Universal Tranverse Mercator, zone 9.
North America Datum 1983

Base map at the scale of 1:50 000 from Natural Resources Canada, with modifications.
Elevation in feet above mean sea level

Mean magnetic declination 2013, 23°27'E, decreasing 31' annually. Readings vary from 23°36'E in the NW corner of the map to 23°18'E in the SE corner of the map.

The Geological Survey of Canada welcomes corrections or additional information from users.

Data may include addtional features not portrayed on this map. *See* documentation accompanying the data. Additional references are included in the map information document.

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CANADIAN GEOSCIENCE MAP 101
GEOLOGY
NORMAN WELLS (SOUTHWEST)
Northwest Territories