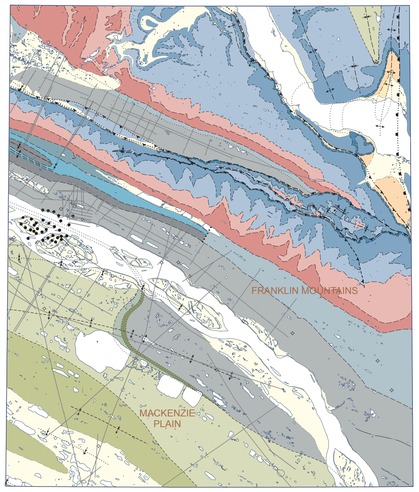


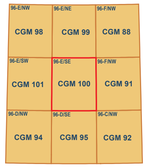
Figure 1. Southeast Norman Wells map area (NTS 96-E/SE) showing seismic lines on record with the National Energy Board that were used to augment the bedrock geology interpretation. Line names are provided in the data files.

Abstract

The southeast quadrant of Norman Wells map area (NTS 96-E) covers parts of the Franklin Mountains and Mackenzie Plain, Northwest Territories. The area varies from low-lying forested plain to alpine mountainous terrain along the Norman Range, with bedrock exposures concentrated along the mountain ridges, and stream or lake outcrops. 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 triggered uplift of Cambrian and younger strata along reverse or thrust faults in the Franklin Mountains. The variation in trend of significant faults is believed to be due to the reactivation of older normal faults. To the southwest of the Norman Range, the Mackenzie Plain is dominated by folded Devonian and Cretaceous siliciclastic strata that have largely been planed off by glacial activity. The presence of the Saline River Formation, an evaporitic unit, in the hanging wall of larger faults suggests its involvement as a local detachment surface. An unconformity at the base of Upper Cretaceous strata cuts more deeply into underlying Lower Cretaceous and Devonian strata to the northeast, a reflection of uplift along the Keele Arch before deposition of the Slater River Formation. This map area includes the Norman Wells oilfield, a field that has been active for many decades, producing oil from the Kee Scarp of the Ramparts Formation, a limestone reef encased in shale.

Résumé

Le quadrant sud-est de la région cartographique de Norman Wells (SNRC 96-E) couvre des parties des monts Franklin et de la plaine du Mackenzie (Territoires du Nord-Ouest). La région passe d'une basse plaine boisée à un terrain montagneux alpin le long du chaînon Norman, avec des affleurements rocheux qui sont concentrés le long des crêtes montagneuses, ainsi que des ruisseaux ou des lacs. L'interprétation géologique dans les portions pauvres en affleurements de la plaine du Mackenzie 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 déclenché le soulèvement des strates du Cambrien et de temps plus récents le long de failles inverses ou de failles de chevauchement dans les monts Franklin. La variation dans la direction des failles d'importance serait causée par la réactivation de failles anciennes. Au sud-ouest du chaînon Norman, le sous-sol de la plaine du Mackenzie est constitué en prédominance de strates siliciclastiques du Dévonien et du Crétacé qui ont été en grande partie arasées par l'action des glaciers. La présence de la Formation de Saline River, une unité évaporitique, dans le toit de grandes failles donne à penser qu'elle a agi comme surface locale de décollement. Une discordance à la base de la succession du Crétacé supérieur s'enfonce plus profondément dans les strates du Crétacé inférieur et du Dévonien au nord-est, ce qui témoigne du soulèvement s'étant produit le long de l'arche de Keele avant le dépôt de la Formation de Slater River. Cette région cartographique englobe le champ pétrolifère de Norman Wells, actif depuis plusieurs dizaines d'années, où le pétrole est extrait du Membre de Kee Scarp de la Formation de Ramparts, à partir d'un récif calcaire encaissé dans du shale.



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

Cover illustration
View looking southwest at a minor thrust fault placing brown-weathering dolostone of the middle member of the Franklin Mountain Formation over light grey-weathering upper member on the northeast side of Discovery Ridge, Norman Range, Northwest Territories.

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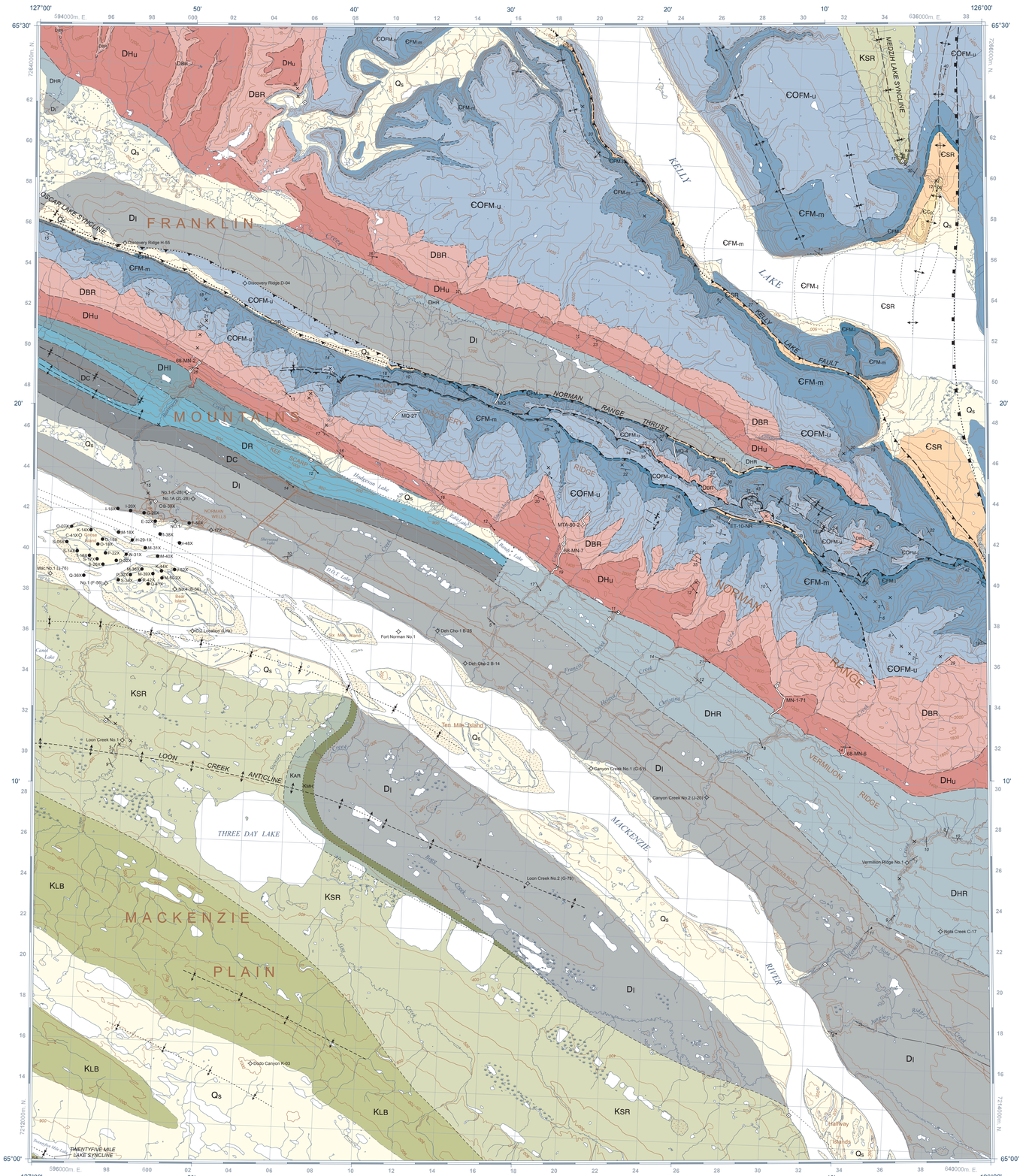
CANADIAN GEOSCIENCE MAP 100
GEOLOGY
NORMAN WELLS (SOUTHEAST)
Northwest Territories
1:100 000



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

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.

CAMBRIAN TO ORDOVICIAN

COFM-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

CFM-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.

CFM-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 rubstone, locally stromatolitic or bioturbated; interbedded with shale: dolomitic and silty, varicoloured, laminated, and fissile.

CSR — **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.

CCp — **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.

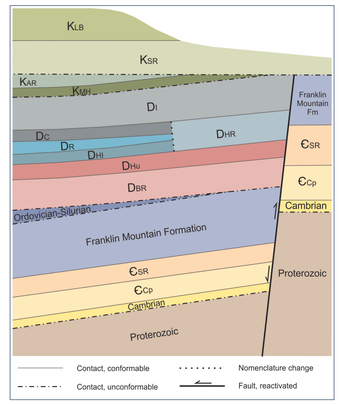


Figure 2. Schematic stratigraphic relationship diagram for southeast Norman Wells map area (NTS 9-6E/SE). Subsurface units are constrained by well and seismic data. Differential preservation of units beneath erosional unconformities reflects tectonic activity adjacent to the Keele Arch from the Paleozoic to the Cretaceous. The reactivated fault shown is postulated to exist beneath the Kelly Lake Fault.

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

Drift contact
- Approximate

Reverse fault, symbol on hanging-wall side
- Approximate
- Concealed

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

Anticline, upright
- Defined
- Approximate
- Inferred
- Concealed

Syncline, upright
- Defined
- Approximate
- Concealed

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

Monocline, synclinal bend, shorter arrow on steeper limb
- Approximate
- Inferred

- Visited outcrop, no measurements
- Outcrop observed remotely from ground or air

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

- Fossil locality
- MQ-4 — Measured stratigraphic section with name of section
- Petroleum well with well name or number
  - N-31X — Injection
  - Loon Creek No.1 — Dry and abandoned
  - B-30X — Unknown status
  - M-40X — Oil producing
- Oil pipeline

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), Silurian and Devonian usage follows that of Morrow (1991), and Cretaceous to Paleocene formation names are those of Dixon (1999). Cambrian to Ordovician units have recently undergone revision to their terminology, as outlined below.

Previous work by the Geological Survey of Canada in the Norman Wells map area (Aitken et al., 1973) 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 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, Kelly Lake Fault, Oscar Lake syncline, Medzih Lake syncline, Twenty Five Mile Lake syncline, and Loon Creek anticline have been introduced to facilitate discussion of these structural features. Cordilleran deformation in this map area has generated two types of faults: thrust faults which are interpreted to be detached within the Cambrian Saline River Formation, and reverse faults which are interpreted to be inverted normal faults with steep dips at depth, in Proterozoic strata. Seismic-reflection data are the basis for interpreting the Norman Range Thrust as a thrust fault. The north-trending fault north of Kelly Lake is an example of an inverted normal fault, supported by the presence of Mount Cap Formation in the hanging wall.

Due to the high density of petroleum wells in the Norman Wells oil field, a subset of wells was selected to be shown in this map representation for legibility reasons. The full list of wells in the public record is provided in the data of this publication. Coverage of public domain reflection seismic 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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CANADIAN GEOSCIENCE MAP 100

Authors: K.M. Fallas and R.B. MacNaughton

Geological compilation by K.M. Fallas and R.B. MacNaughton, 2011–2012

Geological field observations by K.M. Fallas, K. Montgomery, R. Lemiski (Northwest Territories Geoscience Office), R.B. MacNaughton, T. Proks, and J. Powell (University of Ottawa), 2009–2012, D.G. Cook, C.W. Thayer, J.D. Aitken, M.E. Ayling, H.R. Balkwill, and C.J. Yorath, 1968–1973, and J. Davison (University of Calgary), 2008

Seismic data interpretation by B.C. MacLean, 2010–2012. Stratigraphic sections measured by E.C. Turner (Laurentian University), 2010, R.W. Macqueen, W.S. MacKenzie, A.E.H. Pedder, and T. Uyeno, 1968-1971, and D.W. Morrow, 1980

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

Cartography by S.D. Orzeck and R. Kung

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, 00411, and 00912.

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.
Elevations are in feet above mean sea level

Some geographic names on this map are not official.

Mean magnetic declination 2013, 23°21'E, decreasing 31' annually. Readings vary from 23°31'E in the NW corner of the map to 23°11'E in the SE corner of the map.

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

Data may include additional 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 100
GEOLOGY
NORMAN WELLS (SOUTHEAST)
Northwest Territories

1:100 000

2 0 2 4 6 8 km