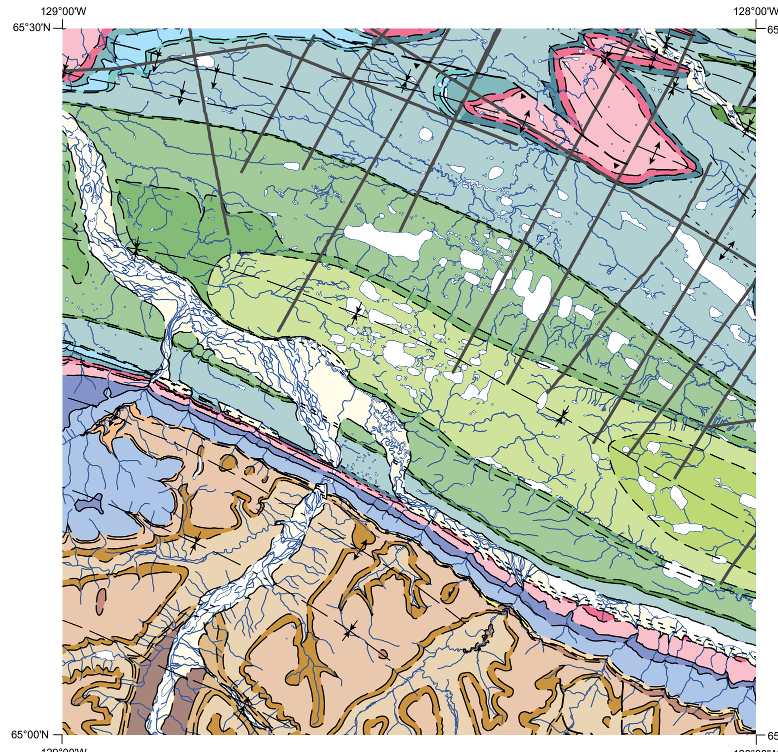


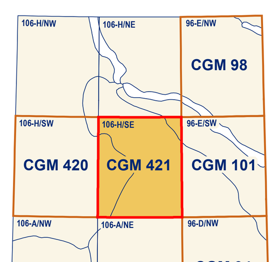
Figure 1. Southeast quadrant of Sans Sault Rapids map area (NTS 106-H/SE) showing seismic lines on record with the National Energy Board (NEB) that were used to augment the bedrock geology interpretation. Line names are provided in the digital data files.

Abstract

The southeast Sans Sault Rapids map area (NTS 106-H/SE) covers the transition from the northern Mackenzie Mountains to the Mackenzie Plain and northwest Franklin Mountains of the Northwest Territories. Bedrock exposures in the area include carbonate and siliciclastic strata ranging from Neoproterozoic (Tonian) to Cretaceous age. These strata were deformed in Cretaceous to Eocene time by folding and contractional faulting associated with Cordilleran deformation. Major structures include the Stony and Imperial anticlines. A minor set of pre-Cordilleran extensional faults are preserved within Neoproterozoic strata of the Mackenzie Mountains Supergroup, and are locally associated with diabase or gabbro dykes assigned to the Gunbarrel magmatic event (~780 Ma). Variable preservation of Neoproterozoic units beneath the sub-Cambrian unconformity indicates tilting or warping of strata before Cambrian time. A second major unconformity between Devonian and Cretaceous strata is marked by low-angle truncation of Paleozoic strata beneath the Cretaceous units.

Résumé

La partie sud-est de la région cartographique de Sans Sault Rapids (SNRC 106-H/SE) se situe à la transition de la partie nord des monts Mackenzie à la Plaine Mackenzie et à la partie nord-ouest des monts Franklin, dans les Territoires du Nord-Ouest. Dans la région, les affleurements du substratum rocheux comprennent des strates carbonatées et des strates silicoclastiques dont les âges s'étendent du Néoprotérozoïque (Tonien) au Crétacé. Ces strates ont été déformées lors du Crétacé à l'Éocène par la formation de plis et de failles de compression que l'on peut associer à la déformation cordillérienne. Les anticlinaux de Stony et d'Imperial constituent des structures d'importance. Dans les strates néoprotérozoïques du Supergroupe de Mackenzie Mountains, subsiste un ensemble d'importance secondaire de failles d'extension antérieures à la déformation cordillérienne, auxquelles sont associés par endroits des dykes de diabase ou de gabbro attribués à l'épisode magmatique de Gunbarrel (env. 780 Ma). Un degré variable de conservation des unités néoprotérozoïques sous la discordance marquant la base du Cambrien révèle un basculement ou un gauchissement des strates avant le Cambrien. Une seconde discordance d'importance entre les strates dévoniennes et crétacées est soulignée par une ablation suivant un angle faible des strates paléozoïques sous les unités crétacées.



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

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CANADIAN GEOSCIENCE MAP 421

BEDROCK GEOLOGY

SANS SAULT RAPIDS SOUTHEAST

Northwest Territories
NTS 106-H southeast
1:100 000

QUATERNARY

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

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.

KT — **Trevor Formation:** sandstone: chert- and quartz-rich, medium grey, light-brown-weathering, very fine- to medium-grained, thin- to thick-bedded, hummocky cross-stratified, ripple crosslaminated, some parallel lamination, mudstone laminae, rip-up clasts; interbedded with mudstone: clay-rich but can be silty, thin- to medium-bedded, rare bivalves or wood fragments, some horizontal burrows; upward-coarsening packages from mudstone to sandstone dominate.

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; minor sandstone: silty, very fine- to fine-grained, grey or brown, very thin- to thin-bedded, locally laminated or crosslaminated; unit becomes sandier upsection where Sans Sault Member is preserved.

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; this member is typically preserved at the top of Arctic Red Formation.

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.

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

DHR — **Horn River Group (Hare Indian and Canol formations):** 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; group undivided where Ramparts Formation is not recognizable.

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.

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; 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.

DL — **Landry Formation:** limestone: lime mudstone to crystalline limestone, locally dolomitic, grey to brownish-grey, weathers light grey, thin- to thick-bedded, parallel-bedded, parallel-laminated, pelletal, no visible body fossils. Well-defined bedding gives a ribbed appearance; laterally equivalent to, and locally overlies, Bear Rock Formation.

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

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.

CAMBRIAN

ЄN — **Nainlin Formation:** shale: light green, brick red, or grey, fissile, mud cracks; interbedded with sandstone: quartz wacke to quartz arenite, locally dolomitic, rarely conglomeratic, cream to pink, red, or brown, variable weathering colour, very thin- to medium-bedded, parallel-bedded or crossbedded, salt casts, ripple marks, sporadic horizontal or vertical burrows; minor conglomerate: found at base or within unit.

ЄSR — **Saline River Formation:** 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; shale: silty, grey, red, or green, fissile, minor salt casts, desiccation cracks, and horizontal burrows; 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.

TONIAN (NEOPROTEROZOIC)

ŦGb — **Gabbro and diabase:** fine- to medium-grained, dark grey to dark green, weathers brown to grey or black, homogeneous texture, occurs as both dykes and sills in Proterozoic strata.

Mackenzie Mountains Supergroup (Tsezotene Formation and Katherine Group)

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

ŦAP — **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.

ŦM — **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.

ŦSR — **Shattered Range Formation:** sandstone: quartz arenite, cream to light pink, weathers grey to light reddish-brown, medium- to thick-bedded, very fine- to fine-grained, planar or crossbedded, wavy or ripple crosslaminated, parallel laminated, mudstone rip-up clasts; rare interbeds of black or red mudstone.

ŦEt — **Etagochile Formation:** shale: purple, red, dark grey, and greenish grey, minor silt; interbedded with lesser sandstone: locally glauconitic, weathers cream, to light brown, pink, or reddish, thin- to medium-bedded, very fine- to fine-grained, crossbedded, ripple crosslaminated, minor mudstone rip-up clasts; and minor dolostone: weathers orange, thin-bedded, laminated, intraclast-bearing, mudcracks; red to purple shale is prominent; sandstone locally forms medial unit up to 50 m thick.

ŦGR — **Grafe River Formation:** sandstone: quartz arenite, white to cream or pink, weathers light brown to light orange-pink, medium- to thick-bedded, fine- to very fine-grained, planar or crossbedded, wavy or ripple crosslaminated, parallel laminated, mudstone rip-up clasts; rare interbeds of mudstone or siltstone: black or red.

ŦTa — **Tawu Formation:** shale and mudstone: dark grey to greenish grey or red; interbedded with lesser sandstone: weathers light brown, thin- to medium-bedded; and/or dolostone: light grey, weathers orange, thin- to medium-bedded, laminated.

ŦEd — **Eduni Formation:** sandstone: quartz arenite, white to pink or purple, weathers light brown to pink or purple, thin- to thick-bedded, fine- to very fine-grained, planar or crossbedded, wavy or ripple crosslaminated, parallel laminated, rare mudstone rip-up clasts; rare interbeds of mudstone or siltstone: black, dark grey, or red.

ŦTz — **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*

Drift contact:
- *Approximate*

Nomenclature or mapping precision change

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

Backthrust, symbol on hanging-wall side:
- *Inferred*
- *Concealed*

Normal fault, symbol on hanging-wall side:
- *Approximate*

Fault, hanging wall undefined (steep dip):
- *Approximate*

Anticline, upright:
- *Approximate*
- *Inferred*
- *Concealed*

Syncline, upright:
- *Approximate*
- *Inferred*
- *Concealed*

Anticline, homeoclinic, shorter arrow on steeper limb:
- *Approximate*

Syncline, homeoclinic, shorter arrow on steeper limb:
- *Approximate*

Visited locality, no measurements

Locality observed remotely from aircraft

Bedding:
- *Horizontal*
- *Bedding strike and dip, inclined, upright:*
  - *Younging direction known* (30)
  - *No evidence for younging direction or younging evidence unknown* (29)
  - *No evidence for younging direction, estimated measurement* (45)
- *Bedding strike and dip, inclined, overturned:*
  - *Younging direction known*

Measured stratigraphic section with name of section

Fossil locality

Petroleum wells:
- *Dry and abandoned*

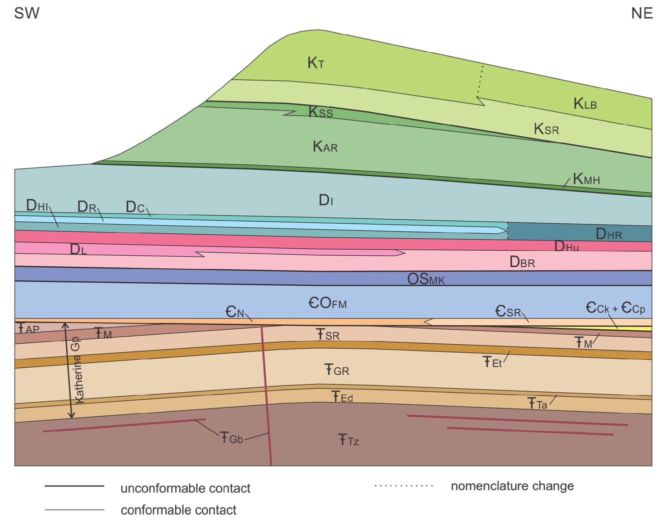

Figure 2. Schematic stratigraphic relationship diagram for the southeast Sans Sault Rapids map area (NTS 106-H/SE). Unit abbreviations match those used in the map and legend.

Descriptive Notes

Initial bedrock mapping and stratigraphic studies by the Geological Survey of Canada (GSC) in the Sans Sault Rapids map area (NTS 106-H) were conducted in 1968 as part of Operation Norman. This operation and subsequent stratigraphic work up to 1977 led to the release of a GSC Memoir and 1:250 000 scale map of the area (Aitken et al., 1982). In the present compilation, observations collected in 2016 to 2018 as part of the Geo-mapping for Energy and Minerals (GEM) program were combined with observations from Operation Norman, along with observations from the Peel Project of the Northwest Territories Geological Survey collected in 2006 to 2007 (Pyle and Jones, 2009; Pierce and Jones, 2009). Stratigraphic information from additional reports of the Northwest Territories Geological Survey and GSC is also incorporated (Pyle and Gal, 2007, 2012; Serié et al., 2013). Petroleum exploration wells and reflection-seismic data drilled or collected since 1970 also helped constrain the map interpretation (Fig. 1). Bedrock units are interpreted beneath local Quaternary cover to provide a seamless bedrock interpretation.

Formal stratigraphic nomenclature used for the Operation Norman maps in the area (Aitken et al., 1982) is largely still in use, although more recent stratigraphic work has added new formal terms for previously informal units found in southeast Sans Sault Rapids map area. An outline of updated stratigraphic relationships in the northern Mackenzie Mountains was provided by Fallas et al. (2016), and schematic relationships within southeast Sans Sault Rapids map area are illustrated in Figure 2. Within the Mackenzie Mountains Supergroup, the Katherine Group is subdivided into seven formations (Long and Turner, 2012), replacing the "lower" and "upper" subdivisions of Aitken et al. (1982). Although typically not well exposed, these seven formations have been mapped within this area as outlined by Fallas (2019). A gabbro sill that intrudes strata of the Mackenzie Mountains Supergroup southeast of the Sans Sault Rapids map area was dated at 779.5 Ma by Harlan et al. (2003) and assigned to the Gunbarrel mafic magmatic event. Similar intrusions within the Sans Sault Rapids map area are also assigned to the Gunbarrel suite.

Within the Cambrian succession, the Nainlin Formation of MacNaughton and Fallas (2014) is introduced in place of the "basal red beds" of the Franklin Mountain Formation, and is considered to be a lateral equivalent of the Saline River Formation. Nainlin Formation is a clastic-dominated unit beneath the Franklin Mountain dolostone that lacks the evaporite deposits of the Saline River Formation. It lies unconformably on Neoproterozoic (Tonian) strata of the Katherine Group, or Cambrian strata of Mount Clark and Mount Cap formations. Aside from the exclusion of the basal red beds, Franklin Mountain Formation follows the usage of Aitken et al. (1982), as does Mount Kindle Formation. Devonian units in the southeast Sans Sault Rapids map area also follow the usage of Aitken et al. (1982), with some refinement to the relationship between Bear Rock and Landry formations as noted by Morrow (1991).

Unconformably overlying the Devonian succession, the Cretaceous succession was treated as an undivided package of Arctic Red River and Trevor formations by Aitken et al. (1982), largely following the work of Yorath and Cook (1981). Subsequent work by Dixon (1999) and Thomson et al. (2011) provided a basis for subdividing the Cretaceous into six units: the Lower Cretaceous Martin House Formation, Arctic Red Formation, and Sans Sault Member of Arctic Red Formation, and Upper Cretaceous Slater River, Trevor, and Little Bear formations. Trevor and Little Bear formations occupy the same stratigraphic position, but available biostratigraphic data indicate different age ranges for the units (Dixon, 1999; Thomson et al., 2011). In the absence of direct biostratigraphic evidence, assignment to either unit is made based on terminology on adjacent maps (Aitken et al., 1982; Fallas et al., 2013). Subsurface data from petroleum exploration wells and reflection-seismic surveys helped constrain the distribution of these Cretaceous units.

Subsurface data and stratigraphic refinements allow for the addition of structural detail to the major structures identified by Aitken et al. (1982). Evidence from reflection-seismic survey data indicates the presence of a south-dipping thrust fault on the north flank of the Imperial anticline, consistent with the interpretation of Cook and MacLean (1999). This fault appears to be a continuation of the Hoosier Ridge Fault mapped to the east by Fallas et al. (2013). The additional detail provided by mapping the seven units of the Katherine Group reveals thrust fault segments on either side of Imperial River, which are interpreted to connect to the Canyon Fault mapped to the southeast by Fallas and MacNaughton (2014). An additional fold pair, the Cambrian Creek anticline and syncline, is also identified in the Katherine Group and younger units on the north flank of the broader Stony anticline. Aitken et al. (1982) previously identified the north limb of the Cambrian Creek anticline as the Gayna flexure. Other additions include steeply dipping normal faults and north-northwest-trending mafic dykes of the Gunbarrel suite cutting Katherine Group strata west of Mountain River.

NOTE: The name Stony anticline was introduced by Aitken et al. (1982) to indicate the broad culmination cored by Tsezotene Formation and Katherine Group, without differentiating individual anticlinal hinges. As refined mapping has revealed that this structure comprises multiple en échelon anticlinal hinges along its full strike length, these are herein differentiated as segments named on the basis of a geographic feature in close proximity to the segment named.

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Geological Survey of Canada
Canadian Geoscience Maps

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Geological compilation by K.M. Fallas and R.B. MacNaughton, 2016–2019

Geological field observations by K.M. Fallas, R.B. MacNaughton, G.S. Stockmal, and P. Kabanov, Geological Survey of Canada, 2009 and 2016; Y. Lemieux, Geological Survey of Canada, 2006 and 2007; T. Hadlari, Northwest Territories Geological Survey, 2006 and 2007; J.D. Aitken, H.R. Balkwill, D.G. Cook, and C.J. Yorath, Geological Survey of Canada, 1968–1971

Stratigraphic sections measured by P. Kabanov and S.A. Gouwy, Geological Survey of Canada, 2016; L.P. Gal and W. Zantvoort, Northwest Territories Geological Survey, 2006–2011; L.J. Pyle and C. Bergquist, contractors, 2006–2011; D.G.F. Long, W.S. MacKenzie, R.W. Macqueen, A.E.H. Pedder, and T.T. Uyeno, Geological Survey of Canada, 1968–1977

BEDROCK GEOLOGY

SANS SAULT RAPIDS SOUTHEAST

Northwest Territories
NTS 106-H southeast
1:100 000

2 0 2 4 6 8 km

Reflection-seismic data interpreted by B.C. MacLean and K.M. Fallas, 2015–2018.

Geological data conforms to Bedrock Data Model v. 4.0.

Geomatics by K.M. Fallas and M. Le

Cartography by M. Le

Scientific editing by A. Weatherston

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Map projection Universal Transverse Mercator, zone 9
North American Datum 1983

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

Mean magnetic declination 2020, 20°07'E, decreasing 27.4' W annually
Readings vary from 20°11'E in the NW corner to 20°03'E in the SE corner of the map

This map is not to be used for navigational purposes.

Title photograph: View looking northeast down Fan Creek in the Canyon Ranges of the northern Mackenzie Mountains, Northwest Territories. The creek exposes sandstone-dominated strata of the Neoproterozoic Katherine Group overlain downstream by lighter coloured Paleozoic carbonate strata. Photograph by K.M. Fallas. NRCan photo 2019-003

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

Data may include additional observations not portrayed on this map. *See* map info document accompanying the downloaded data for more information about this publication.

This publication is available for free download through GEOSCAN (https://geoscan.nrcan.gc.ca/).

CANADIAN GEOSCIENCE MAP 421
BEDROCK GEOLOGY
SANS SAULT RAPIDS SOUTHEAST
Northwest Territories
NTS 106-H southeast