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CANADIAN GEOSCIENCE MAP 179

BEDROCK GEOLOGY

CAMPBELL LAKE

Northwest Territories

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ABSTRACT
The Campbell Lake map area, NTS 107-B/2 is located in the Northwest Territories on the southeastern edge of the Mackenzie Delta. The western map area is underlain by Quaternary fluvial deposits and parts of the central and northeast area by fluvial and fluvial fan deposits. The eastern area is underlain by poorly exposed Cretaceous strata, and the central area by poorly exposed Proterozoic and Paleozoic strata which comprise the southwestern Campbell Uplift. These Proterozoic and Paleozoic strata may be part of an earlier Paleozoic arch. However this feature is now part of the Tuk Horst (Wielens, 1992), which centers the Eskimo Lakes Arch. The horst features a complex subcrop of Paleozoic and Proterozoic sedimentary strata and local volcanics, beneath a pre-Mesozoic unconformity. All strata are openly folded on a scale of tens to hundreds of meters and cut by normal faults. Normal faulting is likely complex, and much of it Cretaceous.

RÉSUMÉ
La région cartographique de Campbell Lake (SNRC 107-B/2) est située dans les Territoires du Nord-Ouest, à la bordure sud-est du delta du Mackenzie. Le secteur occidental de la région cartographique est occupé par des dépôts fluviaux du Quaternaire et des parties des secteurs central et nord-est le sont par des dépôts fluviatiles et des dépôts de cône fluvial. Le secteur oriental est occupé par des strates du Crétacé, peu représentées en affleurements, et le secteur central l'est par des strates du Protérozoïque et du Paléozoïque, elles aussi peu représentées en affleurements, qui composent la partie sud-ouest du soulèvement de Campbell. Ces strates du Protérozoïque et du Paléozoïque pourraient être des éléments d'une arche du Paléozoïque plus ancienne. Toutefois, cette entité est maintenant une constituante du horst de Tuk (Wielens, 1992), qui constitue la partie centrale de l'arche d'Eskimo Lakes. Sous une discordance pré-mésozoïque, le horst présente un agencement complexe de strates sédimentaires, et localement de strates volcaniques, du Paléozoïque et du Protérozoïque. Toutes les strates sont reprises dans de grands plis ouverts à l'échelle de dizaines ou de centaines de mètres et elles sont recoupées par des failles normales. Le jeu de ces failles normales est vraisemblablement complexe et remonte principalement au Crétacé.

SHEET 1 OF 1, BEDROCK GEOLOGY

GENERAL INFORMATION
Authors: M.P. Cecile, L.S. Lane, L.D. Dyke, and D.K. Norris

Geological compilation by M.P. Cecile, L.S. Lane, and L.D. Dyke, 2012–13, and D.K. Norris, 1981

Field Observations of area northwest and around Campbell Lake by M.P. Cecile, 1987, 1988, 1992; L.S. Lane, 1987; and L.D. Dyke, 1974. Geology of the remaining area interpreted from D.K. Norris' 1:250 000 Map 1517A compilation published in 1981.

Geomatics and cartography by L. Kung and F.A. Hardjowirogo

Map projection Universal transverse Mercator, zone 8.
North American Datum 1983

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

Magnetic declination 2017, 21°59'E, decreasing 33.1' annually.

This map is not to be used for navigational purposes.

Title photograph: Aerial view southwestward across Campbell Lake toward the Mackenzie River. The lake occupies a segment of the Sitidgi Graben, part of an extensional block fault system that was active leading to the initial formation of the Beaufort Sea in Cretaceous time, more than 100 million years ago. The lake features an unusual reverse delta. Normally, the stream drains water from Campbell Lake into the Mackenzie River. But during the spring flood when the water level in the river is high, the flow reverses, bringing silt-laden water from the river into the lake. Over time the silt has built up this reverse delta, filling up the centre of the lake. Photograph by L.S. Lane. 2014-023

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Map Viewing Files

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Descriptive Notes

The Campbell Lake map area (NTS 107-B/2) is located in the Northwest Territories on the eastern edge of the Mackenzie Delta. The area was mapped in the 1960's and 1970's and a compilation of that work was published by D.K. Norris (1981). All Mesozoic rock units on this map are as mapped by Norris (ibid.) except that some map unit

names have changed based on new regional stratigraphic observations. The central Campbell Lake map area was remapped in the 1980's and early 1990's. In addition detailed traverse notes of L.D. Dyke from the 1970's have been re-evaluated and incorporated into the current interpretation of the geology.

The central map area exposes the southern half of Campbell Uplift. It was first noted as a feature by Norris (1973) and described as Campbell uplift (lower case). It is briefly mentioned in the Geology of Canada # 5" (Stott and Aitken, 1993) as the Campbell Lake Uplift and Wielens (1992) shortened the name to Campbell Uplift. Norris (1997) and Dyke (1997) provide the first detailed descriptions of the uplift. Dyke (ibid.) described it as 15 km south of Inuvik and consisting of a northeast trending, oval shaped area, roughly 22 km long and 11 km wide and situated between the East channel of the Mackenzie River and Campbell Lake (there are a few kilometres of uplift exposures east of Campbell Lake). The uplift consists of block faulted and gently folded Proterozoic and Paleozoic strata surrounded by Cretaceous and Quaternary strata. It plunges northeast below Lower Cretaceous and younger rocks (Norris, 1997) and it continues as outliers to the southwest before it disappears below fluvial sediments of the Mackenzie Delta (Dyke, 1997). On the uplift proper, in the Inuvik map area (NTS 107-B/7), there is a local accumulation of terrestrial Cretaceous pebbly quartz lithic sandstone and shale with coaly plant material, and a small area of Horton River Formation shale and siltstone. Wielens (ibid.) demonstrated that Campbell Uplift is continuous with a variety of Proterozoic and Paleozoic strata that directly underlie Cretaceous strata along what he referred to as “Tuk Horst” which trends northeast in the subsurface along the center of Eskimo Lakes Arch (Young et al., 1976). Except for Campbell Uplift, Eskimo Lakes Arch is largely buried under Upper Cretaceous to Quaternary sediments (ibid.).

The oldest rocks within the uplift are a succession of buff yellow dolostone, red/maroon and green argillite and quartzite. The age for this succession is based mainly on the fact that they underlie the Upper Cambrian to Lower Ordovician Franklin Mountain Formation. No macrofossils have been recovered from surface exposures of these strata and six samples of various lithologies analysed for acritarchs were either barren or contained non age-diagnostic forms (Asselin, 2012). Molar tooth structure was observed in the dolostone. Molar tooth structure is commonly found in Proterozoic strata, and is rarely found in Paleozoic strata. Norris and Black (1964) report a Late Precambrian age for this unit based on paleomagnetic data, however that result needs to be re-evaluated in the context of current paleomagnetic interpretations. In the Amoco Ulster D-54 well on the northwest side of Inuvik, Chamney (1972) reported algae and cone shaped fossils of probable Paleozoic age from the "Upper Clastic Unit" (*see* below). New detrital zircon ages from an outcrop of the quartzite unit in this map area (NTS 107-B/2) indicates that most zircon grains have ages of 1150–2100 Ma, with scattered Paleoproterozoic and Archean ages, as well as one grain dated at 567 Ma (L.S. Lane, unpublished data). Omitting the single grain age (a single grain is not considered reliable), these data indicate a robust depositional age less than 1150 Ma. Further, the overall age distribution is very similar to that of Shaler Supergroup strata (Rayner and Rainbird, 2013) or Ediacaran-Cambrian rocks derived largely from them (Lane and Gehrels, 2014). On the basis of these data we have assigned to these rocks a Proterozoic to Cambrian age.

In a quarry northeast of the center of Dolomite Lake (Inuvik map area, NTS 107-B/7), is an exposure of what is thought to be the oldest of the Proterozoic-Cambrian uplift succession, the dolostone unit. Here the dolostone unit outcrops in the core of a small anticline with strata of the argillite unit exposed on both limbs. The quartzite unit is only

found in this map area where it is only juxtaposed with the argillite unit and therefore is thought to be the youngest in the Proterozoic-Cambrian succession. However the stratigraphic order of Proterozoic-Cambrian units is tentative because it relies on one anticline which exposes only a few meters of the dolostone unit. This stratigraphy is very similar to the interpretation of Dyke (1975).

Proterozoic-Cambrian strata were also intersected in the Inuvik D-54 well which is 10–15 km north of the northern Campbell Uplift in the NTS 107-B/7 map area. That well encountered pre-Mesozoic strata at 320 m, below Cretaceous shale and siltstone, that are described by Wielens (1992) as consisting of a Lower Clastic unit, a Dolostone unit and an Upper Clastic unit. Both the Upper Clastic and Lower Clastic units have thick successions of quartzite. Wielens (ibid.) details a log of the Lower Clastic unit showing it to be greater than 410 m thick. It consists of a complex succession with dolomitic quartzite, quartzitic sandstone, quartzite, green, red, and grey-black shale, including a 3 m interval with sandstone and dark green and maroon volcanics. This D-54 Lower Clastic unit is not exposed on Campbell Uplift. The D-54 Lower Clastic unit is overlain by the D-54 Dolostone unit which Wielens (ibid) describes as 759 m thick, and consisting of brown, grey, tan, black and pinkish dolostone, with quartzitic sandstone, grey shale, and white and buff chert. It likely correlates with the Campbell Uplift Dolostone unit. The D-54 Upper Clastic unit is described by Wielens (ibid.) as consisting of 240 m of pink, red and apple green shales with a few chert pebbles, units of quartzite (there are two quartzite units, 11 and 14 m thick), sandstone, siltstone and quartzitic dolomite and dolomite. As noted above Chamney (1972) reported fossils of probable Paleozoic age in the upper part of the D-54 Upper Clastic unit. The Argillite and Quartzite units exposed on the Campbell Lake Uplift are likely equivalent to the D-54 Upper Clastic unit. Cook et al. (1987) identify what they believe to be 15 km of Proterozoic strata below Paleozoic strata under the uplift.

Pre-Devonian Paleozoic carbonate strata exposed on Campbell Uplift were lumped together as the Vunta Formation in the map compilation of Norris (1981, 1997) and Dyke (1997). However Dyke (1975, 1997) noted the existence of two distinct units within the Vunta Formation. More detailed mapping in the 1980's and 1990's, together with a review of detailed notes taken by L.D. Dyke in the 1970's, shows that the two carbonate units identified by Dyke (ibid.) are easily mapped. In terms of colour, texture, fossil content and associated chert, the lower unit strongly resemble the Franklin Mountain Formation, and the upper unit, the Mount Kindle Formation, as described in the Mackenzie Plains and Mountains (Norford and Macqueen, 1975; Cecile, 1982) and therefore these units names are used here in place of Vunta Formation for consistency with regional mapping.

The Franklin Mountain Formation is a typically light grey or white crystalline, often buff weathering dolostone barren of fossils, and rarely yields microfossils. Its upper part has abundant white-grey replacement chert. The Mount Kindle Formation is typically grey to dark grey, fine to medium crystalline, with some black chert and is commonly fossiliferous featuring chain and solitary corals. It often yields microfossils (conodonts). Dyke (1975, 1997) noted that in the Inuvik D-54 well there were 750 m of Paleozoic carbonates above the Proterozoic-Cambrian clastics. However it would appear that, although initially in early well logs this 750 m of dolostone was identified as Paleozoic, this 750 m succession is in fact the same dolostones identified as Proterozoic by Wielens (1992), and they do strongly resemble the Proterozoic dolostones mapped at the surface in NTS 107-B map area.

Devonian strata consist of the Arnica and Imperial formations. The Arnica Formation was originally mapped as Gossage Formation by Norris (1981) and also called

Cranswick Formation by Dyke (1997). However, the Gossage Formation is mainly used to refer to subsurface strata, and on the surface Gossage has been replaced by Arnica and Landry formations (Hills, 1981). In the opinion of D. W. Morrow (personal communication 2012) the Campbell Uplift strata are more typical of Arnica Formation. On the uplift, it consists of dolostone with units of limestone, is grey white and often crystalline. It is also typically fossiliferous with abundant poorly preserved stromatoporoids, stromatolites, stromatactis and locally solitary and colonial corals, brachipods and twin canal crinoid ossicles. The Imperial Formation outcrops south and southeast of Campbell Lake. There it consists of black-grey and rusty weathering shale and grey weathering sandstone in alternating thick beds and units. Sandstones are often laminated and crosslaminated, and have flutes, load casts and plant impressions.

The oldest Mesozoic unit in Campbell Uplift is a pebbly quartz-lithic sandstone with coaly plant material. This unit is found east of Dolomite Lake and northeast of Campbell Lake in the NTS 107-B/7 map area to the north of this sheet. It is inferred to underlie the Horton River Formation but there is no direct contact between the two. The Horton River Formation outcrops extensively in the eastern third of the map area. It is a marine Lower Cretaceous unit described by Norris (1981) as consisting of shale and siltstone. To the north in the Inuvik map area (NTS 107-B/7) the Horton River Formation is overlain by the shallow marine Upper Cretaceous strata labelled then as Tent Island Formation and described as consisting of shallow marine mudstone, conglomerate and sandstone. Later stratigraphic work in the Mackenzie Delta area indicates that these exposures comprise Smoking Hills Formation (Dixon et al., 1992, p. 45) and that nomeclature is used here.

All pre-Mesozoic strata are found in normal-fault bounded slabs with a tendancy for south and east dips. Open folds, on a scale of tens to hundreds of meters, can be observed. Folds typically have a northeast trends in all Proterozoic-Paleozoic units. Cretaceous strata are poorly exposed and we have very few data on their structural characteristics. Norris's 1981 map shows a few horizontal and few gentle dips in the Mesozoic. There is also a widespread northeast trending steeply dipping fracture cleavage in Proterozoic and Paleozoic units.

Certainly the current uplift exposure of the Campbell Uplift is mainly the result of Mesozoic-Tertiary block faulting (*see* Fig. 1 cross-section). This block faulting is likely continuous with the Eskimo Lakes Arch, where most Paleozoic and Proterozoic strata are buried under Cretaceous strata.

Within Campbell Uplift (in NTS 107-B/2 and 107-B/7), the Cambro-Ordovician Franklin Mountain Formation lies locally on all three Proterozoic-Cambrian units suggesting uplift and exposure of these strata before the Late Cambrian. This was noted by Dyke (1997) as an irregular boundary. Dyke (1975, 1997) also suggested an angular unconformity between the Proterozoic and Paleozoic because of dips up to 55° within the Proterozoic, and shallower in the Paleozoic. However our observations show structural attitudes in the Proterozoic and Paleozoic are very similar. This would suggest instead a paraconformity or slight angular unconformity.

The Proterozoic and Paleozoic exposures of the uplift are asymmetric in that the oldest rocks exposed beneath Mesozoic and Quaternary strata are on the north side of current exposure. Thus, the central axis of an ancestral arch likely runs on the north side or even farther north of the axis of the Mesozoic-Tertiary Eskimo Lakes Arch. We interpret this older version of the uplift as a local expression of the ancestral Aklavik Arch complex, which is part of a system of sub-aerial highs that included the Mackenzie and Ogilvie arches (Aitken et al., 1973; Morrow, 1999). In addition, Coflin et al. (1990) and Cook et al. (1987) hypothesize that the area was folded and faulted during

Ellesmerian orogenesis and that some of the positive structure of the Campbell Uplift itself is the result of a structural culmination due to an Ellesmerian-age duplex, in the subsurface. Unpublished thermochronology data suggest that much of the uplift/cooling occurred in pre-Mesozoic time.

Also on the uplift (in NTS 107-B/2 and 107-B/7), different Cretaceous strata sit directly on the Proterozoic-Cambrian argillite unit and the Devonian Arnica and Imperial formations. Campbell Uplift area and Eskimo Lakes Arch exerted an important control on sedimentation and facies throughout the Early Cretaceous and undergoing active uplift from Late Hauterivian through Albian time (Dixon, 1986), coincident with important phases of continental rifting preceding development of the Beaufort-Mackenzie Basin (Dixon, 1993). The area of Campbell Lake proper is part of Norris, (1981) Sitidgi Graben. The graben and associated normal faults are related to major basin-bounding faults of Jurassic to Albian age (e.g. Cook et al., 1987; Embry and Dixon, 1990).

Quaternary deposits consist of fluvial and lacustrine clays, silts, sands and gravels and fluvial fan and fan aprons of clays silts, sands and gravel (Norris, 1981). Finally, glacial and glacial-fluvial features are common in the area and fault scarps have fans of quaternary fluvial material.

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The Additional Information folder of this product's digital download contains figures and tables that appear in the map surround as well as additional geological information not depicted on the map, nor this document, nor the geodatabase.
- Excel file of the Master Legend Table (legend symbols, descriptions, headings, etc.).
- PDF(s) of cross-section(s).

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Coordinate System

Projection: Universal Transverse Mercator
Units: metres
Zone: 8
Horizontal Datum: NAD83
Vertical Datum: mean sea level

Bounding Coordinates

Western longitude: 134°00'00"W
Eastern longitude: 133°00'00"W
Northern latitude: 68°15'00"N
Southern latitude: 68°00'00"N

Software Version

Data has been originally compiled and formatted for use with ArcGIS™ desktop version 10.2.2 developed by ESRI®.

Data Model Information

No Model

This Canadian Geoscience Map does not conform to either the Bedrock or Surficial Mapping Geodatabase Data Models. The author may have included a complete description of the feature classes and attributes in the Data\Data Model Info folder.