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GEOART: A Contribution to Geo-Mapping for Energy and Minerals (GEM-Energy) Program and Geoscience Outreach

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GEOART: A Contribution to Geo-Mapping for Energy and Minerals (GEM-Energy) Program and Geoscience Outreach

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Abstract

The Geological Survey of Canada, through the Geo-mapping for Energy and Minerals Program, is helping to increase economic prosperity of northern Canada by providing critical geoscience information required for long-term investment, targeted exploration, sustainable development and management of new energy and mineral resources. As a contribution to this program and outreach initiative to increase public awareness and interest in geoscience, seven paintings by the author depict the surficial geology and geomorphic history of northeastern British Columbia, including the northwest limit of the Fort Nelson Lowland, western Etsho Plateau, Maxhamish Escarpment, Tsoo Tablelands, and the Liard, Fort Nelson and Petitot rivers. Lowland regions are underlain by gently dipping natural gas-bearing shale, siltstone and sandstone. Folded and fault-bounded conglomerate, sandstone, carbonaceous shale, coal and limestone form escarpments, tablelands and plateaux. During the last glaciation (30,000 to 12,000 calendar years before present), Maxhamish Lake and numerous smaller basins were excavated as the Laurentide Ice Sheet and meltwater scoured older glacial deposits and weak bedrock. The modern Fort Nelson and Petitot rivers occupy meltwater spillways that drained northwest into glacial lakes confined to the Liard River basin. Over the last 12,000 years, slopes and drainage networks have been modified by fluvial erosion and deposition, landslides, forest fires, beavers and human activity.

Keywords

Geoart, Geo-Mapping for Energy and Minerals Program, Yukon and Liard Basin Project, Maxhamish Lake, NTS 94O, Surficial Geology, Laurentide Ice Sheet, Glacial History

Introduction

The Geological Survey of Canada (GSC) is currently compiling regional-scale information on surficial deposits and landform processes in northeastern British Columbia as part of the Geo-Mapping for Energy and Minerals (GEM) Program Yukon and Liard Basin Project (**Figure 1a, b**). The region is a traditional territory for the Dene Peoples, whose nomadic ancestors have long sustained an economy based on hunting, fishing and fur trapping. More recent land use activities are related to forest and natural gas industries. Field-based studies, started in 2009, aim to reduce the risks for exploration and development of energy and mineral resources, and attract new investment in this part of northern Canada (Huntley and Hickin, 2010).

Since 2003, the landscapes and geology of the region have inspired paintings by the author. As an outreach initiative of this project, a series of works depicting geological landscapes of northern Canada are presented here (cf. Huntley, 2006). Accompanying notes describe the paintings in the context of our current understanding of the regional surficial geology and geomorphic history of northeastern British Columbia, Yukon and Northwest Territories (e.g., Mathews, 1980; Rampton, 1987; Rutter et al., 1993; Lemmen et al., 1994; Duk-Rodkin and Lemmen, 2000; Smith, 2000; Clement et al., 2004; Bednarski and Smith, 2007; Bednarski, 2008; Hartman and Clague, 2008; Hickin et al., 2008; Trommelen and Levson, 2008).

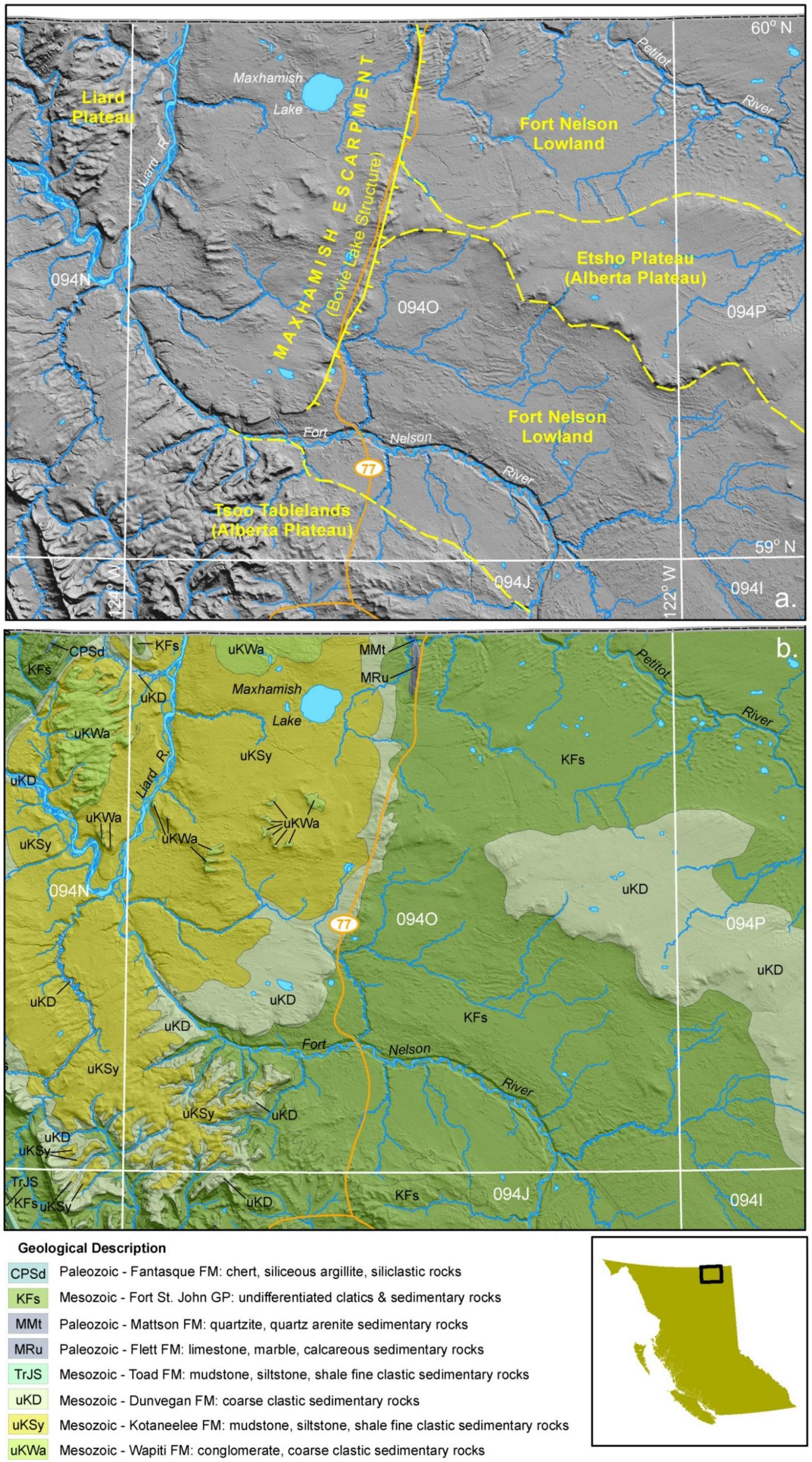

Figure 1 Paintings in this paper were inspired by and depict the landscape of the Maxhamish Lake map area (NTS 94O), northeastern British Columbia: a) major physiographic regions and hydrology (after Bostock, 1970); b) bedrock geology, modified after Stott and Taylor (1968)

Geology and the Landscape

Northeastern British Columbia encompasses the following physiographic regions: a) the northwestern limits of Fort Nelson Lowland; b) the western Etsho Plateau; c) Maxhamish Escarpment (and Bovie Lake structure); d) Tsoo Tablelands, northernmost part of the Alberta Plateau; e) Liard, Fort Nelson and Petitot rivers (**Figure 1a, Figure 2**). Lowland regions are underlain by shallow dipping shale, siltstone and sandstone (Upper Cretaceous Kotaneelee Formation overlying Lower Cretaceous Fort St. John Group rocks). Folded and fault-bounded Lower Carboniferous (Mississippian) sandstone, shale (Mattson Formation) and limestone (Flett Formation), and Upper Cretaceous conglomerate, sandstone, carbonaceous shale and coal (Dunvegan and Wapati formations) form escarpments, tablelands and plateaux (**Figure 1b, Figure 2, Figure 3**; Stott and Taylor 1968).

Figure 2 Maxhamish Lakescape (2003) original 5 x 7 inches; acrylic on cotton; private collection

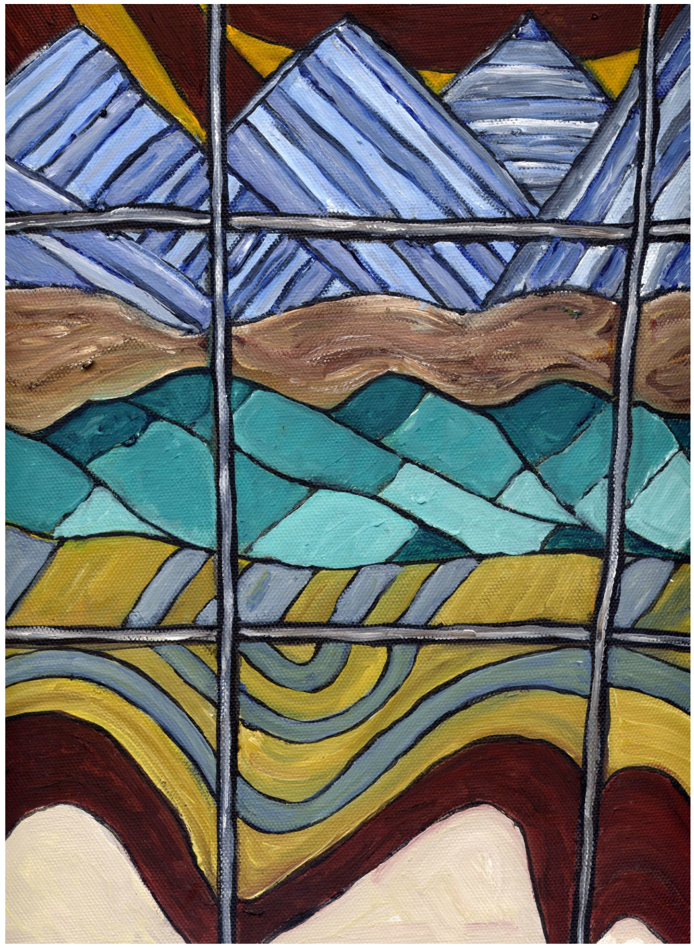

Figure 3 Western Sedimentary Basin (2008) original 10 x 14 inches; oil on canvas; private collection

Glacial History

The distinctive landscape of northeastern British Columbia is largely due to bedrock structure, tectonic history and the Late Wisconsinan Glaciation, equivalent to the Fraser Glaciation in British Columbia and McConnell Glaciation in Yukon. This last glaciation began about 30,000 calendar years ago and terminated in the region around 12,000 years ago (Dyke et al., 2003; Dyke, 2004; Bednarski, 2008). The Tsoo Tablelands and Maxhamish Escarpment formed barriers to westward meltwater drainage as continental ice advanced into the region. Proglacial lakes were impounded in paleovalleys east of the escarpment and tablelands, into which were deposited advance-phase sand and gravel outwash (Huntley and Hickin, 2010).

Advance-phase deposits were subsequently overridden and deformed by the Laurentide Ice Sheet at the glacial maximum (ca. 18, 000 years ago). Along the foothills of the Northern Canadian Rockies, mountain glaciers and the Cordilleran Ice Sheet joined up with the Laurentide Ice Sheet which advanced from centres of continental glaciation to the northeast and southeast (Bednarski and Smith, 2007, **Figure 4**).

During the onset of glaciation and deglaciation, ice-free interior areas likely provided refugia for vegetation and wildlife; and migration corridors for ancestral North Americans as alternatives to coastal routes (cf. Perego et al. 2009).

Figure 4 Ice Sheet (2003) original 8 x 10 inches; oil on canvas; private collection

Topography and drainage patterns were greatly modified during the phase of maximum ice cover. Maxhamish Lake and numerous smaller basins were deepened or excavated when continental (Laurentide) ice and subglacial meltwater scoured older glacial deposits and weak bedrock (**Figure 5**). Bedrock had an important influence on the iceflow dynamics: the presence of weak siliciclastic bedrock would have resulted in deformable, lubricated conditions at the glacier sole (Boulton, 1987; Fisher *et al.*, 1995; Boulton, 1996; Hindmarsh, 1997; Stokes and Clark, 2001; van der Meer *et al.*, 2003; Evans, 2005; Rose and Hart, 2008).

Figure 5 Ice Carved Lake (2007) original 9 x 16 inches; acrylic on canvas; private collection

Drift thicknesses in excess of 5 m are observed in major valleys (cf. Smith and Lesk-Winfield, in press). Drift cover thins to less than 2 m over bedrock on the Maxhamish Escarpment and on the Tsoo Tablelands. Tills contain proximally derived Cretaceous siliciclastic sedimentary rocks; but also distal exotic igneous and metamorphic clasts from the Canadian Shield exposed hundreds of kilometres to the northeast (**Figure 6**).

Glacially sculpted landforms up to several kilometres in length but generally less than 50 m high (drumlins, fluted till ridges and furrows) indicate tills were deposited beneath an active, wet-based Laurentide Ice Sheet (**Figure 7**). Ice flowed in from the northeast and southeast, and then continued westward into the Liard River basin and southwest over the Tsoo Tablelands toward the Northern Rockies. Drumlinized terrain is most pronounced south of the Petitot River and west of the Maxhamish Escarpment where ice flowed uphill and thick accumulations of till were deposited over soft bedrock and advance-phase sediments (Huntley and Hickin, 2010). Numerous small ridges drape streamlined bedforms in cross-cutting patterns. These features are interpreted as crevasse fillings and minor moraines deposited shortly after drumlinization ended or as ice retreated from the map area (cf. Bednarski, 2008). Their mapped distribution implies that ice margins receded to the northeast in the Petitot valley, and to the southeast in the Fort Nelson valley. Till- and bedrock-walled subglacial meltwater channels (tunnel channels), esker systems and numerous kettle lakes on either side of the Maxhamish Escarpment and Etsho Plateau suggest drainage routes established under full glacial conditions were maintained while stagnant glacier ice remained in lowland areas (cf. Boulton et al., 2009) Eskers are composed of glaciofluvial sand and minor gravel, and likely exploited pre-existing crevasse patterns beneath the ice sheet (Huntley and Hickin, 2010).

Figure 6 Erratic with Hummocky Cross-Stratification (2007) original 10 x 10 inches; acrylic on canvas; private collection

Figure 7 Landform Assemblages: Flutes, Moraines, Glacial Lakes and Meltwater Channels (2007) original 8 x 10 inches; oil on canvas; private collection

Ice retreat began some 16,000 years ago with eastward retreating Laurentide, Cordilleran, and stagnant ice masses initially blocking regional drainage (Dyke et al., 2003; Dyke, 2004, Bednarski, 2008). As a result, an extensive system of proglacial lakes was created in the Laird, Fort Nelson and Petitot valleys, linked by spillways that drained meltwater northward into the Mackenzie River basin until at least 10,500 years ago (**Figure 8**). Glaciolacustrine deposits draping till and bedrock indicate lakes had surface elevations of ~610 m and 420 m above sea level (Huntley and Hickin, 2010). Following lake drainage, late Pleistocene glacial spillways continued to drain meltwater from retreating glacial margins. These channel valleys are now occupied by the underfit Fort Liard, Fort Nelson and Petitot rivers.

Late during deglaciation and into the Holocene, changes in regional drainage base-levels led to episodes of channel incision and aggradation, resulting in the formation of terraces along most stream and river valleys. Observations from 2003 and 2009 field seasons suggest forest fires are a key trigger for landslide activity on slopes. Stream networks in lowland watersheds are prone to disruption by beavers, and to a lesser extent, humans (Huntley and Hickin, 2010).

Figure 8 Mackenzie Valleyscape (2007) original 10 x 14 inches; oil on canvas; private collection

During the Holocene (10, 000 years ago to present), slopes and stream networks have been modified by forest fires, beavers and eventually human activity. Pulses of fluvial terrace building followed initial valley incision by the Liard, Fort Nelson and Petitot rivers. Most streams and rivers have alluvial terraces <5 m above active floodplains consisting of gravel overlain by silt and sand (Huntley and Hickin, 2010). Charcoal is observed in dug pits, suggesting forest fires may have contributed to periods of local fluvial aggradation (Clement et al., 2004). Landslides are common where bedrock outcrops form escarpments, or where shale or fine-grained glacial deposits are exposed along steep cutbanks. Poorly drained clay-rich till on the plateaux and glaciolacustrine sediments in lowland areas are covered by extensive peat-lands and fens (Huntley and Hickin, 2010).

Geoart Influences and Geoscience Outreach

Paintings presented here show the influence of: 1) *Impressionism* in use of broken brush-strokes, tilted perspective and holistic composition; 2) *Post-Impressionism* and *Surrealism* in use of colour, texture and symbols; 3) *Abstract Expressionism* and *Imagist* works through use of large fields of pulsating colour to evoke geological and psychological landscapes; and 4) *Environmental Art* in that the knowledge gained and emotions evoked by the content of each painting hopefully influences viewer perception and understanding of the form and function of the natural environment.

GEM-funded geoscience research and outreach in northeastern British Columbia is providing government agencies, industry, universities and the public access to a wide range of secure and reliable geoscience data. Paintings and art cards developed as part of the Yukon and Liard Basin Project describe regional landscapes and geomorphic history from an artist's perspective and contribute to the geoscience knowledge base in a manner that is more accessible to non-scientists (cf. Huntley, 2006). The glacial history presented here supports the proposed sequence of events described by other workers (e.g., Mathews, 1980; Rutter et al., 1993;

Lemmen et al., 1994; Duk-Rodkin and Lemmen, 2000; Smith, 2000, Bednarski and Smith, 2007; Bednarski, 2008, Hartman and Clague, 2008).

Geoart is an initiative to increase public awareness and appreciation of the landscape, climate change, geohazards, sustainable use of natural resources, and the role of geoscientists in society. It is an attempt to encourage government agencies, industry partners and communities to evaluate their relationship with Planet Earth through geoscience and art. Original works are in private collections or on loan to GSC offices in Calgary and Vancouver. A range of end-users, including resource explorationists, geotechnical engineers, land-use managers, terrestrial ecologists, archaeologists, geoscientists, community leaders and the public will benefit from the essential baseline geoscience information presented here. Annotated geoart cards accompany selected paintings and are available at the GSC-Vancouver bookstore.

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