Term Project Part-1

The Quaternary Geology and Regional Analysis of The Abitau Lake Area, Northwest Territories.

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**Introduction**

The designated map sheet is situated within the geographical coordinates of 106°00’00’’W to 108°00’00’’W longitude and 61°00’00’’N to 60°00’00’’N latitude. This area lies just above the northern border of Saskatchewan, as depicted in Figure 1. It is a part of the extensive Canadian Shield, specifically falling within the confines of the Rae Province. The Canadian Shield is renowned for its ancient geological formations and diverse topography.

The region is characterized by its rugged terrain, numerous pristine lakes, and vast boreal forests. It is relatively sparsely populated and experiences challenging climatic conditions, particularly during the winter months.

A map of canada with a square in the middle

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Figure1. The black box outlines our map area.

Notable features near our map area are Lake Athabasca to the southwest and the impressive Great Slave Lake to the northwest.

A map of a country

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Figure2. The Yellow box shows the general region analysed to make our interpretations.

The predominant rocks in the region are granite gneiss, with small areas of granite intrusions. The Abitau Lake map area boasts distinctive and characteristic physiographical features that reveal its unique geological history. The region is marked by excessive drift cover, which includes the presence of drumlin fields and parallel esker systems, testifying to past glacial activities. Notably, there are 14 parallel flowing subglacial meltwater corridors that traverse the area, spaced at intervals of 5 to 15 kilometres and typically extending 1 to 4 kilometres in width. Within these corridors, one can observe the presence of either hummocky glaciofluvial deposits or terraced glaciofluvial deposits, as well as trains of hummocky till. Bedrock outcrop is most extensive in the western portion of the map, with smaller outcrops also found on the eastern side. The map area is predominantly covered by a characteristic and homogenous thin till, which serves as a testament to the geological processes that have shaped the landscape over time. These features collectively provide insights into the region's glacial history and the interplay between ice and meltwater in shaping its topography.

**Objective:**

Our primary objective is to conduct a comprehensive analysis of the Quaternary Geology in the Abitau Lake area, subsequently leveraging this analysis to provide insights into the area's larger geological framework. To effectively attain this overarching goal, we have established a set of specific, interconnected objectives aimed at achieving a more thorough understanding of the region's geological history.

Objectives for the Abitau Lake Area Quaternary Geology Analysis:

* ***Interpretation within Geological Context:*** Interpret the findings and insights obtained from the Quaternary Geology analysis in the broader geological context, connecting local geological phenomena with regional and global geological processes.
* ***Focus on Holocene and Wisconsin Glaciation:*** Emphasize the Holocene epoch while also delving into the preceding Wisconsin Glaciation period, which significantly influenced the geological evolution of the area.
* ***Notable Formation Examination:*** Examine the origin and placement of notable geological formations, including eskers and drumlins, to elucidate the reasons for their specific locations within the Abitau Lake map area.
* ***Integration of Geological Data:*** Integrate geological data collected from various sources, utilizing not only primary field data but also data from existing geological research, to create a comprehensive and coherent understanding of the area's geological history.
* ***Event Timeline Construction:*** Construct a well-supported event timeline in the geological history of the Abitau Lake area by harmonizing the geological data with information from diverse sources. This timeline will offer a structured narrative of the area's geological evolution, providing a clear and connected view of its history.

**Methodology**

Methodologies for Geologic Analysis in the Abitau Lake Area:

* ***Map Sheet Analysis (and accompanying spatial data):***
  + The initial point of contact for the assignment involved a meticulous examination of the map sheet's Legend, Scale, and Rock descriptions.
  + Systematic categorization into three subcategories and further subcategorization based on the age of the unit and composition. Each unit's characteristics were then assessed in terms of frequency, shape, size, and homogeneity within the map area.
  + In-depth analysis of physiological features and their location on the map, utilizing trends and formation types compiled from the legend.
  + Recognition and documentation of differentiation in boulder size and concentration within the mapped units.
* ***QGIS (Quantum GIS):*** Utilized for precise elevation, surface area, and proportion calculations of map units, providing spatial quantitative information crucial for a comprehensive geological analysis.
* ***Various Research Papers and Lecture Content:*** Integrated for the interpretative phase of the assignment, leveraging these sources to describe the geological history and regional processes in proximity to or within the analysis area.

**Analysis of the Map Sheet:**

The primary landform assemblages in the region are initially categorized into three groups, which include rocks from the Quaternary (Holocene) formed in a non-glacial environment, those from the Wisconsin Glaciation (most recent glaciation) created in a proglacial or glacial setting, and the Pre-Quaternary rocks.

In the Quaternary (Holocene) period of the Abitau Lake area, distinct geological formations are discernible, primarily classified into two groupings: Alluvial Sediments and Organic Undifferentiated Deposits. The Alluvial Sediments, including plains, fans, and terraced deposits, are predominantly situated in the northwestern corner of the map. Characterized by sands and gravel with varying thickness, often exceeding 2 meters, these formations give rise to fans, floodplains, and elevated benches. On the other hand, the Organic Undifferentiated Deposits manifest as a scattered, nearly continuous sheet spanning the entire map area. Comprising peat and various fibrous organics with a thickness ranging from 1 to 5 meters, these deposits foster the creation of numerous bogs and fens, particularly in low-elevated regions near lakes and rivers. Additionally, various unmapped peat regions have been identified, contributing to the rich and diverse geological tapestry of the region.

During the Wisconsin Glaciation Period, a significant phase marked by extensive glacial activity, various tills were deposited over the Abitau Lake area due to the flow of ice sheets and glaciers over an extended period. The deposits from this period can be categorized into three subcategories: Glaciolacustrine, Glaciofluvial, and Glacial Deposits.

Glaciolacustrine deposits, encompassing beach, deltaic, nearshore, veneer, and blanket sediments, are scattered throughout the map in the remnants of ancient glacial lakes and ponds.

Glaciofluvial Deposits, exhibiting a consistent southwest flow pattern, are primarily confined to subglacial meltwater corridors and valleys. These deposits manifest as thin, sinuous layers featuring a diverse array of sediments, including Outwash Plain, Hummocky, Esker, Ice-Contact, and more.

The main grouping, Glacial Deposits, dominates the map area, with till deposits, generally less than 5 meters thick, being prevalent beneath the active ice. Till Blanket Sediments and Till Veneer cover extensive portions of the map, with Till Blanket exhibiting silty sandy to sandy diamicton forming thick drapes streamlined into drumlins, flutings, and crag-and-tails. Till Veneer, similar to Blanket, presents a boulder surface and covers with 10-40% bedrock exposure.

Other deposits within this grouping include Hummocky Till, Ridged Moraine, Boulder Fields, and undifferentiated Till. Notably, the exotic lithology Dubawnt Supergroup, sourced from the northeast corner of the map area, is variably present in low concentrations throughout the entire map, adding to the geological complexity of the region.

The Pre-Quaternary group consists of only bedrock deposits and can be found in the Western corner of the map. They are not concentrated in one region but rather are dispersed all over the western region of the map. Some deposits of bedrock can be seen in the Eastern region of the map as well. The bedrock consists of undifferentiated and metamorphosed felsic to intermediate intrusives, with major mafic dykes trending NW-SE and N-S. The landscape of the Abitau Lake area is marked by the presence of distinctive geological features such as striations and roches moutonnées. These formations emerge as a result of the exposure of a thin till cover, ranging from 10% to 40%, on uplands, in subglacial meltwater corridors, and in close proximity to eskers. The interplay of these elements gives rise to prominent crags, contributing to the formation of crag-and-tail ridges within the streamlined terrain. Notably, these geological phenomena bear a chronological imprint dating back to the Archean to Paleoproterozoic periods, underscoring the enduring impact of glacial processes on shaping the terrain over geological epochs.

A map of the land

Description automatically generated with medium confidence

Figure 3. Shows the superficial geology of the map area. The arrows depict striation data which generally follow a Southwest trend.

A black screen with white text

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Figure 4. This acts as a legend for the map sheet given below (figure 5)

A pink and green background

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Figure 5. The major surficial units have been grouped and are represented here.

|  |  |  |
| --- | --- | --- |
| Unit | Average Elevation (above sea level) | Percentage coverage of Map area |
| Glaciolacustrine Deposits | 488.739 m | <1% |
| Glaciofluvial Deposits | 475.423 m | ~8% |
| Glacial Sediment Deposits | 480.914 m | ~62% |
| Alluvial Sediments | 459.289 m | <1% |
| Organic Undifferentiated Deposits | 462.239 m | ~27% |
| Bedrock | 472.273 m | ~3% |

**Interpretation:**

A map with different colored lines

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Figure 6. Simplified glacial flow directions and relative chronology in the Abitau Lake area (NTS 75-B) derived from small-scale erosional ice-flow indicators and trends of streamlined landforms. The main ice flow is to the southwest

Upon closer examination of the overall geology in the area, it becomes immediately apparent that the Last Glaciation played a pivotal role in shaping the geological history of this region. Clear traces of glacial retreat and ice divide are discernible in the form of prominent landforms, including Eskers, Roches Moutonnees, Kames, Drumlins, and Crag-and-tail formations. Notably, the formation of Crag-and-Tail features provides insightful clues about the direction of the glacier's movement, as the tail portion consistently faces downwards indicating the ice flow direction. Similarly, the orientation of Drumlins, with their elongated axes parallel to the glacier's flow, further contributes to our understanding of the glacial dynamics. These unmistakable clues collectively point to a Region Ice Flow Chronology that predominantly follows a southwest direction.

To delve into the Quaternary Geology, our initial focus is on the Alluvial Sedimentary Deposits, which are sparsely scattered, with the most substantial concentration located in the northwestern corner of the map. These deposits, formed by rivers depositing materials, indicate the presence of a river system in the area during the last glaciation, leading to the creation of floodplains and fans at the mouths of small streams. The sediments, initially entrapped in the glacier, followed the flow influenced by ice and meltwater during deglaciation from the Keewatin Ice divide to the northeast. Other streams formed during this process, often resulting in valleys with deep incisions that trace the original glacier meltwater flow. While the valleys were initially shaped by tectonic actions, continuous water flow over the years has eroded and sculpted them, ultimately leading to the deposition of Alluvial Sediments in the map area. Eskers, though influenced by pre-existing topography, sometimes override it.

Contrasting with the Alluvial Deposits, the primary Quaternary deposits are the Organic Undifferentiated deposits, forming an extensive, nearly continuous sheet scattered throughout the entire map, intermixed with other rock units. These deposits predominantly occupy low-elevation areas, following the same glacial path as all rock units in the region, tilted diagonally from southwest to northeast. Generally overlying glaciolacustrine sediments or till, these Organic Undifferentiated Deposits, primarily peat, fibrous organics, and soft muck, are prevalent in bogs and fens. Their composition and distribution point to ongoing surface and groundwater input in these ecosystems.

Placing this geological narrative within the broader context of North America requires delving into the region's ancient history. During the Archean age, the Churchill Province rocks in this area predominantly comprised granite gneiss, punctuated by small areas of granite intrusions. This geological foundation originated from significant tectonometamorphic intervals that induced deformation and metamorphism across the northern Hearn and Rae regions. Subsequently, the glacial period unfolded with the formation of the massive Laurentide ice sheet, which blanketed most of Canada. Its eventual melting triggered basal sliding, regelation intrusion, subglacial sediment deformation, and internal deformation across the entire Canadian expanse.

This locale stands as a representative microcosm of Northern Canada, characterized by scattered lakes adorned with glacial deposits overlaying till remnants from the colossal ice sheet that once dominated the country. Traces of its icy path extend southward to California and reach as far north as the Innuitian Ice Sheet. The Keewatin ice divide, situated northwest of the map area, played a pivotal role in establishing the diagonal relationship between the two ice sheets. It is due to this divide that the Laurentide glacier flowed southwest, depositing the array of sediments and till meticulously scrutinized in the analysed region.

**Conclusion:**

In conclusion, an intricate geological history unfolds in Map 350, situated in the southeastern part of the Northwest Territories bordering Saskatchewan. The pervasive influence of the Keewatin ice divide emerges as a significant precursor to the Quaternary period, orchestrating the southwest-directed basal sliding of the Laurentide ice sheet.

Zooming into the Quaternary era, a distinctive feature dominates the landscape—Organic Undifferentiated Deposits. This category takes precedence over Alluvial Sediments, constituting the majority of the Quaternary narrative. These organic deposits, comprising peat, fibrous organics, and soft muck, overlay till and glaciolacustrine deposits, define the predominant Quaternary history in the form of bogs and fens. The geographical distribution of these deposits aligns with the lowest-lying areas, mainly ancient riverbeds, lakes, and ponds, providing a rich tapestry of the region's recent geological past.

Tracing the remnants of rivers in reverse of the glacier's direction unveils a discernible pattern—the absence of pre-Quaternary bedrock, except for the northeastern corner of the map. This conspicuous absence underscores the extensive erosion and transport processes that have shaped the landscape predominantly in a southwest direction. In synthesizing these insights, the complex geological chronicle of Map 350 comes to light, highlighting the interplay of ice, water, and time in sculpting the intricate topography of this unique region.

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