Granular Resource Requirements for Proposed Mackenzie Valley Pipelines:

Technical Papers and Workshop Proceedings

Sponsored by:
Northern Oil and Gas Action Program (NOGAP) Project A4:
Granular Resources Inventory and Management

NOGAP Project Manager:
R.J. Gowan
Department of Indian Affairs
and Northern Development (DIAND)

Prepared by:
R.J. Mahnic and T.J. Fujino
Stanley Associates Engineering Ltd.

June, 1993

Stanley

SECTION 3.

TECHNICAL PANEL "A"

SOURCES OF INFORMATION ON GRANULAR RESOURCES

SURFICIAL GEOLOGY MAPPING OF THE MACKENZIE TRANSPORTATION CORRIDOR

Alejandra Duk-Rodkin, Ph.D.

Research Scientist, Terrain Sciences Division
Geological Survey of Canada, Calgary, Alberta

ABSTRACT

The surficial geology mapping of the Mackenzie Valley Transportation Corridor was undertaken by the GSC in 1971-1973. Two A-Series maps cover the northern part of the Corridor, while the southern Corridor is covered by 11 maps. The maps include terrain evaluation for engineering purposes, sources of aggregate (sand and/or gravel), geomorphic processes, natural hazards (landslides), thickness of drift, and ground-ice content. The maps also include a comprehensive glacial history of the region that helps to determine problematic areas for engineering evaluation.

Most of the Quaternary sediments in the Mackenzie Valley are of glacial origin. During advance and retreat of the Laurentide ice sheet, glaciofluvial sand and gravel were deposited on the glaciated surfaces. Particularly important sources of aggregate are former deltas built into glacial lakes. Glaciofluvial complexes, kames and eskers are mostly related to long periods of ice sheet retreat. Glaciofluvial channels are also excellent sources of gravel and sand. Former glacial lake sediments and some morainic sediments have high ice content, and thus are unsuitable for any type of construction.

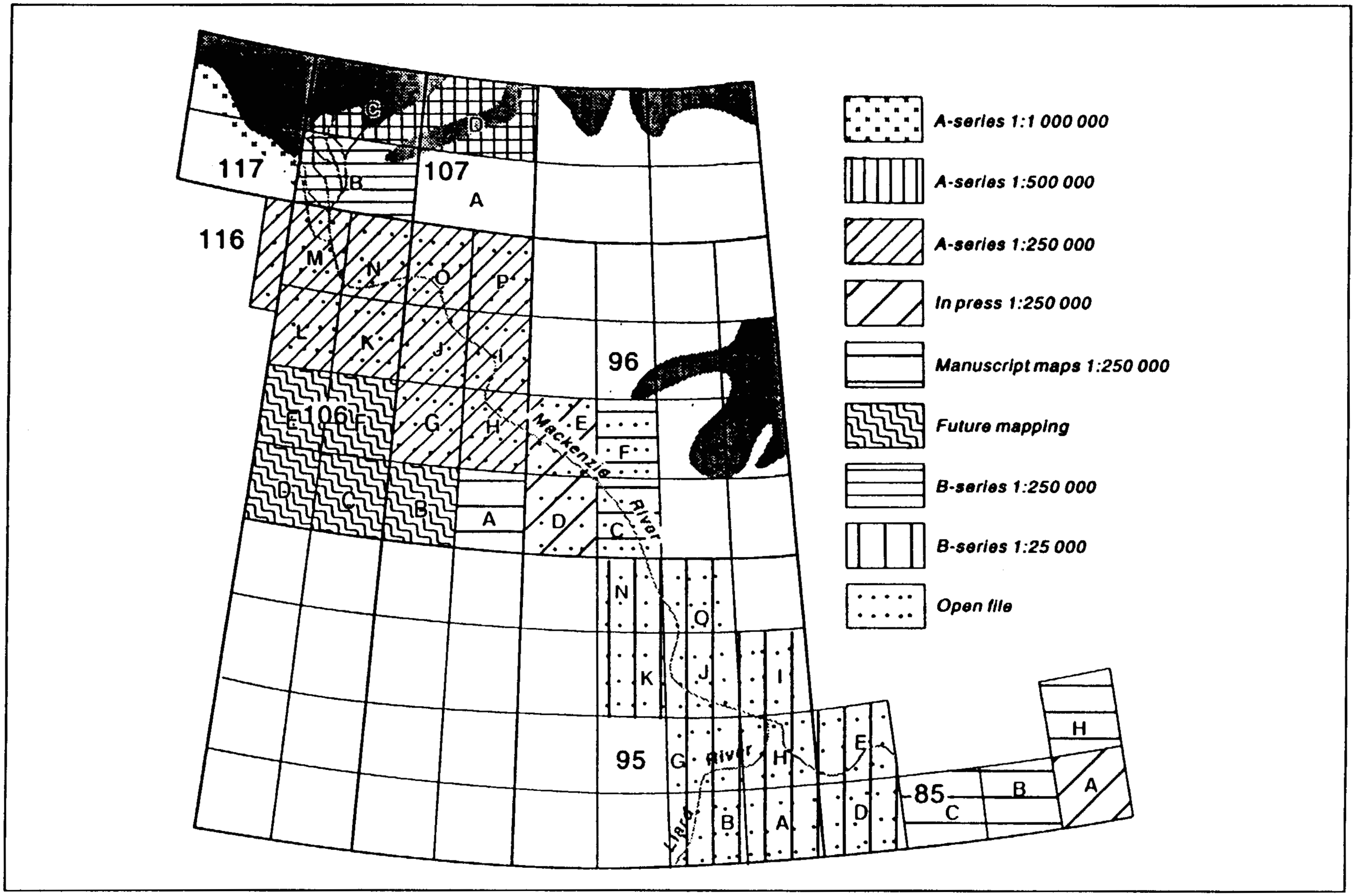
Introduction

Surficial geology studies in the Mackenzie Valley began in the late 1960s as part of "Operation Norman". The oil and gas pipeline proposal for the Mackenzie Valley initiated a series of studies within the Mackenzie Valley transportation corridor including studies of surficial geology. This mapping resulted in 35 Open File maps being completed in three years at 1:125,000 scale (Figure 1). The Mackenzie Valley Corridor was divided into three regions: northern (7 maps), central (16 maps) and southern (11 maps). Maps covering the three regions have been upgraded to A or B Series. Those of the northern region have been published as A-Series at 1:1,000,000 and 1:250,000 scales and B-Series at 1:250,000 scale and the southern region as B-Series at 1:125,000 scale. Mapping of the south part of the corridor has been expanded to the east to cover areas south of Great Slave Lake. These maps will be published as A-Series at 1:250,000 scale. Mapping of the central part of the corridor was begun by Duk-Rodkin in 1985. When the complete series of maps in the central region is finished it will total 19 maps published as A-Series at 1:250,000 scale.

The maps of the central part of the corridor were compiled from various sources of information including airphoto interpretation, field work, and seismic data (obtained from oil companies such as Amoco, Aquitane, Chevron, Dome, Imperial, Mobil, Shell, Sun, Western Decalta and others). Additional information on surficial geology and granular materials was obtained from Canadian Arctic Gas Pipeline, Foothills Pipe Lines, Dempster Lateral Gas Pipeline Project, Ripley, Klohn & Leonoff, EBA Engineering Consultants, Public Works Canada and others.

These maps contain information that have two main uses: 1) scientific, and 2) applied. Scientific information includes a comprehensive glacial history of the region. Glacial limits, erratics, meltwater channels, moraines, ridges, kames, and eskers are shown on the surficial geology maps and enable the user to understand past glacial movements. Applied information is of a geotechnical nature. Granular materials, quality of deposits for construction, geomorphic processes, natural hazards (slides), thickness of drift and ground ice content are some of the characteristics described in the extended legend on the back of the map sheets.

Figure 1. Surficial Geology Mapping: Mackenzie Corridor



Terrain Evaluation

Glaciofluvial channels and moraine belts associated with ice margins are often important sources of aggregate materials. Other sources include kames, glaciofluvial plains and terraces. Deltas deposited into glacial lakes are a source of sandy material rather than gravel, except where they were derived from mountainous terrain. Moraine plain areas were rarely associated with major ice margins, but may have scattered gravel deposits related to minor meltwater channels and/or eskers.

Following deglaciation, climatic conditions resulted in the formation of permafrost and associated active layer development. Processes resulting from active layer dynamics include retrogressive thaw flow slides that are particularly common in glaciolacustrine sediments. Up to 500 metres of down cutting by streams in the Canyon Ranges has caused major landslides, particularly in the foothill regions.

Relevant geotechnical information contained on the GSC surficial geology maps includes the location of granular deposits of glaciofluvial, morainic, lacustrine and alluvial origins.

1) Glaciofluvial deposits

Glaciofluvial plains and terraces are good construction sites where the material is gravel rather than sand. Glaciofluvial hummocks and eskers are a good source of gravel and some sand. Small unmapped deposits may also occur in association with minor meltwater channels.

2) Moraine deposits

Generally, moraine deposits provide good construction sites. When vegetation is removed there is potential for subsidence due to thawing of ground ice. The ice content can be up to 25%. Where the moraine cover is thin it can be removed and the underlying bedrock used for rip-rap. Areas of rolling moraines usually have a high ice content at depth and result in differential subsidence of up to 3 metres due to thawing of segregated ice masses. Most of the hummocky moraine units also have high gravel content (60-70%) and may be used as aggregate.

3) Lacustrine deposits

Forest fires or other disturbance of vegetation may cause active layer detachment slides followed by retrogressive thaw flaw slides. These occur commonly in glacial lake sediments. These deposits are also very susceptible to gullying and not recommended for any type of construction.

4) Alluvial deposits

Alluvial plains and terraces may be a source of aggregate where underlain by gravel rather than sand. Certain alluvial plains have thermokarst depressions and ice wedges due to high ice content (up to 50%). When the vegetative cover is removed the ice wedges melt, forming polygon-shaped depressions. Terraces are good construction sites. Alluvial deposits are also subject to periodic flooding; particularly alluvial fans which are generally unsuitable for any type of construction.