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SURFICIAL GEOLOGY AND GEOCHEMICAL SAMPLING IN THE GRAND FALLS TO GLENWOOD AREAS (NTS 2D/13, 2D/14, 2E/3)

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ABSTRACT

The surficial geology between Grand Falls and Glenwood was mapped in support of ongoing mineral exploration activities in the area. Samples of diamicton were collected for geochemical analyses to augment existing data in north-central and northeastern Newfoundland.

The study area was completely glaciated during the last glacial period that affected Newfoundland. The main ice-flow direction was between the northeast and the north, toward the Bay of Exploits. An early eastward ice flow, and a later local eastward ice flow have been identified, although they had little impact on dispersal patterns of the surficial sediment. This regional north to northeastward ice flow molded the bedrock and dispersed the surficial sediment, and should be the ice flow taken into consideration in any drift-exploration program.

The sediment is dominated by a single unit of diamicton, 2 to 5 m thick, although areas south of Grand Falls have up to 10 m of sediment. Sediment colour and texture commonly reflect the underlying bedrock geology. Areas of hummocky moraine found on the southern part of the Grand Falls map area and scattered elsewhere indicate ice stagnation. The diamicton may be far-travelled and should be used with caution in sampling programs. Major valleys contain sand and gravel, either derived directly from melting glaciers, or subsequently reworked by postglacial fluvial systems. This sediment was transported along different flow paths to glacial sediment and should be considered separately in any drift-exploration program.

The geochemical analyses of the samples collected in the field commenced in 1997; the release date for these results is planned for fall 1998.

INTRODUCTION

During the 1997 field season, the surficial geology was mapped and a collection of samples for geochemical analyses was undertaken between Grand Falls and Glenwood. The object of the study was to detail the area's Quaternary history in support of mineral exploration activities, and to interpret the regional geochemical data, through the definition of sediment dispersal patterns. The study will provide an important link in geochemical data coverage between areas to the east (Batterson and Vatcher, 1991; Scott, 1994) and the west (e.g., Sparkes, 1984; Klassen, 1994; Davenport *et al.*, 1996).

The distribution and character of the Quaternary sediments and landforms, and the ice-flow directional indicators have been mapped. The maps derived from these data are useful in mineral exploration activities and provide data on sediment dispersal patterns, as well as defining suitable sediment sampling media for drift-exploration programs.

LOCATION AND ACCESS

Field work was conducted over three 1:50 000-scale NTS map areas located in central Newfoundland: Grand Falls (NTS 2D/13), Mount Peyton (NTS 2D/14), and the southern part of Botwood (NTS 2E/3) (Figure 1). Access to much of the area was by truck or by all-terrain vehicle using paved roads, or roads constructed for logging. The southern parts of the Grand Falls map area, the central and southern parts of the Mount Peyton map area, and small areas in the Botwood region were accessible only by helicopter. Some roads on the topographic maps were either completely overgrown, or the bridges were washed out and could not be crossed.

BEDROCK GEOLOGY AND PHYSIOGRAPHY

Rocks within the study area increase in age from east to west (Figure 2). The oldest are Cambrian to Middle Ordovician mafic to felsic volcanic rocks of the Victoria Lake Group situated south of Diversion Lake, and north of West Lake

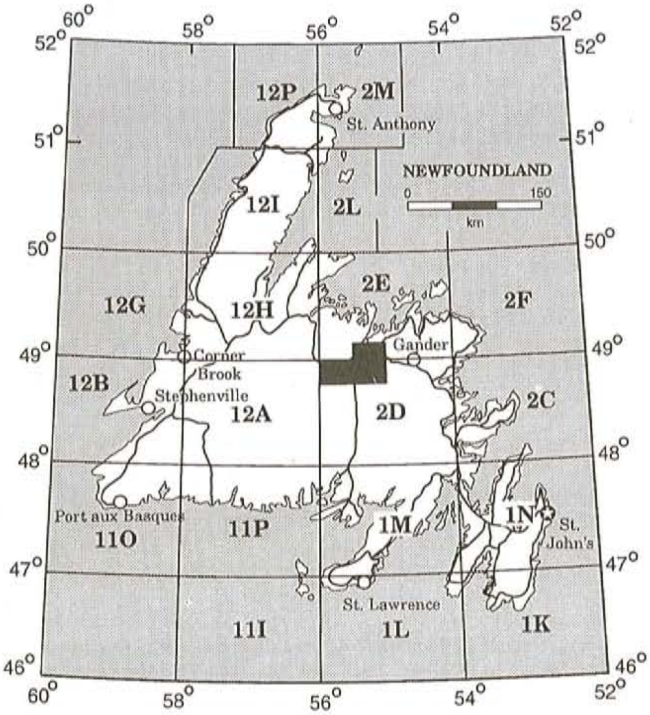


Figure 1. *Location of study area.*

(Kean and Mercer, 1981). To the east are Late Ordovician and Early Silurian turbidite sandstone, shale and conglomerate, and associated submarine mafic volcanic rocks. There is a wide belt of Silurian sandstone, siltstone and conglomerate of the Botwood Group that extends eastward from Stony Brook valley to the Rattling Brook valley and northward toward Botwood. The youngest rocks in the area are those of the Silurian–Devonian Mount Peyton Intrusive Suite. These rocks define the Mount Peyton batholith that occupies most of the Mount Peyton NTS map area. The western and northern parts of the batholith are a grey, fine- to medium-grained gabbro, and the eastern and southern parts are a pink, biotite granite (Dickson, 1992).

Mineral exploration activity is centred in areas underlain by volcanic and sedimentary rocks west of the Botwood Group, and along the contact between the Botwood Group and the Mount Peyton Intrusive Suite. Much of the area between Lemotte's Lake and Diversion Lake was staked in 1997; gold is the main target of the exploration.

Generally, the area has a rolling topography dissected by northeast–southwest oriented valleys (Plate 1). The physiography is controlled mainly by the bedrock. Areas underlain by the Botwood Group are more rugged than those areas to the east and west. Hills are commonly oriented northeastward, reflecting bedrock lineations. Mount Peyton (482 m asl) is the highest point in the study area. The area is dissected by several northeast–southwest-oriented valleys, including Northwest Gander River valley in the east, and the Rattling Brook, Sandy Brook and Stony Brook valleys that flow northeastward into the Exploits River valley. The Exploits River flows eastward to Grand Falls, downstream of which it flows northeastward to enter the ocean in the Bay of Exploits, northeast of Bishops Falls.

GEOCHEMICAL SAMPLING

A detailed diamicton sampling program was conducted. Sample spacing was about one sample per 2.25 km^2 in areas of good access. In areas where helicopter support was required, sample spacing was about one sample per 4 km^2. Approximately 850 samples were collected, mostly from the C-soil horizon. The finer than 4ø (0.063 mm) fraction will be analyzed for a large suite of elements that will include gold and base metals. Samples are currently being processed and data will not be available until later in 1998. They will be integrated with data collected during previous surveys by the Geological Survey of Newfoundland and Labrador from adjacent areas.

PREVIOUS WORK

Vanderveer and Sparkes (1980) provided a brief overview of the glacial geology of the Grand Falls map area, as part of a regional sampling for a till-geochemistry project centred on the Central Volcanic Belt. The ice-flow directions described in the Vanderveer and Sparkes (1980) study were later re-examined and refined by St. Croix and Taylor (1991), who identified three ice-flow events in the Grand Falls area.

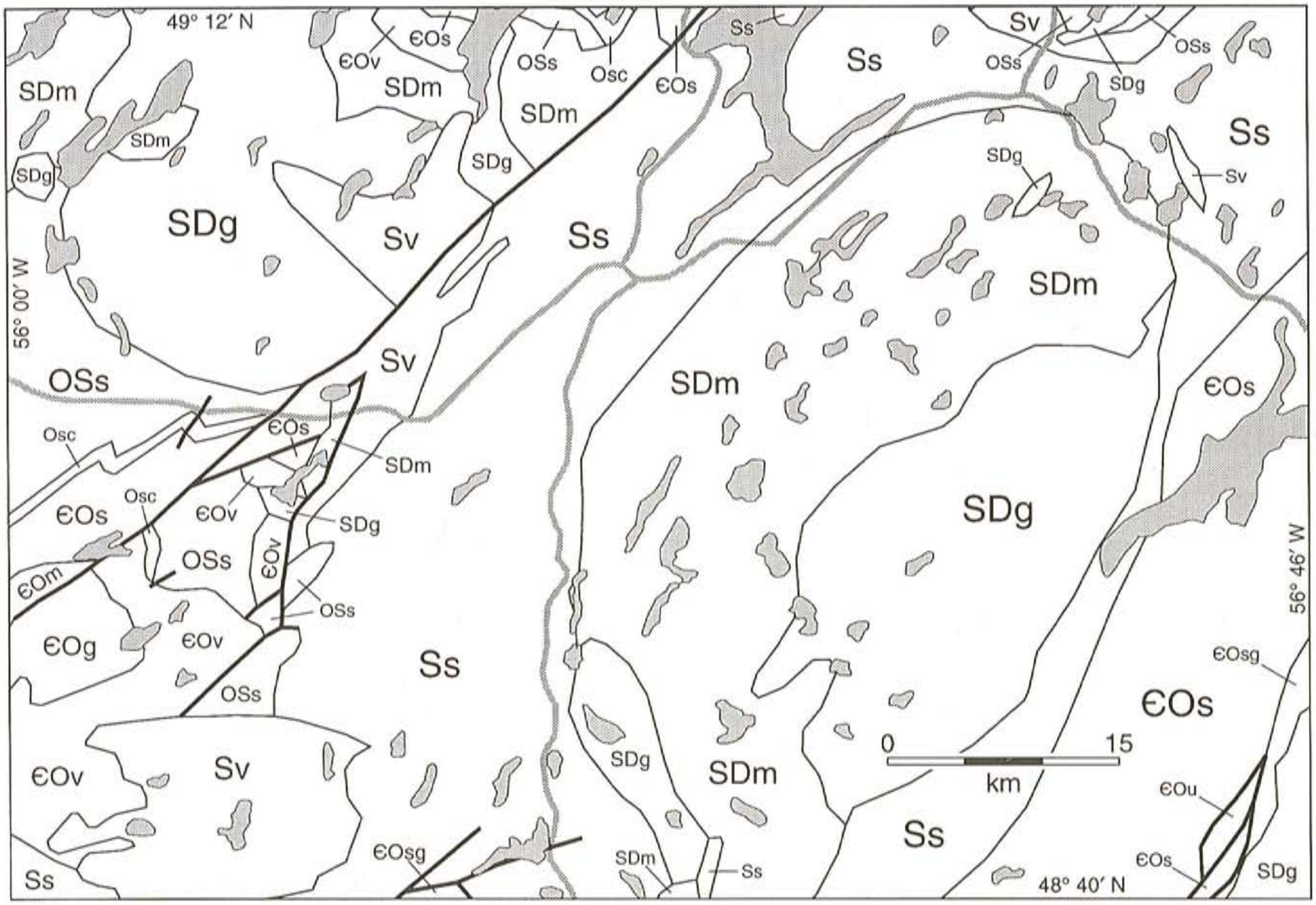
A regional surficial geology map by Liverman and Taylor (1990) shows the broad distribution of surface sediments. MacKenzie (1993) produced a more detailed map of the Botwood map area, although the area south of the Trans-Canada Highway was not field checked.

Marine pelecypod shells (*Hiatella arctica*) found below the dam at Bishops Falls at 3 m asl were dated at 11 400 ± 100 BP (GSC-3687) (Vanderveer *in* Blake, 1983). This date provides a minimum date for deglaciation of this part of the coast. A similar date of 11 600 ± 210 BP (GSC-2134) on *Balanus* sp. shells was recorded from the Exploits River farther downstream (Grant *in* Blake, 1983). The marine limit at the coast was about 58 m asl, recorded from a delta surface at Laurenceton, near Botwood (MacKenzie and Catto, 1993). A date of 11 500 ± 110 BP (GSC-5527) on *Hiatella arctica* shells reported by Liverman (1994) from Botwood may relate to this highstand. Marine sediments have not been mapped from upstream of the Bishop Falls dam.

RESULTS

ICE-FLOW HISTORY

Striation mapping records the pattern of ice flow across the area. The data collected during this project supplements



LEGEND

Silurian and Devonian

SDm	Gabbro and diorite intrusions, including minor ultramafic phases
SDg	Gabbro-syenite-granite-peralkaline granite suites, and minor unseparated volcanic rocks

Silurian

Sv	Bimodal to mainly felsic subaerial volcanic rocks (part of Botwood Group)
Ss	Shallow marine and non-marine siliclastic sedimentary rocks (Rogerson Lake Conglomerate, part of Botwood Group)

Late Ordovician and Early Silurian

OSs	Turbidites consisting of sandstone, shale and conglomerate

Middle and Late Ordovician

Osc	Black shale, slate and argillite

Cambrian-Ordovician

ЄOsg	Quartzite, psammite, semipelite and pelite; includes mafic and felsic volcanic rocks
ЄOs	Marine siliclastic sedimentary rocks, including sandstone, shale and argillite; minor volcanic and intrusive rocks (Davidsville Group, part of Victoria Lake Group)
ЄOv	Submarine mafic, intermediate and felsic volcanic rocks (part of Victoria Lake Group)
ЄOg	Granitoid intrusions
ЄOm	Mafic intrusions, including granitoid rocks, gabbro and diabase
ЄOu	Ultramafic rocks

SYMBOLS

Geological boundary .... ——— Fault .... ━━━

Figure 2. *Bedrock geology of the study area (*after *Colman-Sadd* et al., *1990).*

Plate 1. *An oblique aerial photograph of the area northeast of Sandy Brook. Much of the lowland area is covered by a blanket of till, up to 5 m thick. The sediment was deposited by northeast-moving ice.*

data collected during earlier surveys to provide a foundation for an ice-flow history of the area. Three separate phases of ice flow were identified (Figure 3). An early eastward ice flow is recorded by striations over the northern part of the area; bedrock outcrops were rarely stossed by this flow. A later, regional north to northeast ice flow is shown by striations and bedrock stossing on outcrops. Striations from the earlier flow are commonly preserved on the lee side of bedrock outcrops. Flow directions are generally more northward on the Mount Peyton and Botwood map areas; these were produced by ice flow into the Bay of Exploits. The most recent ice-flow event was an eastward flow identified on the north half of the Grand Falls map area and the northwest part of the Mount Peyton map area. This flow is recorded by fine striations overprinting those striations produced by the regional north to northeast ice-flow event. This most recent eastward flow did not mould bedrock outcrops.

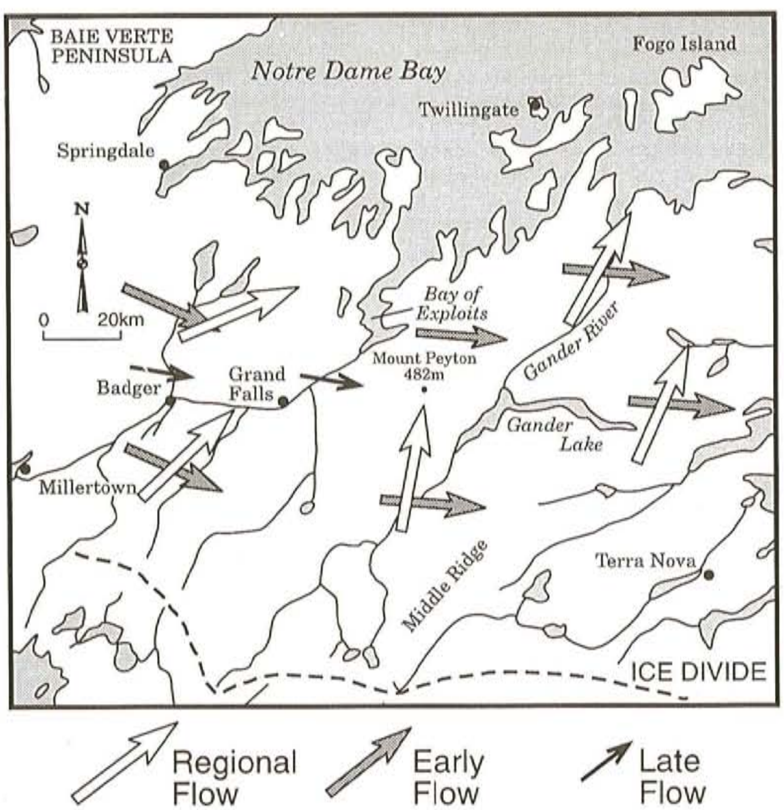


Figure 3. *Summary of ice-flow history of north-central Newfoundland (modified from St. Croix and Taylor, 1991).*

This pattern of ice flow is similar to that described by St. Croix and Taylor (1991). The early ice flow likely had its source within The Topsails, although no erratics were found to confirm this. The early eastward flow is recorded across much of northern Newfoundland (Taylor and St. Croix, 1989; Batterson and Vatcher, 1991; Scott, 1994). Northward ice flow is recorded across much of north-central Newfoundland flowing from an ice divide postulated by St. Croix and Taylor (1991) as lying between Middle Ridge (south of Gander Lake) and Meelpaeg Lake (Figure 3). The source of the late eastward ice flow is uncertain. It is found in areas adjacent to the Exploits River valley and may reflect topographic control on ice flow, and drawdown into the Bay of Exploits.

SURFICIAL GEOLOGY

Surficial mapping consisted of 1:50 000-scale aerial photograph interpretation of landforms and surficial sediment verified through a detailed ground survey. Most of the area is covered by diamicton (Figure 4). Sediment texture and colour is controlled by the underlying bedrock geology. Red, silty to sandy, diamictons are common in areas underlain by the Botwood Group, whereas diamictons covering the Mount Peyton Intrusive Suite are brown to grey and coarse grained. Diamictons mostly contain clasts of local origin, although non-local clasts are common. Transport directions for exotic clasts, where determined, were northeastward. Clasts derived from the rocks of the Botwood Group, for instance, are found over the northwest margins of the Mount Peyton Intrusive Suite, and red conglomerate clasts from the Rogerson Lake conglomerate were found up to 10 km northeast of its source area, south of Diversion Lake. The diamictons overlying the Mount Peyton Intrusive Suite commonly contain no exotic clasts derived from south of the batholith. This would suggest that the ice divide was north of the southern edge of the batholith.

The surface morphology of areas underlain by diamicton is commonly rolling, with few constructional forms noted. The overburden thickness is variable, ranging from thin and discontinuous over the rocks of the Mount Peyton Intrusive Suite, to continuous blankets over much of the area south of Grand Falls. In this latter area, overburden thickness is estimated at between 5 and 10 m, based on backhoe pits and drill-core data.

Areas of hummocky moraine (Plate 2) along the southern part of the Grand Falls map area have hummocks that are commonly 3 to 5 m high, and 40 m diameter. These features may indicate areas of ice stagnation (e.g., Gravenor and Kupsch, 1959) or were formed at the base of active ice (e.g., Hambrey *et al.*, 1997). These features are composed of diamicton, but were not examined in detail to determine their environment of deposition. If they represent supraglacial sedimentation, they may contain far-travelled material, and are generally unsuitable for sampling as part of a mineral exploration program. Alternatively, they may be composed of subglacial till, similar to that found elsewhere across the area, and provide a good sample media. Caution should thus be exercised when sampling for geochemical analysis as part of a regional survey.

Areas of non-glacial sediment are generally confined to the valleys. The Great Rattling Brook, Sandy Brook, Stony Brook, and the Exploits River valleys all contain moderately to well-sorted, stratified, sand and gravel deposited in a glaciofluvial or fluvial environment. These are commonly less than 5 m thick in the Sandy Brook, Stony Brook and Great Rattling Brook valleys. These systems were the routes of meltwater during deglaciation. The Exploits River valley contains a series of terraces, reflecting a decreasing base level in response to falling sea level. Sediment within these areas is commonly greater than 10 m thick.

An interesting feature was identified within terrace gravels exposed by a gravel pit near the mouth of Great Rattling Brook (Plate 3). The feature was near vertical, of constant width (about 20 cm) and 440 cm in length, and contained sandy gravel at the edges, commonly showing vertical or near vertical clasts, and a central 7- to 8-cm-wide core of silty sandy gravel, with silt comprising about 10 percent of the unit. The surrounding sediment was a weakly stratified, poorly sorted, sandy gravel. This feature is interpreted as a ice-wedge cast. Ice-wedge casts have been described from other areas of Newfoundland (e.g., Brookes, 1971; Eyles, 1977; Liverman and St. Croix, 1989; and Corney, 1993). These features indicate a period of periglacial conditions following deposition of the enclosing sediment. This period may correspond to the Younger Dryas, a cooling episode from about 11 to 10 ka, widely recognized in the recent sedimentary strata in Atlantic Canada.

An area of fossiliferous silt and clay was mapped adjacent to the Exploits River below the hydroelectric generating station at Bishops Falls. These are the same sediments from which Vanderveer (*in* Blake, 1983) collected shells dating 11.4 ka. These sediments indicate that the lower reaches of the Exploits River valley were inundated by the sea during deglaciation, at least as far west as Bishops Falls.

CONCLUDING REMARKS

The area between Grand Falls and Glenwood was completely covered by glacial ice during the Late Wisconsinan. The dominant ice-flow direction was north to northeastward toward the Bay of Exploits. This dominant ice flow molded bedrock outcrops and dispersed sediment; in any drift-exploration program to be undertaken in this area, due consideration must be given to this flows' characteristics discussed in the text. The sediment is commonly 2 to 5 m thick, although areas south of Grand Falls have up to 10 m of sediment. Sediment colour and texture commonly reflect the underlying bedrock geology. Areas of hummocky moraine found on the southern part of the Grand Falls map area, and scattered elsewhere, indicate either areas of ice stagnation or terrains where sediment was deposited under active ice. If deposited supraglacially, the hummocks may be composed of far-travelled sediment and caution should thus be used in any sampling programs.

The major valleys contain sand and gravel, either derived directly from melting glaciers, or subsequently reworked by postglacial fluvial systems. This sediment was transported along different flow paths to glacial sediment and should be considered separately in any drift-exploration program.

Marine sediments were noted close to present river level below the dam at Bishops Falls. These indicate that the lower reaches of the Exploits River valley were inundated by the sea

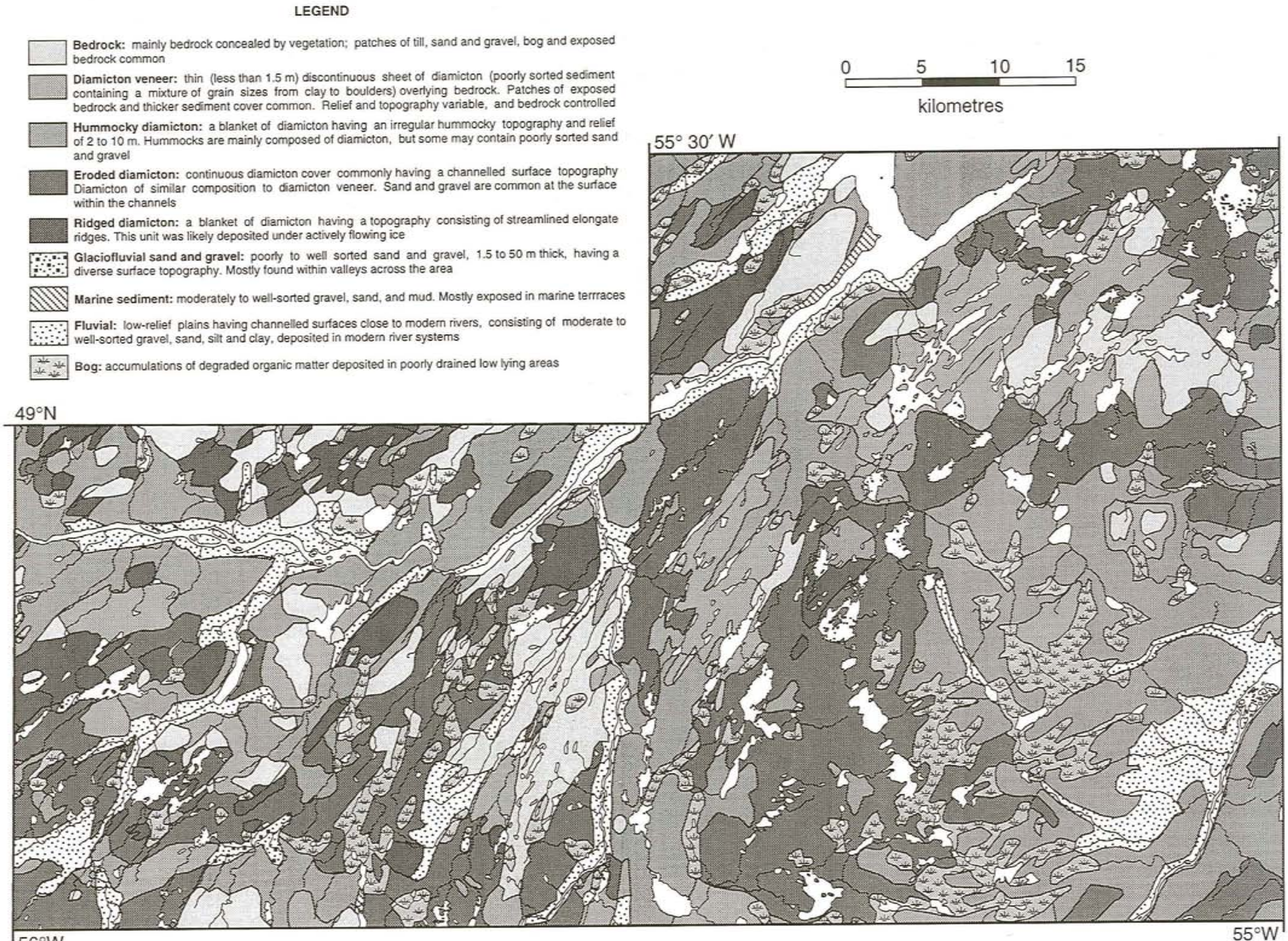


Figure 4. *Surficial geology of the Grand Falls to Glenwood area* (after *Liverman and Taylor, 1990)*.

Plate 2. *An oblique aerial photograph of an area of hummocky moraine found south of Diversion Lake. Areas of hummocky moraine indicate ice stagnation and melting. Interpretation of geochemical data from sediments deposited in this environment must be used with caution in drift-prospecting projects.*

during deglaciation, up to about 10 to 15 m asl. Sediments are commonly fossiliferous and fine grained, and should be avoided during drift-exploration programs.

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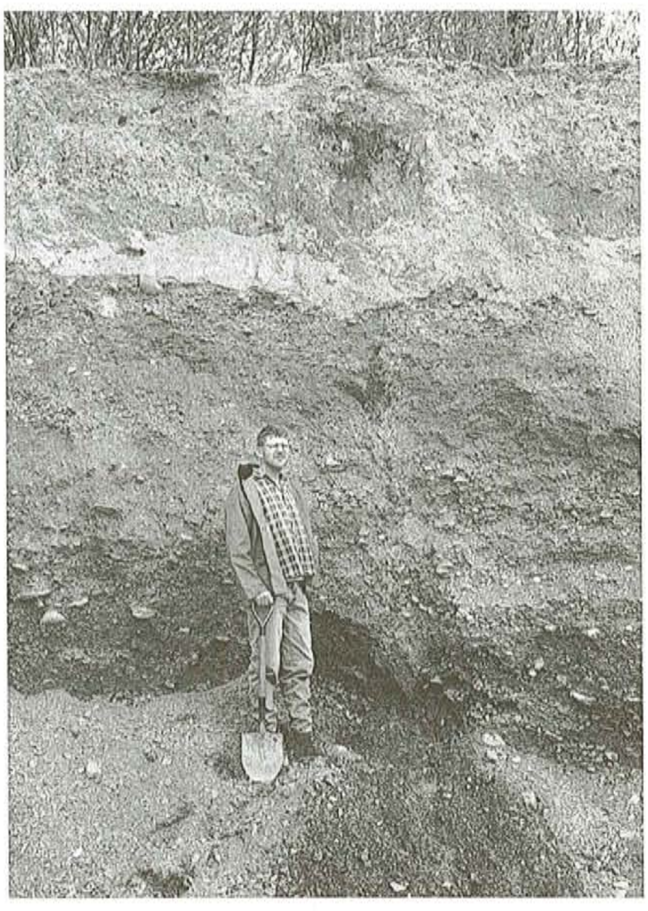

Plate 3. *An ice-wedge cast in terrace gravels above the Exploits River, east of Grand Falls. This feature indicates periglacial conditions sometime after deposition of the gravels. A regional cooling event, termed the Younger Dryas (~11 to 10 ka) is found in other records, and this feature may be related to this cooling period.*

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