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PART 1

REPORTS ON NOGAP REGIONAL STUDIES

Granular Resources Off The Southwest Coast of Banks Island
(NOGAP Project A4-16)

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1.0 Introduction

Despite long sailing distances from present hydrocarbon exploration sites in the central Beaufort Sea, the narrow shelf bordering the southwestern coast of Banks Island has been identified by the Department of Indian and Northern Affairs Canada (INAC) as a prospective area for gravel deposits. Although O'Connor (1983) indicated that more than 50,000,000 m^3 of gravel may exist at suitable depth for dredging between Cape Lambton and Sachs Harbour (Figure 1), the granular resources in this area remain largely unexplored. Between 1981 and 1983, three separate geophysical programs have been carried out by the industry to investigate the surficial geology for gravel deposits off the island coast. The results of two site specific surveys conducted in 1981 and 1982 at the mouth of the Masik and Rufus rivers have been reported to Dome Petroleum by Fortin (1982 and 1984; Figure 1). A detailed evaluation of the regional survey completed in 1983 was prepared by Fortin (1987) on behalf of INAC (A4 NOGAP project; Sub-Project A4-16). The regional survey includes six lines totalling 130 km of seismic data (echo sounder, side scan sonar, sub-bottom profiler, boomer and air gun systems) recorded in water depths oscillating between 10 and 25 m. The present paper summarizes the findings of the 1983 regional survey. This information was presented with more details in Fortin (1987) who constructed three synoptic plates showing both on-shore and off-shore geology (Plates I, II and III; Figure 1).

2.0 On-Shore Geology (Vincent, 1983)

The surficial geology of the coast is dominated by morainal deposits that include three distinct glacial till sheets; the Bernard, the Sachs and the Carpenter tills (Table 1 and Figure 2). The Bernard Till (Unit 2; Figure 2) covers extensive areas of the western region of Banks Island and is present north of Sachs Harbour. This deposit is relatively thin (1-10 m) and comprises a fine-grained matrix. The distribution of the Sachs Till (Unit 12; Figure 2) has been particularly well established in the Sachs Harbour and Masik River areas. The Sachs Till is thin (1-2 m) and includes a sandy matrix with a high fraction of sediments coarser than 2 mm. The Carpenter Till (Unit 15; Figure 2) extends along the coast between Masik River to the south and Middle Lake to the north. The Carpenter Till is characterized

by a sandy and rocky matrix, as well as a significant proportion of gravel and rock fragments. Of particular interest is the "young" morphology of the Carpenter Till which consists of crests of till and ice contact deposits oriented parallel to the coast and separated by kettles. The main till properties are summarized in Table 1. In the near shore area, deposits of borrow materials may originate from erosion and reworking of these three till units, as well as from undifferentiated Quaternary deposits (Unit 1; Figure 2) that include stratified sand and gravel deposited by glacial meltwater at the mouth of the Masik River.

Table 1
Till Properties

Till Units	N	Grain Size (%)				Characteristics
		>2 mm	Sand	Silt	Clay	
Bernard Till (Unit 2, Figure 2)	34	28.7	45.0	33.0	22.0	Blackish colour and fine matrix. Fraction >2 mm: high proportion of sedimen-tary rocks (carbonates, sandstones and chert), small proportion of igneous rocks (diabase and gabbros).
Sachs Till (Unit 12, Figure 2)	3	50.7	61.4	21.8	16.8	Light colour, sandy matrix and high fraction >2 mm. Fraction >2 mm: mainly sedimentary rocks (carbo-nates and sandstones), higher proportion of gabbros than other tills.
Carpenter Till (Unit 15, Figure 2)	1	38.6	46.5	32.2	21.3	Sandy and rocky matrix. Fraction >2 mm: high proportion of gravel and diabase rock fragments. Granitic rocks within the till.

Note: N - Number of samples.

3.0 Discussion on Off-Shore Borrow Prospects

The procedure used to predict the occurrence of aggregate deposits near the seabed is mainly based on qualitative interpretations of seismic data as only six sediment samples were taken along the survey lines. For this reason, the geological inferences propose herein may not be exact at specific sites since only a detailed seabed sampling program can confirm the presence and extent of borrow deposits.

Given the limitations inherent to the dredging techniques used at the present time and in the foreseeable future, eleven target areas have been identified as borrow prospects (Table 2 and Figure 2). Several of the promising sites (high or fair priority) appear to coincide with off-shore extensions of the Sachs Till or Bernard Till and their associated morainic system (Sites B, C, E, J and K). These relatively old deposits may have been reworked at

several times in the past which would have resulted in pockets of well sorted materials lying on a flat seafloor (Figure 3). Another high priority site (Site A) may include glaciofluvial sand and gravel deposited at the mouth of the Masik River. Although gravel resources are likely associated with the off-shore extension of the Carpenter Till, this type of deposits (Site D) has a low potential as a result of its high seabed relief, its young appearance (little reworking) and the presence of numerous erratics (Figure 4).

Recommendations for follow-up studies (Table 2) are made on a site specific basis in order to improve our understanding of the geological setting of each individual borrow prospect and to determine the extent and quality of the granular deposits. In addition, the portion of the shelf between Middle Lake and Mary Sachs Creek is designated for future regional investigations.

4.0 Conclusions

Based on the available acoustical data and a very limited amount of bottom samples, one may conclude that the potential for gravel deposits is important between the mouth of the Masik River and Duck Hawk Bluff (Figure 2). However, the very uneven seafloor relief in certain areas (Carpenter Till) and the complexity of stratigraphic conditions encountered in several places present challenging environmental obstacles to the safe and efficient dredging of these granular resources. In addition, development of these patchy deposits will require accurate horizontal control systems aboard the dredges. The potential for gravel in the surveyed area off Cape Kellett Spit appears to be low because of both the presence of a fine- to medium-grained (silt and fine sand) surficial layer covering this area and the absence of source deposits (till units) for very coarse materials.

With respect to the complex geology, great diversity of source deposits, poor seismic coverage and near absence of ground-truth information, there is an obvious need for both additional high-resolution seismic reflection and refraction data. These surveys will serve to position bottom sediment samples and shallow boreholes at critical locations in order to determine the quality and exact thickness of the granular deposits.

Table 2 - Summary Table of Off-Shore Borrow Prospects

Site	Priority	Prognostic	Constraints to Future Development	Recommended Future Studies[1]				
				Sample	Geo	Mosaic	Photo	Drill
"A"	High	Large volume of well sorted materials (fluvioglacial deposits?). Re-worked sand with some gravel.	Shallow gas might cause difficulties during drilling of deep holes.	(1)	(2)	—	—	(3)
"B"	High	Fair volume of patchy materials (sand and gravel). Till (Sachs?) outcrops. Erratics.	Number of erratics (cobbles and boulders) near seabed may increase toward the Sachs Till outcrops.	(1)	(2)	(3)	(4)	(5)
"C"	Fair	Small volume of thin patches of re-worked materials (sand and gravel) atop a till (Sachs?) surface. Frequent erratics.	Frequent outcrops of an old till surface (poor sorting, high compaction, possibly ice-bearing). Numerous erratics visible on sonograph. Proximity of the coast.	(1)	(2)	(3)	(4)	(5)
"D"	Low	Re-worked materials originating from a young till sheet (Carpenter Till?). Westward fining facies change.	Irregular sea floor. Erratics may be common. Till outcrop (poor sorting, high compaction possibly ice-bearing). Proximity to the coast.	(1)	(2)	(3)	(4)	(5)
"E"	Fair	Patches of re-worked sand with some fine gravel. Frequent out-crops of a fine-grained till (Sachs or Bernard Till?).	Frequent outcrops of a till surface (poor sorting, high compaction, possibly ice-bearing). Patchy nature of good granular materials. Possible presence of erratics. Proximity to the coast.	(1)	(2)	(3)	—	(4)
"G"	Low	Thin veneer of re-worked sand with some gravel. Fining facies change away from the source deposit (fine-grained till?).	Occurrence of till outcrops that may include fine-grained units, highly compacted and ice-bearing sediments.	(1)	(2)	(3)	—	(4)
"H"	Low	Thin veneer of re-worked sand with some gravel originating from an old till unit (Sachs or Bernard Till?).	Occurrence of till outcrops that may include fine-grained units, highly compacted soils and ice-bearing sediments. Marginal volume of borrow.	(1)	(2)	(3)	—	(4)
"I"	Low	Lag deposit? Submerged coastal feature?	Geologic origin not well established. Marginal potential?	(1)	(2)	—	—	(3)
"J"	Fair	Thin veneer of re-worked sand with some gravel originating from an old till unit (Sachs or Bernard Till?).	Frequent outcrops of a fine-grained till (Sachs or Bernard Till?) that may include a variety of lithologies, highly compacted soils and ice-bearing sediments.	(1)	(2)	(3)	—	(4)
"K"	High	Large volume of re-worked sand and gravel originating from a frontal moraine (Sachs Till?).	No serious constraints.	(1)	(2)	—	—	(3)

Notes: [1] The recommended future studies should not be conducted simultaneously, but in the order shown. One should proceed with the next step only if the results of the previous step(s) dictate additional works.

Sample: Seabed sampling (grab samplers and corers).

Geo: Detailed geophysical program including precision bathymetry, side scan sonar, sub-bottom profiler, uniboom and deep-tow refraction data.

Mosaic: Preparation of a sea floor mosaic from side scanning imagery.

Photo: Seabed photographs and/or video, diving.

Drill: Shallow geotechnical drilling.

5.0 References

Fortin, G.R. (1982). Marine Bottom and Sub-Bottom Survey, Banks Island Borrow Site, Beaufort Sea. Report submitted to Dome Petroleum Ltd. by Geoterrex Ltd., Project No. 93-15.

_____ (1984). Marine Bottom and Sub-Bottom Survey, Banks Island Gravel Search. Report submitted to Dome Petroleum Ltd. by Geoterrex Ltd., Project No. 93-28.

_____ (1987). Interpretation and Synthesis of High Resolution Reflection Seismic Data from Banks Island Borrow Area. Report submitted to Department of Indian Affairs and Northern Development by H.R. Seismic Interpretation Services Inc., Project NOGAP A4; Sub-Project A4-16.

O'Connor, M.J. (1983). Regional Inventory of Off-Shore Gravel Prospects, Canadian Beaufort Sea. Report submitted to Department of Indian Affairs and Northern Development by M.J. O'Connor & Associates.

Vincent, J.-S. (1983). La Géologie Quaternaire et la Géomorphologie de l'Ile Banks, Arctique Canadien. Commission Géologique du Canada, Mémoire 405, 118 pp.

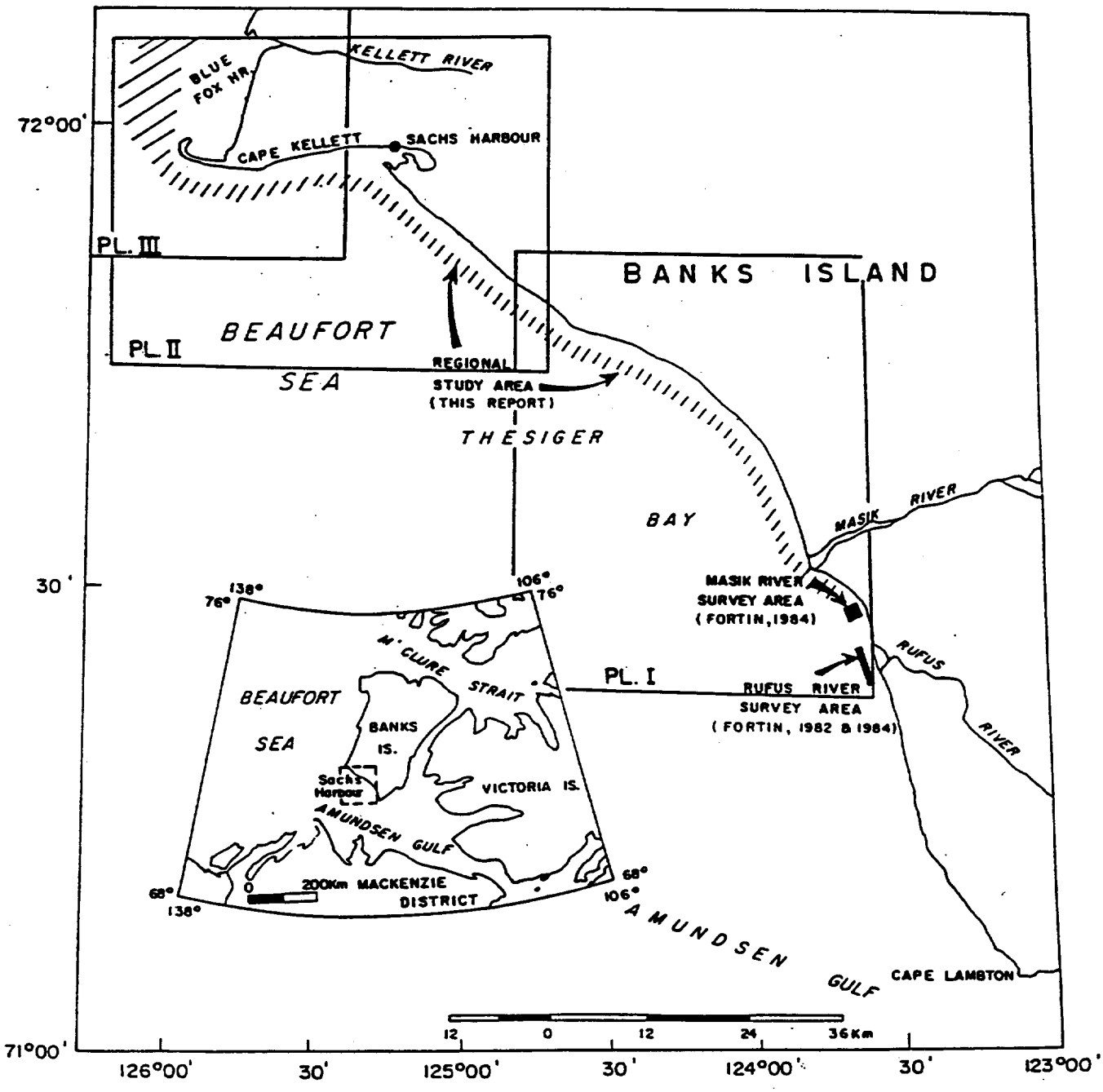

FIG. 1 LOCATION MAP

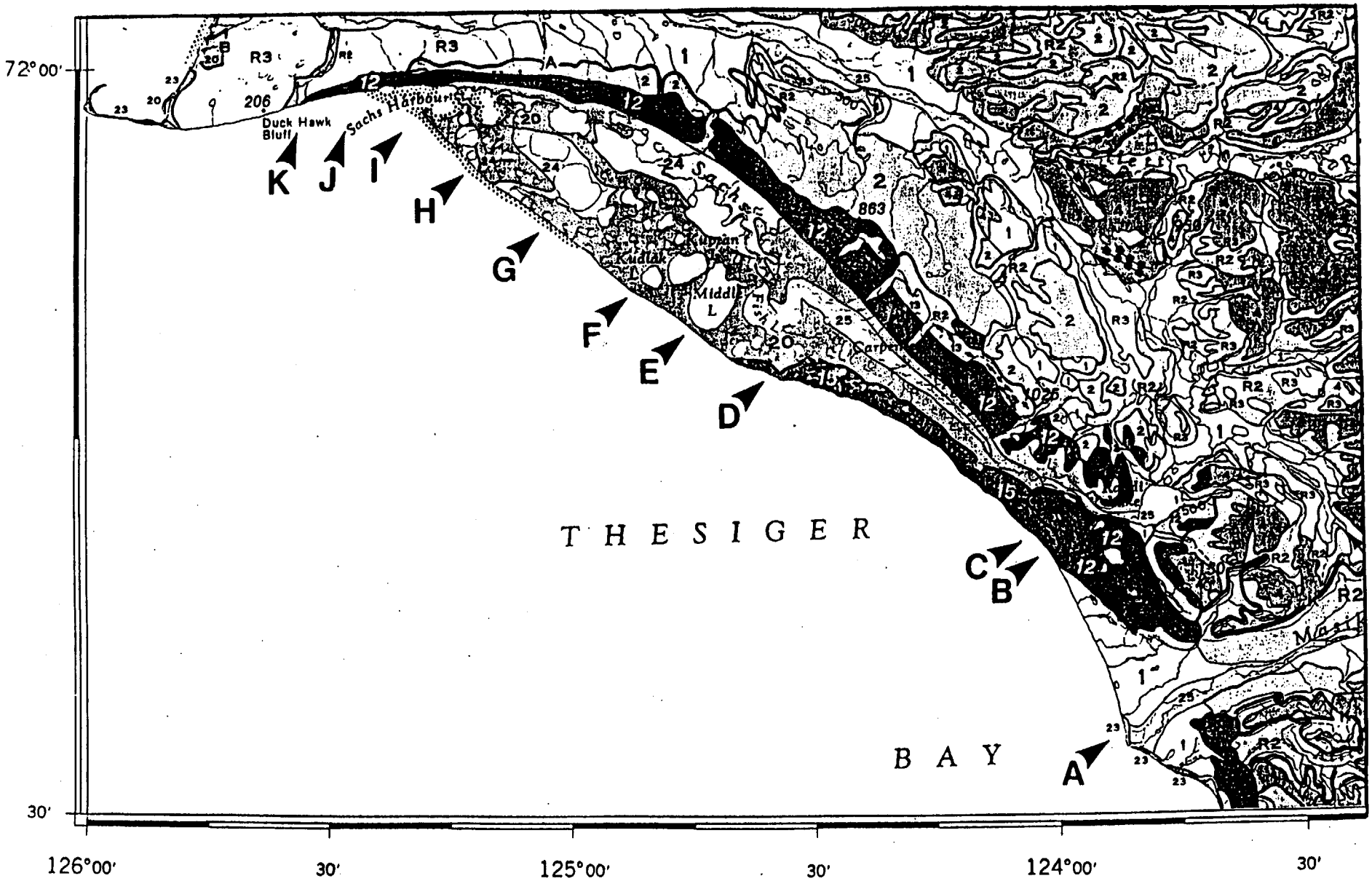

Figure 2. Onshore geology (Vincent, 1983) and approximate location of offshore borrow prospects (Fortin, 1987).

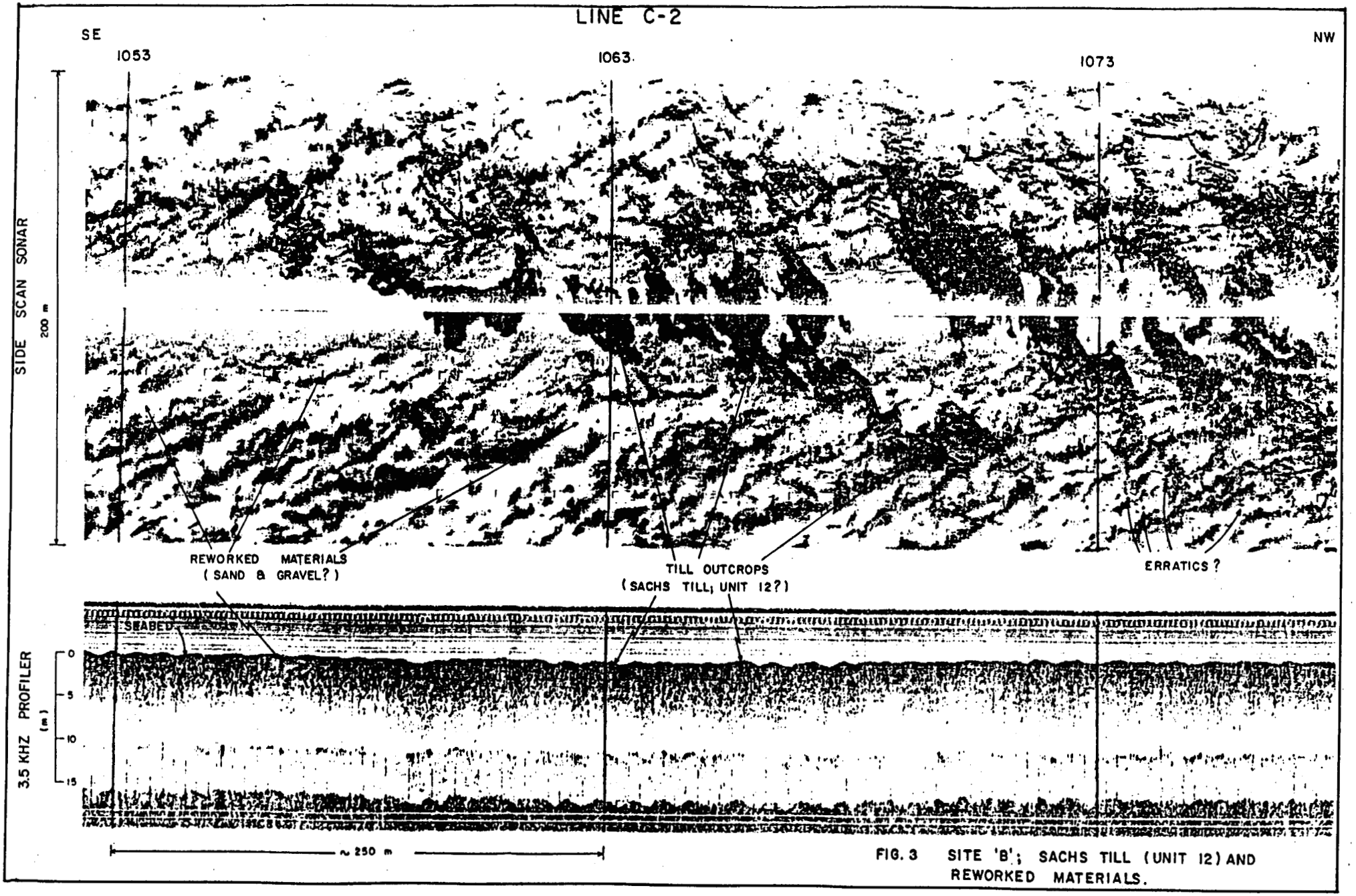

FIG. 3 SITE 'B'; SACHS TILL (UNIT 12) AND REWORKED MATERIALS.

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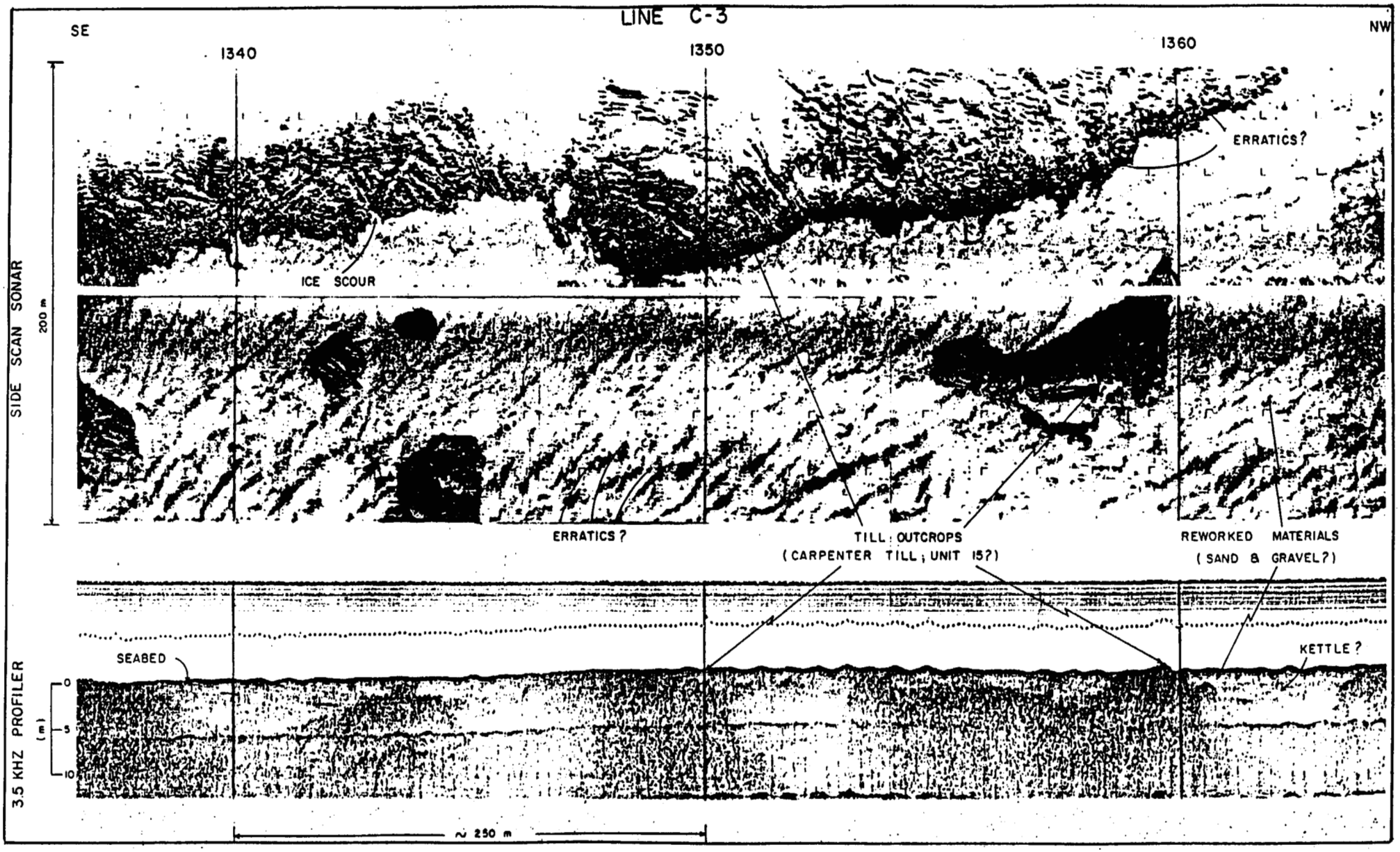
FIGURE 3



CARPENTER TILL (UNIT 15) AND REWORKED MATERIALS **FIGURE 4**