FOUR MARL DEPOSITS WITHIN THE SKEENA RIVER DRAINAGE (103I/16W, 103P/1W, 93M/5E)

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KEYWORDS: Industrial minerals, marl, bog lime, Skeena River, Buccaneer of the North, Gee Kid, Robinson Lake, Wilson Kettle.

INTRODUCTION

Marl deposits have been known from the Skeena drainage, in the Terrace-Hazelton region, since the early 1930s. Several deposits were identified at that time as possible sources of lime for neutralizing acidic soils. Although only minor amounts of marl have been mined, these occurrences have received more attention recently. Marl has a potential use in neutralizing acid mine drainage and in the acidic cycles of mill processes.

The four marl deposits discussed in this article, Buccaneer of the North, Gee Kid/Lime Lake, Wilson Kettle and Robinson Lake are all within a few kilometres of the Skeena River between Terrace and Old Hazelton (Figure 5-3-1). The term marl is used in this report to indicate a friable mixture of greater than 40 per cent calcium carbonate together with insoluble detritus and noncarbonate plant material. The colour is usually white or buff, but grey to brown or black shades occur as the organic content increases. Bog lime is an alternate term for marl.

REGIONAL GEOLOGIC SETTING

The Terrace to Hazelton area lies within the Stikine Terrane, a component of the Intermontane Belt. Lower Jurassic volcanics outcrop over a large area to the south of the marl deposits. In the Bowser basin to the north, Jurassic and Lower Cretaceous siltstones, argillites and greywackes underlie a veneer of Quaternary Fraser glacial land forms which host the marl deposits discussed in this article. The Fraser glaciation, beginning 25 000 to 30 000 years ago, was the most recent glacial advance (Clague, 1984). During this time, coalescent piedmont glaciers moved southwestward through the study region. Commencing approximately 15 000 years ago, as the glacial age waned, the coalescent ice mass downwasted forming several separate glaciers within the Skeena Valley. These isolated glaciers gradually lost mobility and stagnated, leaving behind fluvioglacial deposits and glacial landforms such as kettle depressions and kame terraces as they melted.

BUCCANEER OF THE NORTH MARL DEPOSIT (MINFILE 103I 001)

A marl deposit known as Buccaneer of the North (or Bockner of the North), occurs 46 kilometres north-northeast of Terrace and approximately 1 kilometre west of the Canadian National Railway Ritchie siding on the west side of the Skeena River (Figure 5-3-1). Access is by crossing the river from a sand bench beyond the north edge of the Kwa-tsa-lix Indian Reserve 4 at Klootch Canyon. A trail on the west bank of the Skeena leads 1 kilometre to the deposit. Alternatively, an old road can be followed southwestward from Ritchie siding.

The property was first staked in 1931 and discussed in the British Columbia Minister of Mines Annual Reports for 1931 (p. A72), 1932 (p. A90) and 1935 (p. C34). Duffel and Souther (1964) report that several railcar loads of marl were shipped to Terrace in 1935 and used for soil dressing.

TOPOGRAPHY AND SURFICIAL GEOLOGY

The marl deposit lies at an elevation of 130 metres in an ephemeral kettle lake within an abandoned channel of the Skeena River (Figure 5-3-2). To the east there is a bench 100 metres wide which gives way to kames that rise gradually 50 metres, separating the lake from the Skeena River channel (Figure 5-3- 3).

The glaciofluvial sedimentary cover which blankets the area consists of gravel and sand, thicker than 10 metres, deposited during the waning stages of the Fraser glaciation (Clague, 1984). Postglacial accumulations of alluvium and colluvium flank the glacial deposits on the north, east and south.

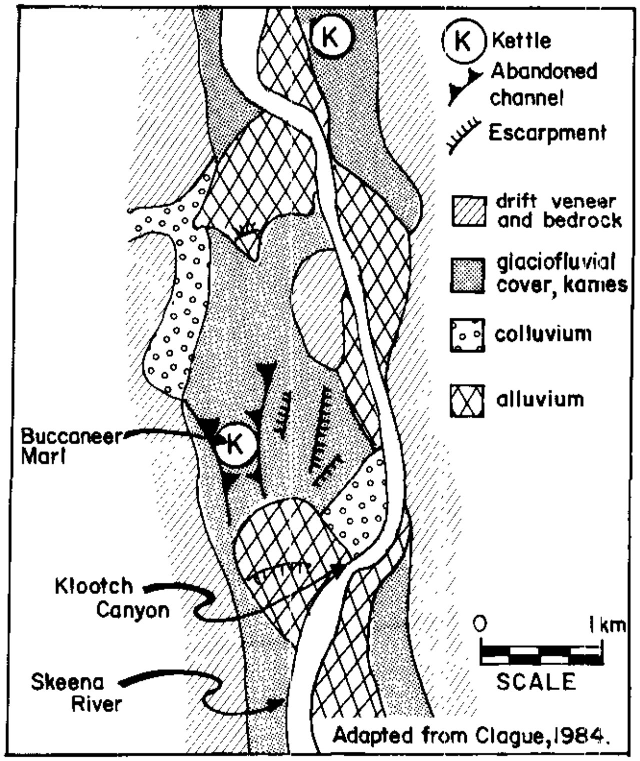

Figure 5-3-1. Geology of the Terrace–Smithers region

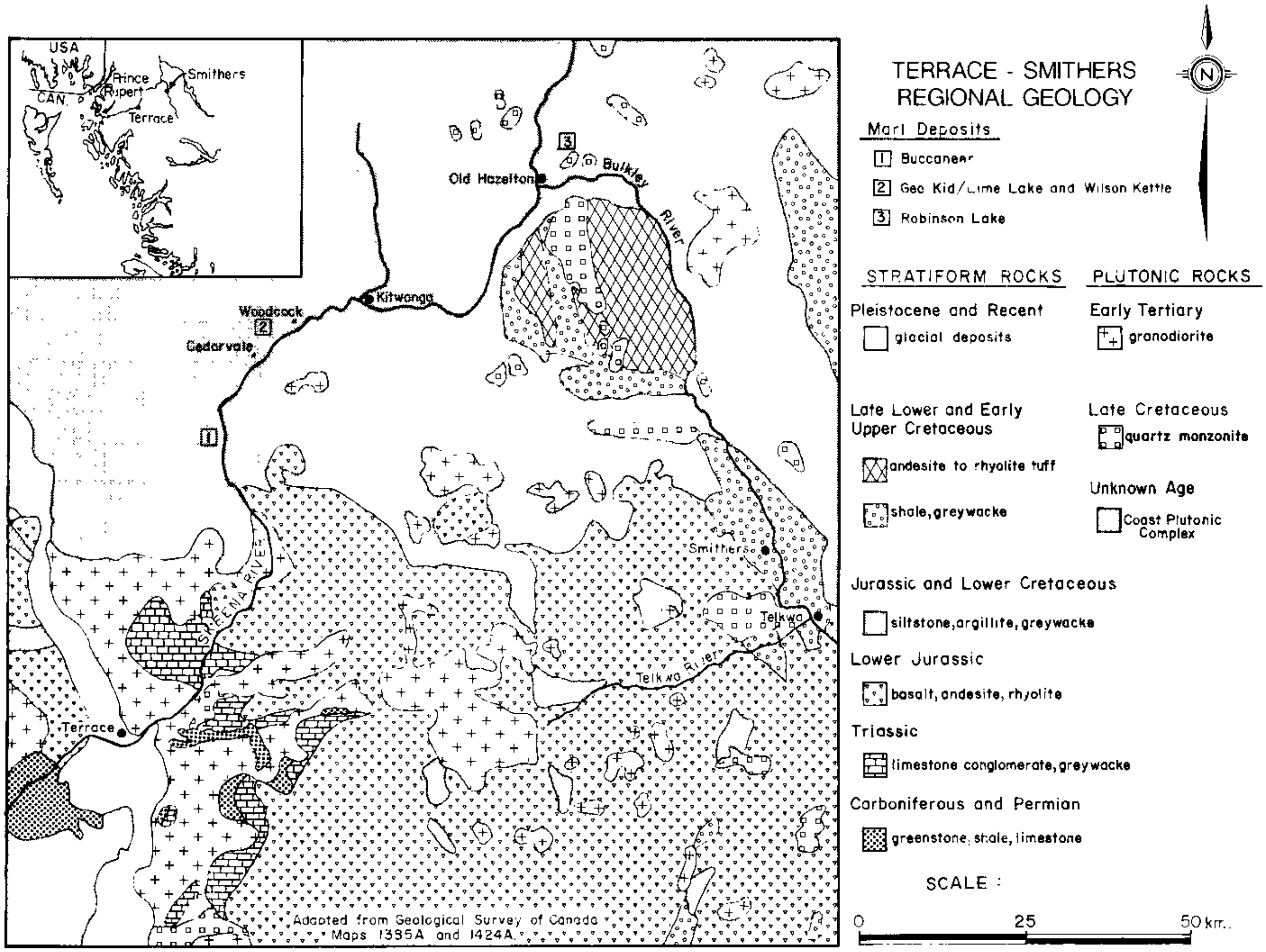

Figure 5-3-2. Surficial geology in the Buccaneer of the North area.

VEGETATION

Aspen and birch fringe the lake amidst a mature stand of lodgepole pine 20 to 30 metres tall. Marsh grasses and horsetails, *Equisetum* sp., fill the intermittent lake site. Nucules from the algal family *Characeae* have been identified (J. White, GSC, personal communication) from the marl and the algae are assumed to be present in the lake.

HYDROLOGY

The deposit lies within a depression that collects runoff locally, and from an intermittent stream (dry at the time of the property visit) which enters in the southwest corner (Figure 5-3-2). An earlier report (B.C. Minister of Mines Annual Report, 1935) indicates that a stream cutting through calcareous argillites to the west of the marl disappears into the glacial debris flanking the meadow. This stream may be the dry creek mentioned above, or may be an additional source of water for the catchment basin which has no known outlet. The water supply appears to have a yearly cycle. In the fall, winter and spring, water collects and then completely evaporates and percolates away through the late spring to early fall.

SIZE

The deposit lies within a depression approximately 110 metres wide by 115 metres long. The marl underlies the depression and extends at least 70 metres beyond it to the south-southeast, beneath a gently dipping bench. The depth of the marl on the bench, in the vicinity of an old dragline cut (Figure 5-3-3), is known to be 1.5 metres for a length of 70 metres. In the 1935 report the marl is described as being 10 metres deep at the eastern end of the bench. The present owner reports that hand drilling has encountered marl to a depth of 9 metres within the depression.

Systematic sampling to define the extent of the marl within the depression and bench has not been attempted. A rough estimate in the 1935 report suggests approximately 65 000 tonnes of wet crude marl could be present in the 90 by 90 by 9 metre bench area based on the marl occupying 0.5 cubic metre per tonne. Using a linear relationship (Figure 5-3-4) between the moisture content of crude marl and tonnes of dry marl per cubic metre, (Macdonald, 1982) an estimate can be made of the dry marl under the bench and depression. A volume of 63 250 cubic metres of marl may exist within the depression assuming dimensions are 110 by 115 by 5 metres.

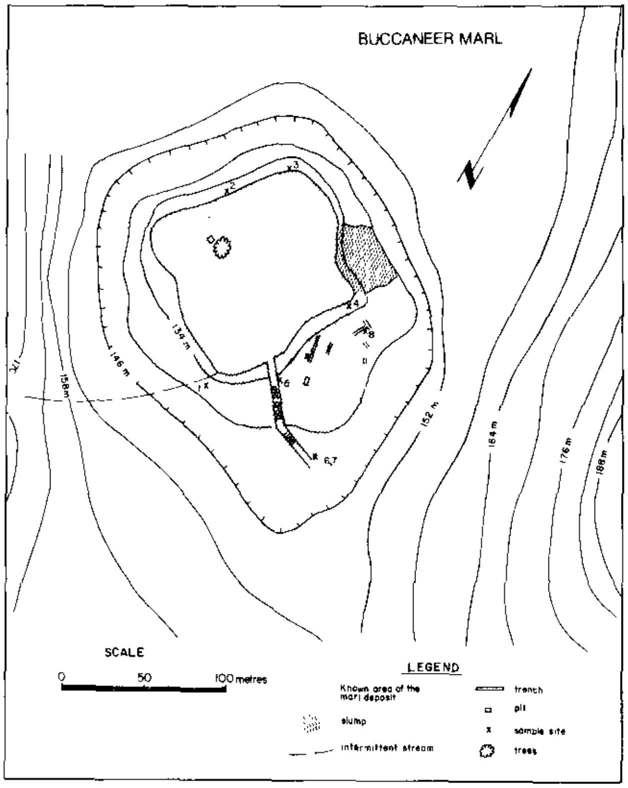

Figure 5-3-3. Topography and deposit configuration of Buccaneer of the North.

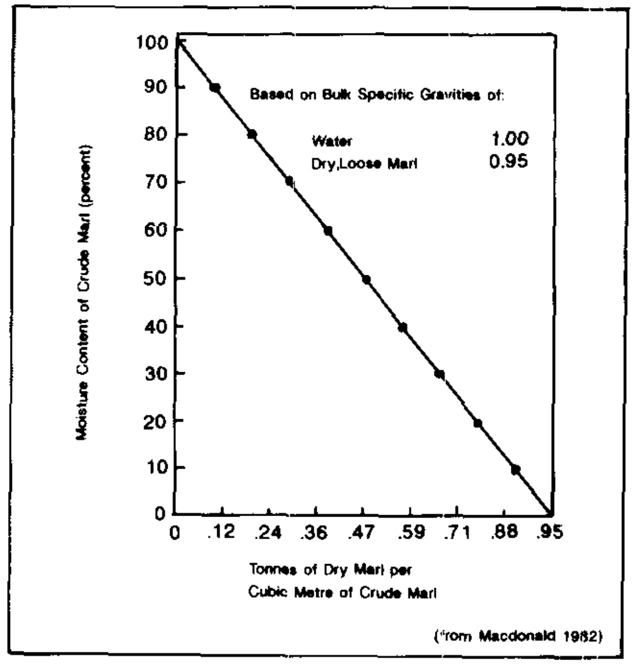

Figure 5-3-4. Estimation of dry marl available in the wet crude.

Assuming a moisture content varying between 30 and 50 per cent then the depression may contain between 30 000 and 41 000 tonnes of dry marl. Again assuming the same variable moisture content, 34 600 to 47 400 tonnes of dry marl may exist on the bench. The deposit may therefore contain between 64 600 and 88 400 tonnes of dry marl in total.

Analysis and Composition

Oxide analyses revealed that the samples are all marls with the total CaO content ranging from 39 to 51 per cent and averaging 45 per cent (Table 5-3-1). The $CaCO_3$ equivalence of these values ranges between 70 and 92 per cent with an average of 82 per cent. Contaminants such as silica, aluminum and iron are present in quantities averaging less than 8, 2 and 0.7 per cent, respectively. Other elements, as determined by spectrographic analysis, are present in amounts ranging from 0.5 per cent to traces. (Table 5-3-2).

Dispersal of the marl in a detergent solution indicated the presence of numerous organics. Root fragments and small wood fragments, some charred, are abundant. Fragments of aquatic mosses as well as pelecypod and gastropod shells are more abundant than *Characeae* nucules or the more rare calcareous charophyte axes (J. White, GSC, personal communication, 1989).

GEE KID/LIME LAKE AND WILSON KETTLE MARLS

Several marl localities are situated about 1.5 kilometres northwest of the Skeena River and approximately 6 kilometres northeast of Cedarvale (Figure 5-3-1). One is known in the literature as the Gee Kid, or locally as Lime Lake. The second is a dry lake bed 750 metres to the southwest of Gee Kid and here named the Wilson Kettle marl. Both are accessible by gravel road from Kitwanga. On the north side of Wilson Creek gravel pit travel west 1 kilometre on a logging road. From here Wilson Kettle is approximately 100 metres to the west, in a depression. Continue on the winding logging road approximately 750 metres north and east to the end of the road; Gee Kid is 200 metres farther to the northeast. The Gee Kid marl was staked in 1936 and discussed by Kindle (1937). The presence of marl in Wilson Kettle has not been reported previously.

Topography and Surficial Geology

Gee Kid lies at 340 metres elevation with the Nass Range mountains rising to the north and west. The marl occurrence is situated 1.5 kilometres north of the Skeena River, on a 1000 by 250 metre bench blanketed with glacial drift more than a metre in thickness. Wilson Kettle is at about 325 metres elevation. Measuring approximately 500 by 300 metres, it is a depression, probably a kettle, in the glacial drift covering the area.

Vegetation

The forest in the vicinity of the Gee Kid occurrence has been clear cut. Mature 30-metre lodgepole pine and spruce with some aspen surround Wilson Kettle which is covered with marsh grasses and has a number of dead spruce near the periphery.

Hydrology and Size

The Gee Kid occurrence collects local runoff in a lake measuring about 230 by 110 metres which drains into the

TABLE 5-3-1
CHEMICAL ANALYSES OF GRAB SAMPLES FROM THREE MARLS*

Field Number	SiO_2	TiO_2	Al_2O_3	Fe_2O_3 (T)	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	BaO	LOI**	SUMS	$CaCO_3$#	CO_2	S	FeO
Buccaneer																	
1	3.33	0.03	0.61	0.31	<0.01	0.55	49.10	0.33	0.22	0.01	0.02	43.16	97.69	87.64	41.0	0.03	0.44
2	14.50	0.18	3.29	1.27	0.01	0.68	39.09	0.77	0.40	0.06	0.04	37.69	97.96	69.78	34.8	0.03	1.32
3	12.50	0.09	2.67	0.74	0.02	0.78	44.61	0.42	0.18	0.06	—	38.04	100.11	79.61	38.5	0.04	1.61
4	13.57	0.18	3.32	1.49	0.02	0.75	39.92	0.78	1.17	0.27	0.04	37.27	98.78	71.25	35.2	0.04	1.24
5	7.61	0.09	1.83	0.78	0.01	0.40	45.54	0.50	0.30	0.04	0.03	41.09	98.22	81.28	37.7	0.03	1.10
6	3.71	0.03	0.78	0.14	0.02	0.97	51.39	0.10	0.04	0.03	—	42.62	99.83	91.73	41.7	0.03	0.73
7	2.70	0.02	0.46	0.28	<0.01	0.50	49.92	0.32	0.17	0.01	0.02	42.13	96.54	89.11	40.1	0.02	0.28
8	5.60	0.07	1.33	0.61	0.01	0.40	47.47	0.43	0.25	0.02	0.03	41.58	97.79	84.73	38.8	0.02	1.06
Average	7.94	0.09	1.79	0.70	0.01	0.63	45.88	0.55	0.34	0.06	0.03	40.45	—	81.89	38.48	0.03	0.97
Wilson Kettle																	
9	8.12	0.05	1.80	0.48	0.03	0.86	42.68	0.32	0.11	0.05	—	45.34	99.84	76.18	40.6	0.38	6.05
Robinson Lake																	
10	63.95	0.85	16.40	6.98	0.06	1.71	0.99	2.22	1.41	0.02	—	5.28	99.87	1.77	1.96	0.06	4.06
11	46.37	0.63	13.79	4.71	0.07	0.99	2.34	1.52	0.90	0.18	—	28.45	99.95	4.18	29.0	0.38	—

Note: Samples 1-9 are an unconsolidated, nongritty, crumbly paste containing organics (detrital moss, root and algal fibre). Field descriptions are:
Sample 1 – light grey, slightly moist, 10% organics
Sample 2 – mottled light and medium green-grey, slightly moist, 10% organics
Sample 3 – mottled light and medium green-grey, slightly moist, 10% organics
Sample 4 – mottled light and medium green-grey, very moist, 10% organics
Sample 5 – light grey, very slightly moist, 5% organics
Sample 6 – white with light grey layers, dry, 15% organics
Sample 7 – light grey, dry, 10% organics
Sample 8 – light grey, dry, 15% organics
Sample 9 – light grey-brown, moist paste, 20% organics
Sample 10 – dark grey, clay rich, gritty, very moist paste
Sample 11 – black, clay-rich, gritty, very moist paste
* all values are percentages
(T) Total Iron
** LOI values (± 2 per cent absolute) are elevated due to the high calcium carbonate content and predominantly represent volatiles such as CO_2, H_2O, Fl and Cl.
# Calcium Carbonate Equivalence

TABLE 5-3-2
SPECTROGRAPHIC ANALYSES OF GRAB SAMPLES FROM THREE MARLS*

Sample	Si	Al	Mg	Ca	Fe	Pb	Cu	Zn	Mn	Ag	V	Ti	Ni	Co	Na	K	W	Sr	Ba	Cr	Ga	Zr
Buccaneer																						
3	7.0	5.5	0.7	>10	1.0	—	Tr	Tr	0.1	—	—	0.06	—	—	0.5	<0.3	—	Tr	Tr	Tr	—	—
6	1.5	2.0	0.4	>10	0.4	—	Tr	Tr	0.06	—	—	0.03	—	—	0.3	<0.3	—	Tr	Tr	—	—	—
Wilson Kettle																						
9	>10	2.0	0.3	>10	0.6	—	Tr	—	0.09	Tr	—	Tr	—	—	0.3	<0.3	—	Tr	Tr	—	—	—
Robinson Lake																						
10	>10	4.0	0.6	0.25	2.7	—	Tr	—	0.1	Tr	—	0.06	—	—	1.0	<0.3	—	Tr	Tr	—	—	—
11	>10	>10	1.6	1.2	7.0	—	Tr	—	0.12	Tr	.02	0.3	Tr	Tr	>2	>2	—	Tr	0.1	—	Tr	Tr

* all values are percentages

Skeena River through an outlet on the southeast side. A beaver dam crossing the northeast section of the lake has raised the water level.

Wilson Kettle is oval in shape, measures approximately 170 by 100 metres and is bisected by a small stream entering on the north and draining to the south toward the Skeena River. It is not known if the lake bed is now permanently dry or whether it floods periodically.

In the time intervening since the field visit, local residents reported that a small beaver dam at the southern end of the area gave way and exposed approximately half a metre of white to light grey marl. This indicates that the marl deposit may extend the 170-metre length of the kettle, but its depth is unknown.

SAMPLING AND ANALYSIS

With the extensive flooding caused by the beaver dam across Lime Lake, the water level has risen to such an extent that sampling can only be done by boat. A boat was not available at the time of the field visit and repeated attempts to sample the present lake shore encountered only gravel.

However, the presence of a high calcium carbonate content in the water is suggested by the abundance of several species of freshwater snails along the present shoreline.

Wilson Kettle was sampled with a shovel in the middle of the northeast end. At this location approximately 50 centimetres of dark brown to black, wet peat overlies a wet light grey to brown marl with abundant organics. The oxide analyses of this sample indicate a 43 per cent CaO content (or 76 per cent $CaCO_3$ equivalence) together with 8 per cent SiO_2 and 2 per cent Al_2O_3 contaminants (Table 5-3-1).

ROBINSON LAKE (MINFILE 93M 103)

Ten kilometres northeast of Old Hazelton a marl deposit is reported in Robinson Lake (Kindle, 1954; Figure 5-3-1). Access is by the Silver Standard/Nine Mile Mountain gravel road which begins 3.2 kilometres north of the Hagwilget bridge. At a point 8.5 kilometres along the Silver Standard road an old logging road provides access on foot to the northeast corner of the lake, 200 metres to the north.

TOPOGRAPHY AND SURFICIAL GEOLOGY

The lake is at 470 metres elevation on the eastern margin of the Skeena River valley. Till greater than 1 metre thick blankets the area and the lake occupies a depression 630 metres long, with an average width of 120 metres.

VEGETATION

Mature 20 to 30-metre spruce surround the lake, except for the northwest section which has been clearcut. Small patches of birch and aspen together with a stand of 30 to 40-metre hemlock and cedar border the northeast shore. Marsh grasses are abundant along the edge of the lake. As well as the grasses, *Sphagnum* sp. moss, Labrador tea, and especially horsetails, *Equisetum* sp., are abundant in the wet northern portion.

HYDROLOGY

Robinson Lake collects local runoff and is drained to the southwest by Two Mile Creek from which the town of Hazelton draws its water. Beaver dams across the northeast and the southwest ends of the lake have considerably raised the water level and created an extensive marshy area to the northeast.

SIZE

Kindle (1954) reports that the shallower parts of the lake are bottomed by marl, particularly in the south where it is at least 4 metres deep. At present the beaver dams have raised the water level to such an extent that the dimensions of the deposit can only be determined by sampling from a boat.

SAMPLING AND ANALYSIS

Attempts to sample the marl along the southeast shoreline encountered a dark grey, clay-rich, gritty paste. Analysis shows about 1 per cent CaO with SiO_2, Al_2O_3, and Fe_2O_3 being the principal components (Table 5-3-1, Sample 10). Another sample was taken in the northeast, above the beaver dam, where a number of mounds of light grey sediment dot the lake bottom. These mounds appear to be deeper sediment, possibly marl, brought to the surface by gases, noticeably rich in hydrogen sulphide. The gas is probably produced from decaying organics deeper in the sediments. Penetrating only 35 centimetres with a shovel, not enough to reach the light grey material, obtained a sample of black, slightly gritty, clay-rich paste. (Table 5-3-1, Sample 11). Although CaO is present, SiO_2, Al_2O_3 and Fe_2O_3 are the major constituents (Table 5-3-2).

DISCUSSION

MARL FORMATION

Marl deposits usually have four features in common: they are associated with present or past groundwater discharge areas; they are located in topographically low, poorly drained sites; they have highly permeable recharge areas nearby and they are fed by groundwater with high Ca^{++} and $(HCO_3)^-$ ion concentrations (Macdonald, 1982). A study by Thiel (1930) revealed that high, irregular morainal topography favours marl accumulation. He found the greatest number of large marl deposits located in coarse outwash sands and gravels.

The marl deposits in the Skeena drainage are situated in depressions on permeable glaciofluvial landforms which facilitate groundwater discharge. Adjacent areas of high relief allow rapid recharge within the water cycle and contain permeable sediments rich in calcium carbonate.

A number of theories have been put forward to explain the formation of marl in lakes. Generally they fall into two broad categories: physiochemical processes such as carbon dioxide degassing and thermal stratification, or biologically linked processes, such as calcium carbonate precipitation by the algal family *Characeae* and by blue-green algae, or through accumulation of invertebrate remains. Duston *et al.* (1986) concluded that calcium carbonate precipitation is probably the result of a complex interaction between these physiochemical and biological processes. Physiochemical factors certainly play a role in the formation of the deposits discussed here and biological processes also appear to be active. *Characeae* are known to be present and gastropods have been found associated with at least one deposit.

DEPOSIT CLASSIFICATION

Marl deposits can develop through a series of stages, as depicted in Figure 5-3-5. The Buccaneer deposit typifies the gradual in-filling of a kettle depression since the last glacial retreat approximately 10 000 years ago.

A seepage-ponded classification (MacDonald, 1982) best characterizes the Buccaneer deposit. The kettle depression collects local runoff, with the water level fluctuating according to annual precipitation and evaporation cycles. The precipitation of calcium carbonate is facilitated by the hummocky terrain with, presumably, short groundwater-flow systems. Groundwater flows through permeable and reportedly calcium carbonate rich sedimentary rocks and permeable surficial sediments. In conjunction with these physical features, the presence of the algae *Characeae* and the phys-

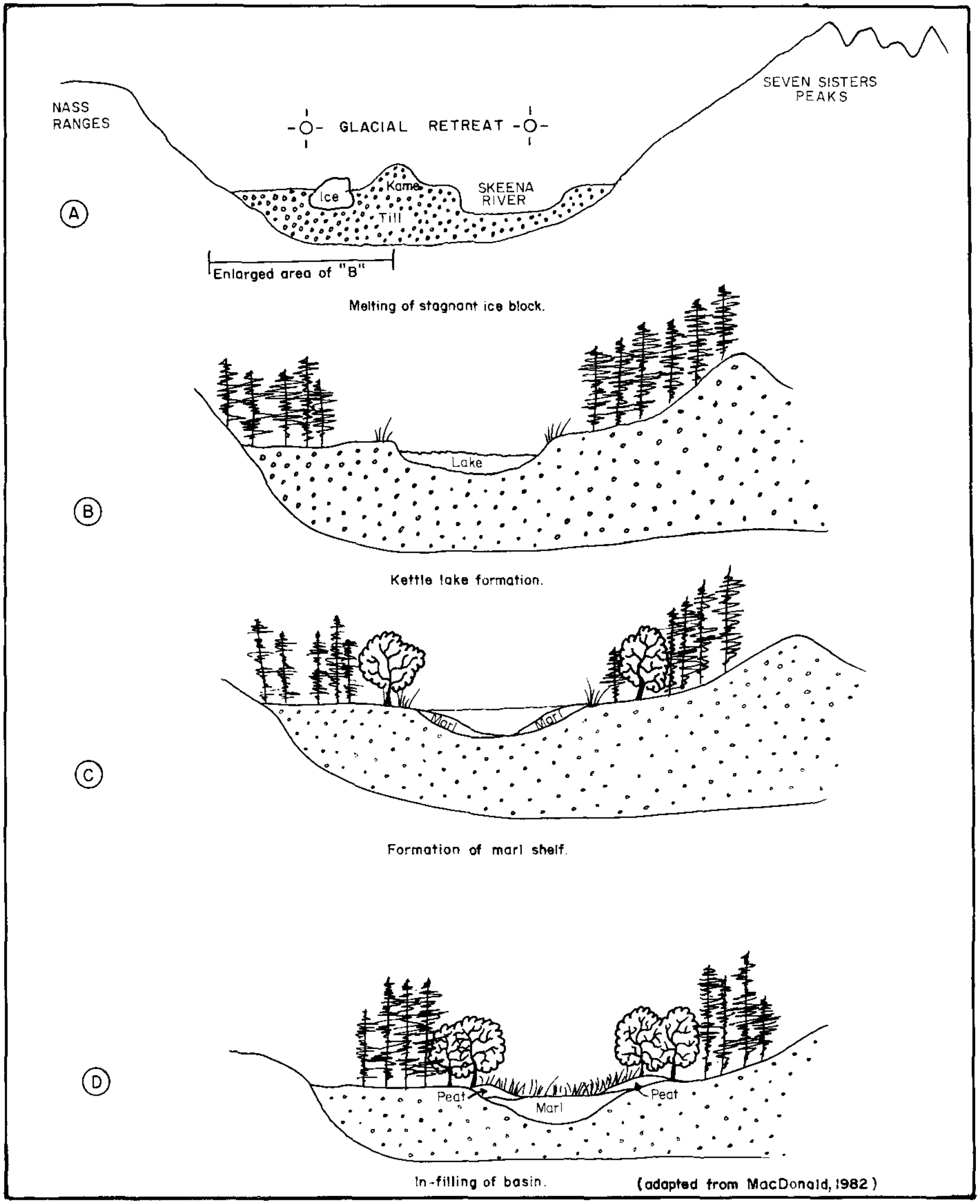

Figure 5-3-5. Development stages of a marl lake.

iochemical factors of thermal stratification and carbon dioxide degassing probably cause the precipitation of calcium carbonate. Grasses cover the ephemeral lake and the locality is presumably in the late stages of the development of a marl deposit.

Gee Kid and Wilson Kettle marls are also best described as seepage-ponded deposits. Both sites appear to be kettle depressions which collect water and favour the deposition of marl. Precipitation of marl may be on-going in Lime Lake due to the raised water level. Wilson Kettle appears to be only intermittently wet, if flooded at all, and is covered by grasses. It is probably in the later stages of marl development (Figure 5-3-5).

The Robinson Lake marl may be a shoreline-fringe deposit, as classified by Macdonald (1982). Adjacent to a high-relief area to the north and east, the lake collects local groundwater flow and calcium carbonate is precipitated in shallow water by thermal stratification, probably aided by the biological carbonate-fixing ability of *Characeae*.

SUMMARY

Of the four marl deposits studied, two, Buccaneer of the North and Wilson Kettle, contain good quality marl. The other two, Gee Kid and Robinson Lake reportedly contain marl, but are presently flooded and need further study.

The Buccaneer is estimated to contain as much as 88 400 tonnes of dry marl averaging 82 per cent calcium carbonate with a low percentage of contaminants. After removal of the thin vegetative cover, the marl could readily be scooped out and trucked to the railway only a kilometre away.

The Wilson Kettle deposit contains marl of good quality with only a small percentage of contaminants, but further sampling is needed to determine its dimensions and overall quality. A maintained all-weather road passes within a kilometre of the deposit.

The extent and quality of the Gee Kid and Robinson Lake deposits was not ascertained because of extensive flooding, but exploitation of the Robinson Lake marl would be difficult as the town of Hazelton draws its water from the lake.

In summary, the marl in the Terrace-Hazelton area is of good quality, adjacent to transportation, readily removable, and at least one site has significant estimated reserves.

ACKNOWLEDGMENTS

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NOTES