Sedimentological Studies of the Yellowknife Supergroup in the Slave Structural Province

John B. Henderson

Several areas in the Slave Structural Province that are particularly well preserved and exposed were examined. The stratigraphic and structural relations of various members of the Yellowknive Supergroup were established and in particular the transition from dominantly volcanism to dominantly sedimentation in these areas during the Archean was examined. The relationships of certain mineral deposits to the sediments and volcanics was investigated in order to better appreciate the resource potential of these rocks. Models previously developed regarding the sedimentological volcanological and tectonic evolution of the Province are being considered as is the direction further sedimentological work in the Yellowknife Supergroup should take.

To this end visits were made to the Back River area, High Lake area, Point Lake area, Winter Lake area and the Beechey Lake area. In addition, a brief visit was made in the Hearne Lake area.

OPEN FILE

232

19 p.

BACK RIVER

One of the largest areas of felsic volcanic rocks in the Slave Province is found in the eastern part of the province north of the headwaters of the Back River (see also Baragar, this report). The dominantly felsic volcanic terrain occupying a more or less rectangular area about 40 km long and 20 km across, is surrounded by the typical greywacke sandstone turbidites of the Yellowknife Supergroup. The sediments on the eastern and western sides of the volcanic terrain are in the greenschist facies of metamorphism. The contact area between the volcanic rocks and the sediments on the eastern side of the volcanic terrain is easily accessable from the Back River (64°50'N, 107°45'W).

In this area the felsic volcanics outcrop~~s~~ very well although the particularly luxurient lichen growth largely obscures flow contacts and textures on weathered surfaces. Fresh surfaces indicate the largely fragmental felsic volcanics have for the most part undergone only minimal deformation. ~~Little~~ Few or no sedimentary units other than local minor volcanogenic beds occur within the main volcanic ~~side~~ pile.

The area between the main volcanic ~~side~~ pile and the Back River is underlain by very thick bedded units of coarse grained greywacke turbidites and felsic fragmental volcanic units in about equal proportion. Thick units of dominantly argillite are present in this area as well. The turbidites are among the coarsest grained and thickest bedded seen anywhere in the Slave Province. To the east away from the main volcanic area and to the south the amount of felsic volcanics becomes less abundant and the sediments in general thinner bedded and finer grained. In the coarsest grained material (up to 1 cm) it is evident that the sediments had a dominantly felsic volcanic provenance. In this area the sediments and volcanics dip at relatively shallow angles (35°) although commonly the most prominent structural feature visable is the very steep fracture cleavage. In addition the metamorphic grade of the sediments is as low as seen anywhere in the Province.

At the contact between the main volcanic unit and the mixed sediments and volcanics is a zone of sediments dominated by carbonaceous mudstone and iron formation. This zone was traced more or less continuously over 20 km. The most complete sequence is located on the Back River ($64^{\circ}55'$N, $107^{\circ}40'$W) where the zone changes from a generally northerly striking unit to one with a generally westerly strike. In this area the intermediate to felsic volcanics are capped by a felsic volcanic breccia. An iron formation consisting of thin bedded siderite and chert with very minor magnetite overlies the breccia and is followed by a massive unit of ~~dolomitic carbonate~~ dolomite. At the top of the sequence is a massive black carbonaceous mudstone commonly containing finely disseminated pyrite to pyrite concentrated into spectacular concretions. This sequence is followed by the normal siltstone to greywacke turbidites typical of the Yellowknife Supergroup. Along strike the zone is quite variable, commonly with parts of the sequence missing or at least not exposed. The most persistent facies is the carbonaceous mudstone that locally has small but locally quite spectacular frost boil gossans developed over it. The only sulphide identified was pyrite. The iron formation is variable in composition. In the north and central part of the zone it consists dominantly of thin bedded to laminated siderite with variable amounts of chert layers and locally minor magnetite concentrations. In the southern part of the zone near the south end of the island filled lake the Back River flows through, the iron formation is the chert magnetite type and at the ~~north~~southernmost point observed, consists of silicate iron formation overlain by siderite magnetite iron formation. The black carbonaceous mudstone is everywhere closely associated with the iron formation or in close proximity to it, separating areas of iron formation. At several localities along the zone carbonate cemented felsic volcanic breccias occur immediately below the zone that in one instance has associated extensive pyrite mineralization. As well carbonate lenses and irregular veins are common in the felsic volcanics below the zone of chemical sedimentation.

High Lake Area

The High Lake area (76 M/7) has been recently mapped by Padgem (1973). The area is underlain in part by Archean volcanics of which felsic fragmental volcanics greatly predominate over both intermediate and mafic volcanics. Typical Yellowknife Supergroup greywacke turbidites occur in the southeastern part of the area. The remainder of the area is underlain by intrusive Archean granitic rocks and extensive sheets of diabase. The contact area between the volcanics and sediments is well exposed in the area about Snofield Lake ($67^{\circ}17'$ $110^{\circ}47'$).

In the Snofield Lake region south of High Lake mafic and intermediate volcanic rock as well as extensive argillaceous are more common in the volcanic pile than in the Back River area. ~~The volcanic sequence in the Snofield Lake area differs from that seen in the Back River area in that mafic and intermediate volcanics make up a significant proportion of the dominantly felsic volcanic pile and as well extensive argillaceous units are common within the volcanic sequence~~. At two localities within the volcanic sequence iron formations similar to those described at Back River were found associated with these argillaceous units. The largest such sequence is located on the west side of an elongate lake 3 km west of the south end of Snofield Lake where siderite chert iron formation is overlain by black carbonaceous mudstone followed by normal shales. These are followed abruptly by very coarse thick bedded volcanogenic turbidites of very proximal aspect that are overlain by a massive white carbonate unit. This sequence occurs about ½ km north along strike of a large gossan in which traces of sphalerite were seen. It was not possible to trace this sequence any distance to the north or south. A much smaller occurrence of iron formation occurs a few hundred meters north of the northeast shore of Snofield Lake and consists of thin bedded siderite associated with dolomitic carbonate and black carbonaceous mudstone. Chert nodules are common in both the siderite and mudstone. Pyrite mineralization is associated with the siderite layers. The similarity of these sediments to those seen at Back River is striking.

The sediments to the east of the volcanic sequence are similar to the typical greywacke mudstone turbidites of the Yellowknife Supergroup that are so common throughout most of the Slave Province.

Of particular interest is the occurrence of Archean stromatolites in the discontinuous ~~dolomitic carbonate~~ dolomite unit that occurs along the contact between the volcanics and the normal Yellowknife sediments east of Snofield Lake. The unit in most places is highly deformed due to extensive shearing along the volcanic sediment contact. In a few places,however, there has been only minimal deformation and the stromatolites are very well preserved (Fig. 1,2). The stromatolites occur in two forms at the two localities at which they are found. At the first locality (67°17½, 110°45') the stromatolites occur as wavy to corrugated laminations with local nodular convexities with relief of about 1 cm. Rare intraformational breccia layers are present in which the clasts are coated with thin laminations. At the second locality (67°19', 110°46') the stromatolites are much larger and more coarsely laminated forming flattened domes made up of even to corrugated laminae with relief of several centimeters (Figs. 1 and 2).

A thin tuffaceous layer within the carbonate unit at one locality (67°17', 110°45') contained small amounts of sphalerite.

Point Lake Area

The contact between a major sequence of Archean mafic volcanics and sediments of the Yellowknife Supergroup occurs near the central part of Point Lake ($65^{\circ}15'$, $113^{\circ}00'$) (Bostock, 1967). It was in this area that the occurrence of granitic basement to Archean supracrustal rocks was first indicated in the Slave Province (Stockwell, 1932).

In the area of interest (Fig. 3) the volcanic rocks consist of a thick sequence of mainly mafic pillowed and massive flows with locally abundant mafic tuffs and other fragmental mafic rocks of volcanic origin. Felsic volcanics are a very minor component of the volcanic sequence. In most cases the volcanic rocks are strongly deformed, particularly those of fragmental origin. In many places however, the more massive pillowed flows are well enough preserved to provide useful top indicators. The main sedimentary unit consists primarily of the typical Yellowknife greywacke mudstone turbidites but in this region has associated within it elongate lenses to discontinuous units of silicate magnetite chert iron formation (Bostock, 1966).

In this contact area also occurs a conglomerate-sandstone unit (Bostock, 1967) that is of considerable interest. The conglomeratic unit unconformably overlies a highly deformed altered granitic rock. Contact relations are clearly exposed over a length in excess of 1 km. at locality A (Fig. 3). In Figure 4 the nature of the contact can be clearly seen where the fractured granitic surface is overlain by the conglomerate. In places erosional depressions on the unconformity surface are up to 15 meters deep and 35 meters wide. The conglomerate is very massive with only rare beds or lenses of volcanic lithic sandstone. It is locally variable but in general consists of coarse well rounded granitic cobbles similar to the granitic rock it overlies, smaller more deformed mafic volcanic clasts and minor amounts of intermediate and felsic volcanic clasts. The volcanic clasts in most cases are a more abundant if less spectacular component than the granitic cobbles. An important member of the formation is an extensively crossbedded sandstone composed of silicic volcanic rock fragments and quartz that occurs southwest of the granite and on the peninsula south of point B (Fig. 3). This member bears a very close resemblance to the Jackson Lake Formation at Yellowknife which is thought to represent terrestrial sedimentation (Henderson, in press). The conglomerate-sandstone formation is in contact with both the mafic volcanics and the greywacke turbidites. Wherever contact relations were observed the contacts appeared to be conformable with the conglomerate-sandstone formation overlying the volcanics or greywackes.

This together with the fact that the volcanics and turbidites are never found in normal contact with the granite and the fact that the major components in the conglomerate are mafic volcanic clasts tends to support the suggestion that the granite may not be the fundamental basement to the Archean supracrustal succession in the area but may be younger than at least some of the volcanics as first suggested by Bostock (in prep). Material has been collected for radiometric dating in order to help resolve this question.

At several localities mineralized zones and chemical sediments occur at or near the contact with the conglomerate-sandstone formation. ~~in the underlying formations.~~ The most interesting of these occurs at locality B (Fig. 3) where one meter of massive sulphides (pyrite, sphalerite chert and chalcopyrite) occur in a layer within the mafic volcanics about 20 meters west of the contact with the conglomerate. The sulphide layer is well exposed on the shoreline as a slightly lower weathering rusty zone one meter wide. The deformed mafic volcanics (pillowed?) on either side are not altered. The sulphide layer can be traced for about 40 meters but once away from the immediate shoreline appears as a minor rusty rubble zone that might be overlooked. Table 1 consists of analyses of 9 reasonably representative grab samples from the shoreline outcrop. Several smaller rusty zones in the volcanics along this shoreline contain traces of sphalerite. At localities C and D (Fig. 3) again at the contact between the volcanics and the conglomerate is a black carbonaceous mudstone unit with extensive pyrite mineralization. Localities E and F (Fig. 3) are at or near the contact between the conglomerate and the greywacke turbidites. In these areas again is found a major unit of black carbonaceous mudstone that also contains siderite. The siderite iron formation at locality E is the larger, is complexly folded but consists of the same package of lithologies as described at Back River and High Lake areas - i.e. black carbonaceous locally pyritiferous mudstone and thin bedded to laminated siderite iron formation with minor chert layers and local magnetite concentrations. Chert nodules occur in both the mudstone and iron formation.

If these localities of chemical sediments are related as seems to be reasonable if a volcanic exhalative model is invoked, then they may provide a useful time horizon - a rare commodity in the Archean. If indeed these deposits are time equivalent then it is further evidence for the conformity of the conglomerate with other members of the supracrustal succession.

Beechey Lake Area

A narrow belt of volcanic rocks occurs at the western margin of the extensive area of Yellowknife Supergroup rocks that underlie much of the Beechey Lake area. A prominant gossan occurs in this belt (65°36', 107°55') and is the locus of a prominent geochemical anomaly (~~Anomaly,~~ Cameron and Durham, (1973), see also Cameron ~~and Durham~~ et al., this report).

Approximately 2300 meters of volcanic rocks are in intrusive contact with granitic rocks to the west southwest of the belt. They form a steeply dipping monoclinal succession topping east with a prominant quartz feldspar porphyry sill 200 meters thick and 4500 meters long at the top. The lower part of the sequence consists of thick massive units of probable andesitic composition dominantly of fragmental origin. Some pillowed flows are also present in the section. In the lower part of the section are abundant irregular quartz feldspar porphyry intrusions. In the central part of the sequence is a thick intrusive mafic sill. Andesitic and dacitic fragmentals make up the upper part of the sequence that becomes increasingly felsic and thinner bedded towards the top. Minor thin carbonate units also occur in this section of the sequence. It is in this part of the section that the main gossan occurs (see Cameron et al., this report).

Above the volcanic sequence is a 200 meter thick lens of black highly deformed carbonaceous mudstone locally containing finely disseminated to concretionary pyrite. This lens has its maximum thickness above the alteration zone in the volcanic sequence and thins to both north and south over a distance of several kilometers. The mudstones are followed abruptly by thin bedded volcanogenic siltstones that become increasingly coarser grained and thicker bedded to the east where they are similar to the typical greywacke mudstone turbidites of the Yellowknife Supergroup.

Five hundred meters east of the contact with the mudstones is a series of thin discontinuous layers to lenses of silicate chert magnetite iron formation similar in many respects to the silicate iron formation associated with the greywackes in the Point Lake - Contwoyto Lake area. A few meters east of the silicate iron formation is a 50 meter unit of oxide iron formation interlayered with argillite and locally with chert. This is the major iron formation that causes the prominent anomaly on the aeromagnetic map of the region.

Both the volcanics and the sediments in the region are steeply dipping and are metamorphosed in the middle greenschist facies. In the sediments the metamorphic grade increases to the east where the cordierite isograd occurs 2.7 km from the volcanic sedimentary contact.

Hearne ~~MYLONITE~~ LAKE Area

A section across an extensive mylonite zone in the Hearne Lake map-area (85I) previously seen only at isolated helicopter landings (Henderson <u>et</u>. <u>al</u>., 1973) was examined in detail in the vacinity of a lake located at 62°44'N, 112°02'W. The mylonite zone extends for 30 km across the northeast corner of the map-area and has a width of about 2½ km at the locality examined. It varies from a finely laminated granitic mylonite at its western contact with a major intermediate to mafic volcanic belt through to cataclastic granitic rocks on the eastern margin of the zone where it is gradational into the massive granitic rocks ~~on the eastern margin of the zone where it is gradational into the massive granitic rocks~~ to the east. The mylonite zone is intruded by massive to weakly foliated quartz monzonite and pegmatite and contains highly deformed volcanic inclusions near the contact with the volcanics.

A lens of presumed Proterozoic conglomerate and arkose previously reported by Henderson (1939) occurs on the small islands and on the adjacent shores of the lake. The fault bounded lens is 1500 m by 100 m, parallels the mylonite zone (NNE) and is only weakly deformed. The well rounded quartz, quartzite and arkose cobbles of the conglomerate have retained their original shape which contrasts strongly with the adjacent cataclastic to mylonitic rocks.

References

[1]Bostock, H.H.: Geological Notes, Itchen Lake map-area, District of Mackenzie, Geol. Surv. Can., Paper 66-24 (1966).

[2]Bostock, H.H.: Itchen Lake map-area in Report of Activities, Part A, Geol. Surv. Can., Paper 67-1A, pp. 29-33, (1967).

[3]Bostock, H.H.: Itchen Lake map-area, District of Mackenzie, Geol. Surv. Can., Memoir, (in prep.)

[4]Cameron, E.M., Durham, C.C.: Follow-up investigations on the Slave Bear Geochemical Operation, Report of Activities, Part A, Geol. Surv. Can., Paper 74-1A, pp. 53-60, (1974).

[5]Henderson, J.B., Lambert, M.B., Peeling, G.R.: Yellowknife and Hearne Lake map-areas, District of Mackenzie, Rept. of Activities, Geol. Surv. Can., Paper 73-1A, pp. 148-151, (1973).

[6]Henderson, J.B.: Sedimentology of the Yellowknife Supergroup at Yellowknife, N.W.T., District of Mackenzie, Geol. Surv. Can., Bull. 246 (in press), (1975).

[7]Henderson, J.F.: Beaulieu River Area, Geol. Surv. Can., Paper 39-1,(1939)

[8]Padgem, W.A.: Geology High Lake 76 M/7, District of Mackenzie, Prelim. Ed. Dept. Indian Affairs and Northern Development, (1974).

[9]Stockwell, C.H.: Great Slave Lake - Coppermine River Area, N.W.T., Geol. Surv. Can., Ann. Rept. 1932, Part C, pp. 37-63, (1932).

Table 1

Locality B - Sulphide Layer Analyses

Sample	Au oz/ton	Ag oz/ton	Cu %	Pb %	Zn %
HBA-1	trace	1.94	2.52	0.17	5.60
HBA-2	trace	0.52	0.10	0.25	9.84
HBA-3	trace	1.10	1.36	0.44	10.4
HBA-4	trace	1.02	1.14	0.13	3.84
HBA-5	trace	1.04	1.44	0.60	12.9
HBA-6	trace	1.72	1.76	0.53	15.6
HBA-7	trace	1.04	0.33	0.21	5.12
HBA-8	trace	1.60	0.31	0.50	14.4
HBA-9	trace	0.94	0.93	0.39	8.92

trace: less than 0.010 oz/ton Au

Analyses are of representative grab samples taken from the shoreline exposure of the sulphide layer.

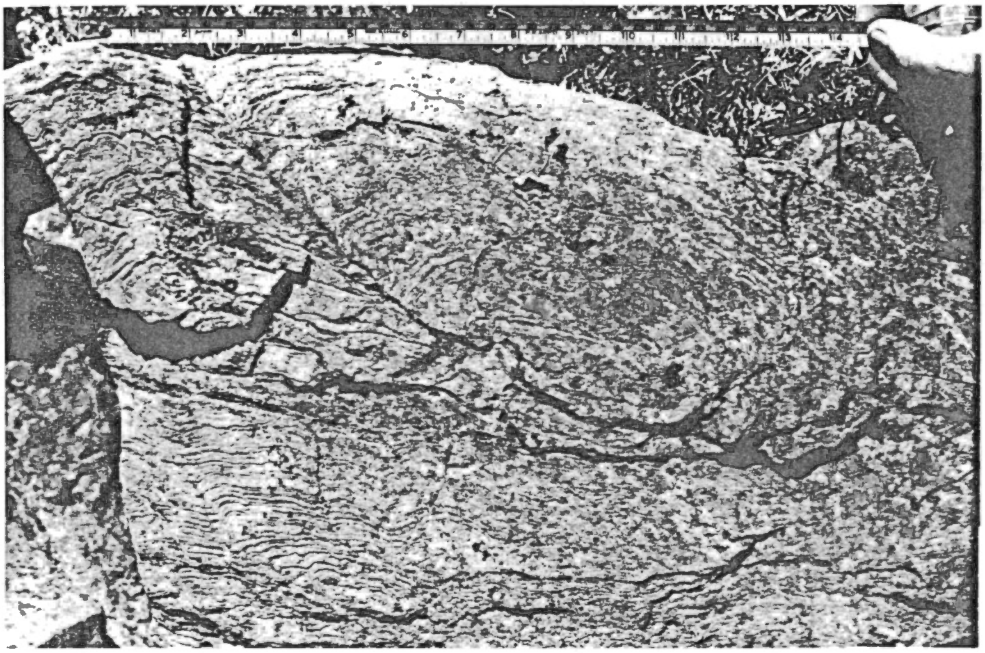
Figure Captions

Fig. 1 Archean stromatolite in dolomitic carbonate, High Lake area, District of Mackenzie.

Fig. 2 Archean stromatolite in dolomitic carbonate, High Lake area, District of Mackenzie.

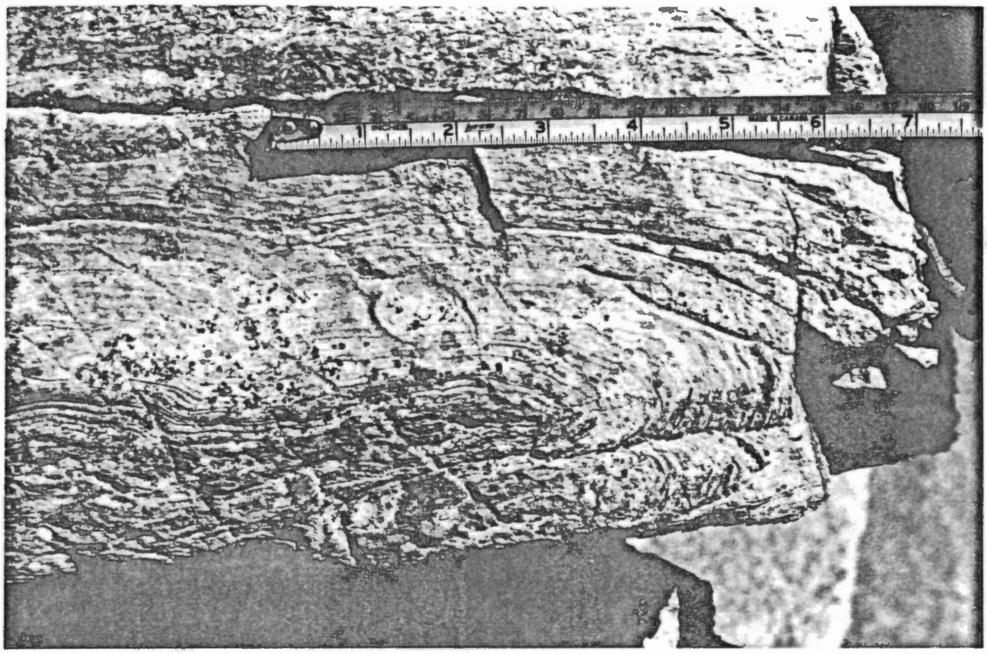
Fig. 3 Geological map of central Point Lake, District of Mackenzie. Geology modified after Bostock (in prep.)

Fig. 4 Unconformity at Point Lake, between granitic basement and overlying Archean conglomerate here composed mainly of mafic volcanic clasts with minor granitic and felsic volcanic cobbles. Note fractures in the unconformity surface containing cobbles of the conglomerate. Scale extended 43 cm or 17 inches.



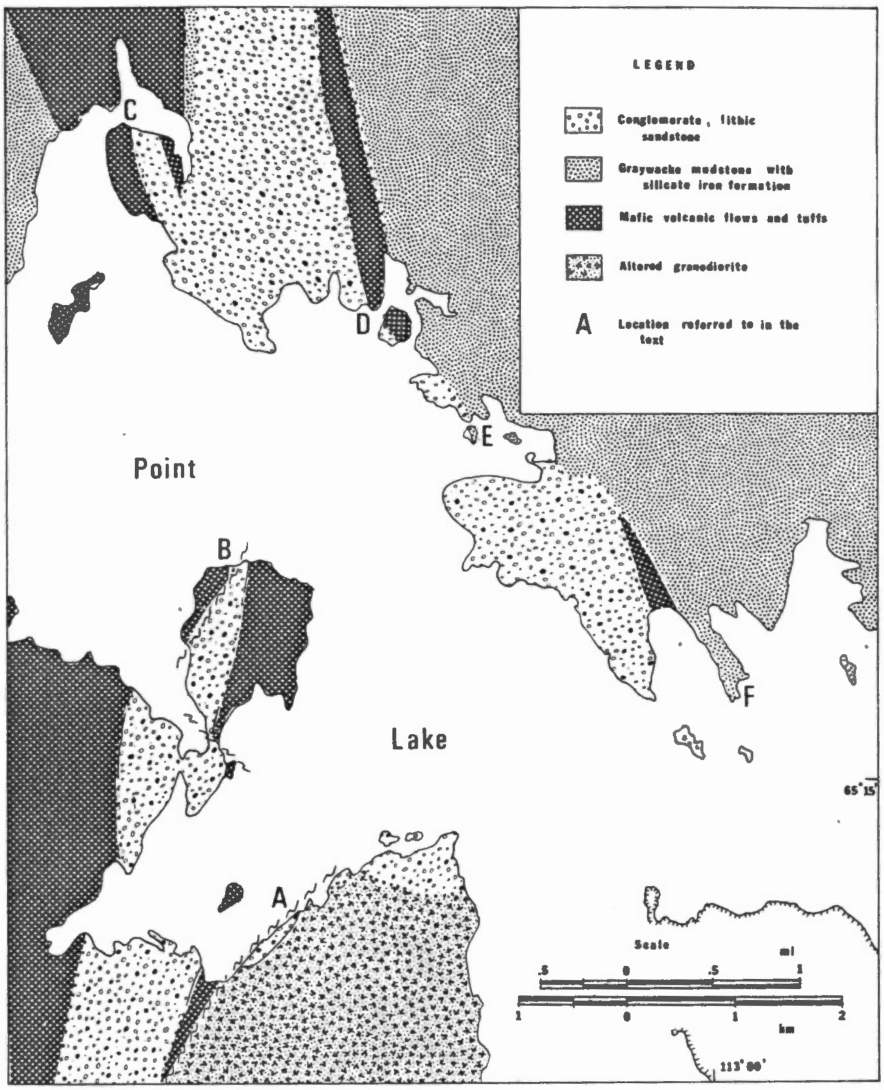
162966

J.B. HENDERSON FIG 1

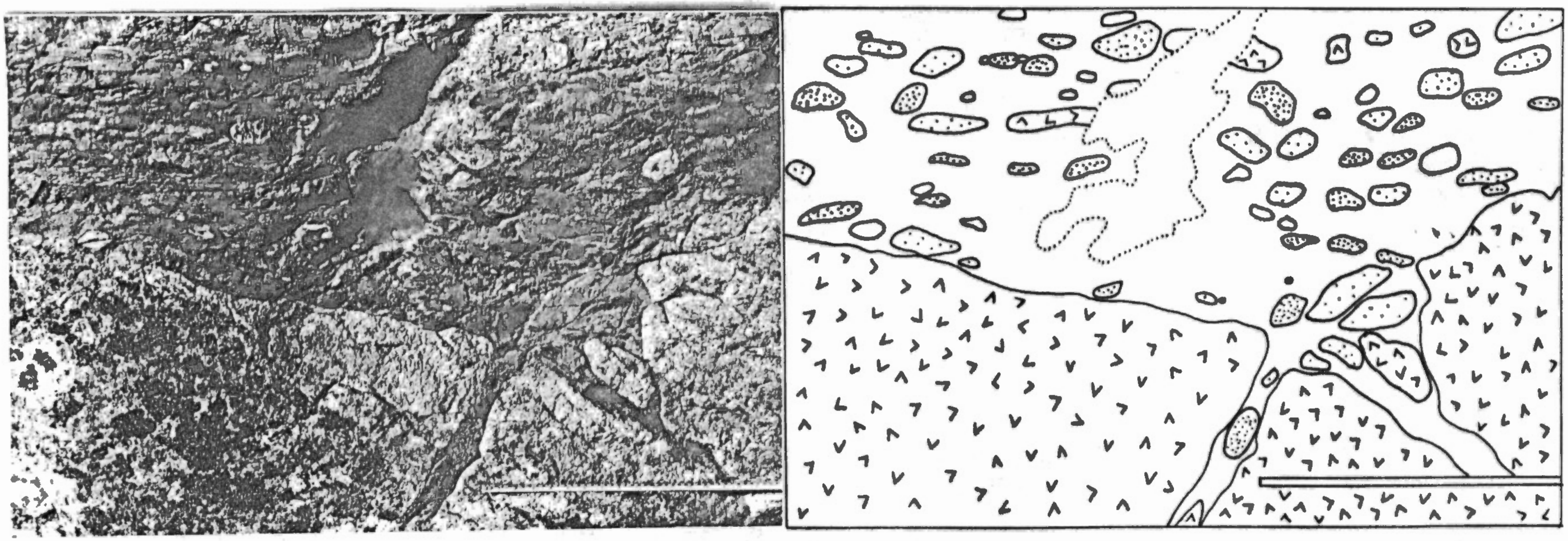


162973

J.B. HENDERSON FIG 2



J.B. Henderson - Fig 3



\# 163013

J.B. HENDERSON FIG 4