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Report 243

Geology of the
Batchewana-Pangis Area
District of Algoma

1986

Ministry of
Northern Development
and Mines
Ontario

Ontario Geological Survey
Report 243

Geology of the
Batchewana-Pangis Area
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by
G.M. Siragusa

1986

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Critical Reader: V.G. Milne

Scientific Editor: Z.L. Mandziuk

Foreword

The Precambrian volcanic and sedimentary rocks comprising the Batchewana-Pangis Area are significant to the development of the Sault Ste. Marie area. These rocks have the potential for containing base metal sulphide and precious metal deposits. No extensive mineral exploration has been done in the map area because of difficult access, land status, and a geological database which was inadequate for mineral potential assessment. Since 1974 a series of projects have resulted in detailed geological mapping of a major portion of the Batchawana belt. This report presents the findings of field mapping from 1974 to 1978.

A good geological database is essential for effective mineral exploration and land use, and integrated resource development planning in this region.

V.G. Milne
Director
Ontario Geological Survey

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CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

If the reader wishes to convert imperial units to SI (metric) units or SI units to imperial units the following multipliers should be used:

CONVERSION FROM SI TO IMPERIAL			CONVERSION FROM IMPERIAL TO SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy)/ton (short)	20.0	pennyweights/ton (short)
1 pennyweight/ton (short)	0.05	ounce (troy)/ton (short)

NOTE—Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries published by The Mining Association of Canada in co-operation with the Coal Association of Canada.

Geology of the
Batchewana-Pangis Area
District of Algoma

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Manuscript accepted for publication by the Chief Geologist, March 31st, 1981. This report is published with the consent of V.G. Milne, Director, Ontario Geological Survey.

Abstract

The map area is bounded by Latitudes 47°07'30" and 47°15'00"N and Longitudes 84°00' and 84°30'W, and includes part or all of Smilsky, Tolmonen, Tronsen, Vibert, Way-White, Nicolet, Norberg, Olsen, Davieaux, Desbiens, Peever, Home, Raaflaub, Runnalls, and Running Townships. Batchewana and Pangis are Algoma Central Railway flag stops.

Metavolcanics in Way-White, Running, and Desbiens Townships comprise a northwest-trending, south-facing, subvertical to overturned sequence, which has an estimated maximum thickness of 9900 m (32 500 feet). The lower 7900 m of the series consists of mafic metavolcanics which vary in composition from tholeiitic basalt to basaltic komatiite. The upper 2000 m of the series include calc-alkaline metavolcanics which are dominantly pyroclastic and of rhyolitic composition. Smaller basaltic units are partially exposed in other marginal zones of the map area. They are not connected with the main northwest-trending sequence. The units are strongly deformed and their structural trends vary considerably from unit to unit. The largest of these units is a north-trending unit underlying part of southwestern Tronsen Township.

A sequence of volcanogenic metasediments comprised of fine grained quartzo-feldspathic clastic rocks having low mafic content, local small ironstone bands, and subordinate metaconglomerate and metaconglomeratic arenite, underlies large parts of Vibert and Tronsen Townships. This metasedimentary sequence thins eastward where it overlies the northwest trending calc-alkaline metavolcanics from which the sediments are considered to have been derived. A second metasedimentary unit which includes arkose and arkosic to subarkosic wacke characterized by relatively high mafic content, underlies parts of northern Tronsen and southern Raaflaub Townships. In Raaflaub Township these metasediments are in contact with northeast trending, tightly folded flows of basalt and basaltic komatiite composition. This sedimentary sequence was probably derived from the mafic metavolcanics adjacent and to the north of it, and was deposited previous to the beginning of the calc-alkaline volcanism and; therefore, is older than the quartzo-feldspathic metasediments derived from these. The contact relationships between the 2 metasedimentary sequences are obscured by folding and metamorphism.

The supracrustal rocks are deformed by: folding about east-trending and north-trending axes; emplacement of granitic and gabbroic intrusions within, and of granitic intrusions marginal to, the supracrustal rocks; shearing associated with folding and intrusion; and faulting. The metamorphic rank increases westward and varies from upper greenschist facies in the northwest trending mafic metavolcanics to the quartz-staurolite subfacies of the amphibolite facies in the metasediments underlying the western part of the map area. Structural relationships in a segment of the Batchawana River valley within the map area suggest that reverse faulting, which post-dated emplacement of granite, occurred along this valley, vertical displacement being apparently the main effect of faulting. Numerous, dominantly northwest-trending regional fractures affected the supracrustal and the granitic rocks of the Batchewana-Pangis Area, and were intruded by diabase in Late Precambrian time.

Mineral occurrences have not been observed in the northwest trending mafic metavolcanics. The pyroclastic nature and calc-alkaline trend of the felsic metavolcanics in the upper section of the sequence (i.e. southwestern Way-White and north central Desbiens Townships), and the calc-alkaline trend of part of the north-trending basaltic unit in southwestern Tronsen Township, make these units a better choice for exploration aimed at location of base metal deposits

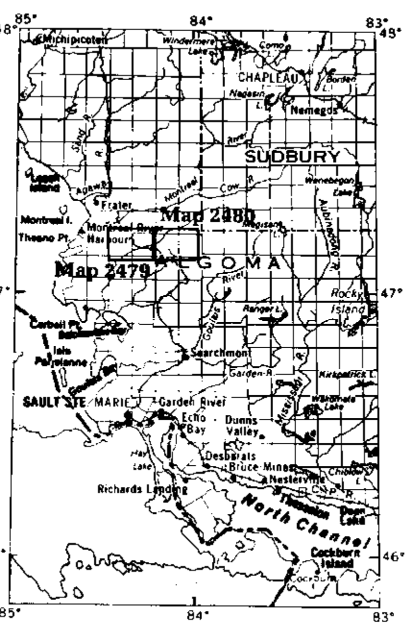
Geology of the Batchewana-Pangis Area, District of Algoma, by G.M. Siragusa, Ontario Geological Survey Report 243, 56 p. Accompanied by Maps 2479 and 2480, scale 1:31 680. Published 1986. ISBN 0-7729-1013-8.

Introduction

Location and Access

The Batchewana-Pangis Area is in the southern part of the Algoma District and is bounded by Latitudes 47°07'30" and 47°15'00"N and by Longitudes 84°00'00" and 84°30'00"W. It includes an eastern strip of Smilsky Township; the 3 contiguous townships of Tolmonen, Tronsen, and Vibert; most of Way-White Township; parts of northern Nicolet, Norberg, Olsen, Davieaux, and Desbiens Townships; and parts of southern Peever, Home, Raaflaub, Runnalls, and Running Townships; for a total of 520 km^2 (201 square miles). The area is within the Sault Ste. Marie Mining Division.

A dirt road connects Highway 17 with the Tribag Mine (outside map area) and with the Algoma Central Railway flag stop at Batchewana (official spelling) in the central part of Tronsen Township. From Batchewana Station the road extends eastward across the Mongoose-Wart Lakes area of Vibert Township and, presumably during the winter of 1975, was extended northward to end at the Batchawana River in Running Township, close to the northern boundary of the map area. In the southern part of the map area this road crosses the Little Batchawana River and the Batchawana River on log bridges which in the spring of 1974 were not passable having been partially washed out; in the spring of 1975 a segment of the road itself was obliterated by the waters of the Batchawana River. Another bush road connects the area around Big Pike Lake with Highway 17 via the Montreal River road, thus giving limited access to the northwestern part of the map area. Although many old bush roads are found within the map area as the result of logging during the past 25 or 30 years, most of these are overgrown and offer no practical means of internal communications. The Algoma Central Railway crosses parts of northern Davieaux, southwestern Vibert, central and western Tronsen, northeastern Tolmonen, and southeastern Home Townships. Spruce Lake (Davieaux Township), Mongoose Lake (Vibert Township), Batchewana Station (Tronsen Township), and Rand Lake (Tolmonen Township) are flag stop points for passenger trains. Big Pike, Patterson, Mitchell, and occasionally Rand Lake, are used as access points to the western half of the map area by float-equipped airplanes. Mongoose, Quintet, Spruce, Wart, Pan, Tribble, and Masten Lakes, and to a lesser extent Guyatt Lake and the "Z" shaped lake at the boundary of Way-White and



SMC 15105

Figure 1. Key map showing location of the Batchewana-Pangis Area. Scale 1:3 168 000 (1 inch to 50 miles).

Desbiens Townships, are used as access points to the eastern half of the map area. However, the only practical means of access to a large portion of Way-White Township and to segments of the northern fringe of the map area is by helicopter because the lakes found in these areas are small, or too shallow, or partially occupied by floating marsh. The Batchawana River, the main waterway in the area, flows southward and drains into Lake Superior. It crosses under Highway 17 approximately 64 km (40 miles) north of Sault Ste. Marie. During most of the summer this river is too shallow to be a convenient canoe route over significant distances within the map area.

Mapping of the area was undertaken during the field seasons of 1974, 1975 and part of 1976. The western and eastern halves of the present map area are covered at the scale of 1:15 840 (1 inch to 1/4 mile) by Preliminary Map P.998 (Siragusa 1975), and by Preliminary Maps P.1193, P.1833 and P.1834 (Siragusa 1976, 1978), respectively. The whole area is covered by Geological Survey of Canada - Ontario Department of Mines Aeromagnetic Map 2202 G at a scale of 1:63 360 (or 1 inch to 1 mile), by the Batchawana topographic sheet at the scale of 1:126 720 (or 1 inch to 2 miles), and by the homonymous topographic sheet at the scale of 1:50 000 (or about 1 inch to 4200 feet).

Physiography

The western, central, and eastern parts of the map area referred to in this part of the report are defined as follows: (1) western part–that part of the map area lying west of the Batchawana River; (2) central part–that part of the map area between the Batchawana River and Longitude 84°05'00"W; (3) eastern part–that part of the map area bounded by longitudes 84°00'00" and 84°05'00"W.

The term "altitude" means altitude above mean sea level (Reference: Topographic Map 41 N/1, Edition 1 MCE, Series A 751, Batchawana, scale 1:50 000, Ottawa, 1969).

Different physiographic features characterize the western, central, and eastern parts of the map area.

Western Part of the Map Area

The western part of the map area is characterized by very rugged topography. In this part of the map area the altitudes of the valley floors vary from 290 to approximately 396 m (950 to 1300 feet), but the altitude of the terrain dissected by these valleys is mostly between 457 and 533 m (1500 and 1750 feet). The higher hills are mostly clustered in 3 areas. These are located in southwestern Home and northwestern Tolmonen Townships, in southeastern Raaflaub and southwestern Runnals Townships, and across the Batchawana River along the boundary of Tolmonen and Tronsen Townships.

Migmatitic granitic rocks underlie the first area, and dominantly supracrustal and subordinate granitic rocks underlie the other 2 areas. Throughout the map area diabase is very frequently found at, or in close proximity to, the tops of individual hills.

With some exceptions, steep slopes (i.e. 40 to 50°) which are often uneven because of subvertical buttresses of variable height, occur from valley-floor or lake-surface levels to an altitude of about 467 m (1500 feet). The gradients of the terrain with altitude above this value are generally less steep. Thus, the 1500 feet (467 m) topographic contour line is approximately coincident with the edge of the highland. Semi-barren cliffs of great natural beauty and up to 150 m (500 feet) high are typical landforms in the western part of the map area. Prominent cliffs occur along many segments of the Batchawana River valley from the southern to the northern boundaries of the map area, specifically in the Mitchell and Carpenter Lakes areas of Tronsen Township, north of the Little Batchawana River in Tolmonen Township, and in the Negick Lake-Negick Creek area of the same township.

The valley of the Batchawana River is the most prominent single physiographic feature of the area. Within the map area it is essentially straight and trends northeast. The floor of the valley in the map area ranges in altitude from about 274 to 320 m (900 to 1050 feet) with an average gradient of about 0.2% downstream from Batchewana Station and an average gradient of half this value (i.e. 0.1%) upstream from the station. The lower gradient of the upper segment of the river is reflected by the occurrence of meanders and meander cutoffs at Batchewana Station and close to the northern boundary of the map area, and by incipient spur trimming at another locality halfway between these two. Except for the Little Batchawana River and a few others, tributary junctions with the Batchawana River are marked by steep gullies, the bottoms of which are dry, or nearly so, during most of the summer.

In the western part of the map area, and generally throughout the Montreal-Batchawana Rivers area, the drainage pattern is essentially controlled by bedrock structure. The outstanding rectangular pattern of the northwest-trending (primary) and northeast-trending (secondary) tributaries on the north side of the Montreal River are the best example of this control (*see* Topographic Map 41 N/8. Ed. 1MCE, Series A751, Grey Owl Lake, scale 1:50 000, Ottawa, 1969). These same trends are typical, although less pronounced, of the tributaries of the Batchawana River. Some of the streams and elongated lakes, that are part of the Batchawana River watershed in northeastern Raaflaub and northwestern Runnals Townships, define a slightly curved pattern which is convex to the north, and parallels the very gentle north-pointing curve of the Montreal River just north of these townships.

Most of the lakes in the western part of the map area occupy local depressions in the northeast or northwest-trending valleys drained by the tributaries of the Batchawana River. Trim, Fuller, Carpenter, and Tay Lakes are examples of this type. Negick, Big Pike, and Hailey Lakes are in areas characterized by intersecting fractures, and thus both the northwest and northeast trends are shown by their outlines. East-trending lakes are uncommon although well represented by Patterson and Mitchell Lakes. The outline and orientation of Patterson Lake are controlled by the east-trending layering of the metasediments underlying the area. Mitchell Lake occupies part of the bottom of a glacial trough the shape of which is parabolic with convexity to the northwest. This feature represents the bifurcate southern end of a northwest-trending trough which extends beyond the northern boundary of the map area, and intersects the Montreal River 750 m (2460 feet) east of the dam in central Home Township. The bifurcate outline of the trough in the Mitchell Lake area resulted from the southeastward flow of ice around the flanks of the prominent hill on the south side of the lake, and the shape and trend of the lake are unrelated to the structural features of the rocks underlying the area. The same applies to other lakes occurring along the northwest-trending segment of the trough as, for example, Rand and Shoepack Lakes.

The gradient relationships of drainage northwest of the Batchawana River show that the divide between the watersheds of the Batchawana and the Montreal Rivers is parallel to and at a distance of 1.5 to 4 km (0.9 to 2.5 miles) south of the Montreal River. The Batchawana and Chippewa Rivers trend northeast whereas the divide between their watersheds trends east being closer to the Batchawana River in the west and closer to the Chippewa River in the east (*see* "Central Part of the Map Area").

Central Part of the Map Area

This area is bounded to the north by a segment of the Batchawana River valley 13 km (8 miles) in length. Apart from the steep, uninterrupted, northwestward slope along the southern margin of the valley, steep slopes are uncommon, and are essentially restricted to the Mongoose Lake-Mongoose Creek area of eastern Tronsen and western Vibert Townships. The rest of the area is characterized by hilly to rolling topography which lacks the marked relief contrasts typical of the western part of the map area. Approximately half of the area has altitudes that range between 396 and 442 m (1300 and 1450 feet). Altitudes in the other half of the area generally range between 457 m (1500 feet) and 533 m (1750 feet) but in 5 locations hills range between altitudes of 533 m (1750 feet) and 564 m (1850 feet). One of the 5 higher hills is in an area underlain by metavolcanics in northwestern Way-White Township. All the other higher hills are in northwestern Vibert Township where they form a northeast-trending ridge along the southern side of the Batchawana River valley. The peaks of this ridge are in 3 areas which are separated by 2 northwest-trending short valleys drained by primary tributaries of the Batchawana River. From southwest to northeast the 3 areas are underlain by metagabbro intruded by diabase; metasediments; and granitic rocks intruded by diabase; respectively.

Mongoose Lake, Wart Lake, and their associated streams are part of the Batchawana River and Chippewa River watersheds respectively. In southern Vibert Township the divide between these watersheds is "V" shaped and lies very close to the Chippewa River (1.5 km or 0.9 mile) whereas in northern Vibert Township the divide is quite close to the Batchawana River (1 km or 0.6 mile). In this area, therefore, conditions are similar to those in northeastern Norberg and northwestern Olsen Townships.

The relationships between the watersheds of the Batchawana and the Chippewa Rivers in southern Vibert and southern Tronsen Townships resulted from shifting of the divide toward the south and southeast, owing to the greater erosive power of the primary tributaries of the Batchawana River and, notably, of Mongoose Creek. Shifting of the divide was locally favoured by the metamorphic foliation in the supracrustal rocks (e.g. southeast of Mongoose Lake), but apart from this, the position of the divide in these areas has no relation to important structural features. It is evident that both the Montreal and the Batchawana Rivers are asymmetrically located within their watersheds. In fact, the Montreal River flows very close to the southern boundary of its watershed, and so does the Batchawana River except in the areas where divide-shifting has occurred (*see* above). This indicates the presence of a generally low-gradient slope to the southeast in the terrain extending: (1) from the edge of the highland along the south side of the Montreal River to the edge of the highland along the north side of the Batchawana River, and (2) from the edge of the highland along the south side of the Batchawana River to the north side of the Chippewa River. This slope may reflect structural conditions (*see* "Structural Geology"), and is not easily recognized using data other than drainage relationships because the ruggedness of the terrain masks the gentle gradient of the slope.

<u>Eastern Part of the Map Area</u>

Swampy and hummocky terrain with a mean elevation of 404 m (1325 feet) forms a broad northwest-trending zone having an average width of about 1.6 km (1 mile). This zone extends from east central Way-White Township to the St. Clair-Marshy Lakes area of southern Running Township. Gentle hills with elevations of 427 to 457 m (1400 to 1500 feet) separated by broad valleys, which are short and trend dominantly northwest, are the typical landforms in the rest of the area, and particularly in southwestern Way-White and northern Desbiens Townships. Elevations of 457 to 488 m (1500 to 1600 feet) occur at 5 localities. Four of the 5 higher hills are in west central Way-White Township, and 1 of them is in northern Desbiens Township. All these areas are underlain by metavolcanics intruded by diabase dikes.

The random drainage pattern of the northern half of the area reflects the topographic influence of glaciation. This area lies within the Batchawana River watershed. The southern half of the area is within the Chippewa River watershed. In southwestern Way-White Township the course of the river changes abruptly from northeast to southeast. The southeast trend of the Chippewa River, and of most of its secondary tributaries, is controlled by layering and metamorphic foliation in the volcanic rocks underlying the area. The same structural features control the orientation and outlines of the rock-rimmed lakes occurring in the area, as for example, Lucky, Masten, and Tribble Lakes.

Rock Exposures

The map area has been extensively glaciated. Even steep slopes are veneered by variably thick soil and hardwood forest. Rock exposures are abundant throughout the map area with many excellent outcrop localities. However, in many areas they are difficult to examine being either prominent cliffs, a thorough examination of which is problematic, or smooth exposures of small size, semiburied by the overburden. These conditions occur particularly in the western part of the map area. Barren to semiburied scree is widespread along the slopes, and often, neither the nature of the terrain, nor other observations establish with certainty whether small exposures represent bedrock or buried scree. Because of this many small exposures have to be avoided.

Natural Resources

The trees within the map area include maple, birch, poplar, and pine, which have been heavily harvested during the past 25 or 30 years. Small spruce and cedar swamps have locally developed along the rivers, and at the foot of the high ground. Bear, moose, partridge, rabbit, and beaver are abundant throughout the map area; in the summer of 1974 the base camp of the field party was twice devastated by bears. Ducks and blue herons were encountered along creeks and swamps in the eastern part of the map area, and loon were common on most lakes. Data compiled by the Ministry of Natural Resources (1963) show that the area is within a zone of relatively good agricultural potential; the annual snowfall, rainfall, and the average July temperature are 2.3 to 3.8 m (90 to 150 inches), 0.76 to 0.89 m (30 to 35 inches), and 18 to 19°C (64 to 67°F), respectively. The regional frost hazard is classified as "moderate". The valley of the Batchawana River is deliminated by steep rocky banks along most of its course, and, if it were to be dammed, a reservoir basin with capacity similar to that of the Montreal River could be developed for production of hydroelectric power. The natural beauty of the area attracts many tourists. Cabins and/or cottages are found along the shores of Rand, Carpenter, Patterson, Quintet, Mongoose, Wart, Spruce, and Tribble Lakes.

Previous Geological Work

The eastern half of the present map area comprised part of the Mississagi Reserve-Goulais River map area mapped in 1924 by E.S. Moore (1925), at the scale of 1:63 360 (or 1 inch to 1 mile). The western half of the present map area was mapped by the same author in 1925, at the scale of 1:126 720 (or 1 inch to 2 miles). The mapping in 1925 was part of a geological survey over a group of 15 townships located in the Batchawana Bay area of Lake Superior (Moore 1926).

Present Geological Survey

The mapping method varied depending upon the lithology, outcrop density, and the aeromagnetic relief of the terrain. Areas underlain by supracrustal rocks were mapped from lake shores and by pace-and-compass traverses at intervals of approximately 400 m (0.25 mile), or less, where this was warranted by the outcrop density. In planning of tie-lines among outcrop areas, the criteria used were the size, the expected quality of exposure, and the aeromagnetic expression of the outcrop areas. Tie-lines connecting cliffs and hill-tops were extensively used in the western half of the map area regardless of spacing. Such lines are the only practical method of locating good exposures in the area. Areas peripheral to the supracrustal rocks but showing aeromagnetic expressions which departed in shape, trend, or both, from those considered typical of diabase dikes, were covered by traverses even when the estimated probabilities of finding outcrops were low. Acetates overlain on air photographs supplied by the Air Photo Library of the Ministry of Natural Resources, at the scale of 1:15 840 (1 inch to 1/4 mile) and flown in 1973, were used to record geological data which were then tansferred to a 1:15 840 (or 1 inch to 1/4 mile) base map supplied by the Cartographic Unit of the Surveys and Mapping Branch. Scale distortions of up to 40% were noted in some air photographs and particularly among those covering the northern half of the map area. These distortions, which are probably related to the ruggedness of the terrain, were overcome in most cases by recalculating the scale of the air photograph in question, and by using a plotting ruler designed accordingly. Another difficulty related to the ruggedness of the terrain originates from the abundance of barren or semiburied scree adjacent to many prominent bedrock exposures. Because of this, the inference of detailed geological relationships close to some of the prominent outcrops relies on interpretation.

Acknowledgments

During the 1974 field season Mr. M. Spazier was senior assistant; R. Stanton and P. Wanless, and J. Witstock were junior assistants. In the summer of the following year R. Stanton was senior assistant; J. Wittstock, S. Finlayson and B. Curtis were junior assistants. Eastern parts of the present map area were covered during a geological survey carried out by the author in 1976 in the Quinn Lake Area. In the summer of 1976 J. Wittstock was senior assistant; K. Chalmers and B. Curtis, and J. Beaver were junior assistants. The capability and enthusiasm of M. Spazier, R. Stanton, and J. Wittstock were particularly appreciated by the author. Mr. P. Cooper of Batchawana Bay was most helpful when the base camp of the mapping crew was devastated by bears in 1974. In 1975 and 1976 most of the resupply service and many fly-camp movements were carried out by the Aviation Service of the Ministry of Natural Resources based in Sault Ste. Marie; the help offered by all the flying and support personnel, and in particular by pilot G. Beauchene, is gratefully acknowledged. Thanks are also extended to HBOG Mining Limited for sending their helicopter, during the summer of 1976, to service one of the fly-camp crews which was stranded because of bad weather.

General Geology

The eastern part of the map area is underlain by an overturned northwest-trending metavolcanic sequence (Table 1) which faces southwest, and has an estimated maximum thickness of 9900 m (32 500 feet). About 1/5 of this thickness, in the upper part of the sequence, consists of calc-alkaline felsic pyroclastic metavolcanics, whereas the other 4/5 consists of mafic metavolcanics. The metavolcanics at the top of the mafic section are high-iron tholeiitic basalts. Basaltic komatiite is present, although in undefined amount, down sequence (i.e. northeastward) of the high-iron tholeiitic basalt.

Volcanogenic metasediments consisting dominantly of fine grained quartzofeldspathic rocks with small local bands of ironstone, and subordinately of polymictic metaconglomerate and metaconglomeratic arenite, underlie parts of the map area west of Way-White Township. These rocks form a succession which thins eastward where it overlies the calc-alkaline metavolcanics at the top of the overturned northwest-trending series. The calc-alkaline metavolcanics are stratigraphically below the metasedimentary succession and are the source material of the latter. Another metasedimentary unit which includes arkose and arkosic to subarkosic wacke with relatively high mafic content, underlies northern Tronsen Township. This unit is bounded to the north by tightly folded flows of basalt and basaltic komatiite that form the southern margin of the northeast-trending lobe of the Batchawana greenstone belt. This is most likely an older unit which derived from the mafic metavolcanics adjacent to it, and the author interprets it as being deposited prior to the calc-alkaline volcanics which were the source material for the younger metasediments. The 2 metasedimentary units are in contact in Tronsen Township where their contact relationships are obscured by folding and metamorphism. If the inferred stratigraphic relationships between the 2 metasedimentary units are correct, then the deposition of volcanogenic sediments in Tronsen Township progressed initially from north to south and subsequently from east to west. At any rate, the accumulation of volcanogenic sediments, in one or more cycles, is thickest in the present area of Tronsen Township, and thinnest in eastern Vibert and western Way-White Townships.

The supracrustal rocks are generally strongly deformed and folded about east-trending and north-trending axes by emplacement of granitic and gabbroic intrusions within them and granitic intrusions adjacent to them, by shearing associated with folding and intrusion, and by faulting. The metamorphic rank increases westward and varies from upper greenschist facies (Fyfe *et al.* 1958) in the mafic metavolcanics underlying Way-White Township, to the quartz-staurolite subfacies of the almandine amphibolite facies in the metasediments underlying Tronsen Township. Numerous diabase dikes of Late Precambrian age trend dominantly northwest and intrude the supracrustal and granitic rocks. The diabase dikes give form to prominent and often spectacular physiographic features throughout the map area.

EARLY PRECAMBRIAN (ARCHEAN)

METAVOLCANICS

Areal Distribution and Relationships of Metavolcanic Units

The main metavolcanic belt, trending northwest, underlies most of Running, Way-White, and Desbiens Townships, and small parts of eastern Vibert Township. Smaller metavolcanic units occur in 6 other separate areas. Five units are situated along the southern boundary of the map area. The sixth is adjacent to the northern boundary of the map area in Raaflaub Township. In addition, minor metavolcanics are found as local interbeds within metasediments at a few localities in Vibert and Tronsen Townships, and as rare xenoliths in migmatitic granitic rocks underlying western Tolmonen Township. The 4 westernmost metavolcanic units along the southern boundary of the map area represent the northern extensions of a continuous and generally east-trending metavolcanic belt located south of the present map area (*see* Geological Map 2251; Giblin and Armburst 1973). There is little doubt that the east-trending metavolcanics underlying the Pangis area are also part of this belt, but further mapping is needed to establish their relationships to the

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR THE BATCHEWANA-PANGIS AREA.

PHANEROZOIC

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT[a]

Boulder, sandy, and silty till; erratic boulders

Unconformity

PRECAMBRIAN

MIDDLE TO LATE PRECAMBRIAN (PROTEROZOIC)

MAFIC INTRUSIVE ROCKS

Olivine diabase; porphyritic diabase

Intrusive Contact

EARLY PRECAMBRIAN (ARCHEAN)

FELSIC INTRUSIVE AND METAMORPHIC ROCKS

Porphyritic biotite quartz monzonite, subordinate biotite-hornblende diorite, and minor biotite granodiorite and trondhjemite; pegmatite; metasedimentary migmatite (*lit-par-lit* gneiss)

Intrusive Contact

MAFIC INTRUSIVE ROCKS

Hornblende gabbro; anorthositic gabbro

Intrusive Contact

METAVOLCANICS AND METASEDIMENTS

METASEDIMENTS

Arkose, arkosic wacke, subarkosic wacke; siltstone; slate, argillite, spotted slate; polymictic conglomerate; conglomeratic arenite; banded mudstone; garnetiferous metasediments; iron formation

METAVOLCANICS

FELSIC METAVOLCANICS:

Rhyolite, dacite; rhyolite agglomerate; porphyritic rhyolite, rhyolite tuff; rhyolite breccia

MAFIC METAVOLCANICS:

Basalt, basaltic komatiite; pillowed, porphyritic, vesicular, and porphyroblastic basalt; lapilli-tuff, tuff, and pyroclastic breccia with basaltic matrix

Note:
(a) Not described in this report.

northwest-trending metavolcanics of the main belt in the present map area. The large and dominantly north-trending metavolcanic unit close to the boundary of Tronsen and Tolmonen Townships, and the 2 main metavolcanic units in the northeast-trending metavolcanic-metasedimentary sequence underlying part of northern Norberg Township, are parts of formerly continuous supracrustal units which were folded and partially disrupted at the time of the emplacement of the granitic rocks underlying eastern Tolmonen and parts of Norberg Townships. The north-trending metavolcanic unit is approximately 7.2 km (4.5 miles) long and represents the eastern limb of an antiform which has a shallow plunge to the north and a subvertical north-trending axial plane slightly concave toward the west. The "nose" of the fold is in east central Tolmonen Township; in this area the width of the metavolcanic unit is approximately 365 m (1200 feet) or about 1/4 or less of the width of the same unit in the eastern limb of the fold owing to thinning of the metavolcanics in the area of maximum curvature of the structure. The western limb of the fold has been largely obliterated by the intrusion of granitic rocks and is represented by the northeast-trending and northwest-dipping supracrustal rocks on the south side of the Batchawana River in northern Norberg Township. The general relationships just mentioned are further discussed when considering structural data from previous mapping south of the present map area (*see* "Structural Geology"). Previous mapping north of the present map area (Moore 1926) has indicated that the metavolcanic unit located in Raaflaub Township (former Township 26 Range 15) underlies a narrow strip of land within the southern part of this township, but more recent compilation maps (Giblin and Leahy 1967; Ayres *et al.* 1971) show that the unit extends outside the map area to the north and east of Raaflaub Township where it connects with the main northwest-trending belt underlying the eastern part of the map area. The same 2 maps show also that the unit consists of felsic to intermediate metavolcanics, but during present mapping that part of the unit within the map area was found to consist of basalt. Definition of the stratigraphic relationships of the metavolcanic units within the map area is made difficult by the fact that all these units are only partially exposed at the margins of the area, and by the fact that primary structures are found only in a few local areas underlain by metavolcanics of the main northwest-trending belt. This belt underlies the eastern sixth of the map area and extends beyond the northern, eastern, and southern boundaries of the latter. The northwest strike of metamorphic foliation in the metavolcanics of the belt parallels the overall trend of the belt and, to a large extent, the general trend of the aeromagnetic expression associated with it. The aeromagnetic and structural trends are at variance in a narrow strip of land adjacent to the eastern boundary of the map area where the aeromagnetic trend is essentially northerly (*see* ODM-GSC Aeromagnetic Map 2202G, 1963). Where compositional layering occurs in the metavolcanics the bedding and foliation planes were found to have the same (northwest) trend, and where evidence of bedding was lacking these planes were assumed to have the same trend. With the further assumption that the dip angles of metamorphic foliation and bedding are also about equal (*see* "Structural Geology") the maximum thickness of that part of the main belt within the map area is 9913 m (32 522 feet). Repetition by folding may account for part of this thickness. The dominant direction of dip is northeast and the facing directions in pillowed outcrops found at a few localities in Way-White Township indicate that the metavolcanics are, at least locally, overturned.

Lithologies

Basalt is the dominant lithologic type in the main 7 areas underlain by mafic metavolcanics, and rhyolite is the dominant felsic volcanic type particularly in the large unit on the southwest side of the main northwest-trending belt. Basaltic komatiite is of local occurrence within the basaltic portion of the main belt and at 1 locality in Raaflaub Township. Dacite is rare and is apparently restricted to some of the small felsic units interbedded with basalt or metasediments. Both the mafic and the felsic metavolcanics include porphyritic and fragmental types. Data on the chemical composition and trends of the metavolcanics are presented and discussed under "Petrochemistry of Metavolcanics".

Mafic Metavolcanics

Basalt, Basaltic Komatiite

This unit includes basalt and lesser basaltic komatiite. In general, the basaltic rocks of the main northwest-trending belt have lighter colour and finer grain size than those underlying the other parts of the map area. These differences reflect the lower metamorphic rank of the former (*see* "Metamorphism"). In the present case, regardless of the metamorphic rank of the rocks considered, basaltic komatiite can not be distinguished from basalt by means other than chemical analysis, and thus the general and microscopic descriptions given for basalt apply also to basaltic komatiite.

The basalt of the main northwest-trending belt is medium to light grey, grey-green, or green in colour on the fresh surface and weathers mostly to light grey and grey-tan hues; reddish-brown staining due to oxidation of minor pervasive pyrite disseminations may be locally present. Owing to lichen development, bleaching of outcrops close to stagnant water, and presence of a black crust on those along forested gullies or adjacent to flowing water, the colours of the weathered surfaces have no diagnostic significance. The rock is fine grained to aphanitic, dominantly affected by metamorphic foliation, locally massive, and may contain quartz veins and/or "pods" or, less commonly, calcite veins. Altered basalt is locally present. It has a very light grey colour on the fresh surface and an almost white weathered surface. The colour and the dense textural character of the aphanitic altered basalt in particular, are such that the rock may appear very similar to rhyolite. However, altered basalt is generally softer than rhyolite, although the reverse may be true if the rhyolite is strongly sheared, and lacks the sheen commonly imparted to rhyolite by the presence of muscovite microlites. Brown-grey ankeritic mottles may also be present on the whitish weathered surface of altered basalt. Pillow structures occur in a few outcrops in the St. Clair, Logan, Masten, and Raine Lake areas of Way-White Township and at 1 locality in the western part of the same Township. Relatively numerous pillows are found along the southern shore of Tribble Lake in Desbiens Township, outside and adjacent to the southern boundary of the map area. The pillows tend to be rather small and in most cases they can not be utilized for top determinations owing to their strained state, or to their elliptical or lobate outlines (e.g. Tribble Lake) from which no packing relationships may be inferred without 3 dimensional exposures which, as a rule, are lacking.

The basaltic metavolcanics other than those of the main northwest-trending belt are mostly medium to dark green on the fresh surface, and although they weather to generally lighter colours the difference may be practically insignificant. The rocks are fine to medium grained, occasionally coarse grained, lack primary features, are almost invariably well foliated, and are locally gneissic. The mafic rich layers of the gneissic variety may be almost black on both the fresh cut surface and the weathered surface (e.g. Raaflaub Township).

Porphyritic, Vesicular, and Porphyroblastic Basalt

Porphyritic and/or vesicular basalt is apparently very rare and because of this no specific mapping code has been used for this rock. The porphyritic texture is best seen on the fresh surface of massive or nearly massive basalt of low metamorphic rank (e.g. local outcrops in the St. Clair Lake area), and is defined by the presence of dull white grains, generally 0.5 mm in size, scattered through the aphanitic groundmass of the rock. The grains are of 2 types, namely, those consisting of variably altered subhedral plagioclase phenocrysts, and those consisting of carbonate(s) crystals or aggregates displaying sharply defined irregular or lenticular outlines, well developed polysynthetic twinning, and no recognizable plagioclase relics (*see* "Petrography of Basaltic Rocks"). The grains of the first type indicate a primary porphyritic texture, and those of the second type suggest either a primary porphyritic texture in which former plagioclase phenocrysts have been thoroughly replaced by carbonate(s), or a secondary filling of small vesicular cavities. Microscopic evidence suggests that both processes may have occurred, but in the field no observational criterion is consistently applicable to the distinction of these processes mainly because of the small size of the grains. The weathered surface of basalt of relatively high metamorphic rank (i.e. underlying areas other than that of the main northwest-trending belt) may locally show a texture characterized by abundant medium to dark green hornblende nodules. The nodules are generally 1 to 3 mm in size, and are set in a finer grained and lighter coloured groundmass. The texture of this rock is porphyroblastic (*see* "Petrography of Basaltic Rocks"), but as a rule this is not apparent on a fresh cut of the rock which has a uniform dense green colour.

Lapilli-Tuff, Tuff, Breccia

These rocks are of minor occurrence. Lapilli-tuff forms rare layers generally about 50 cm (16 inches) thick interbedded with basaltic flows at a few localities in western Way-White Township. Tuff layers 2 to 15 cm (1 to 6 inches) thick are interbedded with lapilli-tuff or basaltic flows in some of these localities, and at 1 locality in the Logan Lake area. Breccia was found only at 1 locality in northern Desbiens Township. Breccia is characterized by the angular to subangular outlines of the clasts contained within it. In all 3 types of fragmental rocks the clasts are rhyolite or dacite and the groundmass is basalt and accounts for an estimated 1/2 to 2/3 of the volume of the rock. The amount and composition of the groundmass, regardless of the composition of the clasts, are the criteria used to ascribe these rocks to the basaltic unit and to distinguish them from the pyroclastic felsic metavolcanics. The weathered surfaces of these rocks are heavily textured by white to greyish-white clasts commonly in slight relief owing to stronger erosion of the green or grey-green fine grained groundmass. The clastic texture is recognizable or clearly apparent also on the fresh cut depending on whether the latter is dry or wet. Lapilli-tuff and tuff are affected by variably severe shearing and because of this the clasts have elliptical or lens-like cross sections with axial ratios generally between 1:3 and 1:12. The breccia is the least deformed rock and contains many angular clasts the cross sections of which have axial ratios of 1:1.5 to 1:2, or about equant outlines. The clasts consist of dense to pumiceous rhyolite and represent an estimated 40% in volume of the rock. Although they are predominantly within the lapilli size range, they may be up to 14 cm (5.5 inches) long. Two excellent exposures of this rock were found close to the southern boundary of the map area, approximately 1200 m (4000 feet) west of Tribble Lake.

Petrography of Basaltic Rocks

The following petrographic description is based on 36 thin sections of basaltic samples, 21 of which are from the main northwest-trending belt, and 15 which are from the other volcanic units in the map area.

In order of decreasing abundance, chlorite, carbonates, and plagioclase are generally the principal components of metabasalt from the main northwest-trending belt. The volume of carbonates was found to exceed that of chlorite in a few thin sections. Chlorite commonly accounts for an estimated 60 to 70% in volume of the rock, has pleochroic colours ranging from green, grey-green, or brownish-green to nearly colourless, and in some sections shows the anomalous blue interference colour characteristic of penninite. It occurs as scaly, lamellar, and fan-shaped aggregates of relatively large size and, together with carbonates, epidote, and hematite, as a component of the cloudy cryptocrystalline groundmass of the rock. Depending upon the mutual proportions of large chloritic aggregates and groundmass, 1 of 3 general textural types may result. A common type is a rather uniform cloudy cryptocrystalline texture resulting from lack of large chloritic aggregates and poor definition of the few that are present. The reverse conditions produce a relatively coarse texture characterized by the abundance of large randomly oriented shreds and lamellar aggregates of chlorite, and by the interstitial nature of the little cryptocrystalline groundmass present between them. The third textural type is "porphyritic" in appearance and occurs where the large chloritic aggregates or shreds and the cryptocrystalline groundmass are both present in significant proportions. These features are interpreted to be due to the effects of slight differences in metamorphic conditions which were sufficent to modify the texture of the rock, but were too small to be recorded by changes in mineralogical composition. Carbonates are ubiquitous as cryptocrystalline groundmass components, as subhedral individual crystals or as aggregates of euhedral interlocking crystals filling tiny fracture networks and pinpoint vesicles, and as alteration or replacement products of plagioclase phenocrysts in porphyritic basalt. Polysynthetic twinning is commonly well developed in the carbonates. Plagioclase occurs as subhedral to anhedral laths which are mostly 0.08 to 0.2 mm in size, and which are commonly affected to variable extent by carbonatization and kaolinization. In many cases the plagioclase laths maintain their original outlines but have been thoroughly decomposed by these alteration processes. The composition of plagioclase could not be determined in 17 of the 21 thin sections that were examined; it was found to be albite (An_5), andesine (An_{34}, An_{41}) and oligoclase (An_{21}) in 1, 2, and 1 of the remaining 4 thin sections, respectively. The common accessory minerals are quartz, epidote, hematite, leucoxene, and pyrite. Rare accessory minerals include biotite, muscovite, actinolite, zircon, and pyroxene relics. One thin section of breccia (*see* "Lapilli-tuff, Tuff, Breccia") shows that the matrix of the rock is basaltic, is of the uniform cryptocrystalline type previously described, and that the clasts consist of porphyritic rhyolite. Because these clasts are a subordinate component of the unit, it was found preferable to give their description in this subsection rather than in the following general subsection on the rhyolitic and dacitic rocks. The clasts have angular to subrounded outlines and, in thin section, have long dimensions of 2 to 12 mm. The porphyritic texture of the clasts results from the presence of 3 types of phenocrysts differing from each other in size, composition, and shape, embedded in a microcrystalline quartzofeldspathic matrix. This matrix has grain size of 0.012 to 0.034 mm, is dominantly feldspathic, and consists in part of cloudy aggregates of cryptocrystalline chlorite, sericite, epidote, and lesser hematite. The amount of these alteration products varies among individual clasts but does not exceed a estimated maximum of 8% by volume of any clast. The cryptocrystalline aggregates transect the boundaries of some clasts, and this suggests the possibility that hydrothermal alteration was induced in these clasts by the basalt which engulfed them (i.e. present groundmass of the breccia). The prominent type of phenocrysts includes feldspar crystals generally between 0.3 and 0.7 mm but up to 2.5 mm in size. Many of these phenocrysts have rhomboidal or hexagonal outlines (*see* Photo 1), and virtually all of them are thoroughly replaced by a dense aggregate of cryptocrystalline epidote which may be mottled by hematitic striations. Where iron oxides are present in more than trace amounts, they tend to concentrate at the margins thus emphasizing the outlines of the phenocrysts. A second kind of phenocryst includes fresh looking crystals which are untwinned, have rather uniform size of 0.045 to 0.07 mm, give a biaxial interference figure, and show first order white-yellowish birefringence. The unusual feature of these crystals, which are probably albitic plagioclase, is that many of them tend to be, and some are, almost perfectly square in shape. The third kind of phenocryst includes a few subrounded or amoeba shaped quartz domains up to 1.3 mm in size. The quartz in these domains is unstrained and unusually pure owing to lack of inclusions. The rounded embayments characteristic of the larger amoeboid domains are clear evidence of magmatic corrosion at the margins of formerly euhedral quartz phenocrysts.

Hornblende and plagioclase are the principal components of the basaltic units except in the main northwest-trending belt. Variable amounts of one or more of chlorite, carbonates, and epidote were seen in 5 of the 15 thin sections that were examined, and accessory actinolite was found in 2 of the chlorite-bearing thin sections. Chlorite, carbonates, epidote, and to a lesser extent hematite, occur essentially as cryptocrystalline groundmass components; epidote and/or carbonates are also present as alteration or replacement products of feldspars. The common accessory minerals are quartz, hematite (present also as an oxidation product of pyrite), penninite, garnet, pyrite, and microcline. Biotite, muscovite, clinopyroxene relics, and zircon (as inclusions in hornblende) are rare accessory minerals. Hornblende commonly accounts for 50 to 80% of the composition of basalt, and in a few cases is virtually the only component of the rock. It has pleochroic colours ranging from light green and tan to intense green and has 2

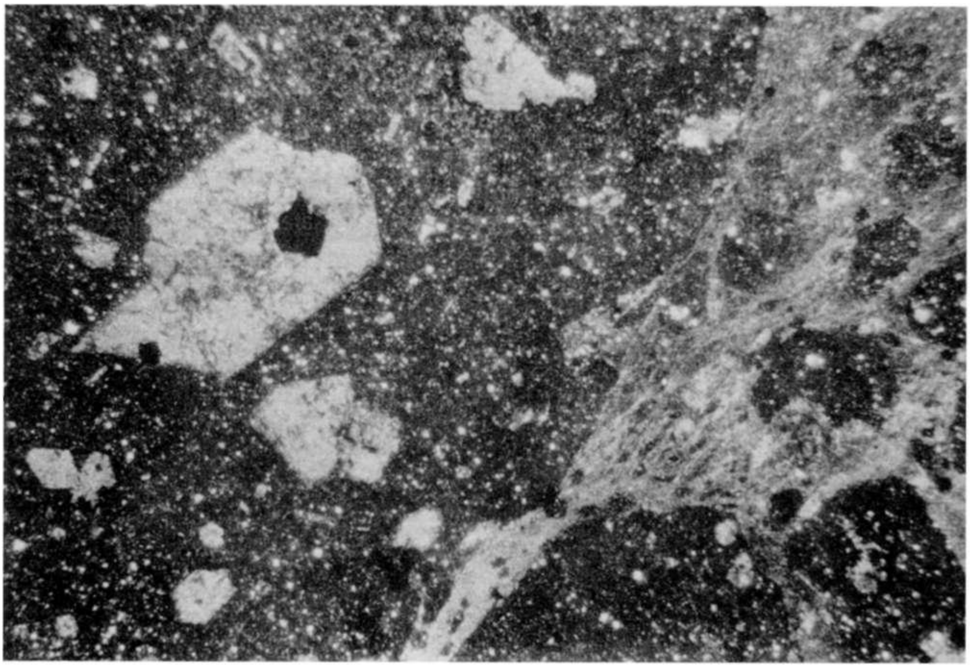


Photo 1. *Photomicrograph of volcanic breccia showing clasts of porphyritic rhyolite (large grey fields) separated by an interstitial aggregate of cryptocrystalline chlorite and carbonates (nebula-like patch on right side). Small clasts of porphyritic rhyolite are also partially visible within the area occupied by the cryptocrystalline matrix of the breccia. Note the feldspar phenocrysts embedded within the microcrystalline groundmass of the clasts. The 2 black objects within the largest feldspar phenocryst are abraded spots in the thin section (crossed nicols, sample 5-25-4).*

general modes of occurrence: (1) as euhedral strongly pleochroic equigranular microlites which are elongated or prismatic in habit, subparallel in fabric, and are uniformily distributed throughout the rock, and (2) as irregularly shaped patchy aggregates of grains which are heterogeneous in shape, size, and orientation. In the fine grained basalt the size of the individual hornblende microlites generally ranges between 0.024 and 0.047 mm. Part of the amphibole clustered in the aggregates may show noticeably less dichroism than does the amphibole of prismatic habit, particularly where subordinate amounts of chlorite are present. The patchy aggregate texture is more common than the prismatic texture and indicates prophyroblastic growth of the amphibole owing to a slight shift of metamorphism toward higher rank conditions. By further increase in metamorphic rank the heterogeneous aggregates give place to euhedral hornblende phenocrysts up to 4 mm long separated by minor amounts of interstitial microcrystalline quartz-feldspar matrix. Hornblende commonly has segregations of iron oxides and only rarely is seen to be pseudomorphic after clinopyroxene. Plagioclase generally accounts for an estimated 10 to 25% of the rock in volume and occurs as a component of the microcrystalline groundmass, and rarely as subhedral phenocrysts up to 1.2 mm in size. It is replaced to a variable extent by epidote and carbonates, such that determination of the original composition is for the most part impossible. However, the extent and type of the alteration products and the length-slow character of albite twinning observed suggest that the plagioclase was fairly calcic in composition. Quartz is the most common accessory mineral and occurs mostly as a groundmass component and is distinguishable from plagioclase by its lack of alteration. It may also be present in the form of minute poikilitic inclusions within hornblende porphyroblasts, and as aggregates of fresh looking interlocking crystals filling fracture networks. The total amount of quartz seldom exceeds an estimated 4% in volume of the rock.

Felsic Metavolcanics

Rhyolite, Dacite

This unit includes rhyolite and minor dacite. Because, in the present case, no criteria other than chemical analyses are consistently applicable to the distinction of these 2 types, the descriptions of the general and microscopic characters given for rhyolite apply also to dacite. Rhyolite includes agglomeratic, tuffaceous, and porphyritic types, and rare breccia. These rocks are almost invariably sheared. The effects of shearing range from a merely perceptible foliation which does not induce loss of cohesion in the rock, to a schistosity such that hundreds of paper-thin laminae are packed within a thickness of rock of about 2 cm. Where the second condition applies (e.g. local areas of northern Desbiens Township) the rock reduces to a soft muscovite schist which, owing to its extreme fissility, reacts almost elastically to impact. While the intensity of shearing varies between the 2 extreme conditions just mentioned, it is generally sufficent to prevent a meaningful interpretation of the small scale textural features observed in the field and, to a lesser degree, also in thin section. Thus, for instance, sheared porphyritic rhyolite and rhyolite-tuff are mostly indistinguishable in the field, and may be distinguishable only under particular conditions in thin section. For this reason these 2 types have been ascribed to the same unit (unit 2d).

Rhyolite Flows

Rhyolite is commonly aphanitic to fine grained, foliated to strongly schistose, and rarely massive or nearly so. It has very light grey to green or cream colours on the fresh cut, and weathers mostly dull white which may be mottled by pinkish or greenish hues. The schistose variety may include metamorphic derivatives of one or more of the porphyritic and/or fragmental types described below.

Porphyritic Rhyolite, Rhyolite Tuff

The weathered surfaces of these rocks are textured by few to abundant inclusions which are mostly 1 to 3 mm or less in size. They have nearly equant, ovoid or lensoid outlines depending upon the intensity of deformation undergone by the rock. In general these inclusions are lighter coloured than the rhyolite within which they are embedded, but they can not be recognized on the fresh cut surface of the rock. In the rocks that were thin sectioned the evidence of primary porphyritic texture is widespread, and the evidence suggesting a primary fragmental texture (i.e. lithic tuff, crystal tuff) is uncertain and scarce. On this basis it is tentatively suggested that porphyritic rhyolite and rhyolite tuff represent major and subordinate types, respectively. These rocks occur mostly within the large felsic unit on the southwest side of the main northwest-trending mafic metavolcanic belt.

Rhyolite Agglomerate

This rock consists of variably well defined white ovoid and lensoid rhyolite clasts generally 5 to 13 cm (2 to 5 inches) thick and 15 to 35 cm (6 to 14 inches) long, embedded in a fine grained rhyolitic matrix (*see* Photo 2). The matrix commonly accounts for an estimated 20 to 50% of the rock in volume, and may have a light greenish-tan colour, or may be white and thus distinguishable from the clasts with some difficulty. In some outcrops the clasts are closely packed together and the matrix is a minor component of the rock. Many clasts have uniform colour and texture throughout their cross sections, while others have thin rims of appreciably darker colour. These rims may be slightly finer grained than, or have the same grain size as, the rock at the core of the clasts. This evidence is interpreted by suggesting that the clasts showing rims are volcanic bombs, the outer portions of which were partially chilled before the bombs were engulfed, upon reaching the ground, by rhyolitic lava which also contained fragments of solidified rhyolite (i.e. the clasts with uniform colour and texture). Agglomerate is found in northern

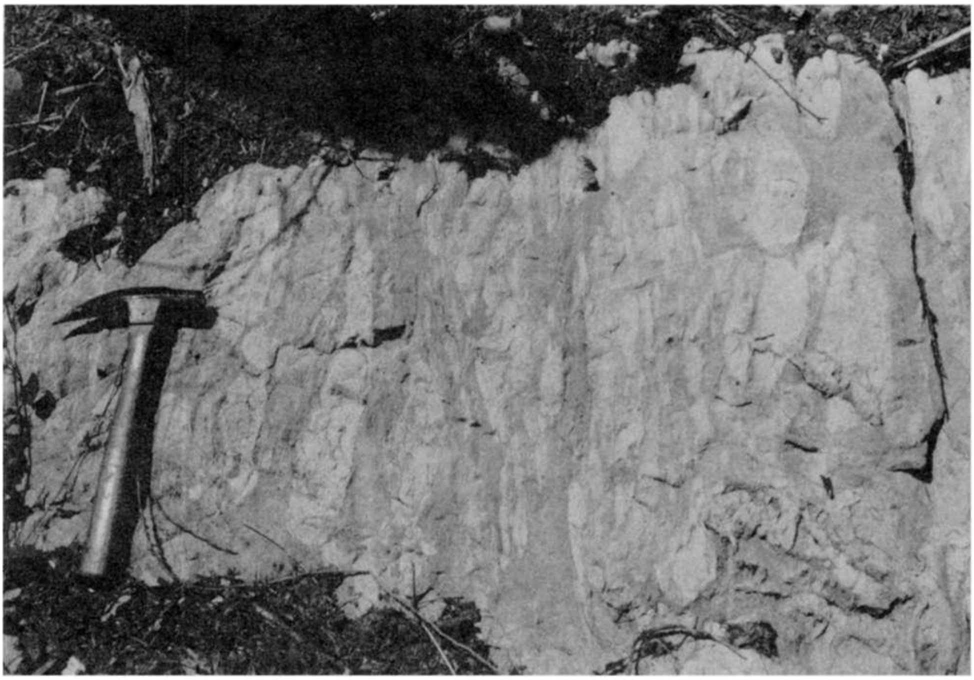


Photo 2. *Sheared rhyolite agglomerate; Martin Lake area, Vibert Township.*

Desbiens, southwestern Way-White, and western Vibert Townships, and is commonly interbedded with porphyritic rhyolite and/or rhyolite tuff. Because many outcrops of muscovite schists might consist of sheared (and thus unrecognizable) agglomerate or breccia (described below), these types could be more widespread than shown on the accompanying maps.

Rhyolite Breccia

This rock is rare and consists of dominantly angular rhyolite clasts that are mostly 2 to 30 cm (1 to 12 inches) in size embedded in a rhyolitic matrix which accounts for an estimated 5 to 15% of the rock in volume. The matrix contains about 60% in volume of clasts with size of 1 to 20 mm (0.04 to 1 inch). The colour and texture of the clasts and of the matrix are identical on both the fresh cut and the weathered surface of the rock; the fresh cut and the weathered surface have uniform light grey, and white-greenish colours, respectively. The clastic nature of the rock is revealed by networks of thin dark lines which mark the interface between matrix and clasts, and which are visible only in smooth areas of the weathered surface. The only outcrop of this rock that was found is a prominent one, and is located in north central Desbiens Township about 600 m (2000 feet) north of the southern boundary of the map area.

Petrography of Rhyolitic Rocks

Examination of 15 thin sections has shown that the porphyritic character of rhyolite is the most recurrent textural feature of this rock, regardless of whether the latter is a flow (Photo 3), or is part of the clastic fraction or the matrix in the pyroclastic types (Photo 4). In relatively unmetamorphosed rhyolite the porphyritic texture is defined by randomly oriented euhedral plagioclase phenocrysts embedded in a microcrystalline quartzo-feldspathic groundmass which commonly contains accessory amounts of one or more of muscovite, chlorite, sericite, carbonates, epidote, iron oxides, and pyrite. The feldspar phenocrysts are commonly altered by kaolinization and sericitization and the widespread occurrence of these alteration

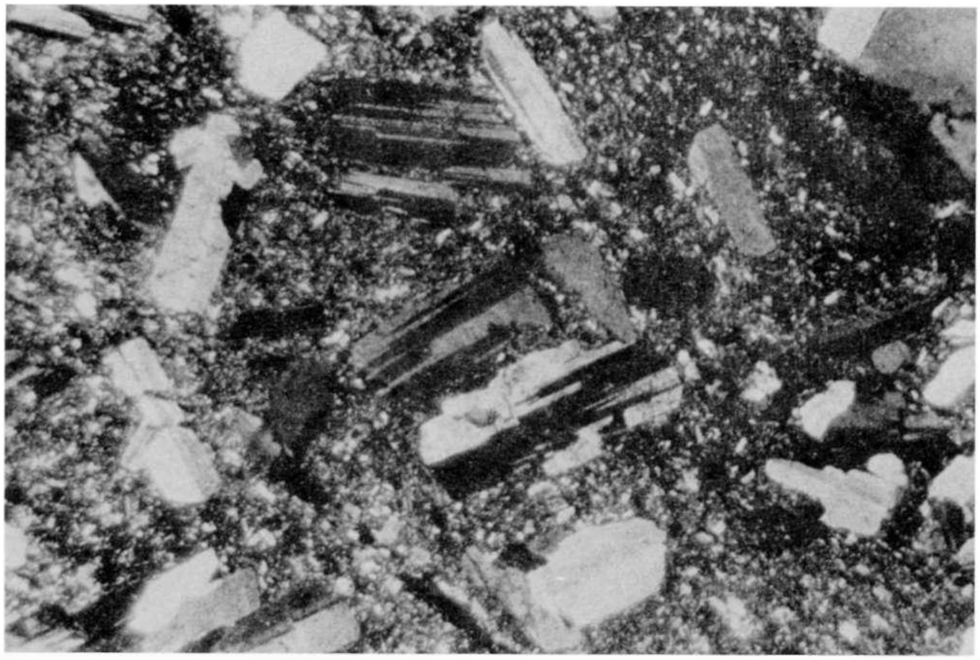


***Photo 3.** Photomicrograph of porphyritic rhyolite flow showing oligoclase (An_{20-29}) phenocrysts embedded in a microcrystalline quartzo-feldspathic matrix (crossed nicols, sample 4-19-5A).*

processes is typical of porphyritic rhyolite. Where extreme alteration of the phenocrysts has developed, the existence of a primary porphyritic texture may be apparent only in plane polarized light where it is revealed by the distribution of iron oxides and, notably, of hematite. This is due to the concentration of iron oxides in hexagonal, rectangular, or rhomboid patterns which mark the margins of former feldspar phenocrysts indistinguishable from the groundmass under crossed nicols. Because microscopic evidence of primary crystal fragments is rare and uncertain, rocks which in the field may be interpreted as crystal tuff are likely to be porphyritic flows in which variably developed shearing has modified, or obliterated, the former euhedral habit of the feldspar phenocrysts. The presence of lithic fragments 2 to 3 mm or less in size, is the only practical microscopic criterion suitable to identify tuffaceous rhyolite. These fragments commonly occur as a subordinate component of the coarse fraction of breccia and agglomerate, and consist of porphyritic rhyolite and, rarely, of variably altered aggregates of equant interlocking feldspathic crystals containing subordinate quartz. Due to shearing, the outlines of both types of fragments tend to be ovoid or lensoid in shape, and their fabric may show a variable degree of preferred orientation. Rhyolite breccia consists of blocks, lapilli, and lesser tuff-size clasts, embedded in a groundmass of cryptocrystalline muscovite and chlorite containing lesser amounts of thoroughly altered feldspars, and accessory quartz and opaques. Virtually all clasts, regardless of their size, consist of porphyritic rhyolite. The porphyritic rhyolite clasts are much the same as the previously described clasts in the mafic breccia.

Petrochemistry of Metavolcanics

Chemical analyses performed by the Geoscience Laboratories, Ontario Geological Survey, Toronto of 23 samples of mafic metavolcanics, and of 12 samples of felsic metavolcanics are shown in Table 2. Fifteen of the 23 mafic metavolcanic samples are from the main northwest-trending belt. They are aphanitic to fine grained rocks of light to medium grey-green or green colour. Four of the remaining 8 mafic

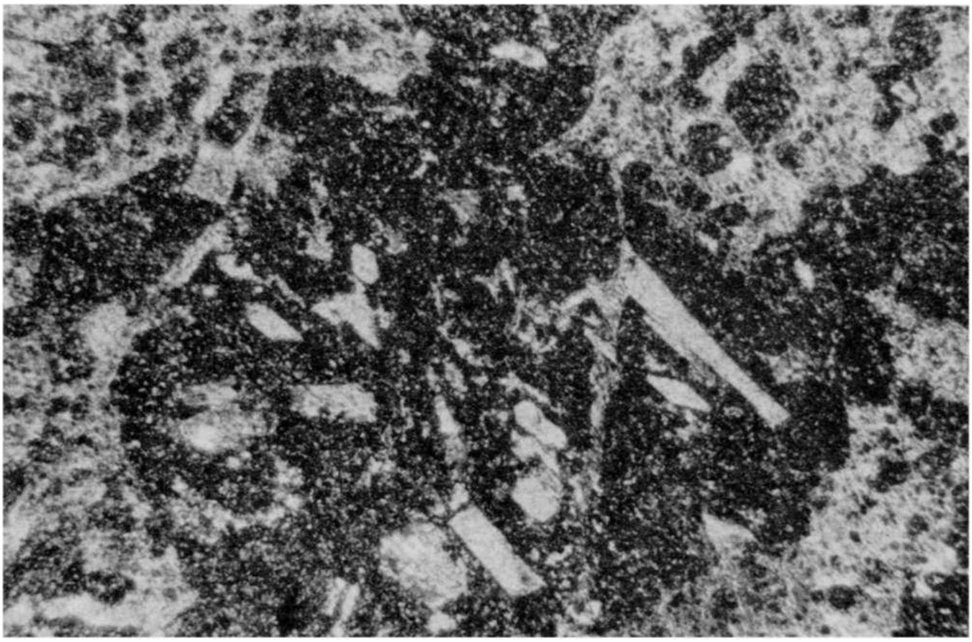


Photo 4. *Photomicrograph of rhyolite breccia showing clasts of porphyritic rhyolite (grey areas) embedded in a groundmass of cryptocrystalline muscovite and chlorite. This rock is texturally similar to mafic breccia (compare with Photo 1) and differs from the latter in that it contains a greater proportion of large clasts and has a felsic matrix (crossed nicols, sample 5-25-5).*

metavolcanic samples are from the large north-trending unit at the boundary of Tolmonen and Tronsen Townships, 3 are from the unit in Raaflaub Township, and 1 is from the westernmost unit along the southern boundary of the map area. These 8 samples are fine to medium grained rocks that are mostly of medium to dark green colour. Seven of the 12 samples of felsic metavolcanics are from the prominent felsic unit on the southwest side of the main northwest-trending belt; the remaining 5 samples are from small felsic volcanic layers which are interbedded with metasediments at 4 localities of Tronsen Township, and with mafic metavolcanics at 1 locality of Way-White Township. These samples are fine grained to aphanitic rocks of very light grey to white colour. The numbers identifying the chemical analyses in Table 2 and on Figure 2 correspond to those shown on the geological maps accompanying this report (*see* back pocket). The chemical trends of the analyzed rocks are shown in the ternary cation plot of Figure 2. The analyzed volcanics are few in number and include rocks in which colour changes have resulted from variable conditions of metamorphism. These conditions prevent, in the present case, unambiguous correlation of colour and chemical composition. Because of this the correlation is omitted, and the plot is used only to outline general chemical trends. Figure 2 shows that the mafic metavolcanics are mostly tholeiitic basalts of iron-rich and magnesium-rich types, the former being more common. The significance of the 3 plots within the calc-alkaline basaltic field (samples 12, 17, 20) is limited by their closeness to the field boundary. The same applies to the plot of sample #16 in the field of tholeiitic dacite. The main features illustrated by the plot are: (1) that the basaltic rocks have a larger spread in magnesium content than in iron content and they vary in composition from basalt to basaltic komatiite; (2) that volcanics of intermediate composition are lacking, and (3) that the felsic metavolcanics are essentially calc-alkaline in trend. One of the samples that plots in the basaltic komatiite field is from Raaflaub Township (sample 3) and the other 2 are from the main northwest-trending belt (samples 18, 19). Six of the 7 basaltic samples from the southern section of this belt plot in the iron-rich portion of the tholeiitic field (samples 24, 28, 30, 31, 32, 33), 2 of the 4 samples from the northern section of the belt plot in the same area of the same field (samples 5, 6), and the remaining 2 plot in the magnesium-rich portion of the tholeiitic field (samples 4, 7) together with one of the samples from the southern section of the belt (sample 29). Except for the apparent predominance of iron-rich tholeiite at the top of the basaltic section of the main northwest-trending belt, the present data appear to be insufficent to indicate significant trend changes, if any, across strike in this section. More data would be desirable but much difficulty was encountered in sampling volcanics that were not visibly altered.

One of the 4 samples from the north-trending basaltic unit in western Tronsen Township plots in the magnesium rich portion of the tholeiitic field (sample 26), and the other 3 plot virtually at the boundary of the calc-alkaline and tholeiitic fields (samples 11, 12, 20). Apart from the spread in magnesium content between samples 20, and 26, the plots of the 4 samples suggest that the basalt along the whole length of the unit has a relatively uniform chemical character.

Two of the 3 samples from the basaltic unit located in Raaflaub Township plot in the iron rich portion of the tholeiitic field (samples 1, 2), and the third one plots in the field of basaltic komatiite (sample 3). Without further chemical data the coexistence of these divergent trends within a small area of the unit is of problematic interpretation.

Samples from thin felsic volcanic layers interbedded with metasediments or basalt plot either in the fields of calc-alkaline dacite (samples 9, 34) and tholeiitic dacite (sample 16), or at the boundary separating the fields of calc-alkaline rhyolite and dacite (samples 8, 35). These relationships suggest that the occurrence of "dacite" may be restricted to the thin felsic interbeds. Six samples from the large felsic unit on the west side of the main northwest-trending belt, and 1 sample from the relatively thick felsic interbed located on the east side of Carpenter Lake (Tronsen Township), all plot in the field of calc-alkaline rhyolite (samples 10, 14, 21, 22, 23, 27, 13).

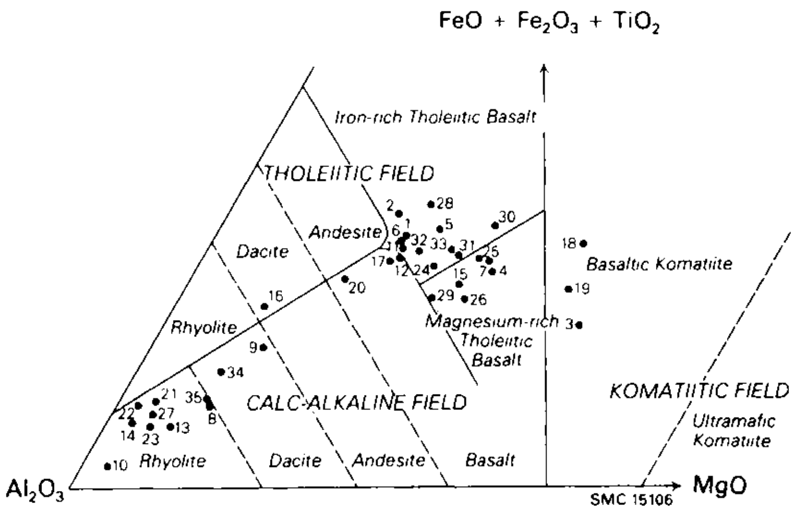


***Figure 2.** Simplified Jensen (1976) Cation Plot of chemical analyses shown in Table 2; only the portion of the cation plot close to the Al_2O_3 vertex is shown.*

TABLE 2 PARTIAL CHEMICAL ANALYSES OF METAVOLCANIC ROCKS FROM THE BATCHEWANA-PANGIS AREA.

Major Components in Weight Percent

Analysis Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Field Sample Number	0-11-4	0-11-5	0-11-10	1-22-1	1-22-1A	1-23-1	1-24-2	1-24-4	2-10-222	2-22-11	3-7-74	3-7-75	3-11-452	3-20-58	3-22-1	3-24-1A	3-24-3	3-24-6
SiO_2	51.90	49.10	49.80	48.80	50.70	50.40	48.50	66.90	63.90	73.80	49.60	47.70	72.10	74.10	52.80	61.20	49.00	28.70
Al_2O_3	15.30	14.70	12.40	13.90	14.00	14.90	14.40	16.20	16.50	16.10	15.50	16.80	15.90	15.80	12.30	15.70	16.00	17.90
Fe_2O_3	1.90	2.46	1.32	0.90	2.70	3.76	2.80	0.75	1.90	0.08	3.76	2.80	0.70	0.25	3.74	3.63	6.09	2.10
FeO	9.61	10.20	7.57	10.20	9.68	8.05	9.11	1.63	3.13	0.29	7.78	9.03	0.90	1.24	4.88	3.09	4.96	20.20
MgO	4.72	4.22	11.30	7.98	5.53	4.67	8.31	1.48	2.13	0.35	5.07	5.51	1.00	0.39	5.97	1.70	4.98	17.80
CaO	9.09	12.00	10.30	6.19	8.85	11.50	9.41	1.94	3.70	0.13	11.20	10.10	2.10	0.40	8.96	4.10	11.70	1.46
Na_2O	3.33	2.21	2.14	2.62	2.59	1.53	2.76	5.44	5.03	0.41	2.71	3.42	3.83	4.31	5.31	4.17	1.76	0.08
K_2O	0.51	0.55	0.60	0.02	0.19	0.05	0.04	2.16	1.38	6.67	9.24	9.28	2.84	1.22	0.40	1.59	0.03	0.01
TiO_2	1.42	1.50	0.57	0.89	1.15	0.94	0.85	0.49	0.53	0.38	1.15	1.21	0.36	0.43	0.82	0.69	0.71	1.71
P_2O_5	0.16	0.09	0.32	0.09	0.11	0.11	0.10	0.13	0.15	0.08	0.10	0.10	0.04	0.10	0.14	0.18	0.07	0.15
S	0.00	0.02	0.00	0.03	0.04	0.01	0.11	0.01	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.20	0.03	0.01
MnO	0.36	0.36	0.26	0.19	0.28	0.24	0.19	0.04	0.06	0.00	0.21	0.27	0.02	0.02	0.17	0.11	0.23	0.43
CO_2	0.00	0.23	0.00	4.84	1.00	0.33	0.22	1.00	0.00	0.08	0.00	0.00	0.10	0.18	3.10	0.66	1.95	0.10
H_2O^+	1.07	0.86	1.99	5.12	2.62	2.07	2.59	1.49	1.67	1.08	1.43	0.47	0.60	1.00	1.87	1.58	2.77	10.10
H_2O^-	0.00	0.28	0.00	0.26	0.31	0.28	0.25	0.22	0.00	0.42	0.00	0.00	0.31	0.61	0.23	0.39	0.23	0.33

Note: Partial chemical analyses performed by the Geoscience Laboratories, Ontario Geological Survey, Toronto.

TABLE 2 — continued

Major Components in Weight Percent

Analysis Number	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Field Sample Number	3-24-9	4-8-3	4-21-91	4-22-146	4-22-147	4-26-1A	5.1-4	5-8-1	5-24-6	5-25-6	5-25-8	5-25-11	5-26-3	5-26-7	5-26-13	R-1	R-5
SiO_2	46.30	52.20	65.40	73.30	71.80	48.90	48.30	47.90	71.10	44.70	52.00	42.90	45.90	43.20	49.40	65.10	63.40
Al_2O_3	13.30	16.30	15.80	14.20	14.70	14.60	14.50	16.50	14.00	12.40	15.80	15.70	15.80	14.40	14.30	16.60	18.10
Fe_2O_3	2.10	2.50	0.52	1.22	0.38	3.20	1.94	1.95	0.14	0.50	1.79	2.80	3.30	1.20	3.90	1.21	1.01
FeO	9.67	6.55	1.75	0.65	1.06	7.56	10.40	8.60	1.53	11.80	7.28	13.40	9.33	9.18	7.65	2.65	1.73
MgO	11.70	3.59	0.59	0.31	0.60	5.96	7.81	8.32	0.54	4.51	6.30	8.96	7.55	5.12	6.51	1.45	1.85
CaO	8.30	12.10	4.37	0.36	1.90	13.10	10.80	10.30	3.31	11.50	7.28	5.04	10.10	11.10	9.51	2.44	2.07
Na_2O	1.71	2.28	3.30	3.26	3.39	1.36	2.02	2.47	2.78	0.61	3.63	2.83	2.02	1.50	3.95	4.31	3.96
K_2O	0.06	0.24	2.57	3.87	2.34	0.04	0.31	0.24	1.90	0.26	0.81	0.17	0.06	1.41	0.51	2.12	3.93
TiO_2	0.63	0.93	0.38	0.39	0.34	0.80	0.90	0.85	0.34	0.98	0.84	1.60	1.27	1.27	1.18	0.42	0.42
P_2O_5	0.08	0.08	0.10	0.14	0.12	0.10	0.02	0.07	0.09	0.09	0.07	0.14	0.11	0.13	0.12	0.04	0.02
S	0.05	0.00	0.01	0.04	0.01	0.01	0.03	0.00	0.01	0.01	0.01	0.01	0.06	0.02	0.01	0.01	0.01
MnO	0.25	0.23	0.05	0.06	0.04	0.20	0.02	0.20	0.05	0.19	0.22	0.29	0.20	0.42	0.31	0.05	0.03
CO_2	2.28	0.00	3.30	0.22	1.30	2.12	0.12	0.00	2.76	9.84	0.46	0.14	0.23	6.40	0.56	0.21	0.18
H_2O^+	4.26	2.35	1.17	1.18	1.43	2.43	1.08	1.71	1.37	4.27	2.17	5.04	3.32	3.52	1.31	1.51	1.46
H_2O^-	0.22	0.00	0.38	0.15	0.14	0.19	0.30	0.00	0.32	0.43	0.39	0.49	0.35	0.57	0.42	0.45	0.44

METASEDIMENTS

The general term "arenite", and the specific terms "arkose", "arkosic wacke", and "subarkosic wacke" used in this report to describe metasediments which are dominantly within the sand-size range (i.e. 0.06 to 2 mm), are defined after Wood (1975) (*see* Figure 3). Because recrystallization has variably affected the primary textural features of these rocks, the present arkose may in part include recrystallized wacke. The term "siltstone" describes metamorphosed clastic sedimentary rocks with grain particles dominantly within the silt size range (i.e. 0.004 to 0.06 mm), and which have, as a rule, very low mafic content; these rocks can not be meaningfully ascribed to either the wacke or the mudstone categories of the present classification scheme for reasons stated further on, *see* "Siltstone". The term "iron formation" is also defined under that section heading.

Arkose, Arkosic Wacke, Subarkosic Wacke

This unit includes arkose, arkosic wacke, and minor subarkosic wacke. These rocks have brown to grey-brown weathered surfaces, are medium to dark grey on the fresh cut, and show a well developed metamorphic foliation determined by the fabrics of biotite and of deformed larger grains of feldspars and quartz. The weathered surfaces may be locally heavily textured by staurolite (Photo 5). The type localities for this unit are northern Tronsen and south central Raaflaub Townships, and parts of northeastern Norberg Township.

The following petrographic description is based on 15 thin sections. The main components are feldspars, biotite, and quartz. In the arkose and arkosic wacke the amounts of these minerals vary between 55 and 76, 15 and 40, and 12 and 23 volume percent respectively, and in the subarkosic wacke the ratios of their volumes are approximately 5:2:3. The feldspar content drops to about 30% in volume in the rocks containing 10% or more staurolite. The feldspars and quartz in the fine grained fractions of the arkosic and subarkosic wackes are mostly equant and vary in size from 0.061 to 0.082 mm.

In the arkose and the coarse grained fractions of the arkosic and subarkosic wackes they are elongated with a consistent width/length ratio of about 1 to 2, and width of 0.15 to 0.18 mm.

Owing to recrystallization the rocks of this unit are very fresh looking in thin section and twinning of feldspars is very rare. In a few cases, however, retrograde metamorphism has resulted in the replacement of the feldspars by cloudy masses of alteration products and in the replacement of biotite by chlorite. Because of alteration the composition of the feldspars could not be established in 4 thin sections. The refractive indexes of feldspars were less than 1.537 in 2 of the remaining 11 sections, greater than 1.537 in another 7 sections one of which contains andesine (An_{49}), and gave uncertain results in the last 2 sections. Plagioclase with anorthite content greater than An_{21} appears to be the most abundant feldspar; the alkali feldspars (potassium feldspar, albitic plagioclase) occur in subordinate concentrations. Biotite is euhedral, shows strong preferred orientation, commonly contains zircon inclusions, and is markedly dichroic (yellow-dark brown). The whole fabric of biotite is generally optically continuous. Five percent euhedral muscovite associated with biotite occurs in 1 sample. Staurolite and garnet in amounts varying from trace to 17 and 5% in volume, respectively, may be present as subordinate minerals, and in the form of crystalloblasts which transgress the biotite and the quartz-feldspar fabrics. Iron oxides and epidote are common accessory minerals. Epidote, in the form of cryptocrystalline aggregates replacing feldspars, is a main component of the rocks affected by retrograde metamorphism. Minor hornblende was present in 2 thin sections, and traces of a low birefringence colourless mineral (andalusite?) occur in another thin section.

Siltstone

This unit includes metamorphosed epiclastic sediments consisting largely of grain particles within the silt size range and having a sand size fraction which seldom

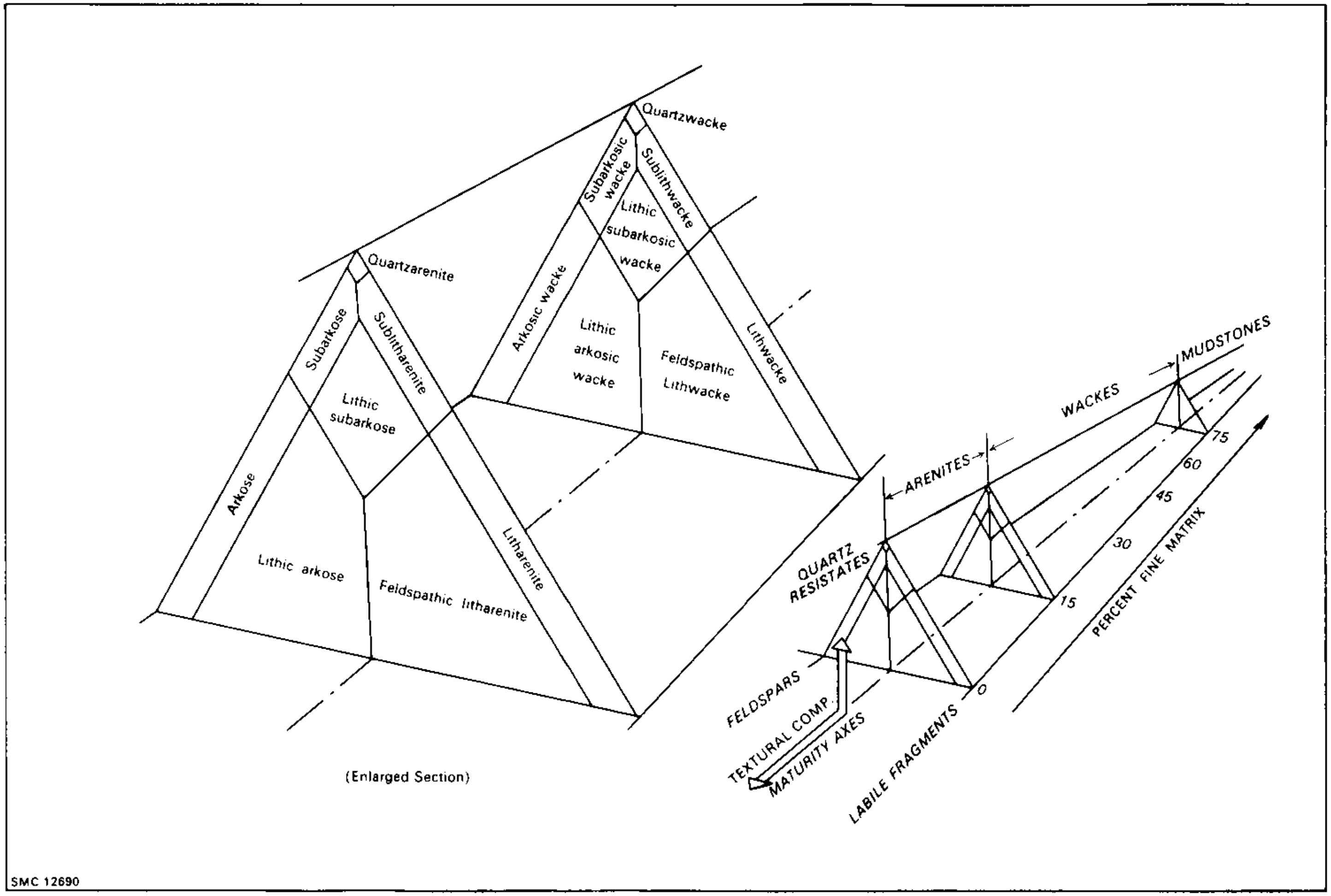


Figure 3. *Scheme for classification of sandstones, after Wood (1975).*

Photo 5. *Euhedral staurolite crystals in arkose; Patterson Lake, Tronsen Township.*

exceeds 8% in volume. Because these rocks contain more than 75% of grains that are silt size or smaller, they can not be ascribed to the wacke category. On the other hand, as they rarely contain significant amounts of particles that are under silt size, they can not be ascribed to the mudstone category without assuming that their present grain size is the result of recrystallization of formerly finer grained rocks. This assumption, although it may be valid in some cases, is unjustified for the bulk of the rocks in this unit. Therefore, Wood's (1975) nomenclature is not applied to this unit and the rocks within it are collectively referred to as siltstone. Siltstone has tan, light grey, greenish, or nearly white weathered surfaces which often show a fine granular texture. With some exceptions, the fresh cuts have a homogeneous dense texture, and a slightly darker colour than the weathered surfaces. Siltstone is generally medium to thickly bedded (10 cm to 1 m). It forms a main lithologic unit in Tronsen Township and is well exposed in the Mitchell Lake area of the same Township. Because of its fine grained texture and low mafic content it is readily distinguished from the arkose and wackes but transitional types do occur locally. In small outcrops lacking evidence of bedding the distinction of siltstone from felsic volcanics may be problematic because these rocks are very similar in composition. With reference to rocks that are not sheared, siltstone breaks into fragments which tend to be parallelepiped-like in shape whereas the volcanics break into splinters delimited by jagged or conchoidal surfaces. Fracturing along surfaces that are parallel or nearly so is more pronounced in aphanitic varieties of cherty siltstone. Moderately sheared siltstone may occasionally be distinguished from felsic volcanics due to the presence, in the siltstone, of bedding oblique or parallel to the shearing plane, but where strong shearing has affected the rock, as for example in some areas at the boundary of Vibert and Way-White Townships, the geological boundary separating siltstone from felsic volcanics is necessarily interpretative.

The following petrographic description is based on 26 thin sections. The main components of siltstone are feldspars and quartz with grain size range and mean value of 0.008 to 0.05 mm, and 0.034 mm, respectively. About 1/4 of the samples

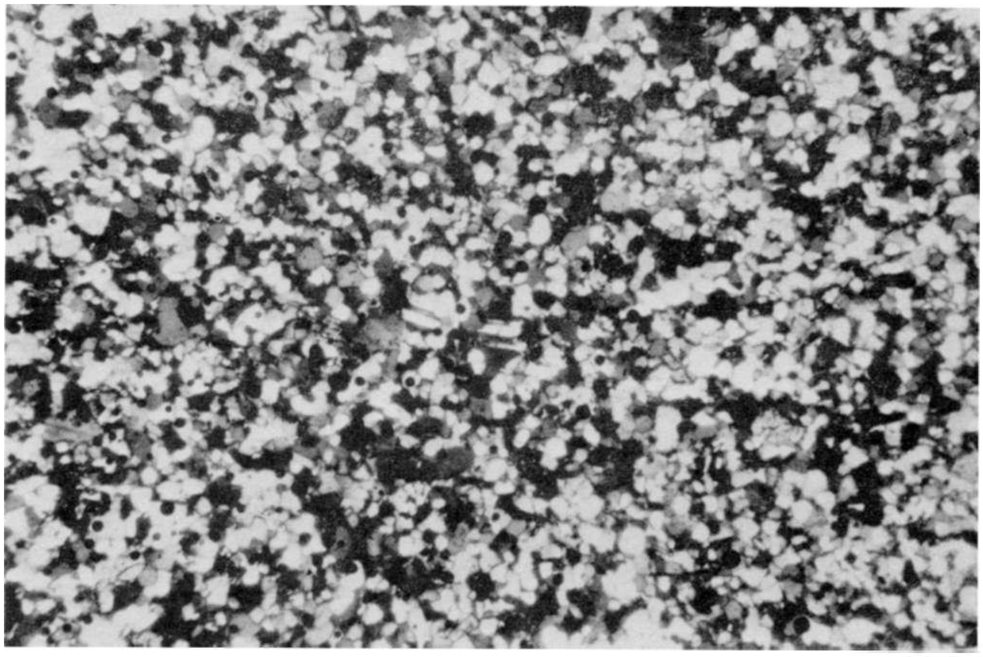


Photo 6. *Photomicrograph of recrystallized siltstone showing the homogeneous textural character of siltstone containing virtually no particles in the sand size range (crossed nicols, sample 3-9-79).*

contain up to 10% in volume of individual sand-size grains of feldspar and quartz, and tiny rock fragments that are variably affected by alteration or recrystallization. The siltstone is mostly feldspathic; the volume ranges and mean values for feldspars and quartz in the 26 samples are 35 to 75% and 63%, and 10 to 60% and 26%, respectively. The feldspars are variably cloudy in appearance and in order of decreasing abundance consist of oligoclase (An_{19-21}), microcline, albite (An_{5-7}), and andesine (An_{40-42}). One or more of biotite (with zircon inclusions), muscovite, chlorite, hematite, and pyrite are the accessory minerals commonly present in amounts of up to about 6% in volume. Muscovite, developed at the expense of potassium feldspar, can be a main component of siltstone affected by even a moderate amount of shearing. Sericite, carbonates, and epidote are occasionally present as alteration products of feldspars. Traces of hornblende, altered pyroxene fragments, penninite, and garnet, represent rare accessory minerals.

Photos 6 and 7 illustrate the homogeneous texture of siltstone containing virtually no sand size grains; and the clastic texture of siltstone containing a small proportion of sand size particles, respectively.

Slate, Argillite, Spotted Slate

This unit includes slate, and lesser argillite and spotted slate which are found locally in northern Davieaux and Desbiens Townships. The rapid weathering of these rocks is responsible to some extent for the scarcity of exposures in the map area. It is also possible that they are present in other parts of the map area which have flat topography and low outcrop density (e.g. local areas of Way-White Township). The slate is grey to black on the weathered surfaces, mostly black on the fresh cut, and generally lacks evidence of bedding although it is occasionally thinly laminated (3 mm). It is extremely fissile owing to the conspicuous development of slaty cleavage. A silky sheen is characteristic of the weathered surfaces and the cleavage planes of the fresh rock. Excellent exposures of slate occur along the tracks of the Algoma Central Railway east of Spruce Lake in northern

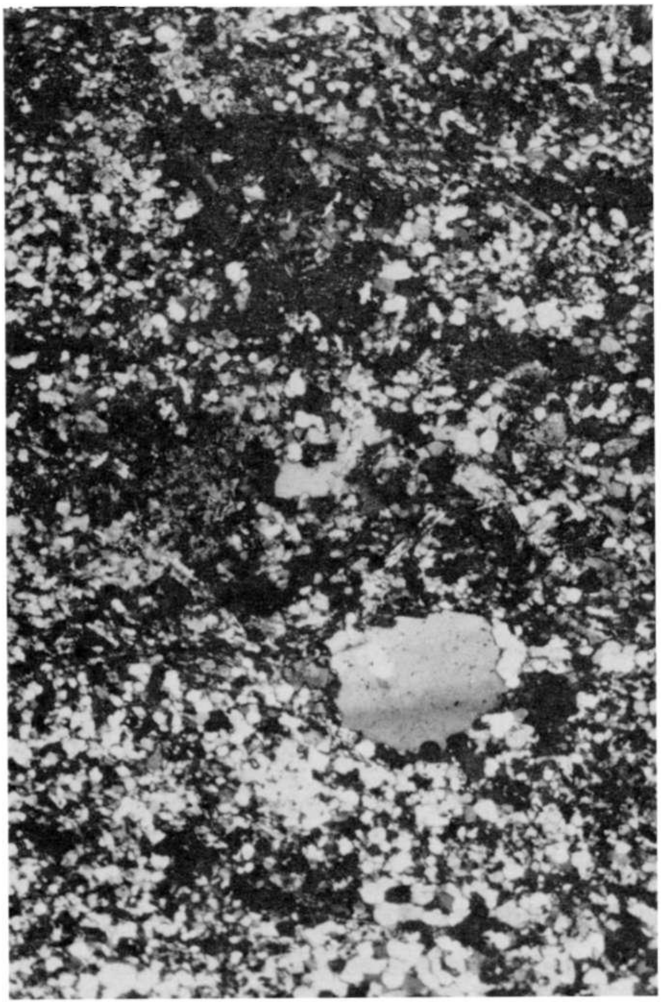


Photo 7. *Photomicrograph of siltstone containing about 4% sand size particles. The large grain in the lower part of the photo is quartz. The 2 dark masses having about the same size as the large quartz grain and located above and slightly to the left of the latter are disrupted and strongly altered feldspar grains (crossed nicols, sample 2-21-4).*

Davieaux Township. Argillite, a lower metamorphic equivalent of slate, occurs rarely interbedded with siltstone and chert-magnetite sequences. Argillite has a dull rather than shiny appearance and has incipient to poorly developed cleavage. Spotted slate is a higher metamorphic equivalent of slate, is not fissile, and contains abundant dark brown nodules which commonly have the shape and about the same size as wheat grains, and stand in prominent relief on the weathered surfaces of the rock. A bed of spotted slate about 60 cm (2 feet) thick containing nodules up to 3 cm (1.2 inches) in size occurs on the north side of, and adjacent to, the outlet of the second northernmost lake of Quintet Lakes in northwestern Davieaux Township.

The following petrographic description is based on 4 thin sections. The main component of slates and argillites is cryptocrystalline chlorite containing up to 8% in volume of iron oxides and leucoxene, and accessory quartz, biotite, muscovite, epidote, and pyrite. The groundmass of spotted slate consists of biotite, feldspars, and quartz, with accessory muscovite, chlorite, and iron oxides. Due to recrystal-

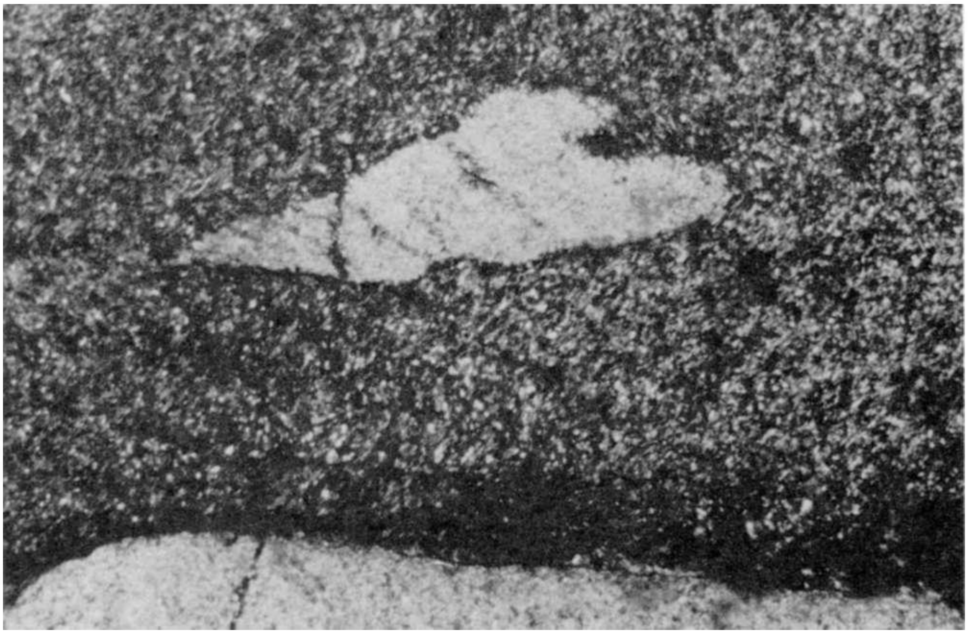


***Photo 8.** Photomicrograph of spotted slate. The large light coloured object in the middle of the field is a nodule of cryptocrystalline sericite and chlorite containing minute muscovite flakes. A much larger nodule of the same type is partially visible at the bottom of the photograph. The black rims at the margins of the nodules are hematite (crossed nicols, sample 5-14-32). Dark acicular crystals in the matrix surrounding the nodules are biotite. Note that the fabric of biotite is gently crenulated and intersects the long axes of the nodules at an acute angle of approximately 65°.*

lization the size of the groundmass components is mostly that of silt. Biotite is fresh looking, is moderately to strongly dichroic (yellow to dark brown), has crenulate fabric, and has developed at the expense of chlorite, which occurs as poorly defined patches of relatively large size. The nodules are 2 to 15 mm in size and consist of cryptocrystalline sericite and chlorite containing numerous tiny flakes of subhedral muscovite (Photo 8). These minerals are alteration products, possibly of cordierite, but an X-ray diffraction pattern of the nodules shows only the sharp peaks typical of mica; and, if small amounts of other minerals are present they are masked by the diffraction peaks of muscovite and chlorite. Minute disseminations of hematite form dark rims around the margins of the nodules and along small fractures occurring within them. The nodules are elongated, have cross sectional axial ratios of 1:2 to 1:5, and, because their long axes are parallel, they define a foliation which can be oblique to the foliation defined by the biotite fabric.

Polymictic Conglomerate

This unit includes matrix-supported polymictic conglomerate consisting of pebbles and boulders which are dominantly of felsic volcanics and subordinately of sedimentary rocks embedded in a sand size to silt size matrix of grey-bluish colour. The clasts and the matrix weather generally to dull white and tan hues, respectively. The sedimentary clasts are fine grained and include wacke, chert, and siltstone; the volcanic clasts include aphanitic and tuffaceous types. The conglomerate is variably deformed; the cross-sections of the clasts have broad elliptical outlines, are elongated parallel to the shear plane, and have axial ratios commonly varying between 1/3 and 1/8. This parameter, however, may have little significance in relation to the strain of the conglomerate because the shape of the

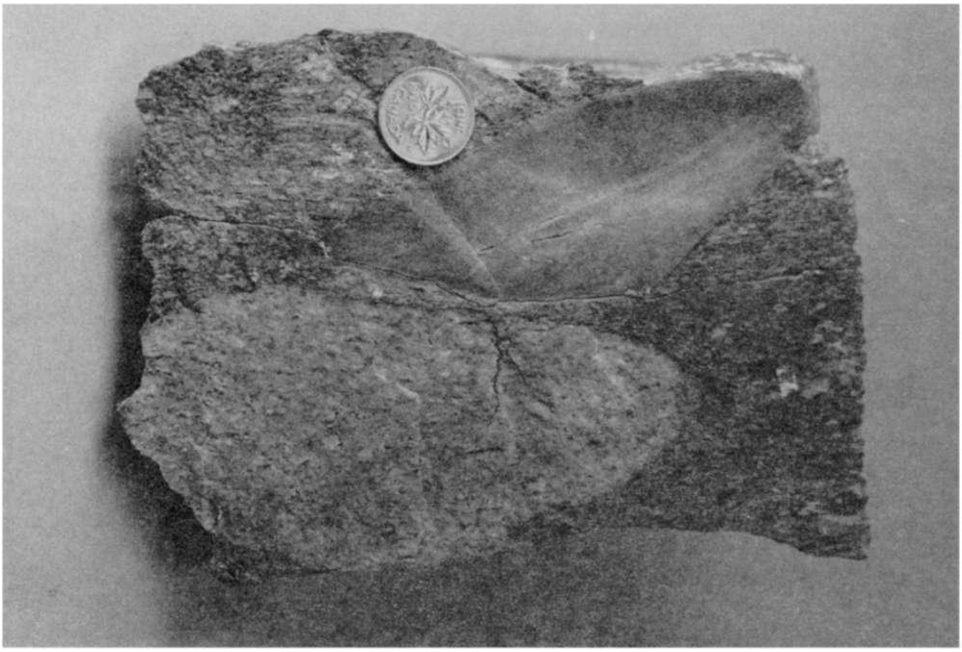


Photo 9. *Chert clast (close to coin) and crystal tuff clast (lower part of photograph) in relatively undeformed polymictic conglomerate. The outlines of the clasts reflect the quasi-ellipsoidal shape of common beach or stream pebbles (sample 5-22-2 from detached conglomerate block, southwestern Way-White Township).*

clasts in relatively undeformed rock is much the same as that of common beach pebbles having a short, an intermediate, and a long axis which are mutually perpendicular or nearly so. It is evident that except for 2 specific conjugate cross sections which contain the intermediate axis and have approximately circular outlines, any randomly oriented section through such pebbles will produce elliptical outlines such as those shown in Photo 9. The long axes of the sections of some clasts, and particularly of large ones, may be oblique to the trace of the shearing plane and this suggests that simple shear, rather than irrotational strain, was probably the main deformational mode of the conglomerate. Small exposures of deformed conglomerate occur along the western shore and at the end of the westernmost northern bay of Wart Lake in Vibert Township. Good exposures of relatively undeformed conglomerate are found along the shores of a small swamp located about 4.4 km (2.75 miles) west and 2.6 km (1.63 miles) south of the northwest corner of Vibert Township, and in the Martin Lake area of the same township.

The following petrographic description is based on 2 thin sections of 2 samples considered to be representative of the matrix of the conglomerate.

The matrix of the conglomerate consists of equant feldspar and quartz grains with a size of 0.005 to 0.08 mm and in proportions of about 70 and 15% by volume, respectively. Bedding evidence is preserved in the form of subparallel bands with grain size ranges of 0.007-0.01 mm, and 0.05-0.08 mm. As the refraction indexes of 13 out of 20 peripheral feldspar grains were seen to be less than 1.537, the feldspars are probably dominantly alkalic in composition (i.e. potassic feldspar, albitic plagioclase). The feldspars and quartz in the 0.005-0.08 mm grain size range are mostly very fresh looking owing to recrystallization. About 6% by volume of the rock consists of uniformly distributed particles of feldspar, rock fragments, and quartz, about 1 to 3 mm in size. These particles have characteristic ovoidal outlines and show evidence of rotation and slip at the interface with the

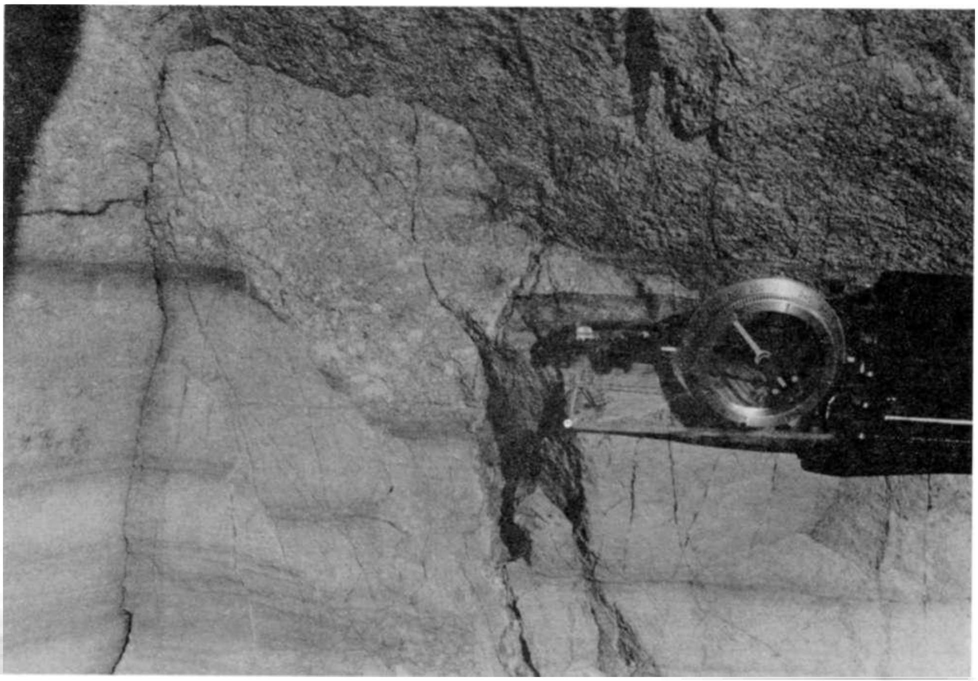


Photo 10. *Thin sequence of clay rich conglomeratic arenite (dark rock in upper part of photograph), conglomeratic arenite, and thinly bedded mudstone (lower part of photograph) from eastern Vibert Township. Note the small downward slumping on the left-hand side. As the shear planes along which the slumping developed do not extend into the conglomeratic arenite, slumping of the mudstone represents a local reaction of this rock to the pressure load of the overlying conglomeratic arenite when the former was not completely lithified, and the latter was being deposited.*

fine grained groundmass of the rock. The feldspathic particles, or portions of particles, are altered or completely replaced by sericite. Large euhedral muscovite flakes and fibrous aggregates are associated with muscovite in some of the particles, transgress the boundaries of the latter in a few cases, and occur also within the fine groundmass of the rock. Preferentially oriented muscovite microlites occur within the groundmass and the total amount of muscovite is about 5% by volume. Chlorite, iron oxides (as segregations within chlorite), and traces of staurolite, garnet, and zircon (in chlorite), account for the balance.

Conglomeratic Arenite

Conglomeratic arenite is similar to conglomerate the main difference between these rocks being that the former contains a much smaller proportion of large clasts. The clasts consist mostly of ellipsoidal gravel sized pebbles of felsic volcanics, siltstone, and chert in amounts varying from a few clasts to about 10% by volume. Small clay rich domains are locally present in conglomeratic arenite; these may considerably darken the matrix of relatively unmetamorphosed rock or may be emphasized by conspicuous local development of garnet crystalloblasts where high rank metamorphism has occurred. A depositional environment of lower energy than that of conglomerate is indicated by fine small scale primary sedimentary features present, although rarely, in conglomeratic arenite (*see* Photo 10). The largest unit of conglomeratic arenite is adjacent to and to the south of the main conglomeratic unit underlying the Wart-Martin Lakes area. Smaller units of conglomeratic arenite interbedded with other sedimentary units and minor conglomerate occur in Vibert Township northwest and northeast of Wart Lake.

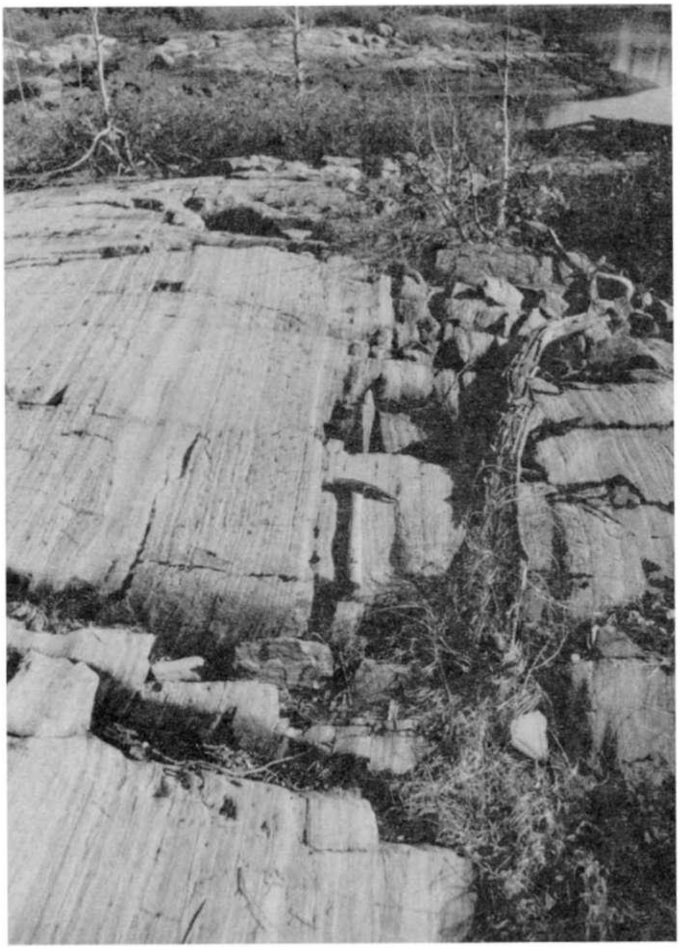


Photo 11. *Typical aspect of banded mudstone; Wart Lake area, Vibert Township.*

Laminated Mudstone

This unit includes light coloured epiclastic sediments dominantly within silt size range, and intimately interbedded with darker coloured mudstone; both the leucocratic and the mafic rich domains may contain variable amounts of chert. The unit is laminated or thinly bedded, is locally medium bedded and appears in the field as intercalated white, grey, and tan bands distinguished by variably sharp tonal contrasts (*see* Photo 11). The tan and grey colours primarily reflect the concentration and distribution of micas and this, in turn, may reflect differential shearing within the rock. Metamorphic rank higher than about middle greenschist facies is generally indicated by loss of subtle tones in the mafic rich domain of the rock, and thus by sharper definition of the bands. Definition may be locally enhanced by the presence of thin laminae containing iron oxides segregations and/or garnet disseminations. Well preserved load cast structures were noted in one outcrop of banded mudstone located on the eastern shore of Wart Lake (*see* Photo 12). Medium bedded and dominantly felsic rich outcrops of this unit, locally found in the Quintet Lakes area, contain abundant chert.

A comprehensive petrographic study of the unit would have required collection and thin sectioning of many samples from various localities of the map area; this could not be done for the same reasons previously stated with reference to conglomerate. The following descriptions are based on 3 thin sections of 3

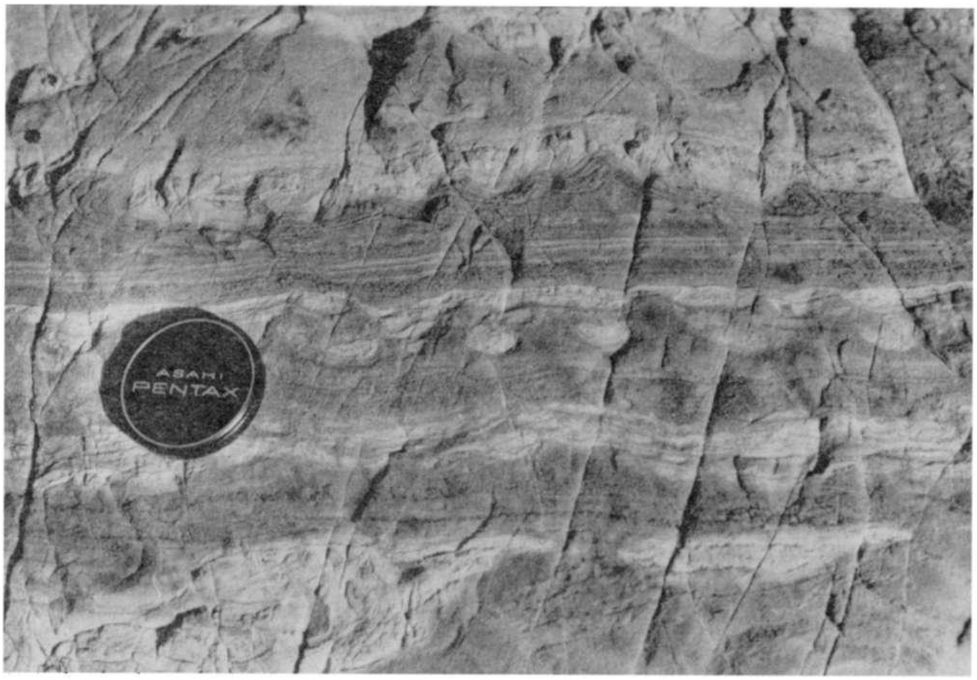


Photo 12. *Detail of very thinly bedded mudstone showing pseudo-nodules of siltstone (small white lensoidal objects) embedded in upper part of mudstone bed (dark bed in central part of photograph). The pseudo-nodules represent lenses of silt detached from the silt laminae just above them; when these lenses settled in the underlying clay their thin edges were bent slightly upwards (eastern shore of Wart Lake, Vibert Township).*

samples representative of: (1) thickly laminated and dominantly mafic rich mudstone with colour range of dark to medium grey, (2) thinly laminated and dominantly felsic rich mudstone with colour range of white to tan or very light grey, and (3) cherty section of thinly bedded cherty mudstone with colour range of nearly black to dark grey.

About 1/3 of the volume of mafic rich mudstone consists of muscovite and lesser biotite with accessory iron oxides and chlorite. Equant to slightly elongated quartz and untwinned feldspar grains (0.03 to 0.08 mm) account for the balance. The proportion of feldspars to quartz is about 4:1 and the feldspars are probably non-alkalic (i.e. plagioclase with anorthite content greater than 21%) as the refraction indexes of 8 out of 9 peripheral grains were found to be greater than balsam. Evidence of bedding is present in the form of laminae consisting of particles of slightly different grain size. The concentration of mica and notably of muscovite and chlorite varies considerably among individual laminae. The mica content, and to a much lesser extent the distribution of iron oxides, are responsible for the colour differences among the laminae. This feature distinguishes the rock from banded iron formation in that the banding and tonal contrasts of the iron formation primarily reflect the distribution and concentration of magnetite. Moderate shearing has affected local domains of the banded mudstone and is indicated by the occurrence of non-equant (i.e. elongated) quartz and feldspar grains in muscovite rich laminae, and by the presence of preferred orientation and crenulation in the fabric of muscovite.

The felsic rich mudstone consists of non-alkalic feldspars, quartz, and muscovite + chlorite in approximate volumetric proportions of 5.8:2.5:1.5; the combined content of iron oxides and biotite accounts for about 0.2% in volume. The grain size and the evidence of bedding are similar to the specimen of mafic rich mudstone (*see* above) but the bedding is somewhat less obvious due to mild shearing affecting the whole area of the section.

The cherty section of thinly-bedded mudstone consists of a very dense aggregate of microcrystalline quartz particles which are mostly globular or ovoidal in shape, and are 0.005 to 0.01 mm in size. Barely perceptible laminar domains of microcrystalline to cryptocrystalline quartz and clay(?) mineral are present in areas of the section. The rock contains about 15 volume percent of oriented subhedral chlorite microlites, the concentration of which controls: the colour banding (approximately 5% iron oxides), and occasional individual sand size particles or aggregates of quartz, strongly altered feldspars, and carbonates. Minute fractures are present and are filled by carbonates and/or iron oxides.

Iron Formation

The dominant type of iron formation found in the map area consists of banded mudstone interbedded with magnetic laminae or thin beds which contain an estimated volume of 15 to 70% magnetite, and which collectively account for 1/3 to 2/3 of the exposed bedding thickness of the unit. The rock is similar in appearance to (barren) banded mudstone although in general it shows sharper definition of the bands (*see* Photo 13); the colour tones of the iron-oxide rich domain reflect essentially the concentration and distribution of magnetite, and "rusty" staining is virtually absent even in severely weathered outcrops of this rock. Contorted or recumbent folding that resulted from gravitational sliding and slumping is common. Excellent exposures of iron formation were found during mapping along segments of the shore of a small lake (Old Man Lake) located in eastern Vibert Township. Barren banded mudstone metamorphosed under conditions higher than about middle greenschist facies (i.e. quartz-albite-epidote-biotite subfacies of Fyfe *et al.* 1958) can be visually indistinguishable from banded iron formation; this is mainly caused by the dominance of biotite (in place of muscovite and/or chlorite) in the mafic rich domain of mudstone, thus darkening and giving sharp definition to the mafic rich domain. The distinguishing criterion used in the field was the attraction of the mafic rich domain of iron formation to a standard 25.8 g pocket magnet.

A type of iron formation which is apparently of less frequent occurrence has virtually uniform dark grey or black colour, does not have a felsic rich domain, and consists of fine grained dark micas and magnetite. The presence of laminae containing variable concentrations of magnetite within this rock is readily ascertained with a magnet, but may not be discernible by visual inspection alone. Outcrops of this rock occur mostly as accumulations of black blocks or slabs which may display pervasive ocher staining due to oxidation of disseminations and tiny massive stringers of fine grained pyrite. Exposures of this kind are found at the eastern tip of the small iron formation unit located south of the granitic contact in north central Vibert Township. A few subvertical layers of this rock, the largest of which is about 2 m (6 feet) thick, are interbedded with banded iron formation along the southern shore of Old Man Lake in the eastern part of the same township.

In the outcrops of uniformly dark coloured iron formation that were observed, no evidence of metamorphic differentiation was seen and there is little doubt that the laminar distribution of magnetite within this rock reflects a primary depositional process. Evidence of metamorphic differentiation is not uncommon in deformed portions of banded iron formation metamorphosed under amphibolite facies conditions. It includes occurrence of abundant coarse grained garnet porphyroblasts in the iron rich domain of the rock, and of quartz-feldspar veining and fillings in sheared, boudinaged, or otherwise deformed parts of the iron formation. No indication was found of remobilization of the iron rich domain of the rock however (e.g. iron rich veins); and it is apparent that the primary laminar distribution of iron within the rock was unaffected, although it was locally texturally enhanced by metamorphism.

Photo 13. *Typical aspect of banded iron formation. Note sharp definition of bands and plication of bedding indicative of sliding in right hand side of photograph; the small magnet across the 2 thick magnetite rich laminae indicates the scale of the photograph (Old Man Lake area, Vibert Township).*

The following petrographic description is based on 2 thin sections of 2 specimens considered representative of the iron oxide-rich laminae of banded iron formation of low metamorphic grade.

The principal components of the rock are magnetite and chlorite in estimated proportions of 42 and 40 volume percent respectively, and a quartzo-feldspathic fraction which accounts for a volume of approximately 13%. Magnetite occurs as relatively coarse euhedral crystals with average size of about 0.03 mm, and as local aggregates 0.5 to 0.8 mm in size. In some of these aggregates the outlines of individual crystals are partially visible owing to incomplete suturing along the boundaries of adjacent crystals. Several laminae characterized by minor to significant variations in magnetite content may be recognized within a thickness of about 1 mm of rock, or even less. Chlorite is present dominantly as weakly dichroic scaly aggregates, and subordinately as acicular microlites preferentially oriented parallel to the laminar fabric of magnetite. It contains traces of biotite and hematite, and in 1 thin section shows unusually low birefringence (i.e. first order grey).

The quartz-feldspar fraction consists of an aggregate of microcrystalline to cryptocrystalline interlocking particles of quartz and feldspar. The microcrystalline particles are mostly 0.003 to 0.01 mm in size. Although the presence of feldspar is indicated by slight alteration, lower birefringence (with respect to quartz), and rare twinning of some of the particles, the specific identification of this mineral is problematic owing to the small size. The quartz-feldspar fraction, inclusive of the chlorite microlites interspersed within it, is the finest grained component of the rock and shows evidence of bedding in the form of laminar distribution of perceptibly different grain sizes. This component is clearly an impure chert, the metamorphism of which has not obliterated the original character of a chemical precipitate. It contains a small clastic fraction consisting of 3 to 4 volume percent of quartz and feldspar particles which are 0.08 to 0.15 mm in size and may show roughly

Photo 14. *Typical texture of coarse hornblende gabbro; Wart Lake area, Vibert Township.*

rounded or oval outlines. Evidence of the depositional mode of iron has been thoroughly obliterated by the recrystallization of the original iron rich solid or colloidal particles to magnetite. The metamorphic nature of the magnetite is indicated by the relative coarse size and the euhedral character of the magnetite crystals in virtually all the iron rich laminae.

Carbonates (ankerite?) account for about 5 volume percent of the rock. They occur dominantly as fracture-filling material and subordinately as a few scattered subhedral crystals or aggregates of relatively large size. Polysynthetic twinning is common and locally well developed in the carbonates.

X-ray diffraction analyses of the 2 specimens from which the thin sections were cut (3/19/55, 3/19/IF) have confirmed the presence of some of the minerals described above (i.e. magnetite, chlorite, quartz, feldspar) and have indicated albite in 1 specimen (3/19/IF).

MAFIC INTRUSIVE ROCKS

Hornblende Gabbro, Anorthositic Gabbro

This unit includes essentially massive hornblende gabbro which is coarse to medium grained, and has a green to dark green colour. The coarse phase may exhibit a blotchy texture characterized by hornblende crystals about 1 cm (0.39 inch) in size separated by a finer grained feldspathic interstitial component (*see* Photo 14). Where this component is absent, as for example, in some of the prominent hill-top exposures west of Wart Lake, the rock consists exclusively of equant interlocking hornblende crystals, and is dark green to nearly black in colour.

The main body of hornblende gabbro is elongated in shape, trends west-northwest, has minimum and maximum widths of 213 and 1200 m (700 and 4000 feet), and extends over a distance of 5.6 km (3.5 miles) from the south bank of the Batchawana River in eastern Tronsen Township, to the west side of Wart Lake in central Vibert Township. Two smaller occurrences of hornblende gabbro, interpreted as intrusions separate from the main body, are found along strike of the latter and within a short distance from the western and eastern tips of it. The gabbro intrudes the metasediments and rare xenoliths of arkose and arkosic wacke were noted within it. It is locally intruded by late dikes of felsic rich granite which show very sharp contacts, but apart from these the contact relationships between gabbro and the granitic rocks are largely migmatitic. Good exposures of migmatite characterized by variably developed assimilation of gabbro by parts of granite, are found south of the main gabbro body, between the latter and the northern shore of Mongoose Lake (Vibert Township).

Examination of 3 thin sections has shown that hornblende accounts for an estimated 70 to 85% of the volume of the rock. It occurs as euhedral to anhedral crystals which are up to 12 mm in size, and are generally strongly pleochroic (light to dark green or greenish-brown). The dichroism of hornblende is less pronounced in 1 thin section which contains chlorite (as an alteration product of hornblende), and minor muscovite and epidote. The rock contains subordinate amounts of sphene as small anhedral crystals or aggregates, and of untwinned plagioclase laths, which are up to 3 mm in size, and are probably calcic in composition. These minerals are mostly interstitial to the large hornblende crystals. The accessory minerals include dominant pyrite, which is locally rimmed by hematite, and traces of quartz. Quartz is also present as fracture-filling material.

Anorthositic gabbro is similar to hornblende gabbro but has a greater plagioclase content and lower colour index.

FELSIC INTRUSIVE AND METAMORPHIC ROCKS

The granitic rocks underlying Tolmonen Township and parts of the townships adjacent to it, are referred to collectively as the "western granitic rocks". Large hill-top exposures occur in this very rugged area, but the exposures tend to be scattered and are separated by terrain veneered by extensive Pleistocene deposits. The latter are particularly well developed in the wide segments of the Big Pike Creek, and the Little Batchawana River valleys. The granitic rocks underlying the area which extends south of the Batchawana River and across the boundary of Tronsen and Vibert Townships, are referred to collectively as the "southern granitic rocks"; these rocks are part of a relatively large intrusive body which is mostly well exposed and is completely surrounded by metasediments. The granitic rocks underlying: (1) the area extending north of the Batchawana River from eastern Raaflaub and Tronsen Townships to southern Runnals and northern Vibert Townships, and (2) the areas south of the Batchawana River in northern Vibert, southeastern Runnals, and northeastern Vibert Townships, and referred to collectively as the "northern granitic rocks". The outcrop density in all these areas is generally good along the northern bank of the Batchawana River in southern Runnals Township.

The main granitic types found in the map area include dominant quartz monzonite, and subordinate dioritic rocks which are closely spatially associated with the hornblende gabbro. Minor occurrences of rocks within the compositional ranges of granodiorite and trondhjemite are also locally present. Quartz monzonite, granodiorite, and trondhjemite are rocks containing more than 10% quartz, in which the ratio of potash feldspar to total feldspar is between 0.33 and 0.66, between 0.12 and 0.33, and less than 0.12, respectively. The dioritic rocks were empirically subdivided into 2 groups depending upon whether their estimated hornblende content was 15 to 30% or less than 15%.

The western granitic rocks consist mostly of massive quartz monzonite which is commonly pink to red, has a grain size of 2 to 5 mm (0.08 to 0.19 inch), and contains an estimated 2 to 6% biotite. Extensive domains of leucocratic pegmatite and, to a lesser extent, of biotite-bearing pegmatite are found within quartz monzonite. Magnetite nodules generally about 6 mm (0.23 inch) in size may occur within these pegmatites. Epidotization along fractures and joint planes is not uncommon and may be locally conspicuous in quartz monzonite. The granitic rocks at a few localities of western Tolmonen and eastern Smilsky Townships are crudely foliated to gneissic, contain an estimated 8 to 14% biotite, and are granodioritic to trondhjemitic in composition. These rocks have probably resulted from complete assimilation of metasediments, as suggested by the presence of biotite rich xenoliths of arkose and arkosic wacke in the general area. Gneissic to sheared quartz monzonite occurs in the Big Pike Lake area close to the contact with the large metasedimentary unit to the southeast of the lake. The quartz monzonite and the metasediments underlying this area have the same northeast-trending and southeast-dipping structural attitude.

The southern granitic rocks are massive, dominantly dioritic in composition, and commonly have a grain size of 1 to 4 mm. Hornblende-biotite granodiorite and quartz monzonite are of local occurrence within the southern granitic rocks, and pegmatite is virtually absent. The dioritic rocks exhibit a mottled texture characterized by variable proportions of equant dark green, black, or brownish ferromagnesian grains uniformly distributed throughout the leucocratic domain of the rock, which consists largely of feldspars, and has a white to pink colour. Hornblende-rich inclusions which are generally 2 cm to 0.6 m (1 inch to 2 feet) in size, with elliptical, lensoid, or irregular outlines, and dark green to black colour, are frequently found within these rocks. By delineating the dioritic outcrops on the basis of their estimated mafic content, 2 zones of mafic enrichment were outlined. One of these is adjacent to the contact with the hornblende gabbro underlying the Mongoose Lake area, the other is in the southeastern corner of Tronsen Township. Further detailed mapping is required to establish whether the hornblende gabbro and the dioritic rocks are intrusions of different ages, in which case the latter are younger rocks and the hornblende-rich inclusions are gabbro xenoliths, or whether they are differentiation products of the same intrusion, in which case the mafic inclusions represent primary features.

The northern granitic rocks consist almost exclusively of massive biotite quartz monzonite. This rock differs from the quartz monzonite underlying the western part of the map area in that it does not contain pegmatitic domains or xenoliths, and is almost invariably porphyritic. The porphyritic texture is determined by dominant potassium feldspar and quartz phenocrysts generally 1 to 4 cm (0.4 to 1.5 inches) in size.

Apart from the western, southern, and northern granitic rocks described above, minor granitic bodies are found within metasediments at a few localities of Vibert, Davieaux, and Norberg Townships. These rocks are mostly quartz monzonitic to granodioritic in composition.

The following petrographic descriptions are based on 26 thin sections stained for potassium feldspar. Twelve, 7, and 5 of these represent the western, northern, and southern granitic rocks, respectively, and the remaining 2 represent minor granitic intrusions in the Wart Lake, and the Spruce Lake areas. Except for the 5 thin sections of the southern granitic rocks (i.e. dioritic rocks), all the other sections are of rocks with potassium feldspar to total feldspars ratios essentially within the quartz monzonite compositional range. Accordingly, the descriptions cover only the 2 main granitic types found in the map area, namely, quartz monzonite and diorite.

Microcline, oligoclase (An_{14-27}), albite (An_{3-7}), and quartz are the principal components of quartz monzonite. Biotite and one or more of chlorite, sericite (as alteration product of feldspars), epidote, pyrite, magnetite, hematite, and zircon (in biotite) are the common accessory minerals. Muscovite, penninite, carbonates, hornblende relics, and apatite are rare accessory minerals. Microcline occurs as euhedral phenocrysts which are particularly conspicuous in the porphyritic quartz monzonite, are not uncommonly perthitic, and contain numerous rounded poikilitic inclusions of plagioclase, quartz, and biotite. Plagioclase is affected to variable extent by kaolinization and sericitization, except for thin albitic rims surrounding the poikilitic inclusions of plagioclase within microcline. Normal zoning occurs rarely in plagioclase. The general freshness of microcline contrasts with the widespread alteration of plagioclase and indicates that potassium feldspar crystallized late. Quartz is anhedral and interstitial to the feldspar crystals, and almost invariably shows a weak to moderate undulatory extinction. Biotite occurs mostly as fresh, well defined, tabular crystals which show strong dichroism (light greenish-brown to dark brown). It also occurs as irregularly shaped small patchy aggregates which are commonly altered to chlorite, and contain minute segregations of iron oxides.

The dioritic rocks consist of andesine (An_{31-38}) and microcline, with subordinate amounts of one or more of biotite, clinopyroxene, and hornblende. Chlorite, quartz, iron oxides, pyrite, apatite, and carbonates are the accessory minerals. Plagioclase is less altered than in quartz monzonite; polysynthetic twinning and zoning of plagioclase are also comparatively less developed in the dioritic rocks. In 1 thin section clinopyroxene was seen to occur as euhedral prismatic crystals of augite enclosed within, or adjacent to, large tabular crystals of biotite which are strongly dichroic (yellowish to dark brown). More frequently, however, it occurs as relics pseudomorphosed by hornblende. Euhedral hornblende with strong dichroism (light to intense green) was noted in one thin section, but both hornblende and biotite are generally anhedral and tend to show weak pleochroism owing to chloritic alteration. The estimated total volume of ferromagnesian minerals in the thin sectioned dioritic rocks varies from 12 to about 34%.

MIDDLE TO LATE PRECAMBRIAN (PROTEROZOIC)

MAFIC INTRUSIVE ROCKS (DIABASE DIKES)

Dominantly northwest-trending and lesser northeast to north-trending diabase dikes were seen to cut all the previously described rocks. The dominant northwest trends of the linear fractures in the granitic rocks, and of metamorphic foliation in most of the areas underlain by supracrustal rocks, indicate that the emplacement of diabase was largely controlled by these structures. Many of the dikes with northeastern or northern trends were emplaced along fractures which are conjugate, and in all likelihood coeval, with northwest-trending fractures or planes of least resistance. Consequently, no significant age differences may be attributed to the diabase dikes in the map area on the basis of their trends. The diabase dikes are more numerous than could be shown on the maps. They are generally vertical or nearly so, and although commonly 1 to 15 m (3 to 45 feet) wide, some may be up to 106 m (350 feet) thick. The dikes have fine grained to glassy chill margins, commonly contain pyrite disseminations, and may be porphyritic owing to the presence of altered plagioclase phenocrysts up to 6.2 cm (2.5 inches) in size. The size, frequency, and distribution of the phenocrysts may vary considerably within closely spaced domains of the same dike, and because of this the phenocrysts cannot be used as a diagnostic feature in correlating diabase outcrops over significant distances. Most dikes are homogeneous in texture with grain size of 1 to 2.5 mm but dikes wider than about 10 m (30 feet) or thinner than approximately 2.5 m (8 feet) may depart from these limits, the thinner the dike the finer the grain size, and *vice versa*. The margins of the dikes may contain fragments of the rocks intruded by the diabase and these fragments are generally 5 to 10 cm (2 to 4 inches) in size, and have angular outlines. Less frequently, distorted or lens shaped metasedimentary xenoliths up to 6 m (20 feet) in length, are found in the inner parts of the dikes. The diabase is a massive and essentially fresh looking rock which has green to dark green colour, and weathers a uniform or mottled brown colour which hardly penetrates the rock for more than 2 mm. A mottled reddish brown weathered surface is characteristic, although not necessarily diagnostic, of olivine-bearing diabase.

The petrographic study of these rocks was based on 11 thin sections of diabase samples from various localities of the map area. Labradorite (An_{51-56}) and augite are the principal components of diabase. One or more of biotite, ilmenite, chlorite, leucoxene, pyrite, hematite, and quartz are the common accessory minerals. Olivine, serpentine, and hornblende (pseudomorphic after augite), are rare accessory minerals. Labradorite occurs as essentially fresh and randomly oriented euhedral laths which show good to excellent polysynthetic twinning. It represents an estimated 40 to 60% of the rock in volume. Augite accounts for an estimated 15 to 30% of the rock in volume, and is mostly present as short crystals of prismatic habit which are smaller than, and interstitial to the labradorite crystals. An ophitic texture characterized by small poikilitic inclusions of labradorite, ilmenite, and biotite within large augite phenocrysts, is also present in a few samples of dikes with relatively high augite content. Augite is commonly affected by slight to moderate chloritization, and is rarely replaced by pseudomorphous hornblende. Biotite occurs as euhedral tabular crystals which are interstitial to labradorite and generally show very strong dichroism (dark brown to nearly colourless). Ilmenite may account for up to an estimated 8% of the rock in volume, and is commonly found in the form of skeletal crystals associated with leucoxene. An estimated volume of 4% of unaltered olivine was found in 1 of the 11 thin sections, and minor amounts of serpentine were noted in another section in which no olivine was identified.

Metamorphism

The mineralogical composition of the basaltic volcanics of the main northwest-trending belt indicates that they were regionally metamorphosed under conditions characteristic of the quartz-albite-muscovite-chlorite subfacies of the greenschist facies (Fyfe *et al.* 1958). The rarity of biotite throughout the basaltic section of the main belt suggests that in no area of the latter were these conditions exceeded to any significant extent. The metamorphic rank of the basaltic units occurring in the western half of the map area is probably upper almandine-amphibolite facies; since the composition of plagioclase cannot be determined, the metamorphic grade of these rocks cannot be indicated with certainty on the basis of present data on their mineralogical composition. However, most of these basaltic units are closely associated with sedimentary units which were regionally metamorphosed under conditions characteristic of the quartz-staurolite subfacies of the almandine-amphibolite facies. In summary, the rank of regional metamorphism in the supracrustal rocks of the map area varies from upper greenschist facies in the eastern part of the area, to upper amphibolite facies in the western half.

The supracrustal rocks are locally affected by metamorphism brought about by emplacement of granitic intrusions within or marginal to them, and superimposed on regional metamorphism. Emplacement of granite has primarily resulted in the development of foliation or shearing in the supracrustal rocks, and in limited recrystallization and assimilation of the supracrustal rocks along the intrusive contacts. Apparently, the width of the metamorphic zones adjacent to the granitic intrusions emplaced within the supracrustal rocks is not directly related to the size of the intrusions. In fact, foliation at variance with the regional trend and subparallel to the intrusive contact, is much less extensively developed in the metasediments to the east of the large granitic intrusion south of Mongoose Lake, than it is in the supracrustal rocks east of the small intrusion in the northeast corner of Vibert Township. The metasediments in contact with the western side of the small granitic intrusions locally contain abundant garnet disseminations.

Structural Geology

The supracrustal rocks in the map area are part of a "T" shaped Archean belt, referred to here as the "Batchawana belt", consisting of a main northeast-trending lobe the southern side of which connects at its midpoint with a shorter lobe trending northwest. The present map area includes part of the area of junction of the 2 lobes, a portion of granitic terrain west of the northeast-trending lobe, and part of the segment of the northwest-trending lobe between Latitudes 47°07'30" and 47°15'N. The general northwest and northeast trends characteristic of the 2 lobes of the Batchawana belt are best recognized in the supracrustal rocks underlying the eastern part of the map area, and in those underlying northern Norberg Township, respectively. The structural trends of the supracrustal rocks underlying other parts of the map area are generally quite variable, owing to local conditions of deformation associated with intrusion of granitic rocks. The Batchawana belt is in the Superior Province of the Canadian Shield, and is surrounded by granitic rocks affected by dominantly northwest-trending regional fractures many of which were intruded by diabase dikes. Potassium-argon chronologic determinations (GSC 1969) on granite from 1 locality adjacent to the main lobe of the belt, and of diabase at 3 localities adjacent to both lobes of the belt, indicate ages of 2340 million years for granite, and of 785 to 1450 million years for diabase.

The gradient relationships of drainage in the general Batchawana belt area reveal gentle slopes to the southeast in the 2 adjacent regions comprised between the Montreal and the Batchawana Rivers, and the Batchawana and the Chippewa Rivers. Although these slopes may be the effect of glacial rebound, the author suggests that they primarily reflect regional structural dips to the southeast. This implies that the southern banks of both the Montreal and Batchawana Rivers are upwardly displaced relative to the northern banks of these rivers.

PRIMARY STRUCTURES

Primary structures useful for stratigraphic top determinations are scarce and consist mostly of small pillows, occurring locally in the basaltic rocks of the main northwest-trending sequence. Well preserved load cast structures were observed in conglomertic arenite and banded mudstone at 2 localities. Graded bedding and cross-bedding were also noted in a few outcrops of metasedimentary rocks, but the observed primary structures in these rocks could not be used for top determinations owing to the complexity of folding. However, contorted and/or recumbent folding and plication of bedding in iron formation are in themselves "primary" structures, in that they indicate gravitational slumping prior to complete lithification of the sediments. The pillows are commonly sheared to variable extent; in rare 3 dimensional exposures they were seen to have roughly elliptical maximum-area cross sections which are subparallel to the plane of metamorphic foliation. It was also noted that the points of maximum convexity on the bottom surfaces of adjacent non-overlapping pillows of similar size, define a plane which is subparallel to metamorphic foliation. It is assumed that the depositional plane of the pillowed flows and the plane defined by metamorphic foliation are generally parallel. The pillows face southwest. Metamorphic foliation trends northwest, is dominantly subvertical or dips steeply to the northeast, or locally dips to the southwest at steep angles. It is concluded that the top of the volcanic series of the main northwest-trending sequence is to the southwest, and that the sequence is partially, and possibly completely, overturned.

LARGE SCALE METAMORPHIC STRUCTURES

Folds

The existence of a partially disrupted antiform in the supracrustal rocks underlying western Tronsen, eastern Tolmonen, and northeastern Norberg Townships was previously mentioned (*see* "Areal Distribution and Relationships of Metavolcanic Units").

The western and eastern limbs of this structure are separated by quartz monzonite. In northeastern Norberg Township the quartz monzonite cuts the structure and forms a narrow body or "neck" with a minimum width of about 750 m (2500 feet). This body widens south of the map area, and connects with a larger oval intrusion of granite which is located in the Griffin Lake area of Norberg Township (Giblin and Armburst 1973), where it is completely surrounded by metavolcanics. These relationships indicate that the fold represents a remnant of a north-trending and formerly domed structure which developed concommitantly with, or as a direct result of, the emplacement of mesozonal (Badgley 1965) granitic intrusions within and marginal to the northeast-trending lobe of the Batchawana belt. The metamorphism undergone by the metavolcanics in this fold does not seem to have significantly exceeded the upper amphibolite facies.

The eastern limb of the original north-trending antiform merges with the southern limb of an east-trending fold which is the main structural feature in the metasediments underlying northern Tronsen Township. The metasediments in the Carpenter-Mitchell Lakes area of this township strike east-northeast and dip dominantly to the north at steep angles; those north of Patterson Lake strike east-southeast and have subvertical, dominantly southern dips. These orientations and the outcrop pattern of the metasediments in the general area suggest that the fold is an east-trending synform, probably plunging to the east, with an axial trace which lies very close to the northern shore of Patterson Lake. East of Tronsen Township the synform is virtually obliterated by the intrusive rocks underlying the area. In Raaflaub Township, and at the very northern boundary of the map area, the structural relationships of the northern limb of the synform are complicated by the existence of a tight fold of unknown trend. The presence of this fold is clearly indicated by the closure of outcrop pattern of the mafic metavolcanics underlying the area, and by the changes in the trends of metamorphic foliation in the metasediments flanking the metavolcanics.

The geological boundaries of the supracrustal rocks and their units outline the horizontal section of a broad fold in the Guyatt-Martin Lakes area. Small granitic intrusions are found within the areas of high curvature of the fold (i.e. Wart Lake, Guyatt Lake). Layering and metamorphic foliation:

(1) Trend northwest and dip steeply to the north in the eastern limb of the fold (i.e. northwestern Desbiens and southwestern Way-White Townships)

(2) Have a dominantly easterly trend and subvertical to northerly dips in the "nose" of the fold (i.e. southeastern Vibert Township)

(3) Trend northeast and dip steeply to the south in the western limb of the fold (i.e. Guyatt Lake area of Davieaux Township).

Because of the reversal of dip direction in the 2 limbs of the fold (*see* Figure 4), it is evident that 1 of the limbs is overturned, and because the top of the northwest-trending metavolcanic series (i.e. eastern limb of the fold) is to the southwest, it is also evident that the overturned limb is the eastern one. The portion of this structure within the present map area is a disharmonic and probably noncylindrical overturned syncline with axial surface trending north-northwest and dipping steeply to the east, and hinge line plunging steeply to the north. The metamorphism which accompanied the development of the fold is essentially of greenschist rank.

Faults

In Norberg Township the quartz monzonite on the north side of the Batchawana River is gneissic and rarely sheared. The gneissosity parallels the contact of the quartz monzonite with the supracrustal rocks underlying the southern side of the river, and dips steeply to the south. These relationships and the outcrop pattern of the area indicate the presence of a fault, and because strike slip displacement appears to be negligible along the segment of the Batchawana valley within the map area, the fault is either normal or reverse. The possible upward displacement of the southern side of the Batchawana River valley was previously mentioned. The fault plane is not exposed, and one might speculate that if the south-dipping gneissosity in quartz monzonite and the north-dipping foliation in the supracrustal rocks south of the Batchawana River are taken to be conjugate shear planes, then

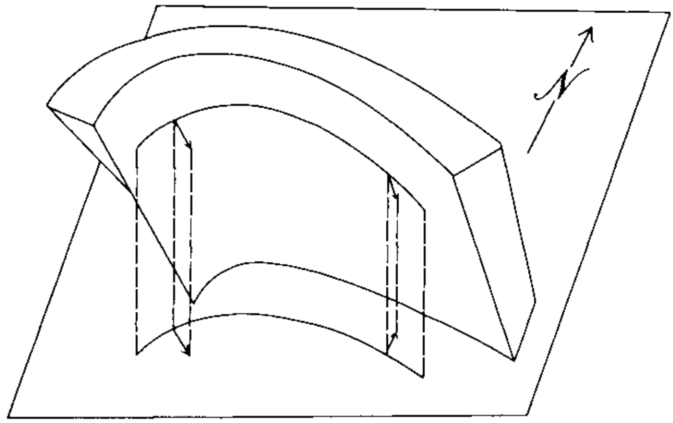


Figure 4. Diagrammatic illustration of reversal of dip direction in the Guyatt Lake fold. To emphasize the change in dip direction from the western to the eastern limb of the fold, the dip direction vectors are projected onto the horizontal plane. The diagram only shows the general geometric relationships of the limbs of the fold and is not intended to depict the shape of the actual fold.

the horizontal plane bisects the larger of the 2 dihedral angles of intersection of the shear planes, and this condition would indicate direct faulting. However, lacking other evidence, it is assumed that the only structural element relevant to the dip direction of the fault is the attitude of gneissosity in quartz monzonite, and consequently it is suggested that the fault is reverse and dips steeply to the south.

The partial disruption of the antiform in Tronsen and Norberg Townships (*see* "Folds"), has caused some displacement of the supracrustal rocks in the western limb of the fold. However, the determination of the displacement is problematic because, on the basis of the present data, one has insufficient means of evaluating to what extent the granitic rocks cutting through the structure may have assimilated and obliterated the supracrustal rocks, without significant concomitant displacement of the latter. Xenoliths of supracrustal rocks and hybrid granitic phases were only found in 1 large outcrop area adjacent to the western limb of the structure; because of this, it is assumed that assimilation of the supracrustal rocks by part of the granitic rocks cutting the structure was negligible. Pending verification of this assumption, the maximum horizontal displacement of the supracrustal rocks in east central Tolmonen Township with respect to those in the southeastern part of the same township, is 5.8 km (3.6 miles).

SMALL SCALE METAMORPHIC STRUCTURES

Shearing

Shearing is rarely found in quartz monzonite, and is moderately to well developed in the metasediments and in the basaltic metavolcanics. It is very well developed in rhyolitic flows and pyroclastics, particularly in the Old Woman Lake area of Vibert and Way-White Townships, and in local areas of northern Desbiens Township. Shearing in the former area is considered by the author to have been caused by the emplacement of the small granodiorite intrusion underlying the northeast corner of Vibert Township. In Desbiens Township it resulted from the development of the overturned syncline in the Guyatt-Martin Lakes area (*see* "Folds").

Foliation

Foliation is ubiquitous in the supracrustal rocks and is locally developed in the granitic rocks (i.e. gneissosity). The geometric relationships of foliation and layer-

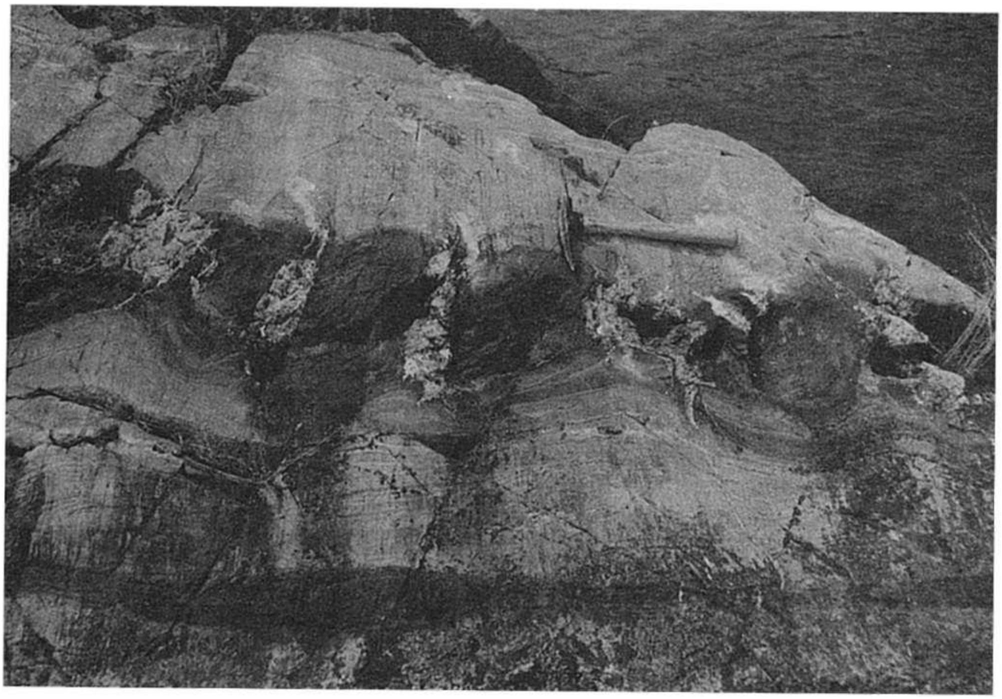


Photo 15. Boudinaged iron formation. Note the quartz filled tension gashes between adjacent boudins.

ing in the greenschist grade metavolcanics has been previously described (*see* "Primary Structures"). In the greenschist rank metasediments foliation is also generally parallel to bedding. However, exceptions do occur and include foliation oblique to bedding noted in a few outcrops of siltstone, and the undetermined relationships of bedding and foliation in spotted slate due to the presence of 2 metamorphic foliations in this rock. Fracturing of chert rich beds and rotation of their fragments through the foliation plane, were also noted in an outcrop of banded mudstone close to the "nose" of the Guyatt-Martin Lakes overturned syncline. Shearing and foliation are both effects of the same process (deformation), the difference being only in the amount of strain produced by it; the empirical distinguishing criterion adopted for mapping purposes was the presence of strong fissility and paper-thin metamorphic laminations in the rocks mapped as sheared. Except for iron formation and felsic interbeds within basaltic metavolcanics, the relationships of metamorphic foliation and primary structures in amphibolite grade supracrustal rocks were generally undetermined.

Small Folds, Boudinage

Folds with wavelengths of several centimetres were found in foliated to sheared felsic metavolcanics at 1 locality in the Old Woman Lake area. These folds trend mostly northeast, plunge to the southwest at angles of 60 to 67°, and could not be correlated to larger structures. Incipient boudinage was rarely observed in the supracrustal rocks. Well developed boudinage of a small iron formation band was noted on a tiny island in the southern part of Wart Lake (*see* Photo 15).

SYNTHESIS OF A MODEL FOR THE MAIN STRUCTURAL AND STRATIGRAPHIC FEATURES

The metavolcanics in the northwest-trending lobe of the Batchawana belt are those which are least metamorphosed, attain greater thickness, face southwest, and appear to have evolved along the southwest direction from basalt and basaltic komatiite to high-iron tholeiitic basalt, and from this to calc-alkaline rhyolite. Volcanogenic metasediments which include dominant fine grained quartzo-feldspathic rocks with low mafic content and containing minor ironstone, and subordinate metaconglomerate and metaconglomeratic arenite, underlie parts of the map area. These rocks form a series which thins eastward and merges with the calc-alkaline metavolcanics. The metaconglomerate was largely derived directly from reworking of the calc-alkaline metavolcanics, and accordingly is found within a short distance from and to the west of the calc-alkaline metavolcanics. The fine grained metasediments derived from reworking of the calc-alkaline metavolcanics, and quite possibly also of the metaconglomerate and metaconglomeratic arenite, extend much further west than the coarse clastic metasediments, and underlie large portions of Vibert and Tronsen Townships. Another metasedimentary series which includes arkose and arkosic to subarkosic wacke characterized by relatively high mafic content, underlies parts of the map area, and a large unit of these rocks is found in northern Tronsen and southern Raaflaub Townships. In Raaflaub Township this unit is in contact with tightly folded flows of basalt and basaltic komatiite that are part of the northeast-trending lobe of the Batchawana belt. This series is most likely an older one which derived from the mafic metavolcanics adjacent to it, and is thought to have been deposited previous to the beginning of the calc-alkaline volcanism from which the younger metasedimentary series originated. The contact relationships between the 2 series are obscured by folding and metamorphism.

The deeper part of the basin in which the volcanogenic sediments accumulated, presumably first from the north and then from the east, corresponds to the present area of Tronsen Township, and the shallower part of it corresponds to the present eastern margin of Vibert Township. The supracrustal rocks of the map area are deformed by folding, emplacement of intrusive rocks, and faulting. Folding accompanied by metamorphism of upper amphibolite rank occurred initially along easterly trends, and was followed in time by folding which occurred along dominantly northerly trends, and developed essentially under greenschist facies conditions. Faulting developed, probably concomitant to, and certainly after, the emplacent of granite within and marginal to the supracrustal rocks. The main feature of the late cross-folding about northerly trends is the overturned syncline in the Guyatt-Martin Lakes area. In the nucleus of this structure, and at the southern margin of the map area, are dominantly basaltic metavolcanics which indicate that another cycle of basaltic volcanism followed the deposition of the metasediments overlying the calc-alkaline metavolcanics in northwestern Desbiens Township.

Economic Geology

MINERAL EXPLORATION

Algoma Central Railway (A.C.R.) controls the mineral rights in Home, Raaflaub, Running, Tolmonen, Tronson, Vibert, Davieaux and Desbiens Townships. Way-White, Runnalls, Peever, Smilsky, Nicolet, Norberg and Olsen Townships are crown land. Seventeen of the 23 mineral occurrences and/or properties shown on the geological maps accompanying this report are in A.C.R. townships and exploration activities pertaining to the A.C.R. properties are described below. Two mineral occurrences located by the present survey occur on crown land in Way-White Township and are described below. No recorded information was found on these 2 occurrences in the A.C.R. Assessment Work Files. As of May 1, 1978 none of the mineral occurrences were staked.

Most of the map area was covered by an airborne magnetometer survey carried out by Jalore Mining Company Limited in 1953 (Resident Geologist Files, Ontario Ministry of Northern Development and Mines, Sault Ste. Marie) and in 1956 Five Townships Syndicate undertook geophysical, geological, and geochemical surveys in Way-White Township. During the summer of 1975 Geophysical Engineering Limited was active in the area.

PROPERTY AND MINERAL DEPOSIT DESCRIPTIONS

ALGOMA CENTRAL RAILWAY

The Algoma Central Railway controls mineral rights in Home, Raaflaub, Running, Tolmonen, Tronsen, Vibert, Davieaux, and Desbiens Townships. Information on exploration in these townships is on file in the Assessment Work Files, Algoma Central Railway, Division of Lands and Forests, Sault Ste. Marie, Ontario. Algoma Central Railway has conducted exploration on its own behalf and has extended into joint venture exploration with other parties. The available information is grouped accordingly in the following descriptions.

Asarco Exploration Company of Canada Limited [1974] (6)

In early 1974, Asarco Exploration Company of Canada Limited entered a joint venture agreement with respect to the mineral rights in Running Township, and during May of the same year electromagnetic and magnetic surveys were flown by Kenting Earth Sciences Limited. Geological and geophysical ground follow-up of this work was carried out by Asarco Exploration Company of Canada Limited in June and August of the same year. The ground follow-up of the geophysical surveys by Asarco Exploration Company of Canada Limited (*see* "Mineral Exploration") indicated that "...the anomalies were caused by graphitic slates of tuffs." Nothing of economic interest was found and it was recommended that no further work be carried out.

Grebe, E. [1970] (8)

In 1970, blasting was carried out and a 31 m (102 feet) hole was diamond drilled at the southeast corner of Wart Lake in Vibert Township on a property optioned by E. Grebe of Midland, Michigan. A quartz-calcite vein containing chalcopyrite is exposed at this location.

Scattered (3 to 5%) chalcopyrite crystals up to 9.5 mm (3/8 inch) in size occur within coarse grained calcite; the chalcopyrite crystals are variably altered to azurite and malachite. Calcite occurs as a lens with approximate maximum exposed length and width of 1.4 and 0.46 m (4.5 and 1.5 feet) respectively, within a subvertical quartz vein approximately 8 to 61 cm (3 inches to 2 feet) thick, which conformably intrudes subvertical metasediments striking N20E. Grab samples were taken by the author and analyzed by the Geoscience Laboratories, Ontario Geological Survey, Toronto. The calcite assayed 1.12% Cu, 0.01% Pb, 2.49% Fe, and 0.18 oz Ag/ton. The quartz surrounding and adjacent to the calcite lens assayed 0.10% Cu, 0.01% Pb, and trace Ag. No further work was recorded as of May 1, 1978.

Rio Tinto Canadian Exploration Limited [1964] (9)

In 1962, detailed geophysical and geological mapping was done by H.O. Seigel and Associated Limited for A.C.R. in local areas of northern Vibert and southern Runnalls Townships; some trenching was carried out in the same general area by Rio Tinto Canadian Exploration Limited in 1964. No further work was reported.

United Petroleum Incorporated [1974] (10)

In the summer of 1974, 4 diamond drill holes totalling 305.7 m (1003 feet) were drilled by Fontaine Drilling near Wart Creek, about 400 m southeast of Wart Lake, Vibert Township for United Petroleum Incorporated. This work was to test a number of self potential anomalies. No further work was recorded.

Raaflaub Township (3a-c) and Tronsen Township (4a-e)

Between 1962 and 1963 detailed geophysical surveys and geological mapping were carried out by F.R. Joubin and Associates Limited for A.C.R. at 5 localities in Tronsen Township (Properties 4a to 4e); and in 1963, a 122 m (401 foot) hole was diamond-drilled by Canadian Longyear Limited for A.C.R. at property location 4d in the southwest corner of Tronsen Township. An additional locality in the same township was geologically mapped by A.C.R., presumably in 1965. All this work involved a total of approximately 27 240 m (89 380 feet) of line cutting. In 1972 geophysical traverses were run by A.C.R. in the Wart Lake area of the same township.

The Batchawana-Hubert sheet of the A.C.R. geological map (1964) shows occurrences of: (1) pyrite in rusty and/or shear zones at 5 localities in the area (occurrences 3b, 3c, 4b, 4c, 4d), (2) "copper" or chalcopyrite in shear and/or rusty zones at 3 localities (occurrences 4a, 4c, and 4d), and (3) molybdenum in a quartz vein at 1 locality (occurrence 3a). For completeness all these occurrences were plotted on the accompanying maps but were not located by the field party, and, for 7 of them, no data on the amount of mineralization, host rock, or development work (if any), were found in the assessment work files. Occurrence 4d is the site of the hole drilled in 1963 by Canadian Longyear Limited (*see* "Mineral Exploration"). This hole intersected a 47.2 m (155-foot) thick sequence of: "...grey schists of probable sedimentary origin containing zones of small pyrite lenses in amounts of up to 5% semi-massive pyrite-pyrrhotite over a two-foot thickness, and traces of chalcopyrite over a thickness of 5 feet. Assays from this hole returned only low values for copper and nickel and no values for gold and silver." (Algoma Central Railway, Assessment Work Files, Sault Ste. Marie). Assessment records filed by F.R. Joubin and Associates Limited in 1962 (*see* "Mineral Exploration") indicate the presence of: (1) a narrow band of magnetite iron formation striking approximately east, with a strike-length of at least 1600 m (5200 feet) in the Carpenter Lake area, (2) a band of the same type 15 m (50 feet) or less in thickness striking east for at least 360 m (1200 feet) approximately 3 km (2 miles) south of Carpenter Lake, and (3) several thin bands of magnetite iron formation striking almost north and with a total strike-length of at least 970 m (3200 feet) in southwestern Tronsen Township. No development was recommended for any of these iron formation occurrences. Except for occurrences 4c and 4d which are found in the basaltic metavolcanics of western Tronsen Township, all the sulphide occurrences are in the metasediments underlying Tronsen Township and part of Raaflaub Township.

Vibert Township (5a-d,S), Desbiens Township (2a-b), and Davieaux Township (1)

In the summer of 1975, 8 small mineral occurrences were discovered during mapping carried out by the author in the A.C.R. Townships area (i.e. occurrences 1, 2a-b, 5a-d,S). No recorded information was found on any of the occurrences located during mapping. Descriptions are from field notes, and the assay data refer to grab samples collected by the author and assayed by the Geoscience Laboratories, Ontario Geological Survey, Toronto.

The occurrences are of 2 types. The first consists of sulphide disseminations (primarily pyrite) in felsic metavolcanics and subordinately in basalt and metasediments. The second type of occurrence consists of magnetite in iron formation which is in places stained by weathering due to the presence of subordinate or minor sulphides associated with magnetite.

Vibert Township (5a-d,S)

Occurrence 5a

Magnetite, pyrite: Magnetite band 30.5 to 35.6 cm (12 to 14 inches) thick within banded oxide-facies iron formation striking N74W and dipping 78NE; the exposed strike-length and width of the iron formation are 21.4 and 1.07 m (70 and 3.5 feet) respectively. Pyrite occurs as disseminations and small massive stringers in a discontinuous band up to 20.3 cm (8 inches) thick adjacent to, and to the south of, the magnetite band. The magnetite assay values were traces of Cu, Zn, and Au, 0.10 oz Ag/ton, and 33% Fe; the pyrite assay values were traces of Zn, Au, and Ag, 0.03% Cu, 0.01% Pb, and 20.5% Fe.

Occurrence 5b

Pyrite: Fine grained pyrite disseminations in felsic tuff of uncertain trend; the concentration of pyrite is 3 to 5% over an exposed area of approximately 4.65 m^2 (50 square feet). The mineralized tuff assayed 0.01% Cu, 0.01% Pb, and trace Ag.

Occurrence 5c

Pyrite: Very fine grained pyrite occurs as ovoid fillings up to 6 mm (3/16 inch) in size within subvertical felsic tuff trending N65E; the concentration of the pyrite ovoids is approximately 3% over an exposed area of about 3.34 m^2 (36 square feet). The mineralized tuff assayed 0.02% Pb, 0.01% Cu, and trace Ag.

Occurrence 5d

Magnetite: Boudinaged, garnetiferous magnetite layer with exposed maximum strike-length and width of 6 m (20 feet) and 45.7 cm (18 inches) respectively, in northwest-trending oxide-facies iron formation dipping 56NE. The magnetite assayed traces of Zn, Au, and Ag, 0.01% Pb, 0.02% Cu, and 31.2% Fe.

Occurrence S

Pyrite: Pyrite disseminations and tiny concordant stringers in a 33 cm (13 inch) thick mafic metavolcanic layer interbedded with metasediments (unit 3f) striking N-NW and dipping 72NE, on the east central shore of Wart Lake. The pyrite concentration is about 5% over an estimated strike-length of 1.5 m (5 feet); the metavolcanic layer assayed traces of Ag 0.01% Cu and Pb, and 0.01 oz Au/ton.

Desbiens Township (2a-b)

Occurrence 2a

Pyrite: Tiny massive pyrite stringers and disseminated pyrite cubes up to 6.3 mm (0.25 inch) in size in felsic metavolcanics striking N40W, dipping 71NE, and adjacent to the northern boundary of a diabase dike trending N36W. The pyrite concentration varies between 5 and 20% over an exposed area of 0.65 m^2 (7 square feet). The pyritized metavolcanics assayed traces of Au and Ag, 0.01% Pb, and 0.04% Cu.

Occurrence 2b

Pyrite, copper: Pyrite mineralization consists primarily of disseminations in concentrations of 2% or less in 5 discrete small outcrops of intermediate to mafic metavolcanics occurring within an approximately triangular area 7000 m^2 (75 000 square feet) in size; the metavolcanics trend N-NW and dip either vertically or steeply to the NE. Semi-massive pyrite stringers up to 2.54 cm (1 inch) in thickness and in local concentrations of up to 5% occur in the southernmost of the outcrops and assayed traces of Ag and Au, and 0.72% Cu.

Davieaux Township (1)

Occurrence 1

Pyrite: Minor pyrite disseminations in felsic metavolcanics occur close to a diabase dike contact. The pyritized metavolcanics assayed traces of Ag, 0.01% Cu and Pb.

FIVE TOWNSHIPS SYNDICATE [1956](7)

In 1956, exploration work was carried out in Way-White Township by Technical Mine Consultants on behalf of a syndicate known as the Five Townships Syndicate which was formed for the purpose of acquiring exploration rights to 5 townships owned by Algoma Central Railway. The exploration program included 2 airborne electromagnetic surveys, staking of 190 claims, and detailed geophysical, geological, and geochemical investigations at various localities of Way-White Township. A total of about 43 037 m (141 200 feet) of line cutting and some local trenching were carried out during the program. The target of the exploration work carried out in 1956 by the Five Townships Syndicate was apparently the location of massive sulphide mineralization, but no recorded information of further development in the area was found in the assessment files.

WAY-WHITE TOWNSHIP (11a-b)

In 1975, 2 small mineral occurrences were found during the present survey in Way-White Township south of Old Woman Lake. The descriptions are from field notes, and all assay data refer to grab samples collected by the author and assayed by the Geoscience Laboratories, Ontario Geological Survey, Toronto.

Occurrence 11a

Minor pyrite disseminations occur in sheared and silicified sandstone which assayed traces of Cu, Zn, and Ag, and 0.01% Pb.

Occurrence 11b

Very fine grained pyrite disseminations and tiny concordant stringers occur in sheared northwest-trending felsic metavolcanics dipping 70 to 74NE; the metavolcanics are characterized by a strongly pitted weathered surface of brownish to rust colour. The concentration of pyrite is 1.5% over an exposed area of approximately 18 m^2 (195 square feet). The pyritized metavolcanics assayed 0.01% Cu, 0.02% Pb and trace Ag.

RECOMMENDATIONS TO PROSPECTORS

The contact between the northwest-trending mafic metavolcanic belt underlying most of Way-White Township and parts of Running and Desbiens Townships, and the prominent felsic metavolcanic unit to the west of it, may warrant exploration. This contact marks a facies change from extrusion of (mafic) tholeiitic flows to (felsic) calc-alkaline and pyroclastic volcanics, a condition regarded by the author as favourable for potential volcanogenic base metals (e.g. "Noranda type" deposits; Sangster 1972).

Strain undergone by the supracrustal rocks in response to emplacement of granitic intrusions and folding could have resulted in local deformational and/or metasomatic processes favourable to gold mineralization. Localities where such processes are likely to have occurred are:

(1) The metasediments marginal to the granitic pluton underlying the Mongoose Lake area, and particularly those that are adjacent to the southeastern side of the pluton (southwestern Vibert Township)

(2) The metasediments and felsic metavolcanics on the eastern side of the small granitic pluton located in the northeastern corner of Vibert Township

(3) The metasediments and mafic metavolcanics to the southeast of the granitic "plug" on the north side of Guyatt Lake (Davieaux Township)

(4) The northwest-trending segment of the prominent felsic metavolcanic unit located south of the Chippewa River in northern Desbiens and southern Way-White Townships.

The iron formation occurrences found in the map area appear to be rather small and scattered in distribution. Nevertheless, recent experience by the author in the "Hemlo belt" has shown that iron formation as well as bands of "rusty" interflow clastic sediments can host significant gold values (Siragusa 1984).

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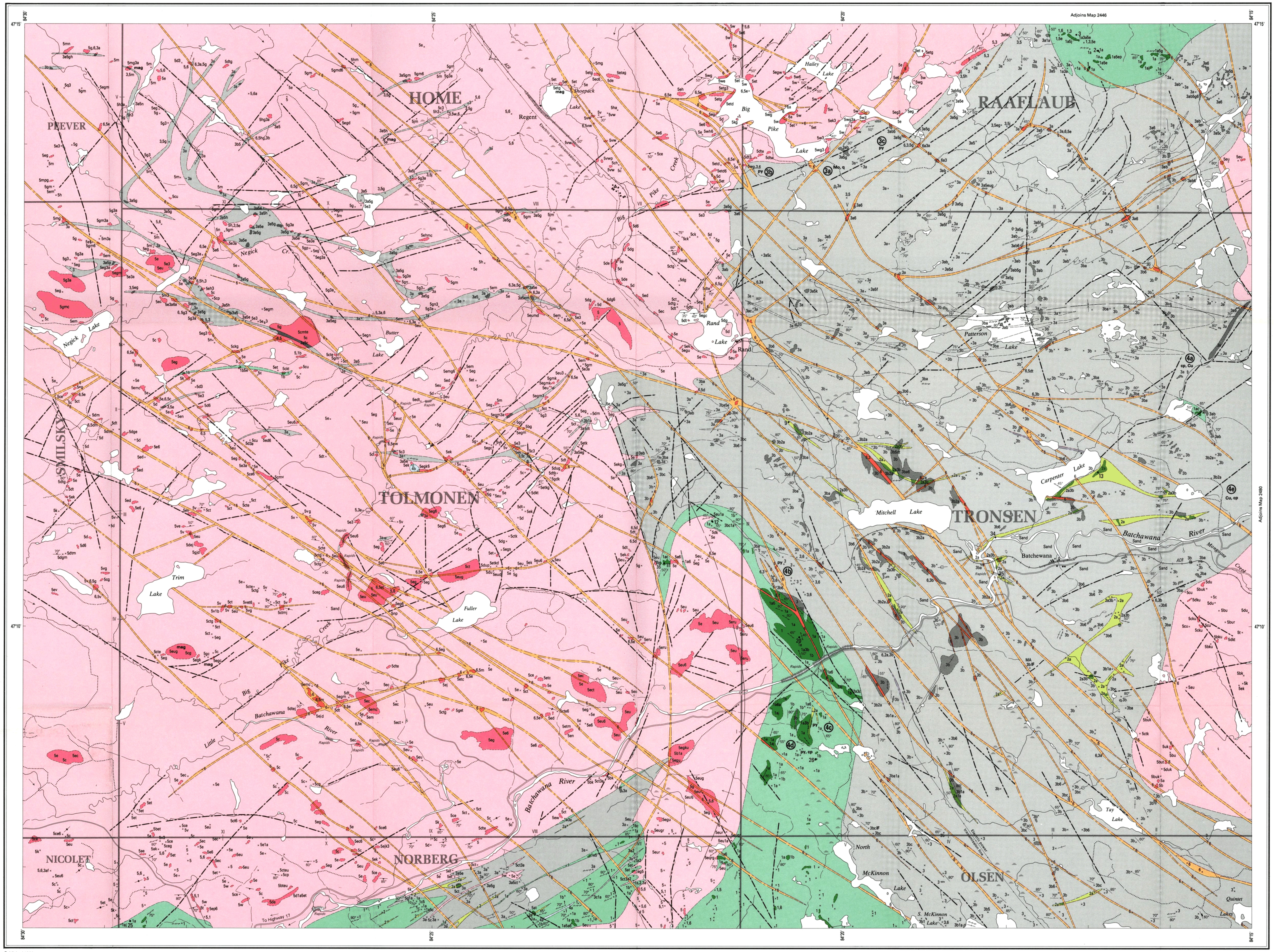
Ministry of Natural Resources
Ontario

Ontario Geological Survey
Map 2479
Rand Lake



Published 1983

SYMBOLS

- Glacial striae. Glacial fluting or drumlin.
- Esker.
- Bedrock; (small outcrop, area of outcrop).
- Bedding, horizontal.
- Bedding, top unknown; (inclined, vertical).
- Bedding, top indicated by arrow; (inclined, vertical, overturned).
- Bedding, top (arrow) from grain gradation; (inclined, vertical, overturned).
- Bedding, top (arrow) from cross bedding; (inclined, vertical, overturned).
- Bedding, top (arrow) from relationship of cleavage and bedding; (inclined, overturned).
- Lava flow; top (arrow) from pillows shape and packing. Lava flow; top in direction of arrow.
- Direction of paleocurrent.
- Schistosity; (horizontal, inclined, vertical).
- Gneissosity; (horizontal, inclined, vertical).
- Foliation; (horizontal, inclined, vertical).
- Shearing ; (inclined, vertical).
- Lineation with plunge.
- Geological boundary; (observed, position interpreted, deduced from geophysics).
- Magnetic contour value in gammas. Magnetic attraction.
- Fault; (observed, assumed). Spot indicates down throw side, arrows indicate horizontal movement.
- Lineament.
- Jointing; (horizontal, inclined, vertical).
- Drag folds with plunge.
- Anticline, syncline, with plunge.
- Drill hole; (vertical, inclined, projected vertically, projected up dip). Overburden shown.
- Location of sample.
- Vein, vein network. Width in inches or feet.
- RA Radioactivity.
- Swamp.
- Motor road. Provincial highway number encircled where applicable.
- Other road. Trail, portage, winter road.
- International or Provincial boundary.
- County, District, Regional or District Municipal Boundary, with mile post.
- Municipal Boundary, (City, Town, Improvement District, Incorporated Township), with milepost.
- Township, Indian Reserve, Meridian, Base Line, Provincial Park, with milepost, (surveyed, unsurveyed).
- Mining property, surveyed. Mineral deposit or mining property, unsurveyed.
- Surveyed line. Unsurveyed line.

All boundary and survey lines are approximate position only.

Some symbols may not occur on this map.

PROPERTIES, MINERAL OCCURRENCES

Algoma Central Railway.
1. Davieaux Township occurrence.†
2. Desbien Township occurrences.†
3. Raaflaub Township occurrences.
4. Tronsen Township occurrences.
5. Vibert Township occurrences.†
6. Asarco Exploration Co. of Canada Ltd., [1974].†
7. Five Townships Syndicate, [1956].†
8. Grebe, E., [1970].†
9. Rio Tinto Canadian Exploration Ltd., [1964].†
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11. Way-White Township occurrences.†

Information current to May 1, 1978.

Former properties on ground now open for staking are only shown where exploration data is available. A date in square brackets indicates last year of exploration activity. For further information see report.

†Occurs only on companion sheet.

SOURCES OF INFORMATION

Geology by G.M. Siragusa and assistants, Ontario Geological Survey, 1974-8.
Geology is not tied to surveyed lines.

Maps and assessment files of the Algoma Central Railway.

Aeromagnetic map 2202G, ODM-GSC.

Ontario Department of Mines.
Map 34d Mississagi Reserve and Goulais Iron Range, 1925.
Map 35b Batchawana Area, 1926.

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P 998, Batchawana-Pangis Area (west part), scale 1 inch to ¼ mile, 1975.
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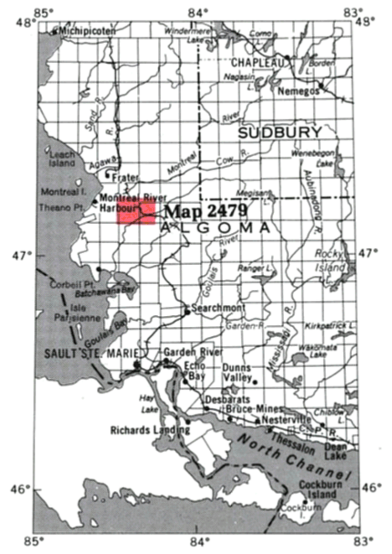
Siragusa, G.M.
1983: Rand Lake; Ontario Geological Survey Map 2479, Precambrian Geology Series, scale 1 inch to ½ mile, geology 1974-8.

Ontario Geological Survey
Map 2479
RAND LAKE
ALGOMA DISTRICT

Scale 1:31,680 or 1 Inch to ½ Mile

Chains 80 60 40 20 0 1 2 Miles
Metres 1000 0 1 2 3 Kilometres
Feet 1000 0 5,000 10,000 Feet



Scale: 1 inch to 50 miles

NTS Reference: 41N/1

LEGEND

PHANEROZOIC
CENOCOIC[a]
QUATERNARY
PLEISTOCENE AND RECENT
Boulder, sandy, and silty till, erratic boulders.

UNCONFORMITY

PRECAMBRIAN[b]
MIDDLE TO LATE PRECAMBRIAN (PROTEROZOIC)

MAFIC INTRUSIVE ROCKS
- 6 Olivine diabase.
- 6a Porphyritic diabase.

INTRUSIVE CONTACT

EARLY PRECAMBRIAN (ARCHEAN)

FELSIC INTRUSIVE AND METAMORPHIC ROCKS
- 5 Unsubdivided.
- 5a Diorite.
- 5b Leucocratic diorite.
- 5c Trondhjemite.
- 5d Granodiorite.
- 5e Quartz monzonite.
- 5f Muscovite-bearing medium-grained granitic rocks.
- 5g Potassic feldspar-quartz pegmatite.
- 5h Biotite pegmatite.
- 5j Muscovite pegmatite.
- 5k Hornblende-rich xenoliths.
- 5m Biotite-rich xenoliths.
- 5n Aplite veins or dikes.
- 5p Granitic rocks containing quartz veins.
- 5q Porphyritic; feldspar phenocrysts.
- 5r Porphyritic; quartz phenocrysts.
- 5s Porphyritic; mafic phenocrysts.
- 5t Foliated.
- 5u Massive.
- 5v Lit par lit gneiss.
- 5w Sheared.

INTRUSIVE CONTACT

MAFIC INTRUSIVE ROCKS
- 4a Hornblende gabbro.
- 4b Anorthositic gabbro.

INTRUSIVE CONTACT

METAVOLCANICS AND METASEDIMENTS

METASEDIMENTS
- 3 Unsubdivided.
- 3a Arkose, arkosic wacke, subarkosic wacke.
- 3b Siltstone.
- 3c Slate, argillite, spotted slate.
- 3d Polymictic conglomerate.†
- 3e Conglomeratic arenite.†
- 3f Banded mudstone.
- 3g Garnetiferous metasediments.†
- IF Iron Formation

METAVOLCANICS

FELSIC METAVOLCANICS
- 2 Unsubdivided.
- 2a Rhyolite, dacite flows.
- 2b Massive medium-to fine-grained flows.†
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cp	Chalcopyrite.
Cu	Copper.
mag	Magnetite.
Mo	Molybdenum.
py	Pyrite.
q	Quartz.
S	Sulphide mineralization.†

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[a]Unconsolidated deposits. Cenozoic deposits are represented by the lighter coloured parts of the map.

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Ministry of Natural Resources
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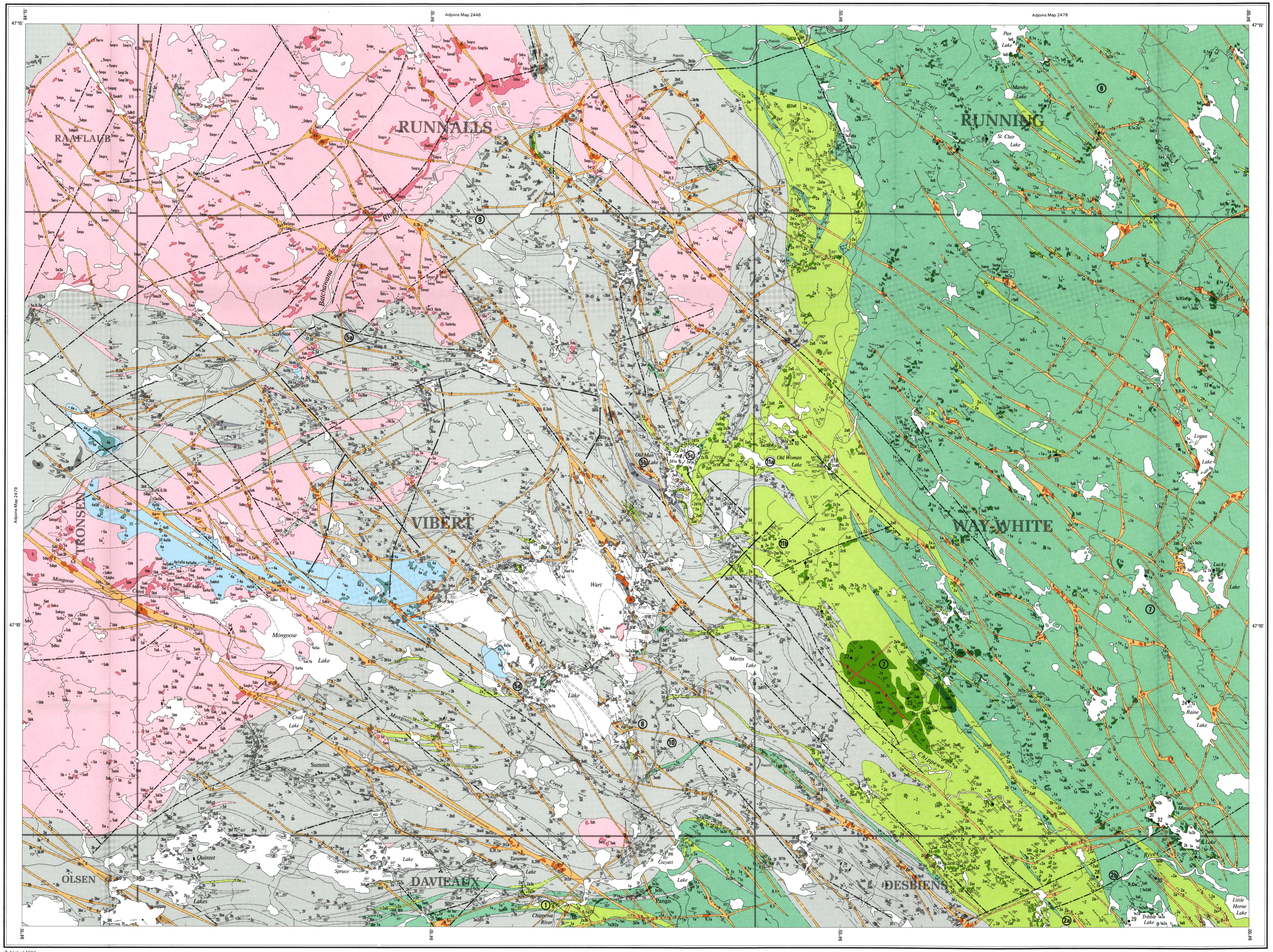

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PLEISTOCENE AND RECENT

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UNCONFORMITY

PRECAMBRIAN[b]

MIDDLE TO LATE PRECAMBRIAN (PROTEROZOIC)

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5v Lit par lit gneiss.†
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INTRUSIVE CONTACT

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