Canadian Mineralogist
Vol. 17, pp. 187-200 (1979)

RELATIONSHIP OF ULTRAMAFIC AMPHIBOLITES TO METAVOLCANIC ROCKS AND SERPENTINITES IN THE THOMPSON BELT, MANITOBA

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ABSTRACT

In the Thompson belt, ultramafic amphibolites occur within the metavolcanic–metasedimentary sequence, in migmatitic gneisses and in association with serpentinized peridotites. The amphibolites, in concordant lenses or sheets, commonly exhibit layering defined by the relative proportions of amphibole, olivine, orthopyroxene and spinel. CIPW norms, calculated on whole-rock analyses, indicate mainly picritic compositions. The association of metapicrites with metabasaltic rocks suggests an extrusive or hypabyssal origin, locally confirmed by pillows. Although no obvious spinifex textures have been found in these rocks, quench textures are preserved in some of the less deformed magnesian metabasalts; the others are completely amphibolitized. All the metapicrites in the Thompson belt are komatiitic, as shown by plots of Al_2O_3 *versus* FeO/(FeO+MgO). Variations in the FeO/(FeO+MgO) ratio in individual units may reflect differentiation during solidification. Similarly, all the metavolcanic rocks are also komatiitic and chemically form a continuous trend with the metapicrites. This suggests derivation from the same magma source. Metapicrites associated with serpentinized peridotites are interpreted as differentiates of peridotite magma. The metapicritic portion is generally located at the margin of a given serpentinite body, and chemically continuous with it. These relationships clearly point to a common magma source. The metapicrites therefore comprise both ultramafic flows and hypabyssal intrusions genetically related to the serpentinites. Their complex metamorphic character indicates that they (and the serpentinites) are either early Hudsonian or pre-Hudsonian in age.

SOMMAIRE

Dans la ceinture Thompson, on trouve des amphibolites ultramafiques dans la séquence métavolcanique–métasédimentaire, dans les gneiss migmatitiques, et associées à des péridotites serpentinisées. Ces amphibolites, lenticulaires ou en couches, montrent une stratification qui reflète les proportions relatives d'amphibole, d'olivine, d'orthopyroxène et de spinelle. Leur composition (d'après la norme C.I.P.W. calculée sur analyses globales) est surtout picritique. Les métapicrites ont une origine extrusive ou hypabyssale qu'indique leur association avec les roches métabasaltiques et que confirment çà et là des structures en coussinets. Nulle texture de trempe (spinifex) n'est visible dans ces roches: on la trouve seulement dans les métabasaltes magnésiens les moins déformés, les autres étant complètement amphibolitisés. Toutes les métapicrites de la ceinture Thompson sont komatiitiques, comme l'atteste la courbe d'Al_2O_3 en fonction de FeO/(FeO+MgO), rapport qui reflète le degré de différenciation au cours de la solidification. Toutes les roches métavolcaniques sont, elles aussi, komatiitiques et forment chimiquement avec les métapicrites une série continue, indice d'une source magmatique commune. Les métapicrites associées aux péridotites serpentinisées sont considérées comme produits de différenciation d'un magma péridotitique. La partie métapicritique se trouve en bordure d'un massif de serpentinite, avec lequel elle est en continuité chimique, ce qui requiert une origine magmatique commune. Les métapicrites comprennent des coulées ultramafiques et des intrusions hypabyssales reliées aux serpentinites. Le métamorphisme avancé de ces deux types de roches les fait remonter au début du Hudsonien, voire au pré-Hudsonien.

(Traduit par la Rédaction)

INTRODUCTION

Volcanic and ultramafic rocks have been recognized in the Thompson belt for several decades but were simply grouped as greenstones, amphibolites and serpentinites. It is only in the last decade or so that attempts have been made to study and classify these rocks in detail. A better understanding of the relationships between ultramafic amphibolites, volcanic rocks and serpentinites in the Thompson belt has evolved in recent years as a result of detailed field observations and chemical data. This paper summarizes some of this work, and the previous contributions of Alcock (1921), Dawson (1941, 1952), Gill (1951), Godard (1968), McInnes (1913), Patterson (1963), Tyrrell (1902) and Wright (1938).

REGIONAL GEOLOGY

The Thompson Precambrian mobile belt separates the Churchill and Superior provinces of the Canadian Shield in northern Manitoba (Fig. 1). The belt trends northeast and is fault-bounded on both sides. The Churchill province to the northwest comprises Kisseynew paragneisses of greywacke character; to the southeast are acidic and basic granulite-facies gneisses of the 'Pikwitonei province', at one time considered (Bell 1971) to constitute the basement of the Superior province. Weber & Scoates (1978), however, contend that Pikwitonei-province rocks are continuous with the Superior and therefore cannot be the basement.

Rocks in the Thompson belt comprise acidic gneisses with numerous metasedimentary and metavolcanic assemblages and acidic, basic and ultrabasic intrusions. The gneisses are migmatized and mineralogically layered, commonly with narrow bands of basic amphibolite of uncertain origin. They are considered to be paragneisses, at least in part. The acidic intrusions are of two ages: older orthogneisses and younger intrusions of Hudsonian age. The metasedimentary assemblages include siliceous, calcareous, pelitic and ferruginous rocks. The metavolcanic units comprise pillowed and massive flows of basalt with some concordant bodies of ultramafic composition; these may have been flows.

Basic and ultrabasic rocks intrude the gneisses, metasedimentary and metavolcanic rocks. The basic rocks are mainly metagabbros, some of which have differentiated ultramafic layers. Serpentinized ultrabasic intrusions form concordant bodies in the metasedimentary pile, especially along the western side of the belt. These host many of the nickel sulfide deposits in the area.

The gneisses, metasedimentary and metavolcanic rocks are all highly deformed and metamorphosed. The folding is tight, with both sub-

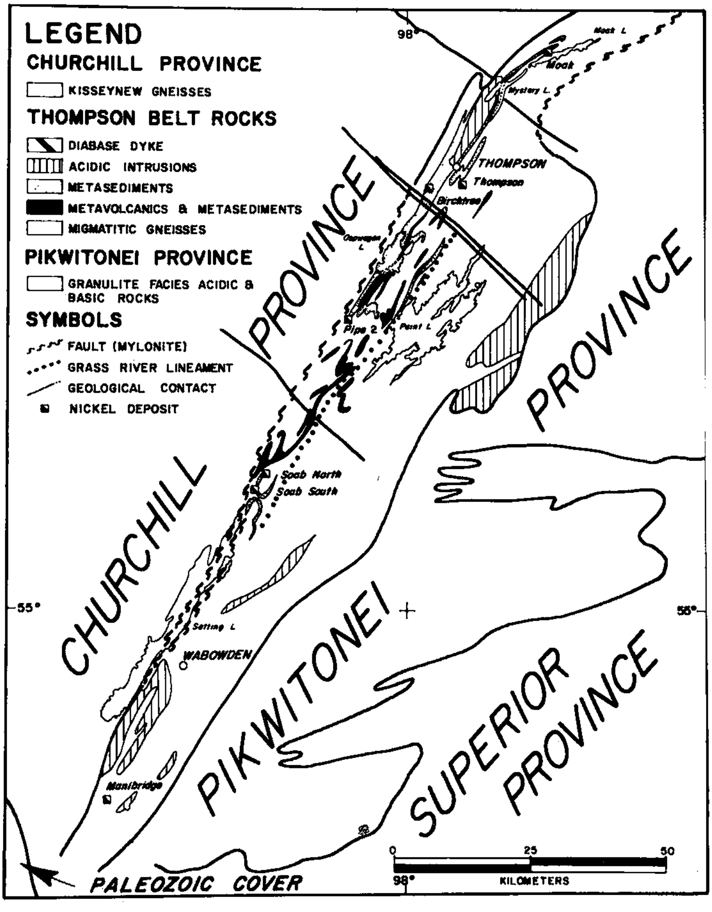

FIG. 1. Regional setting of the Thompson belt.

horizontal and vertical plunges; vertically plunging folds are dominant and are probably of Hudsonian age (1.8 Ga, representing the last major tectonic and metamorphic event. This event is reflected in K–Ar dates on the migmatite and pegmatite by Bell (1971) and Rb–Sr dates on gneisses by Cranstone & Turek (1976). The latter authors considered the gneisses to be remobilized Pikwitonei basement, and postulated that the metasedimentary and metavolcanic rocks were deposited on, and infolded with, the gneisses.

Wilson & Brisbin (1961) interpreted the Thompson belt as a root of a Precambrian mountain range of the island-arc or alpine type. Bell (1971) considered it might be an autochthonous slice from the Flin Flon subprovince, a "horst" of Archean basement underlying the Churchill province, or an Archean allochthon related to the Pikwitonei–Superior continental block.

PETROLOGY

In classifying the rocks, Quirke *et al.* (1970) and Coats *et al.* (1972) subdivided the various amphibolites into two groups (6 and 8) on the basis of presence or absence of volcanic features and lithologic associations. All rocks of obvious volcanic origin were assigned to group 6; they are spatially associated with group 5, a metasedimentary assemblage. Other amphibolites lacking obvious volcanic features were assigned to group 8; they are spatially associated with the gneisses (group 7).

In the present study, the basic and ultrabasic rocks are subdivided into four major groups:

I. Old layered complex
II. Basic sills or dykes
III. Volcanic rocks
    (a) Metabasalts and intermediate rocks
    (b) Magnesian metabasalts
    (c) Ultramafic flows
IV. Ultrabasic intrusions
    (a) Ultramafic amphibolites ± serpentinite
    (b) Serpentinites

Old layered complex

Numerous basic to ultrabasic rocks occur throughout the gneisses; these are interpreted as remnants or slices of an old layered complex (OLC) that range from a fraction of a metre to tens of metres in size. The rocks are commonly layered mineralogically and range from gabbro to pyroxenite. Some slices are anorthositic in character. The layers generally range from a centimetre to a metre thick; the contacts between layers are sharp and attitudes are variable. Dips range from vertical to horizontal, whereas in the surrounding gneisses they are essentially vertical. The strike of the layering is generally subparallel to the regional fabric but may deviate by as much as 20°. Such field relationships suggest that the OLC could constitute the oldest rocks in the gneisses, but this does not exclude the possibility that originally they were intrusive into the gneisses.

The OLC rocks are coarse-grained and texturally completely recrystallized, showing partial or complete retrogression from granulite to amphibolite facies of metamorphism. The following mineral assemblages are common in the OLC rocks: 1. amph ± plag ± cpx ± opx ± gar ± mica; 2. gar ± plag ± mica ± amph; 3. plag ± cpx ± opx ± amph.

The highly retrograded rocks of gabbroic composition are petrographically similar to the basic amphibolites that are common in the gneisses. This similarity suggests that at least some of the basic amphibolites could be related to the OLC.

Basic sills or dykes

Some hornblende–feldspar amphibolites exhibit intrusive features. They have coarse-grained interiors and finer grained margins suggestive of original chilling. In places they clearly transect the country rocks although for the most part, they are concordant with the gneisses and metasedimentary assemblages.

Sill-like amphibolites also occur in the volcanic rocks and are rather difficult to distinguish from massive flows. A few of the larger sills are differentiated. One such sill on the west shore of Upper Ospwagan Lake measures some 30 m in width, trends parallel to the regional structure, has a subvertical dip, and ranges in composition from gabbro to mafic gabbro.

The sills or dykes are recrystallized to amphibolites and may be either massive or foliated. The massive rocks are equigranular and commonly have relict diabasic textures. In foliated rocks the original texture is completely obliterated by recrystallization. Some are porphyritic with up to 30% large saussuritized phenocrysts. Another textural variety, locally referred to as the 'leopard-skin' gabbro, consists of coarse-grained hornblende porphyroblasts in a fine-grained amphibole–feldspar groundmass. This gabbro is associated with gneisses and metavolcanic rocks.

Hornblende–feldspar amphibolite sills or dykes also intrude the serpentinites. These have coarse-grained interiors and fine-grained margins, suggestive of chilling. They are commonly several metres wide, foliated and recrystallized.

Volcanic rocks

The volcanic rocks are subdivided into three major groups of which metabasalts are the most common. Other varieties include a more magnesian metabasalt that is characterized by quench textures. Abundant ultramafic amphibolite bodies are also associated with the volcanic rocks; some of these may be ultrabasic flows.

Metabasalts and intermediate rocks. These rocks form narrow belts that generally parallel the regional fabric. The largest volcanic belt, at Ospwagan Lake, is 20 km long and about one km wide. Its structural fabric is characterized by steep dips and subvertical dragfolds similar to those in the surrounding metasedimentary rocks and gneisses.

The metabasaltic pile consists of pillowed and massive flows and minor fragmental rocks. The pillowed flows are generally highly deformed; however, in a few locations, the pillows are fairly well-preserved (Fig. 2). They average 70 cm in diameter in plan view although they are elongated up to several times this diameter along the plunge. Stretched variolites occur close to the pillow margins and some pillows have elongate vugs filled with quartz ± feldspar ± carbonate ± clinopyroxene ± epidote ± garnet. Other pillows have amygdules mineralogically similar to the vug fillings. There is very little interpillow material; for the most part, it is of the same composition as the pillows.

The fragmental volcanic rocks (Fig. 3) are associated with the pillowed and massive flows. They contain strongly elongated fragments of coarse- to fine-grained amphibolites, which range from a few to several tens of centimetres in length and are closely packed. Some fragments are of gneissic country rocks.

FIG. 2. Pillowed metabasalt from Lower Ospwagan Lake. Hammer handle points north in all illustrations in this study.

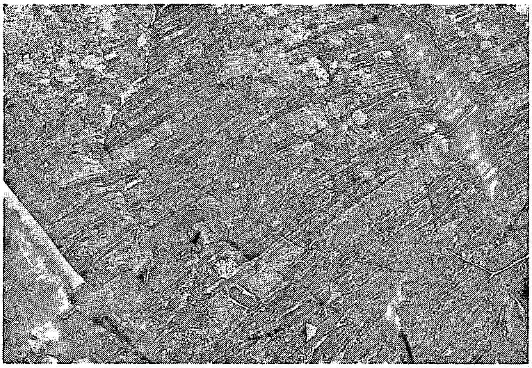

FIG. 3. Highly deformed fragmentary metavolcanic rock associated with metabasalts in Pipe–Upper Ospwagan Lake area.

The metabasalts are essentially amphibole-feldspar rocks with foliated fabrics and metamorphic textures. Quartz, clinopyroxene and garnet are locally present; other minor minerals include apatite, sphene, oxides and sulfides. Alteration is common, particularly in the sheared schistose varieties; it is characterized by abundant biotite, chlorite, sericite, epidote and saussurite.

An intermediate rock in the stratigraphically lower portion of the volcanic pile at Upper Ospwagan Lake may be of volcanic origin. This rock, exposed on a small island close to the west shore of the lake, has pillow-like structures (Fig. 4) up to a metre in diameter, outlined by micaceous selvages. The rock is moderately foliated where the pillows are visible and schistose where it is strongly deformed. The pillows are composed of pale green to colorless amphibole, biotite, feldspar, minor opaque minerals and quartz. In the highly recrystallized schist,

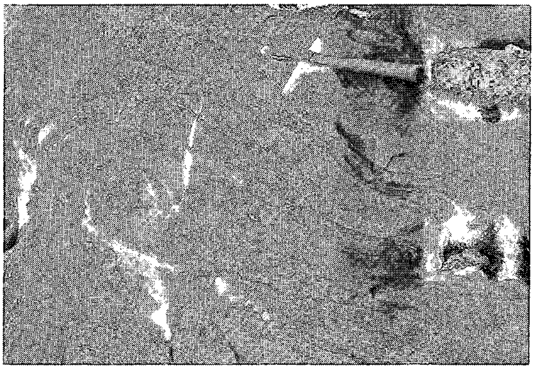

FIG. 4. Pillow structures in a massive intermediate volcanic rock from Upper Ospwagan Lake.

biotite is more abundant than amphibole and sillimanite is also present. This latter assemblage is similar to some of the sillimanite-bearing schists that occur in the gneisses and also in the metasedimentary terranes, *e.g.*, at the Thompson mine where they host much of the nickel sulfide mineralization. This anology may have a bearing on the interpretation of the pelitic members in the metasedimentary assemblages.

Magnesian metabasalts. Magnesium-rich metabasalts are closely associated with metabasalts at Lower Ospwagan and Mystery Lakes. They are characterized by quench textures in both pillowed and massive lava flows. The quench textures are typified by long mafic crystallites altered to amphibole and an apparently devitrified, relatively felsic matrix (Fig. 5). The crystallites form parallel, radiating and sheaf-like patterns typical of quenched komatiitic rocks or mafic slags. The magnesian metabasalts are light greyish-green, in contrast to the dark green metabasalts, and comprise several flow units, each 10 to 30 m thick. Each flow unit consists of a lower massive member and an upper pillowed member as illustrated in Figure 6. The pillows show radial alteration patterns along possible original cooling fractures. Oval variolites occur peripherally to the pillows and at the margins of massive flows. Elongate amygdule-like structures filled with devitrified felsic matter are locally concentrated in layers in the upper half of massive flows.

Ultramafic amphibolites are closely associated with massive flows at Lower Ospwagan Lake. These ultramafic rocks are rich in amphibole ± carbonate ± chlorite and seem similar to some of the ultramafic amphibolites described in the following section. They are interbanded with the flows and have sharp or sharply gradational contacts with them. Their intimate association suggests the ultramafic rocks could be more basic portions of the magnesian metabasalt flows. Alternatively these ultramafic rocks could be highly altered and deformed intrusions.

Fig. 5. Mystery Lake magnesian metabasalt with quench texture. The long dark needles are amphibole pseudomorphs after pyroxene in a devitrified matrix. The sample measures 10 x 17 cm.

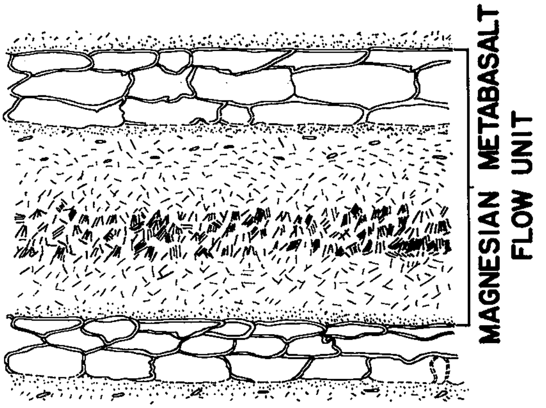

Fig. 6. A diagrammatic interpretation of pillowed and massive magnesian metabasalt flows with quench textures. The pillows merge with the underlying massive flow, but are sharply defined with the overlying massive flow. In the upper portion of the massive flow there are amygdule-like structures filled with devitrified-looking felsic material.

Ultramafic flows. Ultramafic pillow lavas (Fig. 7) are found at the south end of Lower Ospwagan Lake. The pale green pillow structures are outlined by thin dark green selvages. In surface plan the pillows attain a metre in diameter and are elongate in a subvertical direction, plunging moderately to the northeast with the regional fabric. The pillows are composed of fine-grained felty amphibole, and minor colorless chlorite. The amphibole may be a product of devitrification of mafic glass. Mineralogically

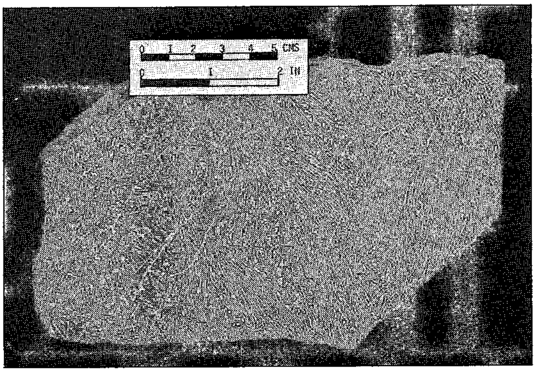

Fig. 7. Pillow structures in the ultramafic amphibolite at Lower Ospwagan Lake.

or texturally, this rock is indistinguishable from many of the amphibole-rich phases in the ultramafic amphibolites. The pillowed ultramafic flows are closely associated with magnesian metabasalts and layered ultramafic amphibolites that might represent massive flows or intrusions. Their close spatial association is suggestive of a genetic relationship.

Ultramafic amphibolites

The term ultramafic amphibolite is used strictly as a descriptive field term in this paper. Unless specified, no distinction is made between intrusive and extrusive rocks. Ultramafic amphibolites are found in the metavolcanic rocks and the gneisses where they are associated with other hornblende–feldspar amphibolites of uncertain origin. Some are also found within the metasedimentary pile as at Thompson mine, where it is unclear whether they are intrusive or have been tectonically emplaced.

The ultramafic amphibolites generally form concordant sinuous bodies that seem lens- or sheet-like. They range from a fraction of a metre to several hundred metres in width. They commonly have sheared schistose contacts and show complex folding, similar to the host rocks. Some of the ultramafic amphibolite bodies are relatively homogeneous, but others have mineralogical banding suggestive of primary layering (Fig. 8).

The ultramafic amphibolites contain amphibole, olivine, orthopyroxene and spinel in various proportions; minor plagioclase, oxides and sulfides may be present. Secondary products are chlorite, phlogopite, serpentine and oxides. Amphibole is dominant in all mineral assemblages. Three main types of mineral assemblages are recognized: 1. amphibole ± spinel ± plagioclase; 2. amphibole + olivine ± orthopyroxene ± spinel; 3. amphibole + orthopyroxene ± olivine ± spinel.

The first assemblage consists primarily of pale green actinolite and is probably equivalent to the 'hornblendites' described by Quinn (1955) and Godard (1966). It generally occurs at the margins or as layers within the ultramafic amphibolite bodies. Some bodies consist almost entirely of this monomineralic rock. The rock can be either massive or foliated; texturally it is granular, coarse-grained and recrystallized. In highly deformed rocks, phlogopite or chlorite may be important constituents.

The second mineral assemblage is characterized by olivine even though amphibole remains the most abundant mineral. Orthopyroxene may or may not be present; plagioclase has not been observed in this rock. The olivine occurs as coarse-grained equigranular or elongate crystals in a granular or felty amphibole-rich matrix (Fig. 9). Stephenson (1974) interpreted such coarse-grained olivines as primary phenocrysts modified by metamorphism. In some ultramafic amphibolites the olivines have a peculiar long prismatic habit. They attain several centimetres in length and occur in zones measuring up to several metres in width. The olivines are randomly oriented, optically homogeneous and constitute up to 20% of the rock. Various cuts of large slabs of this rock revealed that the olivines are kinked and folded (Fig. 10), which suggests that they formed before the last deformation event.

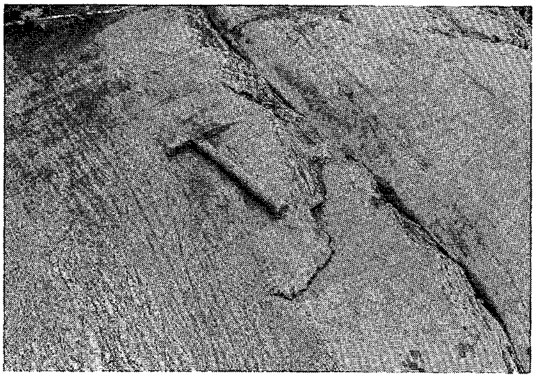

FIG. 8. Mineralogical banding or layering in the ultramafic amphibolite at Lower Ospwagan Lake. Amphibole-rich (right) and olivine-rich (left) layers. Glacial striae are trending about east–west.

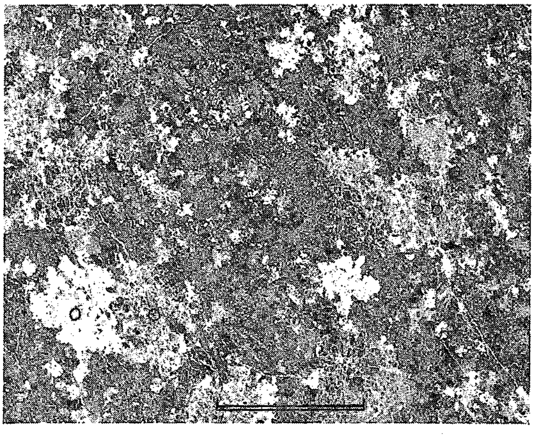

FIG. 9. Ultramafic amphibolite with large anhedral olivines (O) in an amphibole-rich matrix. The bar is 5 mm long.

The orthopyroxene, optically a hypersthene, occurs as granules interstitial to amphibole in the matrix, as subhedral inclusion-free metacrysts and as inclusion-packed poikiloblastic crystals up to a centimetre or more in diameter. The inclusions are commonly of amphibole and dust-like granules of green or olive-green spinel. Rarely the inclusions form oval patterns that are suggestive of zoning in the original mineral, indicating that at least some of the orthopyroxenes may have formed by recrystallization of primary pyroxene.

The spinels are either green or brownish-green, and occur as finely disseminated grains interstitial to amphibole or included in amphibole, orthopyroxene and rarely in olivine.

Serpentinite-ultramafic amphibolite association

Ultramafic amphibolites that are texturally and mineralogically similar to the ones described above are also found associated with the serpentinites in a number of places in the Thompson belt; they are particularly well known in the Thompson mine area. Study of these rocks led Zurbrigg (1963) to surmise that amphibole-rich rocks (his 'metaperidotites') associated with serpentinites may have developed from serpentinized peridotite through progressive metamorphism. It is now proposed that they represent differentiates of an ultrabasic magma, for the following reasons: (1) The ultramafic amphiboles tend to occur only on one side of a given serpentinite body. (2) They show gradational contacts with the serpentinite. (3) They are commonly mineralogically layered, with the layering more or less parallel to the serpentinite contact.

The proportion of ultramafic amphibolite to serpentinite varies among the individual bodies. At Thompson mine, many bodies consist entirely of ultramafic amphibolite, whereas some are entirely serpentinite. Where both are present, their proportions range from about 3:1 to 1:5. Large ultramafic inclusions within the nickel sulfide ore of the Thompson mine are mainly serpentinite although a few consist of ultramafic amphibolite. These inclusions, together with blocks showing mineralogical layering, were probably derived from a once larger ultramafic mass.

COMPOSITION

Metabasalts

Chemical data on metabasalts, amphibolites and serpentinites from the Thompson belt are assembled in Table 1. The basalts and amphibolites of possible volcanic origin are plotted in terms of Al_2O_3 *vs.* FeO/(FeO+MgO) in Figure 11. This diagram was developed by Arndt *et al.* (1977) to distinguish between komatiitic and tholeiitic suites of rocks of Munro Township in Ontario. Naldrett & Cabri (1976) have used it as a chemical screen to distinguish ultramafic rocks of komatiitic affinity from those of other associations. However, they point out that it is not a sufficient test in itself and is only useful in conjunction with field and petrographic criteria also indicative of a volcanic or subvolcanic environment and magmatic liquids of unusually high magnesium content.

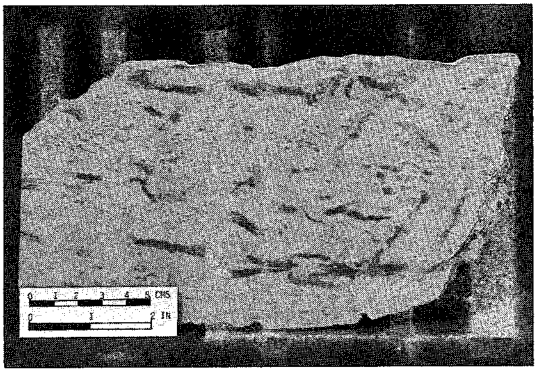

FIG. 10. Ultramafic amphibolite associated with metabasalts from Upper Ospwagan Lake. The elongate large olivines, kink-folded and partly serpentinized, occur in an amphibole-rich matrix.

The metabalsalt samples, including metavolcanic rocks from groups 8 (Hambone and Soab Lakes) and 6 (Ospwagan Lake area), consistently plot in the field occupied by the komatiitic basalts of Munro Township. The one odd sample of metabasalt plotting in the tholeiitic field is from an altered pillow lava. The metabasalts contain up to 11% MgO. The TiO_2 content, in most cases below 1%, is considerably lower than in most tholeiitic basalts, but typical of komatiitic basalts.

Magnesian metabasalts and ultramafic flows

The magnesian metabasalts and ultramafic flows also plot in the komatiitic field (Fig. 11) and form a continuous trend with the metabasalts of Ospwagan Lake. The magnesian metabasalts (nos. 26–30, 33–34) contain 12–14% MgO, and the ultramafic flows (nos. 31–32), about 18%. In both of these groups the TiO_2 content is below 1%, as in the komatiitic metabasalts mentioned earlier.

TABLE 1. ANALYTICAL DATA ON THE METAVOLCANIC ROCKS, ULTRAMAFIC AMPHIBOLITES AND SERPENTINITE FROM THE THOMPSON BELT

No.	Field No.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Ni	Co	Cr_2O_3	$H_2O\pm$	S	CO_2	LOI	Total
1	R-250	47.12	1.19	13.17	2.70	10.61	0.24	8.44	11.88	2.34	0.33	0.08	-	-	-	1.41	-	Tr.	-	99.51
2	R-242	49.97	0.84	14.66	1.60	8.49	0.13	7.69	12.89	1.62	0.46	Nil	-	-	-	1.16	-	Nil	-	99.51
3	R-237	47.93	1.06	13.62	2.03	9.69	0.22	6.41	16.36	1.80	0.26	0.08	-	-	-	0.42	-	Nil	-	99.88
4	R-240	47.39	0.96	13.86	1.42	9.91	0.13	7.58	14.32	1.96	0.48	0.03	-	-	-	1.08	-	0.16	-	99.28
5	R-239	48.08	0.70	15.03	1.20	9.48	0.19	7.63	14.17	1.92	0.57	0.01	-	-	-	0.85	-	Nil	-	99.83
6	18-72-210-2	50.3	1.86	12.35	1.94	14.40	0.27	6.33	8.93	1.86	0.09	0.19	-	-	-	1.28	-	0.15	-	99.9
7	18-72-212-2	53.55	0.78	14.1	1.39	8.18	0.17	8.44	9.57	2.47	0.30	0.04	-	-	-	1.20	-	0.15	-	100.3
8	18-72-214-1	51.75	0.81	13.9	1.53	8.88	0.17	8.53	11.86	1.74	0.09	0.08	-	-	-	0.96	-	0.15	-	100.4
9	18-72-222	50.55	0.79	12.7	0.89	8.88	0.18	9.18	12.99	1.55	0.09	0.04	-	-	-	1.39	-	0.25	-	99.5
10	18-72-223	51.05	0.65	17.8	0.86	8.18	0.19	6.63	9.12	3.35	0.32	0.13	-	-	-	0.91	-	0.15	-	99.4
11	18-72-387	49.7	0.79	12.5	1.66	9.13	0.18	10.60	11.32	1.98	0.17	0.08	-	-	-	1.19	-	0.10	-	99.4
12	18-72-403	50.13	0.87	13.05	1.20	9.09	0.16	9.22	11.98	2.15	0.17	0.08	-	-	-	1.10	-	0.05	-	99.2
13	18-72-430	49.05	0.86	13.1	1.55	8.96	0.18	11.02	11.06	1.78	0.17	0.10	-	-	-	1.44	-	0.15	-	99.4
14	18-72-587-1	51.75	0.85	13.85	1.01	6.97	0.16	6.54	17.66	0.70	0.11	0.11	-	-	-	0.57	-	0.05	-	100.3
15	18-72-587-2	50.45	1.00	14.95	1.55	8.63	0.16	8.25	12.44	1.42	0.16	0.12	-	-	-	1.03	-	0.05	-	100.2
16	T72-6003	49.8	0.79	12.76	-	11.36	0.17	9.5	12.54	-	0.15	-	0.03	0.008	0.08	-	-	-	0.36	97.55
17	T72-6004	49.9	0.86	13.78	-	11.12	0.18	8.2	9.94	-	0.47	-	0.04	0.007	0.03	-	-	-	0.67	95.20
18	T72-6017	49.5	0.84	13.36	-	10.23	0.17	9.5	11.50	-	0.22	-	0.02	0.007	0.07	-	-	-	0.77	96.19
19	T72-6020-4	48.5	0.91	13.86	-	10.96	0.18	9.5	10.71	-	0.26	-	0.03	0.007	0.04	-	-	-	0.87	95.83
20	T72-6021	50.2	0.74	14.23	-	9.39	0.16	9.3	11.93	-	0.24	-	0.02	0.005	0.04	-	-	-	0.80	97.06
21	T72-6018	48.3	0.88	15.01	-	9.94	0.17	9.1	11.55	-	0.30	-	0.02	0.006	0.04	-	-	-	1.00	96.32
22	T72-6019	48.5	0.72	15.41	-	9.46	0.15	9.5	11.08	-	0.32	-	0.03	0.006	0.05	-	-	-	1.17	96.40
23	T72-6020-1	50.3	0.69	13.01	-	10.20	0.26	10.7	10.76	-	0.24	-	0.04	0.007	0.08	-	-	-	0.95	97.24
24	T72-6020-2	47.3	0.76	12.34	-	11.09	0.17	13.4	10.79	-	0.15	-	0.05	0.008	0.04	-	-	-	0.77	96.87
25	T72-6020-3	49.5	0.86	13.33	-	10.69	0.17	10.2	10.78	-	0.18	-	0.04	0.007	0.04	-	-	-	0.57	96.37
26	18-72-289	46.7	0.92	17.15	1.41	9.42	0.17	8.80	6.70	2.96	1.25	0.12	-	-	-	3.30	-	0.65	-	99.5
27	18-72-290	56.75	0.83	14.65	1.28	6.85	0.10	6.48	5.69	4.65	0.68	0.05	-	-	-	1.70	-	0.20	-	100.0
28	15384 @ 40	47.2	0.58	11.6	-	10.34	0.17	14.5	10.2	-	0.16	-	0.05	0.009	0.21	-	-	-	0.60	95.62
29	@ 50	47.3	0.60	11.9	-	10.30	0.17	14.2	9.93	-	0.19	-	0.05	0.009	0.19	-	-	-	0.57	95.41
30	@ 75	47.4	0.59	11.9	-	9.91	0.17	13.9	10.3	-	0.11	-	0.05	0.009	0.21	-	-	-	0.47	95.02
31	@ 20	46.1	0.54	10.7	-	10.00	0.17	17.4	9.95	-	0.10	-	0.07	0.009	0.22	-	-	-	2.51	97.77
32	@ 30	46.5	0.47	9.25	-	10.01	0.17	18.6	8.89	-	0.10	-	0.07	0.009	0.23	-	-	-	2.87	97.17
33	T72-0664A	49.5	0.61	11.7	-	9.65	0.15	12.5	8.17	-	0.95	-	0.03	0.007	0.14	-	-	-	3.34	96.75
34	T72-0664B	50.4	0.62	12.2	-	9.11	0.15	12.2	8.94	-	0.63	-	0.03	0.006	0.14	-	-	-	2.13	96.56
35	18-72-208	46.8	0.75	11.0	1.82	9.30	0.18	16.1	10.05	1.63	0.09	0.05	0.07	-	0.25	2.04	0.01	0.10	-	100.2
36	18-72-215	43.6	0.50	7.9	3.08	7.80	0.17	23.3	6.34	0.87	0.11	0.09	0.11	-	0.32	5.66	0.06	0.75	-	100.6
37	18-72-216	48.0	0.55	6.8	2.51	7.64	0.20	19.75	9.78	0.74	0.05	0.06	0.07	-	0.17	3.69	0.01	0.20	-	100.2
38	18-72-217	46.65	0.41	6.8	2.88	6.60	0.10	21.85	8.50	0.44	0.03	0.04	0.15	-	0.54	4.68	0.12	0.15	-	99.9
39	18-72-218	47.7	0.57	8.15	1.86	8.26	0.18	17.85	10.95	1.10	0.06	0.09	0.10	-	0.37	3.03	0.07	0.15	-	100.5
40	18-72-220	45.65	0.56	8.55	2.47	8.42	0.17	18.95	9.50	0.85	0.22	0.05	0.11	-	0.40	3.68	0.00	0.20	-	99.8
41	18-72-230	42.9	0.38	7.15	1.65	7.59	0.15	25.10	6.28	0.42	0.03	0.09	0.20	-	0.49	6.78	0.03	0.95	-	100.2
42	18-72-413	46.45	0.62	9.0	2.34	6.06	0.12	19.0	10.02	1.22	0.12	0.04	0.11	-	0.44	4.26	0.01	0.15	-	99.9
43	18-72-457	47.05	1.40	4.90	4.33	10.28	0.23	21.30	4.82	0.70	0.44	0.05	0.18	-	0.08	3.99	0.16	-	-	99.9
44	44120 @ 583.4	52.35	0.29	6.46	-	9.00	0.18	17.82	10.80	-	0.72	-	0.07	0.011	0.29	-	-	-	(1.84)*	97.98
45	588.3	46.62	0.28	7.84	-	10.54	0.17	23.97	6.90	-	0.20	-	0.12	0.014	0.31	-	-	-	(1.13)	96.97
46	592.9	48.79	0.38	7.90	-	9.89	0.18	21.69	8.35	-	0.20	-	0.09	0.012	0.25	-	-	-	(1.85)	97.73
47	608.6	47.58	0.46	11.46	-	9.39	0.16	16.99	9.14	-	1.94	-	0.07	0.012	0.19	-	-	-	(2.33)	97.40
48	619.3	48.25	0.52	9.36	-	8.77	0.16	18.94	10.79	-	0.45	-	0.08	0.011	0.21	-	-	-	(5.81)	97.55
49	622.5	49.43	0.72	14.18	-	7.52	0.14	14.90	6.16	-	3.83	-	0.07	0.009	0.18	-	-	-	(2.76)	97.15
50	626.5	51.30	0.28	6.40	-	9.02	0.19	25.60	3.31	-	2.50	-	0.12	0.013	0.29	-	-	-	(2.40)	99.03
51	628.9	46.88	0.57	11.47	-	9.65	0.16	17.45	8.41	-	2.49	-	0.08	0.013	0.21	-	-	-	(1.48)	97.39
52	637.6	46.24	0.58	10.92	-	9.53	0.21	17.76	10.82	-	0.34	-	0.07	0.012	0.19	-	-	-	(2.07)	96.68
53	642.7	50.82	0.39	8.67	-	9.20	0.19	17.38	10.47	-	0.30	-	0.07	0.011	0.24	-	-	-	(1.64)	97.75
54	648.9	47.96	0.50	10.41	-	9.60	0.16	18.67	7.17	-	3.37	-	0.08	0.013	0.19	-	-	-	(2.04)	98.13
55	23500 @ 750	53.58	0.57	13.55	-	9.38	0.19	9.48	9.00	-	1.42	-	0.21	0.007	0.10	-	-	-	(1.87)	97.50
56	760	49.11	0.30	5.86	-	9.10	0.20	27.09	5.83	-	0.17	-	0.42	0.010	0.28	-	-	-	(3.39)	98.36
57	772	51.61	0.27	5.30	-	7.42	0.20	24.28	9.52	-	0.13	-	0.15	0.005	0.29	-	-	-	(1.60)	99.20
58	780	50.92	0.26	5.18	-	7.52	0.15	25.05	9.12	-	0.13	-	0.20	0.006	0.18	-	-	-	(1.84)	98.74
59	790	45.50	0.25	5.47	-	9.42	0.15	32.92	3.83	-	0.10	-	0.26	0.008	0.29	-	-	-	(2.24)	98.19
60	799	46.45	0.21	5.40	-	8.79	0.15	33.69	3.17	-	0.10	-	0.27	0.009	0.43	-	-	-	(2.08)	98.67
61	810	41.50	0.25	4.27	-	10.26	0.15	39.21	2.52	-	0.10	-	0.49	0.012	0.34	-	-	-	(4.00)	99.10
62	820	41.63	0.16	3.90	-	9.80	0.13	41.22	2.21	-	0.10	-	0.30	0.010	0.33	-	-	-	(2.53)	99.79
63	830	41.35	0.22	3.74	-	9.60	0.12	43.50	1.05	-	0.10	-	0.32	0.011	0.29	-	-	-	(2.60)	100.29
64	840	38.50	0.20	3.79	-	12.51	0.15	40.86	1.22	-	0.10	-	0.50	0.014	0.30	-	-	-	(2.66)	98.14
65	850	42.38	0.17	3.09	-	8.90	0.14	40.86	2.95	-	0.10	-	0.35	0.009	0.19	-	-	-	(1.63)	99.14
66	860	41.32	0.16	2.89	-	9.06	0.14	39.89	3.02	-	0.10	-	0.39	0.012	0.37	-	-	-	(1.77)	97.36
67	870	41.90	0.16	2.99	-	8.98	0.13	40.79	2.88	-	0.10	-	0.64	0.013	0.19	-	-	-	(0.97)	98.77
68	880	42.18	0.17	3.13	-	8.46	0.13	42.08	2.55	-	0.10	-	0.33	0.011	0.29	-	-	-	(1.64)	99.44
69	890	42.51	0.17	3.15	-	9.07	0.13	43.14	2.09	-	0.10	-	0.39	0.009	0.15	-	-	-	(3.69)	100.92
70	900	40.52	0.17	3.23	-	12.45	0.17	38.42	2.19	-	0.11	-	0.43	0.016	0.51	-	-	-	(10.10)	98.20
71	910	40.66	0.18	3.20	-	12.13	0.16	39.00	2.12	-	0.11	-	0.47	0.014	0.44	-	-	-	(11.10)	98.48
72	920	41.69	0.18	3.42	-	12.08	0.14	37.62	2.12	-	0.11	-	0.70	0.020	0.43	-	-	-	(10.00)	98.52
73	930	41.33	0.21	3.84	-	12.50	0.15	36.52	2.69	-	0.11	-	0.24	0.013	0.47	-	-	-	(9.33)	98.07
74	30935 @ 585	47.23	0.43	7.11	-	10.60	0.17	25.85	7.01	-	0.21	-	0.13	0.010	0.28	-	-	-	(3.80)	99.02
75	581	48.89	0.31	7.56	-	10.25	0.16	23.47	7.85	-	0.21	-	0.11	0.008	0.24	-	-	-	(2.93)	99.05
76	595	45.46	0.42	6.93	-	10.81	0.15	29.40	5.76	-	0.21	-	0.15	0.011	0.30	-	-	-	(5.00)	99.61
77	600	43.06	0.45	6.91	-	11.67	0.15	32.69	3.82	-	0.21	-	0.18	0.013	0.34	-	-	-	(6.84)	99.50
78	607	45.20	0.48	7.84	-	11.56	0.18	25.77	7.25	-	0.21	-	0.12	0.011	0.32	-	-	-	(3.90)	98.94
79	622	44.90	0.42	6.66	-	10.75	0.16	29.62	6.02	-	0.21	-	0.16	0.010	0.31	-	-	-	(5.40)	99.21
80	620	46.19	0.32	5.25	-	9.91	0.14	31.95	5.61	-	0.22	-	0.18	0.010	0.28	-	-	-	(7.93)	100.07
81	637	45.82	0.49	7.88	-	11.20	0.17	24.00	8.14	-	0.52	-	0.12	0.011	0.31	-	-	-	(3.90)	98.65
82	652	45.91	0.46	7.27	-	10.85	0.17	24.26	9.08	-	0.21	-	0.15	0.011	0.30	-	-	-	(4.10)	98.65
83	660	46.16	0.47	7.82	-	10.48	0.16	25.59	8.35	-	0.31	-	0.14	0.009	0.29	-	-	-	(4.43)	99.78
84	667	45.98	0.47	7.87	-	10.74	0.17	23.35	8.62	-	0.62	-	0.12	0.011	0.30	-	-	-	(3.80)	98.25
85	680-1	46.38	0.49	8.21	-	10.90	0.18	21.65	9.05	-	0.82	-	0.11	0.011	0.30	-	-	-	(3.10)	98.13
86	680-2	46.91	0.52	8.96	-	10.98	0.17	20.68	9.80	-	0.93	-	0.11	0.011	0.31	-	-	-	(2.87)	99.39
87	690-1	46.41	0.49	8.13	-	10.85	0.17	23.00	8.07	-	0.73	-	0.12	0.011	0.30	-	-	-	(3.60)	98.28
88	690-2	46.52	0.43	7.23	-	10.19	0.16	26.30	8.03	-	0.21	-	0.14	0.009	0.30	-	-	-	(4.77)	99.50
89	697	48.08	0.48	8.59	-	10.51	0.19	18.20	10.55	-	0.83	-	0.11	0.010	0.27	-	-	-	(3.40)	97.81
90	710	45.43	0.35	7.31	-	11.66	0.18	25.84	6.61	-	0.52	-	0.13	0.012	0.43	-	-	-	(4.20)	98.47

TABLE 1. ANALYTICAL DATA ON THE METAVOLCANIC ROCKS, ULTRAMAFIC AMPHIBOLITES AND SERPENTINITE FROM THE THOMPSON BELT (CONTINUED)

91		706	44.17	0.40	7.58	-	12.20	0.20	26.90	6.56	-	0.21	-	0.14	0.013	0.49	-	-	-	(4.67)	98.86
92		717	50.44	0.40	6.52	-	9.67	0.13	25.96	5.43	-	0.42	-	0.17	0.010	0.36	-	-	-	(5.53)	99.51
93		720	47.97	0.35	5.85	-	10.09	0.17	27.66	6.11	-	0.21	-	0.15	0.010	0.29	-	-	-	(3.60)	98.85
94	15353 @	284	48.23	0.54	9.13	-	10.60	0.18	18.23	9.65	-	0.51	-	0.08	0.010	0.28	-	-	-	(2.40)	97.45
95		294	46.25	0.55	8.72	-	11.19	0.17	20.22	9.32	-	0.21	-	0.10	0.011	0.34	-	-	-	(3.70)	97.09
96		315	45.82	0.51	8.21	-	11.52	0.18	22.34	8.25	-	0.21	-	0.11	0.011	0.35	-	-	-	(3.90)	97.51
97		335	46.83	0.54	8.70	-	10.97	0.15	18.59	11.09	-	0.21	-	0.10	0.011	0.33	-	-	-	(2.70)	97.52
98		355	46.33	0.55	8.94	-	11.35	0.15	18.45	10.86	-	0.20	-	0.09	0.011	0.33	-	-	-	(2.50)	97.28
99		365	46.65	0.55	8.75	-	10.85	0.17	19.09	10.94	-	0.20	-	0.10	0.011	0.35	-	-	-	(3.20)	97.66
100		373	47.20	0.53	8.54	-	10.57	0.17	20.29	9.40	-	0.41	-	0.09	0.010	0.32	-	-	-	(3.50)	97.52
101		385	45.17	0.42	6.17	-	10.84	0.14	28.76	5.50	-	0.21	-	0.15	0.014	0.56	-	-	-	(7.30)	97.93
102		399	48.75	0.49	8.59	-	9.95	0.16	20.88	7.35	-	0.94	-	0.09	0.009	0.29	-	-	-	(4.40)	97.51
103		406	48.31	0.79	12.10	-	11.87	0.17	12.61	10.68	-	0.41	-	0.02	0.009	0.14	-	-	-	(1.70)	97.11
104		415	47.21	0.59	9.23	-	10.76	0.16	16.90	12.08	-	0.31	-	0.07	0.010	0.29	-	-	-	(2.40)	97.61
105		435	45.86	0.62	9.23	-	11.51	0.16	17.85	11.08	-	0.21	-	0.08	0.010	0.31	-	-	-	(2.60)	96.92
106		445	45.72	0.61	9.22	-	11.51	0.17	18.16	11.97	-	0.21	-	0.07	0.011	0.30	-	-	-	(3.20)	97.94
107		455	46.02	0.60	9.22	-	11.27	0.16	17.53	12.30	-	0.20	-	0.08	0.010	0.31	-	-	-	(2.50)	97.72
108		485	46.42	0.58	8.85	-	11.31	0.17	20.33	9.62	-	0.21	-	0.09	0.011	0.35	-	-	-	(2.70)	97.95
109		495	47.45	0.63	9.75	-	11.28	0.17	15.54	11.68	-	0.41	-	0.07	0.010	0.26	-	-	-	(1.60)	97.26

Nos. 1-5: various amphibolites from the Hambone Lake area (Godard 1966); 6-15: metabasalts from the Ospwagan Lake area (Stephenson 1974); 16-17: pillowed and massive metabasalts from Lower Ospwagan Lake (this study); 18-19: pillowed and massive metabasalts from Upper Ospwagan Lake (this study); 20: massive metabasalt flow from N. Soab mine area (this study); 21-25: metagabbro sill in metabasalt from Upper Ospwagan Lake (this study); 26-27: magnesian metabasalts from Lower Ospwagan Lake (Stephenson 1974); 28-30: magnesian metabasalts from Lower Ospwagan Lake (this study); 31-32: ultramafic pillowed lava from Lower Ospwagan Lake (this study); 33-34: massive magnesian metabasalt flows from Mystery Lake (this study); 35-43: ultramafic amphibolites (metapicrites) associated with metavolcanic rocks from the Ospwagan Lake area (Stephenson 1974); 44-54: ultramafic amphibolite (metapicrite) body in gneiss from Thompson mine area (this study); 55-73: ultramafic amphibolite-serpentinite body in metasedimentary rocks at Thompson mine (this study); 74-93: ultramafic amphibolite body in metasedimentary rocks at Soab mine (this study); 94-109: ultramafic amphibolite body associated with the metabasalts and metasedimentary rocks in the Pipe-Upper Ospwagan Lake area (this study).
* In numbers 44-109 inclusive, all oxides have been recalculated on a dry basis using the loss-on-ignition (LOI) values given in parentheses. Loss on ignition for one hour at 1000°C.

Ultramafic amphibolites

Stephenson's (1974) samples of ultramafic amphibolites from Ospwagan Lake (nos. 35–43) fall in the komatiitic field and overlap with the ultramafic-flow data points (Fig. 11). A close genetic relationship between the two rock suites is suggested by this and other similarities in chemistry and mineralogy.

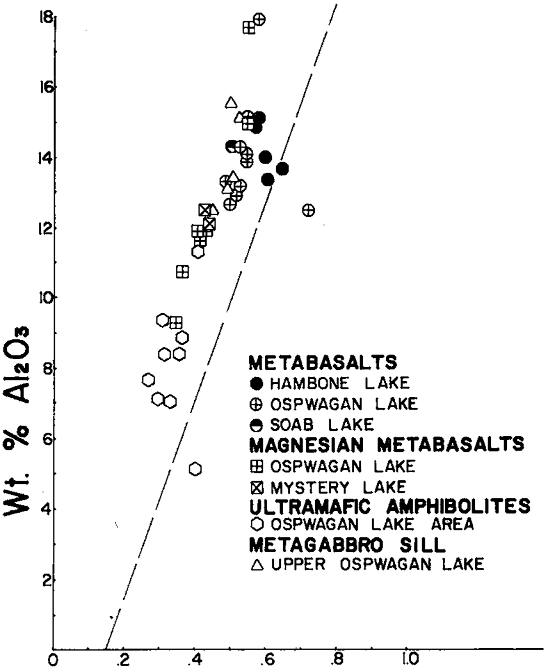

FIG. 11. A plot of metavolcanic and associated rocks in terms of Al_2O_3 *vs.* FeO/(FeO+MgO). Most of the data plot in the komatiitic field as defined by Arndt *et al.* (1977).

Chemical data on ultramafic amphibolites, including those associated with serpentinite, are plotted in Figure 12. The data are from four different ultramafic bodies in gneissic, metasedimentary and metavolcanic terranes in the Thompson belt. Samples of ultramafic amphibolite in gneisses in the Thompson mine area (nos. 44–54) plot in the field characteristic of komatiites and produce a relatively steep, or little differentiated, trend in terms of the

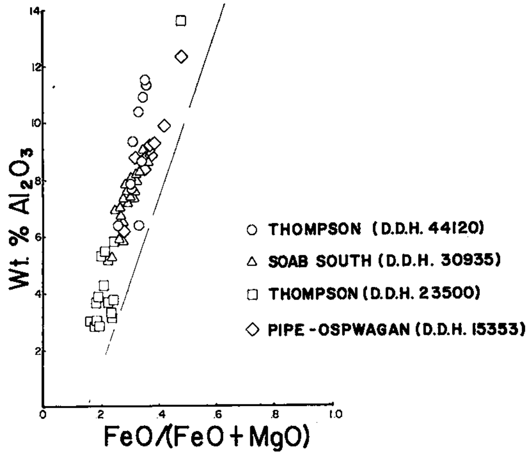

FIG. 12. A plot of ultramafic amphibolites and serpentinite in terms of Al_2O_3 *vs.* FeO/(FeO+MgO). All samples plot in the komatiitic field and seem to form a continuous trend. The individual bodies show distinct variation in alumina, iron enrichment trends and basicity.

FeO/(FeO+MgO) ratio but a wide range in terms of alumina. Such a trend could be the result of mixing of variable proportions of olivines and pyroxenes of constant composition with variable amounts of an Al-rich liquid also of constant composition. Samples of ultramafic amphibolite in metasedimentary rocks at Soab South mine (nos. 74–93) are likewise komatiitic but are distinctly more magnesian in composition. Their FeO/(FeO+MgO) trend is somewhat less steep, perhaps indicating a higher degree of differentiation. They also exhibit a wide range in terms of alumina. Samples from an ultramafic amphibolite–serpentinite body in metasedimentary rocks at Thompson mine (nos. 55–73) also plot in the komatiitic field, and form a continuous trend with the data from Soab South mine. One sample of gabbroic composition (no. 55) overlaps with metabasalts discussed previously. The serpentinite samples from Thompson mine have the lowest Al_2O_3 and highest MgO contents and plot as the most ultrabasic end-members of this trend.

Chemical data on the ultramafic amphibolite body associated with the metabasalts in the Pipe–Ospwagan Lake area (nos. 94–109) also plot in the komatiitic field in Figure 12. In terms of basicity, this data set is comparable to the ultramafic amphibolite in the gneissic terrane but shows a wider variation in FeO/(FeO+MgO) ratio and Al_2O_3 content.

Differentiation

As noted above, variations in the FeO/(FeO+MgO) ratio and alumina clearly indicate that some of the ultramafic bodies are differentiated. In the ultramafic amphibolite–serpentinite body at Thompson mine the FeO–(FeO+MgO) ratio varies from 0.17 to 0.25 and there is a general enrichment of iron relative to magnesium toward the ultramafic amphibolite side of the body. Similarly, in the ultramafic amphibolite bodies, there is usually a discernible enrichment towards one side.

The variation patterns of major and minor oxides within the ultramafic body also indicate that differentiation has occurred. In the ultramafic amphibolite–serpentinite body in the metasedimentary rocks at Thompson mine, there is a general decrease in MgO relative to FeO towards the ultramafic amphibolite side of the body (Fig. 13). The variation of the other oxides is in agreement with this trend. Only one anomalously high K_2O value (1.45%) is found, at the contact with the metasedimentary rocks.

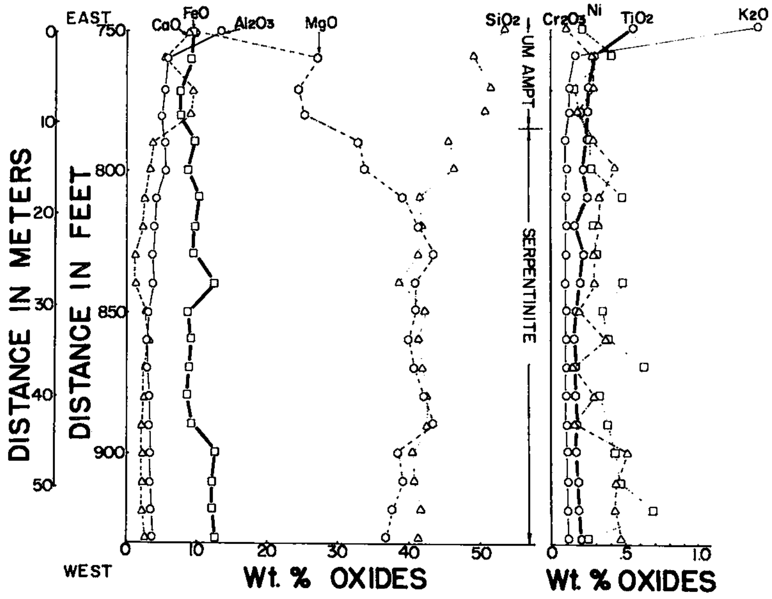

FIG. 13. Variation of oxides in the ultramafic amphibolite–serpentinite body (D.D.H. 23500) from the metasedimentary terrane at Thompson mine. The rocks show continuity from serpentinite to the ultramafic amphibolite in terms of the oxides; their variation could be explained in terms of magmatic differentiation. Within the serpentinite there is a negative correlation between chromium and nickel suggestive of cryptic layering.

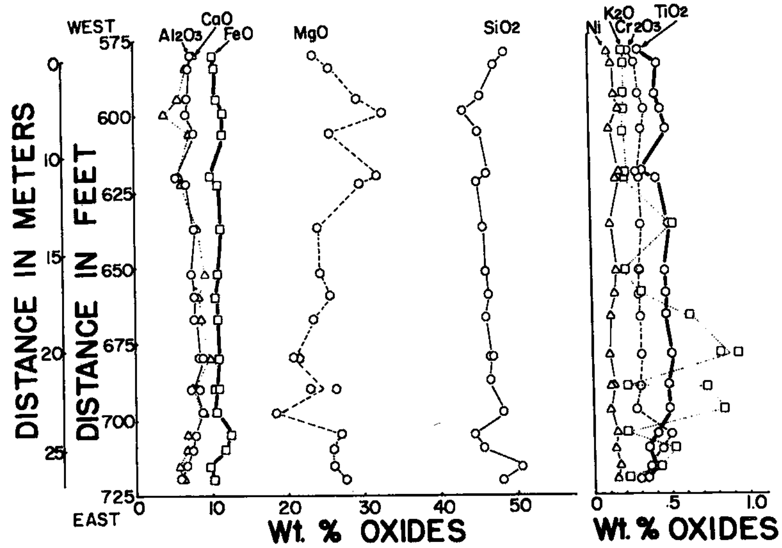

FIG. 14. Variation of oxides in the ultramafic amphibolite (D.D.H. 30935) from the metasedimentary terrane at Soab South mine. Near the east side there is a definite reversal which could be interpreted as a separate pulse of magma.

The sample contains a high proportion of phlogopite, attributable to metasomatism. The nickel content in serpentinite averages about 0.4% and generally decreases towards the ultramafic amphibolite side of the body; within the ultramafic amphibolite itself it is generally less than 0.30% (av. 0.25%). In the middle portion of serpentinite, the proportions of chromium and nickel seem to vary in a regular manner suggestive of cryptic layering not otherwise apparent in the rock.

The ultramafic amphibolite in the metasedimentary rocks at Soab South mine shows a distinct decrease in MgO relative to FeO towards its eastern side, but close to its eastern margin there is a distinct change over a short distance:

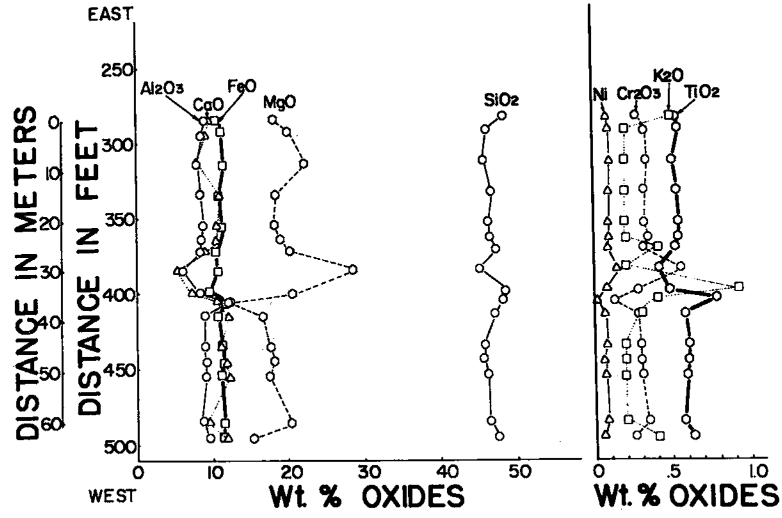

FIG. 15. Variation of oxides in the ultramafic amphibolite (D.D.H. 15353) associated with metasedimentary rocks and metabasalts in the Pipe–Upper Ospwagan Lake area. Two distinct trends are apparent which could reflect two ultrabasic flows.

the rocks become rich in magnesium (Fig. 14). This could reflect a separate pulse of magma. In general the Al_2O_3, CaO, Cr_2O_3 and TiO_2 trends are in agreement with the iron–magnesia trend. Nickel content is between 0.1 and 0.2%.

In the ultramafic amphibolite body associated with the volcanic rocks in the Pipe–Upper Ospwagan Lake area (Fig. 15), two distinct zones can be recognized, each showing evidence of differentiation in its oxide profile. These two zones may represent separate magma pulses; both show a characteristic depletion in magnesia relative to iron to the east. Each has an MgO-rich, possible olivine cumulate layer at the base (west) followed by progressively more fractionated series of rocks to the east. In each pulse chromium varies sympathetically with MgO, and TiO_2 and iron show a slight enrichment towards the east side of the ultramafic body. The two pulses are chemically distinct from each other, the one on the east side being more magnesian and having more chromium and nickel than the other.

DISCUSSION

Some distinction between the various amphibolites in the Thompson belt was attempted by Quirke *et al.* (1970) and Coats *et al.* (1972). Their group 6 classification applied to rocks of volcanic origin, and all other basic rocks were assigned to group 8. However, it is shown in this paper that many of the group 8 rocks are probably also of volcanic origin and furthermore, that the basic metavolcanic rocks in both groups are quite similar in mineralogy, texture, composition, grade of metamorphism and, to a certain extent, in their lithologic association. Both groups seem to have a komatiitic affinity.

The magnesian metabasalts at Ospwagan and Mystery Lakes are closely associated with metabasalts and also appear to be komatiitic in character. The presence of quench textures in the magnesian metabasalts (12–14% MgO) and not in the metabasalts (7–11% MgO) does not seem a function of compositional differences alone because these differences are apparently not that significant. It should be noted that Stephenson's (1974) metabasalts (nos. 26–27) with quench textures have less than 9% MgO. More likely, the preservation of quench textures in magnesian metabasalts may be a function of tectonism and their apparent lower grade of metamorphism relative to the metabasalts. The present intimate association of these two rocks could have resulted from tectonic emplacement of the magnesian metabasalts as deeply infolded or down-faulted slices from the upper levels or the original stratigraphic pile. This is analogous to the suggestion offered by Binns *et al.* (1976) to explain variations in metamorphic grade in the Yilgarn greenstones in Australia.

The presence of pillow structures in some ultramafic amphibolites is indicative of an extrusive origin. Like the closely associated magnesian metabasalts, they are low in TiO_2 and have a komatiitic character.

Ultramafic amphibolites without obvious volcanic features occur in both the gneisses and the metavolcanic rocks. Their concordant attitude in the gneisses suggests an intrusive origin whereas the ultramafic amphibolites in the volcanic pile probably include both intrusive and extrusive varieties. Recrystallization during metamorphism has obliterated most of their primary textures. Metasomatic introduction of potash and possibly silica and removal of lime have accompanied metamorphism.

The association of ultramafic amphibolite with serpentinite at Thompson mine clearly indicates a close genetic relationship. Both plot in the area of the Al_2O_3 *vs.* FeO/(FeO+MgO) diagram characteristic of komatiites. The suggestion that the ultramafic amphibolites were produced by progressive metamorphism of serpentinite is considered untenable. Ultramafic amphibolites exist both as separate bodies and as phases in conjunction with serpentinite. In this latter case they are not found on both sides of a given serpentinite mass as would be expected if they were metamorphically derived from the serpentinite.

The degree of metamorphism, deformation and structural complexity in the ultramafic amphibolites is similar to that of the associated metasedimentary rocks and gneisses. Dating indicates that this occurred during the Hudsonian tectonothermal event about 1.8 Ga ago. This places the age of the ultramafic amphibolites and related serpentinites and volcanic rocks as pre-Hudsonian and possibly even Archean. Field relationships suggest that the metavolcanic and metasedimentary rocks may be coeval.

A variety of basic sills and dykes occur in the gneisses, metasedimentary and metavolcanic rocks. At least some of them postdate the emplacement of the serpentinites; others are apparently comagmatic with the metavolcanic rocks and predate the Hudsonian event as they have been affected by it.

The presence of old layered complex (OLC) rocks in the Thompson belt had not previously been recognized. These rocks must be at least as old as the gneisses, as both exhibit granulite-facies metamorphism. Structural relationships suggest that the OLC may be even older and could represent the basement of some of the group 7 gneisses. If so, it would constitute one of the oldest group of rocks in the Thompson belt, and in the Canadian Shield.

The following model incorporates most of the salient points made in this study. Sedimentation accompanied by volcanism was widespread but of short duration in a long graben-like structure at the site of the present-day Thompson belt. Volcanism was mainly komatiitic in character and included basaltic and more magnesian flows piled on a complex acidic gneiss basement. In the waning stages of volcanism a series of basic and ultrabasic pulses gave rise to sills and dykes in the basement and the overlying sedimentary and volcanic rocks. Initially the ultrabasic magmatism gave rise to moderately MgO-rich ultrabasic flows and abundant sills. In the later stages, the magma pulses became more magnesian and gave rise to peridotite sills in the gneisses, volcanic and sedimentary rocks. Crystallization and differentiation of the magma produced layering in the sills. Towards the end of the magmatic cycle, the volcanic–sedimentary cover and the basement rocks were folded, metamorphosed, migmatized and intruded by granodioritic bodies. Later, during the Hudsonian event, all rocks were again folded and extensively migmatized, recrystallized, sheared and faulted. Towards the end of this event large acidic plutons were emplaced. Late Hudsonian faulting further complicated the deformation pattern.

Much of the nickel sulfide mineralization in the Thompson belt is directly or indirectly associated with peridotitic magmatism, in particular with magmatism in the metasedimentary pile. No significant nickel mineralization is found in the ultramafic amphibolites or the ultramafic flows.

The nickel sulfide mineralization is broadly categorized as a disseminated primary type confined to the serpentinites, and a massive type that has undergone complex metamorphism and tectonic mobilization. The effects of tectonism and metamorphism are variable and give rise to a wide variety of tectonic settings for the nickel deposits in the Thompson belt.

ACKNOWLEDGEMENTS

Much credit is due to the staff members of Mines Exploration department, Inco Metals Company, Manitoba Division, for their work in the field and mines. Their contribution to the understanding of the geology in the Thompson belt is recognized and acknowledged. Various staff members have read the manuscript and made a number of valuable comments and many helpful suggestions. Anne Iveta, Mines Exploration department, Manitoba Division, typed the manuscript and Lyle Fennell prepared the diagrams. The paper is published with the permission and support of the Inco Metals Company.

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Received October 1978, revised manuscript accepted December 1978.