NJ 49 12
NJ 94 29

KENORA

92 50

DRYDEN

N49°

95°W

Ft. FRANCES

VOLCANIC STRATIGRAPHY OF THE KENORA-DRYDEN AREA, ONTARIO.

By M.G.MORRICE & H.D.B.WILSON

METAVOLCANIC and METASEDIMENTARY ROCKS

- Upper Diverse Group
- Middle Felsic Group
- Mafic Group (undivided)
- Middle Mafic
- Lower Mafic

INTRUSIVE ROCKS

- Granitic Rocks
- Gabbroic Rocks

N

0 10 20 30 Km.

Marginal notes to accompany Open File 695

VOLCANIC STRATIGRAPHY OF THE KENORA-DRYDEN AREA, ONTARIO

M.G. Morrice and H.D.B. Wilson
Centre for Precambrian Studies, University of Manitoba

INTRODUCTION

The volcanic stratigraphy of the western portion of the Kenora (Wabigoon) Subprovince of the Superior Province of the Canadian Precambrian Shield has been subdivided into four major groups. These groups, Lower Mafic, Middle Mafic, Middle felsic, and Upper Diverse, represent Archean volcanic development stages. Analogues have been identified in the Shield regions of South Africa and Western Australia (Wilson, 1974a; Wilson et al., 1974). The basis for this subdivision combines field and geochemical observations of several localities in the western Kenora Subprovince (Beakhouse, 1974; Morrice, 1974a, b, 1975a; Morrice and Wilson (in preparation a, b); Wilson, 1973; Wilson and Morrice, 1974; Wilson et al., 1974; Ziehlke, 1975).

LOWER MAFIC GROUP

The Lower Mafic Group comprises an interlayered sequence of pillowed and massive mafic flows, mafic sills and very minor felsic tuffaceous sedimentary rocks. Flows are non- to weakly-vesicular and invariably nonbrecciated. Flat-bottom, convex-upward gas cavities, indicative of lava drainaway, are locally common features. Phenocrysts are usually absent, except for local accumulations of "leopard" flows which are characterized by abundant (up to 60%), large (1-3 cm), plagioclase phenocrysts. Pillows are devoid of internal structure except for infrequent radial joints. Selvage edges are thin (0.5-1 cm) and interpillow material is absent. Individual flow units average 10-20 m in thickness and often consist of both pillowed and massive portions.

Mafic sills average 10-20 m in thickness, are usually fine-grained, aphyric, and are generally internally homogeneous. They are invariably conformable to the surrounding units and may grade laterally into pillowed flow units. The felsic tuffaceous rocks are thinly bedded and are usually sheared and altered.

The flows and sills are basaltic in composition, and tholeiitic by the definitions of Miyashiro (1974). They are characterized and defined by low K_2O (<0.10%) and associated "LIL" element contents, high MgO (7-10%), high Ni (110-150 ppm), high Cr (300-375 ppm), low FeO* (10.5-13.5%), low TiO_2 (0.6-0.9%), and low FeO*/MgO (1.1-1.7). Rare earth element (REE) patterns are flat to slightly light REE-depleted ($(La/Yb)_N$ = .68-.99) at 6 to 12 X chondrites.

MIDDLE MAFIC GROUP

The Middle Mafic Group is dominated by interlayered pillowed and massive mafic flows and mafic sills. Flows are invariably vesicular, with vesicles concentrated near the flow contacts in massive flows. Individual pillows contain vesicles, which are commonly concentrically arranged with the largest vesicles occurring near the pillow centre and becoming progressively smaller towards the pillow margins. Vesicles may also be radially aligned. Radial jointing or concentric onion-skin jointing are common features of Middle Mafic pillows. Autoclastic and hyaloclastic breccias occur locally and appear to increase in abundance up-section. Individual flow units average 10-20 m thick and usually comprise pillowed and massive portions. Mafic sills are <100 m thick and although most are internally homogeneous, flow- and gravity-differentiated varieties occur.

All Middle Mafic Group flows and sills are basaltic in composition and, like the Lower Mafic Group, tholeiitic according to Miyashiro (1974). The unifying geochemical trait of these rocks is their trend towards iron enrichment. They are characterized by high FeO* (>13%), moderate to high TiO_2 (>1%), high FeO*/MgO (>1.7), low K_2O (<0.25%), low MgO (4-8%), low Ni (30-80 ppm), and low Cr (40-200 ppm). REE patterns are slightly LREE-enriched ($(La/Yb)_N$ = 1.76-2.21) at 20 to 35 X chondrites.

MAFIC GROUP (UNDIVIDED)

The Mafic Group (undivided) comprises interlayered pillowed and massive mafic flows and mafic sills. Field characteristics are ambiguous and/or geochemical data lacking to warrant further designation into Lower or Middle Mafic Groups at the present time.

MIDDLE FELSIC GROUP

The Middle Felsic Group comprises a sequence of coarse and fine volcaniclastic rocks, locally intruded by thick, conformable mafic-ultramafic sills. The volcaniclastic rocks include a wide variety of lithologic types but are dominated by lahars, debris flows and tuffaceous sandstones and siltstones. Most coarse volcaniclastic units are matrix supported, polymict deposits with clasts ranging in composition from basalt to rhyolite with andesite-dacite dominating. These deposits are thickly bedded, and show internal variations in such parameters as clast: matrix ratio, clast size and clast compositions. The tuffaceous sandstones and siltstones are well bedded with bedding thickness proportional to grain size. Coarse and fine deposits are often highly interlayered although most commonly either type will dominate in a particular stratigraphic interval.

The large layered mafic-ultramafic sills are up to 1.3 km thick and persist laterally for distances up to 20 km. They range in composition from peridotite to granodiorite. Primary non-hydrated mineral assemblages are commonly preserved.

The Middle Felsic Group volcaniclastic rocks define a calcalkaline suite dominated by andesites and dacites. As such, both major and trace element contents show considerable variation and, by themselves, are not distinctive. Of interest are the high MgO (4-5%), Ni (60-80 ppm) and Cr (115-270 ppm) contents of the Middle Mafic Group andesites. These values are as high as or higher than some of the basalts of the Middle Mafic Group. REE patterns are highly fractionated. Light REE are enriched at 21-55 X chondrites while heavy REE are relatively depleted at 3.5-5 X chondrites. $(La/Yb)_N$ ranges from 20-55 and exhibits a positive correlation with SiO_2 content.

UPPER DIVERSE GROUP

The Upper Diverse Group comprises an interlayered sequence of coarse and fine volcaniclastic rocks, flows and sills, ranging in composition from peridotite to rhyolite. The volcaniclastic rocks include a wide variety of lithologic types; labaric and debris flow deposits and tuffaceous sandstones and siltstones dominate, but significant thicnesses of volcanic wacke and volcanic conglomerate are present. Mafic flows are dominated by pillowed units which grade vertically and laterally into isolated and broken pillow breccia units. Flows are invariably vesicular, although non-vesicular variolitic units locally composed significant stratigraphic thicknesses. Intermediate flows may be pillowed or massive, or may contain isolated and broken pillow breccia portions. Rhyolite flows tend to be thick, autoclastic units of limited lateral extent.

Sills are conformable mafic-ultramafic bodies usually <100 m thick.

Geochemical data are available only for some intermediate and mafic flows. The most significant observation is the occurrence of high MgO (8.5-14%), high Ni (130-380 ppm), low K_2O (<0.50%) basalts in the Western Peninsula area of Lake of the Woods (Morrice, 1974b).

APPLICATION TO MINERAL EXPLORATION

The combination of detailed field observations and geochemistry has been used to subdivide the volcanic stratigraphy of the Kenora Subprovince into four major Groups. The identification of these Groups in Archean granite-greenstone belts may be useful in planning mineral exploration strategy (Wilson, 1974b). The Lower Mafic and Upper Diverse Groups are favourable areas for mineral exploration. The massive nickel sulphide deposits of Western Australia are associated with ultramafic units of the Lower Mafic Group, whereas massive copper-zinc sulphide orebodies (Noranda-type) are characteristic of fragmental deposits of the Upper Diverse Group. The Middle Mafic and Middle Felsic Groups appear to be low priority exploration targets, although the Maybrun copper deposits of the Kenora Subprovince occurs in pillow basalts of the Middle Mafic Group (Morrice, 1975b).

REFERENCES

BEAKHOUSE, G.P.
1974 Volcanic stratigraphy in the Greenwater-Upper Shebandowan Lakes area, northwestern Ontario. Centre for Precambrian Studies, 1974 Annual Report, p. 89-99.

MIYASHIRO, A.
1974 Volcanic rock series in island arcs and active continental margins. American Journal of Science, v. 274, p. 321-355.

MORRICE, M.G.
1974a Principal structures and textures characteristic of the volcanic group. Centre for Precambrian Studies, 1974 Annual Report, p. 61-65.

1974b Volcanic stratigraphy, Western Peninsula, Lake of the Woods. Centre for Precambrian Studies, 1974 Annual Report, p. 101-107.

1975a Volcanic stratigraphy, Bigstone Bay (Lake of the Woods)-Shoal Lake. Centre for Precambrian Studies, 1975 Annual Report, p. 22-28.

1975b Maybrun copper-gold deposit. Centre for Precambrian Studies, 1975, Annual Report, p. 16-18.

MORRICE, M.G. AND WILSON, H.D.B.
Volcanic stratigraphy of the Lake of the Woods-Kakagi Lake Archean greenstone belt, northwestern Ontario. (in preparation (a))

Petrology and geochemistry of the Lake of the Woods-Kakagi Lake Archean greenstone belt, northwestern Ontario. (in preparation (b))

WILSON, H.D.B.
1973 Archean volcanic belts - Kakagi Lake and Stormy Lake sections. Centre for Precambrian Studies, 1973 Annual Report, p. 74-84.

1974a Archean volcanic sequence. Centre for Precambrian Studies, 1974 Annual Report, p. 58-60.

1974b Stratigraphic position of orebodies in the volcanic sequence. Centre for Precambrian Studies, 1974 Annual Report, p. 79-80.

WILSON, H.D.B. AND MORRICE, M.G.
1974 Geochemistry of the volcanic sequence. Centre for Precambrian Studies, 1974 Annual Report, p. 66-76.

WILSON, H.D.B., MORRICE, M.G. AND ZIEHLKE, D.V.
1974 Archean continents. Geoscience Canada, v.1, p. 12-20.

ZIEHLKE, D.V.
1975 Eagle-Wabigoon-Dinorwic-Manitou Lakes volcanic belt. Centre for Precambrian Studies, 1975 Annual Report, p. 35-48.

OPEN FILE
DOSSIER PUBLIC
695
1980
GEOLOGICAL SURVEY
COMMISSION GEOLOGIQUE
OTTAWA