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THE HP PIPE, A PRELIMINARY REPORT* (82N/10)

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INTRODUCTION

The HP pipe, located at latitude 51°41′30″, longitude 116°57′00″ at an elevation of 2400 metres, is the southernmost diatreme in the Golden cluster (Ijewliw, 1986, 1987; Pell, 1986, 1987a, b). It is an ultrabasic, alkaline lamprophyre with alnöitic affinities. The pipe has been chosen for detailed study because it is relatively unaltered and almost completely exposed.

The 347-Ma HP intrusion (Pell, 1987a) is dominated by light green breccia cut by two sets of dykes. North-trending, dark green dykes are cut by a later east-trending set, also dark green. Both sets extend into the surrounding Lower to Middle Cambrian carbonates. Short, narrower, brown dykes that occur entirely outside the diatreme intersect the later dyke set.

PETROGRAPHY

The breccia contains abundant angular, deformed and recrystallized (marmorized) limestone clasts attesting to the relatively high temperature of emplacement. Nodules resembling dyke material (Ijewliw, 1987, 1986), and rare fragments of altered plutonic rock are also found in the breccia. Megacrysts of black and green clinopyroxenes, biotite books and red-brown spinels form the cores of dark green globular segregations (Pell, 1987a; Plate 4-3-2), in a calcite matrix (Plate 3-2-1). Some clinopyroxenes and biotites (which range from several millimetres to several centimetres in length) are

Plate 3-2-1. Photomicrograph of globular segregations with opaque rims and cores of either zoned clinopyroxene or lithic fragments. Calcite is interstitial. Plane polarized light; field of view = 4 millimetres.

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British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1987, Paper 1988-1.

Plate 3-2-2. Photomicrograph of mica with resorbed biotite core and two generations of phlogopite overgrowths. Groundmass phlogopites on left and near top have iron-rich rims. Plane polarized light; field of view = 4 millimetres.

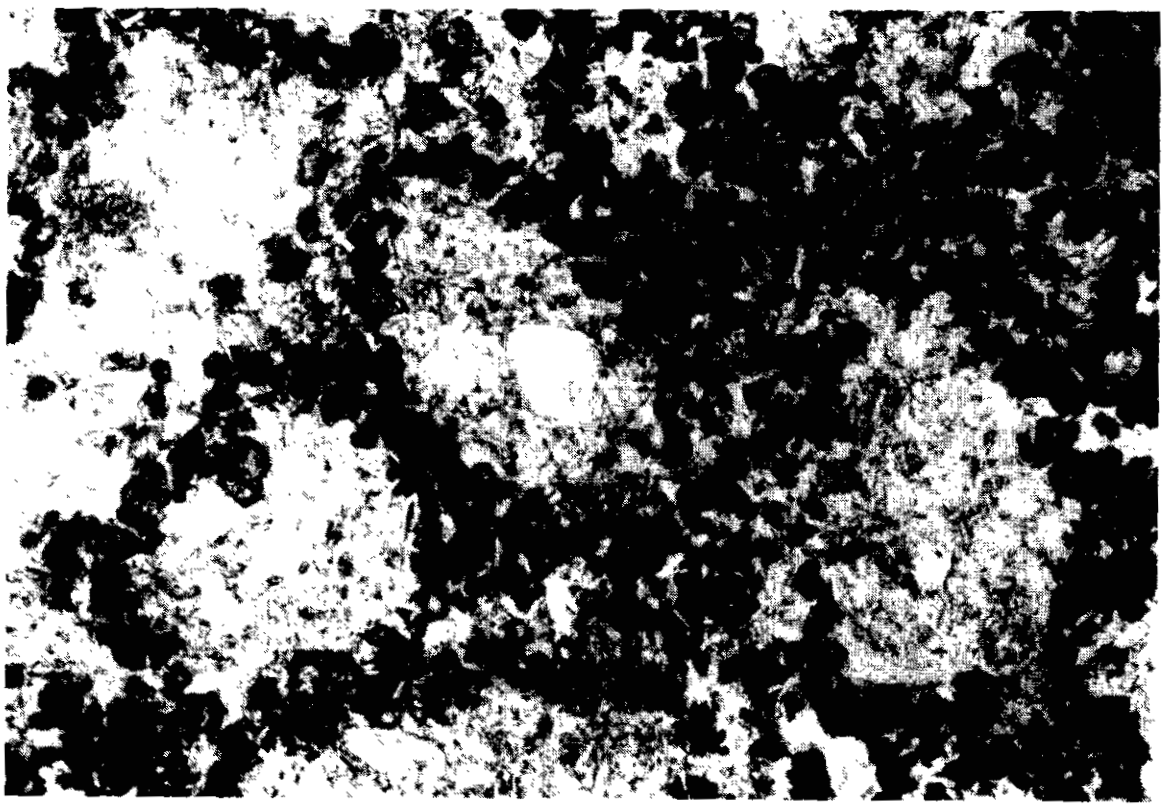

Plate 3-2-3. Photomicrograph of melanite garnet rimming globular segregations. Plane polarized light; field of view = 4 millimetres.

zoned (Plates 3-2-1 and 3-2-2). Melanite garnet, sphene and melanite or opaques rim the globular segregations (Plates 3-2-1 and 3-2-3), which are surrounded by a groundmass consisting of carbonate, serpentine, mica, talc and matted clumps of very fine-grained sphene and melanite. Where the breccia does not contain globular segregations, it consists of rare megacrysts and macrocrysts in a matrix of melanite, mica, serpentine, carbonate, talc, chlorite and pyrite.

Garnets occur as euhedral, complexly zoned grains up to a millimetre in diameter (Plate 3-2-4) and as unzoned, clear, anhedral groundmass crystals (Plate 3-2-5). Dyke melanites are larger, generally zoned and have dark brown cores unlike the yellow cores of the breccia melanites.

Globular segregations and crustal xenoliths do not occur in the dykes. Most megacrysts and macrocrysts of clinopyroxene and biotite are zoned, as are the melanites. The matrix of the green dykes is similar to that of the breccia, though biotite is more abundant. The brown dykes are entirely carbonatized and devoid of megacrysts, macrocrysts or any fresh silicate minerals.

MINERAL CHEMISTRY

Mineral compositions were determined by energy dispersive analysis with an ARL-SEMQ electron microprobe at Queen's University. In Figures 3-2-1 and 3-2-2, the data for the HP pipe are compared with those from olivine-melilitites in South Africa (Boctor and Yoder, 1986), alnöites in Malaita (Nixon and Boyd, 1979; Nixon *et al.*, 1980), the Ile Bizard alnöite (Raeside and Helmstaedt, 1982), and the Colorado-Wyoming kimberlites (Eggler *et al.*, 1979).

The magnesian group of black clinopyroxene megacrysts and macrocrysts are similar in terms of Ca/Mg/Fe values (Figure 3-2-1) to those from the groundmass of the olivine melilitites and Malaita alnöite. The wide range of Mg/(Mg + Fe) values of the entire HP suite is similar to the Ile Bizard clinopyroxene megacrysts, though more calcic [higher content of Ca-Tschermak's molecule

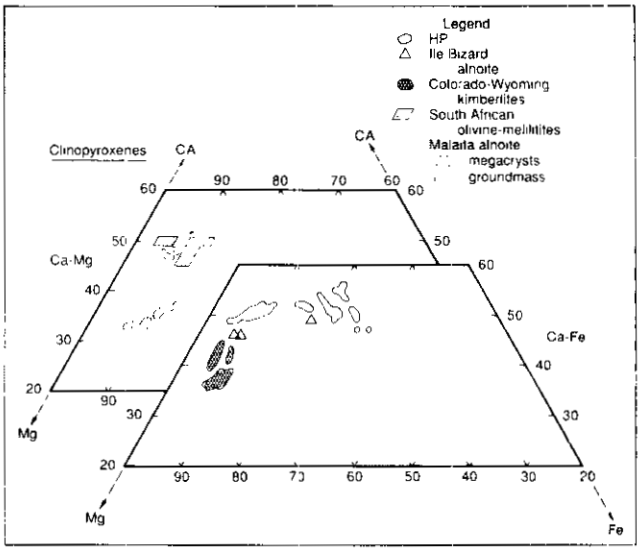

Figure 3-2-1. A Ca-Mg-Fe mole per cent plot showing a comparison of HP clinopyroxenes with those from the Ile Bizard alnöitic rock (Raeside and Helmstaedt, 1982), South African olivine-melilitites (Boctor and Yoder, 1986), Colorado-Wyoming kimberlites (Eggler *et al.*, 1979), Malaita alnöite megacrysts and groundmass pyroxenes (Nixon *et al.*, 1980).

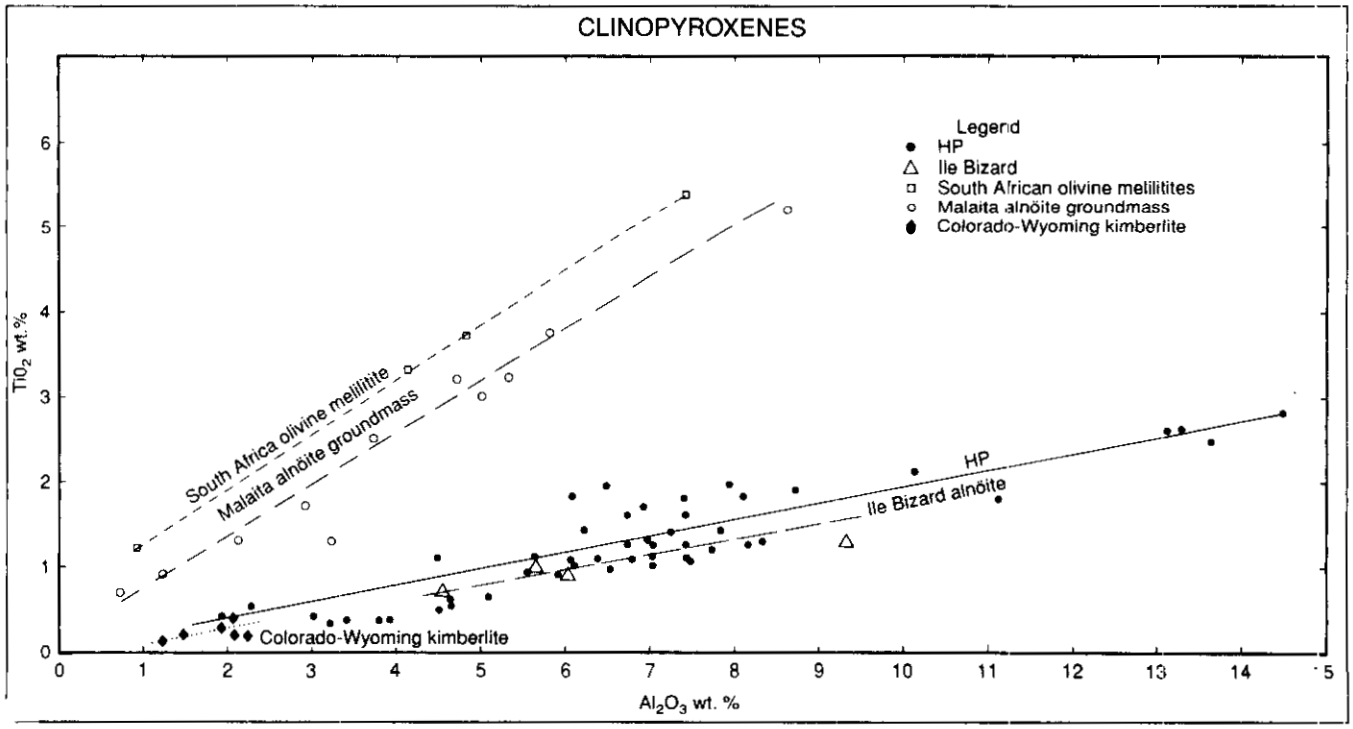

Figure 3-2-2. Al_2O_3 and TiO_2 weight per cent value of HP clinopyroxenes and those from the Ile Bizard alnöitic rock (Raeside and Helmstaedt, 1982), South African olivine-melilitites (Boctor and Yoder, 1986), Colorado-Wyoming kimberlites (Eggler *et al.*, 1979), Malaita alnöite megacrysts and groundmass pyroxenes (Nixon *et al.*, 1980).

Plate 3-2-4. Photomicrograph of oscillatory zoned melanites from the dyke phase.
Plane polarized light; field of view = 4 millimetres.

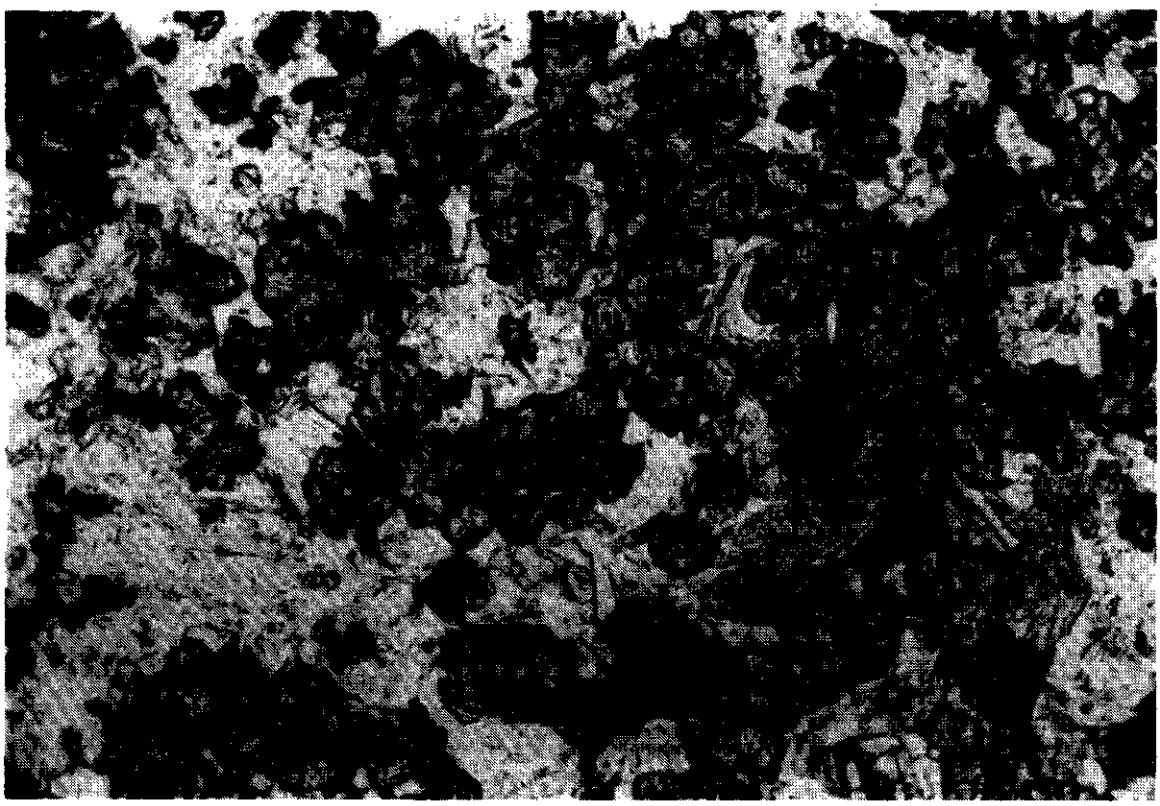

Plate 3-2-5. Photomicrograph of breccia phase groundmass composed primarily of clear, titanium-poor melanite garnet. Plane polarized light; field of view = 1.5 millimetres.

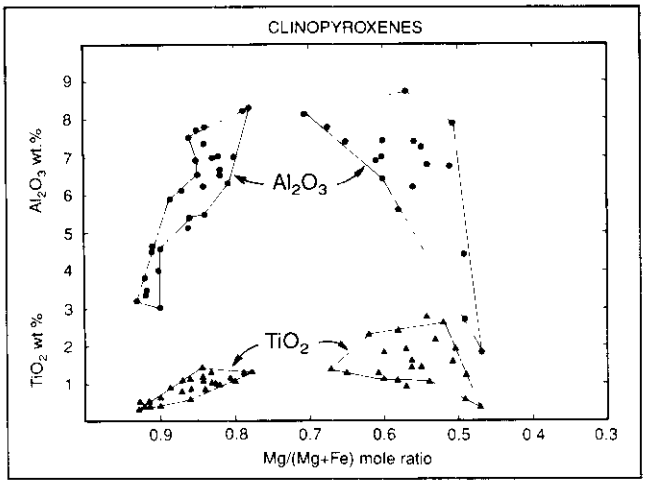

Figure 3-2-3. HP clinopyroxene mineral chemistry showing a bimodal distribtion of Mg/(Mg + Fe) values, enrichment and subsequent depletion of TiO_2 and Al_2O_3.

$(Ca,Mg)Al(AlSi)O_6$]. HP clinopyroxenes do not overlap with megacrysts from Malaita or the Colorado-Wyoming kimberlites. The black pyroxenes are rich in titanium (up to 2.6 weight per cent TiO_2) and aluminum (up to 14.5 weight per cent Al_2O_3) (Figures 3-2-2 and 3-2-3) and there is a positive correlation between titanium and aluminum (Figure 3-2-2). These values are similar to the clinopyroxene megacrysts from Ile Bizard, but dissimilar to the other clinopyroxenes in Figure 3-2-2.

There is a bimodal distribution of Mg/(Mg + Fe) values for the HP clinopyroxene megacrysts (Figure 3-2-3). Although all data are from mineral cores, preliminary investigations of zoning trends indicate that rims are relatively enriched in iron.

The clinopyroxenes show a good linear fractionating trend in the higher Mg# group with titanium and aluminum increasing as magnesium values decrease. In the lower Mg# group there is more variation, especially in aluminum as magnesium values decrease.

The black clinopyroxenes have low chrome contents (<0.10 weight per cent Cr_2O_3). A single green clinopyroxene megacryst has been analysed and contains approximately 1.0 weight per cent Cr_2O_3, considerably less titanium (0.3 weight per cent TiO_2) and has a higher Mg/(Mg + Fe) value of 0.96 than the black ones.

Mica megacrysts have biotite cores with Mg/(Mg + Fe) values of approximately 0.45. Overgrowths are more magnesian, with ratios ranging up to 0.85. Titanium is approximately constant at 3 to 4 weight per cent TiO_2. These values do not correspond to those of mica megacrysts from either kimberlites or alkalic basalts (Schulze, 1987).

Matrix garnets are the titanium-rich variety of andradite known as melanite. Cores of the yellow melanites in the breccia have 3.0 to 5.5 weight per cent TiO_2 compared to 6 to 10 per cent for melanites from the dyke phase. There is an inverse relationship between aluminum and titanium suggesting that titanium occupies the aluminum site in the andradite-grossular-almandine solid solution series. The Mg/(Mg + Fe) and Ca/(Ca + Fe) ratio ranges are restricted, 0.025 to 0.125 and 0.65 to 0.75 respectively, and do not correlate with titanium or aluminum contents. Compositionally similar melanite garnets also occur in the South African olivine melilitites and the Ile Bizard alnoitic rocks.

HP macrocrystic and groundmass spinels have a restricted compositional range. The $Fe^{2+}/(Fe^{2+} + Mg)$ values are between 0.34 and 0.38, Cr/(Cr + Al) ranges from 0.54 to 0.68 and TiO_2 is less than 1 per cent by weight. These spinels are close in composition to the Ile Bizard spinels (Mitchell, 1982). They are unlike those from the olivine melilitites, which have lower chromium values and a greater range in Fe^{2+} values, and unlike the Malaita spinels which contain 11 to 16 per cent TiO_2.

SUMMARY AND CONCLUSIONS

The compositions of HP clinopyroxene, spinel, melanite and biotite/phlogopite are similar to those of the Ile Bizard alnöitic rock and the South African olivine melilitites, but are distinct from kimberlites and alkalic basalts. The HP intrusion, like the Ile Bizard diatreme (Gold *et al.*, 1986) is tentatively classified as an aillikite, a variety of alnöite (Rock, 1986).

Evidence from textures and mineral chemistry suggests that enrichment of titanium, aluminum and iron occurred as crystallization progressed. The megacrysts are always found singly and are relatively unaltered. No polymineralic clusters were found and this, combined with the orderly trends in the pyroxene and mica chemistry, suggests that they are cognate to the system.

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