GARNET BEARING ULTRABASIC AND DISCRETE NODULE SUITES FROM MALAITA, SOLOMON ISLANDS, S.W. PACIFIC, AND THEIR BEARING ON AN OCEANIC GEOTHERM

Peter H. Nixon, Dept. of Geology, P.O. Box 4820, University Papua, New Guinea
F. R. Boyd, Geophysical Laboratory, Carnegie Institution, 2801 Upton Street, N. W., Washington, D. C. 20008

A volcanic rock previously described only from limited samples (Allen and Deans, 1965) from Babaru'u, Northern Malaita, Solomon Islands, contains a wide variety of deep seated inclusions that resemble those found in kimberlites. Shallow inclusions of country rock mudstone, limestone and basalt show metasomatic (and possibly fenitic) alteration. The rock is close to alnoite composition and consists of olivine microphenocrysts, melilite and some augite and phlogopite in a fine grained matrix of magnetite, perovskite and spinel with glass, carbonate and/or gonnardite cement. Textures indicative of a vent (pipe) origin include lapilli and autoliths. Varieties which are brecciated, rich in phlogopite, and carbonate but deficient in melilite appear as "yellow ground" and "hardebank," and are indistinguishable from kimberlite. This is unusual in an oceanic environment (outer melanesian arc) but nevertheless suggests a relationship with the few other circum-Pacific deep-seated volcanic occurrences at Kakanui, Kamchatka and SE Kalimantan.

The ultrabasic nodules have coarse grained to tabular textures and are lherzolites and pyroxenites with spinel and/or garnet. Olivine is largely altered but opx, cpx and garnet have similar ranges in chemistry to those found in other mantle suites: (numbers of electron microprobe analyses given in parentheses).

Wt %	orthopyroxene (15)	clinopyroxene (14)	garnet (7)
TiO_2	0.00 - 0.16	0.00 - 0.51	0.00 - 0.14
Cr_2O_3	0.25 - 0.86	0.53 - 1.40	0.65 - 5.46
Na_2O	0.01 - 0.10	0.28 - 1.80	0.00 - 0.02
Mg/(Mg + Fe)%	89.4 - 92.3	91.2 - 93.2	79.2 - 85.8

A notable feature is the presence in many nodules of aluminous spinel. Six out of eight analyses clustered close to Al: Cr: Fe^3, 85:11:4 and $Mg(Mg+Fe^2)$% = 82%. All have TiO_2 < 0.25 wt %. Brown amphibole was noted in one small nodule.

The discrete nodule (megacryst) suite is richer in Ti and Fe but poorer in Cr than that of the ultrabasic nodules and is thus similar to the Lesotho nodules (Nixon and Boyd, 1973). However there is a two-fold subdivision which is especially noticeable in the clinopyroxenes and which can be detected by slight colour differences and chemically, as shown by the ranges in the following table:

Wt %	Subcalcic Diopsides (7)	Augites (5)
TiO_2	0.59 - 1.02	0.82 - 0.92
Cr_2O_3	0.03 - 0.29	0.02 - 0.03
Na_2O	1.70 - 2.41	3.43 - 3.86
Mg/(Mg + Fe)%	80.0 - 85.6	69.8 - 72.6

Since some of the parameters overlap and because peripheral augitic alteration of diopside xenocrysts has been seen in thin section it is tentatively concluded that the augites are a shallower equilibration product of the subcalcic diopsides brought about by changing magma conditions.

A two-fold chemical division of discrete nodule (megacryst) clinopyroxenes from kimberlites at Sloan, Colorado (Eggler and McCallum, 1976) and Kamfersdam and Jagersfontein, S. Africa (unpublished data) may have a similar explanation. A clinopyroxene from an ilmenite lamellar intergrowth from Malaita has interemediate properties of the two groups.

The five bronzite nodules analyzed probably equilibrated with the subcalcic diopsides (see below). Four chromium poor samples are chemically similar as shown by the following ranges in wt %; a fifth sample with more chromium is indicated in parentheses: TiO_2, 0.30-0.34 (0.29); Cr_2O_3, 0.03-0.07 (0.16); Na_2O, 0.28-0.29 (0.29) Mg/(Mg + Fe)% = 84.8-85.9 (87.3).

The garnets are rounded, fractured, reddish brown discrete nodules which attain a large size (gegacrysts!)--up to 8.2 kg. They are Cr-poor (Cr_2O_3 = 0.08-0.17 wt %) but richer in Ti (TiO_2 = 0.54-0.59 wt %) and contain detectable amounts of Na (up to 0.05 wt %).

Six analyses of ilmenite from gravels, including two lamellar intergrowths have geikielite (15.6-34.4%), haematite (8.3-9.6%) and unusually low amounts (for kimberlitic rocks) of Si and Cr which were not detected by the probe. Other minerals noted in the gravels include zircon, (?) kaersutite, and abundant phlogopite. Garnet-spinel (alkremite) and garnet-clinopyroxene (griquaite) chips were observed in the breccia.

A geotherm calculated from garnet bearing ultrabasic nodule data (Boyd, 1973) suggests that for equivalent temperatures, sampling of the mantle has taken place at unusually shallow depths compared with previously calculated continental geotherms e.g. Lesotho. The geotherm is considered to be more typical of non-shield or oceanic regions of the earth but, nevertheless, the proximity of Malaita to the Ontong Java Plateau--a thickened portion of the SW Pacific Plate--suggests that even this gradient defines a "minimum." Although data on "hot" garnet bearing nodules from oceanic regions are sparse, original equilibration chemistry of exsolved pyroxenes in nodules from Hawaii (Beeson and Jackson, 1970) points to a steeper oceanic geotherm.

The discrete subcalcic diopside nodules appear to have equilibrated at higher temperatures than any of the ultrabasic nodules and the discrete bronzites are calculated to have equilibrated within the same range (using a Ca/(Ca + Mg) calibration curve derived from co-existing pyroxenes in the ultrabasic nodules). These bronzites define an inflected limb of the geotherm. It is concluded that all crystallization phenomena associated with the nodules took place within PT conditions of the graphite stability field and that the Malaita pipe is unlikely to contain diamonds.

References

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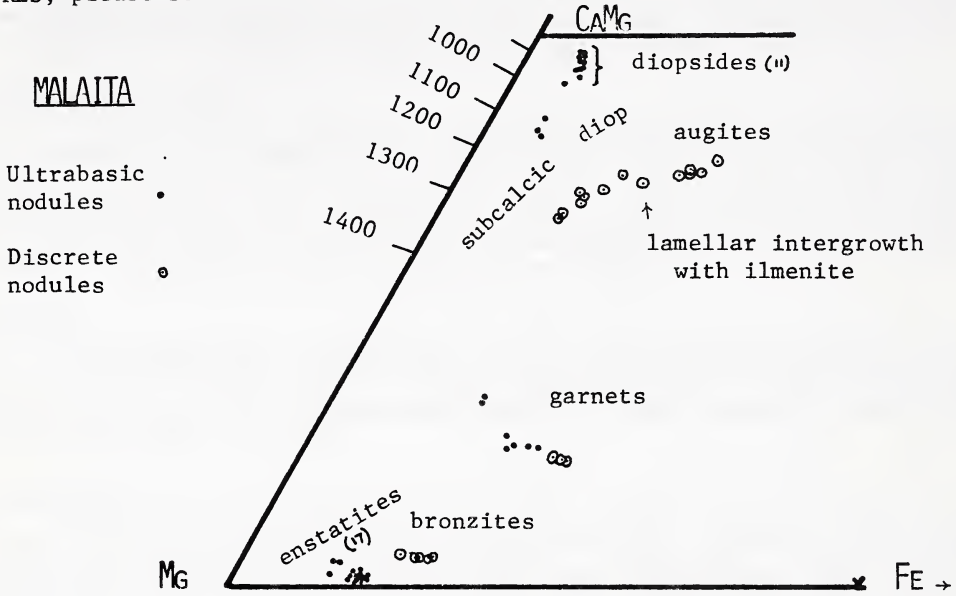
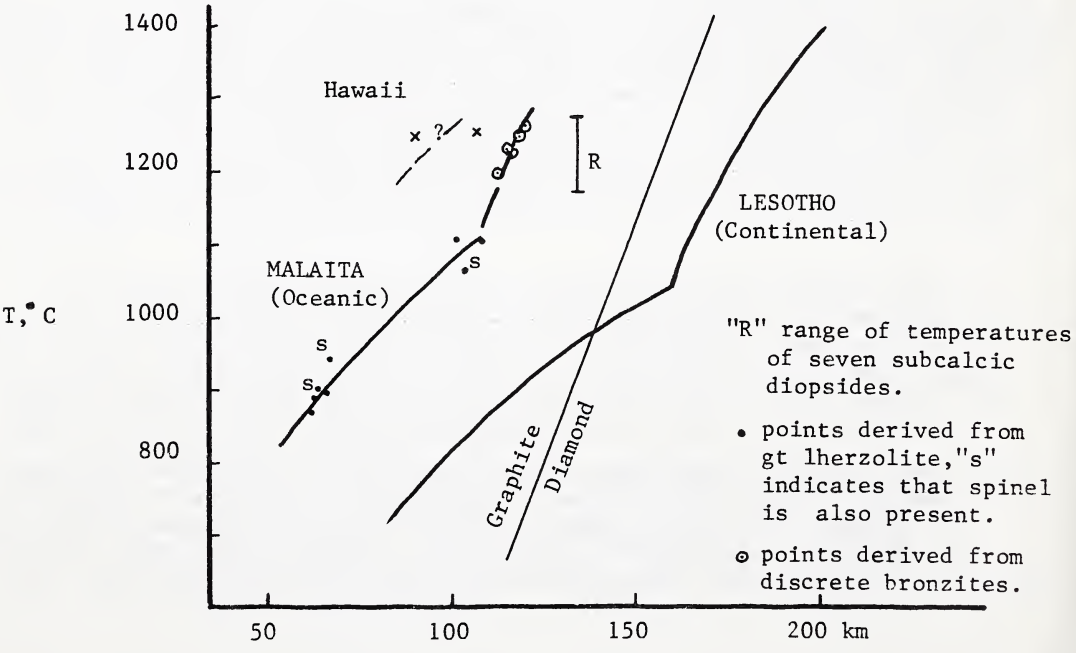
F.R. Boyd(Geophysical Laboratory, Washington, D.C., U.S.A.)

FIGURES; please see Extended Abstract Volume for text



Compositions of minerals from the ultrabasic and discrete nodule suites from the alnoitic pipe, Babaru'u, Malaita, Solomon Islands, S.W. Pacific.



Comparison of Oceanic (Malaita) geotherm with that of Continental (Lesotho) geotherm. Two points calculated from reconstituted unexsolved pyroxene data of Beeson and Jackson (1970) for Hawaiian garnet pyroxenite nodules are also shown. The graphite/diamond equilibrium boundary is from Kennedy and Kennedy (1976).