

resulting metastable textures probably owe their preservation to the relatively rapid transport of nodules to the surface in kimberlite magma. Garnet exsolution from pyroxene could have been facilitated by decreased temperatures accompanying kimberlite cooling. Formation of peridotite suite garnet by the above pyroxene-spinel reaction also may have been induced by decreasing temperatures; however, locally higher pressures possibly associated with tectonic adjustments related to intrusion of kimberlite may have perturbed the garnet-spinel phase boundary triggering crystallization of garnet at shallower mantle depths. (Study supported by Earth Sciences Section of NSF, Contract EAR-7810775)

D7

GARNET-PYROXENITES ASSOCIATED WITH THE ULTRAMAFIC ROCKS: ECLOGITES, ARIEGITES, GRIQUAITES OR GROSPYDITES?

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Garnet(py-al) + clinopyroxene associations related to metamorphic rocks were termed "eclogites" by Hauy (1822). This appellation designs also various gt-cpx assemblages related to ultramafic bodies or xenoliths. So the same appellation classifies different types of gt-cpx bearing rocks whereas different names are still used to qualify the same class of rocks. It is suggested:

1- To keep "eclogite" for rocks associated with high-pressure/low-temperature metamorphic units. Most of them are saturated in silica and the clinopyroxene is Jd-rich and Ca-Ts-poor. Silica undersaturated compositions may involve corundum in their parageneses.

2- To consider the high pressure/ high temperature gt-cpx rocks:

a) As "ariegites" when orthopyroxene and spinel are also abundant phases. The ariegites, characterizing the high pressure subfacies of spinel-lherzolite facies (O'Hara, 1967), would breakdown at higher pressure to give gt-harzburgites or -wehrlites.

b) As "griquaïtes" when clinopyroxene and garnet are the main phases (plus or minus spinel). The griquaïtes equilibrated in the ariegite subfacies as well as in the garnet-lherzolite facies.

c) As "grosphydites" when garnet and clinopyroxene are associated with kyanite and/or corundum. Such rocks are characterized by Ca-rich garnet with Ca-Ts and Jd-rich clinopyroxene; giving a larger acceptance to this word than previously defined by Bobriyevich et al. (1960), the grosphydites would involve most of corundum and kyanite eclogites associated with kimberlites. They crystallized at very high pressure in the ariegite subfacies or in the garnet-lherzolite facies.

D8

PETROLOGY OF A SUITE OF ECLOGITE INCLUSIONS FROM THE BOBBEJAAN MINE, SOUTH AFRICA:

I. MAJOR PHASE CHEMISTRY

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A suite of more than forty eclogite samples from the Bobbejaan kimberlite, near Bellsbank, South Africa, has been examined in thin section and major phases have been analysed by electron microprobe. Most samples are biminerallitic eclogites, although a few contain up to 20% apparently primary phlogopite. Primary accessory phases include sulfides (pyrrhotite, pentlandite, chalcopyrite), kyanite, rutile, and graphite. Also, two corundum grosphydites are described in a companion paper.

Some systematic trends are observed in the major-element chemistry of the principal phases.

1) The more calcic garnets occur with the more aluminous clinopyroxenes, and conversely, the more Fe- and Mg-rich garnets occur with the more aluminum-poor clinopyroxenes.

2) When temperatures are estimated from the Fe-Mg distribution between garnet and clinopyroxene, the highest apparent temperatures correlate with the highest Fe contents of both clinopyroxene and garnet, and the lowest temperatures correlate with the most calcic garnets and aluminous clinopyroxenes.

It is postulated that these inclusions are a suite (or suites) of igneous eclogites derived by magmatic differentiation at pressures between 25 and 40 Kbar. If this is true, the generalized chemical trends observed may be representative of high pressure differentiation within the alkali basalt system.

D9

PETROLOGY OF A SUITE OF ECLOGITE INCLUSIONS FROM THE BOBBEJAAN MINE, SOUTH AFRICA:

II. TWO UNIQUE CORUNDUM GROSPHYDITES

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Two small corundum grosphydite inclusions from the Bobbejaan kimberlite, near Bellsbank South Africa, have been observed in thin section and analyzed by electron microprobe. One sample (SBB-2H) contains approximately 60% garnet ($\text{Gr}_{40}\text{Py}_{37}\text{Alm}_{15}$), 35% clinopyroxene ($\text{Jd}_{52}\text{Di}_{39}\text{CaTs}_7$), 5% kyanite, and less than one percent corundum. The second (SBB-3P) contains 58% garnet ($\text{Gr}_{48}\text{Py}_{37}\text{Alm}_{16}$), 25% clinopyroxene ($\text{Jd}_{55}\text{Di}_{36}\text{CaTs}_9$), 14% kyanite, and 3% corundum. In both samples most corundum is observed as inclusions in kyanite, but in the second sample it is also observed as inclusions in garnet. In neither sample is corundum observed in contact with pyroxene.

In this second sample clinopyroxenes are observed to include lamellae of both kyanite and garnet in an apparent exsolution texture. If the kyanite and garnet lamellae in this clinopyroxene were once a single pyroxene, it would have a composition of approximately 30% $\text{CaAl}_2\text{Si}_4\text{O}_{12}$, 40% jadeite, and 20% diopside. Such pyroxene compositions have not been reported in kimberlite eclogites but may be stable at pressures in excess of 40 Kbar.

It is postulated that these two grosphydites formed by magmatic differentiation within the eclogite system at pressures between 40 and 60 Kbar and subsequently re-equilibrated at pressures between 25 and 35 Kbar. The initial phases were garnet, clinopyroxene, and corundum, plus possible kyanite. Breakdown of the $\text{CaAl}_2\text{Si}_4\text{O}_{12}$ -rich pyroxene to form clino-

pyroxene, garnet, kyanite, and silica gave rise to the garnet and kyanite lamellae in the clinopyroxene. The excess silica from the reaction would have reacted with corundum to form kyanite in the observed texture.

D10

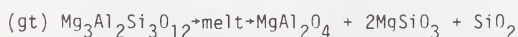
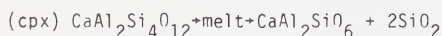
PETROLOGY OF A SUITE OF ECLOGITE INCLUSIONS FROM THE BOBBEJAAN MINE, SOUTH AFRICA. III. PARTIAL MELTING, RECRYSTALLIZATION AND P-T TRAJECTORIES

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A suite of eclogite nodules from the Bobbejaan Mine near Bellsbank, South Africa, all show partial melt textures and evidence of recrystallization at intermediate pressures. Most of the nodules are typical bimineralic eclogites that are associated with kimberlites, however some may contain primary phlogopite. Accessory phases are rutile, pyrrhotite and pentlandite. Jadeite components in unaltered clinopyroxene cores range from 15% to 40% by weight and may contain appreciable $\text{Ca}_{0.5}\text{AlSi}_{2.6}$ (to 10 wt%). Garnet cores can contain up to 75 mol% pyrope but commonly have subequal pyrope and almandine components with up to 40% grossularite.

The epitaxial recrystallization rims of the phases show very different compositions from the cores. Clinopyroxene rims show low jadeite (to 5 wt%) and higher Ca-Tschermaks components; stoichiometry calculations indicate up to 12 wt% acmite and the absence of $\text{Ca}_{0.5}\text{AlSi}_{2.6}$. Recrystallization phases around garnet rims are primarily orthopyroxene and spinel. The following recrystallization reactions are typical for these clinopyroxene and garnets:



Pressure and temperature estimates of the crystal cores indicate that the diamondiferous eclogites equilibrate at 950° - 1100°C and 35-45 Kb. These eclogites have partially melted and recrystallized near the spinel-garnet lherzolite boundary. Aluminum content in orthopyroxene yields temperature estimates of 1250° to 1300°C while spinel chemistry (high Al/Cr) and the absence of garnet indicate pressures of 20-22 Kb during the partial melt and recrystallization episode.

D11

ORIGIN OF A SANIDINE-COESITE GROSPYDITE

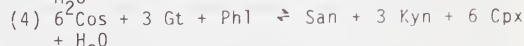
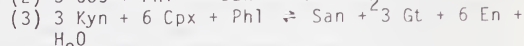
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A grosspyrite xenolith from the Roberts Victor kimberlite pipe in South Africa presents an unusual phase assemblage of clinopyroxene, garnet, kyanite, coesite, and sanidine. The rock as previously described consists of 50% omphacitic clinopyroxene, 28% garnet ($\text{Gr}_{50}\text{Py}_{28}\text{Alm}_{22}$), 9% kyanite, 6% coesite, and one percent sanidine (Or_{99}). Assuming the addition of three additional compatible phases (phlogopite, enstatite, and H_2O vapor) and a simplified chemistry of the phases present a Schreinemakers thermodynamic analysis was attempted in order to

estimate the pressure and temperature of equilibrium of the rock.

Four reactions involving six components are likely to have determined an invariant point for the assemblage.



Using tabulated as well as estimated thermodynamic data for the phases, the calculated values for equilibrium temperatures and pressures for the reactions yield an invariant point for the assemblage at a depth of about 104 km (32 kbars) and a temperature near 1180 K.

D12

INCLUSIONS IN THE LAKE ELLEN KIMBERLITE, NORTHERN MICHIGAN, USA

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The recently discovered Lake Ellen kimberlite indicates that bedrock sources of diamonds in glacial deposits in the Great Lakes area could lie within the northern U.S. Magnetic surveys show that the poorly exposed kimberlite is 200m in diameter and has a body 25x90m(?) adjacent to it. The kimberlite cuts Proterozoic volcanic rocks that overlie Archean basement, but is post-Ordovician on the basis of abundant Ordovician(?) dolomite inclusions. Xenocrysts and megacrysts are ilmenite (abundant, 13-15% MgO), pyrope-almandine and Cr-pyrope (up to 9.3% Cr_2O_3), Cr-diopside (up to 4.5% Cr_2O_3) olivine (Fo 91), enstatite and phlogopite. The kimberlite sampled crustal schist and granulite, during emplacement, as well as a heterogeneous upper mantle represented by disaggregated crystals or rare xenoliths of eclogites, garnet pyroxenites and garnet peridotites. Eclogites, up to 3 cm size, show granoblastic equant or tabular textures and consist of jadeitic cpx (up to 8.4% Na_2O , 15.3% Al_2O_3), pyrope-almandine, + rutile+kyanite+sulfide. Garnet pyroxenite contains pyrope (0.44% Cr_2O_3) + cpx (0.85% Na_2O , 0.63% Cr_2O_3) + Mg-Al spinel. Mineral compositions of rare composite xenocrysts of garnet + cpx are distinctively peridotitic, pyroxenitic or eclogitic. Temperatures (T) of equilibration are 900-1020°C for the eclogites and 785-845°C for the garnet pyroxenite using the Ellis-Green method. Kyanite-bearing eclogites must have formed at pressures greater than 18-20 kb. Using the present heat flow value of 44mW/m² (shield geotherm) for the time of kimberlite emplacement, the eclogite T's imply pressures of 33-44 kb (105-140km) and the garnet pyroxenite T's indicate pressures of 24-29 kb (75-90 km). Five peridotitic garnet-cpx composite xenocrysts have T's of 880-1125°C (Lindsley-Dixon, 20 kb solvus); T's of three, if on a shield geotherm, imply pressures within the diamond stability field.

D13

PETROLOGY OF THE EGLAZINES KIMBERLITE-LIKE INTRUSION

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The Eglazines pipe belongs to the Causses