GARNET PYROXENITES AND PARTIALLY MELTED ECLOGITES FROM THE SULLIVAN BUTTES LATITE XENOLITH SUITE, PRESCOTT, ARIZONA

Daniel J. Schulze and Herwart Helmstaedt (Department of Geological Sciences, Queen's University, Kingston, Ontario, Canada K7L 3N6)

Tertiary latite plugs and flows (the Sullivan Buttes Latite) on the margin of the Colorado Plateau near Prescott, Arizona contain numerous garnet-bearing ultramafic xenoliths. Highly altered metamorphic eclogites dominate, though locally garnet pyroxenites and garnet amphibolites may abound. Neither olivine-bearing nor primary plagioclase-bearing xenoliths have been found.

The garnet pyroxenite group is the texturally most spectacular. Well preserved pyroxene porphyroclasts contain exsolution lamellae of garnet and an Fe-Ti oxide (referred to as "ilmenite", though actually consisting of two finely intergrown phases, probably ilmenite and magnetite). The primary (pre-exsolution) assemblage consisted of three coexisting aluminous pyroxenes (calcic clinopyroxene, subcalcic clinopyroxene, orthopyroxene) and possibly garnet and "ilmenite". Porphyroclasts of the calcic cpx (approx. Wo_{45} En_{45} Fs_{10}) and opx (approx. En_{80} Fs_{20}) contain lamellae of both "ilmenite" and garnet. The subcalcic cpx (preserved as granules of intergrown cpx-opx lamellae, in various proportions) also exsolved garnet, seen as poorly preserved garnet lamellae in the areas of the cpx-opx intergrowths, and may also have exsolved "ilmenite", though only granular "ilmenite" is found associated with the subcalcic cpx. In the opx and calcic cpx all stages between lamellae-bearing porphyroclasts and complete recrystallization of the grains are preserved.

The garnets are variable in composition from one xenolith to another, ranging from approx. Py_{50} Gr_{15} Alm_{35} to Py_{35} Gr_{15} Alm_{50}, the Ca content remaining constant. Xenoliths with high-pyrope garnets sometimes contain rutile and not "ilmenite". Within a single xenolith the garnet compositions are constant.

Late stage (though pre-eruption) amphibole replaces some of the pyroxenes, especially in the fine-grained lamellar cpx-opx domains. These xenoliths appear to have reacted little with the latite.

The eclogites, some of which have metamorphic fabrics are in general highly altered, and except for xenoliths from one plug, garnets are not preserved. Prior to late stage amphibolitization which also altered the pyroxenites, these rocks consisted of almandine-rich garnet + omphacite + rutile $\pm$ sodic amphibole $\pm$ apatite $\pm$ quartz (in garnet cores). Phlogopite may be primary or secondary.

The garnets are more variable in composition than those in the pyroxenites ranging within the following limits: Py_{15-35} Gr_{15-30} Alm_{35-65}. On a Mg-Ca-Fe diagram, no overlap between the two groups exists.

The primary pyroxene is omphacite, which contains up to approx. 15 mole % jadeite. The primary amphiboles (barroisite?) are highly altered, but contain up to 4 wt % Na_2O.

Though the extent of alteration varies in the eclogites, garnet is rarely preserved. Most often it is completely pseudomorphed by a very finely intergrown symplectite of plagioclase, orthopyroxene, magnetite and (?) olivine that is nearly opaque due to dispersed magnetite. This symplectite displays a feathery texture caused by dendritic growth of these minerals from radial expansion fractures (formed upon incorporation into the magma) towards unaltered garnet.

Where the clinopyroxenes are incompletely altered, they consist of "porous" rims surrounding clear unaltered cores, commonly in optical continuity. Some pyroxenes show marked dispersion and are optically zoned even where unaltered. Plagioclase is present interstitial to, and within these altered rims.

The amphiboles and phlogopite are usually highly altered as well, and the rutile is commonly surrounded or completely replaced by pseudobrookite.

The rims of the omphacite are jadeite-poor relative to the cores (Fig. 1). They are similar in jadeite content to the diopside phenocrysts in equilibrium with the magma. The core and rim texture is likely due to partial melting of the omphacite to a jadeite-rich liquid + diopside, the liquid having later crystallized as plagioclase ($\pm$ nepheline, which may have reacted with free silica to form more plagioclase). The secondary assemglage plagioclase + orthopyroxene + magnetite + diopside $\pm$ olivine is compatible with partial melting of the omphacite and subsolidus re-equilibration of the garnet upon heating in the latite magma, and subsequent transport to the surface.

Fe-Mg distribution coefficients between garnet and clinopyroxene for both the eclogites and garnet pyroxenites suggest relatively low temperatures of equilibration (600-700°C at 10-20 kb) before incorporation into the latite magma. The sodium-bearing eclogite xenoliths were apparently less stable at high temperatures than were the garnet pyroxenites and could not survive in the latite.

Although metamorphic eclogites have been found in the Four Corners kimberlite diatremes, they are not known from the xenolith suites of basalts in the western United States. Basalts are probably too hot to preserve such eclogites whereas the kimberlites were not. The Prescott eclogites may only have survived because the latite magma was sufficiently cooler than the basalts to allow their partial preservation.

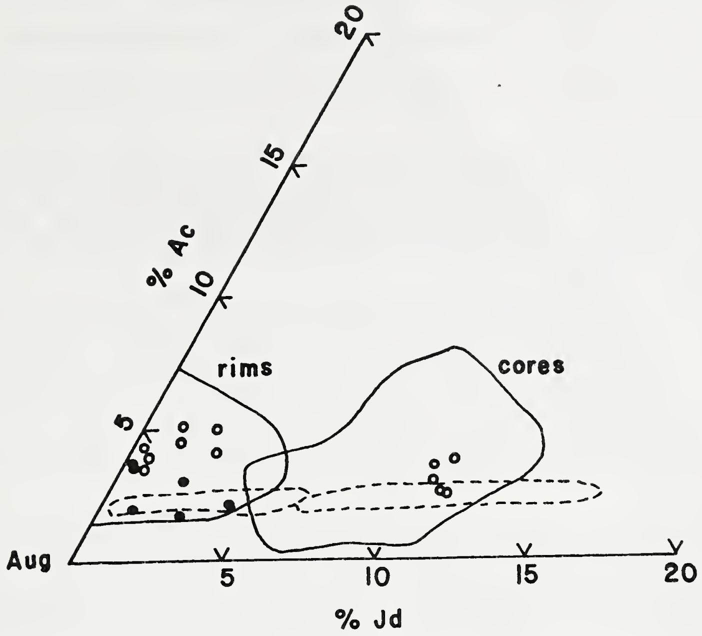

FIGURE 1. Clinopyroxene compositions (mole %) of Prescott and South African xenoliths. Solid lines enclose core and rim pyroxenes from six Prescott eclogite xenoliths, dotted lines enclose core and rim pyroxenes from five South African garnet lherzolite xenoliths (D.A. Carswell, 1975, Phys. Chem. Earth, v. 9, pp. 417-429), open circles represent core and rim pyroxenes from Roberts Victor eclogite SA 11-2, filled circles represent diopside phenocrysts in Prescott latite.