High Pressure Minerals and the Origin of the Tertiary Breccia Pipe, Ballogie Gem Mine, near Proston, Queensland

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ABSTRACT. High pressure minerals found in Miocene basaltic volcanics at Ballogie include large garnets, aluminous clinopyroxenes and orthopyroxenes, olivine, kaersutitic amphibole, anorthoclase and opaque oxides; they occur together with minor amounts of biotite, corundum and zircon. The garnet, some pyroxenes and anorthoclase can be of gem quality. The minerals accompany abundant lherzolite xenoliths in the volcanics and resemble some other occurrences in SE Queensland.

A magnetic survey of the site suggests a diatreme composed largely of breccia intruded by small basaltic bodies. The garnet (Mg$_{62-66}$Fe$_{24-24}$Ca$_{12-14}$), clinopyroxenes (Mg$_{49-56}$Ca$_{34-39}$Fe$_{0-13}$ with 6.7-8.5% Al$_2$O$_3$) and orthopyroxenes (Mg$_{68-64}$Fe$_{12-13}$Ca$_{3-4}$, with 4.8-5.8% Al$_2$O$_3$) probably represent xenocrysts derived from garnet pyroxenites and pegmatitic garnetites interlayered with spinel herzolite mantle. The compositions suggest that these minerals crystallized under pressure-temperature conditions around 14-15 kb and 1000-1100°C. The Ti content of the kaersutites, using a new geobarometer, gives approximate pressures of crystallization mostly between 12 kb and 14 kb.

The bulk of the Ballogie minerals were sampled from a volatile-bearing upper mantle, relatively rich in Ti, but poor in Cr. The model invoked for the emplacement of a composite diatreme such as the Ballogie pipe involves sudden outgassing above a rising diapir by crack propagation. The resultant updrag also provides the potential to transport very deep material from the diamond stability zone.