THE PETROLOGY AND GEOCHEMISTRY OF A POLYMICT XENOLITH FROM THE KIMBERLEY AREA, SOUTH AFRICA

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Polymict xenoliths contain rock clasts from various regions of the lithospheric upper mantle, and show evidence of modal metasomatism. The study sample, JJG 2115, is a polymict xenolith from the Kimberley area. Based on petrography and mineral chemistry, clasts of lherzolite, harzburgite, eclogite, and megacrysts are identified. The modal metasomatic assemblage is represented by the development of interstitial ilmenite, rutile, phlogopite and sulphide (IRPS) minerals. The sample has been deformed and shows evidence of recrystallisation and shearing. Consideration of the structure of the sub-continental lithospheric upper mantle, the nature and evolution of kimberlite and related magmas, and the nature of mantle metasomatism, allows a detailed multistage origin for the origin of JJG 2115 to be proposed.

The first stage involves the development of a magma in the asthenosphere as a response to hotspot or diapiric activity. As the magma rises into the lithosphere, the megacryst suite of minerals precipitates and these are incorporated into the magma. As the rising magma reaches the base of the lithosphere, volatiles are released causing crack propagation into the overlying lithosphere thus providing a pathway for the rising magma to move to higher levels within the lithosphere. En route through the lithosphere the magma samples the regions represented by the various clasts in the polymict xenolith. Temperature estimates for the garnet lherzolite and clinopyroxene-orthopyroxene assemblages are roughly 1000°C, at an assumed pressure of 40 kilobars. This, along with the exsolution of orthopyroxene from clinopyroxene suggests that the initial magma does not transport the polymict xenolith to the surface, but that the xenolith is left behind by the rising magma and undergoes a period of re-equilibration.

As the first magma leaves the xenolith, the metasomatic assemblage precipitates from the fluid remnants. This accounts for the primary interstitial texture and primary metasomatic chemistry of the ilmenite and phlogopite phases.

The final stage in the xenoliths history is the sampling of the consolidated polymict rock by a later kimberlite intrusion. The intrusion is probably of a similar nature to the abundant Cretaceous aged kimberlites in the Kimberley area. Deformation of the xenolith may have occurred during this sampling event. Alternatively, the deformation may have been caused by the closing of the conduit which transported the first magma phase, and in which the xenolith remained.