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Glasses in Mantle Xenoliths from Massif Central, France. Implications for Mantle Processes

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Silicate glasses are frequently observed in mantle xenoliths hosted in basaltic rocks from a variety of geodynamic environments. Several origins have been proposed for the glasses: (1) either linked to the transport of the xenoliths to the surface (infiltration of the host magma and partial melting of hydrous minerals due to decompression /heating effects) or (2) related to mantle processes in the source region (liquid formed and trapped during partial melting of the xenolith or migration of fluids through the upper mantle).

This work focuses on spinel lherzolites from two occurrences in the French Massif central, St Didier and Lapeyre. The xenoliths are protogranular pargasite-bearing spinel lherzolites. One sample (La25) contains pargasite + phlogopite. The amphibole is either interstitial or rims irregularly shaped spinel grains. Glass occurs mostly in pockets (1 mm across) which contain always fresh glass with small (<40 µm) secondary minerals: euhedral to subhedral clinopyroxene, olivine and spinel, and abundant bubble-like voids, suggesting a former high content of volatiles removed during degassing. Glassy patches contain occasional plagioclase in sample La25 and orthopyroxene in samples sd10 and sd14. The location of the glassy pockets is variable in the same sample: frequently observed around amphibole grains, glassy aggregates are also found between spinel and anhydrous silicates. In addition, all amphibole or spinel grains do not show surrounding melt pockets. Glass also occurs as thin veinlets along grain boundaries of the lherzolite phases. The veinlets are clearly connected to the glassy pockets. They may show reactive contact with primary pyroxene and spinel. The glasses are silica- (50-58 oxide wt%) and alkali- (up to 12 wt% total alkalis) rich, and aluminous (18-23 wt%) with significant variations between different samples and within individual xenolith. The compositions of glasses from samples Sd are broadly similar and less variable than that of sample La25 with a large range of variation depending on the pocket which is analysed. The glasses range from silica-undersaturated to quartz-normative compositions. The compositional variation of glasses falls within that exhibited by world-wide xenoliths (Coltorti et al., 1999).

Some of the proposed models for the origin of mantle xenolith glasses will be discussed. Two hypotheses can be discarded on textural and/or chemical grounds and are not detailed here: *infiltration of host magma* and *partial melting of xenolith minerals*. The frequent association of glassy pockets with amphibole and the presence of resorbed amphibole grains with curve boundaries in contact with glass in some pockets are in favor of *in situ melting of the hydrated phase*. The pargasite breakdown products consist of olivine + clinopyroxene + spinel + glass (Boyd, 1959). Three different types of reactional sites are considered: (1) Sites with typical secondary assemblage: mass balance calculation shows that the amphibole composition can be reconstructed by combining reasonable proportions of the associated glass and secondary minerals: 0.18 oliv + 0.39 cpx + 0.08 sp + 0.39 gl. The comparison between observed and calculated composition of amphibole gives agreement better than 5% except for alkalis. The glass Na_2O/K_2O value is too low compared to that of amphibole to result from the fractionation of secondary minerals only. (2) Sites where plagioclase is present among the breakdown products: mass balance calculation again shows poor agreement for alkalis, with calculated glasses less sodic and potassic than the observed ones. Type (1) and type (2) can be present in the same sample. In these two cases, the glass composition requires the incorporation of additional K ±Na components. (3) Sites with additional orthopyroxene: orthopyroxene does not belong to the amphibole breakdown products. The glass composition calculated according to amphibole breakdown alone has lower silica than observed. This suggests a reaction between orthopyroxene and melt giving a high silica melt (Schneider & Eggler, 1986), which is supported by the observed destabilisation of primary orthopyroxenes in contact with glass.

The breakdown of amphibole cannot explain all the chemical characteristics of glasses, and additional components are required. These components may derive from breakdown of mica and primary clinopyroxene, but this is not supported by textural observations. Other external sources have thus to be considered. The nature and the composition of the metasomatic agent(s) remain to be determined.

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