Immiscible dolomitic carbonatitic and trachytic magmas and the first occurrence of carbonatites in the French Massif Central

G. CHAZOT[1], H. BERTRAND[2], J. MERGOIL[1], S.M.F. SHEPPARD[2]

[1] Lab. Géologie, Univ. Blaise pascal et OPGC, 5 rue Kessler, 63038 Clermont-Ferrand, France, G.Chazot@opgc.univ-bpclermont.fr

[2] Lab. Sciences de la Terre, ENS et UCBL, 46 allée d'Italie, 69364 Lyon, France.

A pyroclastic tuff from the Velay volcanic province in the French Massif Central contains as xenoliths mafic and felsic cumulates, some of which contain carbonates, and dolomite-bearing volcanic breccias. The carbonates, Mg-siderite in the mafic cumulates or occasionally in some breccias and calcite in the felsic cumulates, are always associated with a silicate glass of trachytic composition. Dolomite occurs in large amounts (up to 57%), principally as immiscible globules in silicate melt (now glass), in breccias. These samples represent the first occurrence of carbonatite in the French Massif Central. Associated feldspars and carbonates in the three types of xenoliths are approximately in Sr isotopic equilibrium with an initial ratio of about 0.7042. C- and O-isotopic compositions of carbonates covary and cover a very large range of composition from –2.8 to 3.9 ‰ (PDB) and 8.6 to 23.8 ‰ (SMOW) respectively, but the dolomites have primary igneous isotopic signatures with $\delta^{13}C$ from –2.8 to –2.6 ‰ and $\delta^{18}O$ from 8.6 to 8.7‰. The covariation, with slope of ~0.4, is similar to that observed in carbonatites worlwide, but extends to much higher C- and O- isotopic values.

The combined C-O-Sr isotopic data indicate that the dolomitic carbonatitic and silicate magmas came from a mantle source with very similar isotopic characteristics. On compositional arguments, injection of a non-cogenetic carbonatite magma into the differentiating felsic magma within the crust is preferred to the unmixing of a relatively late fractionated melt to carbonatitic and trachytic magmas. The textures, high $\delta^{13}C$ and $\delta^{18}O$ values of Mg-siderite and calcite and their trend are consistent with precipitation of the carbonates during CO_2 metasomatism either (1) by interaction between open-system isotopically evolving CO_2-rich fluid (<20 mole % H_2O), that followed magma degassing, and the pre-existing silicate minerals of the cumulates at temperatures of about 350°C, or (2) and more probably, by interaction between a CO_2- H_2O fluid (>90-95 mole % H_2O) isotopically buffered by the degassing magma and the cumulates at temperatures decreasing down to about 150-125°C for the calcite-bearing felsites. The associated glasses are subtlety altered. Explosive eruption that entrained the xenoliths probably occurred soon after injection of the carbonatitic magma into the felsic magma. The model of CO_2 metasomatism can be applied to other carbonatites displaying the $\delta^{13}C$-$\delta^{18}O$ trend with slope of ~0.4.

Can Komatiites be 'dry' plume-type magmas?

M.J. CHEADLE[1] & D.SPARKS[2]

[1] Dept. of Geology & Geophysics, University of Wyoming, USA (Cheadle@uwyo.edu)

[2] Dept. of Geology & Geophysics, Texas A&M University, Texas, USA (sparks@seaver.tamu.edu)

Archaean komatiites are the highest MgO lavas recorded on the Earth and therefore must have formed by anomalously high temperature, relatively 'dry', melting (in mantle plumes?) or by volatile/water induced melting (in subduction zones?). As with modern-day mafic magmas, it is possible that komatiites were generated in both environments; the key problem is to recognise diagnostic characteristics that can be used to determine the environment in which the komatiites formed.

Field constraints are most important. Many komatiites are demonstrably phenocryst poor lava flows that erupted non-explosively and crystallized spinifex textured flow-tops above olivine-rich cumulate lower zones at low pressures. Consequently, it is most unlikely that they were magmatically wet melts. Even if they were, they probably would have degassed water before crystallization and thus it is difficult to infer magmatic water contents by studying the products of *in-situ* or shallow crystallization.

The second diagnostic characteristic is whole-rock geochemistry, yet this is fraught with the problem that komatiites are high degree melts (up to 50% of the mantle) and thus major and many trace element compositions must converge regardless of whether they are formed by volatile or high temperature induced melting. Interpretation of the geochemistry is further complicated by the fact that komatiites require physical conditions of melt generation that do not occur today. Models of komatiite generation based on geochemistry must be physically plausible and all existing models require high mantle temperatures. Komatiite generation at subduction zones requires higher mantle wedge temperatures (+/- faster convection) than today, and thus implicitly requires the presence of hot mantle plumes. One problem with subduction zone melting models is that they can't produce the 50% melting and the garnet source signature required by some komatiites. We will present the arguments for komatiite generation by anhydrous melting and a viable physical model for their origin in high temperature mantle plumes.