Chemical interpretation of mantle electrical heterogeneities in MORB source regions

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The electrical conductivity of mantle rocks being greatly affected by partial melting [1], the MELT magnetotelluric surveys have allowed major improvements in the knowledge of melt pathway, melt extraction and melt formation in MORB source regions [2]. The connection between electrical structure and melt chemistry remains however difficult to establish.

Here, analyses and interpretations of the MELT magnetotelluric data are discussed to infer the mantle structure down to the transition zone. Magnetotelluric response tensors inverted for a 3-D isotropic conductivity structure allows identification of strong electrical heterogeneities, with profils showing elevated conductivity from the transition zone up to depth where MORB are formed. Such conductive plumes are observed in the south and the north of the studied area, while the central zone is in contrast poorly conductive. The results suggest a fairly complicated scheme for melt migration under this portion of the EPR but it must reflect chemical heterogenities allowing volatile-rich low melt fractions [3] to wet peridotite grain boundaries along some profils whereas others regions remain 100% solids.

Based on new laboratory data on volatile-rich carbonated melts, we discuss these heterogeneities in terms of heterogenity in mantle redox state. Carbonated melts are stable and connected from the transition zone to the depth of MORB formation if redox conditions are sufficiently oxidizing [4]. Otherwise, diamond is stable and chemically enriched carbonated melts are not or poorly involved in MORB generation. This may generate chemical heterogenities in MORB.

[1] Caricchi *et al*. (2011) *Earth and Planetary Science Letters* **302**, 81-94. [2] Evans *et al*. (2005) Nature **437**, 249-252 [3] Gaillard *et al.* (2008) *Science* **322**, 1363-1365. [4] Stagno & Frost (2010) *Earth and Planetary Science Letters* **300**, 72-84.

Copper Partitioning in CO_2-Bearing Melt-Vapor-Brine Systems

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Analysis of fluid and melt inclusions from arc-related intrusions and porphyry copper deposits (PCD) reveal that many fluid inclusions from PCD are typically characterized by $X_{CO2} < 0.10$, which is lower than that found in volatile phases exsolved from shallow (e.g., 5 to 10 km), arc magmas, in general (X_{CO2} up to order ~ 0.45). This disparity remains to be resolved.

The efficiency with which copper can be removed from arc magmas into exsolving volatile phases is a function of the competition between crystalline phases (± liquid sulphides), and the exsolving vapor ± brine. Experiments in melt-vapor-brine systems permit the investigation of the partitioning of copper between silicate melts and volatile phases under magmatic conditions. However, the effect of CO_2 on melt-volatile phase equilibria relevant to the formation of PCD has remained unconstrained. In this study, the partitioning of copper in CO_2-bearing, sulfur-free and sulfur-bearing, experiments may provide additional insights into copper partitioning and the generation of PCD.

We present results from experiments performed at 800 ^{o}C and 100 MPa in CO_2-bearing, sulfur-free and sulfur-bearing melt-vapor-brine systems with X_{CO2} (bulk vapor ± brine) = 0.10 and 0.38. The compositions of vapor and brine inclusions and run-product glasses were used as proxies for the compositions of the magmatic phases. The salinities of vapor inclusions that nucleated clathrate ($CO_2 \pm H_2S$ clathrate) upon cooling were determined via Raman analysis and microthermometry [1]. The partitioning of copper between brine and vapor ($D^{b/v}_{Cu}(\pm 2\sigma)$) increases from 25(±6) to 100 (±30) for sulfur-free experiments and from 11(±3) to 95(±23) for sulfur-bearing experiments, as X_{CO2} is increased from 0.10 to 0.38. The partitioning of copper between vapor and melt increases with the addition of sulfur at $X_{CO2} = 0.10$: ($D^{v/m}_{Cu}(\pm 2\sigma)$) = 9.6(±3.3) (sulfur-free, metaluminous melt); 18(±8) (sulfur-bearing, peralkaline melt); and 30(±11) (sulfur-bearing, metaluminous melt). These values are to be contrasted with ($D^{v/m}_{Cu}(\pm 2\sigma)$) = 2(±0.8) at $X_{CO2} = 0.38$ (the effect of sulfur cannot be distinguished at this mole fraction of CO_2). These data demonstrate that changes in the salinity of the vapor and brine, which are controlled by changes in X_{CO2}, play a major role in controlling copper partitioning in sulfur-free, CO_2-bearing systems. Sulfur-bearing experiments demonstrate that magmatic vapors are enriched in copper in the presence of sulfur at low X_{CO2}. However, the enrichment of copper in the magmatic vapor is suppressed for sulfur-bearing systems at high X_{CO2}. These data indicate that the efficient removal of copper from silicate melts into vapor ± brine is mitigated by high concentrations of CO_2. Furthermore, the poisoning effect of CO_2 is more pronounced for sulfur-bearing volatile phases. As a result, high concentrations of CO_2 may play a negative role in the formation of PCD.

[1] Fall et al. (2011) *Geochimica et Cosmochimica Acta* **75**, 951-964.