Diverse primitive melts from heterogeneous metasomatized mantle

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Primitive arc magmas provide reflect the nature and thermal structure of the mantle wedge. A variety of experimental techniques have been used to explain the compositions of primary magmas and the conditions of their generation. One of these, experimental determination of multiple-saturation points (MSP) can provide robust insights provided that: 1) variance is suitably reduced by the presence of several (≥4) coexisting liquidus phases; 2) the compositions of those phases are consistent with mantle lithology; 3) melt composition at MSP is close to that of the starting material.

Primitive lavas in the Colima Graben, Mexico, span a remarkable geochemical range from high magnesium calc-alkaline basalts to shoshonitic trachybasalts. This chemical diversity suggests that the sub-arc mantle wedge from which they derive is chemically heterogeneous. Equilibrium piston-cylinder experiments were carried out between 1.0 and 2.4 GPa under hydrous, oxidizing conditions (1.5 to 4.5 wt% H_2O, and ΔNNO+3.5) to determine the P-T-H_2O near-liquidus phase relations of a primitive high-K (COM-1) basalt from the Colima Volcanic Complex (CVC), Mexico.

Our results show COM-1 + 3.5 to 4.5 wt% H_2O is multiply-saturated with phlogopite-pyroxenite (cpx+opx+phl+sp) at 1.9 – 2.4 GPa and 1300ºC. It was not possible to saturate additionally with olivine indicating that COM-1 is a product of partial melting of phlogopite-bearing pyroxenite at depths around 65-85 km.

We also encountered MSP with a phlogopite peridotite assemblage (ol+cpx+opx+phl+sp) at 4.5 wt% H_2O, 1.7-1.9 GPa 1250ºC. These conditions lie well below the liquidus of COM-1 and are therefore not appropriate to COM-1 generation. Instead, the composition match with CVC calc-alkaline cones, hence, this magma types could be produced from phlogopite peridotite.

We conclude that a wide range of primitive melts can be generated rated from a phlogopite-bearing, metasomatised mantle source.