Comparative partitioning of Re and Mo between sulfide phases and silicate melt and implications for the behavior of Re during magmatic processes

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In order to better constrain the behavior of Re in magmas of different tectonic settings, the partition coefficients (D) of Re and Mo between sulfide liquid (SL), monosulfide solid solution (MSS), and basaltic to dacitic melts (SM) were determined using a piston-cylinder apparatus. The experiments were conducted at 1050-1200 °C, 0.7-1.5 GPa, and oxygen fugacity (fO_2) of ~FMQ-1.8 to FMQ+1.5. The SL/SM D values range from 0.11 to 76 for Mo and 45 to 76000 for Re. The MSS/SM D values range from 0.32 to 219 for Mo and 280 to 160000 for Re. All D values increase with decreasing fO_2 and the FeO content in silicate melt. We also find that Ds for Re and Mo are strongly correlated regardless of the temperature, pressure, silicate melt composition, and fO_2. This correlation can be explained by the similar dissolution behaviors of Re and Mo in silicate melt. The newly obtained Ds for Re and Mo, in conjunction with the D for Cu, were applied to constrain the behavior of Re during magmatic genesis and differentiation. The results show that the observed Re contents in primitive MORBs can be explained only if the Re abundance in the depleted mantle is between 0.12 and 0.28 ppb. To satisfactorily explain both the Cu and Re contents in primitive arc basalts, (1) the fO_2 of the subarc mantle during melting must be between FMQ and FMQ+1, and (2) the subducting slab must contribute both Re and S to the subarc mantle, although the extent of slab contribution differs between arcs. During arc magmatic differentiation, a significant fraction of Re is sequestered by sulfides, which results in a heterogeneous distribution of Re in the continental crust and the formation of Re-rich cumulates in the deep crust. The delamination of such Re-rich cumulates can form Re-rich and radiogenic Os-rich reservoirs in the depleted mantle, which partially explains the “missing Re” problem.