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Diffusion coefficients for Tl, Pb, Cd, In, Zn, Bi, As, Mo and Sb in hydrous rhyolite at 100-200 MPa

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A series of experiments have been conducted to determine the diffusivities of Tl, Pb, Cd, In, Zn, Bi, As, Mo and Sb in hydrous rhyolitic melt. Diffusion experiments used two adjoining glass cylinder of the same hydrous composition, one doped with the elements of interest at $\sim$ 100 ppm. These couples were rapidly heated to 850, 1000 and 1150°C at 100-200 MPa for a few hours. After quenching the sectioned charges were analyzed by both synchrotron XRF (The Diamond Light Source) and LA-ICP-MS (University of Oxford). The data shows excellent correlation between these two techniques. The diffusion profiles were fitted to a 1-D diffusion couple equation to determine the diffusivities and fitting to the different temperature runs defined the Arrhenius parameters. We find that for 850°C the diffusion coefficients follow the trend Tl>Pb>Cd>Zn>In>Bi>As>Sb>Mo. Additional experiments were performed with either S or Cl added (to both sides of the diffusion couple). In general S increases the diffusion rate of all metals except Mo and Sb, which diffuse slower in the presence of S. Chlorine also speeds up the diffusion of metals with the exception of In, Mo and Sb. The systematic change in diffusivities of these metals and their different behaviour in the presence of the ligands that are also observed to be significant in volcanic gases, are important in determining the distribution of these metals during degassing (e.g. MacKenzie and Canil, 2008). This is particularly important in a dynamic environment such as a volcanic conduit. There are also implications for economic exploration and well as hazard mitigation.