Experiments Supporting IOA Deposit Formation by Interaction of Evaporites and Silicate Magmas

Shengchao Yan[2], **Michael Anenburg**[1], Bo Wan[2], John Mavrogenes[1]
[1]Australian National University, Canberra, Australia, [2]Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China

The key processes that lead to iron-oxide apatite deposit formation are hotly debated. Several genetic processes have been previously suggested, including immiscibility between iron-phosphate and silicate magmas, flotation of magnetite by adherence to hydrothermal fluid bubbles, metasomatism by Fe-rich saline brines, and crystallisation alongside molten salts. Although each is a viable model supported by both natural observations and experiments, a common link between them is still missing.

Here we show high pressure and temperature experiments inspired by the El Laco IOA deposit. We ran layers of silicate magma, sulfate–chloride evaporites, ironstones, and phosphorites at 0.4 GPa and 1000 to 1200 °C. We see formation of emulsion consisting of immiscible silicate and iron-phosphate melts, a third liquid of Fe-rich sulfate–chloride composition, and magnetite covered with phosphate-rich fluid bubbles. Upon quench, dendritic magnetite crystallised out of the silicate magma.

Our results show that when regular andesitic magmas assimilate evaporites, iron and phosphate solubility in the silicate increases substantially. The heat causes melting of the evaporites themselves. These liquid salts are highly corrosive and can effectively extract iron and phosphate from surrounding rocks, and maintain a high equilibrium level of these components in the silicate. Fluid bubbles will float the voluminous magnetite that forms during cooling, as well as transport phosphate within the fluid. Finally, the saline fluids have high iron-carrying capacity and will readily metasomatise existing rocks, forming additional magnetite.

This shows that all the previously-suggested IOA formation models are correct, and occur contemporaneously. This is triggered when arc-related silicate magmas intrude sedimentary sequences that contain evaporites and iron–phosphate rich rocks.