Geochemical evolution of La Torta lava dome, El Tatio, Chile, through melt inclusions

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La Torta is a volcanic rhyolitic lava dome with a height of 5090 m. a.s.l., located in the area of El Tatio Geothermal Field (Chile), to the west of Cerros de Tocorpuri, on the border with Bolivia. La Torta erupted 34 ky ago, and its source was a rhyolitic K-rich magma with 74.5% wt silica that crystalized between 90 and 2390 mt. below sea level.

Main objective of this work is to reconstruct the processes that affected the evolution of magma at La Torta, by using melt inclusions (MIs). For this purpose, we performed EMP and LA-ICP-MS analysis on amphibole- and plagioclase-hosted MIs.

Crystallization temperatures for all observed mineral phases vary between 723 and 949°C, approximately. Oxygen fugacity (logfO2) values calculated for the melt phase is -12.3, indicating an oxidizing environment. Water content obtained by amphibole hygrometer is about 4.9% wt . Despite the above-mentioned data, homogeneous MIs register only the last stage of crystallization, probably due to the initial high silica content of the magma (74% wt). Based on mineral and MIs chemistry, the parental magma was andesitic in composition, as also shown by the amount of andesine present in the rock.

We can define two possible models to describe the magmatic evolution at La Torta: 1) at the beginning of magmatism in this area (0.8 My), an andesitic-dacitic magma was deep in the crust (at least 2.6 km) and formed Tocorpuri Volcano and Cerros de Tocorpuri. 2) Later on, a more evolved rhyolitic magma gets in contact with a deeper and primitive batch and formed La Torta. Our samples show phenocrysts of Mg-Hbl violently dissolved by the high temperatures caused by the contact with this less evolved magma, which has enriched the system in Ni, Cr and HREE (as shown by the composition of MIs) and made enstatite micro-phenocryts rarely surviving the reheating. During its ascent, this magma crystalized quartz and biotite, as also recorded by the decreasing of compatible elements in MIs. After a relative long residence time a decompression and further reheating occurred, producing reabsorption textures in quartz and amphibole and the recrystallization of some MIs.