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Temporal oxidation of Lascar volcanic gases (Chile) recorded by V-Tl-Te zonation of a fumarolic crust

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Arc volcanoes represent the most efficient transfer mechanism of volatile elements from the Earth upper mantle and crust to the atmosphere. Degassing at arc volcanoes represents the link between the deep Earth and its surficial envelopes. Degassing history is critical for studies of global element cycles and also for monitoring purposes. However, continuous monitoring of the composition of gas released by arc volcanoes are scarce due to hazard and remoteness of sampling sites.

Where acid water lakes exist in volcanic environment, it is possible to reconstruct the degassing activity from the zonation of gypsum stalactites formed at lake seepage [1]. In-depth, fluctuations of trace element content record the input from the degassing magma in the hydrothermal system and constrain recent volcanic activity.

This study aims at reconstructing the degassing history of the Lascar volcano (Chile) directly from the small-scale zonation of an incrustation formed at fumarole vents. Our approach rests on previous observations showing that the composition of fumarole incrustations tightly depends on degassing conditions [2].

In situ major-trace element and O isotope analyses were performed along a core-to-rim linear profile in order to build a temporal record of the Lascar volcano gas emissions.

Geochemical time-evolution draws two distinct patterns. (1) A cyclic pattern that affects similarly major, trace elements and O isotopes. We determined that the crust has grown during about 30 years before sampling by confronting the regularity of rainy seasons (1/year) to O isotope cycles. (2) A selective >20-fold increase of V, Tl and Te contents from core to rim where concentrations reach 8500, 8700 and 1600 ppm, respectively.

Vanadium being volatile only under highly oxidizing conditions [3], we propose that the coupled enrichment of V, Te and Tl towards the crust surface reflects the progressive oxidation of Lascar gases through time. Since oxygen isotopes do not show a temporal trend over the studied period, the inferred oxidation does not reflect an increased input of meteoric water. Instead, temporal oxidation of Lascar magmatic gases could be related to the cooling [4] and relative deepening of the magmatic interface following the last major 1993 eruption.

Chemical measurements on zoned fumarole crusts constrain element behaviors during condensation at volcanic vent and bring new insights on volcano evolution.

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