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Automated mineralogy analysis as a first approach to recognize olivine-hosted melt inclusions in lavas from the Central Volcanic Zone (CVZ), Chile

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Volcanism in the Central Volcanic Zone (CVZ) of the Andes has continued since the Pleistocene through a continental crust up to 75 km thick. This volcanism is represented by large stratovolcanoes of mostly andesitic-to-dacitic composition, with significant dacitic-to-rhyolitic ignimbritic activity, but limited mafic magmatism represented by small lava flows, isolated minor centres and scoria cones. Mafic volcanism has been studied in back-arc settings (i.e. Bolivian Altiplano – Argentine Puna Region), and has been associated with a high degree of mantle melting by high fluid flux from the slab followed by delamination beneath the slab, and controlled by structural features [1]. In contrast, there are limited previous studies about mafic volcanism erupted in the main volcanic arc, primarily describing the petrography and the geochemical features of rocks [e.g. 2], with no geochemical information reported about early forming mineral phases (i.e. olivine and pyroxene) hosted in basalts and basaltic-andesites present in the arc.

The 'early forming minerals' which grow in magma chambers beneath volcanoes reflect the composition of the surrounding magma, and thus compositional analyses of these minerals are fundamental to identifying and quantifying the mafic magma source(s) and the deep crustal processes. In addition, the associated melt inclusions provide insight into the primitive magma compositions and the pre-eruption condition(s), which can define major, trace element and isotopic ratios of the erupted rocks. This study focuses on using automated mineralogy (QEMSCAN®) to aid in identifying the olivine-hosted melt inclusions as a first step for a mineral-scale geochemical investigation. The crystals of olivine are commonly only present in low concentrations (<10%) in the basalts and basaltic-andesites from Central Andes, and are difficult to quantify using less precise (and time consuming) methods (e.g. optical microscopy). In addition, automated mineralogy can provide information on other important variables such as mineral grain sizes, mineral liberation, elemental deportment, mineral associations and textural observations, as well as identifying potential melt inclusions. The detailed analysis of 30 samples show that it was possible to identify and quantify such melt inclusions within single olivine crystals (Figure 1). This information is crucial for the initial choice of the samples, and to define the most suitable sample processing and the methodologies to use in the geochemical investigation, as well as obtaining initial information as to the quantity, size, and minerals included in the melt inclusions.

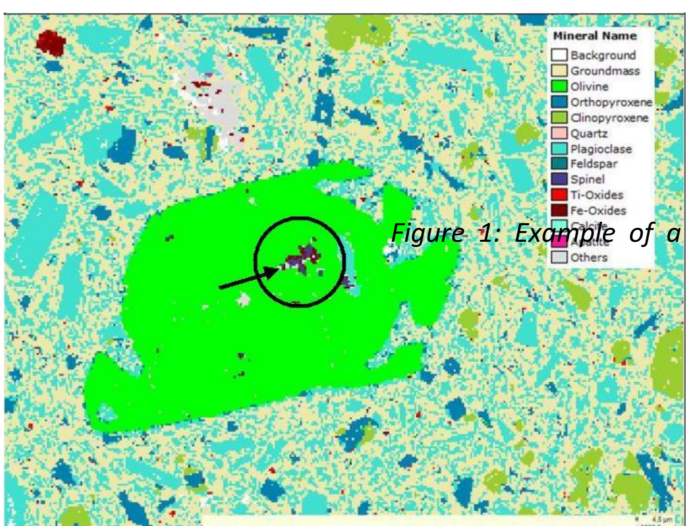

Figure 1: Example of a QEMSCAN®

mineral map. The average composition of

Spinel

the potential melt inclusion (in the circle) that hosts the inclusion of spinel could be masked with the olivine phenocryst composition. The sample is a basaltic-andesite lava from Chile's Central Volcanic Zone (San Pedro Volcano, Western Cordillera, Chile).

References:

[1] Davidson J P y de Silva S L (1995) Contributions to Mineralogy and Petrology, 119(4), 387-408.
[2] Davidson J P et al. (1991) Geological Society of America Special Papers, 265, 233-244.