Timescales of crystal mush storage in the Central Southern Volcanic Zone of Chile

Melvyn BILLON[1], Bernard CHARLIER[1], Olivier NAMUR[2], Jacqueline VANDER AUWERA[1]

1. *Université de Liège, Liège, Belgique (melvyn.billon@uliege.be)*
2. *KULeuven, Louvain, Belgique (olivier.namur@kuleuven.be)*

During the last few decades, there has been an important change in paradigm in igneous petrology from the classic concept of a large melt-dominated magma chamber to a storage reservoir that is dominated by crystal mush where the crystals form a framework in which melt is distributed [1]. During eruption, these crystals may be unlocked from the mush and transported as individual macrocrysts or glomerocrysts.

Time is a fundamental parameter in geology and particularly in volcanology where volcanic hazard must be assessed. If the process of rising magma from the surface reservoir is relatively fast [2], the process of crystal mush storing can take from centuries to thousands of years [3].

The project focuses on constraining the timescales (t) of crystal growth (G) in the main storage region of several volcanoes (Osorno, Calbuco, Villarica, La Picada) of the Central Southern Volcanic Zone of the Andean arc (CSVZ) (Chile). These timescales will be obtained by combining experimentally determined growth rates of plagioclase, the main macrocryst in the studied volcanoes, and detailed plagioclase crystal size distributions (CSD, [4, 5]). Experiments of plagioclase crystallization are performed on a natural basaltic andesite sample (from Osorno) that is representative of the CSVZ and more generally of arc magmatism. We particularly study the effect of melt composition and H_2O content, an important parameter in subduction zone magmatism, on the growth rate of plagioclase. Cooling experiments at different rates (1°C/h, 3°C/h, …) are run at 1 atm (anhydrous) and 2 kbar (hydrous) and at an oxygen fugacity close to NNO. These conditions are constrained by results from our extensive petrological database on these volcanoes. The various experimental charges obtained are then polished, observed by different processes (SEM, electron microprobe, tomography), and texture is analyzed by segmentation with different software (GIMP, ImageJ), so as to compare the shape and growth of the crystals according to the conditions.

Plagioclase crystal size distributions are also acquired on a selection of samples from the different volcanoes. Crystal size data obtained from high quality BSE images are then quantified with the software package *ImageJ* freeware to calculate the CSD plots. Using our data on growth rates (G) and the slope of these plots (-1/Gt) will enable us to extract information about the duration [6, Figure 1] of crystal growth (t).

References

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Figure

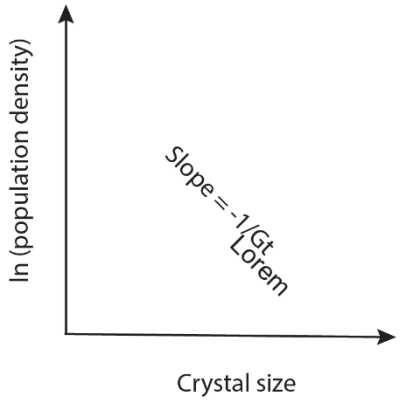

Figure 1: The crystal size distribution of a phase in the magma storage region is a straight line on graph of ln(population density) against size. The CSD analysis on the crystals allows the slope to go back to the residence time (t), thanks to the experimental determination of G (growth rate).