Insight into magmatic processes of open vent volcanoes using crystal pattern recognition techniques

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A good part of our understanding about what drives the frequent eruptions of many active volcanoes, such as Mayon, Stromboli and Etna, crucially depends on proper interpretation of the chemical and textural information recorded by the crystal cargo of the magma. In particular, plagioclase has a good potential for magmatic processes identification, but its usually complex textural and compositional patterns defy interpretation. Thus, despite the abundance of plagioclase phenocrysts in these magmas and the fact that their textural and chemical data can now be easily obtained with SEM and EMPA, we are left wondering what it may mean.

To alleviate this problem, we present a new modelling and analytical approach. Backscatter electron images of full thin section with a FEG-SEM allows complete visualisation of the chemical composition and texture of all the crystals at once, and thus a statistical treatment of a very large amount of crystal data. However, a proper understanding of plagioclase population needs taking into account possible artifacts that are introduced by random 2D cuts of thin sections from complexly zoned 3D crystals. Thus, we also have produced a new user-friendly program called Plagioclase Zoning Patterns (PZP) that allows to check whether the large variety of plagioclase patterns are caused by the mere conversion of 3D crystals into 2D objects. This is done by carrying out a similarity analysis of 2D BSE images and compositional maps from a numerically generated set of zoning patterns.

We applied these methods to the Mayon 1947 eruption. The plagioclase phenocrysts can be classified into more than five groups based on the quite different patterns (such as touching group, two-zoned group). However, we show that a large part of this variety is due to the conversion of 3D to 2D objects. When these artifacts are removed, we find mainly two plagioclase types, one related to a pre-existing crystal mush into which new magma and crystals intrude, and which is likely related to the trigger of the eruption.