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Cross correlation of chemical profiles in minerals: Technical issues and numerical methods

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Crystals grown in magma reservoirs and develop chemical zoning because of the lack of re-equilibration when thermodynamic conditions change. Therefore, the study of chemical zoning in minerals offers the opportunity to reconstruct the pre-eruptive conditions and the temporal evolution of magma reservoirs. We are building a quantitative method that allows the comparison between zonation patterns within minerals. The aim of this method is to identify if similar crystal have partially similar zonation patterns and thus shared a part of their growth history. Our method is based on the correlation method developed first by G. Wallace and G. Bergantz (2004).

Here we present some technical issues linked to the use of a numerical method to compare crystals within their textural context in thin sections. The first issue is related to the acquisition of chemical profiles from images of thin sections (e.g. BSE or cathodoluminescence images). We present a new procedure that significantly improves both image and profile processing. A second issue is related to the random orientation of crystals in a thin section. The software we are building takes in account different orientation of crystals by applying different stretching factors to chemical profiles. Thus the automated selection of the best stretching factor is crucial for the rest of the procedure. The last point is the significance level, the threshold above which the correlation between two profiles is considered as real (and not random). This threshold must also be carefully defined and justified.

All these points were studied with statistical analysis and we present results leading to a more reliable and robust method.

[1] Wallace, G.S. and Bergantz, G.W., 2004. Constraints on mingling of crystal populations from off-center zoning profiles: A statistical approach. American Mineralogist, vol. 89 (1), pp. 64-73.

[2] Wallace, G.S. and Bergantz, G.W., 2004. Reconciling heterogeneity in crystal zoning data: An application of shared characteristic diagrams at Chaos Crags, Lassen Volcanic Center, California. Contributions to Mineralogy and Petrology, vol. 149, pp. 98-112.