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Interpreting zoning profiles in minerals: The sectioning effect

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Chemical zoning profiles in minerals bear important information on rates of geological processes. If such zoning profiles are formed by diffusion, then they may be interpreted in terms of the cooling rate of the system. This was first described by a seminal work of Dodson (1973) and has since been popularized by Lasaga (1983). In particular the partitioning of Fe and Mg in garnet porphyroblasts has since been recognized as geologically relevant and a number of studies have applied this method to determine cooling histories of metamorphic terrains (Ehlers et al., 1994; Cooke and O Brien 2000).

However, geologists typically measure chemical zoning profiles by analyzing minerals thin sections using the electron microprobe. Their work is therefore plagued by the sectioning effect, i.e. the fact that the section position relative to the grain center is not known. Thus, the complete zoning profile is generally unknown and the error between complete and apparent zoning profile increases with section position from the grain center.

Here we present a progress report of a project in which we determine methods to eliminate the sectioning effect. We show how a single zoning profile from an unknown position can be used to infer both: the distance of the section to the grain center and the complete zoning profile of the mineral grain. We also present a statistical approach how the distribution of zoning profiles from many grains can be used to assist in improving a classic stereological problem: The inference of grain size distributions from section circle distributions. We have tested our model using three dimensional compositional information on garnets from the Taita Hills (Tansania) where we have performed a serial sectioning project.

References:

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