Pressure prediction in a poly-metamorphic terrain based on µ-EDXRF. An example from the Archean Vumba Schist Belt, Botswana

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The Archean Vumba Schist Belt in the NE of Botswana comprises komatiitic successions, bimodal volcanics, sediments, Archean soils, banded iron formation, rodingites, and is intruded by several generations of granitoids, late pyroxenite and dolerite dykes. The belt experienced three metamorphic events, where due to strong uplift and tilting a shift of metamorphic centers from high grade in the NW to medium grade in the center and low grade in the SE can be observed. Shear zone and quartz vein hosted gold deposits are related to the late low grade metamorphic impact.

Several hundred rock slices were mapped by the µEDXRF M4 Tornado, Bruker nano. The measurement was performed in 20µm steps, 2msec acquisition time using a Rh-tube at 50kV and 600 µA, a poly-capillary beam guide, no filters, two silicon drift detectors arranged in 180°, 90° to the tube with 51° take off or incidence angle, respectively.

The mapping provided bulk area chemical information and phase distribution for the very same area. Phase distribution was obtained by supervised endmember-based classification using the spectral angle mapper (SAM) algorithm of the hyperspectral software ENVI for 165 spectral regions of interest. The minimum per channel per pixel was obtained for both detectors to widely omit diffraction signals of individual grains. Both, area chemistry and modality were used to select samples of similar chemistry along strike from NW to SE to compare the metamorphic impact. A series of mafic rocks was selected and investigated in detail putting focus on the amphibole chemistry by masking all other phases and applying a second SAM classification based on amphibole solid solution endmembers only. The amphibole endmembers were derived from EPMA analyses and amphibole classification by Li et al. (2022) following the classification scheme of Hawthorne et al. (2012). This second classification is the key to differentiate the impact of individual metamorphic events within individual mafic rock slices by visualizing amphiboles classified according to chemistry representative for different PT environments. The pressure estimation provided by Li et al. (2022), referring to the method of Hollister et al. (1987), was used for pressure prediction of amphiboles in individual samples across the belt. The dominant pressure is around 8.9 kb, but relics indicate values of >10 kb, and retrograde alteration shows values of > 4 kb.

Automated mineralogy applied to µEDXRF, provided a detailed endmember data base exists, is a fast and easy to apply method, despite obscuring effects such as grain boundaries, grain size, shape as well as orientation-based diffraction. Information on rock and mineral chemistry, modality, and mineral sub-classes can be obtained for large sample numbers for preselection of most adequate samples for polished thin sections and EPMA investigations.

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