Quantitative microstructural analysis *vs.* numerical metamorphic petrology as a tool to investigate the *PTdX* evolution of orogenic process

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The final aspect (*i.e.*, fabric arrangement and paragenesis) of the metamorphic rocks is the result of the counterbalancing factors controlled by deformation *vs.* recovery processes. For this reason, the quantification of the rheology properties by means of microstructural analysis, as well as of the definition of the thermodynamic equilibria by quantification of the effective bulk rock chemistries, represent two faces of the same medal. With this contribution, we would like to structure for the first time a unique Local Information System (LIS) platform in ArcGis® able to store and elaborate quantitative information from both microstructural and petrological points of view. The structure of our LIS starts from the acquisition of high resolution optical thin section scans, which are nowadays good input to extrapolate detailed grain boundary maps (*e.g.*, Li et al., 2008; De Vasto et al., 2012). These procedures adopt sequential stepwise controlled procedures consisting of filtering processes, followed by edge detection functions. These algorithms are able to automatically extrapolate polygonal features useful to obtain in turn microstructural derived parameter such as the grain size distribution as well as the shape preferred orientation of mineral grains. Yielded microstructurally derived results have been then integrated with the multivariate statistical image analysis of micro X-ray maps of the entire thin section (Ortolano et al., 2014a) in order to enrich the grain size distribution analysis with the mineral distribution map. This integration have led to structuration of a new local geodatabase where each detected mineral grain is accompanied by geometrical and compositional data features. The following classification of one or several microdomains per thin section, highlighted then in turn the sequence of recognized metamorphic equilibria, which can be used to a better definition of the effective bulk rocks chemistries, based on the objective interpretation of reaction-scale equilibration (*e.g.*, Fiannacca et al., 2012; Ortolano et al., 2014b).

Recently our procedure has been completed with the calibration of previously classified X-ray map *via* a multi-linear regression technique. This new analytical cycle permitted to obtain new image arrays, each of them representative of: a) the elemental concentration within a single phase expressed in a.p.f.u;.b) maps of the end members visualizing the potential zoning patterns of solid solution mineral phases. The latter can be then easily converted into *PT* maps integrating compositional data with thermodynamic modeling constraints.

Yielded results highlight as this new GIS-based workflow can be usefully applied in order to obtain an assisted semi-automated sequential image processing procedure, applicable in all the fields of petrological investigations, with particular focussing in the resolution of metamorphic petrology problems using a new numerical approach. This approach is able to minimize the subjectivity of the petrologists in the definition of the scale and composition of textural equilibria, storing at the same time in a unique LIS structure all the fundamental textural and petrological information of metamorphic rocks.

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