Kriging rocks with non-euclidean metrics

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A rock ordering degree is of great interest for recent petrology. An idea to to use the covariogram analysis and kriging procedure to test their 2D-sections is suggested in the paper.

The first step is to code rock-forming minerals by indicator functions. The second one is to use non-euclidean metrics to calculate the distances between the grains and aggregates:

- h_{ij} = *min dist* (i,j) - minimal number of intergrain boundaries crossed on the way from the *i*-th to the *j*-th grain.
- $\sigma(A,B) = max\ \{\{\zeta(a,B)\}_{a\in A}\ ,\ \{\zeta(b,A)\}_{b\in B}\}$, where $\zeta(a,B) = min\ \{h_{ab}\}_{b\in B}$, $\zeta(b,A) = min\ \{h_{ab}\}_{a\in A}$ - the Hausdorff metric.
- $\xi(A,B) = \mu(A\cup B) - \mu(A\cap B)$ and
- $\rho(A,B) = 1 - \mu(A\cap B)/\mu(A\cup B)$, where μ is any measure.

The first metric was used to calculate covariograms for a pyroxene-scapolite-titanite rock from Quebec, Canada and gabbronorite from the PGE-bearing Pansky massif, Kola Peninsula, Russia. The first rock is found to be a pure mosaic while the second one is partly ordered with a maximal range r=2 taken from the plagioclase-plagioclase and plagioclase-clinopyroxene covariograms. Now, the kriging procedure allows us to forecast the species of any grain, if needed, given the species of its neighbours.

The existence of rocks with the ranges $r > 1$ leads to the concept of "minimal rock cluster" as the maximal set of mineral grains being at the distances $h \le r$ apart from each other. The possibility appears, for the first time, to consider rock at the grain-by-grain and cluster-through-cluster levels simultaneously.