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On the cluster analysis of grains and crystals in rocks

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ABSTRACT

Cluster analysis has the potential to quantify the size and characteristics of groups or clusters of grains and crystals within a rock texture. We present two techniques: (1) the complete linkage hierarchical cluster analysis (CLHCA) technique that we use to analyze grain-center distributions, and (2) the density linkage cluster analysis (DLCA) technique that we use to analyze grain boundary distributions.

CLHCA applies a cluster algorithm to the distance matrix calculated from grain-center coordinates. This produces a hierarchical cluster distribution that is characteristic of the spatial pattern of the texture. This cluster distribution is normalized to that of a random distribution of points to identify clustered and ordered patterns in the data. The technique successfully identified 3-D cluster sizes from 2-D sections of a modal data set. In the application to real rock textures, the CLHCA of a komatiite cumulate identified a glomerocryst population with cluster sizes in the range of 0.3–2.5 mm, and also a variation of cluster patterns up through the cumulate pile. The CLHCA of a polymodal texture from a pyroxene-scapolite-sphene granulite indicated a clustered distribution for the sphene, which was restricted in growth pattern by the pyroxene and scapolite in the texture.

DLCA computes a single solution of clusters that conforms to the search criteria input into the algorithm. DLCA performed poorly when used to identify distributions of large, randomly packed clusters of small spheres, mainly identifying smaller cluster patterns within each large cluster. Application of DLCA to the komatiite cumulate example indicated cluster lengths of 0.72–0.80 mm similar to the CLHCA results, and an average aspect ratio of 1.52.