



3D-Modeling of deformed halite hopper crystals: Object based image analysis and support vector machine, a first evaluation

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Halite hopper crystals are thought to develop by displacive growth in unconsolidated mud (Gornitz & Schreiber, 1984). The Alpine Haselgebirge, but also e.g. the salt deposits of the Rhine graben (mined at the beginning of the 20th century), comprise hopper crystals with shapes of cuboids, parallelepipeds and rhombohedrons (Görgey, 1912). Obviously, they deformed under oriented stress, which had been tried to reconstruct with respect to the sedimentary layering (Leitner et al., 2013). In the present work, deformed halite hopper crystals embedded in mudrock were automated reconstructed. Object based image analysis (OBIA) has been used successfully in remote sensing for 2D images before. The present study represents the first time that the method was used for reconstruction of three dimensional geological objects. First, manually a reference (gold standard) was created by redrawing contours of the halite crystals on each HRXCT scanning slice. Then, for OBIA, the computer program eCognition was used. For the automated reconstruction a rule set was developed. Thereby, the strength of OBIA was to recognize all objects similar to halite hopper crystals and in particular to eliminate cracks. In a second step, all the objects unsuitable for a structural deformation analysis were dismissed using a support vector machine (SVM) (clusters, polyhalite-coated crystals and spherical halites) The SVM simultaneously drastically reduced the number of halites. From 184 OBIA-objects 67 well shaped remained, which comes close to the number of pre-selected 52 objects. To assess the accuracy of the automated reconstruction, the result before and after SVM was compared to the reference, i.e. the gold standard. State-of the art per-scene statistics were extended to a per-object statistics.

Görgey R (1912) Zur Kenntnis der Kalisalzlager von Wittelsheim im Ober-Elsaß. *Tschermaks Mineral Petrolg Mitt* 31:339–468

Gornitz VM, Schreiber BC (1981) Displacive halite hoppers from the dead sea: Some implications for ancient evaporite deposits. *J of Sediment Petrol* 51:787–794. doi: 10.1306/212F7DAB-2B24-11D7-8648000102C1865D

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