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Evolution of deformation mechanisms in active salt glacier (Qum-Kuh, central Iran)

P. Závada (1,2), G. Desbois (1), Z. Schléder (3), and J. Urai (1)

(1) Geologie-Endogene Dynamik, RWTH Aachen, Lochnerstr. 4-20, D-52056 Aachen, Germany, Fax: +49 (241) 80-92358 , (2) Institute of Geophysics ASCR, v.v.i., Boční II/1401, 141 31, Prague, Czech Republic, e-mail: zavada@ig.cas.cz, (3) Midland Valley, 144 West George Street, Glasgow, Great Britain

Active deformation mechanisms in salt rock are greatly dependent on the structural level of the salt body. An important switch from dislocation creep dominated dynamic recrystallization to solution-precipitation controlled grain boundary sliding (SP-GBS) takes place in salt glaciers fed by vertical stems from the source layer.
In this study we carry out a detailed microstructural study of several samples collected from an active salt glacier (Qum-Kuh, central Iran) to identify the relative contribution of different operative deformation mechanisms in salt at atmospheric conditions. Microstructural investigation comprised microscopical observation of gamma-irradiated thin sections, textural analysis of digitized microstructures using the PolyLX Matlab toolbox, palaeopiezometry on polished and chemically etched thin-sections and mapping of crystallographic preferred orientation using EBSD (Electron Back Scattered Diffraction) method.

Qum-Kuh salt dome is located 150 km SSW from Teheran (Iran). It is 3 km wide and rises 315 m above the surrounding plateau. Extrusion of tertiary salt from source layers 3 and 5.5 km deep was facilitated by a releasing bend in a major dextral transpressive fault crossing the Qum basin. Oriented samples of rocksalt were collected from the top part, middle part (ca. 1 km south from the summit) and western margin of the extrusive body. Sections perpendicular to the foliation and parallel to the lineation were used for further analysis. The salt rock is almost pure halite with up to 3 vol.% of insoluble minerals.
In the top part of the glacier the salt consists of 500 μm large equigranular polygonal grains. Larger grains (> 1 mm in size) have subgrain-rich cores. In the rims of some of the grains, subgrains are elongated and their longer axis directs from core of the host grain towards the margin. This feature is interpreted to result from edgewise propagation of subgrains behind the migrating grain boundaries. Moreover, subgrain-free grains growing at the expense of subgrain-rich grains and growth band cross-cuttings sutured by indented contacts point to grain boundary migration mechanism (GBM) and solution-precipitation creep, respectively.
In the middle part of the glacier, the texture is inequigranular and polygonal. Large grains, which are rich in subgrains, reach the size of 3 mm and are surrounded by smaller grains with about 1 mm in diameter. The microstructure reveals again features indicative for both solution-precipitation creep and GBM.
In the distal part of the glacier, the salt is characterized as a mylonite with elongated grains of bimodal grain size and sub-polygonal grain boundaries. The longer axis of the porphyroclasts is ca. 3 mm and their axial ratio is about 4. Smaller grains reach the size of 700 μm and their axial ratio is ca. 2. EBSD mapping revealed that some of the new grains were derived from the large porphyroclasts by subgrain rotation. Solution-precipitation features are common in this sample and GBM was identified only locally.

The microstructural evolution of the documented specimens is interpreted to reflect: 1) The deceleration of salt flow and stress drop from the salt stem towards the apical part of the dome (edgewise propagation of subgrains by GBM and overall grain size increase from the top towards the middle part of the glacier), 2) Transition from GBM controlled dislocation creep with subordinate SP-GBS in the top and middle part of the extrusion to dominant SP-GBS with subordinate subgrain rotation in the large porphyroclasts in the distal part of the glacier.