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# Pressure solution creep under cyclic loading

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Pressure solution creep is widely known to be an important rock deformation mechanism in diagenesis of sedimentary rocks.

Although a number of papers deal with laboratory and field study of pressure solution

in natural and synthetic materials, the mechanism of the process remains somewhat

obscure. In particular, the role of the intensity, geometry and evolution in time of the stress cannot be exactly quantified in the framework of existing models, because it is likely to act in two opposite ways: on the one hand the stress is the driving force of dissolution, on the other hand the stress may be expected to hinder the process by closing or constricting the paths of mass transfer. Accordingly, it may be inferred that

cyclic variations of stress might provide an efficient deformation enhancement. The nature of the expected effect is likely to be as follows: in low stress periods, transport within the interface is noticeably facilitated in comparison to high stress periods. Therefore during low stress periods, material, which was deformed in previous high stress periods, can be quickly removed and transported out of the interface. Therefore, cyclic variations of stress might provide an efficient deformation mechanism by periodically increasing the internal energy of the crystal via elastic or plastic deformation in high stress phases and reducing the energy via dissolution and transport in low stress phases.

We have extensively studied pressure solution creep in halite and calcite in saturated

aqueous solutions during periodically loading-unloading under various conditions (compaction of synthetic calcite, aragonite and sodium chloride powders, uniaxial compression of cylindrical specimens of natural limestone from Myachkovo, and ball indentation of sodium chloride single crystals).

All the experiments show that cyclic loading leads to an immediate manifold creep rate increase which lasts over the whole period of cyclic impact. After returning to the static regime, the initial low strain rate reappears. Increasing impact frequency (up to a certain level) enhances the effect.

A similar behaviour has been observed on calcite powder filled with a two-phase (hydrocarbon and water) liquid mixture, while any noticeable changes are absent in the pure inert medium (paraffin oil).

The indenter-on-monocrystal test method seems to give the most convincing argument for the pressure solution enhancement as a cause of creep acceleration under variable load, excluding alternative explanation involving powder particles rearrangement etc.

The dramatic effects observed not only may be considered as one of probable reasons for seismic impacts in rocks evolution over geological periods, but also should be taken into account in oil recovery as a mechanism for vibration-induced evolution of pore space in carbonate reservoirs .