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Hydrocarbon-bearing halite in the Ara Group (South Oman Salt Basin)

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The rheological behaviour of Halite is under most geological conditions fully non-dilatant and ductile, whereby porosity and permeability remains near zero and crystal-plasticity is accompanied by dynamic recrystallization during halokinetic movements. In the subsurface Halite has a very low porosity (0.1%), which is not interconnected and filled with brine or gas (Urai et al., 1996). Halite of the Infra-Cambrian Ara Group in the South Oman Salt Basin shows abundant oil-impregnation of grain boundaries, microcracks and intracrystalline incorporation of solid bitumen.

The Ara Group is a late Proterozoic sedimentary sequence, which contains rich hydrocarbon source and reservoir rocks with large accumulations of oil. Rapid flooding of a platform with subsequent carbonate sedimentation followed evaporite deposition, which happened during low stand sea levels. The thick accumulations of Ara Salt contain hydrocarbon-bearing carbonate “stringers”.

The scope of this study is to investigate how oil could have penetrated from the carbonate stringers into the Ara Salt.

The fabric of the studied Halite samples is characterized by a grain shape foliation, which is defined by flattened grains. This halite when decorated by gamma-irradiation shows abundant subgrains. The grain boundaries are impregnated with solid bitumen.

This points to an intrusion of oil into the Ara Salt during dynamic recrystallization.

Using subgrain size piezometry (Carter et al., 1993), the calculated maximum past differential stress for the Ara Salt around the “stringers” is < 2 MPa.

This is in the range found worldwide. Following the dilatancy boundary derived from laboratory experiments by Popp et al., (2001) effective stress must be extremely reduced to achieve dilatancy in salt. Under such low differential stress dilatancy is only possible at near-zero effective stress – i.e. in deep subsurface only under lithostatic fluid pressure. Thus, when halite is allowed to dilate it can become much more permeable than “intact” halite. It will lose its sealing capacity, whereby oil can migrate into the Ara Salt along grain boundaries and microcracks. Our observations point to the presence of Hydrocarbons at lithostatic pressures during the geologic history of these reservoirs.