Magnetic properties and their mineralogical origin of salt rocks

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Abstract: The AMS method is not yet established in salt rocks, because pure salt is very weakly magnetic and therefore thought to be ill-suited for AMS studies. However, in some salt rocks there are ferromagnetic and paramagnetic accessory minerals with strong anisotropy like hematite and clay-minerals which could produce an AMS when they are aligned.

Hematite is a very resistant mineral compared to the easily recrystallizing and soluble salt minerals and the investigation of its alignment using AMS measurements might give additional information on the fabric forming processes. Hematite is also responsible for the red color of numerous salt rocks (*Richter, 1962*). For example only 0,005 weight % of hematite causes a slight coloration in carnallitite (*Urai & Boland, 1985*). Therefore, it could be possible that during deformation a magnetic anisotropy has been generated in these rocks.

We have investigated different non-oriented and oriented salt rock samples, like rock salt, carnallitite and sylvinite, from a salt mine in Sondershausen (Thuringia) and from the Gorleben salt dome (Lower Saxony). The values of the low-field magnetic susceptibility generally increase from white rock salt (-14×10^{-6} SI) over carnallite (98×10^{-6} SI) to red sylvinite (242×10^{-6} SI). A measurable magnetic anisotropy exists in numerous samples which is weak (maximum values: $k_{max}-k_{min}=2 \times 10^{-6}$ SI) but significant. The magnetic susceptibility of the insoluble residue of rock salt samples was 3×10^{-3} SI, of carnallitite 5×10^{-3} SI and of sylvinite 82×10^{-3} SI. This leads us to the conclusion that the residues contain ferromagnetic minerals.

In order to interpret the measured susceptibilities and anisotropies correctly, it is important to know the mineralogical composition and the intrinsic magnetic properties of the accessory minerals in salt rock types. The mineralogical composition of one carnallite sample has been investigated with the electron microprobe. The carnallitite sample is coarse-grained with a maximum grain size of > 5 mm for carnallite. The electron microprobe detected carnallite, halite, polyhalite, anorthite, kieserite and as the only iron bearing phase clinochlore. Furthermore, we analyzed the insoluble residue of rock salt, carnallitite and sylvinite with XRD to determine the accessory

minerals. The detected minerals are anhydrite, polyhalite, kieserite, gypsum, quartz and phyllosilicates. Both methods showed no ferromagnetic minerals.
Nevertheless, we think that hematite is the main high-susceptibility component, because only 0,1 % of this mineral could increase mean magnetic susceptibility about 50 x 10^{-3} SI. This small amount of hematite is hard to detect by XRD or microprobe analysis. In addition to the mineralogical methods we used the IRM method to prove the presence of ferromagnetic minerals. The IRM curves (figure 1) show that high-coercive minerals such as hematite or goethite are the most important ferromagnetic minerals in the salt rock samples.
Additionally we will investigate synthetic single crystals of halite as reference.
Furthermore, high-field torque measurements and analysis of hysteresis-curves are employed to separate the contributions of ferromagnetic and paramagnetic minerals to the measured AMS.

Keywords: (salt rocks, magnetic susceptibility, hematite)

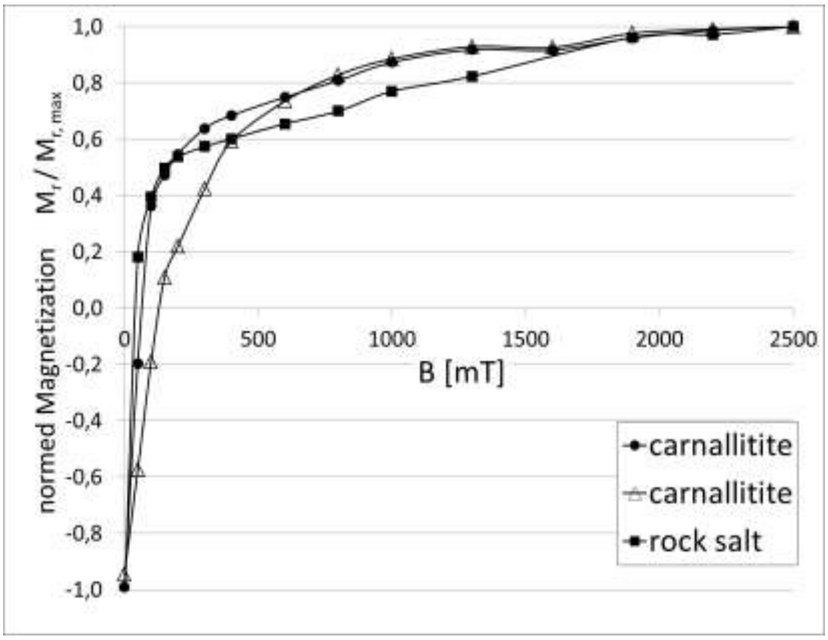

Figure 1: IRM curves of carnallitite and rock salt samples.

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