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NMR relaxometry – a new reliable and non-destructive method to estimate the fluid content of rock salt

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Abstract. In the context of the site selection procedure for a high-level radioactive waste repository in Germany (StandAG, 2017), the fluid content of salt rocks is an important parameter to evaluate their barrier properties, i.e. the potential for gas formation (geoscientific weighing criteria 7 – geoWK-7) and the tendency to form fluid pathways (geoWK-6). Moreover, it can affect hydraulic conductivity (minimum requirement 1 – MA-1, geoWK-1 and geoWK-11), heat resistance (geoWK-8) and rock mechanical properties (geoWK-5), and it can be used for the spatial characterisation (geoWK-3) of the host rock (e.g. Kneuker et al., 2020). Fluids in rock salt (halite) are typically present in small, unconnected inclusions (commonly < 25 µm) located within crystals or arranged along crystal boundaries and fissures, and they can consist of brine, minor amounts of gases and hydrocarbons. When estimating the fluid content of rock salt, the main challenges are (i) the low fluid content (< 1 wt %), (ii) the low permeability of the bulk rock preventing fluid extraction and (iii) the spatial heterogeneous fluid distribution. In summary, the measurements are time intensive, and the results are highly dependent on the sample selection and preparation.

Nuclear magnetic relaxation (NMR) relaxometry is an established petrophysical method in the oil and gas industry for the non-invasive characterisation of hydrocarbon host rocks and their fluids (e.g. Dunn et al., 2002), but it has not been used extensively for rock salt to date. We present the first results obtained from steeply inclined Zechstein rock salt (z2HS2) and compare them with a water content estimated by extensive grinding (< 30 µm) of the salt samples in dried acetone and the subsequent analysis of the extracted fluids using infrared spectroscopy (Mertineit et al., 2022). The first results show that NMR has promising features including (i) a low limit of detection (∼ 0.01 wt %), (ii) non-destructive and (iii) quick (5–10 min) measurements, (iv) no need for extensive sample preparation, and (v) the provision of an average fluid content over a large sample volume (100–900 mL).

References

Dunn, K. J., Bergman, D. J., and Latorraca, G. A. : Nuclear magnetic resonance, Petrophysical and Logging Applications, Pergamon, ISBN 978-0-08-043880-1, 2002.

Kneuker, T., Bartels, A., Bebiolka, A., Beilecke, T., Bense, F., Beushausen, M., Frenzel, B., Jähne-Klingberg, F., Lang, J., Lippmann-Pipke, J., May, F., Mertineit, M., Noack, V., Pollok, L., Reinhold, K., Rummel, L., Schubarth-Engelschall, N., Schumacher, S., Stück, H., and Weber, J. R.: Compilation of objectives for surface exploration as specified in Section 16 of the Site Selection Act (StandAG), 9S2019090000, Technical Report, BGR, Hannover, 2020.

Mertineit, M., Schramm, M., Dlugosch, R., Richter, L., and Furche, M.: Ergebnisse mineralogisch-geochemischer Untersuchungen, Fluid- bzw. Wassergehaltsbestimmungen und in situ ERT-Messungen an der Kurzbohrung 07YER71/RB359, Bereich südlich Lager H, ERA Morsleben, BGR, 9MB140810100, Ergebnisbericht, Hannover, 2022.

StandAG: Gesetz zur Aufsuchung und Auswahl eines Standortes für ein Endlager für hochradioaktive Abfälle, Standortauswahlgesetz vom 5. Mai 2017 (BGBl. I S. 1074), das zuletzt durch Artikel 8 des Gesetzes vom 22. März 2023 (BGBl. 2023 I Nr. 88) geändert worden ist, 2017.

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