Geophysical Research Abstracts
Vol. 15, EGU2013-8385-1, 2013
EGU General Assembly 2013

Dating of polyhalite and langbeinite: preliminary results from German Zechstein

Franz Neubauer, Anja Schorn, Christoph Leitner, and Johann Genser
University of Salzburg, Department of Geography and Geology, Salzburg, Austria (anja.schorn2@stud.sbg.ac.at)

Evaporite mélanges often form decollément surfaces of major extensional and contractional allochthons because of the very low shear resistance of halite. Due to the deposition of evaporites during an early stage of passive continental margin formation, evaporites are commonly overlain by thick successions of carbonates and/or siliciclastic rocks deposited during the main thermal subsidence stage of the passive margin formation. The most common cases of evaporite mélanges are such (1) at passive continental margins, where they are deformed during gravity-driven extension, commonly raft tectonics, in an extensional geodynamic setting, (2) in external foreland fold-thrust belts within a convergent geodynamic setting, and (3) in salt diapirs. In all these cases, halite is strongly deformed by late-stage deformation and only sulphate lenses composed of anhydrite and gypsum preserve early deformational stages. Dating of K-sulphates may allow the recognition of early stages of deformation although this method is poorly applied (Renne et al., 2001). Knowledge of the limitations of K-sulphate chronometers of langbeinite and polyhalite may allow, therefore, dating of full history of evaporite mélanges (for polyhalite, see Leitner et al., 2012).

Polyhalite has the chemical formula [$K_2Ca_2Mg(SO_4)_4 \cdot 2\ H_2O$] and commonly occurs in sedimentary evaporite successions. The mineral can be synthesised under laboratory conditions by a reaction of gypsum with appropriate solutions in the ternary system K_2SO_4–$MgSO_4$–H_2O at temperatures above 70 °C (Freyer and Voigt, 2003). At lower temperatures, polyhalite crystallisation slows down (Wollmann, 2010). In nature, polyhalite, which is stable between $\sim$ room temperature (0–25 °C) and 255–343 °C (Wollmann et al., 2008) or 285 °C (Fischer et al., 1996), most commonly forms early-diagenetically or secondarily (Warren, 2006 and Leitner et al., 2012 and references therein).

The secondary mineral langbeinite [$K_2Mg_2(SO_4)_3$], whose lower formation temperatures are given between 57.1 °C or more commonly 83 °C (e.g. Neitzel, 1992 and references therein), is mined as potash ore at the German Zechstein deposits. Neitzel (1992) summarized two main types of langbeinite formation (1) from kainite and halite (due to thermal metamorphism) and (2) from sylvinitic Hartsalz (= mixture of sylvite, kieserite and halite) due to solution metamorphism. The mineral might also form by decomposition of polyhalite to langbeinite and anhydrite during prograde metamorphism.

In the following, we discuss the first successful results of polyhalite and langbeinite dating in Zechstein salts of Germany (Morsleben, Neuhof). Extremely fine-grained (grain sizes $< 10 \times 10\ \mu$m) recrystallised polyhalite from Morsleben gave an age of ca. 28.68 ± 0.11 Ma, which may represent the age of crystal growth from a brine. Dating of deformed langbeinite from a mylonite zone from Neuhof gave a slightly scattered age pattern at ca. 150 Ma, implying a major step of ductile flow of K-bearing evaporites and crystallization of langbeinite. From analytical point of view, langbeinite is very stable and allows diffusion experiments over a wide range of energies.

References

Fischer, S., Voigt, W., Köhnke, K., 1996. The thermal decomposition of polyhalite K_2SO_4 . $MgSO_4$. 2 $CaSO_4$. 2 H_2O. Crystal Research and Technology, 31, 87-92.

Freyer D., Voigt W., 2003. Crystallization and phase stability of $CaSO_4$ and $CaSO_4$-based salts. Monatshefte für Chemie, 134, 693–719.

Leitner, C., Neubauer, F., Marschallinger, R., Genser, J., Bernroider, M., 2012. Origin of deformed halite hopper crystals, pseudomorphic anhydrite cubes and polyhalite in Alpine evaporites (Austria, Germany). International Journal of Earth Sciences, DOI 10.1007/s00531-012-0836-6.

Neitzel, U., 1992. 100 Jahre Langbeinit. Kali und Steinsalz, 11/1, 7–13.

Renne, P. R., Sharp, W. D. Montañez, I. P., Becker, R. A., Zierenberg, R. A., 2001. $^{40}Ar/^{39}Ar$ dating of Late

Permian evaporites, southeastern New Mexico, USA. Earth and Planetary Science Letters, 193, 539–547.

Warren, J. K., 2006. Evaporites: Sediments, Resources and Hydrocarbons. Springer, Berlin Heidelberg, 1035 p.

Wollmann, G., 2010. Crystallization Fields of Polyhalite and its Heavy Metal Analogues. Ph.D. thesis, University Bergakademie Freiberg.

Wollmann, G., Freyer, D., Voigt, W., 2008. Polyhalite and its analogous triple salts. Monatshefte für Chemie, 139, 739–745.