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BGzEro – backfilling measures with low CO_2 footprint

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Abstract. In Germany, the Federal Company for Radioactive Waste Disposal (BGE) is responsible for the construction and operation of deep, geological repositories. BGE operates the Asse II mine and the Konrad and Morsleben repositories. Initially, these mines were excavated to extract raw materials. As a result, they have large void volumes on multiple levels. The stability of the unfilled cavities is limited in time so that backfilling measures are required for stabilisation. However, there are many requirements to consider when selecting backfill materials.

BGE aims at making its locations climate neutral. Backfilling measures are particularly affected by this effort because of the large material volumes required and the greenhouse gas emissions that are released during material transport and during the entire material production chain. Bulk materials that are produced from the rock debris from the excavation of the respective mine have the smallest carbon dioxide (CO_2) footprint. In order to use this rock debris, this material will be stored in underground excavations and large voids. In order to backfill the underground cavities in accordance with the requirements, the debris will be crushed in an underground crushing plant prior to backfilling. However, numerous cavities in the three mines mentioned above can only be backfilled with flowable, self-levelling and self-hardening materials. Generally, cement-based backfill materials and magnesia binders can be distinguished. The CO_2 footprint of mixtures with cement increases primarily with the proportion of Portland cement clinker. For this purpose, recipes containing high proportions of supplementary cementitious materials such as pozzolan and latent hydraulic additives have been developed. Magnesia binders contain the binders magnesium oxide and/or magnesium hydroxide. Depending on the raw materials and the manufacturing process, different amounts of greenhouse gases are generated during their production. The classic approach is to use magnesium oxide, which is obtained by calcining magnesite ($MgCO_3$). However, a lot of energy is required for this process, and the carbon dioxide content of the magnesite is released.

Due to the extensive experience in the development of backfill materials and emplacement technologies, BGE has entrusted BGE TECHNOLOGY GmbH with the optimisation of the procedures for backfilling and the development of new backfill materials with the lowest possible CO_2 footprint. Thus, raw materials and supply chains have been evaluated and are improved with regard to their environmental performance, taking into account all aspects of transport and logistics. The current focus of work is on the development of magnesia binders with natural brucite (magnesium hydroxide). Another positive aspect is the reduction of heat development of the backfill material during hardening. Furthermore, the reliability of supply for the implementation of the backfilling measures can be increased by a market analysis.

The examples show that BGE and BGE TECHNOLOGY GmbH are on the right track to protect humans and the environment through the safe disposal of radionuclides and the realisation of sustainable, future-oriented technologies.