

Development of a demonstration project for the construction of a compressed air storage in existing disused mining galleries based on geonumerical modelling

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In times of energy transition compressed air energy storage (CAES) is expected to increasingly gain importance as industry moves to greener and more sustainable energy sources and storage capabilities. The requirement for large volumes and very stiff containment for CAES makes subsurface excavations an ideal option for storage. Excavating new subsurface excavations, however, is expensive and resource-intensive, thereby posing a challenge for the use of CAES. With this motivation, this project aims to answer the following research questions: Is it possible to store compressed air inside an already existing, but disused, mining gallery? What are the limiting constraints for this? The results of this study highlight the challenges as well as a methodology to assess the technical and economic feasibility of CAES in disused mining galleries. This study presents an approach to selecting and characterising a disused mining gallery for eventual CAES experimentation, in the underground mining facilities of the Erzberg at the Dreikönig level as a case study, in four phases: The first phase focuses on the challenges of finding a suitable underground location in disused mining facilities. The second phase entails fieldwork, including mapping and characterising the accessible rock mass, mapping the existing gallery support, sampling rock material for laboratory testing, and conducting rapid strength tests on the small samples collected from rock exposures. The third phase is the experimental part in the lab, which is split in the preparation of thin sections, as well as performing non-destructive experiments, e.g. ultrasonic and porosity measurements and destructive experiments, e.g. UCS/triaxial and point load tests. The final phase consists of numerical modelling of the reaction of the rock mass to cyclic loading caused by pressurised air storage and extraction. Once the numerical modelling is completed, the feasibility of the project can be evaluated, as well as the maximum compressed air pressure that can be introduced in these facilities. The key challenges we encountered at the Erzberg are: complex geometry of underground mines, poor condition of support in disused galleries, and lack of access to the rock mass in areas covered by lining. The complex geometry of drifts and stopes in underground mines significantly limits the number of galleries in which to conduct CAES experiments. Support for underground mining galleries is often either non-existent or well below the requirements for safe subsurface work. The often disturbed and altered rock masses encountered in mines provide challenges for rock mass characterisation, such as lack of competent rock for laboratory testing. The methodology we adopted was in response to these challenges and provides a framework for future investigation of disused mining galleries for CAES, as well as other engineering uses.