Preface

Germany has ambitious goals to protect the climate from anthropogenic carbon dioxide (CO_2) emissions as agreed in Kyoto in 1997. This is because CO_2 is held responsible by the majority of scientists for a significant part of the actual global warming. In Germany, an enormous amount of the energy provision is still achieved through, e.g., coal-fired power plants, known for their huge emissions of carbon dioxide. While renewable energy sources are becoming well established, the question remains if the transition to renewables can take place fast enough to largely reduce our greenhouse gas emissions? However, it is to be expected that fossil fuels will still be needed for decades to come. In particular coal is cheap and abundant and will be therefore a significant part of the energy portfolio worldwide in the midterm future. This holds especially true for countries like Brazil, Russia, India, China, South Africa (the so-called BRICS countries), and many more. One solution to the problem is decarbonisation of our coal-based power grid in combination with CCS-technology (Carbon Capture and Storage).

Since 2005, the Federal Ministry of Education and Research (BMBF) of Germany has promoted scientific projects for the development of such technologies in the framework of the Research and Development programme GEOTECHNOLOGIEN. Two GEOTECHNOLOGIEN Science Reports Vol. 6 and Vol. 14 have been published on this topic so far.

Many scientific, technological and safety aspects were investigated since then with regard to CO_2 storage. In recent years, much has been learnt on petrophysical and mineralogical properties of cap rocks like salt or mudstones and from the storage formations, as a base for studies on CO_2-induced alteration e.g. mineral dissolution and precipitation processes. Furthermore CO_2 propagation and fluid replacement processes in the storage complexes and with its gas fluxes in different rocks and formation layers have been modelled with existing and newly developed simulation codes for visualization purposes and to deepen the process understanding. Geochemical and geophysical monitoring techniques have been tested concerning their feasibility to control CO_2 injection and migration and to ensure a safe and long-term storage of CO_2. Various drilling, wellbore assessment and

abandonment technologies have been investigated. In addition, microbiological activities in the deep biosphere and their reaction to CO_2 were studied.

The CLEAN project was planned as a second pilot site in Germany on a research scale to gain experience in this case with enhanced gas recovery (EGR) through the active injection of CO_2 with less than 100,000 t in total into a depleted gas reservoir. Although the permission for the CO_2 storage was not granted by the mining authorities within the time frame of the CLEAN project, many valuable experiments were conducted and excellent results obtained which are highlighted in this Science Report. In that way, the technological, logistic and conceptual prerequisites are provided for implementing a CO_2-based EGR project in the Altmark, and a benchmark is set for similar projects in the world.

Geological storage of CO_2 offers the opportunity to keep enormous amounts of CO_2 permanently out of the atmosphere and the carbon cycle, which are otherwise released from coal-based power generation, from energy-consuming industrial processes (steel, cement) and from burning biomass. To be able to use this innovative technology on an industrial scale in the midterm, more efforts need to be undertaken by governments, scientists and industrial partners. Particular attention should be paid to the permanent and safe storage of CO_2. This focus and projects like CLEAN are prerequisites for the effective mitigation of the climate and the public perception of such new technologies.

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