Preface

Over the next decades global energy consumption will continue to increase. Despite advances in the transition to renewable energy sources, fossil fuels will nevertheless continue to dominate global primary energy consumption and their combustion will further fuel atmospheric carbon dioxide (CO_2) concentrations and global warming. While energy efficiency and increasing share of non-fossil energy generation will contribute to the de-carbonization of the energy system, *Carbon Capture and Storage (CCS)* is the only available technology that allows reducing CO_2 emissions arising from usage of fossil fuels. CCS may be applied to fossil-fuel-based power generation, industrial processes (steel, cement, refineries) and power generation from biomass; in the latter case, CCS may also result in net negative CO_2 emissions. Central to CCS is the secure and long-term storage of the captured CO_2 in deep geological formations preventing the CO_2 from escaping into the atmosphere. Although geological CO_2 storage builds on experiences from hydrocarbon industry and underground storage of natural and town gas, it poses specific challenges on, amongst others, geochemical and geophysical reservoir understanding, reservoir engineering and storage operation, monitoring techniques, material properties, long-term security and risk assessment and management, as well as communication strategies with the different stakeholders. These challenges have to be addressed and solved to ensure industrial implementation readiness of CCS in the near future.

To address these challenges, the German Federal Ministry of Education and Research (BMBF) has initiated and funded several scientific projects for the development of the necessary scientific and technological knowledge base for geological CO_2 storage in the framework of its Research and Development Programme GEOTECHNOLOGIEN. Since 2005, a total of 33 research projects on the different aspects of geological CO_2 storage have been and are still funded within three successive funding periods. Due to this effort, Germany has gained substantial scientific and technological know-how in the field of geological CO_2 storage. From a scientific and technological perspective, the results and outcomes of the different projects lay the fundamentals for secure and reliable implementation of demo-scale projects on CO_2 storage.

In eleven individual chapters, this volume compiles and reviews the main results from the most recent research and development projects on geological storage of CO_2 funded by the third funding period under the GEOTECHNOLOGIEN Programme. The projects concentrate on the development of innovative technologies and processes for the reliable assessment of the operational/long-term safety of potential and existing CO_2 storages. The main goals were the development of methods for the identification and comprehension of security relevant processes of possible weak points (e.g. faults) of the cap rock—from the reservoir to the surface as well as the prognosis of the influence of industrially sequestered CO_2 on reservoir rock and cap rock. Furthermore, experimental analysis of thermodynamic and kinetic data were carried out to model complex reactions between injected CO_2, associate material, natural formation water and mineral phases. In addition, further developments on reactive multiphase transport models were realized. In this context, the analysis of coupled hydraulic and geo-mechanical processes in the reservoir and cap rock with regard to the deformation and mechanical reactions of the cap rock and alterations at the surface are explained in the volume. Furthermore, hydrodynamical reservoir modelling with regard to the replacement of formation fluids to avoid contaminations (e.g. of the groundwater) were developed to ensure the long-term security of a CO_2 storage site. Therefore, the development and realization of effective and efficient technologies to monitor the lateral CO_2 and pressure extension and footprint and the replacement of brines were investigated.

Geophysical methods, numerical modelling procedures, microbiological investigations as well as the development of new optical sensor technologies and their combination will be explained in detail in this volume. Laboratory as well as field studies in Germany, e.g. at the Ketzin pilot site, but also with international partners in Canada and Australia were carried out to merge the already existing expertise in the field of Carbon Capture and Storage (CCS).

In addition to the technical natural science-dominated methods and techniques, social scientists were involved in several projects to evaluate the opportunities and limits for the acceptance of CCS in Germany. On the basis of data from completed projects, using new research approaches to close the existing gaps in acceptance research were investigated. Furthermore, analyses of factors influencing acceptance as well as an assessment of participatory methods were analysed.

Axel Liebscher
Head of Centre for Geological Storage CGS,
GFZ German Research Centre for Geosciences

Ute Münch
Head of the GEOTECHNOLOGIEN coordination office

http://www.springer.com/978-3-319-13929-6

Geological Storage of CO2 – Long Term Security Aspects
GEOTECHNOLOGIEN Science Report No. 22
Liebscher, A.; Münch, U. (Eds.)
2015, X, 245 p. 129 illus., 104 illus. in color., Hardcover
ISBN: 978-3-319-13929-6