Geophysical Research Abstracts
Vol. 16, EGU2014-1868-1, 2014
EGU General Assembly 2014

Fault kinematics and retro-deformation analysis for prediction of potential leakage pathways - joint project PROTECT

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Within the context of long-term CO_2 storage integrity, we determine the seismic and sub-seismic characteristics of potential fluid migration pathways between reservoir and surface. As a part of the PROTECT project we focus on the sub-seismic faults of the CO2CRC Otway Project pilot site in Australia. We carried out a detailed interpretation of 3D seismic data and have built a geological 3D model of 8 km x 7 km x 4.5 km (depth). The model comprises triangulated surfaces of 8 stratigraphic horizons and 24 large-scale faults with 75 m grid size. We have confirmed the site to comprise a complex system of south-dipping normal faults and north-dipping antithetic normal faults. Good knowledge of the kinematics of the large-scale faults is essential to predict sub-seismic structures. For this reason preconditioning analyses, such as thickness maps, fault curvature, cylindricity and connectivity studies, as well as Allan mapping were carried out. The most important aspect is that two different types of fault kinematics were simultaneously active: Dip-slip and a combination of dip-slip with dextral strike slip movement. Using these input parameters stratigraphic volumes are kinematically restored along the large-scale faults, taking fault topography into account (retro-deformation). The stratigraphic volumes are analyzed at the same time with respect to sub-seismic strain variation. Thereby we produce strain tensor maps to locate highly deformed or fractured zones and their orientation within the stratigraphic volumes. We will discuss the results in the framework of possible fluid/gas migration pathways and communication between storage reservoir and overburden. This will provide a tool to predict CO_2 leakage and thus to adapt time-dependent monitoring strategies for subsurface storage in general.

Acknowledgement:
This work was sponsored in part by the Australian Commonwealth Government through the Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC). PROTECT is funded through the Geotechnologien research programme in Germany (grant 03G0797).