An assessment on CO_2 geosequestration in deep saline formations in the Taihsi Basin, central Taiwan

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Abstract

Geological storage of carbon dioxide (CO_2) is to inject and store a large amount of anthropogenic CO_2 in deep and sealed porous rocks in order to mitigate the aggravated threat of global climate changes. Borehole and reflection seismic data are used to understand the spatial distribution of suitable CO_2 reservoirs and cap rocks in the Taihsi Basin, central Taiwan, where the level of seismicity is low.

The Taihsi Basin was a rift basin during the Paleocene to Eocene, followed by a phase of post-rift subsidence during late Oligocene to late Miocene. The loading of the Taiwan mountain belt since late Miocene has turned the Taihsi Basin into a peripheral foreland basin, with strata gently dipping toward the mountain belts in the east. The coastal plain in central Taiwan (Changhua and Yunlin Counties) and its adjacent offshore areas are close to major CO_2 emission sources and no active geological structures are found in these areas, making the study area a favorable CO_2 storage site.

Spatial distribution of formation thickness and depth for CO_2 reservoirs and cap rocks indicates three CO_2 storage systems existed in the study area. They are: (1) late Miocene to Pliocene Nanchuang Formation and Kueichulin Formation (reservoirs)-Chinshui Shale (seals) system (hereafter abbreviated as NK-C system), (2) early to middle Miocene Shihti Formation and Peiliao Formation (reservoirs)-Talu Shale (seals) system (SP-T system), (3) early Miocene Mushan Formation (reservoirs)-Piling Shale (seals) system (M-P system).

The NK-C system contains multiple layers of porous sandstones from Nanchuang and Kueichulin formations, with total thickness around 210-280 m. In the vicinity of the northern bank of the Jhuoshuei River, reservoir top reaches a depth around 1850 m, with 60 m thick seal formation, the Chinshui Shale. However, the Chinshui Shale becomes sand-prone in the Changhua coastal and nearshore areas due to facies changes. The SP-T system consists of two porous sandstone layers from the Peiliao Formation and the underlying Shihti Formation, with thickness spanning in the range of 30-60 m and 40-60 m, respectively. Reservoir top reaches a depth around 2200 m, with average 150 m thick seal formation, the Talu Shale, in the vicinity of the northern bank of the Jhuoshuei River. The M-P system contains multiple layers of porous sandstones from Mushan Formation, with total thickness around 150-300 m. In the vicinity of the northern bank of the Jhuoshuei River and the southern bank of the Wu River, reservoir top reaches a depth around 2700 m and over 3000 m respectively, with 80-150 m thick seal formation, the Piling Shale. However, Mushan Formation

thins southwardly toward the Peikang High and is locally absent in the vicinity of the southern bank of the Jhuoshuei River.

For the NK-C system, although it contains thick reservoirs the seal formation (i.e. the Chinshui Shale) becomes sand-prone due to facies changes, leading to a higher risk of sealing capability. For the SP-T and M-P systems, both reservoirs and seals are all thick enough to contain injected CO_2, excluding a local area in the vicinity of southern bank of the Jhuoshuei River, where reservoir is absent for the M-P system. In addition, north of the study area and close to the Wu River, reservoirs for the M-P system reach a depth more than 3000 m, a depth too deep for storing CO_2 economically. Our results indicate that the SP-T system is the most prominent option for CO_2 geosequestration in terms of depths and formation thicknesses, with M-P and NK-C systems as alternative ones, respectively.

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