Introduction

In 2022, South Korea emitted 557 million metric tons of CO_2 ($MtCO_2$), accounting for approximately 1.7% of global CO_2 emissions, making it the 9th largest emitter worldwide (IEA, 2023). In response to the global push for carbon neutrality, the South Korean government has implemented comprehensive policies to curb emissions. Given the country's limited land availability and challenging climate conditions for renewable energy development, carbon capture and storage (CCS) technologies have become a central focus. Under the national carbon reduction policy, South Korea aims to cut 4.8 Mtpa CO_2 by 2030 and 60 Mtpa by 2050 through CCS. Previous studies have identified several offshore sedimentary basins as suitable sites for CO_2 geological storage (Kwon and Shinn, 2018; Figure 1). Notably, oil and gas exploration has been active in the Jeju, Gunsan, and Ulleung Basins since the 1970s, leading to the accumulation of extensive geological and geophysical data. In the Ulleung Basin, the Donghae gas field, South Korea's first commercially viable gas field, ceased production in mid-2021. Starting in 2028, its depleted reservoirs will be repurposed for CO_2 injection, utilizing existing infrastructure, including platforms and gas pipelines. The Gunsan Basin is also a promising CO_2 storage site due to its proximity to major emission sources, including five coal-fired power plants, and its geologically stable conditions (Shinn et al., 2020). Additionally, the Jeju Basin contains several potential CCS sites, including six basalt flow structures, which play a crucial role in CO_2 sequestration. In this study, considering data confidence levels, we conducted a site screening of the Gunsan and Ulleung Basins using Common Risk Segment (CRS) analysis to assess their potential for CO_2 storage.

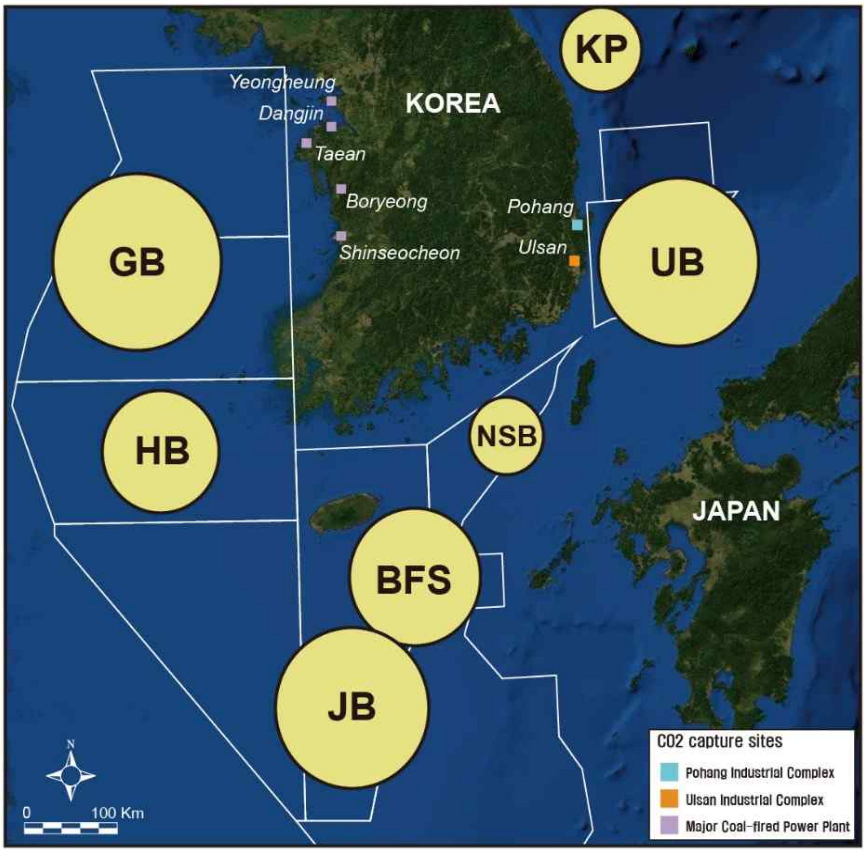

Figure 1 *Distribution of potential sedimentary basins for CO2 geological storage offshore Korea. BFS, basalt flow structure; GB, Gunsan Basin; HB, Heuksan Basin; JB, Jeju Basin; KP, Korea Plateau; NSB, Namhaedo sub basin; UB, Ulleung Basin*

Data sets and method

We utilized 2D multi-channel seismic data acquired from the Gunsan and Ulleung Basins using KIGAM's (Korea Institute of Geoscience and Mineral Resources) research vessel, TAMHAE 2. The seismic data were interpreted using Schlumberger's Petrel software, providing a comprehensive understanding of the subsurface geological features. In this study, we applied CRS analysis to assess the potential for CO_2 geological storage and identify promising areas within the basins. Originally, CRS analysis was a fundamental method for defining play concepts in oil and gas exploration. Notably, Bump et al. (2021) employed CRS analysis to select potential CO_2 storage sites in coastal Texas and Louisiana. The CRS analysis evaluates technical criteria related to subsurface storage feasibility, including capacity, injectivity, and containment, each of which comprises multiple sub-elements. In our study, we considered three criteria with nine sub-elements for the Ulleung Basin and two criteria with four sub-elements for the Gunsan Basin, based on data confidence levels. CRS maps were generated for each sub-element, using a traffic light color scheme: green (low risk), yellow (moderate risk), and red (high risk). Finally, we identified potential CO_2 storage areas by integrating all CRS maps into composite common risk segment (CCRS) maps For the most favorable sites, we estimated prospective storage resources at the sequence scale using the CO2-SCREEN tool, which was developed based on the refined US-DOE-NETL methodology (Sanguinito et al., 2017).

Conclusions

Site screening based on CRS analysis identified three favorable CO_2 storage sites within the Early Miocene formation of the eastern Gunsan Basin: SA1 (North), SA2 (Center), and SA3 (South). Among them, SA1 stands out as the most promising due to its geologically stable environment and substantial sand potential, with prospective CO_2 storage resources of 420 $MtCO_2$ (P50 value). Additionally, the Middle to Late Miocene formations of the southwestern shelf of the Ulleung Basin contains six potential storage sites: MM/LM50-SA1, LM60-SA1 and SA2, LM70-SA1 and SA2, and LM80-SA1. The most favorable sites, MM/LM50-SA1 and LM60-SA1, have prospective CO_2 storage resources of 2,053 $MtCO_2$ and 2,352 $MtCO_2$, respectively.

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