Introduction

Carbon capture and geological storage present a distinctive opportunity for mitigating CO2 emissions and addressing climate change, while also serving as a transformative method for enhancing oil recovery and augmenting the economic value of depleting fields like the Arun Field. However, the injection of CO2 gases into deep geological formations raises concerns about potential leakage paths, including well pathways, cap rocks, geological faults, and fractures. Thus, achieving a comprehensive understanding of effective storage in geological reservoir formations necessitates an exploration of primary storage techniques and trapping mechanisms.This study employs an integrated approach that encompasses reservoir modeling, fracture density mapping derived from well cores, and basin reconstruction via palinspastic restoration to elucidate the formation of reservoir storage and trapping mechanisms resulting from local or global tectonic events. Ultimately, this approach aims to assess the risk associated with potential carbon capture and storage sites.
Focusing on the Arun gas field in the North Sumatera Basin, which has been actively producing hydrocarbons from carbonate lithology in the Arun Limestone Group since its discovery in 1971, this study delves into the factors that influence reservoir behavior, notably pore distribution and carbonate permeabilities. By conducting analyses at both micro and macro scales, the study aims to elucidate why this carbonate reservoir serves as a promising geological carbon capture reservoir. Spatially extensive analyses, including fracture density assessments, are employed to investigate the relationship between physical pore properties, biofacies distribution, and structural deformation within the field. These analyses contribute to understanding the spatial distribution of pore pressure and its potential correlation with fractures, which can significantly impact reservoir quality for carbon storage and the sealing capacity of surrounding rock formations. Furthermore, basin restoration techniques, such as palinspastic analysis, are utilized to reconstruct structural deformation over time, shedding light on the geological processes that have influenced the formation and potential suitability of the Arun Field for carbon capture and storage purposes.

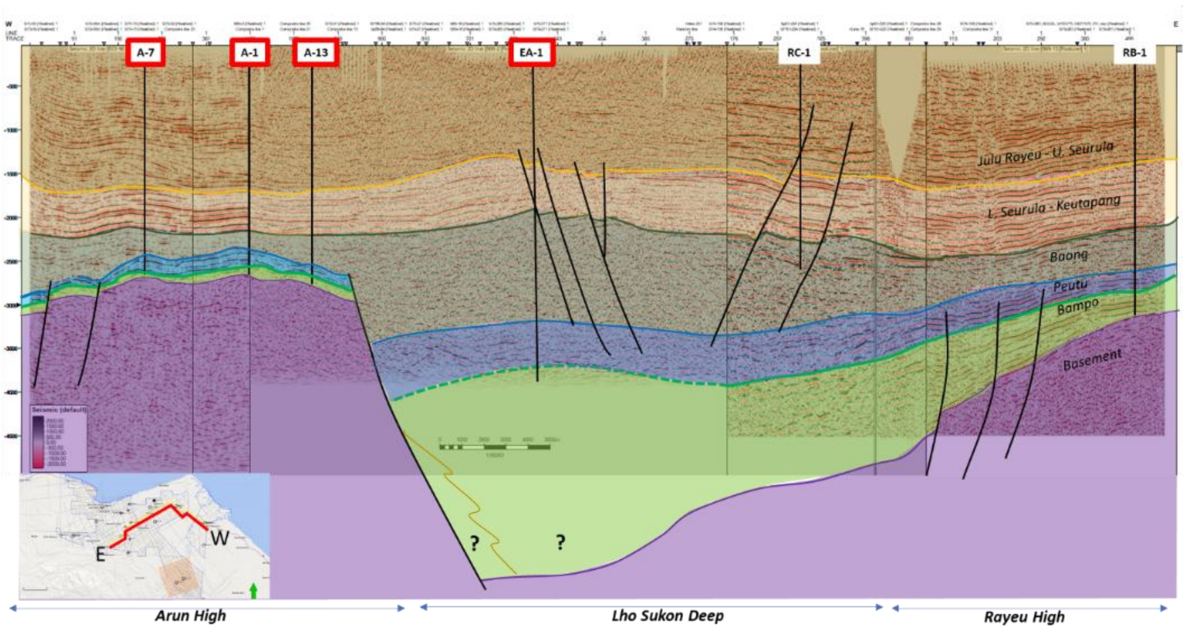

Figure 1,Regional Seismic Section onshore North Sumatra Basin

Geological Framework.

Arun gas field was discovered in 1971 by drilling Arun A-1 exploration well. The field is an asymmetric elongated carbonate build-up sitting on a NNE-SSW trending basement horst block (Grave & Weegar, 1973., Alford et al, 1975, Abdullah & Jordan, 1987). 118 wells have been drilled in the Arun field. The depth of the reservoir is approximately 9,500 – 10,000 feet subsea. The structure is defined by twenty 2D seismic line acquired between 1961-1987. The field is approximately 20 km long and 8 km wide and has productive area of about 23,200 acres (Widarmayana, 2007). The properties of the reservoir are heterogen due to diagenetic processes (Abdullah & Jordan, 1987).

Tectonic setting

The Arun field lies in the North Sumatra Back Arc Basin, formed during the Early Eocene. Marine transgression during the Oligocene led to the formation of the Arun and Lho Sukon horsts.

Stratigraphic Setting

Cenozoic sedimentation, especially at Arun and South Lho Sukon, lies on low-grade metamorphic rock basement. Reefal limestones, such as the Arun Limestone, dominate the Miocene formations.

Petroleum System in Arun Field, North Sumatra Basin.

Source rocks like the Bampo and Baong shale contribute to hydrocarbon accumulation. Middle Miocene reefal buildups serve as prolific reservoirs, sealed by regional shales of Baong Formation.

Conclusion

after the rock forming and genetic has been generated to a schematic model, the fracture density analysis performed and gives an infromation of how this area also stimulated by the fracture growth, this analysis will inform us how the fracture generated and accumulated, and which force are dominant to this fractures by the fracture density widespread. This study shows how integrated analyses may enhance our understanding of fluid-flow pathways, de-risking prospective sites for carbon capture and storage. The method proposed in this work is particularly important to assess the suitability of area with trapped gas pockets and understand tertiary migration in areas proposed for geological storage of CO2

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