Geological Evaluation of the CO_2 Storage Potential and Possible CCS Development in the Central Area of Paraná State, Brazil

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Abstract

The global climate has experienced substantial changes since the Industrial Revolution, resulting in significant impacts. Recent reports from the Intergovernmental Panel on Climate Change (IPCC) show an increase in global average temperature due to anthropogenic emissions of greenhouse gases, including carbon dioxide (CO2). The main cause is the burning of fossil fuels for energy generation, industry, and transportation. This scenario reinforces the importance of limiting the increase in the global mean surface temperature (GMST) to <2°C, and preferably <1.5°C, as recommended by the Paris Agreement (UNFCCC, 2015).

The Carbon Capture and Storage (CCS) is a critical tool to reduce the rate of emissions. It consists of capturing CO2 from industrial sources to prevent its release into the atmosphere, allowing the sustainability of industries such as power plants, cement plants, and steel production.

The present study focuses on the central region of Paraná state (southern region of Brazil). The study area covers approximately 2.7 km2, and its selection is primarily due to its geographical location. It is strategically positioned within the Paraná Basin, where it presents geologically suitable conditions for CCS projects, and is also located in an area of high economic productivity.

The Río Bonito/Palermo-Irati system, which is part of the Gondwana I super-sequence (Carboniferous/Eo- Triassic), exhibits the most favorable geological conditions for this CCS projects. It is located at a depth of 2200- 3000 meters. Although this depth is excessive for CCS projects, it reduces the risk of contamination from leakage in shallower formations like Botucatú Fm, which contains the Guarani Aquifer.

The Río Bonito Formation, favorable for storing CO2, is composed of fine sandstones, siltstones, and carbonaceous siltstones interbedded with coal layers (Bortoluzzi et al., 1987), deposited in a deltaic environment (Northfleet et al., 1969). Regarding the seal, the Palermo and Irati formations stand out. The first one was deposited in a marine shelf environment (Milani, 1997). On the other hand, Iratí Fm represents a hypersaline environment. Under this condition, carbonates, evaporites, and bituminous shales were accumulated (Milani, 1997). Throughout the entire sedimentary column, intrusive igneous bodies are commonly found, consisting of tholeiitic basalts, and basaltic andesites (Peate et al.,1992).

During the development of this project, data from six wells were analyzed. These wells were drilled between 1981 and 1998, and their objective was to discover new hydrocarbon reservoirs. Barra Bonita field discoverer gas and the rest were dry wells with the presence of gas. A preliminary technical evaluation of the geological CO2 storage capacity was conducted on the available data, as well as the analysis of the

presence and effectiveness of the seal rock. Based on data from well-logs, 2D seismic surveys, magnetometry, gravimetry, and prior research in the region, the stratigraphic, structural, and petrophysical characterization were carried out. Then, the volumetric calculation was executed including efficiency factors and probabilistic analysis (P10, P50, P90) essential to evaluate the technical feasibility of the CCS.

In conclusion, this work provides essential information for the decision-making and planning of a subsequent feasibility study, addressing technical aspects related to the injection of CO2 for its geological storage in the studied area.