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Lithological Characterization of the Tremembé Formation (Taubaté Basin, Southeastern Brazil): Integration with Well Logs and Implications for Paleoenvironmental and Paleoclimatic Reconstructions

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Introduction

The Taubaté Basin is a rift-type sedimentary basin located in the state of São Paulo, between the Serra do Mar and Serra da Mantiqueira. It was formed during the Paleogene Period in response to extensional tectonic processes. The basin is filled with predominantly continental sediments, mainly of fluvial, lacustrine, and deltaic origin. The Tremembé Formation represents the Oligocene record of the Taubaté Basin. It corresponds to a lacustrine depositional system and is composed of claystones, organic-rich shales, siltstones, fine-grained sandstones and limestones. The Tremembé Formation is notable for its rich fossil content, including fish, reptiles, birds, mammals, insects, and plants, which suggest favorable preservation conditions, likely associated with bottom-water anoxia in the lake. This study aims to lithologically characterize the rocks that comprise the Tremembé Formation and to develop a paleoenvironmental and paleoclimatic analysis of this interval. Additionally, it seeks to understand how lithological factors influence well log responses, particularly gamma-ray spectrometry, and whether mineralogical factors may control mudrocks structures (laminated claystone, massive claystone or shales).

Method and/or Theory

The study is being conducted on a ~220-meter-long core recovered from the Aligra Quarry, located in the municipality of Taubaté, São Paulo State. The research was carried out in two sequential stages: lithological description, sampling, and subsequent data integration. Lithological description was performed continuously along the entire core, recording features such as lithology, grain size, color (Munsell), and fossil content. Following this stage, a sampling plan was developed based on three main criteria: (1) peaks and troughs in the gamma-ray spectrometry profile, (2) lithological type (massive claystone, laminated claystone or shale), and (3) representative vertical distribution within the core. The collected samples were then analyzed using X-ray diffraction (XRD) and X-ray fluorescence (XRF).

Results and Conclusions

Lithological description of the core allowed the identification of three main lithotypes: massive claystone (65%), laminated claystone (28%) and shale (7%). These lithologies predominantly exhibit a grayish olive-green color (5GY 5/2; Munsell), followed by dark grayish yellow brown (10YR 4/2) and light grayish yellow brown (10YR 6/2) tones. These lithological variations suggest potential mineralogical, depositional, and redox changes, likely driven by paleoclimatic and paleoenvironmental fluctuations. Preliminary results indicate that mineralogy may also play a role in the development of different mudrock types. These variations may also reflect alternating phases of lacustrine shallowing and deepening. Detailed mineralogical and sedimentological analyses are essential to distinguish the relative influence of these factors on the evolution of the Tremembé Formation. The integration of geological and geophysical data enabled correlations between lithological changes and regional paleoenvironmental and paleoclimate. The integrated interpretation of results provided a better understanding of depositional dynamics and supported geological interpretations within the Taubaté Basin.