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Application of Portable Gamma Spectrometry for the Analysis of Electro-units in a Newly Drilled Core in the Resende Formation (Resende Basin, SE Brazil)

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Introduction

The Resende Formation, the most representative unit of the Resende Basin (RJ), comprises alluvial fan and fluvial deposits attributed to the Eocene. Located within the Continental Rift of Southeastern Brazil (RCSB), the basin lies upon Precambrian metamorphic rocks, including gneisses and migmatites. Gamma-ray spectrometry, a technique that records the natural emission of isotopes such as ⁴⁰K, ²³²Th, and ²³⁸U, allows lithological characterization in the subsurface and advances stratigraphic interpretation. However, its application to the Resende Formation, specifically within the homonymous basin, remains limited. This study aims to apply gamma-ray spectroscopy to identify electro-units and enhance the understanding of the stratigraphy of the Resende Formation.

Method and/or Theory

A portable RS-230 BGO gamma-ray spectrometer from Radiation Solutions was used to perform the measurements. This equipment quantifies the radiation dose rate (nSv/h) and concentrations of potassium (K in %), uranium (U in ppm), and thorium (Th in ppm). The measurements were carried out in the first stratigraphic well-core drilled in the Resende Basin, approximately 410 meters long, with 30 cm intervals and an acquisition time of 180 seconds per point. A succession of stratigraphic electro-units was interpreted based on variations in the concentrations of K, Th, and U, as well as on elemental ratios among these components. These observations were compared with sedimentological descriptions from the well core.

Results and Conclusions

Gamma-ray spectrometry data interpretation led to the identification of seven distinct stratigraphic electro-units (top to bottom – E7 to E1). Three main lithostratigraphic units were recognized from the base (409.8 m) to the top (0 m) of the cored interval: the crystalline basement (E1), the Resende Formation (E2-E6), and the Quaternary cover (E7). The first major transition occurs between the crystalline basement (E1), composed of metamorphic rocks from the Ribeira Belt, and the sedimentary deposits of the Resende Formation (E2). Contrary to what is expected, within the Resende Formation, high gamma-ray signatures are associated with feldspar-rich conglomerates, whereas low gamma-ray signatures are associated with mudrocks, as indicated by sedimentological data. Above the basement contact, Electro-unit 2 is characterized by a minor coarsening-upward cycle followed by a finning-upward cycle. Electro-unit 3 displays a decreasing pattern in radiation dose rate, with events marked by U peaks that may be associated with feldspar-rich conglomerates, as inferred from the similarity between Th and U profiles. The boundary between Electro-units 3 and 4 is marked by a sharp trough in Th values, associated with a sandstone with carbonate cementation. A small increase followed by decreasing pattern in gamma-ray counts characterizes Electro-unit 4, indicating another coarsening followed by finning-upward cycle. A zigzag pattern in Th and U curves is observed in Electro-unit 5, where increasing peaks indicate feldspar-rich conglomerates and/or sandstones, while decreasing peaks correspond to mudrocks. Electro-unit 6 exhibits an increase followed by decreasing pattern, indicating a coarsening followed by finning-upward cycle. Electro-unit 7 delimits a transition zone with a decreasing gamma pattern, associated with Quaternary quartz sandstone. These findings provide new insights into the stratigraphic framework of the Resende Formation.