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Integration of geological, geophysical, and geochemical data to characterize the Aptian Barra Velha Formation (Alagoas Stage) using drilling cutting samples in a well at Peroba Area, east of Santos Basin

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Introduction

The Barra Velha Formation - BVE (Aptian) retains a special economic interest as the reservoir of Santos Basin Pre-salt. For this reason, many works approach seismic, petrophysical, petrographic, and stratigraphic aspects of this formation. Although there is a wide bibliography, only a few studies use drilling cutting samples for analyses. There are challenges related to this material, such as the representativeness of the intervals, the description of geological structures, and the contamination by drilling fluid. Despite that, as a commonly obtained product during well drilling, it has a high potential to be broadly used to refine the lithological and stratigraphic characterization of rocks, especially when combined with analytical techniques and well logs. The BVE is composed of autochthonous limestones predominated by calcareous or dolomitic carbonates (shrubstones, spherulitites, and laminated limestones) and reworked facies (rudstones, grainstones, and packstones). It also presents siliciclastic or calcareous mudstones and marls. The identification of Mg-clay, dolomitization, and silicification is important because those aspects can affect the desired properties of reservoir rocks. Based on that, the present work aims to integrate geological, geophysical, and geochemical data to characterize the Barra Velha Formation in the well 1-BRSA-1363-RJS at Peroba Area, east of Santos Basin.

Method and/or Theory

The studied material consisted in 91 drilling cutting samples of the well 1-BRSA-1363-RJS, each representing an interval of 3 meters, totalizing 273 meters. The cuttings were washed and dried to remove contamination from the drilling fluid. We performed lithological description to identify mineralogy, structures, and diagenetic features. We executed X Ray Fluorescence (XRF) and X Ray Diffractometry (XRD) analyses, and applied Principal Component Analysis (PCA) with the XRF results on the whole interval and in BVE subdivisions. All the data was compared to open hole well logs to identify trends comprehending physical, chemical and mineralogical properties.

Results and Conclusions

First, we delimited the BVE with the Pre-Alagoas Unconformity (DPA), which was marked by the upward decrease in Spectral K and the XRF results. The changes in trends of Gamma Ray, Density, Sonic, and Free Fluid match well with SiO_2/CaO ratio. In this case, it was important to consider the effect of CO_2, which affected the response of some well logs. This data was used to identify the Intra Alagoas Unconformity (DIA) and separate three zones in BVE: basal, middle and top. The PCA confirms that the basal and top zones have similar environmental settings, while the middle zone has an inverse correlation between CaO and MgO and a strong correlation between SiO_2 and MgO. This trend could be related to Mg-clays, expected at this portion of BVE. However, XRD analyses clarified that this interval does not contain clay minerals. Those results, alongside the descriptions of cuttings, show that this interval has a strong dolomitization and silicification. It implies that the increase in MgO and SiO_2 cannot be interpreted as siliciclastic inputs or presence of Mg-clay, but represent an increase in diagenetic dolomite and quartz. This fact connotes specific conditions that made pores filled with diagenetic minerals, resulting in a low porosity rock. By integrating analytical techniques in cuttings and well logs, it was possible to comprehend depositional and diagenetic characteristics, enriching the discussion of the unusual conditions that generated the Pre-salt's reservoir rocks.