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Stratigraphic discontinuity surfaces in the Upper Barra Velha Formation, Santos Basin: Implications for reservoir quality in the Búzios Field

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The Santos Basin is a passive margin sedimentary basin located on the continental margin of Brazil, bounded by the Cabo Frio and Florianópolis highs. The Barra Velha Formation (BVE) comprises extensive Aptian carbonate deposits, mainly represented by laminites, grainstones, spherulites, and shrubstones (Wright and Barnett, 2015). These deposits were formed in a hypersaline lacustrine environment, exhibiting features related to chemical precipitation. The Lower BVE is bounded at the base by the Pré-Alagoas unconformity and at the top by the Intra-Alagoas unconformity, separating it from the Upper BVE (e.g., Ferreira et al., 2021; Macedo et al., 2021; Costa et al., 2023). Other unconformities occur in the unit, particularly in the upper portion. This study interpreted and mapped the main stratigraphic surfaces of the south-central portion of the Búzios Field, emphasizing the observed erosional truncations. These unconformities and surfaces were interpreted using seismic reflector termination patterns and the depositional trends related to tectonosedimentation in the Pre-Salt succession. The focus of this study is to identify and characterize stratigraphic gaps within the Barra Velha Formation, as observed in seismic data, due to their significance in controlling variations in porosity and permeability in carbonate systems. Well data were utilized to obtain a more detailed understanding of reservoir deposition, while seismic data were employed for the delineation of stratigraphic surfaces. The presence of potential stratigraphic gaps was identified through the interpretation of seismic data. Therefore, this study can aid in the development of genetic models of sedimentation on carbonate platforms, as well as enhance knowledge and improve the understanding of Brazilian marginal basins.

The software OpendTect from dGB Earth Sciences was used for seismic interpretation, utilizing SEG-Y data from 3D seismic surveys and well logging .las files to correlate well data with seismic information for the interpretation of stratigraphic horizons. A range was established for the area of interest, encompassing inlines from 5250 to 6020 and crosslines from 1980 to 3380. This region corresponds to a significant structural high with possible significant stratigraphic gaps. The surface creation process involved interpreting a grid mesh with 8-step intervals in both inline and crossline directions. After completing each grid, it was verified whether the surface was complete and continuous or exhibited irregularities related to non-occurrence and/or erosion. For complete grids such as the Top of the Basalt (TPB), the Pre-Alagoas unconformity (DPA), the base of the Barra Velha Formation, and the Salt Base (DBS) the gridding method used was Full Survey, which involves interpolation of the entire seismic volume. This method is ideal for surfaces without erosion and employs an inverse-distance weighting algorithm. Conversely, for surfaces with erosion in the Barra Velha Formation, such as the Intra-Alagoas unconformity (DIA), the method used was Only Holes, which focuses on outlining more specific areas of seismic data while preserving areas without data (e.g., erosion or non-deposition), using a triangulation algorithm.

The identification of the lateral continuity of these unconformities and the presence of stratigraphic gaps on the surfaces is fundamental for interpreting the geological history of the Pre-Salt succession as well as for recognizing intervals with higher permo-porosity. In carbonates, erosive and prolonged exposure surfaces are fundamental for generating secondary porosity (vugs). The EasyTrace software from Beicip was also used for the interpretation of petrophysical logs, importing .las files from wells and .ascii files of stratigraphic markers. In the south-southwestern portion of the study area, significant gaps in the upper sequence of the BVE occur, which may extend down to the DIA. These erosional surfaces can be easily identified by seismic reflectors displaying erosional truncations. In these areas, there is direct contact between the lower BVE and the Ariri Formation. The origin of these surfaces in carbonate rocks may affect the permeability and porosity of these rocks.