VOLCANIC AND INTRUSION-RELATED STRUCTURES IN THE SOUTHERN CAMPOS BASIN: 3D SEISMIC INSIGHTS

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ABSTRACT: Intrusion-related structures present important challenges to petroleum exploration and production, because they impact the trapping of hydrocarbons in sedimentary basins worldwide. Therefore, it is important to study the occurrence of such structures, including forced folds, vents, and bridges and junctions. Their shapes vary with sill geometry. The structural and stratigraphic frameworks control the overall geometry of sills, and thus the shape of these structures. Typically, the emplacement of igneous sills is associated with forced folds, locally formed to accommodate sill-induced strain, which results in the flexing of the host rock. In the studied area, the forced-fold structures are characterized by seismic sub-circular dome features, overlying saucer-shaped intrusions. Sill length-to-depth ratio gives a quantitative likelihood of the host rock deformation, due to the emplacement of an igneous sill. The literature suggests that when the ratio is greater than 0.5-0.6, the host rock deforms. In this study, saucer-shaped intrusions flex the host rock at a ratio ranging from 0.67 to 0.75. For all sill types, the ratio ranges between 0.40 and 2.26 (0.92 mean). Saucer-shaped sills, approximately 33% of the mapped intrusions, recorded a ratio of 0.48-0.75 (0.63 mean). The ratio for the layer-parallel sills, which account for 47% of the intrusions, ranges from 0.60 to 2.26 (1.26 mean). For the transgressive sills, 20% of the intrusions, the ratio vary between 0.40 and 0.96 (0.63 mean). In this study, 66% of the mapped sills with a ratio between 0.67-2.09 (1.09 mean) have a supra-sill deformation, previously inferred from the seismic interpretation. Interpreted steps, bridges and junctions may suggest the direction of the emplacement of sills, as they are often parallel to axis of sill emplacement. Identified seismic features describe ‘T’ and ‘J’ shaped junctions between some of the intrusions. Sills are associated with the formation of different-type vent structures, as seismic dome-shaped features. These features are characterized by chaotic internal geometries, onlapping overlying reflectors, and basal flat-lying concordant reflectors. The onlapping reflectors suggest a strong relationship with the overburden. The geometry of these vents may suggest focused fluid flow related to fault and dyke feeder structures. Volume rendering and extraction of geobodies combined with multiattribute analysis was an effective technique applied in this study, for interpreting and extracting a sill complex architecture. This study also highlights the importance of spectral decomposition and color blending for tuning frequency analysis, essential to characterize the intrusion-related structures. The emplacement of saucer-shaped sills often favors the development of forced-fold structures. However, our results showed that a sill length-to-depth ratio within the interval of interest may not form a forced fold. This evidence suggests that the formation of forced folds may also be associated with other controlling factors, providing excellent opportunities to further research. The forceful injection of sills often creates a series of local normal faults on the flexed overburden. This type of structures can be economically important as some may act as hydrocarbon traps and compartmentalize petroleum reservoirs.

KEYWORDS: FORCED FOLDS, BRIDGES AND JUNCTIONS, VENTS.