Structural Analysis of Upper Cretaceous Carbonate Using Curvature Attributes, Campeche Sound, Gulf of Mexico*

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Abstract

Campeche Sound, located offshore of eastern Mexico on the continental shelf of the Gulf of Mexico, is the most important petroliferous region in Mexico. Including the giant Upper Cretaceous Carbonate reservoir Cantarell and Ku-Zaap-Maloob oil fields, Campeche Sound production represents close to 80% of the national production of Mexico. At the beginning of Upper Cretaceous, a lowering in sea level, combined with preexisting high relief of the platform margin, is the likely cause of carbonate slope sedimentation in seen in the 3D seismic data volume where the reservoir rock consists mainly of facies of carbonate debris flows deposited on the Yucatan Slope alternating with pelagic deposits. The debris flows consist of heterogeneous carbonate clasts in a carbonate matrix. The formation is diagenetically altered through dolomitization, dissolution, and fracturing. Near the convergence of the North America, Caribbean, and Cocos plates, the study is structurally complex, with significant compression and strike-slip faulting during Late Oligocene to Miocene. The traps include east-west oriented anticlinal structures that are bounded by reverse and thrust faults. The stratigraphic and structural framework of the carbonate reservoirs was interpreted based on 3-D seismic and well data and used to create a 3-D grid for reservoir modeling. For this field, faults are a major control on secondary porosity distribution; therefore, an accurate and detailed fault interpretation is essential for porosity modeling. To enhance our structural interpretation, we applied edge-preserving, structure-oriented filter to the seismic survey, compute coherence, and then enhanced the faults using a modern Laplacian of a Gaussian filter, which also measured fault dip and azimuth. These 3D structural images were then integrated to generate a more precise 3-D model framework.

References Cited


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Geologic Setting

The stratigraphic and well logs for the study area. Reservoir rock to characterize to this study is from Lower Cretaceous to Upper Cretaceous. Generally more intense dolomitization is present in Breccias of the Upper Cretaceous zone. The strata of the formation is diagenetically altered through dolomitization, dissolution, and fracturing. The reservoir rock consists mainly of facies of carbonate detritus deposits on the Yucatan Slope alternating with pelagic deposits. The debris flows consist of heterogeneous carbonate clasts in a carbonate matrix. The formation is diagenetically altered through dolomitization, dissolution, and fracturing.

Data set

The seismic data used was a 3D V3U depth migrated survey, originally the survey had a size of 2635 km2 but was cropped to focus on the field area (557.5 km2). The expected result was after a structure filtering process, then, the structural image will be enhanced to interpret. The first step was to apply an edge preserving structure oriented filtering, as is shown in Figure 1. Afterward, the rejected noise is shown in the figure C. The rejected noise is shown in the figure C. The rejected noise is shown in the figure C. The rejected noise is shown in the figure C.

Figure 1. Location map of the Submarine Campeche Foldbelt which contained large Gulf of Mexico producing fields such as Cantarell and Ku, Maloob-Zaap. The field objective of the project is contained in this area too (After Murillo-Muñeton, et al., 2002).

Figure 2. Stratigraphy and well type log for study area. Reservoir rock to characterize to this study is from Lower Cretaceous to Upper Cretaceous. Generally more intense dolomitization is present in Breccias of the Upper Cretaceous zone.

Figure 3. Basemap of the study area. Information to characterize this reservoir includes a seismic survey and the data from four exploration wells. These data includes well logs, core description, and core studies.
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Methods

Figure 8. In a traditional interpretation workflow, based only on amplitude, it is even possible to see what are the direction and position of the main fault planes, even for an experienced seismic interpreter. The position of the fault plane could have uncertainty, and its spatial continuity can be confusing.

Figure 9. In consequence, the resulting interpreted fault plane, varies easily from line to line, producing a zig-zag fault plane. These zig-zag fault planes are not useful to model into a 3D geological grid.

Figure 10. Using attributes related to curvature, such as coherence, similarity or Sobel filter, as proposed by Chopra and Marfurt (2007) and using a filtrated data, the fault planes are easier to identify. The minor fault planes, that initially could be confusing to interpret are now easy to interpret and follow from line to line.

Figure 11. The result is an interpreted fault plane can vary significantly from line to line, with a better consistency in its interpretation and a minor uncertainty in its direction. These fault planes, interpreted using this technique are easier to model into a 3D geological grid.

Figure 12. The slices generated from the attributes are helpful to identify main faults and possible fracture corridors. It is even possible to identify possible limits that could separate and compartmentalized structures.
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Results

Conclusions
Using a structurally oriented filter can enhance the original seismic data. These filters subtract the remaining noise and preserve the structural characteristics. Using curvature attributes permits the identification of discontinuities that are hard to see using amplitude, such as fault planes and possible fracture trends. These attributes support the seismic interpretation because it is possible to identify the position and continuity of the fault planes. The resulting faults are a structural framework that supports the interpretation of surfaces, such as the top and the base of the reservoirs.

References


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