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Revealing the Strike-slip Fault Planes in the Persian Gulf

M.S. Mirkamali (Amirkabir University of Technology), N. Keshavarz F.K (Research Institute of Petroleum Industry), H. Ramesh (National Iranian Oil Company) & A.H. Najafabadipour* (University of Tehran)

SUMMARY

Semi-automatic approach was applied for revealing strike-slip fault planes within Mid-Miocene Mishan Formation in eastern part of Persian Gulf. The fault planes revealing provides with neural network technology that analyzes data with integrations of selected attributes. The neural network was used for transforming the selected attributes into a new volume attribute, which attributes extracted at a set of sample locations. The fault volume reveals clearly showing a number of continuous fault planes, as concluded from low homogeneous responses joined to generate the fault planes. The more important attribute of the fault volume that seem to give the highest contributions of the faults contrasting is trace to trace similarity, which is low similar response along the fault planes. The fault volume is in general faulting more continuity than the similarity attribute. The inhomogeneous response of the fault planes change stronger along the fault volume than along dip-steered similarity attributes. Comparing the similarity attributes for the fault volume, the contrast at the fault planes is even better than similarities which have a noisier background level. The obtained results show that this faults with small displacements, is normal fault zones and strike-slip movement with NE-SW trend.

Introduction

Faults play an important role as main pathways for fluids in many basins of subsurface. The vertical movements of the Zagros orogeny and Hormuz salt flow in the eastern part of the Persian Gulf are accompanied by the presence of fault zones. Thus, identification of the fault zones provides a better understanding of a regional petroleum system of economic importance in the Persian Gulf, having reservoir properties of Mid Miocene Mishan Formation (Alsouki et al 2008). Various studies have shown that type of strike-slip faults is not easily detectable from the surface either by field observations or high resolution 3D seismic reflection. Some of recent interpretation method has been developed semi-automatically to achieve seismic objects detection such as faults, gas chimneys, salt and channels. Semi-automatic approach is used to detect the faults based on integrations of selected seismic attributes by an artificial neural network. The obtained results based on this method are more consistent and efficient to map fault patterns on the fault volume than on seismic attributes. Only few of the seismic attributes, such as similarity, curvature, dip and azimuth, are particularly useful in mapping structure and shape of geological features of interest. This geometrical attributes that are of interest for fault characterization, presents a different insight into the faults (Chopra & Marfurt 2007).

It is noteworthy that similarity takes into account the amplitude differences between the two trace-segments and comparing of them gives a high response at high structural dips. To decrease sensitivity of the similarity to the structural dip, dip-steering technique has been used tracking event locally. The faults generate surfaces of low response to the similarity as result of sharp discontinuities in local trace to trace, whereas fault detection is the sensitivity to laterally trace features. The fault detection is successful only if trace-segments are located on either side of the fault (Tingdahl & Rooij 2005). In this study, due to the similarity importance to contribute contrasting of the faults, we have compared between the fault volume and the similarity attributes for revealing strike-slip fault planes within Mid Miocene Mishan Formation in the eastern part of the Persian Gulf. Comparing the fault volume for the similarity attributes indicate that the fault volume may reveal many more surface lineaments, because it is sensitive to a different kind of fault character.

Method and/or Theory

The semi-automated approach for revealing the strike-slip fault planes was performed with a thorough analysis of 3D seismic data offshore Iran. To increase data quality, remove noise and improving seismic-discontinuity attribute data, a few filters was utilized. In order to enhancing discriminatory power of the attributes, a dip-steering was calculated to create resulting attributes with less noise. The dip-steering volume was estimated to contain the local dip and azimuth of the seismic events at every sample location. Figure 1 displays the results of using the dip-steering applied to the similarity attributes on time slices. Note that for the dip-steered similarity attribute reduces noise in background and has a high similarity across the faults compared with non-steered similarity. The fault planes revealing provides with neural network technology that analyzes data with integrations of selected attributes. Firstly, a selection of attributes was calculated which have a potential to increase the contrast between faults and the background. To apply the selected attributes, the dip-steered attributes specially, the parameter settings were set such that they are optimally suited to detect the fault zones.

Figure 1 The influence of dip-steering applied on similarity attributes. Time slices through (a) a non-steered similarity, (b) a dip-steered similarity. Note that dip-steered similarity reduces noise in background and has a high similarity across the faults compared with non-steered similarity.

After the selected attribute were extracted a set of sample locations labeled by interpreter in each fault and non-fault class for training neural network. A supervised neural network was then used for training the attributes extracted to transform the new volume attribute. The trained network was applied to the 3D data volume to generate two fault and non-fault probability volumes. On the fault volume for each sample location is a value between one to zero representing the fault probability. The extracted attributes was weighted by the neural network according to their amount of contribute to the contrasting of the faults. The more important attribute (point of view number and weight) that seem to give the highest contributions is trace to trace similarity, which is low response along the fault planes. Figure 2 shows the fault volume that is applied for automatic fault extraction compared with a similarity volume. The fault volume is in general faulting more continuity than similarity attributes. The NE-SW trending strike-slip faults are seen clearly as high inhomogeneous zones on the volume.

Figure 2 Volumes of (a) a dip-steered similarity, (b) a fault. The NE-SW trending strike-slip faults are seen clearly as high inhomogeneous zones on the volumes. The fault volume is in general faulting more continuity than similarity attributes. On the fault volume the contrast at the fault planes is as good as with the similarities. However, the similarity attributes have a noisier background level.

Conclusions

The fault volume reveals clearly showing a number of continuous fault planes, not otherwise visible on the seismic data to interpret as the strike-slip fault within within Mid Miocene Mishan Formation in the eastern part of the Persian Gulf. It can be resulted from the low homogeneous responses joined across the faults to generate the fault planes. The similarity attributes are very useful at separating the fault planes from the background as concluded from lineaments of low similar response along fault. Comparing the fault volume for the similarity attributes indicate that the fault volume can reveal many more surface lineaments, because it is sensitive to a different kind of fault character. The fault volume is in general faulting more continuity than the similarity attributes. The inhomogeneous response of the fault planes change stronger along fault volume than along the dip-steered similarity attributes. Also, on the fault volume the contrast at the fault planes is as good as with the similarities. However, the similarity attributes have a noisier background level. This faults with small displacements, is normal fault zones and strike-slip movement with the NE-SW trend which developed along half-grabens as a result of Zendan strike-slip fault tectonic movements in Zagros sedimentary basin during sedimentation of Mid Miocene Mishan and Upper Miocene- Pliocene Aghajari Formations.

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