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Geophysical Seismic Reflection Method Application to Detect Subsurface Faults and Structures between Nuhr Bin Umr and Zubair Oil Fields, Southern Iraq

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Abstract: Eighteen seismic lines were chosen to completely cover the area located southern east of Iraq, in order to study the actual subsurface structural variations of the Rumaila, Zubair and Qotnia Formations, as well as the present of faults. Three seismic reflectors were identified on the selected seismic sections by making direct correlation between synthetic seismograms of the wells (A, B, C, D, E, F and G) and the seismic sections passing through these wells. Two of these reflectors represent lower and middle Cretaceous; they represent tops of Rumaila and Zubair respectively, whereas the third one which represents upper Jurassic is the top of Qotnia. These reflectors have good reflectivity and continuity along all studied seismic sections. A general bedding inclination towards the northern east regional direction, NW-SE structural sedal between the obtained Nuhr Bin Umr and Zubair structures and three subsurface deep normal faults trending NW-SE and SW dips were noticed at all levels in the investigated area.

Keywords: Seismic profile, Fault, Structure, Nuhr Bin Umr, Zubair

Basement rocks play important role in the formation of structural and tectonic features. Little available information about the depth and lithology of basement rocks represent one of the major geological problems in Iraq. The basement rocks do not crop in Iraq, as well as, the absence of deep boreholes that penetrate the whole thick sedimentary cover. The only available information about basement beneath Iraq comes from geophysical data mainly being the gravimetric, areomagnetic and deep seismic prospecting, (AL-Banna 1999). Igneous (granite, granodiorite, syanite) or metamorphic (schist, gneiss) rocks are probably the origin of complex and faulted basement rocks. These types of rocks were predicted from the study of the outcrop basement rocks at the adjacent countries like Iran, Turkey, Egypt and Arabian shield, Compagnie Generale De Geophisque-C.G.G.1974 interpreted the aeromagnetic map through the application of the Inflection Tangent Intersection (ITI) method. The basement depths obtained by (C.G.G.1974) range between (10-13) Km at the Iraqi-Iranian boundary near the area under consideration. Accordingly, the present study aim is to determine the main subsurface structural features of the lower and middle Cretaceous (Zubair and Rumaila Formations respectively) and the Anhydritic Qotnia Formation (upper Jurassic), especially the structural sedal posited between Nuhr-Umr and Zubair structures and the possible faults occurred and disrupted these formations.

MATERIAL AND METHODS

Study area: The studied area is about (1300) km^2 located at the southern east of Iraq and is covered by recent sediments composing from alluvial and floodplain deposits (Holocene) and Miocene deposits. Tectonically, the considered area was located inside the unstable shelf (Zubair subzone) including two longitudinal structures with N-S trends (Nuhr Bin Umr and Zubair), and several normal faults trending N-S and NE-SW (Fouad 2015, Sissakianet al 2017). Due to the importance of the area location and the possibility of correlating with the adjacent regions, the study area was structurally investigated using seismic reflection method by choosing 18 seismic lines completely covered the area (Fig. 1).

Seismic reflection survey: A portion of the seismic energy striking an interface between two differing materials will be reflected from the interface. The ratio of the reflected energy to incident one is called "Reflection Coefficient-R", which is defined in terms of densities d_1, $d_2$and seismic velocities (V_1, V_2) of the two media as: (Griffin 1995).

$$R = \frac{d_2 v_2 - d_1 v_1}{d_2 v_2 + d_1 v_1} = \frac{Z_2 - Z_1}{Z_2 + Z_1}$$

Where:

Z_1, Z_2: Acoustic Impedance of the first and second media.

In reflectivity series, each reflector is result of the change in acoustic impedance (Z), which gives important information concerning the nature and lithology of the rocks. The (Z) contrast between two media determines the reflected amplitude value. So, high contrast tend to high amplitude (positive R) and vise versa (Sheriff 1980). Tracing of high continuity reflectors (high R) pick-up one or more pulses and then doing a seismic correlation for a given part from the seismic record for certain horizontal distance along all the chosen seismic lines which covered the study area. In many cases, the seismic continuity may be truncated or disappeared due to different geological reasons, such as the existence of faults, or by lithofacies changes. In other cases, seismic record may be of bad quality in which the reflectors may appear after certain distance, and hence it can be acquired phantomely. Splitting of the reflectors (as a result of sedimentary thickness increasing) as observed on seismic sections give more difficulties in selecting the correct one, (McQuillin 1984).

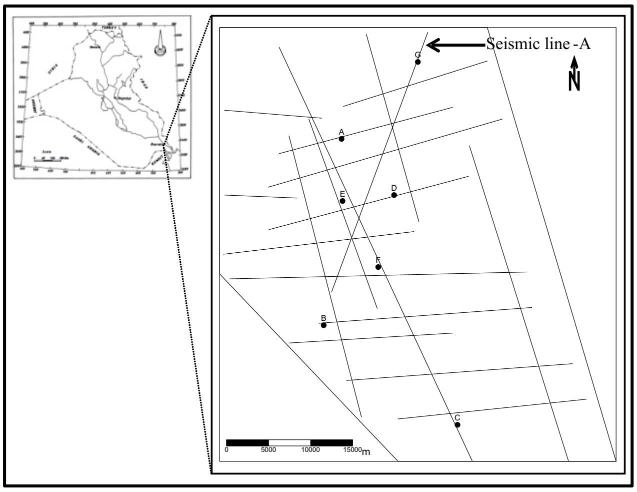

Fig. 1. Location and base map of the study area

Seismic data analysis: Eighteen seismic lines were chosen to completely cover the region of interest. These lines were surveyed by different seismic parties within different adjacent areas. The seismic data processing was carried out at the OEC / processing division, in which the routine methods, migration and coherency steps were used, and hence faults may be detected.

RESULTS AND DISCUSSION

Three seismic reflectors were identified on the selected seismic sections by making direct correlation between synthetic seismograms of the wells (A, B, C, D, E, F and G) and the seismic sections passing through these wells. Two of these reflectors represent lower and middle Cretaceous, they represent tops of Rumaila and Zubair respectively, whereas the third one which represents upper Jurassic is the top of Qotnia. These reflectors have good reflectivity and continuity along all studied seismic sections (Fig. 2). Isochrone and average velocity maps were prepared for the tops of the Rumaila, Zubair and Qotnia reflectors. Then, three depth maps were also plotted accurately relative to the present sea level (Figs. 3-5). It gives similar trends to the isochronic maps because of the little difference in velocities that used in determining reflector's depth. General slopping of structural contour lines toward northern east parts (dealt with the regional bedding of the Mesopotamian sedimentary basin)

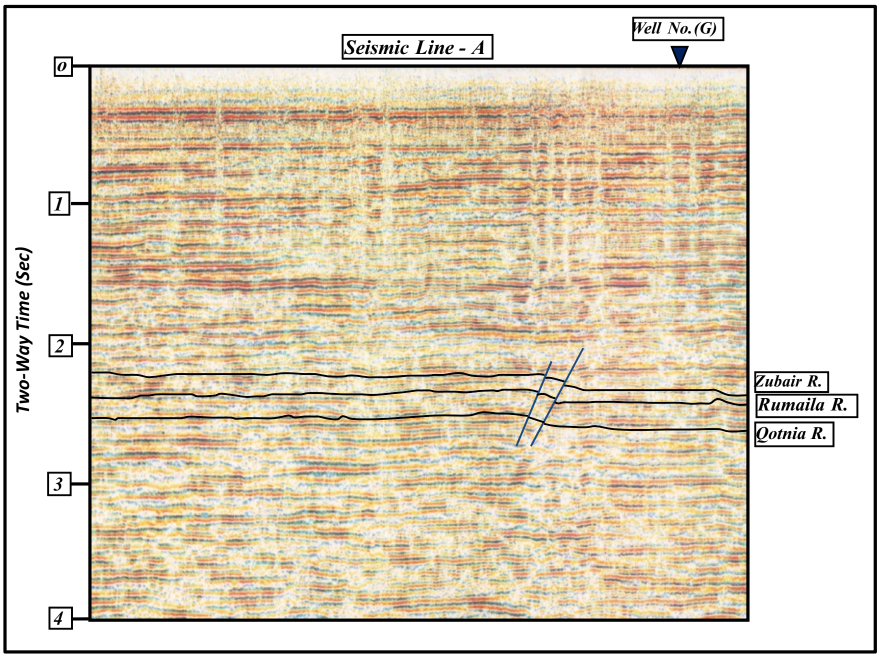

Fig. 2. An example of seismic lines showing the three picked reflectors and faults

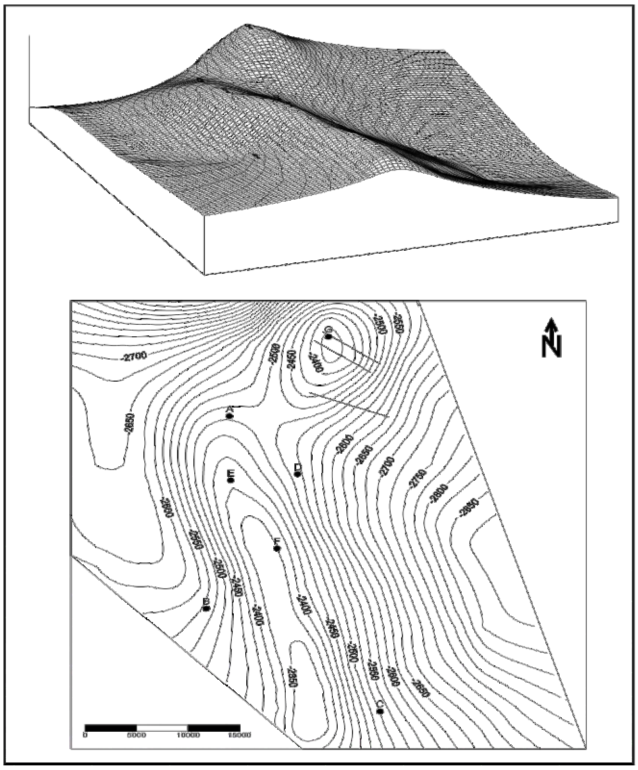

Fig. 3. Depth map of the Rumaila formation relative to sea level

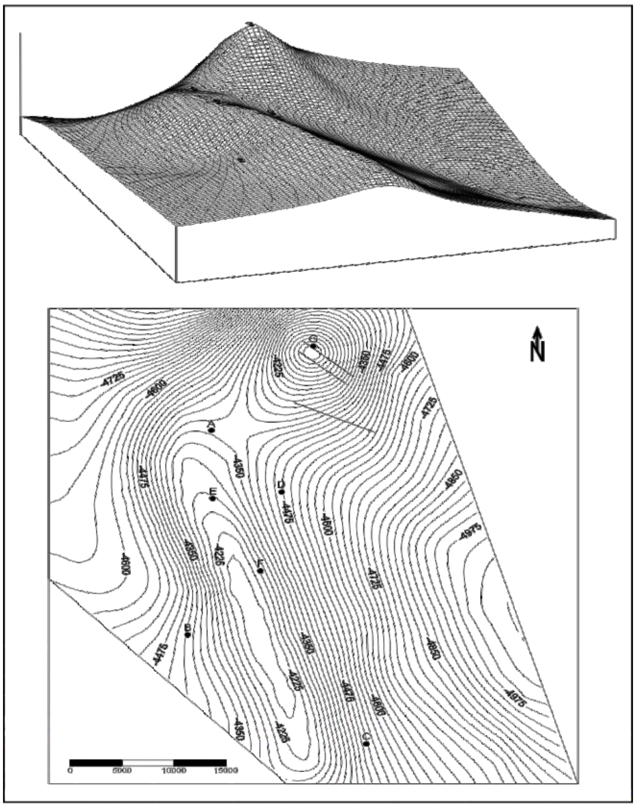

Fig. 4. Depth map of the Zubair Formation relative to sea level

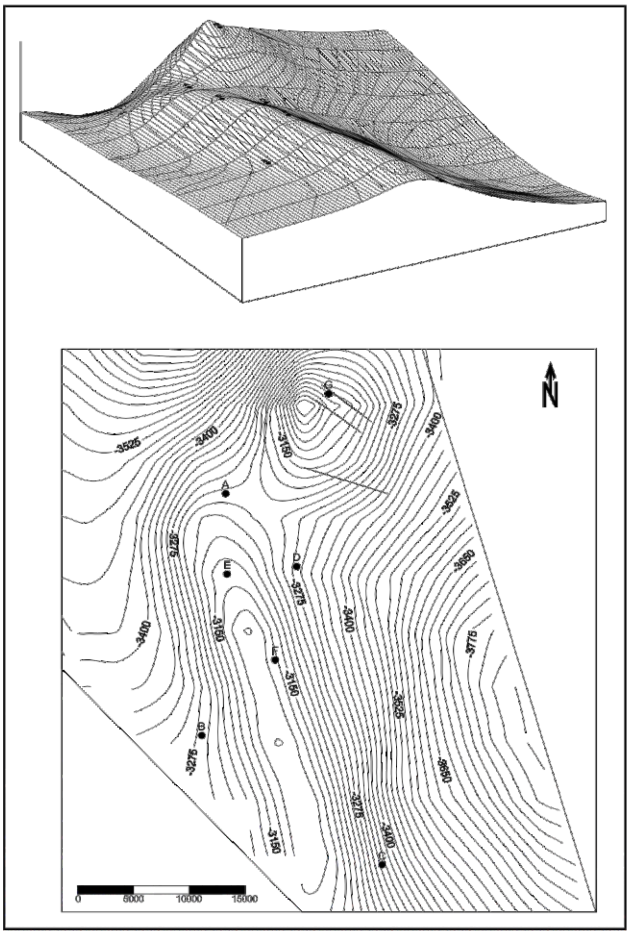

Fig. 5. Depth map of the Qotnia formation relative to sea level

and the presence of the NW-SE sedal between Nuhr-Umr and Zubair structures is noticed (Fig. 3). Subsurface deep normal faults disrupted the above reflectors were extracted from some of the selected seismic sections. They are located at the northern east of the investigated area trending NW-SE and dipping toward SW at all these reflectors.

CONCLUSIONS

Three seismic reflectors were identified on the selected seismic sections. Two of these reflectors represent lower and middle Cretaceous; they represent tops of Rumaila and Zubair respectively, whereas the third one which represents upper Jurassic is the top of Qotnia. These reflectors have good reflectivity and continuity along all studied seismic sections.A general bedding inclination towards the northern east regional direction, NW-SE structural sedal between the obtained Nuhr Bin Umr and Zubair structures. Three subsurface deep normal faults trending NW-SE and SW dips were noticed at all levels in the investigated area. The researchers recommended to obtain potential (gravity and magnetic)/ numerical models, to delineate the basement rocks depth and its morphology along a profile connect between the above structures and compare their results with the seismic results.

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