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Formation evaluation in Dezful embayment of Iran using oil-based-mud imaging techniques

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ABSTRACT

Structural delineation and fracture characterization are two of the main issues for the evaluation of carbonate reservoirs in structurally complex areas. Some of such fields are located in the southwest (Dezful embayment) of Iran. Getting to the Asmari reservoir is not so easy in some cases due to structural complexities where a thick pile of evaporites of Gachsaran Formation overly the reservoir. In such cases structural dip information plays an important role in mapping the structure in the area around the wells. In addition to structural complications, fracture characterization is quite important for Asmari carbonates and in particular for Sarvak carbonates.

In most fields of the Dezful embayment, it is not feasible to drill wells with water-based mud, hence getting information on structural dip and fractures is not so easy with conventional borehole imaging tools. A combination of oil-based-mud imaging tools provided a new way of imaging the characteristics of formations drilled with oil-based-mud. Complicated structures were resolved utilizing the dip data gathered with such techniques. Fractures were characterized for their aperture (open or closed), intensity of fracturing, and directional attributes. The information helped to understand reservoir characteristics of tight carbonates of Sarvak formation. In addition to structural details, the OBM imaging provided quantitative Rxo (resistivity of invaded zone) measurement in oil-based-mud environment. It helped to understand invasion profiles, which generally is a function of permeability, in carbonate and sandstone reservoirs of Asmari Formation, and helped reservoir engineers and petrophysicists to understand response of reservoir formation tester (RFT) measurements for formation pressure and reservoir fluid mobility. The paper describes applications of OBM imaging in Asmari and Bangestan reservoirs of Dezful embayment of Iran.

1. Introduction

The structural style of the fields located in the southern basin of Iran is quite complex due to compression along the northern edge of the Arabian plate marked by Zagros Mountain belt of 200–300 km width (Figs. 1 and 2). It stretches almost 1200–1400 km and crosses most of Iran (Stocklin, 1968; Szabo and Kheradpir, 1989; Tatar et al., 2004). It was caused by Arabian plate's collision with the continental blocks of Central Iran during the Zagros orogeny, which began in Miocene time and continuing today (Stocklin, 1968). It was the strongest tectonic event to affect southwest Iran (Figs. 1–3). So keeping in view the complex nature of structures (like Gachsaran, Agha Jari, Bibi Hakimeh, etc.) comprising the Zagros Mountain belt, precise information on the structural dip and fault pattern in the subsurface is mandatory to plan development/infill wells successfully. In some wells higher than expected thickness of formations is found. In some cases, it is caused by steeper bedding dip and in some it is due to reverse faults. In some cases it is not so easy to determine the exact cause of unexpectedly higher thickness. Apart from structural complexities, it is also desirable to know whether productive fractures are present in a well which is penetrating a reservoir of very low matrix permeability, such as, Sarvak carbonates in the Dezful embayment (Fig. 4). Since most reservoirs in this basin are comprised of carbonates and have a complex tectonics history, therefore the chances of finding good or bad fractures are quite high in these reservoirs and the main challenge is to find out where they are more concentrated in the reservoir and what orientations they have in relation to the structural axis, prevailing

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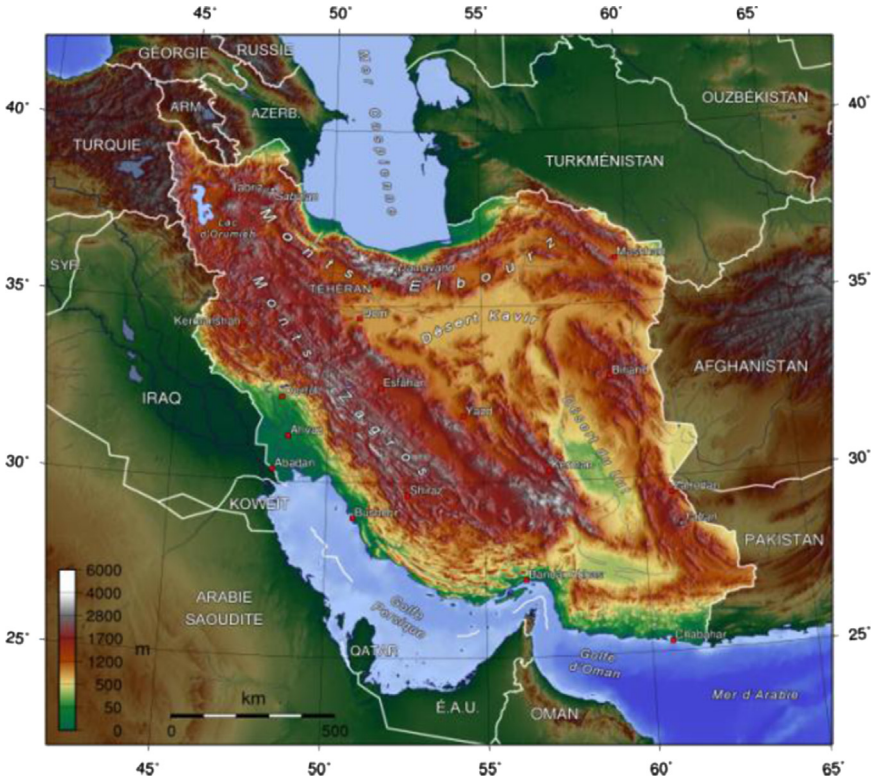

Fig. 1. Satellite image of Iran and part of the Arabian plate highlighting intense folding in the southwest part of Iran.

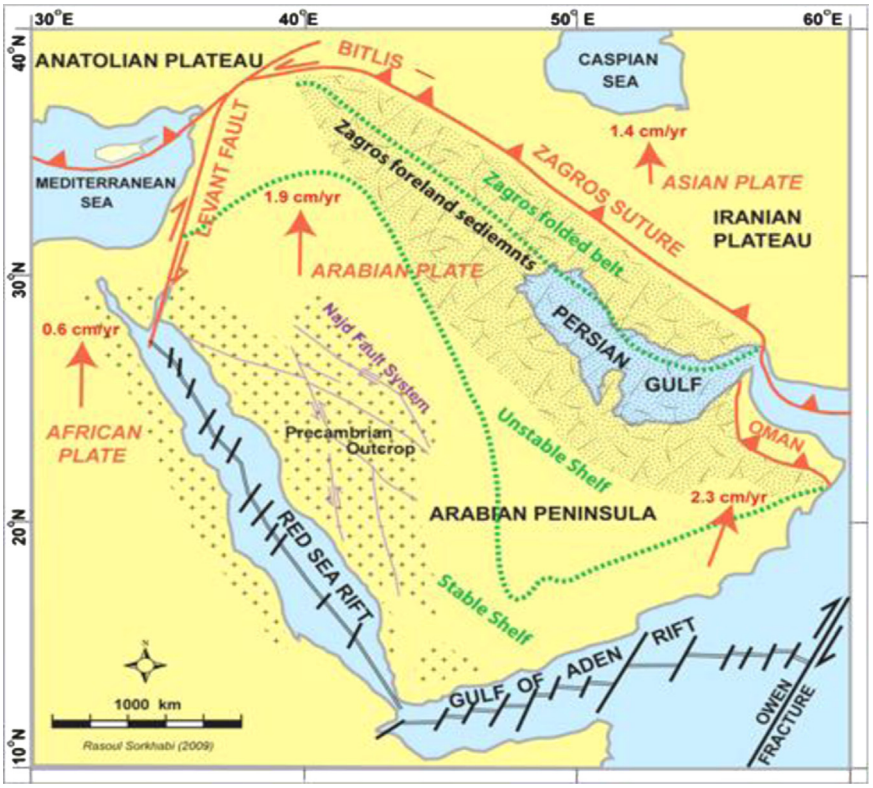

Fig. 2. Tectonics map showing location of Iran between the Asian and Arabian tectonic. Foreland folding in the south west of Zagros convergence and large-scale strike-slip faults are indicated in Iran.

stress regime and gas–oil or oil–water contacts. But, because of certain drilling limitations, it is not possible to always drill through such complex structures and reservoirs with water-based mud. Therefore wells are started to drill with oil-based mud. Which means getting information on structural dip and fracture occurrence through conventional ways (water-based mud imaging) is not so easy. In some cases it is possible but it requires lots of effort and resources to achieve that. In such cases the oil-based mud has