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Evaluate the borehole condition to reduce drilling risk and avoid potential well bore damages by using image logs

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ABSTRACT

By drilling a well, i.e. removal of a cylinder of rock from the subsurface, a disturbance of the natural stress state is created. Where the horizontal stresses are strong and unequal, then the borehole will be subjected to an imbalanced horizontal stress condition. Drilling mud is weighted to create a hydrostatic pressure to balance the formation stress. However, in Iran there are high stresses then stressing anisotropy will remain. After drilling it is important that the borehole stays in good shape if it is to successfully perform its intended function, e.g. produce hydrocarbons. Borehole instability will severely compromise this function and reduce the working life of the well. An evaluation of the borehole condition and the mechanism of borehole failure by using image log tools would clearly help. The tool referred to is the Ultrasonic Borehole Imager (UBI). Currently it is a standard practice to use this tool for a comprehensive structural analysis and fracture characterization; however interpretation of borehole shape analysis needs a lot of improvement. In this study found solution regarding borehole stability by early warning of wellbore instability and improve information about the well condition by working on advanced borehole shape analysis. Image logs showed exactly where the losses are happening and allowed the remedial action to be precisely made.

1. Introduction

Borehole instabilities pose significant challenges to drilling and completion operations, particularly in regions with weak bedding planes and pre-existing fractures where formations have strong anisotropies (Zhang, 2013). Orientations of regional stresses in most part of the Arabian Peninsula (Akbar and Sapru, 1994) is NE-SW for the maximum horizontal stress and NW-SE for the minimum horizontal stress, which is considered as Zagros stress. All Iran and particularly the Zagros mountain front have a strong in-situ stress. The dominant type of horizontal stress is compressive in the direction SW to NE. In this direction, drilling fractures will tend to develop, and is perpendicular to the direction of borehole collapse or breakout due to shear failure in the orientation of minimum horizontal stress, i.e. NW to SE. The Zagros tectonic activity is still continuing to the present day, hence the earthquake activity that is occasionally experienced resulting from movement along faults and folds (Jeffreys, 2005). Present day in-situ stresses acting on the freshly drilled borehole is therefore likely to be substantial (Fig. 1). After drilling in this area, it is important that the borehole stays in good shape if it is to successfully perform its intended function, e.g. produce hydrocarbons. Borehole instability will severely compromise this function and reduce the working life of the well. The acquisition of UBI either at an intermediate stage or immediately following drilling provides an early warning of wellbore instability. If you know what the problem is then you can start to fix it. For example, what type of fracture system is present? Are the fractures dispersed throughout the interval or related to faults? Are they aligned parallel or oblique to the direction of maximum present day in-situ stress? In this study we are going to find a solution regarding borehole stability by working on advanced borehole shape analysis. Image logs will show exactly where the losses are happening and allow the remedial action to be precisely made. So, in this study, our objective is to gain following advantages: (1) early warning of wellbore instability; (2) identification of fractured zones (mud losses), mechanically weak formations and sections where the well is enlarged or restricted; (3) early quick-look data as insurance in the event of subsequent deterioration of borehole conditions; (4) measurement of the mud

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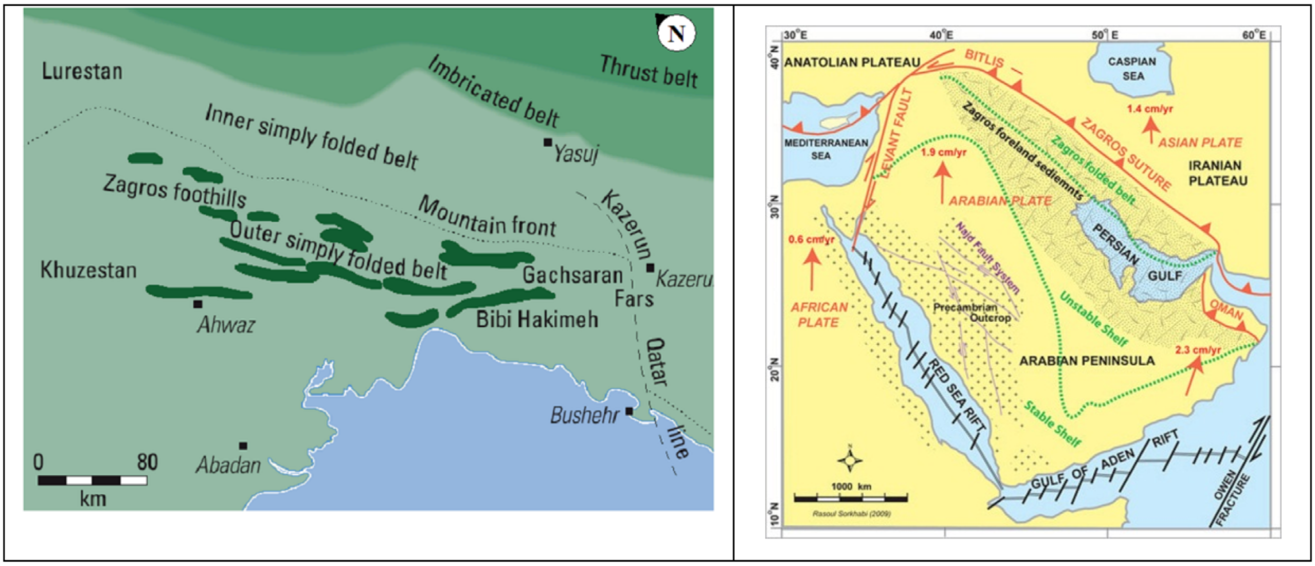

Fig. 1. NW-SE trending major anticlinal structures in the Foreland basin of the Zagros Mountains (left) and Foreland folding in the south west of Zagros convergence and large-scale strike–slip faults are indicated in Iran (right) (Motiei, 1995).

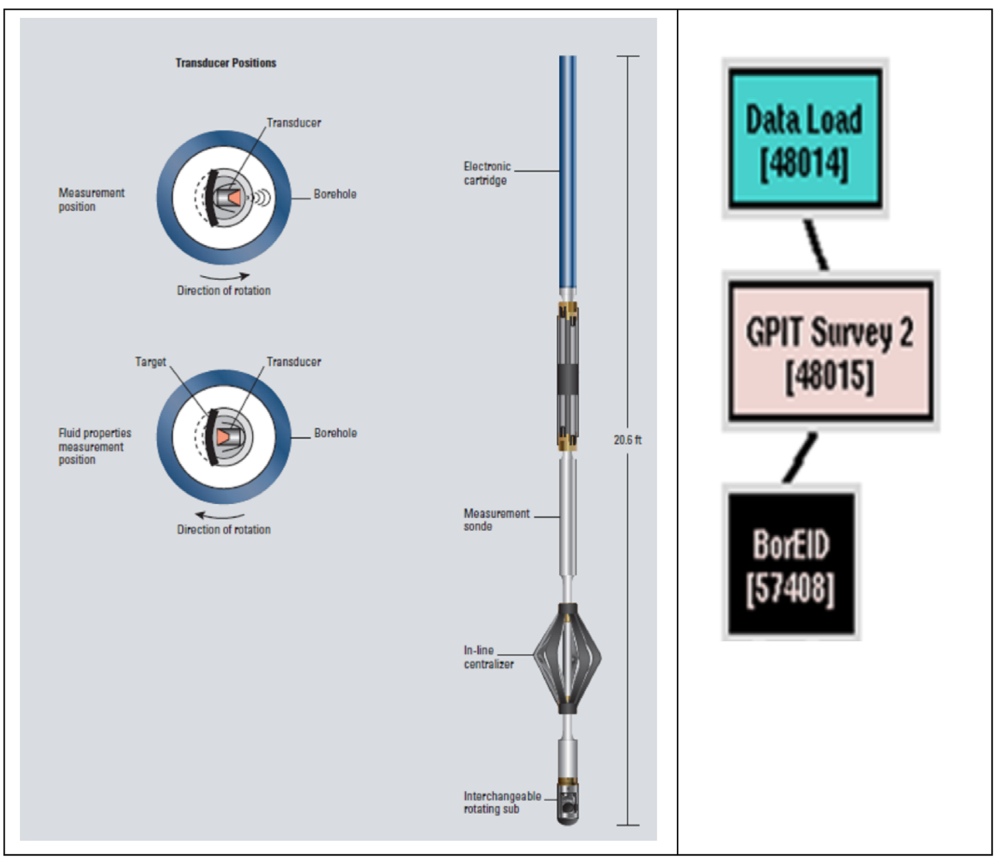

Fig. 2. Sketch diagram showing the direction of rotation of the transducer subassembly controls the transducer position (left) and UBI Image Processing Workflow (right) (Schlumberger, 2002).

slowness, i.e. down hole fluid density; (5) determination of in-situ stress direction and magnitude; and (6) continuous and high-resolution well deviation survey.

2. Used imaging tool and workflow

Geological image logs provide a down hole measurement of the actual borehole conditions. The acoustic tools (UBI) emit ultrasonic echoes that provide a full-bore caliper, i.e. 180 azimuthal samples per depth interval. The UBI tool accurately measures both amplitude and transit time. The processing technique provides improved accuracy, avoids cycle skips and reduces echo losses. The tool operates on two frequencies (250 or 500 kHz); the higher frequency yields higher image resolution, while the lower frequency provides a robust measurement in highly dispersive muds. Acoustic imaging tools utilize a rapidly rotating piezoelectric transducer to emit a focused, high frequency sonic pulse to the borehole wall (Asquith and