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# Application of DSI acoustic log to determine the geomechanical parameters of anisotropy and in situ stress orientation in carbonate reservoirs: a case study in one of the hydrocarbon fields of south-western Iran

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## Abstract

Today, shear dipole sonic measurement is widely used in the oil industry and provides valuable data for seismic interpretation, structural evaluation, and mechanical applications of rock. The data used in this research are taken from Sefid Zakhour in Fars area. In this study, the types of anisotropies resulting from DSI log were calculated and compared with other structural phenomena, leaching and lithology. To achieve this goal, first the shear wave obtained from the DSI tool is divided into two components, fast and slow, then based on the energy difference that these components have, the reservoir anisotropy is determined. The results showed that in the lower depths of the well, the minimum energy in the minimum state and the log in the maximum energy show high values. Anisotropy also increases in areas of fracture and Well fall. The results showed that the areas of the well that are falling have more intense peak waves. Factors affecting the reflection of stoneley waves and the presence of Chevron pattern indicated that well wall falling are the most important factor influencing the formation of Chevron pattern. Evaluation of DSI and FMI about on in situ stresses showed that the maximum direction of maximum stress is along NE-SW10. Also, according to the DSI log data, the maximum directions of NE-SW45 and SE-NW45 were found to correspond to the maximum stress in Zagros.

***Keywords:*** *log DSI, anisotropy, stonely waves, maximum in situ stress*

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**Extended Abstract:**

## 1. Introduction

The DSI tool incorporates new bipolar transmitter technology with the latest advances in unipolar transmitters within a single system and is the best available method for obtaining stonely, shear and compression wave slowness. One of the important parameters of the anisotropic reservoir is calculated by the dipole shear sonic imager (DSI) instrument. Anisotropy indicates a change in one or more properties of matter in terms of direction. Another parameter that plays an important role in the geomechanical analysis of the reservoir is determining the direction of maximum stress. In fractured reservoir rock as well as other reservoirs, in situ stresses can affect the properties of the reservoir and its performance That in this study, two are examined.

## 2. Methodology and Approaches

DSI log have different receivers arranged in linear arrangement at eight receiver stations as well as a single-pole transmitter and two perpendicular bipolar transmitters. The receivers of this tool have the capability of unipolar and bipolar arrangement. The arrangement of the receivers allows for a wider spatial sampling of the entire emitted wave field for complete waveform analysis. It should be noted that the DSI tool is harvested in several modes, each of which is suitable for a specific purpose. In this study, M4, M5, M6 modes have been used to analyze the shear and compression wave slowness, evaluate the waveforms and determine the reservoir anisotropy, as well as to orient the maximum in situ stress.

## 3. Results

By calculating the STC image diagram, continuous diagrams were extracted from the components of compression, shear and stonely waves in terms of passage time relative to depth (Fig. 1). The diagram confirmed that locations of wells that have collapsed have more intense peak wave diagrams. The results show that in the lower depths of the well, the minimum energy is at a minimum and the maximum energy is at a maximum. Also, due to the high fracture density and the presence of chevron pattern calculated from the stonely wave, the lower depths have high anisotropy. FMI data for 140 breakouts were detectable throughout the well plotting interval, indicating the maximum direction of maximum stress along the NE-SW10. DSI data is related to 2101 points in the whole charting range, which shows the two directions of maximum NE-SW45 and SE-NW45 and corresponds to the maximum stress in Zagros.

DSI data is related to 2101 points in the whole charting interval, which shows the two maximum directions of NE-SW45 and SE-NW45. In the studied well, the maximum horizontal stress in most places is equal to the vertical stress and the minimum horizontal stress is less than the horizontal stress. Based on these diagrams, the identified breakouts that indicate the direction of the least stress on the well bore ($\sigma h$) have NW-SE extension and are in line with the usual trend of Zagros (Northeast-Southwest). Also, the tensile fractures that indicate the maximum horizontal stress ($\sigma H$), such as the collapse of the well wall, have a NW-SE extension. In the areas where the borehole wall is affected by breakout and tensile fracture phenomena, the extension of the wall undergoes changes. the azimuth changes of these two phenomena are compared at different depths of the studied well. The changes in the azimuth of tensile fractures in all zones of the well are almost intermittent, while breakouts at different depths have a high amount of changes.

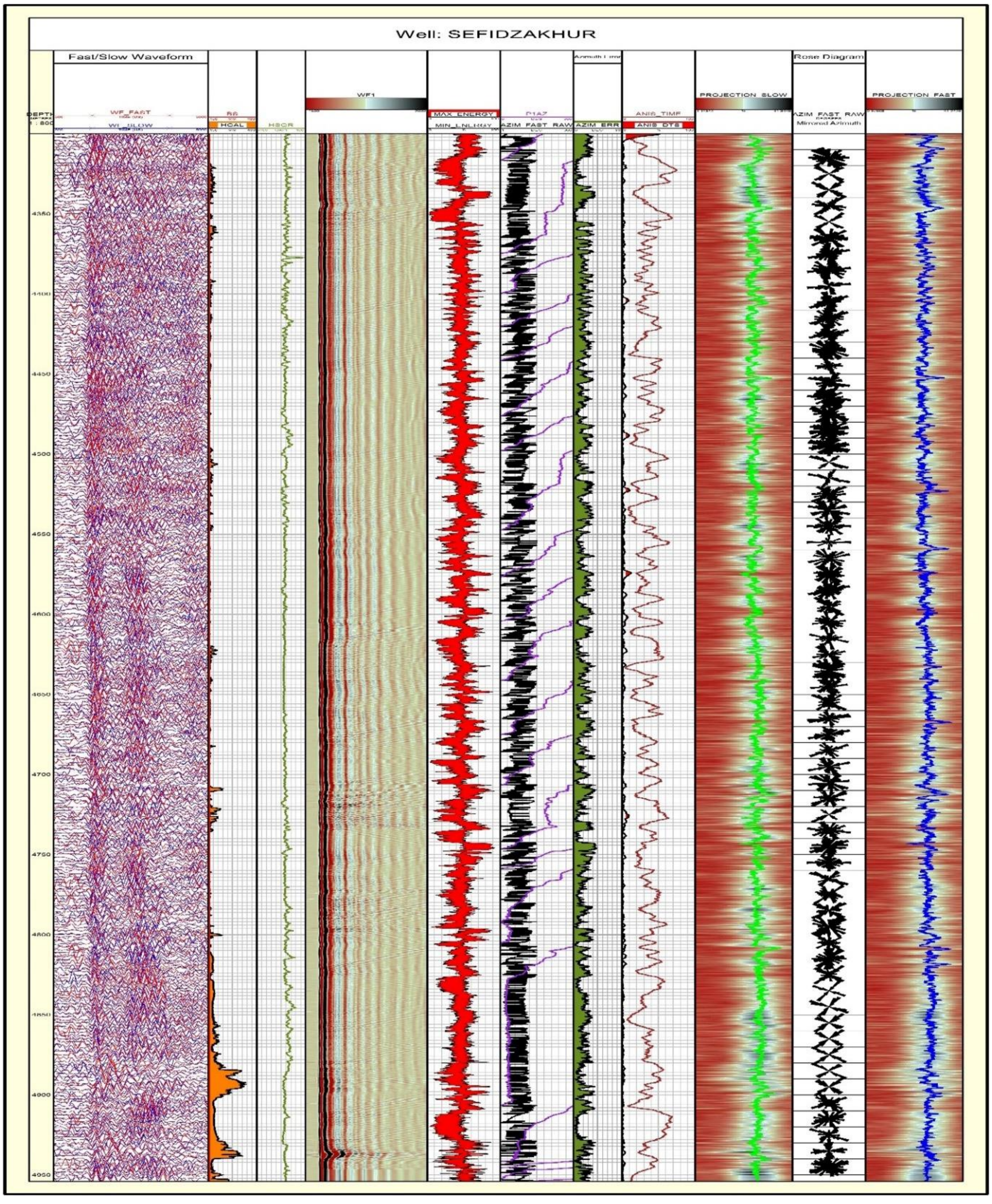


**Fig.1** Extraction of geomechanical parameters in the studied well. Slow and fast waveform diagrams, well wall collapse and gamma, trestles constructions, minimum and maximum energy, tool rotation and maximum direction of stress resulting from Stoneley wave

## 4. Conclusion

In this research, to check the efficiency of DSI sound tool in the field of geomechanical parameters, the data of different modes of this tool were processed and evaluated in one of the wells of Sefid Zakhor reservoir in one of the fields in the southwest of Iran.

By calculating the STC image diagram, a continuous diagram of compression, shear and Stoneley wave components was extracted in terms of transit time relative to depth. This graph confirmed that locations in the well that have dropouts have sharper peaked traveling wave graphs.

study

The orientation of the maximum stress in the field was calculated using the DSI tool and compared with the direction of the maximum stress detected from the FMI graph. FMI data related to 140 breakouts in the entire charting interval from the well could be identified, which shows the maximum direction of maximum stress along NE-SW10. The DSI data corresponds to 2101 points in the entire charting interval, which shows the two maximum directions NE-SW45 and SE-NW45 and corresponds to the maximum stress in Zagros.

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