Microseismic monitoring downhole instrumentation for hydraulic fracture mapping. A review through case histories

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Abstract

The hydraulic fracturing stimulation becomes of prime interest for waterflooding and Enhanced Oil Recovery (EOR). It now plays a fundamental role for unconventional gas plays exploitation such as tight gas.

Therefore he orientation, the extension, and the overall mapping of the fractures are key factors for the evaluation of their efficiency, the further selection of optimum well geometry and location, and stimulation design.

The microseismic monitoring, optimized when placing geophones at the reservoir level, became an established technology applying to hydraulic fracturing treatment as it has now proved to be a valuable tool to map fractures.

Introduction

This paper summarizes the experience accumulated in different locations, including the Middle East, the North Sea, the Americas. where extensive fracturing jobs are carried out to stimulate the oil and gas recovery.

It addresses the difficulty to predict fractures development in various geological contexts from silicilite stringers in salt to turbidites reservoir complexes or shales and shows how microseismic monitoring proves to become an efficient tool for a better understanding of the reservoir structure and behavior and to help improve the production.

Method

The specificity of the presented monitoring surveys stands in the efficiency of deploying sensors at the reservoir level.

Downhole sensors are deployed, whenever possible, in the treatment well itself using tubing conveyed (or behind casing) installations outside the flow, or in observation wells when available in the vicinity, using standard wireline deployment techniques. Combining the two solutions would help fill the gaps inherent to their respective limitations and reconcile both approaches.

Examples

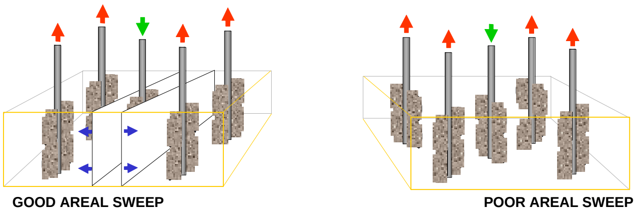

Figure 1 - The highly conductive path generated by fracturing some distance away from the well-bore needs to be imaged in order to control the effective sweep efficiency.

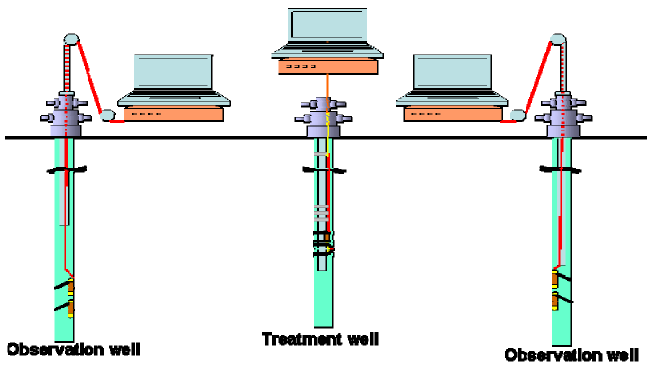

Figure 2 – Example of a survey configuration for fracturing mapping from the treatment well (where the fluids are injected at very high pressures), and observation well

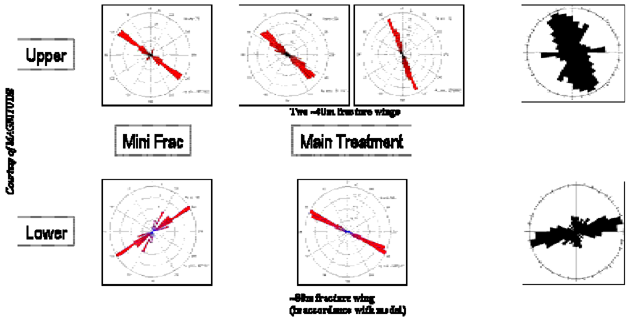

Figure 3 – Fracture orientation analysis from microseismic data and comparison with borehole fracturing interpretation (FMI)

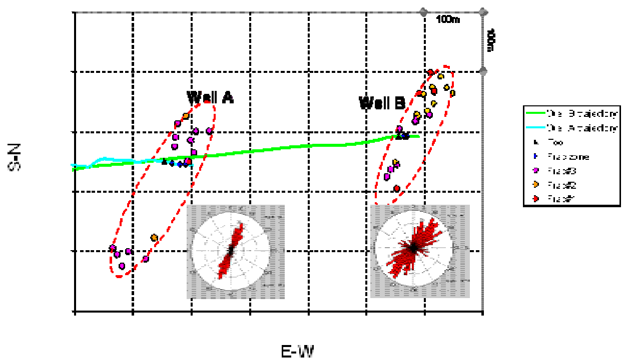

Figure 4 – Example of microseismic events location (horizontal view) The sources distribution shows a consistent orientation (N32°E for well A, N40°E for well B But also a non symetric development of the fractures.

Conclusions

The microseismicity recorded yields to provide consistent orientation, overall geometry and structure of fractures. These results confirm the great potential of this unique approach, as it leads operating companies to improve or review the stimulation scheme for a cost-effective reservoir exploitation.

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