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Intergrated Sweet Spot and Microseismic Monitor to Optimize Reservoir Stimulation: A Wolkflow for Shale Gas, China

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Summary

Research shows, shale gas production impaction factors exist mainly two types, one is seismic factor (e.g. Total organic carbon, brittleness, core pressure, fractures, stress etc.), the other is engineer factors (e.g., micro seismic monitor, fracturing schemes), Single factor, seismic or engineering factors often preferred not guarantee shale gas highly production, only when the most optimal combination of both, can achieve shale gas production maximization. How to integrate seismic and engineering factors for a comprehensive assessment of shale reservoirs it? We tried to find a solution: (1)how to use the geophysics results to guide unconventional hydraulic fracture?(2) how to integrate sweet spot and engineering factors to guide shale gas exploration and development, reducing engineering damage, such as casing deformation, sand blocking, realizing shale gas production capacity maximum.

Introduction

Shale gas production impaction factors exist mainly two types, one is seismic factor (e.g. total organic carbon, brittleness, core pressure, fractures, stress etc.), the other is engineer factors (e.g., micro seismic monitor, fracturing schemes), Single factor, seismic or engineering factors often preferred not guarantee shale gas highly production, only when the most optimal combination of both, can achieve shale gas production maximization. How to integrate seismic and engineering factors for a comprehensive assessment of shale reservoirs? This is a serious problem. In this paper, an integrated workflow of shale gas reservoir prediction and development is proposed.

Method and/or Theory

The new workflow including 3 parts: (1) Pre-fracturing warning. Before the fracturing, using seismic result to provide an early warning, reducing some engineer damage, such as casing deformation, sand blocking, etc. (2) Integrated seismic and micro seismic monitor to adjust fracturing schemes. In the reservoir fracturing site, using seismic attributes and micro seismic monitor to make a real-time optimization of hydraulic fracturing, improving the efficiency of reservoir reconstruction. (3) Evaluation in post-fracturing. After fracturing, looking for the production master factors, and making some modify about well trajectory design, well spacing, section length.

Examples

The study area is located in Sichuan Basin, Sichuan Province, we try to use geophysics results (e.g., fractures, brittleness.) to optimize reservoir stimulation, avoiding some engineering damage.

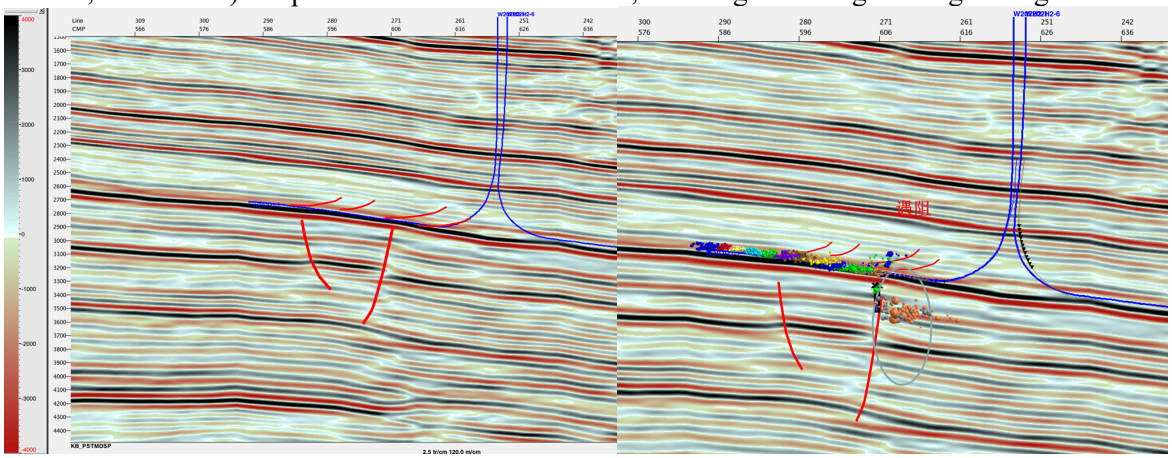

Figure 1 *(a) is seismic amplitude profile crossed the horizontal well, the red line is our interpretation of the fault or tectonic deformation, we can find, there are multiple sets faults or tectonic deformations around horizontal well. During fracturing, these small faults are very easy to be activated, resulting to engineering damages, even case deformation occurs. Therefore, before the hydraulic fracturing, we proposed to reduce the fracturing scale or give up fracturing around these small faults. However, it is regrettable that the fracturing engineer did not adopt our opinion, Figure 1 (b) is the micro seismic monitoring results, a lots big micro seismic events are found in a small faults zone (ellipse direction in the figure), and then, the instruments can't go down next segment fracturing. Finally, the engineer proved that the casing was deformed.*

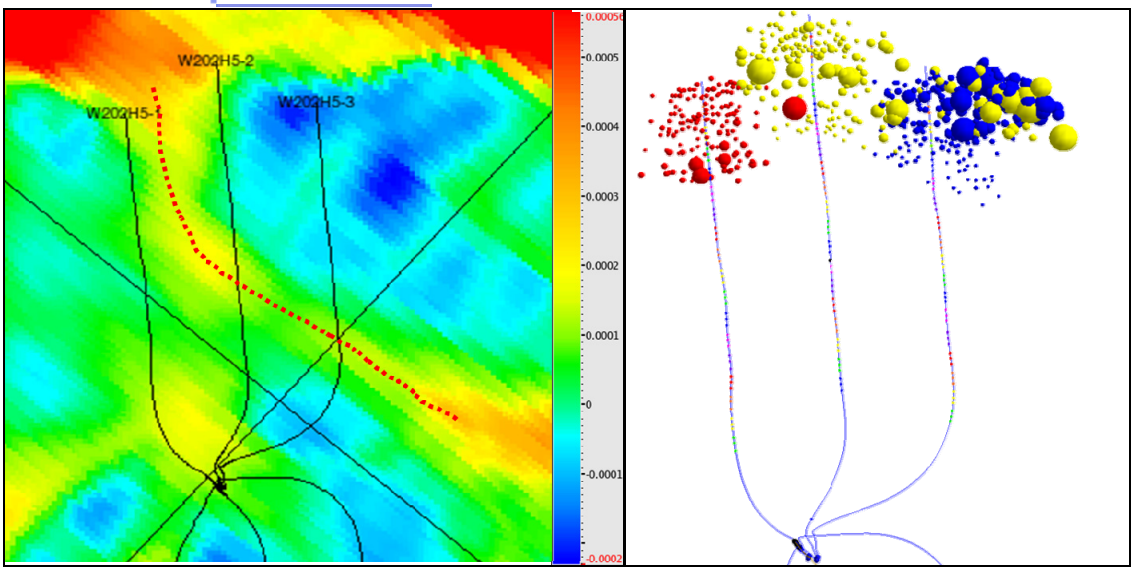

Figure 2(a) *is a fracture attribute horizontal slice, red color indicates fracture developed, blue indicates fracture is not developed. We can find that, there is a cracks strip across the 3 wells. Fig. 2 (b) shows the results of fracturing micro seismic monitoring results at the beginning of fracturing for 3 horizontal wells. It can be found that, micro-seismic events of middle horizon well behind the others. Fracturing engineer suggests that the fracturing sequence should be adjusted, but at the same time, the effect of cracks strip should be considered, otherwise, it will cause casing deformation.*

Conclusions

Integrated sweet spot and micro seismic monitor can be used to optimize reservoir stimulation, reducing engineering damage, realizing shale gas production capacity maximization.

References

Liu Wei，Xu Gang Yu Gang, et al. Natural Fractures Effects on Hydraulic Fracturing: A Case for Shale Gas. 2016 SEG Rock Physics and Borehole Geophysics Workshop, 2016.