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Lessons Learned in Developing a Giant Low-Permeability Conglomerate Reservoir

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Summary

This paper studied a giant tight conglomerate reservoir of a developing history for 40 years. Reasons behind its poor performance were analyzed. Through the analysis, 3 lessons in the past were summarized for similar reservoirs all around the world to learn. Last, the potential remained ahead were pointed out.

Introduction

X reservoir in Karamay oil field, Northwestern China, is a low-permeability (less than 10mD) conglomerate reservoir with oil of over 1.5 billion bbl. Since 1980s, after several rounds of waterflooding and infilling, its recovery has still remained less than 20%. Heterogeneity of the seemed-massive reservoir was gradually realized and studied.

Method and/or Theory

A combination of cores, matrix density calculation, GR logs, MRIs and FMIs of infill wells and seismic tracking was used to establish both the stratigraphic framework and fine depositional architecture. The reservoir was dimensionally divided into independent compartments, which hold different pressure systems and OWCs (Zhang, 1989) (Figure 1).

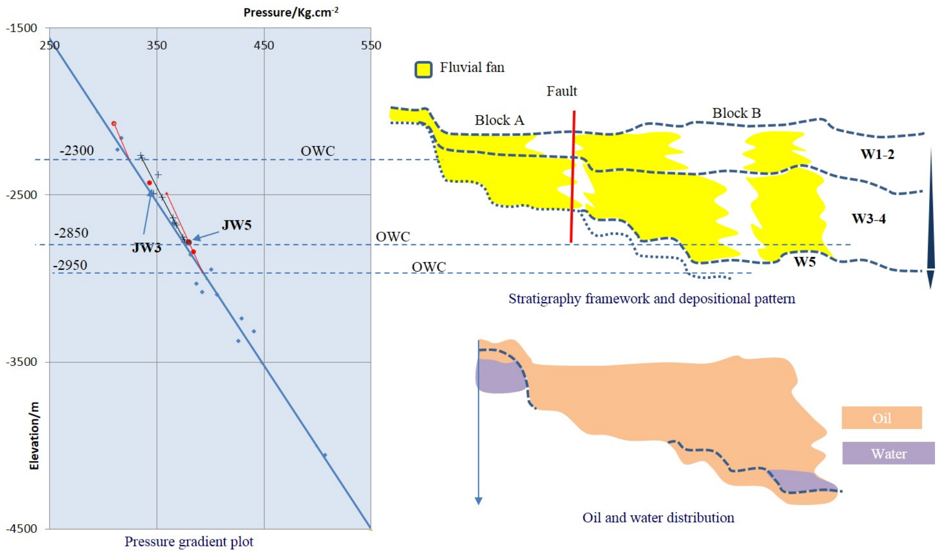

Figure 1 *Reservoir compartments with different pressure systems and OWCs.*

For the convenience of pay quality evaluation, a unified standard based on Archie's saturation equation was established for the whole reservoir with remarkably varying wire-log correspondence (Figure 2). On the other hand, natural and hydraulic fractures were depicted by cores, seismic interpretation, FMIs and conventional logs, along with dynamic data, to analyze the fast water breakthrough.

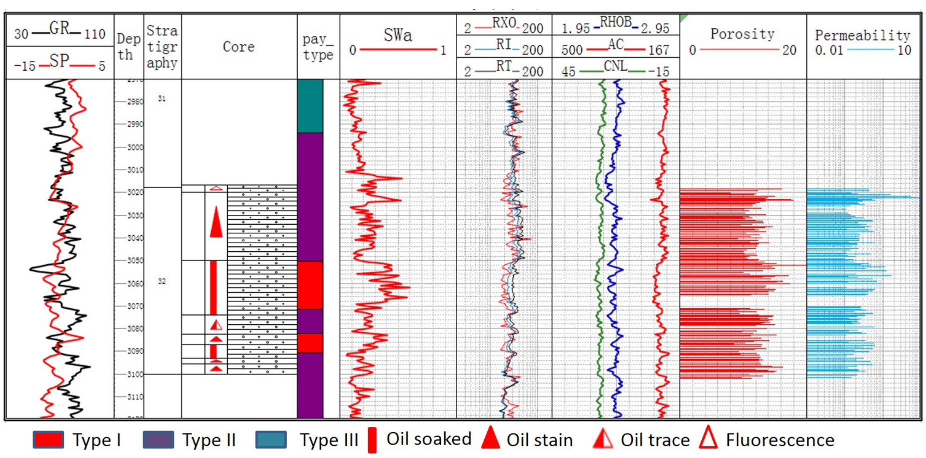

Figure 2 *Reservoir typing according to the proposed parameter SWa.*

Conclusions

3 lessons were learned. First, the giant alluvial-fan complex (average thickness of 450m), relatively homogeneous in wireline logs and cores, is actually highly heterogeneous. An integration of methodologies is necessary for a reasonable compartmentation. Only compared within each compartment, production forecast of pays to be perforated or producers to be drilled could be properly made.

Secondly, its petrophysical properties span a large scope, demanding a comprehensive evaluation of all the plays and applying of different developing strategies to pays with different quality. Pays with good to fair quality could be well exploited by just waterflooding and infilling. Pays of low oil saturation, once defined as dry, are re-evaluated as producible if horizontal well and massive stimulation applied. Furthermore, such “poor-quality” pays generally could rejuvenate an old oil field by a considerable increase of the OOIP.

Third, for a naturally-fractured reservoir with low permeability and bottom water, simultaneously impacted by hydraulic fracturing, water breakthrough by fractures arises as a serious problem. Horizontal fracture passages were triggered by continued water injection into pays with poor permeability; while vertical fracture passages were caused by stimulation near bottom water or areas with high natural fracture frequency. To avoid such problems, the horizontal well with massive stimulation to tap poor but thick pays and stimulation a certain distance higher than the bottom water and away from faults were adopted and corresponding well.

This paper dealt with the case of a naturally-fractured low-permeability reservoir with a developing history of nearly 40y. It points out the possible mistakes could be made, reasons behind the poor performance and corresponding strategy.

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References

Zhang Zhisong. [1989] Several methodologies to recognize the reservoir scale at early stage. Petroleum Exploration & Development, 8, 155-165.