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Through-casing Reservoir Monitoring: Method of Water Investigation in Very Low Water-Cut Wells in Southern Iraq

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SUMMARY

Water production in early field life poses a challenge to field development. This paper describes a study from a giant oil field in southern Iraq where evidence of minor amount of water production was seen in a few wells by monitoring the salt content of the produced well fluids.
With multiple producing layers in the wells, an investigation for the water source then became necessary in order to plan remediation and change future development plans. Limitations on the produced-water capacity in the field required immediate investigation of the source of water.
This paper describes how careful data acquisition delineated the water producing layers in the reservoir.

Introduction

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Method

Initial investigation on individual wells involved monitoring Base Sediment and Water (BS&W) in samples collected from well heads. Alternatively, where BS&W measurement could not be taken at the well head, the measurement was taken by exception when well was shut-in and BS&W measurement was taken at Central Processing Facility (CPF).

For the purpose of identifying the source of water in the wells several cased-hole logs were run. Oxygen Activation (OA) is commonly used in the industry to detect water flow behind the pipe. The rate of its decay can help to identify flow rates, and the shape of the activation spectrum can also help to identify water-flow inside or outside the casing Pulsed Neutron Logging (PNL) tool was run to record OA log to conclusively identify the source of water.

Along with PNL, temperature and capacitance sensors were also run to substantiate the source of water. Where PNL tool could not be run due to operational or other contrainsts, temperature, density and capacitance along with spinners were run to locate the source of water. To ensure that the water was from reservoir and not through channels behind the casing, circumferential cement bond logs were run wherever possible.

While ultrasonic circumferential measurement tools are obvious choice in such cases, limitations were there with tubing internal diameter (ID) being smaller than available ultrasonic tool outer diameter (OD). Radial Cement Bond Log (RCBL) of Halliburton, a sonic tool which comes in two sizes 1.69inch and 3.13inch, and provides circumferential cement map, was hence selected keeping in mind the completion. RCBL of 3.13inch OD was used in one of the wells to rule out possibility of water through channel behind casing.

Example

PLT was run in one of the well which started cutting ~5% water. This well was completed comingled in Nahr Umr and Zubair reservoirs. Two sublayers of Zubair were producing through casing, and the Nahr Umr reservoir which lies behind the 4 ½" tubing, was producing from SSD (Sliding Sleeve Door) through tubing. It then became necessary to identify which of the perforated intervals were potential source of water production. In order to rule out possibility of flow behind the casing, RCBL (Radial Cement Bond Log of Halliburton) was run in the well. This confirmed presence of good cement across the circumference of the borehole.

An increase in flowing pass radioactive density (DENR) was observed across Zubair A perforation indicating flow of heavier fluid. At the same time, capacitance (CWH) showed a drop which confirmed the heavier phase to be water entering the wellbore from this perforation. Contribution calculated from hold-up measurements matched the surface water-cut. (**Error! Reference source not found.**)

Conclusion

After identifying the water producing interval, the Zubair sands were plugged by setting a temporary plug in the tubing and the well is currently flowing dry oil from the Nahr Umr interval through SSD.

A comprehensive field-wide cased-hole data acquisition has been planned as a part of routine reservoir surveillance to understand the changes in reservoir behaviour through the producing lifespan of the field.

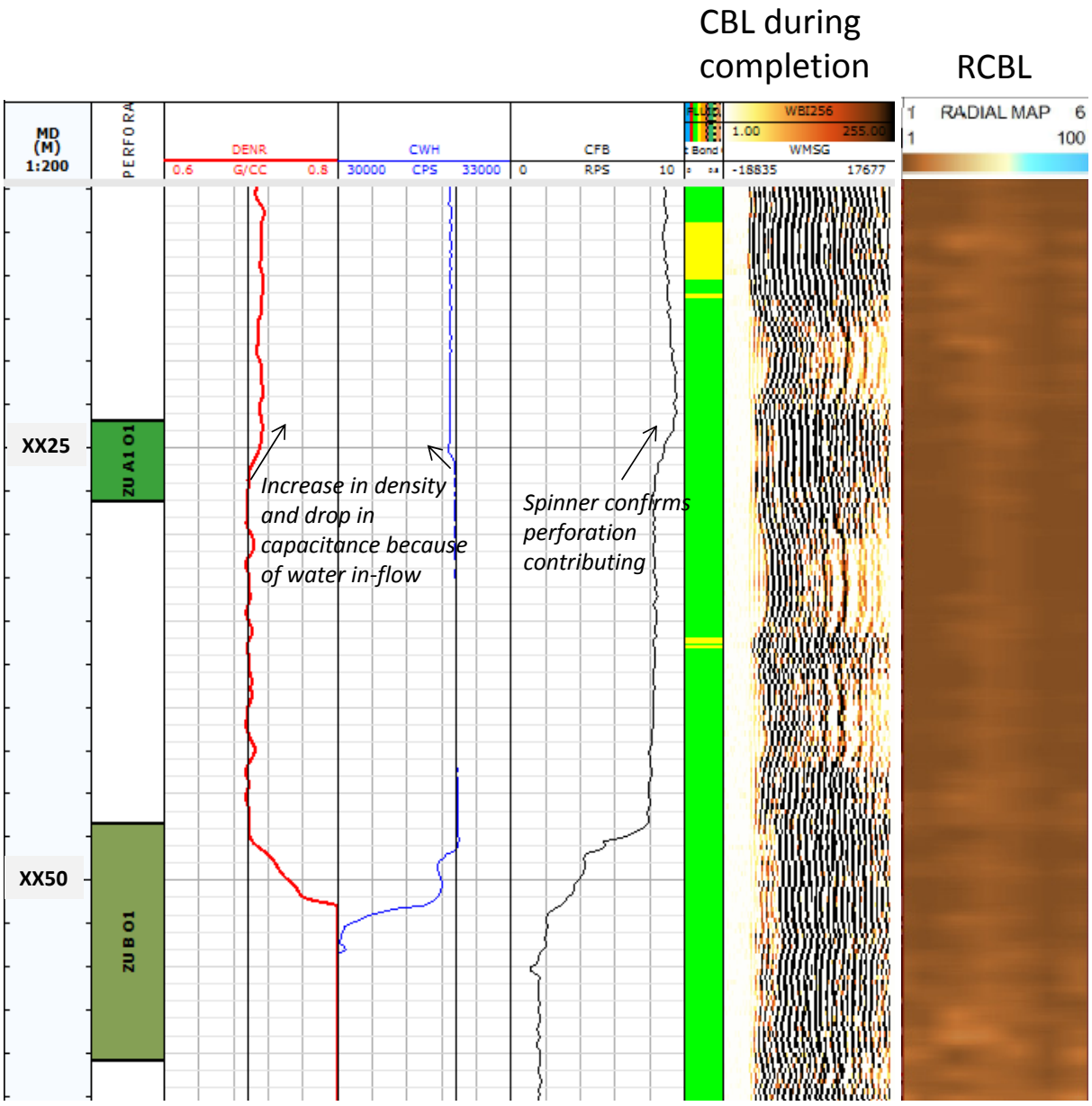

Figure 1 *The figure shows drop in capacitance reading and rise in density measurement across Zubair A perforation in the discussed well. This can be conclusively interpreted as water. Further calculation of Hold-up suggested an amount of water flow which could be matched at the surface water-cut. RCBL confirmed that there was no channel present behind the pipe. Hence, the water is from the reservoir.*