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Interwell Fluid-Front Monitoring Optimizes Injection, Oman

PDO monitors fluid movement with DeepLook-EM service's reservoir-scale resistivity surveys

CHALLENGE

Monitor waterflood conformance and sweep in an Oman field with high fracture density and thief zones.

Solution

Conduct time-lapse surveys with DeepLook-EM* crosswell electromagnetic imaging service to track fluid displacement within the reservoir.

Results

Confirmed success of waterflooding, with large volumes of water swept and indications of remaining oil to be produced.

Tracking injection in a challenging environment

Recovery by Petroleum Development Oman (PDO) from a field was limited by high fracture density and high-permeability thief zones. Five spot water-injection pilots were installed, targeting two reservoir layers, but conventional methods of measuring fluid movement were hampered by the wellbore scale of the data, which required interwell interpolation.

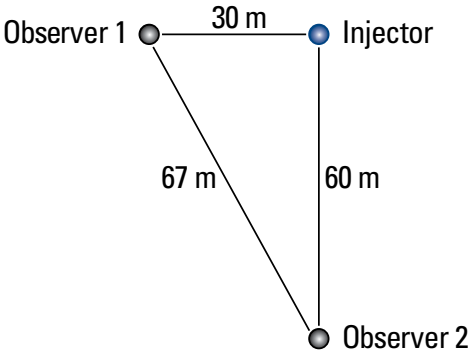
Imaging resistivity on a reservoir scale

DeepLook-EM crosswell electromagnetic imaging service was selected to pioneer fluid-front monitoring in the Middle East. DeepLook-EM service provides reservoir-scale resistivity images between boreholes up to 1,000 m [3,280 ft] apart. Conducted as time-lapse surveys, the images from DeepLook-EM service track fluid displacement within the reservoir without the uncertainties introduced by extending single-well data to field scale in a heterogeneous reservoir.

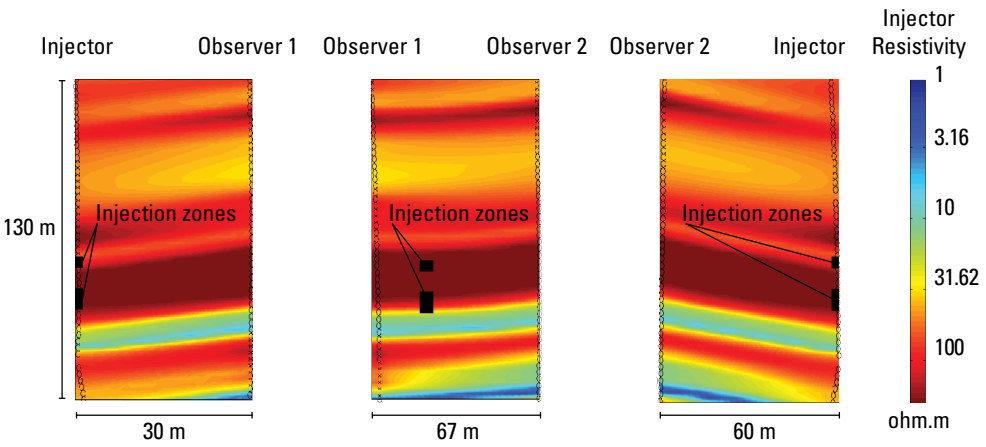
Confirming and optimizing the water flood

The survey geometry involved running the DeepLook-EM service tools in two observer wells relative to an existing injector well. The close well spacing provided a high-resolution view for monitoring.

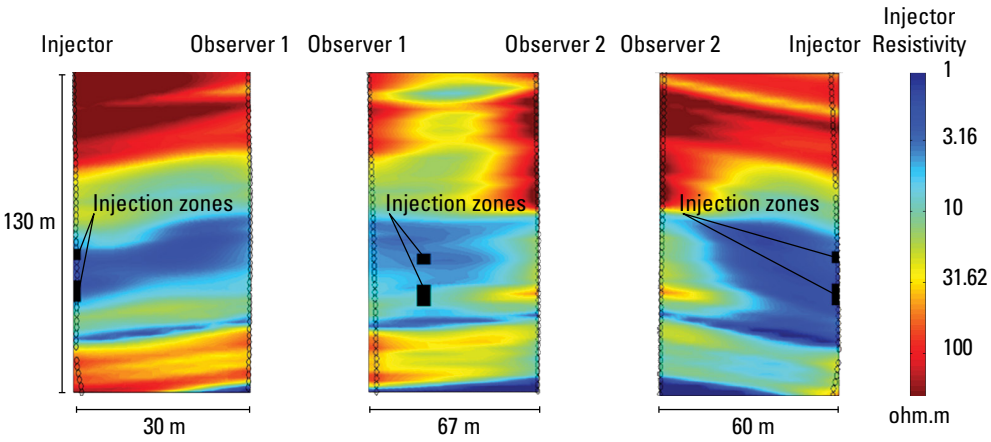
A model of the reservoir was constructed from conventional wireline resistivity measurements made before injection. From this baseline, the time-lapse analysis of DeepLook-EM service's resistivity imaging over a year of water flooding indicated successful movement of a large volume of swept water, which was consistent with the injection volumes and production results. The results also suggest that there could be remaining oil to be produced, and the injection strategy can now be optimized to extract the bypassed pay.



DeepLook-EM service's transmitter and receiver tools were run in two observer wells and an injector to monitor water injection.



A baseline model of the three wells was constructed from conventional wireline resistivity logs made before initiating the water injection.



The images obtained with DeepLook-EM service after water injection clearly show the large volumes of water swept within and outside of the injection interval.

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