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FMI-HD Microimager Identifies Vugs and Fractures in High-Resistivity Carbonate, Permian Basin

Clear images of secondary porosity features and natural fractures obtained across the dynamic resistivity range

CHALLENGE

Clearly image potential zones of secondary porosity and find natural fractures in a high-resistivity carbonate interval in the Permian basin.

SOLUTION

Run the FMI-HD* high-definition formation microimager to obtain borehole images with significantly improved visibility and interpretability for all environmental conditions, including extreme variations in formation resistivity or resistivity anisotropy between the formation and mud.

RESULTS

Easily identified vugs and fractures from sharp image rendering even in formation resistivities exceeding 500 ohm.m.

Conventional imaging ambiguity

Key evaluation objectives for an extended interval of high-resistivity carbonates in a Permian basin exploration well were to identify and characterize potential zones of secondary (vuggy) porosity and the presence of natural fractures. However, in intervals with high resistivity, the low signal of conventional imaging tools amplifies the noise and results in blurry images with ambiguous features. The operator needed better quality imaging for evaluating the porosity and visually quantifying fracture orientation and density.

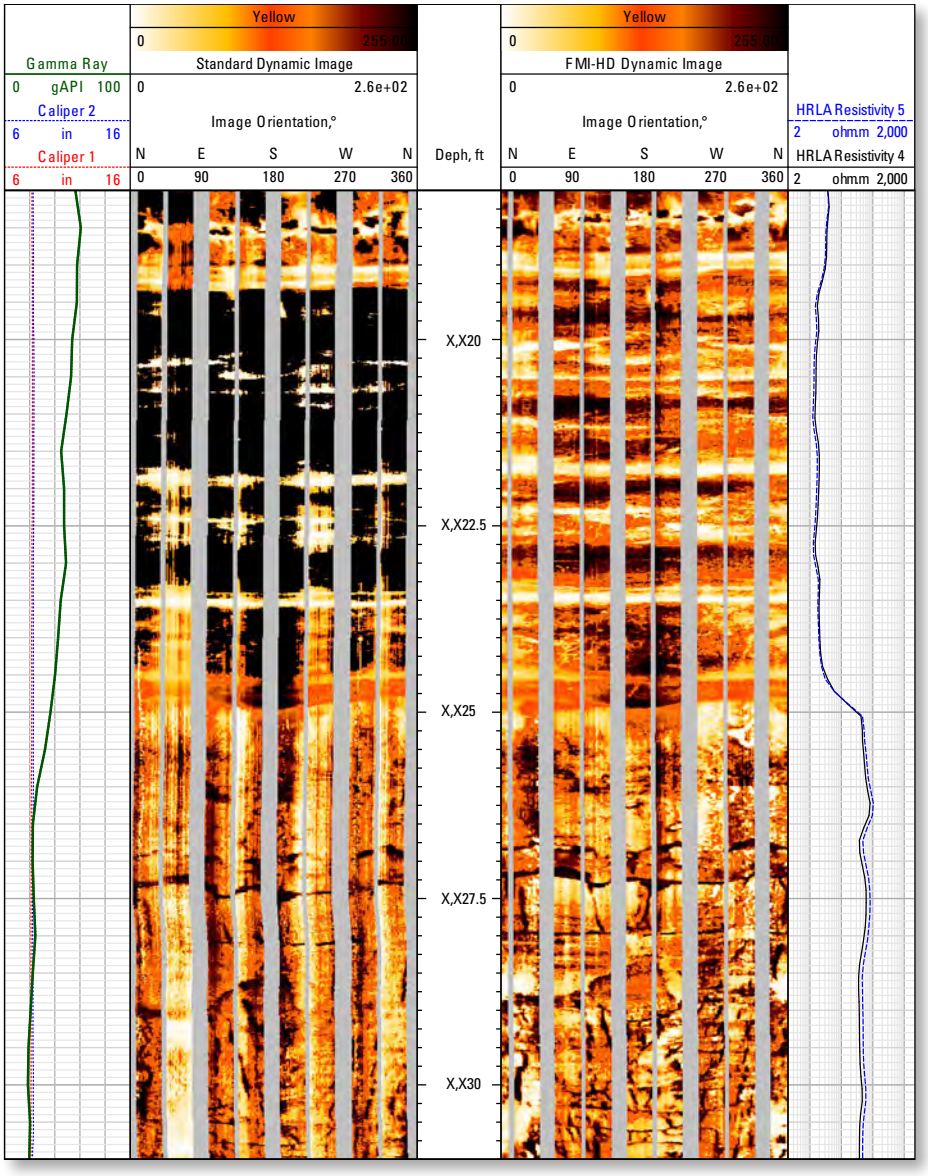
4× increase in image definition

The all-new electronics and parallel signal processing of the FMI-HD high-definition formation microimager mean that environments that cannot be clearly imaged with conventional microresistivity imaging technology can now be seen in great detail, including high-resistivity reservoirs and wells drilled with salt-saturated muds. The tool's significantly improved signal-to-noise ratio results in a superior sensitivity to fine contrasts in resistivity to obtain well-defined images of features smaller than the 0.2-in nominal resolution defined by the size of the button electrodes.

A clear improvement

Both standard microresistivity images from a conventional imaging tool and high-definition images from the FMI-HD microimager were acquired and compared. Both tools rendered clear and representative images of the formation geology where the resistivity was less than 500 ohm.m. Although the imager performance is similar, finer detail can be seen in the images from the FMI-HD microimager.

The images at 0.2-in vertical resolution from the FMI-HD microimager can be displayed on a virtual 3D core by the Techlog wellbore software platform at any scale down to 1:1. Patches of well-developed vuggy porosity are clearly visible as dark spots in this example.*



A conventional dynamic image (left of depth track) from the Permian basin well is compared with a high-definition image from the FMI-HD microimager (right of depth track) and resistivity curves from an HRLA high-resolution laterolog array (far right). The superior definition of the images from the FMI-HD microimager in the 800-ohm.m brecciated carbonate below X,X25 ft clearly delineates more than 30 fracture traces, of which only a few can be seen in the standard image. Bedding planes are also readily identifiable in the images from the FMI-HD microimager, but not in the standard image. Even more remarkable is the difference between the two images in the shale above X,X25 ft; the conventional tool was configured for imaging in a high-resistivity formation, which caused it to completely misread the shale whereas the FMI-HD microimager rendered all of the details.*

Where the formation resistivity was highly variable, only the FMI-HD microimager optimally captured both high- and low-resistivity formation images in a single pass. Automatic signal processing optimization adjusted the FMI-HD microimager to image the entire dynamic range of formation resistivity, whereas the conventional tool had to be retrieved and reset by the engineer to optimize it for either high- or low-resistivity formations and then the well relogged.

At formation resistivities exceeding 500 ohm.m, the high-definition image provided by the FMI-HD microimager consistently provides a superior basis for interpretation. The sharp rendering of fractures and vugs—critical for production—makes them readily identifiable.

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