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Linking downhole logging data with geology and drilling /coring operations - Example from Chicxulub Expedition 364.

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Expedition 364 was a joint IODP/ICDP mission specific platform expedition to explore the Chicxulub impact crater buried below the Yucatán continental shelf. In April and May 2016, our Expedition drilled a single borehole at Site M0077A into the crater's peak ring. It allowed recovering 303 excellent quality cores from 505.7 to 1334.7 meters below sea floor and acquiring more than 5.8 km of high resolution open hole logs.

Downhole logs are rapidly collected, continuous with depth, and measured in situ; these data are classically interpreted in terms of stratigraphy, lithology, porosity, fluid content, geochemical composition and structure of the formation drilled. Downhole logs also allow assessing borehole quality (eg. shape and trajectory), and can provide assistance for decision support during drilling operations. In this work, Expedition 364 downhole logs are used to improve our understanding of the drilling/coring operation history. Differentiating between natural geological features and borehole artifacts are also critical for data quality assessment.

The set of downhole geophysical tools used during Expedition 364 was constrained by the scientific objectives, drilling/coring technique, hole conditions and temperature at the drill site. Wireline logging data were acquired with slimline tools in three logging phases at intervals ∼0-503, ∼506-699 and 700-1334 mbsf. Logs were recorded either with standalone logging tools or, for the first time in IODP, with stackable slimline tools. Log data included total gamma radiation, sonic velocity, acoustic and optical borehole images, resistivity, conductivity, magnetic susceptibility, caliper and borehole fluid parameters. The majority of measurements were performed in open borehole conditions.

During the drilling operations some problems were encountered directly linked to the geology of the drilled formation. For example, two zones of mud circulation losses correlate in depth with the presence of karst cavities or open faults, as evidenced from borehole wall images. Both form conduits probably open at a large scale as suggested by associated anomalies in the borehole fluid temperature profiles. When coring the basement, pieces of metal trapped outside the drill bit apparently led to an increase of the borehole tilt as well as to an enlargement of the hole, although this later remained sub-circular. In the post impact carbonates, 6-7 m long apparent cyclic oscillations in the magnetic field coupled to a spiral shape trajectory of the same wavelength suggest drilling induced artifacts and formation re-magnetization.

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