# Toward achieving the “100% recovery rate” of information in deep, hard rock drill sites using physical properties logging

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Borehole informatics has been a powerful approach to investigate drilled hard rock formation especially where core recovery operations are strategically not planned and/or core recovery rates can be suffered from various environmental and operational reasons. Establishing a realiable downhole lithostratigraphy model at a drilled site is one of the most basic missions to be accomplished for our understanding of the subsurface architecture. Throughout the history of scientific ocean drilling, it has been one of the biggest challenges, however, to draw such a reliable downhole stratigraphy model of any drilled igneous section because core recovery rates are typically very low. Any conventional shipboard volcanostratigraphy includes a great degree of uncertainty due to (a) biased recovery of rock, fractures, and alteration types (e.g., loss of highly altered breccia materials and fracture fillings), (b) uncertainty of the in situ location of recovered core pieces, and (c) inconsistent core description criteria onboard when developed from several cruises. Consequently, critical elements for the understanding of evolution of the oceanic crust, such as alteration processes, changes in physical properties, and crustal accretion system may lead to mistaken conclusions. As an important alternative to the piecemeal shipboard lithostratigraphy, we introduce a complete, less-subjective volcanostratigraphy model by integrating wire-line logging and recovered core data using an example from Ocean Drilling Program (ODP) Hole 1256D, the first drilled hole that penetrated through the entire upper oceanic crust into the top of gabbro sequence, located at the super-fast spreading 15 Ma crust at Cocos Plate. From the Hole 1256D logging data, quasi-2D resistivity contrast images of borehole wall, so-called electrofacies acquired by multiple Formation MicroScanner (FMS) runs, were found particularly useful in deciphering the detailed crustal architecture with unprecedented resolution (i.e. centimeter scale). A volcanostratigraphy model was built by translating these FMS electrofacies into end-member lava flow types observed in the modern day EPR, shedding new light on crustal construction processes. Any future hard rock drilling effort, including proposed arc crust drilling (IBM), continental rifted margin drilling (Lord Howe Rise), and core-mantle boundary drilling (“MoHole”) will evidently foresee challenges in recovering continuous core materials; nevertheless, the “100% recovery rate” of information from these hard rock drilled sites can be achievable by effective physical properties logging.

Keywords: Crust-Mantle Drilling, Borehole Informatics, Well logging

 