DECIPHERING THE STRUCTURE OF THE OCEAN CRUST USING DOWNHOLE LOGS

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Oceanic crust covers a vast portion of the Earth's surface and plays a key role in global recycling systems. Crust inherits its structure when produced from the mantle at mid-ocean ridges. From inception, it emulates an enormous conveyor belt, transporting sediments and fluid to the trenches where it is either fed back into the deep mantle or incorporated into the continents.

Over the years, ODP has drilled several oceanic crustal sections; however, these rocks are notoriously difficult to drill and scientists frequently encounter incomplete recovery of cores. Integration of core and log data provides a unique and effective solution to this problem (Brewer et al., 1998).

Downhole log data reflect variations in lithology (physical characteristics of rock), alteration and fracturing. When recovery is incomplete core data can be used to calibrate the log data (Fig. A) and highlight any bias in recovery. This technique was employed with data from ODP Leg 185, which aimed to determine the flux of elements entering the Mariana subduction zone (Plank, Ludden et al., 2000). The logs are particularly sensitive to the presence of conductive, hydrous and K (potassium)-bearing alteration minerals that are host to elements of importance in subduction factory mass balance calculations. The results show that the more resistant basalt flows are preferentially recovered in the cores, with similar proportions in log and core data, while the amount of pillow basalt and brecciated material predicted by the logs is significantly higher than observed in the core (Fig. B). Future core-log integration studies will provide a more accurate representation of the input flux to subduction zones and continue to increase our understanding of the structure and alteration of the oceanic crust and its influence on global geochemical systems.

References:

Brewer, T. S., Harvey, P.K., Lovell, M. A., Haggas, S., Williamson, G. and Pezard, P., 1998. Ocean floor volcanism: constraints from the integration of core and downhole logging measurements. Geol. Soc. London, Special Publication, 136, 341-362.

Plank, T., J. N. Ludden, C. Escutia, and Ocean Drilling Program Leg 185 Shipboard Scientific Party, 2000. Proc. ODP, Initial Reports, 185.

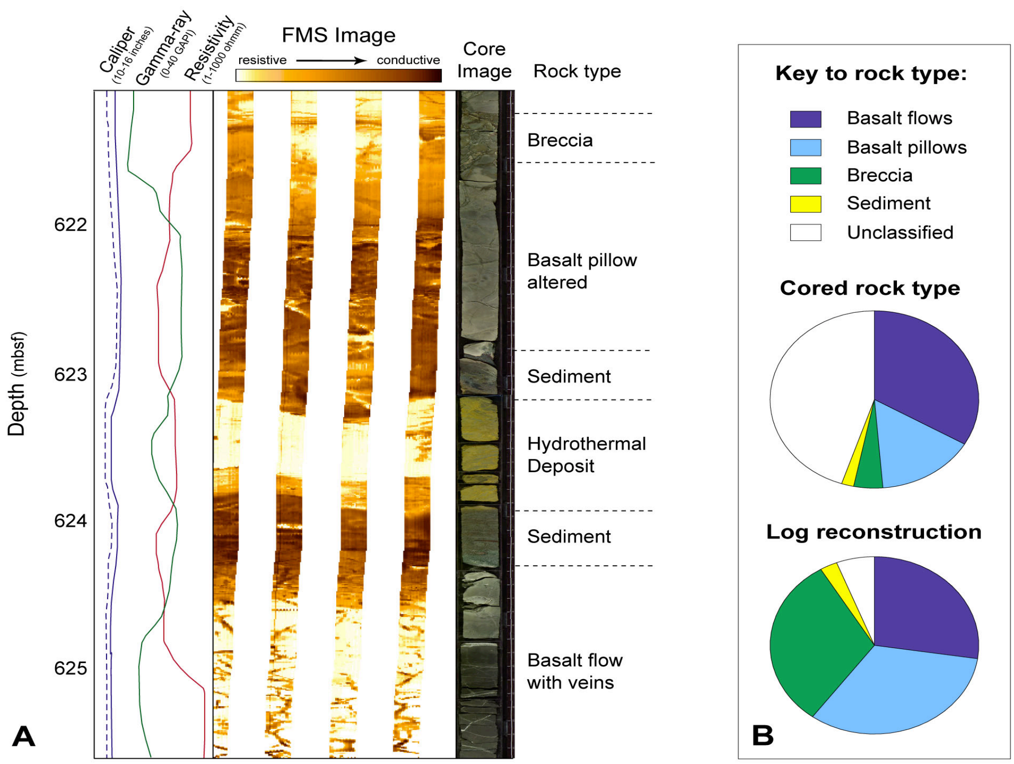

Figure A. A core image and corresponding log responses: The caliper log, which measures the diameter of the hole, indicates good hole conditions over the interval displayed. The gamma ray log reflects variations in natural radioactivity with higher values in the sediment and the altered basalt due to the presence of potassium. The FMS image portrays the electrical properties of the rocks in the borehole wall as an unwrapped cylinder, highlighting lithological and structural changes. The sediments, altered basalts and veins contain hydrous conductive minerals and thus appear darker than the hydrothermal deposit and the basalt flow on the image, and Figure B. The logging data aid classification of unrecovered lithologies and provide a more representative estimate of downhole lithological variation (all data from ODP Leg 185, Hole 801C).