ODP/IODP CORK Observatories: Designs and Geophysical Results since 1991

*Keir Becker[1], Earl E Davis[2], Andrew T. Fisher[3], Masataka Kinoshita[4], Heinrich Villinger[5]

1. University of Miami - RSMAS, Miami FL USA, 2. Geological Survey of Canada, Sidney BC Canada, 3. University of California, Santa Cruz CA USA, 4. Earthquake Research Institute, University of Tokyo, Tokyo Japan, 5. University of Bremen, Bremen Germany

Since 1991, the Ocean Drilling Program (ODP) and Integrated Ocean Drilling Program (IODP) have instrumented >25 subseafloor boreholes with long-term sealed-hole observatories called Circulation Obviation Retrofit Kits (CORKs). As will be described by other speakers in this session, additional installations have been implemented or are planned during the first few years of the 2013-2023 International Ocean Discovery Program (also IODP), using D/V’s Chikyu and JOIDES Resolution. Understanding subseafloor hydrology and its relationship to hydrothermal and tectonic processes have been prime objectives of scientific ocean drilling since the late 1970’s. However, early experience indicated that holes that penetrated through marine sediments into underlying oceanic basement often allowed open exchange between formation fluids and ocean water, perturbing if not totally disturbing the in-situ hydrogeological state. This motivated the CORK approach to seal select holes and instrument them with long-term sensor strings and data loggers, to record the recovery from drilling disturbances to the in-situ state and monitor natural hydrologic, tidal, and geodynamic signals. A brief summary of the designs of the CORK observatories will be presented (attached image), starting from a 1989 concept sketch on a dinner napkin. The original design included a single seal at the seafloor, and later designs have allowed for separately monitoring multiple zones sealed by packers in a single hole. Also, legacy reentry holes can be retrofitted with less expensive “CORK-Lite” models deployed by remotely operated vehicles (ROVs). The sensor strings have always included pressure and temperature monitoring, and many have included self-contained fluid samplers driven by osmotic pumps (“OsmoSamplers”) that can be tuned for a variety of geochemical and microbiological sampling objectives. Typically, data and samplers have been recovered and/or exchanged at average intervals of ~1-3 years using manned or unmanned research submersibles. Installations to date have been in sedimented young ocean crust or in subduction settings. Important geophysical findings to date include documenting the following: (1) small pressure and temperature differentials associated with vigorous off-axis hydrothermal circulation in highly permeable young oceanic crust; (2) formation response to seafloor tidal loading; (3) formation pressure as a proxy for plate-scale strain in response to tectonic stresses and earthquakes; (4) vertical seafloor deformation associated with slow and rapid fault slip; and (5) temperature variations associated with volumetric strain within the crust and turbidity events and other oceanographic events at the seafloor.

Keywords: CORK subseafloor hydrological observatories, Ridge-flank hydrothermal systems, Formation pressure as a proxy for plate strain

Evolution of CORK Designs, 1991-2011

From single-seal original CORK to multi-seal ACORK and CORK-II to downhole single-seal memory "Smart Plug" and "Genius Plug"...