Geophysical Research Abstracts, Vol. 9, 06468, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-06468

ICDP – Permanent downhole monitoring strategy

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Permanent downhole instrumentations allow the in-situ monitoring of spatial and temporal variations of properties of rocks, fluids and geophysical fields thus capturing the dynamic processes of a system. Long-term monitoring extends the scientific benefit of a borehole far beyond recovery of core and logging data.

In a growing number of ICDP projects with very different scientific objectives and borehole situations (earthquakes, active faulting, volcanic systems, mantle plumes, deep biosphere, natural resources) permanent downhole monitoring (PDM) is an essential project part. Scientists often have rather clear ideas what and how precise it should be measured but there is only very few know-how in academia about the technological possibilities and limits. Therefore usually a new research project has to start all over from the beginning to customize its individual down-hole instrumentation design and search for appropriate instruments. To help scientists designing and managing PDM programs the Operational Support Group of ICDP serves as an information hub. Decision aids for scientists help to choose the optimum PDM solution with respect to reliability, sensitivity, risk of failure, availability, and investment/operating costs. For this purpose a PDM database has been established which will continuously be extended and up-dated.

Depending on the type of borehole, the depth of the downhole installation and most important the desired recording signal characteristics there is a broad range of situations from already today available very reliable long-term downhole monitoring solutions to extremely challenging conditions where there is no today's off-the-shelf technology. Temperature durability and long-term sensor stability are in most instances the biggest challenges to meet, followed by non-trivial mechanical and corrosion failures. There are very successful electrical analog and even electrical digital cable based installations, primarily based on industry proven seismometer and p-T borehole logging sonde technology. Recently fiber-optic analog technologies combined with passive op-

tical sensors have been introduced in order to alleviate the poor life-cycle performance of electrical systems.

This presentation summarizes the current state-of-the-art in permanent downhole monitoring in the industry and partially in academia. It gives an overview of the wide range of PDM applications, possibilities and limits. The development of the downhole monitoring program of the ICDP project SAFOD is an outstanding example of modern sensor array technology. Finally an outlook gives recommendations for future research and development to engineer reliable instrumentation with the required sensor stability and high sensitivity for decades of operation.