Long-term and Real-time Monitoring at the Nankai Trough, Japan: Implications for Sources, Pathways and Composition of Upward Migrating Fluids

Motivation

The Nankai Trough, SE offshore Japan, is a highly earthquake-prone area. One of the key parameters influencing seismogenic (i.e. „earthquake-promoting“) processes are fluids, their behavior under greater pressure (p) - temperature (T) - conditions and different stress regimes. Of particular interest are fluid pathways, especially faults, and how stick-slip behavior is influenced by the presence of fluids.

In order to improve our knowledge about possible fluid migration pathways and their depth of origin, this PhD project focusses on long-term monitoring of a splay fault system within the accretionary prism, as well as real-time drilling mud gas monitoring during riser drilling in the Kumano forearc basin.

Long-term monitoring

By using a SmartPlug borehole observatory, it is possible to monitor fluid p and T. Consequently, fluid migration along and hydrogeologic properties of the splay fault can be determined.
In the end of 2013, data from an extended SmartPlug (i.e., a GeniusPlug) will be recovered, which will include fluid samples directly from the splay fault zone. These will be analyzed for changes in the geochemical composition during the monitoring period.

Real-time monitoring during IODP Exp. 338

Drilling mud gas monitoring is a commonly utilized method in the oil industry. During riser drilling, mud is circulating through the drill string. Formation gases released by the drilling are transported upwards and analyzed. This provides valuable information about the parent beds, thermal maturity, permeability, and contribution of deep-situated gases.

Preliminary Results

So far, tidal variations in the long-term pressure data suggest that hydraulic communication between borehole and formation is given by the presence of fractures in the fault zone. However, no conclusions could be drawn for recent fluid migration, and clear coseismic p and T changes are missing.
Drilling mud gas data from the Kumano forearc basin showed intervals, in which elevated permeabilities (indicated by ^{222}Rn) correlate well with high $^{3}He/^{4}He$ ratios. It seems that gases are able to migrate through the accretionary prism and accumulate close to the unconformity between forearc basin and accretionary prism. Further research on the isotope composition of (non-) hydrocarbon gases sampled during IODP Exp. 338 is necessary to verify this assumption.

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