Geophysical Research Abstracts
Vol. 14, EGU2012-6296, 2012
EGU General Assembly 2012

Implications for Petrophysical and Hydrological Properties of the Nankai Trough Megasplay Fault Based on SmartPlug Borehole Observatory Data

S. Hammerschmidt (1), E.E. Davis (2), and A. Kopf (1)

(1) MARUM Research Center, University of Bremen, Leobener Str., 28359 Bremen, Germany, (2) Pacific Geoscience Centre, Geological Survey of Canada, British Columbia, Canada

The SmartPlug is the first borehole observatory in the IODP Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE). It was installed in the Nankai Trough accretionary prism where Hole C0010 penetrates one of the shallow branches of a giant out-of-sequence splay fault system (OOSS), the so-called megasplay fault. The main objectives were to monitor *in situ* fluid pressure and temperature from the fault zone via casing screens and compare them to a hydrostatic reference section. The OOSS may be connected to the seismogenic part of the underlying thrust fault boundary and is thought to act as potential pathway for upward migrating fluids, which subsequently would affect the seismogenic potential of the thrust fault. Moreover, the OOSS is inferred to have shown coseismic rupture during the 1944 Tonankai M8.1 earthquake, which may be supported by potential along-fault flow and elevated fluid pressure in the fault zone. Investigations regarding the petrophysical and hydrogeological characteristics of the OOSS are rare; the SmartPlug pressure dataset helps to overcome this information gap.

The 15 month-lasting record is heavily affected by tidal signals, which are usually removed to allow a proper investigation of anomalies. However, here the tidal noise itself was investigated, because it reveals important hydrogeological characteristics of the megasplay fault zone. The main objective of this work was to determine the tidal loading efficiency, and place bounds on elastic properties, permeability and hydraulic diffusivity. It was also possible to define an instrument compliance ratio from tidal and instrument response analysis, and to estimate the permeability of the damage zone surrounding the casing screens.

A mean tidal loading efficiency of 0.82 was obtained, which is similar to published results for samples from convergent margins of similar porosity. The instrument compliance ratio ranges from ca. 60 to values of up to 10^4 for calculations based on instrument specifications and tidal response analysis, respectively. This together with the low wellbore storage of around 10^{-10}– 10^{-12} m^3 Pa^{-1}, the absence of any phase shift and the low amplitude damping of 0.7% allows the assumption that the SmartPlug is a stiff instrument, surrounded by a sufficiently high permeable material. However, it is suggested that the apparently high permeability is owed to a drilling-induced damage zone surrounding the casing, which allows a good hydraulic connection to the fault zone. At the same time, based on porosity-permeability relationships, a permeability of only 7.5 x 10^{-18} $m^2$was estimated, which led to a hydraulic diffusivity of only 2.6 x $10^{-13}m^2$ s^{-1} (calculated using elastic properties inferred from the tidal loading efficiency and under the assumption that the material at the casing screens is homogeneous). Ultimately, it is unlikely that the megasplay fault can act as fluid pathway.

In summary, our work shows that semi-quantitave estimates of the petrophysical and hydrogeological parameters are possible with pressure data from the SmartPlug borehole observatory, a self-contained instrument of only a little more than 1 m length, compatible with standard industry bridge plugs, and having simple, robust electronics that have a monitoring lifetime of 10 years.