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An overview of gas hydrate and cold seep research along the Hikurangi Margin, New Zealand (2006 & 2007)

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Prior to 2006, the knowledge about cold seeps around New Zealand was based mainly on accidental recovery of seep fauna or methane-derived carbonates by fishermen and the detection of flares in fish-finding sonars. Lewis and Marshall (1996; NZJGG) compiled these findings, providing the first details on 13 seep sites. Four of those are located at the Hikurangi Margin along the east coast of New Zealand's North Island.
Since then, three international cruises in 2006 and 2007 enhanced our knowledge considerably about methane seepage along the Hikurangi Margin, an area which has widely distributed and in places very strong BSR. Two cruises on the RV TANGAROA (led by GNS Science and NIWA, NZ) in 2006 focused on extensive reconnaissance work (multibeam mapping, seismic surveys, flare imaging, visual observations) as well as fauna sampling, geochemical pore water analyses and CTD casts including water sampling for methane analyses. Several new seep sites were discovered during these cruises. Using these data, very detailed investigations in four main working areas could be performed during a 10-week expedition with RV SONNE (SO191, led by IFM-GEOMAR, Germany). All research topics currently discussed in the scientific community were addressed using state-of-the-art equipment (e.g. deep-tow side-scan, TV-guided sampling, lander and ROV-deployments). Fourteen institutes from seven countries were involved (Australia, Belgium, Germany, New Zealand, United Kingdom, United States, Switzerland).
Echosounder and sidescan surveys unmistakably revealed active seep sites by detecting bubbles in the water column and carbonate precipitation at the seafloor forming massive chemoherm complexes. These complexes are associated with typical seep fauna like tube worms, bivalve mollusk species (Calyptogena, Bathymodiolus),and bacterial mats. At the fringe of these chemoherms dark sediment patches were observed which exihibit a novel seep habitat dominated by dense beds of two new species of heterotrophic ampharetid polychaetes. Bubble release was visually observed at several sites and recorded in the backscatter of various acoustic devices. At one site (680m water depth) very strong, pulsing outbursts could be observed repeatedly with methane fluxes of 20 to 25 l/min (60 to 74 mol/min). Intense CTD sampling and onboard methane analyses revealed that at least three of the areas are actively venting methane with an upper boundary at about 500 m, due to a density barrier. ADCP data indicate tide-dependent changes in current speed and direction. Delta 13C values of dissolved methane range from -71 to -19 permil, reflecting bacterial oxidation of methane in the water column, with a removal rate of 38 nM/day (or 11 to 19
Extensive pore-water measurements, including in situ measurements during lander deployments, were aimed at evaluating flux rates of dissolved geochemical species and free gas. These measurements revealed that the dark sediment patches represent a remarkable seep habitat because of its very high methane fluxes and total oxygen consumption rates. Detailed seismic and controlled-source electromagnetic surveys allowed quantification of gas hydrates and regional estimates of fluid-flow focusing and the impact on the gas hydrate stability and BSR occurrence. Furthermore, the geophysical data imaged fluid pathways under seeps and indicated that more seep sites could be found at the seafloor. In 2006 and 2007, 23 new seep sites have been identified and visually observed, which resulted in a total of 31 seeps sites for the Hikurangi Margin. With more cruises proposed, this number is likely to increase.