



## **Porewater geochemistry and methane fluxes of cold seeps at the Hikurangi margin, offshore New Zealand**

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A comprehensive biogeochemical dataset has been collected during RV SONNE cruise 191 at cold seep sites along the Hikurangi margin, offshore New Zealand. The observed porewater profiles appear to have similar characteristics in all investigated areas: Rock Garden, Okamere Ridge, and Wairarapa. Seep-related sediments were generally extensively covered with (mostly empty) clam and mussel shells and shell debris as well as pogonophora, vestimentifera and carbonates. In between, small patches of black sediment inhabited by polychaetes or living clams and mussels occurred.

Pore fluids from these black sediment patches show rapid sulphate consumption due to enhanced methane fluxes from below. Generally,  $\text{SO}_4^{2-}$  is completely depleted below sediment depths of 5-10 cm. Porewaters are depleted in nutrients ( $\text{NH}_4^+$  and  $\text{PO}_4^{3-}$ ) and  $\text{Cl}^-$  concentrations deviate only slightly from the seawater value, unless gas hydrates are found in the sediments. At several sites, we were able to recover thin (<1 cm) gas hydrate layers in the gravity cores.

Porewater profiles outside the black sediment patches, but still within the seep area, indicate mixing of bottom water concentrations down into several meters of the sediment. This pattern can most likely be attributed to methane gas bubbles rising through the surface sediments (Haeckel et al., 2007). Applying a simple 1-D transport-reaction model including Boudreau's expression for bioirrigation (Boudreau, 1984) allows to quantify the respective methane gas flux in the seep areas and to estimate the total methane flux at the Hikurangi margin. This porewater-derived methane flux is com-

pared to in-situ flux measurements using benthic chamber landers deployed at the same sites during the SO-191 campaign.

Overall, the porewater profiles exhibit a general trend of decreasing methane fluxes with respect to the following sequence of fauna observed at the seafloor: polychaetes (black sediment) > pogonophora > clams & mussels > carbonates & vestimentifera > “normal” seep sediments.

#### References

Boudreau, B. P., 1984. On the equivalence of nonlocal and radial-diffusion models for porewater irrigation. *Journal of Marine Research* **42**, 731-735.

Haeckel, M., Wallmann, K., and Boudreau, B. P., 2007. Bubble-induced porewater mixing: A 3-D model for deep porewater irrigation. *Geochimica et Cosmochimica Acta* **71**, 5135-5154.