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Anaerobic oxidation of methane in the Concepción Methane Seep Area, Chilean continental margin

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Within subduction zones of active continental margins, large amounts of methane can be mobilized by dewatering processes and transported to the seafloor along migration pathways. A recently discovered seep area located off Concepción (Chile) at water depth between 600 to 1100 mbsl is characterized by active methane vent sites as well as massive carbonates boulders and plates which probably are related to methane seepage in the past.
During the $SO_2$10 research expedition "Chiflux" (Sept-Oct 2010), sediment from the Concepción Methane Seep Area (CSMA) at the fore arc of the Chilean margin was sampled to study microbial activity related to methane seepage. We sampled surface sediments (0-30cm) from sulfur bacteria mats, as well as clam, pogonophoran, and tubeworm fields with push cores and a TV-guided multicorer system. Anaerobic oxidation of methane (AOM) and sulfate reduction rates were determined using ex-situ radioisotope tracer techniques. Additionally, porewater chemistry of retrieved cores as well as isotopic composition and age record of surrounding authigenic carbonates were analyzed.
The shallowest sulfate-methane-transition zone (SMTZ) was identified at 4 cm sediment depth hinting to locally strong fluid fluxes. However, a lack of Cl- anomalies in porewater profiles indicates a shallow source of these fluids, which is supported by the biogenic origin of the methane (δ13C -70‰ PDB). Sulfide and alkalinity was relatively high (up to 20 mM and 40 mEq, respectively). Rates of AOM and sulfate reduction within this area reached magnitudes typical for seeps with variation between different habitat types, indicating a diverse methane supply, which is affecting the depths of the SMTZ. Rates were highest at sulfur a bacteria mats (20 mmol m-2 d-1) followed by a large field of dead clams, a pogonophoran field, a black sediment spot, and a carbonate rich clam field. Lowest rates (0.2 mmol m-2 d-1) were measured in close vicinity to these hot spots.
Abundant massive carbonate blocks and plates hint to a very old seep system with a probably much higher activity in the past. The U-Th age record of these authigenic carbonates reach back to periods of venting activity with more than 150 ka ago. Carbon isotopic signatures of authigenic carbonates (δ13C -50 to -40‰ PDB) suggest a biogenic carbon source (i.e. methane), also in the past. We found several indications for the impact of recent earthquakes within the seep area (cracks, shifted seafloor), which could be an important mechanism for the triggering of new seepage activity, change in fluid expulsion rates and colonization patterns of the cold seep fauna.