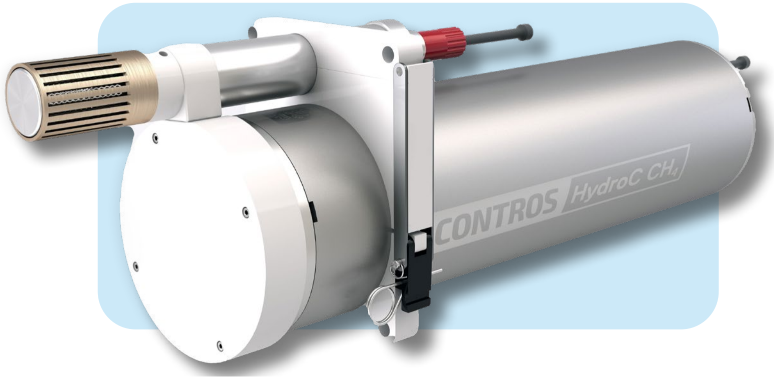
APPLICATION NOTE

4H JENA ENGINEERING

Finding traces of dissolved methane at Deep Sea plate boundaries

Using the CONTROS HydroC CH_4



Oceanic plate boundaries and associated fluid/rock interaction play a major role in element cycles of the oceans, i.e. seawater penetrates oceanic crust and altered fluids are again released along faults in fractured rocks. Transform faults are specific tectonic boundaries caused by strike-slip movement of oceanic or continental plates (e.g. Azores-Gibraltar Fault Zone, San Andreas Fault, respectively).

As fluid release sites along the faults are of increasing scientific interest but hard to find in the abyss, one has to use detectable tracers in the water column, which indicate active fluid release from the seafloor (Hensen et al., 2019).

Methane is one of these tracers as it is formed by seawater/rock interaction in the subsurface. Released methane concentrations from the seafloor in such a tectonic setting are usually low. However, due to latest improvement of deep-sea sensors in sensitivity and stability even the smallest deviations from methane background concentration can be detected.

The Contros HydroC CH_4 sensor from -4H-JENA engineering was used during research cruises between the Azores and Lisbon and east of volcano Etna (Sicily) to locate methane release from the seafloor related to faults in the earth's crust (Hensen et al., 2020; Berndt et al., 2021).

TECHNOLOGY

A video-guided Water Sampler Rosette/Seabird-R/V system (VCTD; Fig. 1) was deployed from the research vessels R/V Meteor and R/V Sonne, respectively, to study oceanographic characteristics of the water column, to survey the seafloor in towed mode for fluid release structures and to measure chemical anomalies in bottom water (Hensen et al., 2020; Berndt et al., 2021).

A HydroC CH_4 sensor (6000 m-rated) was mounted to the rosette frame by replacing one Niskin bottle (Fig. 1) to monitor methane traces in real-time. Therefore, the HydroC CH_4 was connected to an external voltage channel of the Seabird (SBE9plus) underwater unit enabling online CH_4-data visualization and storage into the SBE hex-file during recording.

The methane sensor was powered by three NiMH-rechargeable battery packs (24 V, 9 Ah, 6000 m rated), providing sufficient power for >10 h operation time at water temperatures of 3-4°C (i.e. Hensen et al., 2020). To record underwater position of the towed system a transponder was mounted to the cable 50 m above the VCTD. USBL tracking can be performed by different systems, i.e., onboard R/V Meteor by using the iXblue POSIDONIA system. More technical details of the HydroC CH_4 are provided here.

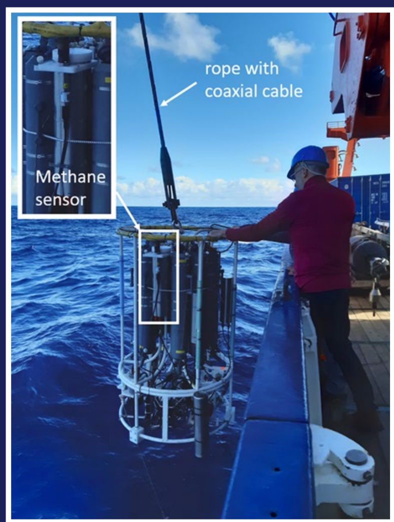


Fig. 1: Deploying the Video-CTD/Water sampler (11x10 L Niskin) rosette including SBE9plus-CTD, O2, turbidity (Chelsea), methane (-4H-Jena Contros), and altimeter sensor.

4H JENA ENGINEERING

APPLICATIONS

Locating methane seepage and deep-sea fauna in the Ionian Sea.

Submarine landslides and transform faults associated with volcanic and tectonic activities east of Sicily in the Ionian Sea were of research interest during a cruise with R/V Sonne (Berndt et al., 2021). A relatively strong methane anomaly could be detected in a submarine channel at about 2100 m water depth (Fig. 2).

The geological setting in combination with the methane anomaly, authigenic rocks, and tube worm colonies living in the methane-rich bottom water raised questions about recent gas formation processes like: deep mineral/water interaction (e.g. Polonia et al., 2017), methanogenesis related to organic matter degradation in sapropels (e.g. Bayonet al., 2013), or volcanic activity (e.g. D'Alessandro et al., 1997).

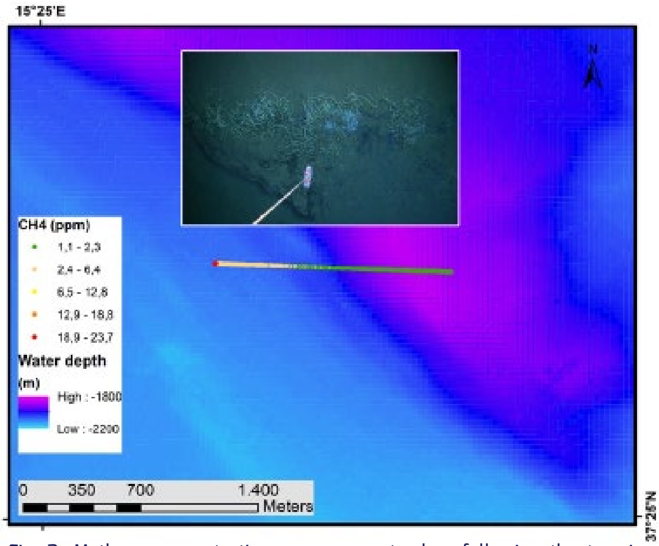


Fig. 2: Methane concentration measurement when following the terrain down-slope in a deep-sea channel of the Ionian Sea (east of volcano Etna). Colonies of tube worms were observed when highest enrichment of methane (~24 ppm) was detected in bottom water(see inset).

Searching methane seepage in the abyss at 3000-5000 m water depth

A research cruise with R/V Meteor was conducted to investigate tectonic and related geochemical processes in the Azores-Gibraltar Fracture Zone, which defines part of the African-Eurasian plate boundary in the North Atlantic (Hensen et al., 2020). One main aim was to locate active fluid (methane) release sites along the fractured boundary.

In general, methane concentrations of water masses in the ocean can be determined during hydro-casts with a CTD-device (Fig. 1). Our recorded sensor data of vertical profiles (upcast) indicates that e.g. oxygen-rich deep Atlantic water is separated from intermediate and shallow water masses at about 1000 and 500 m in the area east of the Azores, which is comparable to e.g. Liu and Tanhua, 2019.

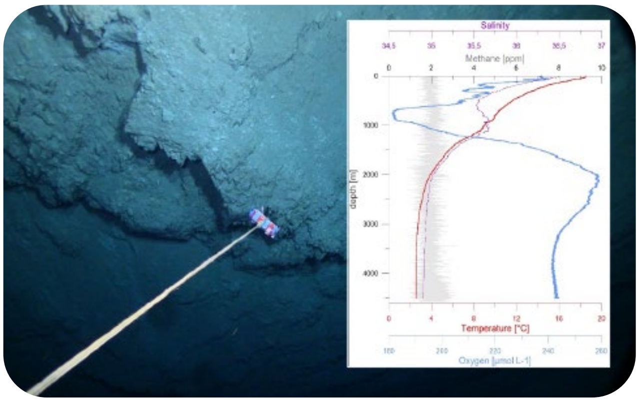


Fig. 3: Sharp edges and erosional structures of a basaltic wall at 4000 m water depth, where the terrain drops sharply ending in a deep-sea channel. The methane concentration increases by 0.2 ppm (see inset), when approaching the seafloor of the deep channel. However, no specific spot of methane release was detected during the survey.

Moreover, the measured methane data indicates a slight increase where oxygen minimum is measured and a slight increase of about 0.2 ppm when entering a deep-sea channel at about 4000 m water depth (Fig. 3). Data evaluation is still ongoing and geophysical and sediment data will be compared with bottom water chemistry and video observations of the seafloor (Hensen et al., 2020)

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