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A new device for high precision in situ sediment temperature profile measurements at the seafloor

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In situ sediment temperature profile measurements at the seafloor provide valuable information on fluid seepage, hydrate stability, and ambient temperature of samples. In addition, it can be convenient to approximate other parameters such as concentrations of porewater constituents from temperature or temperature gradient using transfer functions if their distribution is controlled by the same processes and direct quantification involves time-consuming sampling and laboratory analyses.

We present a new instrument that can be used to obtain precisely positioned sediment temperature profile measurements from the seafloor during ROV dives. Consisting of a 0.4 m-long sensor rod equipped with eight temperature sensors and a standard data logger, the new T-Stick can be operated by an ROV in a fully autonomous mode. The temperature range of the instrument is -5 °C to 35 °C and it can withstand pressures of up to 600 bar. Compared to previously used instruments, the smaller diameter of the new T-Stick reduces the thermal inertia of the lance and results in shorter equilibration times.

Virtual measurements generated by a numerical model showed that the T-Stick provides highly accurate temperature profile measurements with a root mean square error of 0.0027 K for a wide range of thermal sediment properties. Modeled temperature gradients are representative of both normal deep sea settings and cold seep environments with elevated temperature gradients of up to three orders of magnitude above normal background values, which are the primary target areas for T-Stick measurements. Deviations from the true in situ temperature profiles are caused by disturbance of the temperature field by the probe itself and may lead to underestimation of gradients and curvature in the profiles.

A first field test of the T-Stick was conducted at the Håkon Mosby mud volcano at 1250 m water depth on the Barents Sea slope, where the new instrument provided useful information about the origin and extent of freshly erupted mud.