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Development of a CSEM system for the electromagnetic investigation of the North Alex Mud Volcano

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Controlled source electromagnetics (CSEM) may be used to measure the electrical resistivity of the seafloor, which is indicative of the presence of fluids, gas or methane hydrates. A typical CSEM system consists of an electric dipole transmitter producing a time varying source field and electric dipole receivers, which measure the earth's response to this signal. Large CSEM systems are used in oil and gas exploration as well as methane hydrate detection, mapping electrical resistivity variations on a depth scale of up to several kilometers and a horizontal scale of several hundred meters to kilometers.
For a detailed investigation of fluid and gas leakage of the North Alex Mud Volcano with a target area of about 1 km2, we developed a new high resolution CSEM system. The system consists of a lightweight electric dipole transmitter mounted on a small remotely operated underwater vehicle (ROV) and autonomous electric dipole receivers. Since the ROV is used to place the transmitter, electromagnetic signals may be transmitted from different directions with respect to the stationary receivers, allowing for a 3D-style tomographic experiment.
With respect to the experiment at the North Alex, crucial points in the system development were:
- Weight and power-supply of the transmitter,
- mechanical stability of the transmitter's dipole antenna,
- exact time synchronization (<1ms) between transmitter and receivers over an extended time period (14 days)
- precise determination of distances (<5m) between transmitter and receivers.
The new system, developed within the framework of the West Nile Delta Project funded by RWE Dea, was first tested on North Alex in November 2007. Ten receivers were deployed at a total of 16 receiver locations. During three successful dives with a Cherokee ROV (Ghent University, Belgium), the transmitter was deployed at a total of 80 locations. At each location the transmitter was placed stationary during transmissions and operated twice, once inline and once perpendicular to the current profile direction. For navigational purposes and the later determination of distances during post-processing, the ROV (carrying the transmitter) and some of the receiver-stations were equipped with GAPS transponders (IXSEA). All receiver-stations were visited once with the ROV to determine positions, make calibration measurements for later time synchronization (post-processing) and to acquire videos and pictures of the stations.
A first interpretation of data shows that the required precisions for time synchronization and positioning were generally reached within the specified bounds (s.a.). Due to the stationarity of transmitter and receivers during measurements, the unstacked time-series data is already of very good quality. The stacked transient data is suitable for 1D-inversions, of which we will show some first results in our presentation.