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Five years of marine research using EM methods at the IFM-GEOMAR

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Even though first experiments for the characterization of the seafloor using marine electromagnetic (EM) methods were already carried out in the mid 1960's, they have only played a minute role in marine academic investigation for several decades. Only in the past decade, the strongly increasing interest of oil companies for alternative investigation methods for marine oil and gas exploration brought the use of EM methods into the focus of attention. Traditional founders of marine EM methods (Scripps, U of Toronto, U of Southampton) are now accompanied by newly established commercial (e.g. Exxon, AOA Geophysics, OHM surveys, EMGS, Statoil) as well as academic groups.

The marine EM group at the IFM GEOMAR, which was established in 2006, initially focused on the development and testing of EM receivers (RX) for magnetotelluric (MT) measurements. Successful measurements were taken during a cruise to the Costa Rican trench (2007/08, see Worzewski, this session). However, these measurements revealed some problems with this first generation of instruments (e.g. stability of stations on the ocean-floor). A subsequent, much improved generation of MT receivers developed in 2008 was successfully deployed during cruises to the Alboran Sea (2009) and the Cyprus Arc (2010) and is currently used in investigations of the Walvis Ridge (Namibia, 2011) and the New Zealand Subduction Zone (2011).

For a RWE Dea funded project at the North Alex Mud Volcano (NAMV), a second line of development at the IFM-GEOMAR focused on development of controlled source electromagnetic (CSEM) equipment. For this first project, safety concerns (slop stability) as well as the comparatively small size of the investigated target ($\sim$ 1km^2) required a new approach to allow for a secure, high resolution CSEM experiment. For this type of experiment, the existing MT receivers were extended to include a high frequency CSEM mode (10kHz) for the electric fields. Additionally, a lightweight electric dipole transmitter (TX), which can be mounted on a small remotely operated underwater vehicle (ROV) was developed. In a 3D-style tomographic experiment (Nov. 2008), ten receivers were deployed over the surface of NAMV at a total of 16 receiver locations and in three successful dives with a Cherokee ROV (Ghent University, Belgium), the transmitter was deployed at a total of 80 locations. Since both RXs and TX were stationary during measurements, a small dipole moment of 200Am (20A current, 10m dipole length) was sufficient to collect transient data up to RX-TX distances of more than 1km.

Generally, navigational inaccuracy limits the accuracy and thus also the resolution of CSEM measurements, which is mainly due to the constantly moving sources used in most commercial systems. The good quality of data recorded during the initial experiment at the NAMV raises the question, if this issue may for some types of CSEM experiments may be remedied by using stationary transmitters instead of flying sources. During the upcoming experiment in New Zealand (April 2011), we will find some answers to this question with our new CSEM transmitter system, which has a higher dipole moment ($\sim$ 1kAm) and the capability to perform the navigation between TX and the RXs directly on the ocean floor.