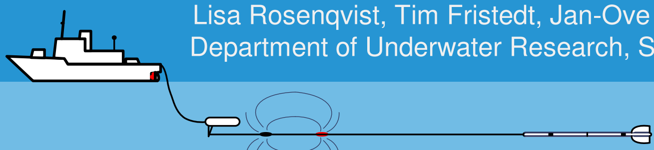
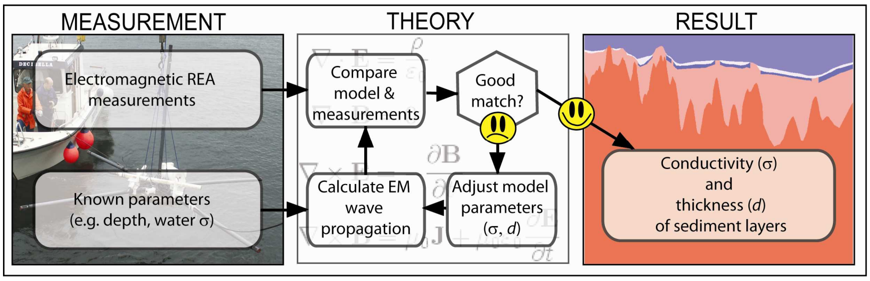
Electromagnetic Rapid Environment Assessment of sediment conductivities and structures

Lisa Rosenqvist, Tim Fristedt, Jan-Ove Hall, Leif Persson and Fredrik Silfverduk
Department of Underwater Research, Swedish Defence Research Agency – FOI



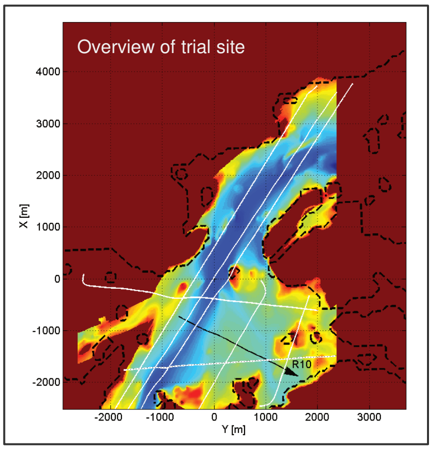
Marine controlled-source electromagnetic (CSEM) soundings can be used to chart sedimentary structure and conductivity offshore. This technique is of particular interest in areas where the commonly used seismic methods encounter strong reflections, such as evaporites, volcanics and carbonates. In this study we use low-frequency electromagnetic fields for Rapid Environment Assessment (REA) of sedimentary properties in the Stockholm archipelago, an area where trapped gas often is encountered in the sediments.

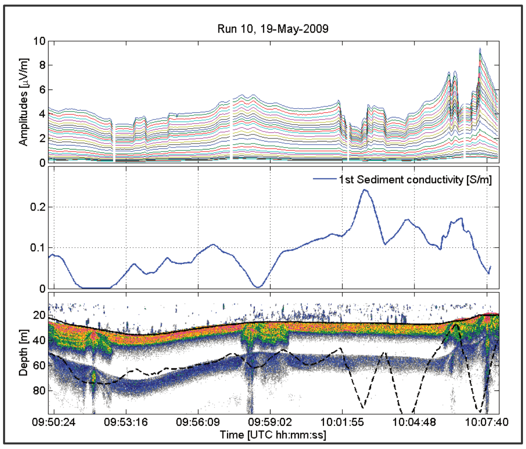
A field trial was undertaken in May 2009 where both the transmit and receiver instrumentation were towed behind the ship and electromagnetic data were collected along the tow track. The data is matched iteratively to a 1D forward propagation model until a best fit to the data is found. A seismic investigation of the same area shows that the sub-bottom sediment is characterized by strong variations. The REA results show a similar variation although a direct comparison is not possible as the tow tracks from the two different measurements do not directly overlap. The statistical distribution of the seismic and REA sediment depths fulfill the Kolmogorov-Smirnov test at 95 % confidence level.



In order to perform electromagnetic REA of sediment conductivities and structures the following is required:

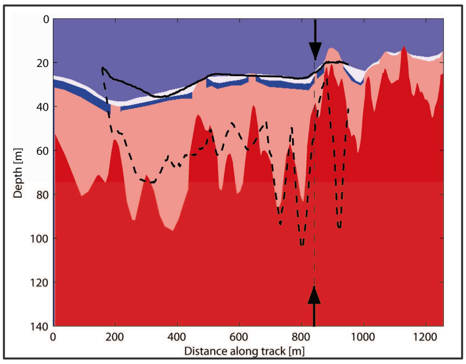
- Equipment to measure and transmit electric signals
- A forward wave propagation model
- An inversion technique which provides estimates of the environmental parameters

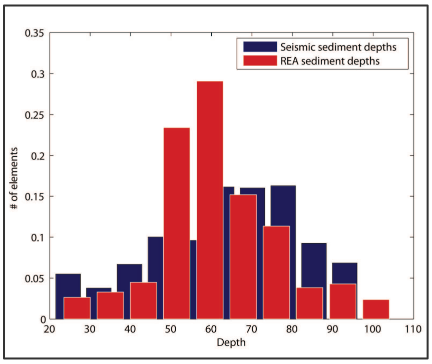




Left Figure:
Measurement tracks of the REA (black) and seismic data (white).

Right Figure:
Results from the inversion of run R10. Top panel shows the received electric amplitudes. The middle panel shows the sediment conductivity in the first layer and the bottom panel shows echo intensity from the echo sounder, together with inversion results (dashed) for the depth of the sediment between the bottom and bedrock. While the echo intensity shows a relatively flat layer the REA results show a very variable sediment thickness. However, the echo sounder has not been able to penetrate to the clay/bedrock interface.





Left Figure:
Seismic data for the closest track crossing run R10 (white-dotted in overview of trial site). The sub-bottom structure consists of three layers, a thin layer of postglacial clay (white) on top of a thicker layer of glacial clay (pink) and last bedrock (red). Pockets of gas are illustrated in blue. The REA sediment depths (dashed) projected onto the figure show very similar vertical variation in spite of the different locations. Arrows indicate the intercept of the two measurement tracks.

Right Figure:
Histograms of the REA and seismic depths at the bedrock sediment interface. The two different distributions fulfill the Kolmogorov-Smirnov test at 95 % confidence level.

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