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Simultaneous acquisition of Sparker and airgun seismic data - a key to understanding the interaction of deep structures and the Quaternary in the Kattegat area

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The geological evolution of the Kattegat and Baltic Sea area during the last 130,000 years encompasses a complex series of glacial advances with highly oscillating ice margins interrupted by marine inundations and significant glacial lake deposition. One of the most significant lacustrine episodes is related to the build-up and drainage of the Baltic Glacial Lake during the last deglaciation. The link of these major depositional events to global climate as well as their impact on local and regional environment is, however, still poorly understood. The relation between the deep structures and Quaternary deposition is also not well resolved. In order to improve this understanding we aim at acquiring an understanding of the 3-dimensional evolution of the Quaternary sediments in the Kattegat and Baltic Sea areas using seismic studies. We relate these seismic data to the palaeoclimatic and sedimentological information obtained through the sedimentological and micropalaeontological analyses of both short sediment gravity cores and of samples from IODP Expedition 347 drilled in the fall of 2013.

Different types of seismic data are needed for studying the relationship between the crustal structure, pre-Quaternary topography, and Quaternary deposition than seismic data needed for studying the detailed depositional dynamics within the Quaternary deposits. This is because when using airguns with a deep penetration needed for studying deep-laying structures the resulting seismic data has too poor resolution for studying the very shallow parts. In contrast the very high resolution sparker data has a poor penetration depth. Traditionally, these two different types of seismic data are for practical reasons not been collected simultaneously, or even on the same cruise. As a result, these two (complementary) dataset are difficult to compare, especially when they are acquired under different conditions (changes in positioning, noise levels, etc.).

In this study, we have solved the problem by acquiring both seismic datasets simultaneously during the same leg. Both the sparker and airgun energy sources are towed behind the vessel, and the common streamer is placed in the middle behind the energy sources. In order to optimize the acquisition hydrophones are spaced with 3.125m for the uppermost 125m of the layout, where the main part of the reflections for the Sparker data is acquired, whereas the spacing is 6.25m at the remaining 400m of the streamer. The energy release of the different sources is timed in order to minimize the interference between the two systems.

The resulting seismic sections are excellent examples of different data from the same area that is resolved at different depth intervals and vertical resolution. This allows us to directly compare the data and gives a hitherto unseen differentiation of seismic resolution in different parts of the succession. A preliminary geological analysis of the data shows that deposition in a number of the Quaternary mini-basins is controlled by the underlying structures, which can be related to the Sorgenfrei-Tornquist fault Zone. This infers that deep structures in some areas may still control the present bathymetry, even within smaller basins. The dating of the events and the relation to global climatic changes awaits the biostratigraphical analysis of the IODP boreholes.