The acoustic response of the seafloor

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In the framework of a variety of projects, acoustic techniques have been used to study and map the seafloor. Although these techniques serve as general accepted tools for marine exploration, the use of digital side scan sonar and multibeam offer today a wide range of application levels for different scientific and commercial purposes.

For years, digital terrain models (DTM's) of the seafloor were produced from narrow spaced single-beam echosounding data, which often implied a strong simplification of the more complex environments. If analogue side scan sonar data was available, the occurrence and geometry of bedforms was manually redrawn from the imagery and superimposed on a general bathymetrical map. This process was very time consuming and often susceptible to inaccuracies. Moreover, the hierarchical link between the different types of bedforms and especially their relation with the larger sedimentary system was often missing.

Since then single-beam echosounders become more and more replaced by multibeam sonars which give a much higher density of seafloor depth information. For that reason, digital terrain models nowadays form far more realistic representations of the bottom topography and hence the interactions between the substrate and the physical processes become much more accessible. Similarly, pure analogue side scan sonar recordings are slowly set aside by the digital acquisition, resulting in geometrically corrected and geo-referenced very high-resolution (VHR) (up to cm) mosaics of complete research areas. These mosaics do not only reveal the often complex morphology of the seafloor (i.e. ripples, megaripples to sandwaves), but from the acoustic reflectivity, also the intrinsic nature of the surface (i.e. sediment type, density, composition) can be deduced and studied in relation to the morphology. Moreover, the very-high resolution of the imagery enables to study the biological and anthropogenical activity imposed on the seafloor. A new approach is to drape side scan sonar imagery over multibeam data, whereby a VHR, multi-parameter, three dimensional digital terrain model is obtained.

Both methods enable the use of acoustic seafloor classification techniques that can aid in the automatic mapping of seabed characteristics such as sediment type or bedforms. Backscatter values are used to calculate statistical parameters, which allow to differentiate between certain seabed classes. In this way it becomes possible to capture the visual information in a quantitative way, such that different areas and surveys can be compared on a common ground. Multibeam backscatter images have the advantage that the reflectivity values are corrected for depth, recording angle, sound velocity,..., while side scan images have a better resolution and hence can be used to study small details.

Clearly, an integrated side scan sonar / multibeam approach opens new perspectives in the understanding of the seafloor architecture and the physical and biological processes involved. As such, more and more information becomes available that can only be addressed through multidisciplinary research.

Keywords: side scan sonar; multibeam sonar; acoustic seafloor classification; modelling.