

## Acoustic Seafloor Classification: Potential and Limitations

When sound waves interact with the seafloor and/or penetrate into the sediments beneath, the incident energy is scattered in all directions. Careful analysis of this acoustic backscatter can tell us important information about the texture and roughness of the seafloor itself, as well as various geophysical and geotechnical characteristics of the underlying sediments. In other words, the acoustic 'signature' of seafloor has the potential to provide quantitative information about seafloor features and sediment structure.



The morphology of the seafloor is a combination of large-scale features (e.g., continental shelves, abyssal plains, seamounts, etc.) overprinted with finer scale features (e.g., ripples, sand waves, shell beds, mud flats, etc.). Acoustic methods have long been used by hydrographers to map the large-scale features of our oceans. Beginning in the early 1950s, improvements in the design of low-cost, high-quality acoustic transducers, combined with significant advancements in signal processing capability, have led to the development of advanced wide angle (multibeam), multi-frequency sonar systems that can provide unprecedented information about the finer scale features of the seafloor and seafloor sediments. As a side note, these new sonar systems also have the ability to simultaneously collect water column data, thereby opening up new opportunities to better understand ocean processes.

Currently, acoustic seafloor classification involves a wide range of techniques, each of which has the potential to yield at least a partial picture of the physical characteristics of the seafloor and underlying sediments. The combination of various techniques and assessment of complimentary results offers the best potential for overcoming systemic limitations of any one technique. For example, the accuracy of seafloor roughness estimates is dependent on segmentation (i.e., subdivision) of the backscatter data into more or less homogenous classes. However, this unsupervised approach is at odds with geo-acoustic inversion modelling insofar as such models are not directly applicable to the acquired data, and therefore seafloor classification is imperative prior to inversion modelling. This is in part due to the fact that at low to medium frequencies (100 to 10,000 Hz) the estimated model parameters fluctuate due to the sound signal penetration into the underlying sediment. This is further complicated by ambient noise, such as wind generated surface waves, and discontinuities in the water column caused by variations in temperature. Moored passive hydrophone arrays may be used to collect ambient noise data, while layer-wise coherent reflection coefficients may be obtained through the application of propagation modelling or analysis of the water column data. These techniques are increasingly being augmented with remote online survey methods (in an effort to reduce time-consuming and costly spot-sampling necessary for parameter validation), and soft-computing techniques (e.g., artificial neural networks) in an effort to blend low-order deterministic chaos theory with higher order stochastic techniques.

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