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Potential and limits of multichannel seismics to image the oceans' finestructure

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Seismic oceanography is slowly becoming a popular tool to investigate the internal structure of the water column. The principle of this technique is that seismic energy is partially reflected at the boundaries between water masses with contrasting temperature (and salinity), then recorded and processed to provide continuous images of these boundaries. Numerous papers have recently appeared showing the potential of seismic oceanography to image the oceans' finestructure with unprecedented lateral resolution (~10 m), the spatial coincidence of seismic reflectivity and temperature/salinity contrasts, and the correlation between seismic reflections and internal wave spectra. Despite the relatively large amount of work, little has been published concerning the existing issues to adapt seismic systems to oceanographic research. As part of the European funded GO Project (www.dur.ac.uk/eu.go) and Spanish funded Geocean project we present here a set of basic synthetic tests to illustrate the relative significance of different parameters for imaging the oceanic finestructure using seismic methods. The parameters considered include the frequency content and energy of the source wavelet, the ambient noise level, as well as the shooting rate, signal redundancy and fold. We show that powerful (>200 dB re 1 microPa), low-frequency (20-60 Hz) sources such as those commonly used in deep seismic soundings (DSS) are very well-suited to image also the oceans finestructure at all depth ranges. The reason for this is twofold: on one hand, the acoustic impedance associated to intra-oceanic boundaries is two orders of magnitude smaller than those associated to geological

boundaries, so it is crucial to use energetic sources to overcome ambient noise regardless of the target proximity. On the other hand, the structures developed by double diffusion, in contrast to the geological ones, do not show abrupt impedance contrasts but rather smooth gradients within layers of several tens of meters, so the dominant wavelength of common DSS sources (20-80 m) is suitable to image them. In addition, we show that for a given system layout one can define the optimal shooting rate that gives the best possible signal-to-noise ratio by taking advantage of system redundancy but at the same time allowing background seismic noise due to repeated shooting to mitigate.