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# Dealing with the kinematics of moving reflection surfaces in seismic imaging of water structure

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The use of seismic reflection methods to image water structure has produced remarkable profiles that can be used by physical oceanographers to understand the fine-scale dynamics of the oceans. In particular, the mapping of internal waves and the transition into turbulent mixing. However, the very dynamic processes we capture in the seismic image gives rise to a problem for processing the data. Standard seismic processing is predicated on two basic principals: firstly that the energy in the scattered wavefield is very small compared to the incident energy; and secondly the target is stationary. Though the first is fulfilled as the reflection coefficients are typically less than 0.001 the second is not and, although the wavelength of the internal waves is long and their propagation speed is slow, the small changes in the normal incidence time creates significant errors in the normal-moveout correction.

In standard processing each trace in common mid-point gather is corrected for moveout that depends on the reflection time at zero offset, source receiver offset and sound speed in the sub-surface. If the reflection time at zero offset is fixed then we can use the moveout to estimate the sound speed structure. For the oceans we can translate the problem as the sound speed can be measured so we can use the moveout to estimate changes in the reflection time at zero offset. We demonstrate the principal using data collected during the EC funded GO-project in the Gulf of Cadiz and show that by analysis of the moveout an estimate of both the speed and direction of the horizontal velocity of the internal wave can be made in the plane of the seismic section. By a more sophisticated Fourier decomposition of unstacked seismic reflection data, individual components of the internal wave motion can be analysed.