Some Acquisition Design Issues for 3D P-S Seismic Surveys

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When converted-wave (P-S) seismic surveys were first recorded in the early 1990's, acquisition design was based upon the assumption of asymptotic conversion points (ACP) at the reflector. The ACP is independent of reflector depth and represents the asymptote to the actual conversion point trajectory as the depth-to-offset ratio approaches infinity. A global Vp/Vs is assumed and the major design issues involved bin size and fold periodicity. The 'natural' bin dimension for a 3D ACP P-S survey design is given by $[\Delta s/(1 + Vs/Vp) \times \Delta r/(1 + Vs/Vp)]$ where Δs is the shot spacing and Δr is the receiver spacing, and this yields a smooth P-S fold distribution. However, this bin dimension is larger than that typically used for conventional P-P surveys (so-called CDP binning) and makes trace-trace correlation between P-P and P-S data volumes more difficult.

For modern 3D P-S survey design, we now use depth-specific conversion point (DSCP) binning in which conversion points for flat-layered models are determined by ray-tracing, given interval Vp/Vs values and target depths. Also, CCP fold is interpolated into CDP bins by a band-limited sinc-function, as described by Cary and Lawton in another paper at this Workshop. DSCP binning is sensitive to a number of factors, for both land and marine P-S surveys, particularly the location of the conversion point. The DSCP will always lie on the receiver side of the ACP (apart from some extreme cases of anisotropy). As Vp/Vs increases, the DSCP will move toward the receiver. If the layered media exhibit Vertical Transverse Isotropy (VTI) the DSCP will move toward the source. For ocean-bottom seismic (OBS) surveys, the DSCP will move towards the receiver as water depth increases (this will also occur for CDP's in the P-P component of OBS surveys. Some of these design issues are illustrated with an example for a 3D P-S survey with source and receiver intervals of 50 m, source line spacing of 100 m, receiver line spacing of 300 m and a target depth of 2000 m. Maximum offset is 2500 m. Figure 1 illustrates variation of CCP fold distribution for increasing Vp/Vs for an OBS survey in 200 m water. Figure 2 illustrates variation of CCP fold with increasing water depth for Vp/Vs = 2.0. Map area in both examples is 2.7 km x 2.0 km and bin size is 25 m x 25 m. Maximum fold (red) is ~170.

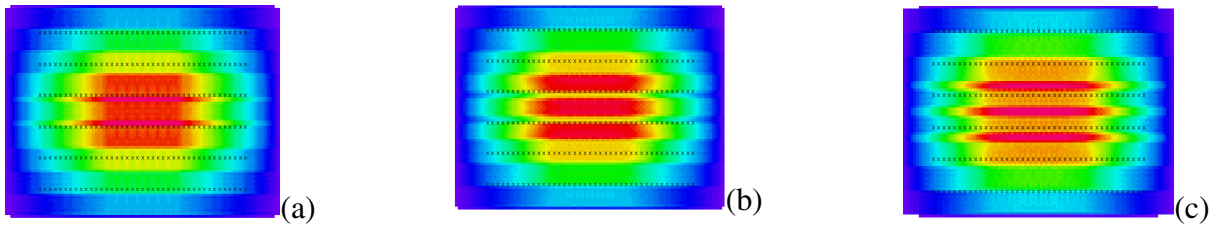

Fig 1: CCP fold for water depth of 200 m. (a) Vp/Vs = 1.8; (b) Vp/Vs = 2.0; (c) Vp/Vs = 2.2.

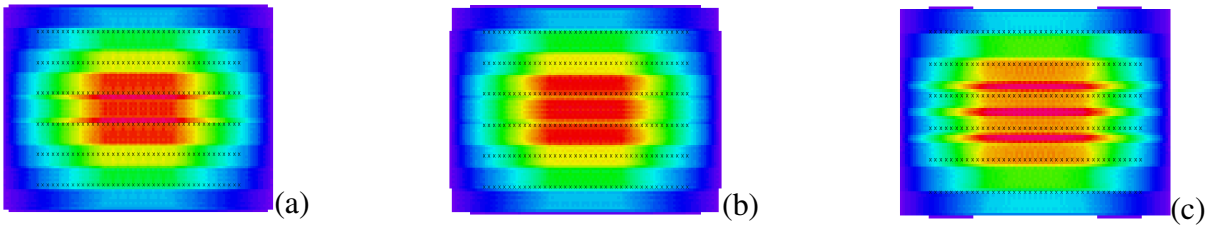

Fig 2: CCP fold for Vp/Vs = 2.0. (a) Water depth (WD) = 0 m; (b) WD = 100 m; (c) WD = 400 m.