Incorporating Near-Surface Velocity Anomalies in Pre-Stack Depth Migration Models

Unresolved velocity anomalies in the near-surface degrade deeper imaging. As a consequence, great care needs to be taken to ensure that all significant near-surface effects have been dealt with before attempting to build the deeper parts of a velocity depth model. All ray paths that pass through a near-surface velocity anomaly will be affected by it, distorting the subsurface response about half a cable length to either side of the anomaly. The distorted region actually extends beyond a half cable length due to the influence of the Fresnel zone: in other words, we are really dealing with wavefronts rather than hypothetical rays.

In the context of this review, by "near surface" I refer to features whose fold of coverage in CRP gathers is either too low or near the practical limit for autopickers to be able to determine residual moveout, and/or whose lateral extent is too small for ray-based methods to perform reliably (i.e. features with lateral velocity changes occurring over distances less than several times the dominant wavelength of the seismic wavefronts reflected from them).

Here, I'll describe current industrial practice for building complex near-surface models, which is based on a range of approximate techniques (depending on whether just the geobody geometry alone is discernible, or whether its velocity distribution as well is known), as well as the more complete solution offered by the emerging technology of waveform inversion. It will be shown that, although usually painstaking, a suitable near-surface velocity model can often be obtained.