Amplitude preserving weights for Kirchhoff prestack time migration

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ABSTRACT
A desirable output from prestack migration is an image of subsurface reflectors, where peak amplitude is proportional to band-limited 'true-amplitude' reflectivity (Gray, 1997). In a 'Kirchhoff' (i.e. weighted diffraction stack) prestack time migration (PSTM) or prestack depth migration/inversion, the diffraction traveltime surface can be defined over the complete set of preconditioned input traces. This set is redundant, however, given that it is composed of a number of sufficient subsets corresponding to idealized acquisition configurations (e.g. common-shot* or common-offset gathers), each of which can provide an aperture-limited and angle- or offset-dependent estimate of subsurface reflectivity. Hence, a summation over the complete diffraction surface is an average of reflectivity estimates from migrated common-shot or common-offset gathers.

The optimal weight for averaged reflectivity should be based on Bleistein et al's (2001) common-offset weight. In comparison, the common-shot and common-receiver weights, although correct for individual gathers, produce average reflectivity estimates with a dip- and depth-dependent bias. Bleistein et al's (2001) common-offset weight is more suitable as a basis for practical weights because it downweights by the cosine of the ray half-opening or obliquity angle at the reflector and hence accounts for the corresponding reduced spatial resolution as obliquity angle increases. In this paper, weights for optimal 2.5-D and 3-D diffraction stack migrations are i) tested using simple noise-free constant-wavespeed synthetics, ii) re-expressed for practical implementation as relative-amplitude-preserving PSTM weights, iii) customized for the equivalent offset method (EOM) of PSTM, and iv) used to image field data from the LITHOPROBE SNORCLE transect.

All references to common-shot gathers also imply common-receiver gathers. With reciprocity, the weighting functions are identical.