Wavefield Extrapolation for Prestack Time Migration with RMS Velocity Part I – Algorithm

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Wave equation migration (WEM) has been widely used in prestack depth migration recently. Its advantage of being able to handle multipath usually generates a better image than Kirchhoff migration. However, apart from less computational efficiency than Kirchhoff migration, WEM cannot be used in time migration with rms velocity because wavefield extrapolation has to use interval velocity. For time migrartion applications of WEM, one has to convert rms velocity to interval velocity by using Dix's equation. Time migration can be viewed as a valid imaging process but its imaging velocity (rms velocity) does not have any physical meaning. To produce physically possible and geologically reasonable values for velocity through Dix's conversion, large scale smoothing is needed before or after conversion, and in doing so the original information of rms velocity is lost.

A wave-equation-based summation (WESUM) algorithm has been developed for prestack depth migration with flexibility and option to output common image gathers in the offset domain. It is shown that WESUM is also applicable for prestack time migration with rms velocity as opposed to running usual WEM using interval velocity. In addition, WESUM is able to use real source and receiver locations and also able to handle crooked line data. Just as in Kirchhoff prestack time migration, image at one point is only related to the rms velocity at that point so that it is possible to use WESUM to perform prestack time migration velocity analysis. The image quality with WESUM is better than the one from Kirchhoff migration in most cases.