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– Review –
Seismic Reflection Imaging

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The research performed in seismic reflection imaging can be assigned to three major categories. These are

A. True amplitude image transformations

B. Macromodel-independent zero-offset simulation

C. Imaging in general

A.) The ultimate aim of any kind of true-amplitude reflection imaging is to provide possibilities of compensating seismic primary reflections for their geometrical spreading loss. In this way, it becomes possible to extract reflection coefficients from reflector images in all kinds of migrated or unmigrated seismic sections. In a series of papers, Tygel, Schleicher, Hubral et al. have continuously developed the Unified Approach to Seismic Reflection Imaging. Two basic articles on this theory were published in Geophysics and received a Honorable Mention at the SEG Meeting in Dallas 1997. Various practically useful seismic image transformations (also called by the CPW Consortium: Data mapping) are based on chaining (or cascading) the migration and demigration operators. All these transformations are in true amplitudes. Apart from their direct use in seismic processing, all image transformation can also be employed in velocity-model updating and in data regularization. The theory of Seismic Image Waves, as partly described in the articles by Mann et al. (Reference!) and Schleicher et al. "Seismic constant-velocity remigration" (Geophysics. 62, p.589-597) involving represents another approach to achieving the same goals. Here, the above image transformations are described by some partial differential equations that allow to "animate" the seismic images.

B.) In seismic reflection imaging, in particular in true-amplitude imaging, macro-velocity models play a dominant role. However, and most excitingly, we find that zero-offset sections can also be simulated from multicoverage reflection data without knowing the macro-velocity model. More precisely, only the near-surface velocity needs to be known. Instead of using a macro-velocity model to determine stacking surfaces as in DMO or MZO, a maximum-coherency search algorithm can be employed. The stacking surfaces, which are given analytically, are determined by optimizing three search parameters. The stacking surfaces implicitly involve optimally illuminating curved reflecting elements (reflector mirrors). This not only enhances the reflections but also provides important wavefield attributes. These are needed for a number of purposes: macro-

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velocity model determination (after zero-offset simulation), true-amplitude imaging, reflector characterization. The theory goes back to fundamental theoretical contributions of Hamilton, Bortfeld, Hubral and Gelchinsky. The subject will be extensively explored in the future.

C.) Special topics of imaging like time-lapse migration, image enhancement, and remigration techniques will be included or continued in future research programs. Other auxiliary research as, for instance, on better algorithms for the necessary Green's functions computations, will also remain a part of the general research in reflection imaging.