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PRACTICAL ASPECTS OF POST-STACK MIGRATION

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A conventional stacked (zero-offset) seismic section is the response of the subsurface on a two-dimensional plane of profile. It can be considered as the image of a passing wave field recorded at selected points on the Earth's surface. In regions of complex geology, this image may bear little resemblance to the image of subsurface reflectors. Migration is the process used to transform the wave field of a seismic section into another, which represents a reflectivity subsurface image. For this reason, any seismic migration method should be related to a solution of the wave equation. Such a solution can be derived from either an integral (summation) or differential (finite difference) form of this equation. The problem of migration can be approached either in the space-time or in the wavenumber-frequency (or in wavenumber-time, or in space-frequency) domain. The output of a migration method can be a time section (in the case of time migration) or a depth section (in the case of depth migration).

Certainly, the approach for a migration method yields an approximate solution of the same wave equation. Although these approximations are not identical, the different migration methods work approximately in the same manner on stacked seismic sections, that is, to move dipping events (reflections) into their assumed true subsurface positions and collapse diffractions. But every migration method has limited performances relating to an ideal migration method (the ability to handle fully variable interval velocity fields in time or in depth, the maximum dip which can be properly migrated, the possibility to attenuate the evanescent energy, the preserving of reflection amplitudes, the ability to image overturned reflectors when waves that turn beyond 90 degrees have been recorded, the sensitivity to velocity errors, migration noise, etc). We mention some well-known industrial post-stack migration methods: implicit finite difference (FD) time (or depth) migration (Claerbout, 1985); explicit FD time (or depth) migration (Hale, 1991, [5]); Kirchhoff depth migration (see, for example, Yilmaz, 1987, p. 252-259); Stolt migration (Stolt, 1978); phase shift migration (Gazdag, 1978 and Bardan, 1980); reverse-time t-k migration (Hale, 1991, [4]).

In this paper some practical aspects of the above post-stack migration methods are considered. Firstly the migration requires the true medium velocity. If we use a velocity model that is significantly different from the medium velocity, then the migrated section can be misleading. For this reason the responses of these methods to velocity errors are examined and a procedure for estimating migration velocities is presented. We consider the effect of the maximum dip to migrate of method on the migrated section. This may be useful when we need to suppress the steeply dipping coherent noise (for example, evanescent energy). Limiting the dip parameter is a way to reduce migration noise and computational cost. The maximum dip to migrate and migration noise can be observed on the sample impulse responses of migration methods (the image of migrated linear event is approximately tangent to impulse response). The explicit FD methods differ from standard implicit FD methods in that each filtered output sample is computed independently of the others via convolution. For this reason the migration noise of explicit FD methods is smaller than the noise of implicit FD methods.

In contrast with the time migration methods, the depth migration methods can handle severe lateral velocity variations. But we have to mention that depth migration algorithms require a detailed velocity model in which all the lateral velocity variations are considered. How do we derive a detailed velocity model? If the detailed velocity model were know exactly, we also would know the subsurface geological model, and, hence, would have no need to do the migration. In this respect, depth migration can be viewed as a mean of testing an initial geologic hypothesis. Consequently, most good depth migrations are the result of an iterative process. Certainly, the determination the velocity model for migration has as starting point RMS stacking velocities. An important improvement of the initial velocity model can be obtained by the analysis of constant velocity migrated sections. For this reason we can use Stolt method, which is the fastest method and requires RMS velocity. Other parameters that affect performances of the post-stack migration methods are analyzed (maximum spatial sampling interval, the maximum dip can be properly migrated, the stretch factor in Stolt migration, etc).

The above-mentioned practical aspects of the post-stack migration methods obtained by their PROMAX implementations are discussed and illustrated by synthetic models and real images. We conclude that the choice of the suitable migration method and its optimum parameters is a very important problem in the processing of seismic data.

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