3-D Velocity Model Building via Iterative One-Pass Depth Migration

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The central issue in imaging complex structures is the elaboration of the velocity field. This is the key to any successful migration, whether it be post or pre stack.

Here we present a pragmatic approach to estimating or validating the 3D velocity field using 3D post-stack depth migration in an iterative quasi layer stripping manner. We show how it can be practical to rapidly perform many steep-dip numerically isotropic non-dispersive depth migrations, perturbing the velocity field in search of an interpreted optimum result.

A real data case history will be presented comparing results obtained via two approaches. The previous approach involved a more conventional route, deriving the model using map migration of the upper layers and a two-stage "layer stripping" depth migration of the deeper target zone. The more flexible approach proposed here also uses a conventional map migration for the simpler upper layers, but then proceeds to an iterative approach to firstly localize boundary positions, and if necessary perturb the velocities laterally by "scanning" a suite of percentage velocity changes in the model for the layer in question.

In the salt diapir considered in the examples, improvement is evident in the image of steeply dipping upturned sediments on the flanks of the structure.

INTRODUCTION

The fact that pre-stack 3D depth migration is still not commercially viable on an entire 3D data volume relegates us to the second-best alternative of post-stack 3D depth migration. Fortunately, the cost of 3D post-stack depth migration has in recent years ceased to be a major factor in deterring people from performing depth migration.

With improvements in the dip response and numerical isotropy of new algorithms (Hale, 1991a, b; Li, 1991, Jones, 1992; Soubaras, 1992a, b), software-generated artifacts (Diet, 1984) have also become less of a concern.

However, the central issue in any imaging strategy remains not the migration itself, but the velocity field employed during that migration. Several authors have suggested strategies for 2D pre-stack depth migration velocity model generation either by focusing analysis (Yilmaz & Chambers, 1984; Jeannot et al, 1986) or techniques involving a tomographic approach (Stork, 1992). However, as yet these techniques have not been generalized in practise to the 3D world, and to date focusing analysis itself does not take place in true "migrated space", hence the reliability of the velocities thus determined is limited to the case of near-vertical incidence (Audebert & Diet, 1990) (although this latter failing has recently been addressed (Audebert, 1993)).