

On Structural Integrity in Seismic Data

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Abstract

The industrialist Peter Scotese once said, “Integrity is not a 90 percent thing, not a 95 percent thing; either you have it or you don't.” In the case of seismic data, structural integrity derives from the combined accuracy of the migration algorithm and velocities used. Indeed, these two components are complimentary. For example, even the most accurate migration method cannot provide reliable structural images if the velocities used are obtained by simply scaling stacking velocities by 90 percent or 95 percent!

The nature of the velocity field is, of course, a major factor in determining the detail, sophistication and intensity required for velocity analysis. However, it also influences the accuracy of the structural image in other, subtler ways. In particular, although the range of velocity variations dictates the complexity of the imaging method that should be used, it can also influence what parts of the earth can be imaged, and, by implication, even place constraints on the data acquisition. Finally, because the focusing aspect of migration is relatively insensitive to certain (anisotropic) aspects of the velocity field, this limits the accuracy with which migration velocities alone can be used to convert directly to depth, and can even introduce lateral mispositioning in the final image. Indeed, this is one of the major reasons why migrated data often do not tie wells correctly.

In this paper, we consider the impact and interaction of velocity variations and migration algorithms on structural imaging. Specifically, we review different migration algorithms, and show how more detailed and accurate consideration of the velocity behaviour on the underlying physics can lead to more reliable images and improved velocity determination. We also show that fundamental limitations in data-derived velocities can be overcome using well information, and that, when this is done, anisotropic prestack depth migration can provide exceptionally accurate images in depth. As General Norman Schwartzkopf once said about integrity, “The truth of the matter is that you always know the right thing to do. The hard part is doing it.”