From depth migration model building through to structural uncertainty analysis: an integrated workflow

Authors:
Matthew G. Lamont
James Gunning
Michael E. Glinsky
James H. Robinson

When evaluating prospects, some of the questions to which we would like answers are:

What is the shape of the container?
What are the potential volumes in a prospect?
Where is the spill point?
What is the best position to site the well/s?

Naturally there are not single answers to any of the above questions, since the seismic inversion problem for structure is inherently non—unique (the velocity/depth ambiguity). Rather what we would like to know is the distribution of potential answers and their likelihood.

A quantitative evaluation of uncertainties based on a PreSDM workflow is proposed. Reflection tomography together with PreSDM allows velocities to be constrained at each point within a volume.

The proposed workflow utilises a reflection tomography scheme which generates a system of constraint equations for the velocity model based on raytracing and pick uncertainty. These constraints acting alone produce an unstable and non-unique inverse problem, but if these constraints are used as a likelihood in a Bayesian scheme (Scales, 1997) which imposes a realistic geostatistical model for the prior spatial distribution of velocities, the instability is removed. The resulting Bayesian posterior distribution is then a compact expression for the distribution of structural maps which satisfy the tomographic constraints and the requirement of geological realism.

To get more background on image gather reflection tomography, readers are referred to Stork, (1992), Kosloff et. al., (1996), and Meng and Bleistein, (2001), to name 3 papers out of the many available.

References:

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