

Three-dimensional depth migration and analysis of the Clearwater Heavy-Oil Reservoir at Cold Lake

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We have been analysing three-dimensional seismic data from a Cold Lake, Alberta heavy-oil field. The particular data set used in our study was acquired in 1994 during a steam enhancement production cycle. Previous work on these data were done in the time domain - a well-established method. Recent advances in migration algorithms and computing at our laboratory, however, led us to believe that a depth migration analysis could be a fruitful approach to more accurately delineate the steamed condition of the Clearwater Formation, the producing reservoir.

The migration process is most often done in the time domain. But, depth migration can be desirable because of the difficulties that can be encountered in converting from the time migrated domain to physical depth. Three-dimensional depth migration in space produces an image which can be used directly with engineering data from well-measurements - an important consideration since the wells at the site are deviated. Other difficulties in integrating seismic data, well logging and other engineering data can result from the usage of time migration. Reflectors may be mis-located since it is generally assumed that the medium has mild lateral velocity variations. In a steam heated reservoir, however, strong lateral velocity variations are expected because of phase changes, temperature increases and gas saturation. Consequently, standard time migration may not always provide adequate accuracy. Three-dimensional depth migration has the potential to resolve the problems described since it is able to transform the time domain directly to depth and second it better handles lateral velocity changes.

The particular omega-x migration we use has been implemented in the PVM environment to run on the different parallel processing systems at the University of Alberta. This allows us to process the large 3-d data set very quickly and efficiently.

Based on the re-processing results - 3D depth migration and subsequent seismic attribute analysis - we believe we have enhanced the resolution of the data at the level of the Clearwater Formation. It is possible to obtain a direct correlation between the migrated seismic images and well-logging data and to delineate the steam heated zones beyond the immediate area where steam is being injected.