

Analysis of Time-Lapse Seismic Technology Using a Physical Model of a Porous Channel Sand

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ABSTRACT

Time-lapse seismic has become an increasingly popular tool in the oil and gas industry as we move from exploration in new frontier basins to production in more mature basins. The goal of time-lapse seismic is to augment the information measured at injection and production wells by attempting to directly detect the movement of fluid fronts in an effort to more completely sweep hydrocarbons from the reservoir.

I represent my reservoir by an idealized channel sand system. To my knowledge, there are very few physical or numerical model experimental studies on this topic so far. Numerical studies suffer from the computational cost of fully 3-D elastic wave equation modeling. Physical models suffer from the limitation of materials where traditionally, we have used epoxies and resins having a Poisson's ratio of about 0.30. To model the idealized reservoir in question, I collaborated with the UH Art Department, and found that sintered glass beads can model a porous sand having a Poisson's ratio close to 0.10.

I started my work with model fabrication and 3-D acquisition in AGL's physical modeling laboratory, followed with data processing prior to interpretation. I pioneered new experimental techniques and work flows in constructing a model with porous media, injected the chosen media with fluid, and calibrated the transducer radiation patterns for AVO analysis.

I gathered three 3-D datasets over my model corresponding to different fluid distributions. I then processed these data with a simple relative-amplitude preserving flow, including 3-D pre-stack time-migration. I delineated the channel fluid-front by extracting and comparing seismic attributes of the datasets. Of these attributes, seismic coherence and AVO were able to better illuminate channel fluid-front than amplitude extraction, envelope and instantaneous frequency.