Multi-Seismic Attributes Analysis Workflows and a Case Study in a Shale Gas Play

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ABSTRACT

A key question to be addressed in applying seismic attribute analysis to the exploration and exploitation of shale and tight sand plays is whether the analysis can help explain the large variability of production among horizontal wells in the same play. It is "common" in these plays to observe an 80-20% phenomenon in well's production, whereas about 80% of the production is contributed by 20% of the wells. Advancement in well completion and horizontal drilling technologies are major factors for the success of shale and tight-sand plays. Due to very low permeability and porosity of the reservoir rock, these plays would not be economical at all without fracking. While acknowledging that proper completion and drilling can determine the success of one well, a large variation of productivity can still be observed among horizontal wells that share similar drilling and completion parameters. It is therefore reasonable to attribute the variation of well productivity to the spatial variation of reservoir properties, which is controlled by the local geological setting. The challenge therefore faced by seismic geophysicists is how to map these reservoir properties before drilling. This talk will present two lines of thought in developing seismic attribute analysis workflows to map high productivity areas (sweet-spots) in shale and tight- sand reservoirs. The first line of thought is a prospecting workflow that is based on model-based attributes. The second line of thought is a forensic workflow that is based on "data-based" analytics. A case study of applying these two workflows in a shale gas play will illustrate the strength and weakness in each workflow. In the prospecting attribute analysis workflow, we rely on seismic attributes that have clear physical meanings, which can be linked to rock properties through physical models. There are a variety of rock properties that are regarded as influential to the productivity of shale and tight-sand plays, such as total carbon content, in-situ porosity and permeability, content of brittle minerals, in- situ fracture density and orientation, local stress field, etc. In the forensic attribute analysis workflow, we use a more "data-driven" approach. We do not assume any direct link between any seismic attribute and rock properties or production potential. Instead, we rely on historic production data in the reservoir to reveal if there is any relationship between production data and seismic attributes. The analysis of such a type of relationship must also consider the influence of drilling and completion parameters. Combining both types of seismic attribute analysis workflows discussed above is a more pragmatic approach in practice. Using these workflows together can help in reducing the uncertainty of mapping "sweet-spot" and increase well productivity.