Nodal Inversion: An Optimization Algorithm to Reduce the Run Time During the Seismic Inversion

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ABSTRACT

For field exploration, development and monitoring plans, quantitative seismic interpretation has been extensively employed recently to carry out seismic reservoir characterisation. With the advent of simultaneous and stochastic seismic inversion, azimuthal AVO inversion and time lapse monitoring, we are faced with a variety of large seismic cubes with traces in different angles, azimuths and acquisition dates. To benefit from all the aspects of the available seismic data, full seismic inversion for any of the above mentioned jobs will take a few days to a few months. Due to the limitations of allocated time and budget on practical projects, this brings an important question on the table. Do we really need all those seismic traces and can we wait up to a few weeks for the full seismic inversion? In response to the above limitation, we introduced an intelligent technique that selects a few percent of seismic data to run the seismic inversion. The theory behind this method is that there is a need for more seismic traces on geologically complex areas, and on the other hand, relatively less complex areas can be characterised using less dense seismic traces. Utilising the seismic attribute maps on the target levels, Nodal Inversion method starts with a very limited number of traces over the complex parts of the study area and at the well location. Subsequently, it generates the attribute maps on the target levels by interpolation and extrapolation of the selected traces. On the third step, Nodal Inversion adds new traces to the regions with the differences between the original attribute map and the estimated map using the selected traces. Nodal Inversion carries out this step by iteration to produce an attribute map with a predefined acceptable difference compared with the original attribute map that is generated using all seismic traces. By this technique, one can reduce the size of the seismic data by up to 99%, depending on the complexity of study area. Since the key traces on the complex area are selected by this method, we are able to replicate the original seismic image by interpolation of the selected traces. In our 3D synthetic seismic data, Nodal inversion was able to reasonably replicate the complexity of the area using 1% of the seismic traces. Thus, we were able to run full stochastic seismic inversion to produce 100 realisations in about 55 minutes.