EAGE

RM05

Inversion of Dynamic Properties from 4D Seismic, Ensuring Coherency between Geology, Engineering and Rock Physics.

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SUMMARY

We showcase a method to provide 4D seismic information in the reservoir engineering domain, making integration into AHM loops more straightforward whilst ensuring that the 4D signal, production data and geology are coherent at the well through calibration of the poro-elastic model. An example is shown on a field undergoing production and water injection.

Integrating the 4D seismic into the characterization and modeling of the reservoir can be difficult as interpretation of the elastic properties can be complex, requiring analysis of a poroelastic model (PEM). However, 4D seismic data has the potential to provide valuable information when updating the structural model and facies distribution. It can be argued that the integration of 4D data is made simpler if interpreted (or inverted) dynamic changes (ΔSw, ΔP, ΔSg) rather than elastic changes are provided to the geologist or engineer. Several inversion schemes exist for the inversion of ΔP and ΔSw (Landro 2001, Meadows et al 2001) with some theoretical examples of the integration of results (Trani et al 2011). Here we use a scheme similar to that of Meadows et al (2001), empirically approximating the PEM as a function of the dynamic parameters only, whilst ensuring that the empirical relationship is a valid approximation (Validation 1 – Figure 1). We have now calibrated the PEM to the local geological variation; however, this does not ensure that the seismic data will be converted to reasonable ranges of dynamic parameters (e.g. maximum fluid displacement in a sand, Buckley and Leverett (1942)). By extracting the 4D seismic local to the well along with the simulated changes in dynamic parameters and plotting with the calibrated relationships (Figure 2) we can see if the inversion will produce spurious results. This process can then be repeated (using different interpretation of the well data, modifying the PEM) until coherency between 4D seismic and dynamic parameters are reached. This workflow is applied to a water injection well in a field offshore Angola.

The calibrated relationships are then used to invert for ΔP and ΔSw across the reservoir and examples of how this data is used to upgrade the geological model and incorporated in history match objective functions are shown.

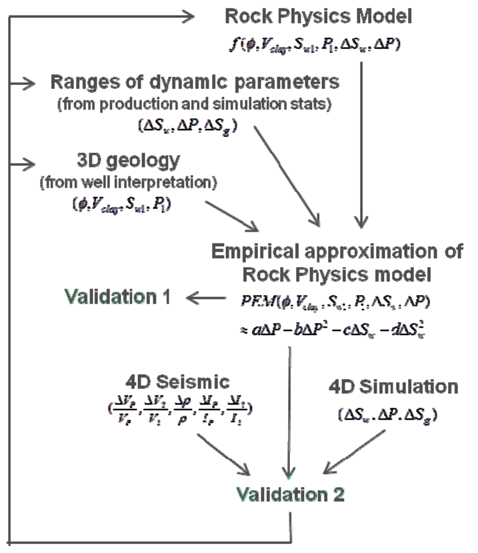

Figure 1 *Schematic of the calibration– highlighted in green are the two validation steps.*

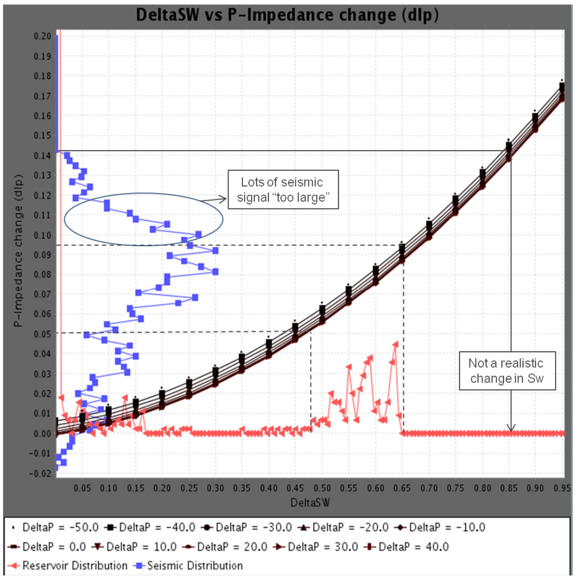

Figure 2 *Validation 2 – 4D Seismic (blue), calibrated PEM (black) and simulation data (red) from around the well are checked to ensure coherency.*

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