

Reservoir characterisation using CSEM, seismic and wells logs: approaches, challenges and pitfalls.

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Combining multiple geophysical data types using integrated interpretation or joint inversion approaches can provide information on earth properties that is either unreliable or simply unavailable when only a single data type is considered. The combination of seismic and CSEM within a robust rock physics framework has the potential to improve the certainty with which reservoir lithology and fluid properties are constrained.

Although seismic data are extremely sensitive to the changes in lithology occurring at the boundaries between geological units, they are less sensitive to fluid changes within these units even when these changes are substantial. Although such changes can in some circumstances be detected and used to provide information on fluid distribution, in other situations this is difficult or impossible to do with certainty.

In many situations electrical resistivity is driven by the properties and distribution of fluids in the earth. This change in resistivity caused by variations in fluid content and saturation can, in principle, be detected using CSEM tools. However when only CSEM data are considered, structural resolution is poor because of the diffusive nature of the EM fields, and the results can be ambiguous because the effect of an increase in pore fluid resistivity cannot be distinguished from the effect of a decrease in porosity. The presence of frustrating resistors in the section (for example tight carbonates or cemented sandstones) can also complicate the interpretation.

Although integrated interpretation brings many benefits, there are a number of challenges to be overcome before such approaches can be robustly applied. Firstly measurements made using very different physical processes must be combined and linked to the underlying rock and fluid properties in a consistent fashion. This requires a rock physics framework to be either numerically derived or empirically calibrated at well locations. Secondly seismic, CSEM and well log techniques sample the earth at very different scales, varying from a few cm in the case of well logs, to hundreds of metres for CSEM. These different scales must be reconciled in an integrated interpretation or joint inversion approach. Finally in order for an integrated interpretation approach to be successful, both seismic and CSEM methods must be sensitive to the interval of interest and changes in properties within it. Although this is perhaps an obvious statement, it is however a key consideration in determining where such approaches can be applied.

The solutions to these challenges are case dependent and must be considered with care. For any given geophysical question, the most robust answer will be obtained by using the tool, or combination of tools best suited to the task. The resulting choice of data must then be integrated within a rock physics framework, to provide a model that is geologically reasonable, and consistent with each of the geophysical data types available.

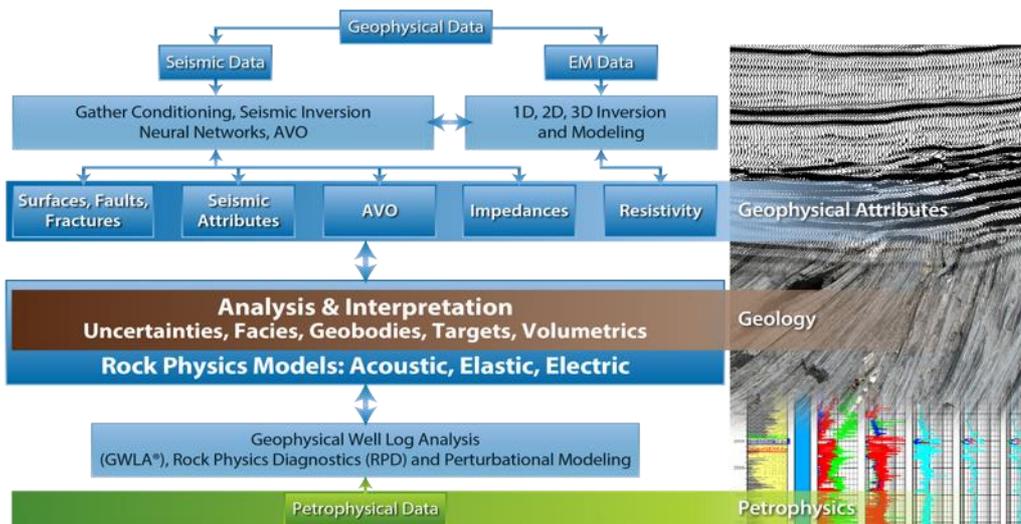


Figure 1: An overview of the integrated interpretation workflow applied to seismic, well log and CSEM data. The goal of this process is to develop a geologically sound earth model consistent with all of the data types used in the analysis.