JOINT GEOPHYSICAL IMAGING FOR FRACTURED RESERVOIRS

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Seismic and electromagnetic wave fields in the accessible (drillable) earth both respond to changes in rock properties and structure, yet are not usually combined into a single subsurface map that reflect these common changes. Variations in layer thicknesses, folds, faults, fault-related offsets, porosity, fluids, and saturation create anomalies in both fields. The presence of oriented fractures and fabric adds anisotropic responses to both as well. Ideally, both fields would be used to create a map that combines their responses to a sought after property, say porosity, in a single "joint geophysical image". The members of the Institute of Earth Science and Engineering are working toward such JGI maps, progress in which is reported on in this presentation.

A simple example of JGI is the inversion of high-resolution seismic refraction and magnetotelluric data collected over a simple layer-over-basement structure. Here the common factor is the layer thickness, the value of which is most accurately found forcing the seismic velocity and apparent resistivity models to give the same number. A less simple example is the combined use of seismic travel times and MT resistivity converted to seismic velocity to locate microearthquakes. An even more complicated example is the inversion of shared S-wave-splitting and MT-polarization effects from zones of oriented and fluid-filled fractures.

Some of theoretical and practical aspects of these three cases will be discussed, including: (a) data gathering techniques, (b) physical models of the shared properties, especially in the case of fractures and anisotropy, and (c) quantitative methods for combining measurements.

PRESENTER PROFILE

PETER MALIN is a geophysicist interested in the properties and dynamics of the crust, specializing in seismology in energy-reservoir exploration and characterization. He is involved in 3 borehole seismology projects in Australia - Cooper Basin, Latrobe Valley, and Paralana. These projects combined different methods to locate and characterize fracture systems. He received BSc and MSc degrees from Stanford in Exploration Geophysics, and a PhD from Princeton for work on surface wave scattering in weathering layers. After 17 years at Duke University in the US, he is now Director of the Institute of Earth Science and Engineering at University of Auckland, New Zealand.
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