Multi-component seismic: applications and new developments

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Multi-component seismic data capture both the vertical and horizontal components of ground motion at the receiver location. The resultant seismic record is a vector entity that enables discrimination between compressional (P) and shear (S) wave arrivals. In practice, conventional P-wave seismic sources are typically used for seismic acquisition. Thus multi-component seismic data refers to the recording of P wave and converted wave (or PS wave) arrivals.

The integrated use of P and PS waves has supported enhanced imaging of the subsurface over the past three decades. This includes "seeing" through gas-bearing sediments, delineating very shallow reflectors and delivering enhanced near-surface resolution, mapping lithologies and fluids (e.g. sand / shale discrimination, fluid description), and characterising anisotropy (e.g. fracture densities and orientation). When used in a time lapse sense, multi-component seismic data are useful for reservoir monitoring. These applications still remain very relevant to the resource industry today, and a number of more recent examples will be summarised.

However, despite many periods of enthusiasm, use of multi-component seismic data remains challenging. Interestingly, the focus of technical developments today is largely unchanged from the turn of the century. This presentation will provide an overview of current developments. Perhaps most demanding is the requirement to address the very slow propagation of S waves in the near surface. Further, S waves are extremely sensitive to anisotropy and absorption effects. All of these phenomena require careful attention during data processing. What has evolved in more recent times is the ability to work directly with the vector wavefield through full elastic imaging, and joint P / PS seismic inversion combined with more sophisticated P and PS image registration methodologies.