Amplitude Variation with Offset (AVO) and Lamé Parameter Analysis of Sediments at the Toe of the Cascadia Accretionary Prism

Christopher Blay

The Cascadia convergent margin lies off the west coast of North America where the Juan de Fuca oceanic plate is being subducted beneath the North American continental plate. West of Vancouver Island a large accretionary wedge has evolved as sediments have been scraped off the subducting oceanic plate and welded on to overriding North American plate. At the toe of the accretionary complex, sediments are squeezed by tectonic forces expelling pore fluids and decreasing porosity. Expelled fluids migrate to other layers where they become trapped and can lead to ‘over pressuring’ of layers.

Porosity and pore pressure variation within sediments lead to changes in elastic properties such as ___ and ___. Changes in these properties affect the angle dependent P-wave reflectivity of a reflector bounding the base or top of a layer. By fitting a linearised approximation to the Zoeppritz equations to P-wave reflection amplitude variation with offset (AVO) it is possible to extract changes in elastic properties with layers, and thus infer regional changes in porosity and pore pressures.

Extracted reflectivities and inverted elastic impedances (and thus ___ and ___) are highly dependent on the available background P- and S-wave velocity information. Currently S-wave velocities are unknown and can only be estimated approximately; thus, extracted values are not quantitatively accurate, and only qualitative interpretations can be made.

A 2-D seismic reflection line is processed to extract P and S-wave reflectivities from P-wave AVO. These reflectivities are subsequently inverted for ___ and ___. These values show that porosities in the Juan de Fuca basin decrease approaching the deformation front. A package of sediments towards the base of the basin sediments is highly fractured, this package has a low ___ relative to surrounding sediments. At the top of this layer a thin bed of extremely low ___ is evident, this layer appears not to be decreasing in porosity at the same rate as surrounding layers. This thin bed shows evidence of having high pore fluid pressures and is thus acting as a trap for fluids escaping the fractured layer below.