Geophysical Research Abstracts
Vol. 18, EGU2016-14120, 2016
EGU General Assembly 2016

Seismic wave propagation through an extrusive basalt sequence

Oliver Sanford (1), Richard Hobbs (1), Richard Brown (1), and Nick Schofield (2)

(1) Department of Earth Sciences, Durham University, Durham, UK (oliver.g.sanford@durham.ac.uk), (2) Geology & Petroleum Geology, University of Aberdeen, Aberdeen, AB24 3UE, UK

Layers of basalt flows within sedimentary successions (e.g. in the Faeroe-Shetland Basin) cause complex scattering and attenuation of seismic waves during seismic exploration surveys. Extrusive basaltic sequences are highly heterogeneous and contain strong impedance contrasts between higher velocity crystalline flow cores ($\sim$6 km s^{-1}) and the lower velocity fragmented and weathered flow crusts (3-4 km s^{-1}). Typically, the refracted wave from the basaltic layer is used to build a velocity model by tomography. This velocity model is then used to aid processing of the reflection data where direct determination of velocity is ambiguous, or as a starting point for full waveform inversion, for example. The model may also be used as part of assessing drilling risk of potential wells, as it is believed to constrain the total thickness of the sequence.

In heterogeneous media, where the scatter size is of the order of the seismic wavelength or larger, scattering preferentially traps the seismic energy in the low velocity regions. This causes a build-up of energy that is guided along the low velocity layers. This has implications for the interpretation of the observed first arrival of the seismic wave, which may be a biased towards the low velocity regions. This will then lead to an underestimate of the velocity structure and hence the thickness of the basalt, with implications for the drilling of wells hoping to penetrate through the base of the basalts in search of hydrocarbons.

Using 2-D acoustic finite difference modelling of the guided wave through a simple layered basalt sequence, we consider the relative importance of different parameters of the basalt on the seismic energy propagating through the layers. These include the proportion of high to low velocity material, the number of layers, their thickness and the roughness of the interfaces between the layers. We observe a non-linear relationship between the ratio of high to low velocity layers and the apparent velocity of the first arrival suggesting that such a sequence may cause a reduction of the apparent velocity by as much as 1 km s^{-1}. We also find that the rate of amplitude decay in the higher velocity layer is related to the interface roughness between the basalt layers.