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Shear-wave splitting results from southwest Ireland: deep-source anisotropy revealed

Van Chuong Do, P.W. Readman, B.M. O'Reilly and F. Hauser

Dublin Institute for Advanced Studies, Dublin, Ireland (e-mail: pr@cp.dias.ie / phone +353-1-662 1333)

Observation of large splitting in shear-wave phases such as SKS/SKKS is usually attributed to upper mantle anisotropy due to a fossilized deformation imprint in the lithosphere, or the influence of asthenospheric flow, or both. Shear-wave splitting measurements have been made on data from 23 temporary and two permanent broadband stations in Ireland in order to investigate possible upper mantle anisotropy that may be related to the Iapetus Suture Zone. Data were selected from about 200 deep and shallow focus earthquakes with epicentral distances of 90-130° and magnitudes Mb $>$ 6.0. Most high quality results are from earthquakes in South America and East Asia. Average delay times of about 1.2 s are observed suggesting an anisotropic layer thickness of 80-100 km. Analysis of splitting in Sg and SmS phases using results data from a controlled-source experiment in southwest Ireland confirmed that the crustal contribution to the observed anisotropy is no larger than expected, and is not a significant contribution to the overall observed anisotropy. The SKS-splitting results show an unexpected back-azimuthal variation of fast directions that suggests a sub-lithospheric source of anisotropy. Events from East Asia show fast polarization directions closely related to the Caledonian/Variscan tectonic fabric indicating that this may be preserved in the mantle lithosphere. However, events from South America give consistently more northerly fast directions that do not appear to carry the signature of the sub-continental lithospheric deformation history. Furthermore, there is no observable alignment of the fast polarization direction with absolute plate motion, and so there is no direct correlation with mantle flow. Results from modelling based on two-layer anisotropy with contributions from mantle flow and lithospheric deformation do not fit the observed splitting pattern. The results show that the anisotropy within the crust and mantle of the western Eurasian Plate is more complex than previously thought.