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Deep-source anisotropy beneath Ireland: new shear-wave splitting and controlled-source results

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High degrees of splitting in core shear wave phases such as SKS and SKKS are usually attributed to anisotropy within the upper mantle, due either to a preserved deformation imprint in the lithosphere or to the influence of asthenospheric flow, or to a combination of both. New shear-wave splitting measurements have been made in Ireland to supplement data from a previous study and to increase the geographical coverage to include the whole of Ireland. The majority of the high quality results are from earthquakes in South America and eastern Asia. Delay times average about 1.2 s, suggesting an anisotropic layer of thickness 80 to 100 km. Analysis of controlled-source data (Sg and SmS phases) from an experiment in southwest Ireland has confirmed that anisotropy within the Irish crust does not make a significant contribution to the overall observed anisotropy. The new SKS-splitting results confirm the earlier results and show a clear variation of fast directions with back-azimuth. Data from earthquakes in eastern Asia show fast polarization directions that are generally related to the Caledonian/Variscan tectonic fabric in Ireland, indicating that the memory of this may be preserved in the mantle lithosphere. However, data from earthquakes in South America show fast directions that are in general consistently more northerly, and so do not appear to carry the signature of the sub-continental lithospheric deformation history. Furthermore, there is no alignment of fast polarization directions with absolute plate motion direction, and so no direct correlation with mantle flow. Preliminary results from modelling based on two-layer anisotropy with contributions from mantle flow and lithospheric deformation do not fit the observed splitting pattern. Hence a more complex origin is required to explain the anisotropy. The splitting results are interpreted to indicate that the observed anisotropy in Ireland cannot be explained purely by upper mantle sources, and is more complex than previously thought.