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Anisotropic Rayleigh-wave tomography of Ireland's crust: Implications for crustal accretion and evolution within the Caledonian Orogen

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The Irish landmass, now at the western extremity of the Eurasian Plate, was formed in the Caledonian Orogeny during the Palaeozoic assembly of Pangea. The associated closure of the Iapetus Ocean is recorded in the NE–SW structural trends that dominate the tectonic set-up of Ireland today. The deep-crustal dynamics of the orogeny and the effect on the crust of the subsequent extension and magmatism in the North Atlantic are debated. Fabrics within deep crustal rocks preserve a record of deformation during and after the continental collisions. Here, we measured Rayleigh-wave phase velocities using seismograms recorded by permanent and temporary intermediate-band stations in Ireland and inverted the data for phase-velocity maps, including azimuthal anisotropy. The observed isotropic phase-velocity heterogeneity reflects moderate crustal thickness and seismic velocity variations across Ireland. Anisotropy of Rayleigh waves at 10–20 s periods shows a NE–SW fast-propagation direction and is largest (up to 2%) at a 15 s period, at which Rayleigh waves sample primarily the middle and lower crust. The NE–SW trend of the deep-crustal anisotropic fabric is parallel to tectonic trends, in particular the Iapetus Suture Zone, which indicates that suture-parallel flow in the middle and lower crust accommodated the continental collision. The apparent preservation of the Caledonian-age fabric also shows that the deep crust of the Eurasian margin in Ireland was neither stretched by the NW–SE extension associated with the opening of the North Atlantic, nor modified significantly by the Cenozoic magmatism in the region.