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Asthenospheric Flow Across the Baikal Rift Constrained With Integrated Seismic Measurements

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The Baikal Rift is located at the boundary of the stable Siberian Craton and deforming central Mongolia. The origin of the late Cenozoic rifting and volcanism are debated, as is the nature of the mantle flow beneath the rift zone. Deriving new evidence from upper-mantle tomography and from a radially-anisotropic profile constrained by interstation surface-wave dispersion, we combine it with published shear-wave-splitting measurements of azimuthal anisotropy across the rift. Shear-wave splitting gives a SE-NW fast direction in the vicinity of the rift (direction perpendicular to the axis), changing towards E-W a few hundred kilometers from it. Previously, this has been interpreted as evidence for mantle flow similar to that beneath mid-ocean ridges, with deeper vertical flow directly beneath the rift also proposed. The new radially anisotropic profile, however, shows that while strong anisotropy with SH waves faster than SV waves is present in the thin lithosphere and upper asthenosphere beneath and SE of the rift, no anisotropy is required below 110 km. The tomographic model confirms the presense of thick cratonic lithosphere on the NW side of the rift, also suggesting that mid-ocean-ridge-like flow is unlikely. These observations imply that instead of a flow diverging from the rift axis, the likely pattern is an asthenospheric flow from beneath the Siberian lithosphere towards SE, across the rift. Possible driving forces of the flow are large-scale lithospheric deformation in East Asia and the draining of asthenosphere at W-Pacific subduction zones; a contribution from a hypothetical plume beneath the Siberian Craton also cannot be ruled out. As shown for the model of subcontinental asthenospheric flow by Morgan and Morgan (2005), such mantle flow pattern can explain the basaltic volcanism observed in the Lake Baikal region.