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The complex isostatic equilibration of Australia's deep crust.

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A recent study, using a new finite-element based gravity inversion method has modelled in high-resolution the density and pressure fields for the Australian continent. Here we analyse the pressure results to consider how Australia's lower-crust and Moho contribute to the isostatic equilibration of topography and crustal masses. We find that the situation is more complex than the commonly applied model of isostatic compensation through crustal thickness variations. Key differences include low pressure-variability at ca. 30-35 km, suggesting that the thickness of the felsic-intermediate crust equilibrates most of the upper-crustal loads; increasing pressure-variability between 30-50 km, suggesting that positively buoyant deep-crustal roots generate disequilibrium. These large roots have previously been inferred to represent mafic underplates. Pressure-variability in the uppermost lithospheric mantle reduces to a minimum at $\sim$125 km depth, suggesting that these loads are compensated by dense mantle at $\sim$100 km depth, rather than by crustal loads or topography. This raises the notion that Australia's lithosphere is isostatically compensated at two levels: Crustal compensation involving topography and the felsic to intermediate crust; and deep-lithosphere compensation involving the mafic lower crust and lithospheric mantle. Rather than its traditional role of compensating for crustal masses, the Moho in this case appears to be a source of isostatic disequilibrium, acting in a separate cell with lithospheric mantle density sources. These results imply that, for cratonised continents like Australia, the notion of crustal isostasy is a poor descriptor of the system.