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An integrated geological and geophysical study of the Parnaíba cratonic basin, North-East Brazil

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Cratonic basins are characterized by their sub-circular shape, long-lived (>100 Myr) subsidence, undeformed shallow marine/terrestrial sediments that young towards the centre of the basin, and thick seismic lithosphere. Despite the recognition of >30 world-wide, the paucity of geological and geophysical data over these basins means their origin remains enigmatic. In order to address this problem, we have used a recently acquired 1,400 km long seismic reflection profile recorded to 20 s TWTT, field observations and well logs, gravity and magnetic anomaly data acquired at 1 km intervals, and five wide-angle refection/refraction receiver gathers recorded at offsets up to 100 km, to constrain the origin of the Parnaíba basin, NE Brazil. We find a depth to pre-Paleozoic basement and Moho of ~3.5 and ~40-42 km respectively beneath the basin centre. A prominent mid-crustal reflection (MCR) can be tracked laterally for ~300 km at depths between 17-25 km and a low-fold wide-angle receiver gather stack shows that the crust below the MCR is characterized by a ~4 s TWTT package of anastomosing reflections. Gravity modelling suggests that the MCR represents the upper surface of a high density (+140 kg m^{-3}) lower crustal body, which is probably of magmatic origin. Backstripping of biostratigraphic data from wells in the centre of the basin show an exponentially decreasing subsidence. We show that although cooling of a thick (180 km) thermal lithosphere following prolonged rifting (~65 Myr) can provide a good fit to the tectonic subsidence curves. Process-oriented gravity and flexure modelling suggest that the basin cannot be due to rifting alone as this does not account for the observed gravity anomaly and predicts too thin a crust (~34 km). Other processes must therefore be involved. The depth to Moho beneath the basin centre appears to greater than beneath the flanking Amazonian/Araguaia and Borborema blocks suggesting warping due, for example, to far-field stresses or basal tractions. Another possibility, which is compatible with existing geophysical data, is a dense magmatic intrusion in the lower crust that has loaded and flexed the pre-existing Moho downwards to greater depths than beneath flanking Archean and Proterozoic terranes.