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# Deep Structure and Subsidence History of Parnaíba Cratonic Basin, NE Brazil

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Cratonic sedimentary basins constitute some of the largest sedimentary basins on Earth. They are typically underlain by thick (i.e. 200 km) lithosphere and are characterized by slow, punctuated subsidence that occurs over hundreds of millions of years. Their stratigraphic records mainly consist of sequences of continental and shallow marine sedimentary rocks bounded by basin-wide erosional unconformities. Despite the importance of these basins, their origin and evolution remain poorly understood, mainly due to scarcity of well-constrained geological and geophysical data. In order to address this problem, an integrative study of the Parnaíba Cratonic basin in NE Brazil has been carried out within the framework of a multidisciplinary investigation. Here, we combine the analysis of a 1400 km long deep seismic reflection profile that crosses the basin, teleseismic earthquakes recorded by 12 broadband and 10 short-period, 3 component seismometers, 25 ancillary seismic reflection profiles, and 46 wells distributed across the basin. Our main goal is to constrain the basin's subsidence history in the context of its deep crustal structure and sedimentary architecture. Joint inversion of receiver functions and Rayleigh wave group dispersion measurements has been used to calculate 1D shear wave velocity models for crust and upper mantle beneath each seismic station. Combined interpretation of these velocity profiles and the deep seismic reflection profile has been carried out. Our results suggest Moho depths of approximately 35 km and 38 km beneath Precambrian basement east and west of the Parnaíba basin, respectively. In contrast, the Moho occurs at approximately 39 km beneath the city of Teresina, located on the eastern region of the basin, and at depths between 40 km and 42 km beneath the central and western areas of the basin. These results are combined to construct a sub-surface model underneath Parnaíba, and gravity modeling is used to test its validity. Average density for the sedimentary basin is obtained from well-log data and our shear wave velocity profiles are used to calculate average densities for the crust and upper mantle. Our calculated gravity anomaly reproduces long-wavelength shape and magnitude of the observed free-air gravity anomaly across Parnaíba. Water-loaded subsidence curves derived from wells distributed through the basin show an overall exponential decrease in subsidence over the last 400 Ma. Modeling results suggests that thermal subsidence characterized by thermal time constants between $\sim$ 70 Ma and $\sim$90 Ma can explain this distinctive subsidence pattern. This background subsidence is punctuated by departures from the long-term trend at times when basin-wide erosional unconformities occur, which are identified in seismic reflection profiles and observable in outcrop. These unconformities are interpreted and modeled as expressions of mild regional uplift events that affect the basin. Thanks to the large volume of newly obtained datasets, the Parnaíba basin constitutes an excellent natural laboratory for investigating the fundamental driving mechanisms of cratonic basins. Our study helps shed light on the long-standing problem of their origin.