

Tectonic setting of Parnaíba Basin: a seismic approach

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The Parnaíba Basin is a Paleozoic sag basin, roughly circular in shape, occupying a 660,000 km² area of northeast Brazil. It has tectonic contact with the Amazon Craton (westwards) and with the São Luis Craton (northwards), and an erosive contact with the Borborema Province (eastwards) and the São Francisco Craton-Tocantins Province (southwards). With the aim of detailing the structure of the Parnaíba Basin and its underlying crust and upper mantle BP supported the acquisition of a WARR profile crossing the basin. The WARR profile runs E-W and is 1,200 km long, crossing the basin and its western and eastern limits, following the path of the previously acquired BP deep seismic reflection line.

Thirty-six short-period three-component seismic stations were deployed along the transect in August 2015, covering the extremes of the line and the western and eastern limits of the basin. The objective was to complement the analysis of WARR data with receiver function results. Another six hundred one-component stations were installed along the profile in September-October 2015 and, during four nights, twenty-two shots, comprising 1.5 tonnes of explosives each, were detonated. The obtained data are of high quality.

The receiver function results and a qualitative analysis of refraction data show a heterogeneous crust along the profile, thinning eastwards and defining four main domains, controlled by steps in the Moho. The first 200 km of the profile show the transition between the Amazonian Craton and the Parnaíba Basin basement. The crust is less than 40 km thick in the Amazonian Craton with Vp/Vs of 1.72 and thickens sharply to 53 km at the suture front. In the Parnaíba Basin, until offset 700 km, the crust is 42-43 km thick with Vp/Vs of around 1.75. At the surface this segment is closely related to the Cretaceous depositional sequences of the Grajaú sub-basin. East of it, the crust thins abruptly to 37 km with Vp/Vs of 1.73, and thickens to 42 km close to the eastern limit of the basin. At the surface, this domain is associated with the older sediments of the basin. From this point, the crust goes thinning, reaching 35 km at the eastern end of the profile. The mantle presents velocities higher than 8.0 km/s under the Grajaú sub-basin and around 8.0 km/s elsewhere.

The Grajaú domain is the portion where the mantle and crust have indeed been affected by magmatism. The initiation of the primitive Parnaíba sag basin may have been caused by the load of these intruded materials (combined with cooling and phase changes) pulling the lithosphere down and flexing the overlying crust. Subsequently, in the Cretaceous, during the opening of the South Atlantic Ocean, the (lower) crust may have been stretched resulting in rebound, exposing the older sediments of the basin and basement rocks, giving rise to the recent topography and defining the erosive limit of the basin. The magnitude and distribution of intraplate deformation would be controlled by the rheology of the lithosphere and, possibly the Grajaú domain was preserved from significant Cretaceous deformation.