Stratigraphic architecture and sedimentary provenance of the intracontinental Parnaíba Basin

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Intracontinental basins are poorly understood in terms of their formation, evolution and sediment provenance. We focus on the Parnaíba Basin as an exemplar of this class of basin, investigating basin evolution using a combination of stratigraphic analysis techniques (field sedimentology, map analysis, well correlation, and seismic interpretation) to create a more detailed architectural framework. Heavy mineral abundance and varietal results are being added to this framework to better understand the temporal and geographic evolution of the basin.

Parnaíba is an intracontinental basin covering an area of 600,000 km^2 with a Silurian-Cretaceous sediment fill. The succession has a maximum thickness of 3.5 km, representing a range of climatic conditions and depositional environments. Published chronostratigraphic compilations represent 2D transects, most recently the stratigraphic chart published by Petrobras in 2007 oriented NW–SE across the basin. This chart emphasises basin-wide unconformities formed in Early Devonian, Early Carboniferous, Late Carboniferous, Late Triassic, Middle Jurassic, and Late Jurassic times. These unconformities separate layer-cake packages of sediment, again of basin-wide extent. However, this transect does not accurately depict the complex stratigraphic relationships in this large basin. Detailed analysis of the existing geological map using ArcGIS indicates local unconformities in the south-west and east of the basin, with complex subcrop patterns rather than the parallel architecture of the current stratigraphic model. These observations are backed up by well and seismic data, petrophysical analysis, and outcrop observations from two field seasons.

Sediment provenance has been investigated using heavy mineral analysis (HMA) on the high density mineral fraction contained within the siliclastic deposits. These mineral assemblages provide information on sediment provenance, transport, and diagenetic history. HMA studies include: bulk heavy mineral assemblage for general provenance; ratios of specific mineral pairs to indicate weathering and diagenesis; and the chemistry of specific mineral species for varietal studies. Forty-eight samples collected in the Parnaíba Basin over the course of two field seasons have been analysed in terms of their bulk heavy mineral assemblage and mineral pair ratios. In addition, 22 of these samples are being dated for their Zircon U-Pb age spectra, and analysed for their rutile and tourmaline geochemistry. Seven samples are from the SW (Serra Grande-Pedra de Fogo formations); another seven from the NE (Serra Grande-Motuca); four from the basin centre (Corda and Pastos Bons); two from the Ubajara Trough; and one from the Borboreama Province (Tacaratu Formation). Heavy mineral assemblages are rather restricted in number of mineral types, dominated by ultra-stable zircon, tourmaline and rutile. The fourth most common mineral is staurolite, especially in the Silurian Serra Grande Formation and the Balsas Group in the south west. This shows that for these formations the primary source rock was a medium grade regionally metamorphosed mica schist. The zircon morphology in most of the samples displays a rounded (most likely recycled) fraction in addition to some euhedral crystals (most likely younger). Varietal studies are still underway but will be presented at the conference and should provide more specific information regarding sediment provenance.

Key words: Intracontinental basin, Stratigraphy & Provenance