COMPARATIVE GEOPHYSICAL STUDIES OF THE PARNAÍBA, MICHIGAN AND CONGO CRATONIC BASINS

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We have used recent compilations of gravity, topography, sediment thickness, seismic reflection, seismic tomography and well data, that includes those recently acquired during the BP sponsored Parnaíba Basin Analysis Project (PBAP), to compare and contrast the crustal structure, subsidence history and tectonic evolution of the Parnaíba, Michigan and Congo cratonic basins. These basins, which range in age from late Precambrian through to Tertiary, are presently located in continental interiors, usually on thick (>150 km) seismic lithosphere. Bouguer gravity anomaly data that has been corrected for the gravity effect of sediment loading and its isostatic compensation reveal the basins are associated with relatively long wavelength gravity 'lows' of up to ~40-50 mGal. Seismic constraints on Moho depth are limited, but wide-angle reflection/refraction receiver gathers in Parnaíba, US Array receiver function data in Michigan, and fundamental-mode surface wave data in Congo indicate a Moho depth that is either similar to or slightly deeper than beneath flanking regions. Backstripping of stratigraphic data from deep wells in the Parnaíba Michigan and Congo basins show a generally exponential form to the tectonic subsidence, which appears fast initially and then slows with time, suggesting a thermal origin. Each basin also exhibits local contractional deformation post formation. An extensional origin that involves large amounts of thinning and heating of the crust during rifting appears inconsistent with the available gravity and seismic reflection data. The occurrence of relatively short wavelength Bouguer anomaly 'highs' of 20-60 mGal in the centres of both the Parnaíba and Michigan basins suggest a role for sub-surface (i.e. buried) loading (due, for example, to the intrusion of relatively dense mafic bodies in the lower continental crust), while 'steps' in the backstripped tectonic subsidence curve and changes in subsidence styles in Michigan and highly correlated long wavelength free-air gravity anomalies and topography (~40 mGal/km) and a zone of high shear wave speeds at ~150 km at Congo argue for deeper flow-induced controls in the sub-crustal mantle. Irrespective, the exponential nature of the backstripped subsidence curves of the Parnaíba, Michigan and Congo basins is a consistent enough feature to suggest that it might be possible to use the long, but incomplete, stratigraphic record of these basins to estimate long-term sea-level change. Preliminary estimates suggest a modest sea-level rise during the Late Silurian to Late Carboniferous, which is notable given that Michigan, and possibly Parnaíba and Congo, are characterized by stratigraphic offlap rather than onlap at their edges during at least part of their evolution.

Key Words: Parnaíba basin; PBAP; Cratonic basins