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Could the mantle cause subsidence of the Congo Basin?

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The Congo Basin (Democratic Republic of Congo in Central Africa) is often cited as a classic example of an intracratonic basin: it is an almost circular depression, is associated with negative gravity anomalies, and experienced slow subsidence over long periods of time. However, the mechanism causing the subsidence is unknown, and, therefore, heavily debated. The basin contains several kilometres of Pre-Cambrian to Tertiary unconformity-bounded sedimentary sequences, which were deposited in shallow marine, lacustrine and continental environments. Unfortunately, detailed information on the basin fill is limited as only four deep wells were drilled in the Congo Basin and most of the seismic survey that was shot in the 1970s is not publicly available. The older sediments may have been deposited in response to thermal contraction after a late Pre-Cambrian to Early Cambrian rift event (Daly et al., 1992; Crosby et al., 2010), but the more recent (Mesozoic to Cenozoic) sediments were deposited at a time of little tectonic activity. Therefore, it has been proposed that the subsidence that allowed deposition of the top layer of sediments is linked to mantle processes (Hartley and Allen, 1994). Recent hypotheses that would explain the latest subsidence phase of the Congo Basin in terms of processes below the crust are: a) A high-density body within the deeper lithosphere (Downey and Gurnis, 2009), b) downward mantle flow beneath the basin driven by small plumes rising up below the basin flanks (Crosby et al., 2010; Forte et al., 2010), and c) a relatively recent response at about 30 Ma to uplifts surrounding the basin formed by shallow mantle convection (Burke and Gunnell, 2008).

These hypotheses inspired us to examine 17 recent to fairly recent seismic tomography models to search for evidence for mantle upwellings, downwellings or high-density bodies beneath the Congo Basin. We evaluated upper mantle tomography and lithosphere thickness models to determine the current boundaries of the Congo Craton, and whole mantle tomography models to delineate the deeper mantle structure under Congo. Unfortunately, the models do not yield a very clear or consistent picture of the mantle beneath the Congo lithosphere. Overall, we find they do not support the idea that there are density anomalies in the sublithospheric mantle causing substantial downward flow and subsidence. Our results are consistent with the finding of Downey and Gurnis (2009) that the joint signal of gravity and topography is best explained by a positive density anomaly within the lithosphere.

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