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Subsidence history and geodynamic evolution of the cratonic Congo basin

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The cratonic Congo basin, which straddles the equator in central Africa, is spatially coincident with a large magnitude (50 mGal) long wavelength (∼1200 km) free-air gravity low. This gravity anomaly along with the subtle topographic depression of the basin, and the observation of a tomographically-imaged positive shear-wave velocity anomaly beneath the basin, implies the presence of a high-density object within the upper mantle beneath the Congo. The relation, if any, between the presence of this object and the long-term evolution of the Congo basin remains to be explained.

We review the elements of the current geodynamic state of the Congo basin and present several new observations that help constrain the subsidence history and geodynamic evolution of the basin. The paleogeographic history of the basin indicates that it was an active depocenter throughout the late Mesozoic and into the early Cenozoic. During this period the basin internally drained into a large shallow lake as indicated by lacustrine fossils present within the basin. This history is supported by subsidence curves inferred from backstripping several wells located within the central Congo Basin. Local subtle relief of up to 100 m is observed between the floodplains of rivers present in the central and western regions of the basin, coincident with the location of the largest gravity anomaly. The presence of this relief indicates that the central regions of the Congo basin are not depositionally active; presently, much of the sediment transported by the Congo River escapes deposition in the basin's interior and is deposited offshore Africa in the Congo submarine fan. Some sediment deposition may occur in the eastern region of the basin located within the Republic of the Congo. A rapid increase in the sedimentation rate on the passive margin indicates that the transition of sediment deposition from within the basin to the passive margin likely occurred at or before the Eocene-Oligocene boundary (34 Ma). The relative thinness of Cenozoic sediments relative to Cretaceous Sediments within the basin may indicate erosional removal of much of the basin's Cenozoic infill.

We present two possible geodynamic scenarios which describe these events. In the first, subsidence of the basin throughout its entire history and into the Cenozoic occurred in response to thermal relaxation after a Paleozoic rifting event. A climatically-induced capture event caused the switch to deposition on the passive margin resulting in an erosional lowering of the basin's base-level to its current position. In the second scenario, subsidence in the basin during the Mesozoic and early Cenozoic was caused in response to partial lithospheric delamination. Here the Congo basin subsided and then rebounded as a piece of the lowermost lithospheric mantle detached and fell into the asthenosphere. It was this rebounding of the basin's surface that caused the switch to deposition on the passive margin. Under these two scenarios the density anomaly inferred to exist beneath the Congo has differing origin. In the thermal relaxation scenario, this body may be related to the rifting event that caused the initial thermal disturbance, in the delamination scenario, this body represents a piece of high-density undetached mantle lithosphere.