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Africa's Distinctive Behavior Over the Past 30 Million Years

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The entire African Plate in its continental and oceanic areas has developed in distinctive and unusual ways over approximately the past 30 million years. I attribute these peculiarities to the African Plate having come to rest with respect to at least part of the convective circulation in the underlying mantle.

The African continent is a high continent that has a relatively small low-lying area, compared with, say, South America. Newly elevated swells that have formed within the past 30 million years separate interior basins such as the Chad and Zaire basins. In the northern part of the continent, these swells are generally capped by young volcanoes.

There has been widespread episodic volcanic activity over much of the African plate since about 30 million years ago. This was the time when the huge Afar plume first generated volcanic rocks in Ethiopia and also the time of the beginning of rift development in the Red Sea. The East African Rift System, in its present phase of activity, has developed since about 30 million years ago. A change in East African Rift System development is discernible at about 15 million years ago, which was the time when Arabia and Eurasia collided along the Zagros suture zone.

The great escarpments of the African continent began to develop about 30 million years ago. At that time pre-existing extensive erosion surfaces were elevated, typically by about 1 kilometer.

Offshore around much of Africa, the global mid-Oligocene unconformity which is recognized around all the continents and widely considered to be related to the first formation of an ice-sheet in eastern Antarctica, is particularly spectacular. I consider that the unusual prominence of the mid-Oligocene unconformity around Africa reflects erosion of high ground generated by the widespread tectonic uplift of the continent that began about 30 million years ago. The effects of erosion associated with the mid-Oligocene unconformity include the cutting of numerous submarine canyons that began to be filled in the Early Neogene (about 22 Ma). Post mid-Oligocene deepwater deposition of thick piles of sediment that reached the foot of the continental slope largely by passage through the great submarine canyons is widespread around Africa. The Neogene piles of sediment that have been deposited near the foot of the continental slope commonly exceed 2 km in thickness. They have buried older, relatively thin sequences of sediments that had accumulated slowly at the continental margin since the ocean began to form 100 or more million years earlier. Burial under the newly deposited, rapidly accumulated Neogene piles of deep-water sediment may have placed organic matter within the older sediments in the oil-generating zone for the first time. New oil would have been likely to migrate updip toward the African continent.

Progradation of the deltas of the Nile, Niger, and the Zambesi, as well as those of many of the smaller rivers of Africa, accelerated beginning about 30 million years ago because the newly elevated areas of the continent provided increased sediment supplies to the deltas. Prominent and possibly largely Neogene deep sea fans are associated with the deltas, as well as with the Zaire River, which has no delta.

I will outline a simple conceptual model of how stopping over-the-mantle circulation might have triggered all these diverse responses, and I will also briefly describe how global climatic changes since about 30 million years ago have influenced the development of the African environment. ■

Kevin Burke has been a professor of Geology in the University of Houston for the past 12 years. Much of his effort during the first five years of that time was devoted to directing the Lunar and Planetary Institute in Clear Lake. For three years afterward, he was loaned to the National Academy of Sciences in Washington as a Scholar in Residence. Since returning to Houston, he has become active in teaching and in research into the tectonics of the Earth, focusing on Asia, Africa, and the Caribbean. Dr. Burke received his PhD at University College, London in 1953.