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What the volcanism of the East African Rift tells us on its evolution and dynamics: a reappraisal

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The East African Rift (EAR) is one of the most studied tectonic structures on Earth. Classically, it is described as extending from Afar in the North to the Malawi rift in the South, along the eastern and western branches, respectively. A widely accepted consensus also exists on two main points: 1- the rift initiated first with plume emplacement below the northern part of the eastern branch and 2- extension and volcanism subsequently migrated southward along the western branch (e.g., Ebinger, 1989). However, an increasing amount of new geochronological data on the volcanic activity in the southern part of the East African Rift tends to weaken these interpretations and imposes a reassessment of the rift dynamics.
The volcanic activity being one of the main characteristics of this rift, I use it here to determine the lateral extension of the rift system and to assess the rift activity through times. First, the volcanism unambiguously indicates that the rift is not limited to the African continent but can be traced in the Mozambique Channel and in Madagascar where it is closely related to active tectonics (graben and transfer faults) initiated since at least the Miocene. Moreover, the synthesis of more than 800 published geochronological data of volcanic products distributed over the overal East African Rift allows the distinction of two parts. The first part, the Northern EAR, corresponds to the sole eastern branch, which is characterized by volcanic plateaus resulting from huge magma flux during three main periods (32-28, 18-12, 6-0 Ma). Provinces of the second part, the Southern EAR (the western branch, the Mozambique Channel and Madagascar), share rift-related scattered volcanic centres characterized by coeval periods of activity since the Oligocene (28-24, 20-16 and 12-0 Ma).
This synthesis highlights the lack of southward migration of the volcanism during the evolution of the East African Rift and instead reveals the almost synchronous development of the volcanism all along the rift system. Moreover, it suggests the existence of two parts that experienced different evolutions since around 30 Ma. The volcanism of the Northern EAR shows characteristics, which agrees with a mantle plume origin. On the contrary, the development of stationary volcanic centres in the Southern EAR despite the northward motion of the African plate disagrees with such an interpretation and instead suggests a tectonically-assisted origin of the volcanism along main Precambrian lithospheric structures. The occurrence of several pulses of volcanism in each part of the East African Rift, coeval with periods of crustal uplift, could stem from successive main tectonic phases favoured by mantle bursts fed by the African superswell.
Reference: Ebinger, C.J., 1989, Tectonic development of the western branch of the East African rift system: Geological Society of America Bulletin, v. 101, p. 885–903.