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Two-stage evolution of the Kivu rift segment in Central Africa

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The Kivu rift region forms the central segment of the western branch of the East African rift system, between the northern termination of the Tanganyika rift and the southern extension of the Edward-George rift. Its structure and geological evolution has been revised in the light of a compilation of existing data on earthquake epicenters, focal depth, focal mechanisms, thermal springs and neotectonic faults.

We evidence that the Late Cenozoic rifting occurred in two main stages. The first one (Late Miocene-Pliocene) created a relatively linear NNE-SSW rift valley, running from Lake Edward to Lake Kivu, and continuing southwestwards to the Mwenga – Kamituga tectonic depression. During the Quaternary, the Mwenga-Kamituga branch was progressively abandoned due to the establishment of a tectonically controlled connection between the northern end of Lake Tanganyika and Lake Kivu, through the Rusizi valley. The initial NNE-SSW rift valley is bordered on its western side by the Lubero, Mitumba-North and Kahuzi-Biega chain of rift shoulder mountains. The Mwenga-Kamituga depression and south Kivu basin are flanked on their eastern side by the South-Mitumba Mountains in DRC, and the Nyungwe massif in SE Rwanda. This eastern flank is dissected by the Rusizi valley, which forms the northern termination of the N-trending Tanganyika rift basin. This complex architecture is controlled by basement structures and influence also the tectonic stress field. The distribution of seismicity and thermal springs shows that tectonic deformation is not limited to the central part of the rift valley, but also affects its flanks. It is particularly well expressed for the western flank, which is affected up to 200 km away, i.e. up to the margin of the Congo basin. The eastern flank is also affected by neotectonic activity, in Burundi, Rwanda and NW Uganda. This area was strongly uplifted and tilted in response to rifting activity, as shown by the presence of river flow reversals and captures, inundation lakes, swamps and recent lacustrine deposits, as well as by seism epicenters and rare thermal springs.

Development of the Rusizi valley was associated to N-S faults that appear to overprint the earlier NNE-SSW fault system. This valley is also associated to more numerous and shallower earthquakes and warmer thermal springs than the rest of the Kivu rift. The stress field distribution, as deduced from earthquake focal mechanisms, also reflects the separation of the Kivu rift into the Mwenga-Kamituga depression and the Rusizi valley. At the scale of the African plate, the western shoulder of the Kivu rift marks the transition between the Congo Basin, characterized by E-W horizontal compression, and the Kivu rift basin, characterized by E-W horizontal extension. This is expressed by a progressive rotation of stress directions, together with a progressive change in stress regime. The basement structural fabric plays an important role in controlling this change.