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Volcano-tectonic evolution of the Western Afar margin: new geochronological and structural data

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The rift system in NW-Afar (Ethiopia) is part of the Nubia-Somalia-Arabia triple junction located above the Afar hot spot active mainly since Oligocene times. It represents a unique natural laboratory for field study of superficial and deep lithospheric structure and process interactions during the transition between rifting and oceanic spreading in magma-rich setting.

Most past field studies in Afar focused on the recognition and correlation of Afar's volcano-stratigraphic record and led to models of margin development that stress out the major trends of volcanic structures and give accordingly the following chronological "big picture". (1) 2km-thick flood basalt province emplaced at ca. 30 Ma due to hot spot activity over Jurassic to Permian sedimentary rocks and basement. (2) Rifting started around 25-20 Ma with half graben and great escarpment formation along with localization of volcanic activity in highly faulted narrower basins followed by lithospheric flexure. (3) The deformation migrated toward the rift centre with the emplacement around 8-5 Ma of bi-modal volcanics later faulted. (4) A second pulse of flood-basalt, the so-called Stratoid series, started at 4 Ma, until 1 Ma.

In this contribution, we present new structural field data and lavas (U-Th/He) datings along a cross-section from the marginal graben to the Manda-Hararo active rift axis. In the newly explored Sullu Adu ranges, which were previously thought to be made of 8 Ma Dahla Basalts Fm., we mapped normal faults arrays affecting a complex magmatic series. We dated highly tilted 30 Ma pre-rift basic and silicic volcanic rocks that are unconformably overlain by syn-rift volcanics (25 to 8 Ma). This pattern is in some places either masked by unconformable thick stratoid cover or strongly eroded by dense river drainage. However, it is preserved enough to suggest a lower-than-expected extension ratio and/or the presence of major normal faults controlling seaward-dipping reflectors (SDR) emplacement such as the one observed on seismic reflection profiles in North and South Atlantic volcanic margins.