

EGU2020-3084

<https://doi.org/10.5194/egusphere-egu2020-3084>

EGU General Assembly 2020

© Author(s) 2022. This work is distributed under the Creative Commons Attribution 4.0 License.



Anomalous deep earthquakes in the March 2018 swarm along the Western Margin of Afar

Alessandro La Rosa^{1,2}, Cecile Doubre³, Carolina Pagli¹, Federico Sani², Giacomo Corti⁴, Sylvie Leroy⁵, Abdulhakim Ahmed³, Atalay Ayele⁶, and Derek Keir^{7,2}

¹Dipartimento di Scienze della Terra, Università di Pisa, Pisa, Italy

²Dipartimento di Scienze della Terra, Università di Firenze, Firenze, Italy

³IPGS, École et Observatoire des Sciences de la Terre, Université de Strasbourg, Strasbourg, France

⁴Istituto di Geoscienze e Georisorse, Consiglio Nazionale delle Ricerche, Firenze, Italy

⁵ISTeP-Institut des Sciences de la Terre de Paris, Sorbonne Université, Paris, France

⁶Institute of Geophysics, Space Science and Astronomy, Addis Ababa University, Addis Ababa, Ethiopia

⁷Ocean and Earth Science, University of Southampton, Southampton, UK

During the evolution of continental rift systems, extension focuses along on-axis magmatic segments while extensional structures along the rift margins seem to progressively become inactive. However, how strain is partitioned between rift axes and rift margins is still poorly understood. The Afar Rift is the locus of extension between Nubia, Arabia and Somalia and is believed to record the latest stages of rifting and incipient continental break-up. The Afar rift axis is bounded at its western margin by a seismically active system of normal faults separating the Afar depression from the Ethiopian Plateau through a series of large bounding faults and marginal grabens. Although most of the extension in Afar is currently accommodated on-axis, several earthquakes with $M_w > 5.0$ occurred in the past decades on the Western Afar Margin (WAM). Here we analysed the most recent M_w 5.2 earthquake on the WAM on 24 March 2018 and the following seismic sequence using data recorded by a temporary seismic network, set up between 2017 and 2018. We located 800 events from the 20 March to the 30 April 2018 using twenty-three local seismic stations and a new velocity model for the WAM based on a new receiver function study. Preliminary results show that seismicity during the 2018 event focused at mid-to-low crustal depths (from ~15 km to ~35 km) along west-dipping fault planes. Shallower upper crustal earthquakes also occurred on west-dipping fault planes.

The hypocentral location of the mainshock has also been investigated using InSAR. We processed four independent interferograms using Sentinel-1 data acquired from a descending track. None of them shows any significant surface deformation, confirming the large depth of the hypocenters. Furthermore, we tested possible ranges of depth by producing a series of forward models assuming fault located at progressively increasing depths and corresponding to a M_w 5.2 earthquake. Our models show that surface deformations are < 1 cm at depths greater than 15 km, in agreement with our hypocentral depth of 18 km for the main shock estimated from seismic data.

Our seismicity observations of slip along west-dipping faults show that deformation across the WAM is currently accommodated by antithetic faulting, as suggested by structural geology studies. Lower crustal earthquakes might occur in a strong lower crust due to the presence of mafic lower crust and/or be induced by migrating fluids such as magma or CO².