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The Age and Geochemical Evolution of the Western Ethiopian Shield: It's Role in Gondwana Formation

Blades, M.L.[1], Collins, A.S.[1] Foden, J.[1] Payne, J.L.[2] Alemu, T.[3] Woldetinsae G.[4] Clark, C.[5] Taylor, R.J.M.[5]

[1]Centre for Tectonics, Resources and Exploration (TRaX), Department of Earth Sciences, The University of Adelaide, Adelaide, SA 5005, Australia [2] Centre for Tectonics, Resources and Exploration (TRaX), School of Built and Natural Environments, University of South Australia, Australia
[3] Geological Survey of Ethiopia, Addis Ababa, Ethiopia [4] Ministry of Mines, Research and Development Directorate, P.O. Box 486, Addis Ababa, Ethiopia
[5] The Institute for Geoscience Research (TIGER), Department of Applied Geology, Curtin University, GPO Box U1987, Perth, WA 6845, Australia

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The East African Orogen (EAO) is a Neoproterozoic to early Cambrian mobile belt that records the collision between Neoproterozoic India and the African Neoproterozoic continents—it is the major collisional orogeny that formed as central Gondwana coalesced. The EAO provides a complex record of magmatic and tectonothermal events that mark the closure of a major ocean basin (the Mozambique Ocean). The orogen encompasses vast tracts of juvenile Neoproterozoic crust that represent volcanic arc magmatism that formed by subduction of the Mozambique Ocean. Despite the extent of this magmatism, the timing and duration of arc formation is only slowly being resolved, with most work so far focused in the north of the orogen (Saudi Arabia, Egypt), or in its southern extent (Madagascar, Tanzania). The Western Ethiopian Shield (WES) is one of the largest continuous outcrop tracts in the EAO and lies between these better studied north and south regions. The WES forms the interface between the dominantly juvenile Arabian-Nubian Shield in the north and the high-grade Mozambique Belt to its south; it holds a key position vital to understanding the role of the East African Orogen in Gondwana formation. The WES is made up of a range of supra-crustal and plutonic rocks that formed in Tonian volcanic arc environments. Here we present new U-Pb and Hf isotopic data from zircons as well as whole rock geochemistry to help constrain the age and source of igneous intrusions located within the WES. Collectively, the data will provide provenance and geochemical information to develop a temporal framework for the evolution of the extensive Western Ethiopian Shield and the formation of this part of Africa.

New data suggests that there are three tectono-thermal events—ca. 854 -804 Ma, ca. 790-770 Ma and ca. 660-600 Ma—which are broadly supported by previously published ages from elsewhere in the WES. Foremost, hafnium isotopic analyses of the WES indicate that the early Cryogenian magmas were generated from juvenile Neoproterozoic mantle sources (+11.91 – + 1.94) with little involvement of the pre-Neoproterozoic continental crust. The timing of deformation and metamorphism can be constrained by the intrusion of the post-tectonic 585 ± 8 Ma Ganjii Granite. Chrondrite normalised rare earth element (REE) plots for these rocks show moderate light REE enrichment with negative niobium and titanium anomalies, typical of arc magmas, confirming that magmatism in the WES is, in fact, arc related. The data presented in this study further reveal the timing and nature of these tectonothermal events

and also illustrate that the pre –, syn – and post – tectonic history is complicated by metamorphism/deformation occurring both at ca. 790-770 Ma and at ca. 660-600 Ma.

Age constraints on orogenesis in the Western Ethiopian Shield (ca. 660 Ma) are similar to those in NE Uganda (ca. 690-660 Ma), but are older than the Ediacaran peak orogenesis reported from the Southern Ethiopian Shield, Eritrea and northern Ethiopia and from SE Kenya. This suggests that closure of the western Mozambique Ocean involved progressive volcanic-arc accretion to the active margin of Cryogenian-Ediacaran Africa.