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# The occurrence of a complete continental rift type of volcanic rocks suite along the Yerer–Tullu Wellel Volcano Tectonic Lineament, Central Ethiopia

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ABSTRACT

The Yerer–Tullu Wellel Volcano-tectonic Lineament (YTVL) is an E–W trending fault system or aborted rift that intercepts the Main Ethiopian Rift (MER) at Debre Zeyt (Bishoftu)/Yerer, in the eastern periphery of Addis Ababa. The structure is in correspondence with the westward extension of the southern margin of the Gulf of Aden rift. The YTVL extends for more than 500 km with a very clear northern fault margin, between Addis Ababa and Ambo known as the "Ambo Fault". The southern margin is indicated by an E–W trending segmented lineaments at the latitude of about N 8°30′, the Bedele–Metu being the most clear segment. In between these limits there are several evolved central volcanoes and cinder cones.

The central volcanoes range in age from 12 to 7 Ma in the western most (Tullu Wellel) and gradually the upper limit get younger towards East to less than 1 Ma in the Wenchi and Debre Zeyt (Bishoftu) areas. These volcanic products cover the whole spectrum of a continental rift volcanic rocks suite: (1) in the eastern zone (Yerer–Bishoftu) the suite is silica **over-saturated**, ranging in composition from transitional basalt to peralkaline rhyolite, (2) moving westwards, between Wechacha and Wenchi, the rocks suite is silica **saturated** ranging in composition from alkali basalt to trachyte, (3) further West between Ijaji–Konchi and Nekemt the rocks suite is silica **under-saturated** ranging in composition from basanite to phonolite. Crossing the Dedessa lineament, the Tullu Wellel rocks appear to be silica **saturated**.

Within a single suite fractional crystallization is the predominant evolutional process even in the silica over-saturated suite. The westwards progressive silica under-saturation and increase in alkalinity (except for the Tullu Wellel volcanic centers) is interpreted by the gradual deepening of an anomalous mantle where partial fusion took place. Therefore, as distance increases from the MER junction to the West, the amount of melt on the upper mantle was gradually reduced and became more alkaline but poorer in silica.



## 1. Introduction

### 1.1. Geographic limits of the YTVL

The YTVL is defined by an E–W alignment of central volcanoes from the eastern peripheries of Addis Ababa (Mount Yerer) E39°00′, until the border of the Sudan (Tullu Wellel) E34°30′. The lineament of these central volcanoes is bounded to the north at about N9°05′ by a clear fault known as the Ambo fault (Abbate and Sagri, 1980, Figs. 1 and 2). To the West of Guder, the Ambo fault can be traced as a tectonic lineament.

The southern limit of YTVL is also represented by a series of lineaments that are segmented by the interception of the NW–SE and the NE–SW trending fault/lineament systems. The most clear portion is the Bedele–Metu lineament at about N8°30′ that is also traced by the course of the river Geba (Figs. 1 and 2).

### 1.2. Physiography and drainage

In like manner to the rest of the Western Ethiopian plateau, topography of the YTVL is very much uplifted in the rift margin to more than 3000 m a.s.l., and gradually decreases to the West to less than 1000 m a.s.l. along the western river valleys (Fig. 1). The average altitude covered by most planes within the YTVL is about 2000 m a.s.l., and there are some spikes indicating the central volcanoes (Fig. 2). Most of the major rivers follow the NW–SE lineament trend, but NE–SW and E–W trending rivers and streams are also common. Other than these, there are circular and semi-circular drainage patterns within and around the central

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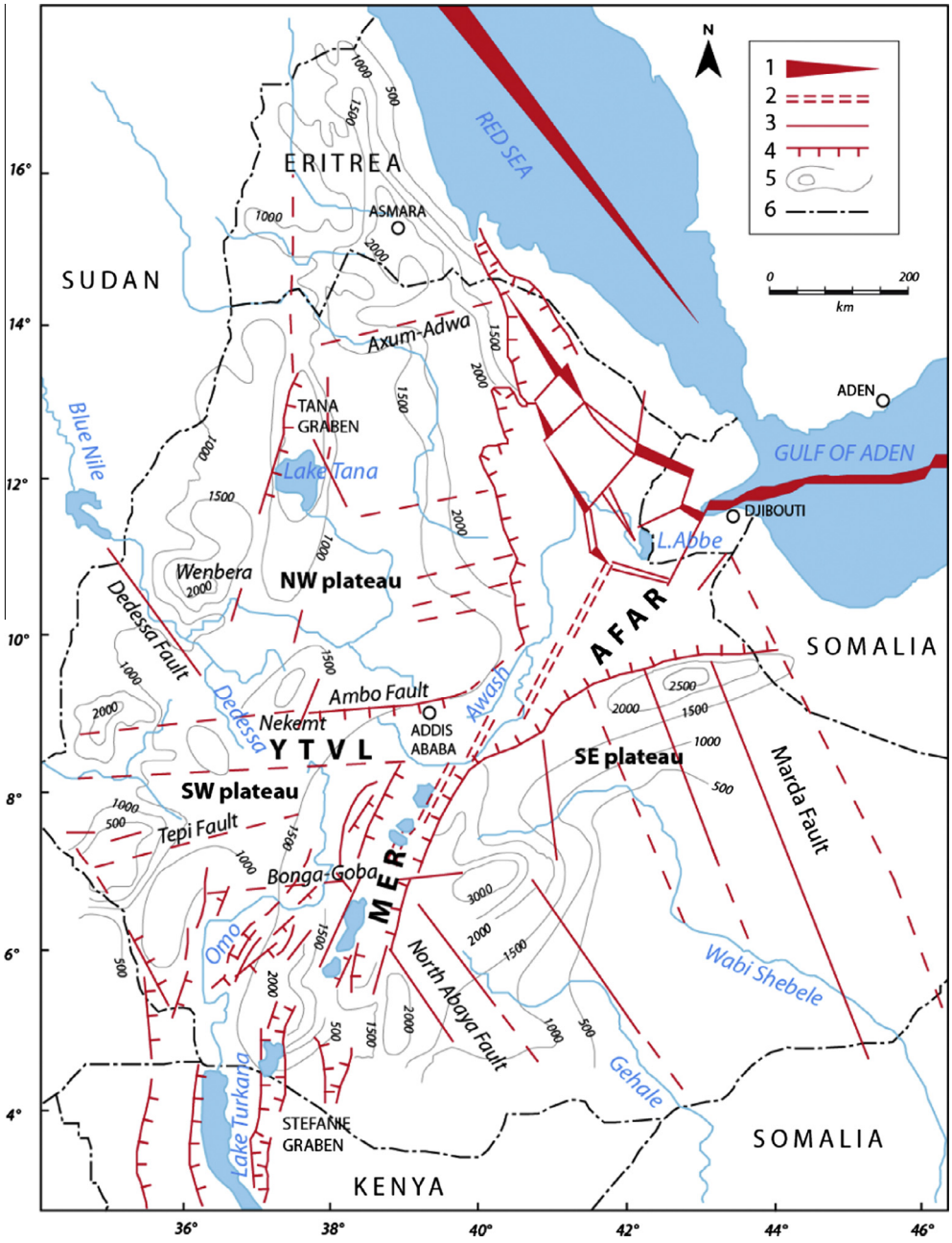


**Fig. 1.** Contour map of outcrops of the Pan-African basement rocks and important tectonic structures in the northern East African Rift System and location of YTVL, modified from Berhe et al. (1987a,b). 1. Principal oceanic rift expansion axis, 2. Principal continental rift expansion axis, 3. Rift transversal or transform (oceanic rift) structure, 4. Main fault, 5. Pan-African basement outcrop contour, 6. Approximate country border line.

volcanoes. This indicates that, the drainage pattern is controlled not only by the rift shoulder uplifted topography, but also by the predominant fracture systems and the central volcanoes. Most of the rivers flow away from the rift due to the abnormally uplifted rift margins, but Awash river flows into the rift, thanks to the YTVL that has dissected the rift shoulder at the eastern outskirts of Addis Ababa (Figs. 1 and 2).

## 2. Structural setup

In the East African Rift System (EARS), there are three major tectonic trends: the Red sea (NW–SE), the Gulf of Aden (ENE) and the Ethiopian Rift (NE–SW), that form a triple junction at the center of Afar. Away from the triple junction, one of these systems dominates over the other two, in which one is usually important transversal structure. In the case of the Ethiopian Rift the predominant structure being the NE–SW, the Red Sea fracture system usually forms a transversal component. The Gulf of Aden (ENE) fracture system with respect to the Ethiopian and Afar Rifts forms transversal structure at three latitudes; the Axum–Adwa, the YTVL and the Goba–Bonga lineaments (Mohr, 1968; Abbate and Sagri, 1980, Fig. 1). Considering the YTVL as the main structure, there are both the NW–SE and the NE–SW trending systems cross cutting the YTVL and to each other. In particular the NE–SW trending fracture system has significantly contributed in the blocks configuration and type of magma generation of the YTVL in the last ten million years.

Fig. 2 shows that the basement rocks of the Northwestern and the Southeastern plateaus have been uplifted to more than

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