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The Marda Fault Zone, Ethiopia

THE Marda Fault Zone in south-eastern Ethiopia was first recognised in the Marda Range near Jijigga (Fig. 1) and was called the Marda Hills line. The "linear NW–SE arrangement of basalt capped summits with basaltic plugs" and the associated Bouguer anomaly were considered indications of a major "volcanic-tectonic" lineament[1]. Subsequently the fault zone was described as a complex of NW–SE trending faults, down thrown to the NE and possibly extending 200 km into the Ogaden Basin[2]. Recent studies have indicated that the fault zone extends over 400 km beyond the Marda Range to the Belet Uen area in Somalia[3]. Moreover, a major fault zone trends south-east from Belet Uen to the Somalia coast and can be considered a further extension of the zone[4]. These indications of a zone of faulting from the southern margin of the Afar Depression south-east to the Indian Ocean define a length for the Marda Fault Zone of >900 km. The feature must therefore be recognised as a major structural element in the Horn of Africa. We here attempt to define the structure and age of the zone, and have made use of ERTS-1 (LANDSAT) Band 7 imagery, supplemented locally with colour composites, detailed photostudy between 7°50′N and 9°00′N, and potential methods surveys near Daghabur to supplement earlier geological and geophysical surveys.

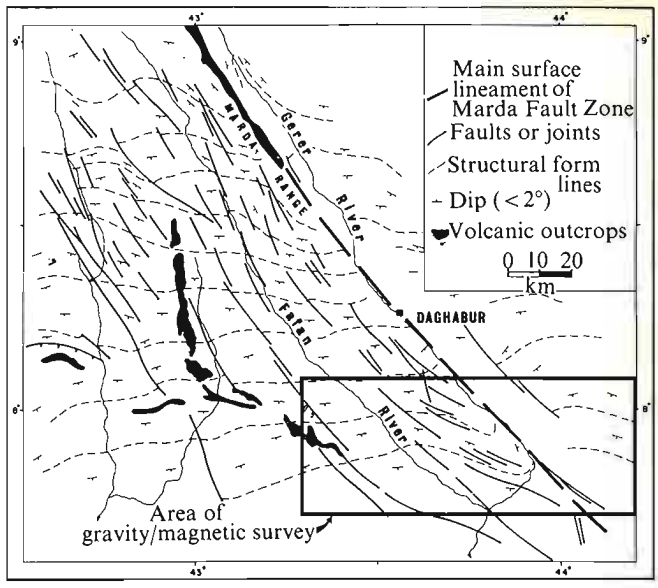

Fig. 2 Structural photogeology map of the Marda Fault Zone between 9°00′N and 7°40′N. This interpretation is part of an unpublished company report by Photogravity Inc., Houston.

The ERTS imagery clearly shows the outcropping volcanics and Hamanlei Formation sediments in the Marda Range, the linear valleys of the Fafan, Gerer and Wabi Shebelli rivers, and numerous linears (Fig. 1) between 10 and 100 km long, several of which near Jijigga have been proved to be wrench faults[3]. Numerous NE–SW linears are also seen, which in the southern Ogaden seem to offset the zone. Similar cross-faulting has been mapped on the ground near Jijigga[2]. Structural form lines determined from air photography consistently swing to the right near the zone (Fig. 2) suggesting dextral displacement on the faults.

South of Daghabur a positive Bouguer anomaly of ~40 $\times 10^{-5}$ m s^{-2} trends NE–SW on the eastern side of the Marda lineament and east–west on the western side (Fig. 3). Similar Bouguer anomalies in the zone near Shilavo and Abred are associated with significant basement structure[5], though the

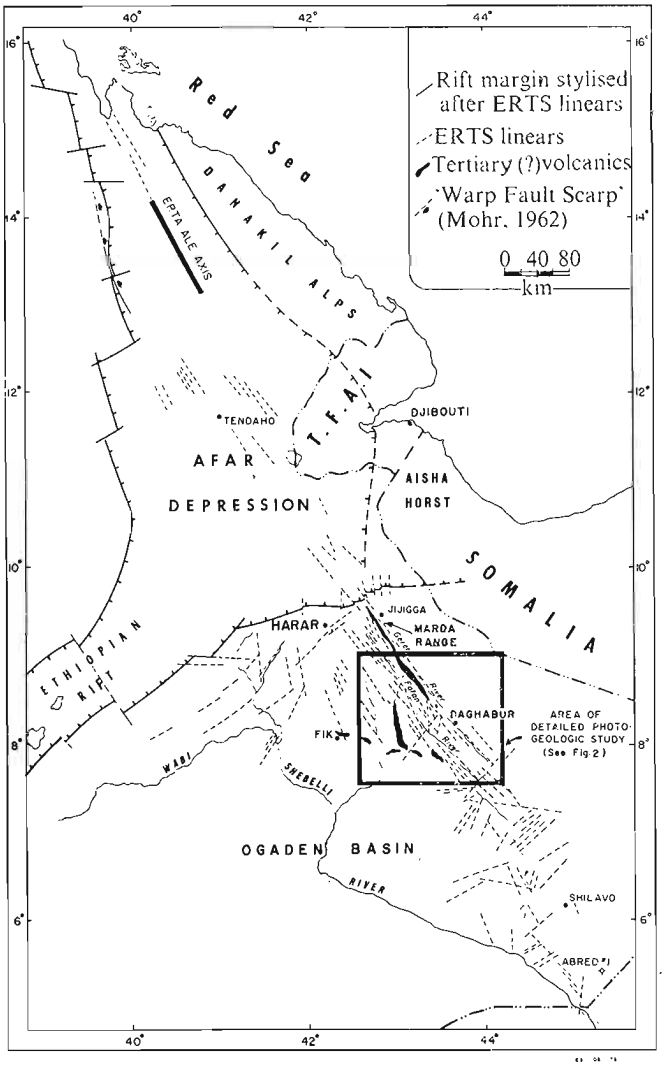

Fig. 1 Location map showing ERTS linears along the Marda Fault Zone. Only linears on trend with the zone are shown in the Afar Depression and most linears on the southern Somalia plateau have been omitted for clarity. 'Tertiary Volcanics' refers only to the volcanics on the Plateau in the vicinity of the Marda Fault.

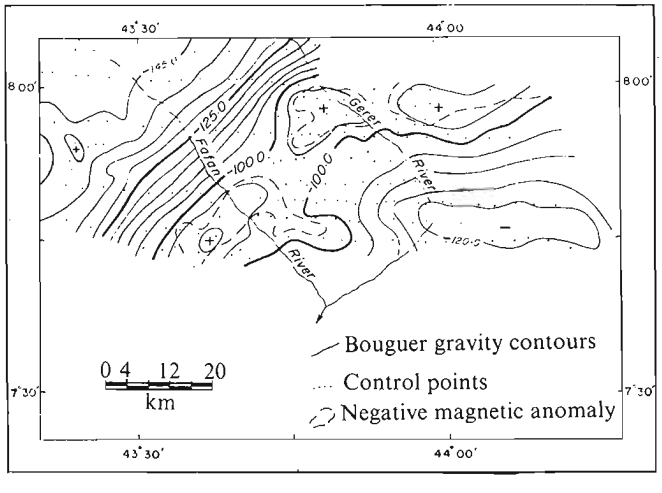

Fig. 3 Bouguer gravity map of a portion of the Marda Fault Zone between 7°30′N and 8°10′N.

anomalies can only be adequately explained by assuming superposition of intrabasement and suprabasement density contrasts as in the El Nala Bouguer anomaly in Saudi Arabia[6]. Profile analysis of the Daghabur anomaly defines a residual anomaly of almost 5×10^{-5} m s^{-2}, which may indicate suprabasement structure. This is supported by a negative magnetic anomaly of $\sim 10^{-7}$ T coincident with the gravity anomaly. The main anomaly may be interpreted in terms of crustal structure similar to the Bouguer gravity anomaly on the zone near Jijigga. In this case, major arching of the Moho discontinuity appears coincident with the Marda Fault zone[7].

Black *et al.*[3] defined a Tertiary age for the zone, evidenced by the abrupt contact of Mesozoic and Tertiary outcropping units across the zone, the displacement of Mesozoic sediments by NW–SE faults near Jijigga and the volcanics of the Marda Range which locally overlie the Cretaceous Amba Aradam sediments[8]. Mesozoic activity on the zone is, however, evidenced by structural thinning of the lower Jurassic Hamanlei Series on the basement structures, confirmed by reflection seismic surveys, and the thinning of Upper Jurassic limestones west of Jijigga[9]. The large Bouguer anomalies on the zone and the basic change in character of the regional Bouguer field across the zone have been interpreted as indirect evidence of Precambrian tectonism[5]. Mohr[10] has noted that the NW–SE faulting near Tendaho, the alignment of Pleistocene volcanic centres on the Afar floor and the sharp reduction in the magnitude of the Afar margin structures east of the Marda Fault, point to the "continuing influence of the Marda line on Neogene tectonism of the southern margin of Afar despite the apparently extinct tectonism of the line itself". These indications of activity in the zone from Precambrian to Recent times qualify the proposal that the Marda Fault marks a zone of crustal weakness, continuing the Red Sea trend across the horn of Africa.

The fault zone has been projected via a line of epicentres into the Erta Ale volcanic axis, possibly as part of a major mid-Tertiary shear zone extending along the Red Sea[3]. Alternatively, the fault has been projected north-westwards across the Afar into the highlands of Eritrea where it corresponds with a zone of Precambrian faulting and a significant facies change in the Jurassic limestones[8].

Current detailed geological mapping of the zone southwards to 7°50′N and projected additional gravity and magnetic surveys will hopefully provide new insights into the nature and age of the fault zone and its regional significance.

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