peralkaline trachytes of unknown age puncture Palaeozoic rocks in the Tabuk area[14]. The chemical similarity of Cenozoic basalts in the Afar, Ethiopia[18], and the Arabian peninsula[19] indicates that the mantle source region was not fundamentally different beneath the Arabian and Nubian shields.

As the Phanerozoic undersaturated alkaline magmatism in the northern Nubian shield has different character from that of the late Proterozoic Pan-African granitic magmatism, we see no reason to assume that this magmatism is an extension of the Precambrian episode. It would be more objective to say that the entire Arabian-Nubian shield experienced late Proterozoic calc-alkaline to peralkaline magmatism, and that a restricted province of predominantly undersaturated to peralkaline magmatism developed in the northern Nubian (and possibly north Arabian) shield region. Phanerozoic alkaline and peralkaline magmatism is found elsewhere in north Africa and that the Phanerozoic Nubian magmatism might be related to events in these regions.

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HARRIS AND GASS REPLY—Jackson and Stoeser have not distinguished between the identification of a Phanerozoic alkaline province in north-east Africa and our speculations on possible causes of this event and its apparent absence in Arabia.

Jackson and Stoeser identify an undated syenite and trachytes from north Arabia to counter our assertion that the Red Sea marks the eastern boundary of the Phanerozoic alkaline province. Future research may discover instances of pre-30 Myr Phanerozoic magmatism in the Arabian shield, but previous work has shown that the plethora of such intrusions in north-east Africa is not present in Arabia. Current geochronological studies on samples from both sides of the Red Sea substantiate the assertion that this igneous province represents the most significant geological contrast between the two sides of the Red Sea.

Following the identification of this igneous province we gave three reasons for its eastern margin being coincident with the Red Sea whilst emphasizing that more data are needed before we can be sure which of these is most relevant. Most of Jackson and Stoeser's comments are directed against our preference for the subduction zone model.

Many have commented on the apparent continuity of structures across the Red Sea, but with coastal plains covered with late Tertiary sediments and rotation of Arabia during the opening of the Red Sea the best that can be postulated is that there seems to be, in many places, structural continuity. The lithostratigraphical correlation between Arabia, Ethiopia, Sudan and Egypt has been shown to be unconvincing even within the southern Arabia shield[1], and correlation of ill-defined and regionally unknown stratigraphical units in the northern Arabian shield is highly questionable. To extend this 'correlation' across the Red Sea with no geochronological or geochemical control is misleading. For example, results from geochronological studies from several of the Egyptian units mentioned by Jackson and Stoeser are totally at variance with their "lithological matching" of Arabian units. The conclusion that there is precise correlation through the Proterozoic across the Red Sea which precludes any relative movement between north-east Africa and Arabia during late Proterozoic times cannot be substantiated by available data. However, our prime purpose was to identify the Phanerozoic alkaline province in north-east Africa. We then argued that a post-500 Myr distinction in upper mantle geochemistry across the Red Sea line seemed likely. Finally we speculated that an eastward dipping subduction zone with a surface expression along the line of the Red Sea could explain the presence of alkaline magmatism in Africa and its seeming absence in Arabia. If future studies preclude such a suture, this will indicate that the Phanerozoic alkaline province in north-east Africa is the only crustal expression of the geochemical difference in the upper mantle across the Red Sea line until the opening of the Red Sea at 30 Myr.

Jackson and Stoeser imply that the peralkaline magmatism of Arabia is part of the calc-alkaline event, and requires no change in tectonic setting. Whilst the switch from calc-alkaline to peralkaline magmatism was diachronous, the appearance of metaluminous granitoids within peralkaline complexes does not support their view as such granitoids have 'within plate' trace element characteristics (such as high Nb) and are quite distinct from the widespread homogeneous calc-alkaline plutons[2]. Such a marked change in high field-strength element abundance requires a variation in the volatile composition of the upper mantle which could be due to a change in tectonic setting. There are several granitic provinces, such as that of Mesozoic age in Nigeria[3], which lie in a within plate tectonic setting and include peralkaline and metaluminous types both with characteristic high field-strength trace-element abundances. It seems realistic therefore to use the terms 'within plate' and 'subduction zone' based on diagnostic trace element abundances, rather than the now outdated calc-alkali–peralkali classification, to identify granitoid provinces.

We believe that the contrast in Phanerozoic magmatism in north-east Africa and Arabia is well-established and the points raised by Jackson and Stoeser do not challenge this. Its relationship with earlier subduction processes suggests that contrasting mantle geochemistry may prove to be the reason and, if so, the Red Sea line was defined in the mantle (and possibly in the crust) as early as 500 Myr.

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