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Giant dyke swarms and triple junctions do not necessarily define a mantle plume signature

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Giant dyke swarms and triple junction define geometries that are generally inferred to mark the response of the crust to mantle plume head impact. Poor consideration is generally given to the possible role of structural inheritance of the basement fabric in the emplacement of these swarms. Cases of inheritance can easily be addressed using geochronology and structural observations. Here, we review in detail selected case examples of multi-generation dyke swarms that are related with large igneous provinces and subduction settings and that do not require mantle plume impact to explain their patterns.

(1) The 700km-long Independence dyke swarm (California) is beyond any doubt a subduction-related feature. It was intruded in several major magmatic episodes over more than 100 Ma. Interestingly, despite major changes in the orientation of plate convergence, the direction of dyke emplacements remains constant [1]. (2) The 1700-km-long Red Sea dyke system include both Neoproterozoic and Cenozoic (24-21 Ma) dykes [2] suggesting that the dyking event associated with the Red Sea opening followed an ancient Proterozoic direction. So, this arm of the Afar triple junction was not initiated by the Afar plume (3) The 180 Ma Karoo giant radiating dykes swarms include Jurassic, Proterozoic ($\pm$ archaean) dykes. Dyke orientations are largely controlled by pre-existing structures that also controlled emplacement of Precambrian dykes [3]. (3) The trend of several 200-Ma CAMP dyke swarms follows Pan-African and Hercynian directions and South American dyke swarms include both Proterozoic and Jurassic dykes [4]. (4) The Senneterre ($\sim$2.21 Ga), Biscotasing ($\sim$2.17 Ga) and

Abitibi (∼1.14 Ga) southern Canada dyke swarms [5] are geographically superposed, suggesting strong structural inheritance and a multi-reactivated weakened crustal pathway. Finally, we note that two of the 65-Ma-Deccan dyke swarms follow the western limit of the Indian craton and the third branch follows the Central Indian Tectonic Zone suggesting structural control. However, no Precambrian dykes have been identified yet. Other concise examples are addressed.

Although our observations do not rule out a mantle plume origin for most of these dyke swarms (which is well-established in some cases), they cast some doubt about the significance of dyke swarms and other triple junctions in the mantle plume model.

[1] Jourdan et al. (2003), AGU 2006. Abstract V21D-0634

[2] H. Bertrand and G. Féraud, unpublished results

[3] Jourdan et al. (2006), EPSL 241, 307-322

[4] Deckart et al. (1997), EPSL 150, 205-220.

[5] Buchan et al. (1993), CJES 30, 1286-1296