Discussion of

Lithospheric control on Gondwana breakup: Implication of a trans-Gondwana icosahedral fracture system

by

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This paper presents a non-plume-paradigmatic, interesting view about the top-down control of plate fragmentation and massive outburst of magma. Two points raised in the paper are worth emphasising: (i) the comparison between Gondwana fractures and inherited weak belts within the supercontinent, and (ii) the age of magmatism later than rifting.

A comparison of Gondwana fractures and troughs with former craton borders and continent structural grain clearly support a prominent role for lithospheric weak linear structures in determining the location of Gondwana rifts/fractures (Tommasi and Vauchez, 2001; Vauchez et al., 1997; Vauchez et al., 1998). Indeed, both the successful and failed Gondwana fractures are located between two old cratons, e.g. the Benue trough between West Africa-Sahara-Chad and Congo cratons, the Transkei-Namibia line between Kapvaal (Kalahari) and Zimbabwe/Congo cratons, the Parana line between Amazonian-San Feliciano and Rio de la Plata cratons.

The development of LIPs some 100 Ma after the development of fractures is a significant observation to be coupled with structural-geochronological data from the Karoo triple junction. Here it is demonstrated that magmatism occurred both several tens of Ma after fracture development and long before in the Proterozoic and the Archean (Jourdan et al., 2006). Thus the triple junction is triple in space but not in time, the arms not being magmatically coeval. Rather, dike emplacement occurred over thousands of Ma, further supporting a control by lithospheric structures that drove magma ascent over a time magnitude comparable to the lifespan of plate tectonics.

Furthermore, in some cases, also the low-volume alkaline rift magmatism was activated several tens of Ma after the main rifting process, as for the West Antarctic rift system, where the main rift phase is late Creataceous and the magmatism started in the middle Eocene (Rocchi et al., 2002). This lends further support to the inference that initiation of rifting is not driven by impacting plumes, even when magmatism is low-volume, and alternative mechanisms have to be invoked based on the role of inherited lithospheric structures (Rocchi et al., 2005; Salvini et al., 1997).

7th February, 2007, James W. Sears

I thank Rocchi for sharing his observations of further evidence that many of the fractures that broke apart Gondwana followed earlier lithospheric weaknesses, and that magmatic activity was sporadic along these fractures, in cases following initial rifting by tens of millions of years. His clarifying comment that the Karoo triple junction is triple in space but not in time accentuates the importance of considering the magmatic and structural aspects of continental breakup as separate phenomena. This strengthens the case for lithospheric control of continental breakup and large igneous eruptions. Evidently, the lithosphere breaks up along the least resistant zones that are favorably disposed to the global stress field.

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