Geophysical Research Abstracts,
Vol. 10, EGU2008-A-05384, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-05384
EGU General Assembly 2008

A Case for Degree-1 Mantle Convection During and Shortly After Pangea Formation

S. J. Zhong

Department of Physics, University of Colorado at Boulder, Boulder, Colorado, USA (szhong@colorado.edu)

A recent study [Zhong et al., 2007] showed that for a mantle viscosity structure with a moderately strong lithosphere and lower mantle that is consistent with observations, mantle convection with a mobile-lid tends to evolve to a planform that displays a hemispherical asymmetry or spherical harmonic degree-1 structure. Zhong et al. [2007] suggested that the degree-1 convection is responsible for forming supercontinents including Pangea and Rodinia with the upwelling (downwelling) hemisphere pushing (pulling) all the continents to the downwelling hemisphere to collide there. They further suggested that after supercontinent formation, degree-1 convection evolves to degree-2 convection with the second major upwelling that forms under supercontinent as a result of return flow from circum-supercontinent subduction and is antipodal to the upwelling in the previous degree-1 convection, and that the second major upwelling is responsible for continental magmatism and breakup of the supercontinent. Zhong et al. [2007] further suggested that the Earth's mantle convection alternates between degree-1 and degree-2 planforms, causing cyclic formation and breakup of supercontinents in the Earth's geological history.

While the antipodal African and Pacific super-plumes from seismic studies for the present-day Earth's mantle [e.g., Ritsema et al., 1999] and distribution of hotspot volcanism and large igneous provinces for the last 250 Ma [Torsvik et al., 2006] are consistent with Zhong et al. [2007]'s model for Pangea and post-Pangea, an important, also more difficult, test for the model is whether mantle convection is largely degree-1 with a single major upwelling and major downwelling during and shortly after the supercontinent formation, which is the goal of this study. I suggest that three lines of

evidence support a largely degree-1 convective planform associated with Pangea. 1) Continental reconstruction showed that during the Pangea formation, subduction occurs along continental margins in both interior and exterior seas [e.g., Scotese, 1997], suggesting that the hemisphere with continents where Pangea is formed is predominately for downwellings. 2) Volcanic and magmatic activities recorded on continents are at a minimal level during and shortly after supercontinent formation [Bleeker and Ernst, 2007], suggesting that supercontinents initially override a relatively cold mantle occupied mainly by downwellings. 3) Although most of Panthalassic seafloor on the other hemisphere have been subducted, leaving little geological record, the eustatic sea-level change for the last 200 Ma suggests that only one major upwelling system is permitted under Panthalassic seafloor – the same upwelling that is now in the central Pacific. Including a major downwelling or subduction system in the middle of Panthalassa would have lead to a significantly younger seafloor and higher sea-level at Pangea, thus presenting difficulties in explaining the eustatic sea-level variations [Cogne et al., 2006].