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Does the formation of Gondwana coincide with a change in global geodynamics?

Michael Brown

Laboratory for Crustal Petrology, Department of Geology, University of Maryland, College Park, MD 20742-4211, USA (mbrown@umd.edu)

There is a close relationship between periods of orogenic metamorphism imprinted in the rock record and the supercontinent cycle. For example, geologic and paleomagnetic data support a loosely knit amalgamation of the continental lithosphere in Rodinia ca. 1100–1000 Ma, but by ca. 900–800 Ma this supercontinent had begun to disintegrate; Gondwana was a product of the first stage in the Rodinia-to-Pangea supercontinent cycle. This cycle involved the diachronous break-up of Rodinia by rifting and formation of ocean basins along internal spreading margins while subduction continued at external convergent margins, followed by the multistage amalgamation of dispersed continental fragments by closure of both internal and external ocean basins. The network of Brasiliano–Pan-African belts reflects the way part of the Rodinian continental lithosphere broke up into fragments cored by cratons and how these fragments were reconfigured in Gondwana. Although the suturing of West Gondwana was not completed until the Cambrian, it nevertheless formed the nucleus to which fragments of East Gondwana were accreted during the Ediacaran–Cambrian. Eclogite–high-pressure granulite metamorphism (e.g., Brazil, Africa) and granulite–ultrahigh temperature metamorphism (e.g., Brazil, Africa, Madagascar, southern India, Sri Lanka, and East Antarctica) are characteristic of the network of Brasiliano–Pan-African orogenic belts. For the lower crust to achieve ultrahigh temperatures (> 900°C) at a regional scale either there must be an external source of heat, or the crust must be enriched in the heat producing elements relative to average continental crust and the duration of the orogenic cycle must be long enough to allow conductive heating. In both cases heating must overcome the thermal buffering due to partial melting. These conditions were commonly satisfied during suturing of the continental fragments making up Gondwana, as evidenced by the widespread formation of ultrahigh temperature granulite terranes. Although eclogites are generally scarce, the Trans-Saharan segment of the Pan-African records the oldest coesite-bearing eclogites, and sutures within the Anti-Atlas and the South China block record the oldest blueschist metamorphism, features that signal a change to colder thermal regimes associated with orogenesis during the Phanerozoic. In contrast, for the Laurasian fragments of Rodinia the first step in the transformation to Pangea involved the successive separation of Siberia, Baltica and Laurentia from Pannotia by generation of the new lithosphere of the Iapetus and Rheic ocean basins, leaving a unified Gondwana. Terrane export across and sequential closure of these ocean basins led to the formation of the large, essentially linear Appalachian-Caledonian–Variscan–Altaid orogenic system which sutured Laurasia to Gondwana forming Pangea. The Paleozoic sutures are marked by high pressure to ultrahigh pressure metamorphism and eclogite–high-pressure granulite metamorphism, whereas ultrahigh temperature metamorphism is rare. Limited subduction and the choking of subduction zones by terrane accretion may have reduced transport of water into the mantle wedge, suppressed the development of small-scale convection and the formation of backarcs and facilitated the formation and exhumation of ultrahigh-pressure metamorphic terranes. The large, essentially linear Terra-Australis accretionary orogenic system formed along the Panthalassan margin of Gondwana during the Paleozoic and was the precursor of the modern circum-Pacific orogenic system. The formation of Gondwana coincided with a transition in global geodynamics to an Earth system dominated by two mantle convection cells, a Panthalassan cell containing only oceanic plates and a Pangaean cell containing the continental plates, which controlled the change in scale and style of orogenic systems formed during the Phanerozoic compared with those formed during the Proterozoic.