Rodinia to Gondwanaland to Pangea to Amasia: alternating kinematics of supercontinental fusion

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According to one model based on preliminary tectonic matchmaking between cratons, the Neoproterozoic supercontinent Rodinia was transformed into Paleozoic Gondwanaland by means of bilateral extraversion (turning inside-out). Following the piecemeal calving of a keystone block (Laurentia, Baltica, Siberia), the split halves of the remaining supercontinent (East Gondwanaland and the disaggregated cratons of West Gondwanaland) were folded back-to-back. Relatively young crust from the margins of Rodinia became landlocked within the interior of Gondwanaland; relatively old crust from the interior of Rodinia became vulnerable to tectonically-driven erosion at the outside of Gondwanaland. This effect contributed to the large concurrent shift in measured proxy seawater $^{87}Sr/^{86}Sr$ ratios from .706 in geon 7 to .709 in geon 5 (geon 5 = 599-500 Ma).

A comparable supercontinental extraversion appears to be under way at present. As the Atlantic basin opens inexorably at the expense of the Pacific basin, the Americas are swung clockwise with respect to Eurasia, pivoting about their diffuse mutual plate boundary beneath the Verkhoyansk Ranges of northeast Siberia. The western margin of the Americas seems destined to collide with the eastern margin of an already coalesced Africa+Eurasia+Australasia, instituting the future supercontinent Amasia. The isotopically young crust of the circum-Pacific region will have been landlocked within Amasia and the relatively old crust of the circum-Atlantic margins, formerly located within the interior of Pangea, will have been turned outward. Since the breakup of Pangea, this is reflected in the rise of proxy seawater $^{87}SR/^{86}Sr$ ratios from .707 to .709. Accordingly, Gondwanaland was and Amasia will be products of supercontinental extraversion.

Rodinia and Pangea, on the other hand, seem to have been products of convergent kinematics, rather than extraversion. Rodinia coalesced through Grenvillian orogenesis in geons 11 to 10. In the Rodinia model mentioned at the outset, the now-dispersed segments of the Grenvillian orogenic belt are reunited in the form of a U-shaped loop, 10,000 km long. Its form suggests that the composite craton inside the loop (Laurentia+East Antarctica+Gawler) acted as a mega-indentor during the assembly of Rodinia. Existing orogen-scale kinematic data are consistent with identation: the Albany Fraser (Australia) and Eastern Ghats (India) belts on the left side of the loop (as viewed from its apex) experienced dextral transpression, while the Sveconorwegian (Baltica) and Grenville (Laurentia) belts on the right side of the loop underwent sinistral transpression. Detritus eroded from the Grenvillian mountains was carried by rivers to the Arctic, at the open end of the orogenic loop.

The fusion of Pangea culminated with the collision between Gondwanaland and Laurussia (Laurentia+Baltica), followed closely by the accretion of Kazakhstan and Siberia. Kinematically, the fusion of Pangea resembled that of Rodinia more than that of the extraverted supercontinents, although indentation (by Gondwanaland into Laurussia) was less extreme. Predictably, the accretion of Pangea was accompanied by a negligible shift in seawater proxy $^{87}SR/^{86}Sr$ ratios (but data for the interval encompassing the fusion of Rodinia and older supercontinents believed to have formed in geons 18 and 27 are lacking). Thus, we observe an alternation between convergent and extravergent kinematic instances of supercontinental fusion.