Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)
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SCG04-01 会場:302 時間:5 月 21 日 09:00-09:30

The yin and yang of continental crust creation and destruction by plate tectonic processes
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It is generally assumed that the volume of continental crust has grown with time, but there is increasing evidence that continental crust volume is approximately constant or is decreasing. On modern Earth, continental crust is both created and destroyed, especially by plate tectonic processes. Continental crust creation and destruction both mostly occur at convergent plate margins, added by arc magmas and subtracted by sediment subduction and subduction erosion. Crust is also created and destroyed by non-plate tectonic processes, including magmatic rifts and hotspot additions as well as losses by lower crust foundering (delamination) and subduction of continents. Estimates for losses by foundering and for subducted continental crust are especially poorly constrained. Stern and Scholl (2010) estimate that creation and destruction of continental crust is either in balance (˜3.2 km3/year, or 3.2 Armstrong Units, AU) or that more crust is being destroyed than created. These estimates, which do not include a term for crustal foundering (delamination), are comparable to, but distinctly lower than, those of Clift et al. (2009) (additions <5 AU, losses ˜4.9 AU) or losses estimated by C.R. Stern (2011) (5.25 AU). The range of these estimates (growth of 3.2-5 AU, loss of 3.2-5.3 AU) usefully captures our present understanding and uncertainty.

The near-balance of continental crust formation and destruction by plate tectonics is encapsulated by the traditional Chinese concept of yin-yang, whereby dualities act in concert as well as in opposition. The yin-yang creation/destruction balance changes over a supercontinent cycle, with crustal growth being greatest during supercontinent break-up due to high magmatic flux at new arcs and crustal destruction being greatest during supercontinent amalgamation due to subduction of continental material and increased sediment flux due to high mountains formed by collision. The balance may change during a supercontinent cycle. For example, there have been 1.5 supercontinent cycles over the past 630 million years. The first supercontinent cycle encompassed Ediacaran and most of Paleozoic time (630-300 Ma). Continental collisions to form Greater Gondwana (Pannotia) at 630-500 Ma created great mountain chains that were eroded down and much of the detritus that this shed was likely transported to trenches and subducted. It is also likely that a significant but unknown volume of continental crust was subducted (net destruction). Greater Gondwana break-up encompassed much of Paleozoic time and was accompanied by formation of new hotspots, rifts, and intra-oceanic subduction zones, forming new welts of juvenile continental crust (net growth). Laurasia and Gondwana came back together in Late Paleozoic time (350-250 Ma) to form Pangea, the assembly of which again created great mountains and much detritus and continental crust subducted (net destruction). Mesozoic and younger breakup of Pangea again produced new hotspots, rifts, and intra-oceanic subduction zones, forming new welts of juvenile continental crust (net growth). Yin-yang balance is shifting once again towards net destruction, as significant proportions of the continental crusts of Africa, Arabia, India, and Australia are being subducted beneath the growing supercontinent of Asia. We do not understand the relationship between foundering losses and supercontinent cycle; delamination has been inferred to occur beneath rifts and arcs as well as collision zones.

キーワード: continental crust, plate tectonics, island arc, subduction erosion, crustal growth
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