QUANTIFYING CRUSTAL RECYCLING AND GROWTH

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Mantle/continental crust mass transfer has both cyclic (recycling) and unidirectional (growth) aspects. The questions are: What are the processes and mass fluxes? Is there time dependence? Geophysical and geochemical studies of specific areas reveal recycling of chemically diverse crustal masses. In particular, lower crustal foundering (delamination), slab-breakoff and forearc subduction-erosion are physically and mechanically viable processes for recycling lower crust. Given that these processes are really tectonic events with m.y.-scale duration, how do we recognize them as they are happening, and after they have happened? Present-day examples include those from the Andes, Western Mediterranean, and Turkey; examples from the past include those from Eastern Australia, California (Sierra Nevada), Central China, and Canada (Slave province). What is the relative importance of the various recycling/growth mechanisms? This question is answered for the candidate mechanisms. As a yardstick for importance the unit of an Armstrong--1km3 /yr = A-- is proposed (after Richard Armstrong, an early proponent of crustal recycling). Globally, important recycling/growth mechanisms process mass at fluxes on the order of an A; the time-averaged growth rate of continental crust is about 2A. An important corollary to the realization that important recycled lower crustal units are mafic-ultramafic is that intermediate-composition crust can be the net result of addition of mafic magma (50% silica) to the crust and subsequent removal of 40-45% silica lower crust (often with dense, high-P eclogite mineralogy), leaving andesitic composition (58% silica). Direct mantle/crust transfer of andesite occurs, but at lower flux than for basaltic transfer, even in the Archean.