Continental versus crustal growth: Resolving the paradox

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Over the last 6 years, geophysical, geological, and geochemical data on the crust and lithospheric mantle have been integrated to generate maps of lithospheric composition and architecture. This mapping suggests that ≥70% of sub-continental lithospheric mantle (SCLM) may have an Archean parentage. Most preserved Proterozoic crust overlies Archean SCLM that has been variably refertilised and metasomatised by mantle melts associated with convergent margin, post-collisional, and mantle plume processes. This suggests that consideration of lithospheric preservation and recycling is crucial to understanding Earth evolution, including the concepts of crustal, as against continental, growth. In a recycling model, ancient, rigid, bouyant SCLM survives the rifting and accretionary processes of supercontinent cycles, whilst juvenile, fertile, dense SCLM typical of island arcs is largely returned to the convecting mantle. Significant areas of preserved post-Archean juvenile crust can be attributed to the complexities of plate tectonic processes. These include:- (i) obduction; and (ii) resurfacing. The latter may may involve mantle-derived magmatism during regional extension, or follow rifting and detachment of variable (upper- to whole-) crustal thicknesses. Post-Archean continental nett growth is likely near zero. Plate tectonic processes implicit in supercontinent cycles redistribute continental lithosphere via continental collisions and microcontinent migrations.

Mantle melting beneath the ultra-slow spreading Gakkel Ridge: Insights from melt inclusions and numerical modeling

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We present new analyses of volatiles and major elements for a suite of glasses and melt inclusions from ~85°E on the ultra-slow spreading Gakkel Ridge. The samples were collected in July–August, 2007 on the Arctic Gakkel Vents Expedition (AGAVE). Major volatiles (H_2O, CO_2, F, S & Cl) were measured using SIMS techniques on WHOI's 1280 ion microprobe. The major element and volatile compositions of the melt inclusions are more variable and consistently more primitive than the glass data. CO_2 contents in the melt inclusions extend to higher values (170–1700 ppm) than in the co-existing glasses (190–250 ppm), indicating that the melt inclusions were trapped at deeper levels. Based on the vapor saturation model of *Dixon and Stolper* [1995], we estimate that melt inclusions were trapped between seafloor depths (~3500 m) and ~10 km below seafloor, as compared to the glasses, which are all in equilibrium with their eruption depths. One intriguing observation is the lack of variability in water contents of the melt inclusions and glasses; all data range from 0.21–0.28 wt%. This could support experimental and theoretical models advocating rapid diffusion of water through olivine grains, thereby obscuring original source values. Alternatively, these water contents could represent true source compositions preserved at the time of entrapment.

The melt inclusion and glass data are compared to calculated melt compositions based on the model of *Kinzler & Grove* (1992a,b; 1993). 2-D mantle flow and temperature structure beneath the Gakkel Ridge is calculated assuming a visco-plastic temperature-dependent rheology. The model fits the major element data remarkably well and the data are consistent with fractional crystallization from a single pooled melt that crystallized near the top of the melting column (3–5 kbar). In contrast, the water data do not display a trend that can be easily explained by fractional crystallization. Finally, using the same model we show that much of the global variability in MORB glass compositions can be explained due to changes in spreading rate alone.