Continental crustal differentiation: What happens in the upper and lower crust?

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Earth's continental crust has formed from the mantle as a net result of tectonically and magmatically driven processes of mantle-crust mass exchange. The important candidate processes are erosion, subduction, subduction erosion, slab breakoff, and delamination.. To be important in this context, a process must have a global time averaged rate of about a km3/yr (or an AU—Armstrong Unit). Compositional differentiation of the crust is driven by the same tectonic and magmatic processes that form and destroy the crust itself. The differentiation can occur in a closed crustal system, but more frequently occurs in the open crust-mantle system (delamination and Andean magmatic flareups). As to rate, the time interval for averaging is flexible, as some of the processes are relatively continuous in the short time scale (subduction) while some are events that occur locally only every 1-10 million years (episodic subduction erosion at the Japanese margin) or once only (collision of terranes in British Columbia)..Tectonically, contraction ("orogeny") seems the most common setting for crustal growth, destruction and differentiation. Basaltic plume crustal underplating and accretion of oceanic plateaus has too low a rate to be important for more than a short duration (as in the CLIP source for silicic magmatism in Costa Rica), The realization that intracrustal differentiation requires large heat input makes expected the subequal mass contribution of mantle and crustal melts to even silicic plutons and ignimbrites (Sierra Nevada,US: Lachlan granites, Australia; Puna ignimbrites,Argentina. Advances in geochronology have sharpened and shortened the time scale of some orogenic events and their post-orogenic magmatism (e.g.: "Orogeny can be Short"—J.F. Dewey). In this context, the cause for orogenic crustal differentiation by magmatism becomes a question of where the heat comes from (eclogite delamination is implicated, especially where the silicic magmas have a "garnet signature" as in the Solonker suture zone China) The low abundance of mafic and ultramafic lithologies in UHP terranes implies that there was a density-driven separation of mafic and felsic lithologies at great depth., similar to the return to the crust of felsic lithologies only during.slab breakoff .

Central Andean Galan Ignimbrites: Magma evolution from the mantle to eruption in a thickened crust

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The 6 to 2 Ma Cerro Galan ignimbrite complex in the southern Puna plateau with an erupted volume over 1200 km^3 is a classic example of a "monotonous intermediate" meta to weakly peraluminous rhyodacitic ignimbrite formed in thickened backarc crust above a hot backarc mantle. Existing and new major and trace element and isotopic analyses can be linked with constraints for a low velocity mantle and crustal low velocity zones from the ongoing passive seismic experiment (PUNA08) to examine magma evolution within the crust. The combined data support the erupted magmas being near 50:50 mixtures of enriched mantle melt (^{87}Sr/^{86}Sr ~ 0.7055) and crust that evolved as fractionating mantle melts produced crustal melts to form hybrid magmas at depth in a > 50 km thick crust. These melts rose, accumulated and continued to evolve at mid-crust levels (~30–20 km). Lower crustal processing is indicated by steep REE patterns (Sm/Yb=4-7) and AFC modeling for Sr. Mid-crustal processing is indicated by 45-65% negative Eu anomalies largely unrelated to the ignimbrite crystals and strong enrichments of the most incompatible elements (e.g., Cs, U, Th) relative to those in contemporaneous aphyric andesites/ dacites along faults. These enrichments indicate sequential open system magma processing. Very low Nb/Ta (8-6) ratios are best explained by rutile dissolution from eclogites. Support for mid-crustal mush zones comes from published experiments on granites. Volume considerations at an intrusive to extrusive ratio of 4-5 suggest the evolving mush zones could leave an ~ 5 km thick tabular pluton under the caldera. Minor element differences, major element similarities and variable crystal contents in the ignimbrites reflect the addition and subtraction of eutectic granitic melts in the sequentially accumulated magmas. As elsewhere, the ignimbrite crystals largely formed in upper crustal ephemeral magma chambers at 4-8 km just before eruption. The near simultaneity of the eruptions with uplift of the Pampean ranges east of the plateau on high angle reverse faults supports regional contractional forces playing a role in high level magma concentration prior to eruption.