The role of island arc collisions in building the continental crust: Evidence from Tyrone, Ireland

PETER D. CLIFT[1], AMY E. DRAUT[2], JEFF AMATO[3] AND DAVID CHEW[4]

[1]School of Geosciences, University of Aberdeen, UK (pclift@abdn.ac.uk)
[2]152 Torrey Pine Terrace, Santa Cruz, CA 95060, USA (amydraut@yahoo.com)
[3]New Mexico State University, Las Cruces, NM 88003, USA (amato@nmsu.edu)
[4]Department of Geology, Trinity College, Dublin, Ireland (chewd@tcd.ie)

Large volumes of continental crust are lost back into the upper mantle via sediment subduction, tectonic erosion of forearcs, subduction of passive margins and gravitational loss of lower crustal material. These losses are balanced largely by arc magmatism. Although oceanic arcs account for only 31% of the total active margins in the world, mass budgets suggest that 40% (ca. 1.2 km^3/yr) of global arc melt production occurs along these margins. As a result their preservation is essential to maintaining the volume of the continental crust. New work from the Cambro-Ordovician Tyrone Igneous Complexes (TIC) in Northern Ireland adds to our understanding of how oceanic arc crust is transformed during its accretion to continental masses. U-Pb dating of zircons from primitive arc gabbros shows that subduction was active at least by 493 ± 2 Ma, but that the arc had started to collide with the passive margin of Laurentia by 475 ± 10 Ma based on U-Pb zircon dates from tonalite (possibly as as early as 490 Ma; Chew *et al*. 2007). LREE enrichment in volcanism and silicic intrusions of the TIC exceeds that of average Dalradian continental material, that would have been thrust under the colliding forearc and potentially recycled into arc magmatism. This implies that substantial crystal fractionation, in addition to magmatic mixing and assimilation, accompanied the formation of new crust in the Grampian-Taconic Orogeny. Our new data support earlier suggestions that although arc crust is too mafic and depleted to be a good analog for the construction of continental crust it is the injection of enriched material during accretion that helps modify the bulk composition to more continental values, especially if accompanied by loss of lower crustal ultramfic cumulates. Tectonic evolution of the Palaeozoic Caledonides show close parallels with those observed in modern day Taiwan.

Large mantle heterogeneities in H_2O and δD below the Southwest Indian Ridge (35-70°E)

MATTHIEU CLOG, CYRIL AUBAUD AND PIERRE CARTIGNY

Lab. Géochimie des Isotopes Stables, IPG Paris, 4 place Jussieu, 75252 Paris Cedex 5, France (clog@ipgp.jussieu.fr)

The concentration and isotopic composition of hydrogen in the upper mantle depend on exchanges during subduction, melting at ridges and interaction with a possible lower mantle. The δD of the present-day upper mantle is assumed to be -80±10‰, and its H_2O/Ce ratio 175±30, but most of the measurements were done on basaltic glasses from the Middle Atlantic Ridge and the East Pacific Ridge. The Southwest Indian Ridge (SWIR), known to be heterogeneous in chemical and isotopic composition is key to understand the processes affecting the variability of the water in the mantle and shed light on the global water cycle.

We present new δD and H_2O measurements on 45 basaltic glasses from the SWIR (35-70°E). Large heterogeneities are observed in H_2O/Ce and δD in the different ridge segments. The δD values range from -44 to -78‰ and H_2O/Ce ratios range from 101 to 435. The δD distribution is bimodal, with most segments being D-enriched with an average δD of -55±5‰ and two D-depleted segments with an average δD value of -70±8‰ (the 39-41°E and the 57-61°E segments). Most of the H_2O/Ce ratios are under 200, except for segments around 50°E and east of the Melville fracture zone (62°E).

All these glasses are undersaturated in water, indicating that degassing is negligible. Crystal fractionation, partial melting of an homogeneous source or contamination by either seawater or a brine cannot explain the observed variations. Thus, both δD and H_2O/Ce variabilities mostly reflect source heterogeneities in the southwest indian upper mantle.

The influence of the nearest hotspots is highly unlikely according to previous data in Sr-Nd-Pb compositions. Our results calls for the existence of a general deuterium enrichment of the SWIR mantle compared to the Atlantic and Pacific oceanic mantles.