Are Large Igneous Provinces net-sinks for CO_2?

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Continental flood basalts are subaerially erupted Large Igneous Provinces (LIPs), often covering significant continental areas with millions of cubic kilometers of lava. Recent evidence from the Central Atlantic Magmatic Province (CAMP) record in the Eastern North American (ENA) Newark Rift Basin demonstrated that LIPs may result in a transient doubling of atmospheric pCO_2, followed by a ~300 ky falloff to near pre-eruptive concentrations (*1*). We use the pedogenic carbonate paleobarometer in the corollary Hartford Basin to confirm findings in the Newark, and to test the million-year scale effect of the CAMP eruptions.

We find that the Hartford basin pCO_2 record is consistent with observations from the Newark, where a ~4400 ppm pCO_2 peak is identified just after each volcanic episode. The significantly longer post-extrusive Portland formation of the Hartford Basin shows a fourth CO_2 pulse to ~4500 ppm, about 250 ky after the last lava recorded in the ENA section, which may correlate to a later basalt in the Central High Atlas Basin of Morocco. The Hartford record also shows a rapid post-eruptive decrease in pCO_2, reaching pre-eruptive background concentrations of ~2000 ppm in <~300 ky, consistent with observations from the Newark Basin. Furthermore, the Hartford post-extrusive section exhibits a long-term decrease in pCO_2 to levels below the pre-CAMP background over the subsequent 1.5 My following the final apparent episode of eruptions.

We use a simple geochemical carbon-cycle model to demonstrate that the rapidity of these decreases, and the fall to concentrations below background may be accounted for by a 1.5-times amplification of continental silicate weathering due to the presence of the CAMP basalts themselves. If basalt has 10-times the chemical reactivity of continental crust, such an amplification would require eruption of lavas over an aerial extent of ~8.3 $x10^6$ km^2, well within independent estimates of the CAMP at 1.1 x 10^7 km^2. Together, these results indicate that continental flood basalts result in an extreme short-term perturbation of the carbon system, followed by a long-term decrease in pCO_2 to below pre-eruptive levels, implying they may have an overall net-cooling effect on global climates.

[1] M. F. Schaller, J. D. Wright, D. V. Kent (2011) *Science* **331**, 1404.

Alkaline mantle melts pinpoint late Triassic thinning of the Southern Alpine lithosphere (Ivrea Zone, Italy)

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Following granulite facies metamorphism and abundant mafic magmatism in the Permian lower crust, the European – Adriatic continental crust thermally equilibrated prior to upper Triassic to lower Jurassic rifting and exhumation. During this process, decompressional partial melts from the asthenosphere intruded into the lower continental crust and locally triggered partial melting and rejuvenation of isotopic systems. Such features have been described from the Ivrea zone [1, 2].

We studied Na-rich peralkaline leucocratic pegmatoid lenses within the ultramafic Finero body (N-Italy/S-Switzerland) at the eastern end of the Ivrea zone. These pegmatoids are composed of nepheline, plagioclase, biotite, zircon, apatite, sodalite and corundum. High-precision U-Pb ID-TIMS age determinations on single crystals, fragments and on a transect through a one centimeter sized zircon, combined with *in situ* laser ablation ICP-MS data, as well as initial Hf isotopes provide evidence that zircon grew episodically between 210 and 190 Ma from melts originating from an enriched mantle source. Variations in trace element composition and in age - up to 2 million years within one zircon crystal - are compatible with a first emplacement of plagioclase/albite and nepheline megacrystal bearing pegmatoids that are subsequently brecciated by a K, REE and trace element rich, fluid-saturated liquid. Both liquids are zircon saturated. The pulsed zircon growth is interpreted to reflect episodes of enhanced crustal stretching and thinning, producing a low-percentage of mantle melting. Our data may explain why the granulite-facies parageneses in the Ivrea zone have been locally overprinted and rejuvenated, solving the decennial controversy on the age of the regional granulite-facies event.

[1] Schaltegger & Brack (2007) *Int. J. Earth Sci.* **96**, 1131–1151. [2] Quick *et al.* (2009) *Geology* **37**, 603–606.