What Can Inherited Zircons Tell Us About the Origins of The Central Atlantic Magmatic Province and Its Transit Through the Earth's Crust?

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The Central Atlantic Magmatic Province (CAMP) was emplaced at ~201 Ma, spread over 11 million km^2, and interpreted as producing one of the largest CO_2 emissions in the last 500 million years (1, 2), resulting in the end-Triassic mass extinction. Despite much progress, the origins of CAMP are still highly controversial. CAMP derivation from subducted Iapetus back-arc crust (3) provides a model that can be tested by examining the old "detrital" zircons reported (4) to be in the CAMP. We sampled pegmatitic segregation veins in intrusive and extrusive CAMP rocks of the Newark and Culpeper Basins for crystallization age and detrital crystals. We isolated zircons (via ZirChron) dating them by LA-ICP-MS (at LaserChron). Four of our six samples contained grains of Grenville age but virtually none of early Paleozoic age, providing no evidence for the Iapetus back-arc model. Surprisingly, two Palisade Sill samples in the same vein less than a 50 m apart differed, one with 247-299 Ma grains which the other lacked, both with crystallization age zircons. We interpret most of the zircons as crystallized in situ the segregation veins from pressure-filtered, silica-rich fluid (5) while detrital grains spalled off from locally surrounding layers predict to have only detrital and no crystallization age grains, with the 247-299 Ma zircons interpreted as juvenile crystals contaminated with Grenville nano-xenocrysts following ref. (6). CAMP chemistry aligns with mixtures of <10% partially melted felsic material (7) with depleted mantle that could be of Grenville origin. Preakness lavas also have Grenville grains and these show that these zircons cannot be from Triassic sediments through which the magmas traveled because there are no sills of Preakness chemistry in the basin to act as conduits. We will test these ideas using Hf isotope ratios and by examining CAMP rocks lacking segregation veins that we predict to have Grenville zircons both as nano-xenocrysts and larger grains that sourced the anomalously old grains in our segregation vein samples.

1. Blackburn+ Science 340, 941–945 (2013).
2. Schaller+ Science 331: 1404-1409 (2011).
3. Puffer, AGU Monog 136: 151–162 (2003).
4. Bowring pers comm to PEO (2012).
5. Philpotts+ J Pet 37:811–836 (1996).
6. Davies+ Cont Min Pet 176, 1-24 (2021).
7. Callegaro+ Lithos 188:15–32 (2014).