Constraints on CAMP sills intrusion-depth from low-temperature thermochronometry

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The Central Atlantic Magmatic Province (CAMP) generated voluminous lava flows and numerous sills, and its emplacement coincided with the c. 201 Ma end-Triassic mass extinction and global warming[1]. CAMP sills, in particular, may have played a crucial role in the end-Triassic crisis by generating greenhouse and toxic gases (e.g., CH_4, CO_2, SO_2) when they intruded into organic-rich sediments[1,2]. The release of such gases into the atmosphere was likely eased by shallow intrusion depths[3]. In Amazonia, for instance, the shallow intrusion-depth of CAMP sills was inferred by their emplacement depths within upper Paleozoic sediments[2]. The thickness of these sediments above the sills is generally <0.5 km and Triassic sediments are absent, but the original stratigraphy and thus the sill intrusion-depths are unknown.

Here we reconstruct the intrusion-depth of CAMP sills at the time of emplacement using apatite fission-track (AFT) and (U-Th)/He (AHe). These systems have distinct closure temperature windows of c. 110-60 and 80-40˚C respectively, and yield information on when a sample cooled below these temperature windows and was subsequently exhumed from shallow depths to the surface. This work employs the following assumptions:

(1) The sills were hot enough to reset the AFT and AHe dating systems of the country rocks when they intruded.
(2) If the AFT and AHe systems yield c. 200 Ma ages, then the sills were emplaced at <1 km-depth (and have remained so due to limited post-200 Ma sedimentation).
(3) If the AFT and AHe systems yield <200 Ma ages then: (i) the sills were intruded at >3km-depth and were subsequently exhumed, or (ii) the sills were buried by thick post-200 Ma sedimentary cover and then exhumed to the surface. Regional stratigraphy, borehole data, and time-temperature modelling allow us to characterize and account for significant post-200 Ma burial.

Following these assumptions, we discuss AFT and AHe ages obtained from Paleozoic sedimentary rocks collected close to sills from Morocco and Amazonia, and whether sill intrusion-depth can be estimated using thermochronometry.

[1]Ruhl et al., 2011; [2]Heimdal et al., 2018; [3]Iyer et al., 2013