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Zircon and baddeleyite U-Pb geochronology and Hf isotopes from the Central Atlantic Magmatic Province (CAMP)

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Large Igneous Provinces (LIPs) are anomalously large volumes of dominantly mafic magma that erupted and intruded into the upper crust over short time scales. The origin of these volcanic provinces is very likely specific for each case, partly explained by plate tectonic processes or mantle plumes. Despite an ambivalent plate tectonic connection, there is a striking temporal correlation between the timing of LIPs and periods of mass extinction on Earth. However, establishing the relationship between these two is quite complicated since mass extinctions are typically recognised in the marine record, and LIPs are usually terrestrially emplaced. High precision geochronology of LIPs is essential to (i) establish the synchrony and infer the causal relationship with mass extinctions, and (ii) to understand how LIPs form.

In this study, we apply high-precision zircon and baddeleyite U-Pb geochronology to rocks from the ∼200 Ma Central Atlantic Magmatic Province (CAMP), in an attempt to reconstruct the overall timing of the event, its spatial distribution in time, and determine its relationship with the end-Triassic mass extinction. We also present Hf isotope data from the separated zircon and baddeleyite to both elucidate the origin of the LIP and also to determine if the magmas all originate from the same source. Our data suggest that the majority of the CAMP magmas were emplaced over a 0.5 Ma period from ∼201.5 Ma to ∼201.0 Ma with a possible small secondary event occurring much later at ∼199 Ma. Spatially, it appears that CAMP magmatism occurred roughly simultaneously over the entire province (i.e. ∼8000 Km North to South). However, the Hf isotopic composition varies over this length with the highest values (∼5.5 εHf) occurring in a small area to the south of the province in Brazil and Sierra Leone. Towards the north, the εHf values become negative, indicating the presence of an older or more enriched component in the magmas. Our geochronology also indicates that CAMP magmatism was occurring as dykes and sills in at least two locations prior to the emplacement of the basalt flows. We speculate that SO_2 and CO_2 degassing of these early magmas along dykes and fissures may have caused the climatic disturbance necessary to initiate the extinction.