Extended zircon crystallization histories in residual melts of mafic magmatic systems

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Zircon is being found rather commonly in mafic rocks from large igneous provinces (LIP) despite their high crystalization temperatures and low zirconium contents, which apparently contradicts zircon saturation conditions. However, zircon in these rocks occur as tiny crystals in pockets of highly evolved melt that crystalize at much lower temperatures than the bulk of the magma and that contains high concentrations of incompatible elements. Consequently, such zircon grains contain variable and high trace element concentrations. Zircon U-Pb ages from mafic rocks typically record uniform ages at around the ± 0.02% level (once the effects of Pb loss have been removed). This type of zircon crystals have been instrumental in determining precise and accurate ages for many of the Phanerozic large igneous provinces.

Here we report zircon U-Pb ages from 2 samples from the North Mountain basalt (Bay of Fundy, Canada), one of the earliest eruptions from the Central Atlantic magmatic province (CAMP) that range in age from ~204 Ma to ~201.5 Ma. This age range is significantly longer than what would be expected from typical LIP zircon. CL images of a large suite of these zircon crystals do not contain evidence for xenocrystic cores, also Hf isotope data do not suggest crustal contamination. Simple mass balance calculations suggest that only tiny xenocrystic cores of ~600 Ma (the age mode of zircon from the sediments through which the North Mountain basalt is emplaced) would be required to explain the oldest ages, although these have not been discovered in the CL imaging. Alternatively, the old ages could reflect early magmatic activity associated with the CAMP, which implies (i) that this presumably mafic early magmatism would have to produce zircon with low U, which is a characteristic of the >201.5 Ma grains, and (ii) that these grains would then have to survive transport in a zircon under-saturated mafic melt to the surface, which seems rather unlikely. However, this study highlights the fact that zircon data from LIP magmas can be as complicated to interpret as those from more felsic systems.