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# Tracking disturbances in the $^{40}$Ar-$^{39}$Ar isotopic system in plagioclase crystals of the Karoo flood basalts

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High precision dating of Large Igneous Provinces (LIP) is useful to provide insights into their link to environmental changes (Courtillot and Renne, 2003), and their geodynamic setting (Encarnación et al., 1996). The Drakensberg continental flood basalts (CFB) of South Africa and Lesotho are part of the Karoo LIP in which the paucity of zircon or baddeleyite renders it difficult to match the sub-permil age precision and accuracy of U/Pb CA-ID-TIMS. Previous attempts to date the Karoo lavas using the $^{40}$Ar-$^{39}$Ar method failed to yield sufficient precision and accuracy to resolve the sequential stacking of different basalt units or to give a reasonable emplacement age relative to the intrusive complex. We test the hypothesis that previous, inconsistent $^{40}$Ar-$^{39}$Ar dates of plagioclase were a consequence of degassing of primary, metasomatic and alteration phases (mainly zeolites alongside sericite and carbonate) within crystals that were invisible under a binocular microscope. The lavas are mainly tholeiitic basalts that host two distinct sizes of plagioclase. The larger crystals (250-400 μm) are more altered and fractured than the smaller grains and thus more likely to have modified Ar isotopic reservoirs. We present $^{40}$Ar-$^{39}$Ar data from i) leached groundmass, plagioclase separates ii) untreated that host visible alteration phases, iii) untreated and devoid of visible alteration phases (2 grain size aliquots), and iv) leached and devoid of visible alteration phases (2 grain size aliquots). Ar isotope data were collected using a multi-collector Argus VI mass spectrometer by step heating to permit identification of different gas reservoirs in the sample through isochemical dating. The two distinct size fractions yield distinguishable dates that do not overlap, and thus $^{40}$Ar/$^{39}$Ar analysis of a bulk plagioclase concentrate would yield an average date. Furthermore, leaching has the effect of enhancing recoil effects on the smaller sized plagioclase (<150 μm), adding another artifact to the already biased dates. Our results suggest that previous $^{40}$Ar-$^{39}$Ar analyses of carefully selected plagioclase separates (Jourdan et al., 2007a; Moulin et al., 2011, 2017) that are not consistent with their high emplacement rate are influenced by post-crystallization open-system modification, and thus do not accurately record the time of crystallization.