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Argon isotopic fractionation in obsidian : Big Obsidian Flow, Newberry, OR, USA

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The $^{40}Ar/^{39}Ar$ technique has the potential to be the most accurate method of directly dating obsidian, but is often hampered by problems centred on the apparent composition of trapped argon. The high solubility of argon in felsic melts can lead to a very high proportion of non-radiogenic argon. This in turn leads to large ^{40}Ar corrections, an effect that increases with decreasing sample age. Emplacement processes may fractionate the trapped components, e.g., atmospheric argon or magmatic argon. The combination of these two processes can lead to significant imprecision and inaccuracy in obsidian age determinations.

The Big Obsidian Flow (BOF) was chosen for study due to its well-constrained young age and it apparent lack of alteration, especially hydration. The BOF is well exposed along the southern rim of the Newberry Caldera, Oregon, USA, covering ~3 km^2. The middle and ends of two flow lobes and the vent have been sampled, with various textures selected at each site. Carbon-14 dating of an underlying ash flow places the age of the BOF at ≤1310 years. At this age, very little radiogenic argon has accumulated, meaning that bulk of the argon measured in the samples will be the trapped component. Both un-irradiated and irradiated chips were analysed by CO_2 laser step-heating and argon was measured on an ARGUS V multi-collector instrument.

The step-heating experiments reveal that the samples are affected by a fractionation process that is approximately mass dependent, i.e., lies close to a mass fractionation trend. The magnitude of the mass-dependent fractionation is reproducible at the hand sample scale but varies significantly between locales on the flow. The mass-dependent fractionation process yields $^{40}Ar/^{36}Ar$ trapped component compositions as low as ~280. If unaccounted for, individual steps in plateau age calculations can be up to several million years too young. However, using the trapped component compositions to correct individual steps yields relatively flat plateaux with ages that are indistinguishable from assumed age, ca. 1310 years.