Intercalibration of $^{40}Ar/^{39}Ar$ standards: Towards an *R*-matrix

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$^{40}Ar/^{39}Ar$ is one of the most versatile geochronometers in terms of relevant time span and scope of applicability to diverse geological environments. The achievable precision of $^{40}Ar/^{39}Ar$ dating has increased by an order of magnitude over the last decade, but accuracy is still limited by several factors. Standards coirradiated with samples and used to calibrate $^{40}Ar/^{39}Ar$ ages are among the most important sources of uncertainty. The age (or equivalently, the $^{40}Ar^{*}/^{40}K$) of any standard can be determined by various means, but achieving desired levels of precision and quantifiable accuracy is non trivial.

To minimize limitations inherent to mass spectrometry (e.g., mass discrimination, detector non-linearity) it is desirable to use standards whose $^{40}Ar/^{39}Ar$ ratios (i.e., to a good approximation, ages) are similar to (i.e., are small multiples of) those of samples. An efficient and achievable goal is to have a set of widely available, highly standards whose ages define a geometric progression, such as 100 ka, 300 ka, 1 Ma, 3 Ma, … We advocate a vigorous multilaboratory effort to develop and intercalibrate such a set of standards such that the relationship between any two of them embodied by the ratio of their $^{40}Ar^{*}/^{39}Ar$ values, termed the *R* value, is determined to better than ±0.05% relative precision. The feasibility of this goal is demonstrated by results summarized by Niespolo et al., 2017, in which an *R* value between the ~1.2 Ma Alder Creek sanidine and the ~28 Ma Fish Canyon sanidine has a relative precision of 0.03% based on data from three laboratories.

The standards must meet requirements of availability, ease of preparation, and reproducibility. Optimization of iradiation times ideally requires each standard to be co-irradiated with its nearest age multiples. With a sufficient number of laboratories participating, the workload need not be onerous.

The product of this effort can be encapsulated in what we call an *R*-matrix [Niespolo et al., 2017], which is an N x N matrix if there are N standards involved, and whose elements R_{ij} are the *R*-values between the standard in row i, column j. An analogous matrix of uncertainties in these values is a natural corollary.

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