Imprecisions and errors in ^{226}Ra-^{230}Th volcanic mineral ages from Ra-Ba partitioning difference estimates

K.H. RUBIN[1]* AND G.F. ZELLMER[2]

[1]Dept. of Geology and Geophysics, SOEST, University of Hawaii, 1680 East-West Rd., Honolulu HI 96822, USA (*correspondence: krubin@hawaii.edu)
[2]IES, Academia Sinica, 128 Academia Rd. Sec. 2, Taipei 115, Taiwan (gzellmer@earth.sinica.edu.tw)

Mineral isochron dating using ^{226}Ra-^{230}Th ($t_{½}$=1.6 ka) differs somewhat from more common isotope systems (e.g., ^{87}Rb-^{87}Sr) because there is no stable Ra isotope to normalize parent and daughter abundances (e.g., ^{86}Sr in the ^{87}Rb-^{87}Sr system). Many papers have thus advocated using the geochemically highly similar element Ba as an imperfect, yet plausible stable analogue for ^{226}Ra-^{230}Th isochron dating. Various other authors have taken a modified approach, whereby a non-unity solid-melt partition coefficient ratio, D_{Ra}/D_{Ba}, is used to estimate a mineral ^{226}Ra/^{230}Th intial ratio, the result generally portrayed as being always both more accurate and more precise (e.g., [1,2]) than age estimates made with the assumption that $D_{Ra}=D_{Ba}$. Such studies mostly apply a mineral-specific strain parameterization estimate of D_{Ra}/D_{Ba} [3], although recently a small experimental data set has also become available [2]. While we do not question the theoretical framework of D_{Ra}/D_{Ba} variations or the plausibility that some predictied or experimentally determined values can be usefully applied in some circumstances, we caution that in geochronologic applications, where the prediction of initial abundances is paramount for determining an accurate age, the $D_{Ra}\neq D_{Ba}$ model has significant limitations arising from, among other things, (1) the vagaries of natural minerals growing under magmatic conditions; (2) the small number of experiments; (3) incomplete strain parameterizations; (4) mineral impurity or inclusion estimates; and (5) age errors from D_{Ra}/D_{Ba} approximations, which tend to be grossly under-estimated in the literature. Age estimates of minerals with $D_{Ra}/D_{Th} > 1$ (e.g., plagioclase) using $D_{Ra}\neq D_{Ba}$, must be viewed and used with extreme caution. However, D_{Ra}/D_{Ba} estimates have generally minor age effects on minerals where $D_{Ra}/D_{Th} << 1$ (such as magnetite and clinopyroxene [4,5]). Nevertheless, adhoc application of poorly constrained D_{Ra}/D_{Ba} in a mineral can lead to variably erroneous ages.

[1] Cooper *et al.* (2001) *EPSL* **184**, 703-718. [2] Fabbrizio *et al.* (2009) *EPSL*, **280**, 137-148. [3] Blundy & Wood (2003) *Rev. Min. Geoch.* **52,** 59-123. [4] Zellmer *et al.* (2008) *EPSL* **269**, 387-397. [5] Rubin & Zellmer (2009) *EPSL*., **281**, 115-123.

The double spike toolbox

JOHN F. RUDGE*, BEN C. REYNOLDS
AND BERNARD BOURDON

Institute for Isotope Geochemistry and Mineral Resources, ETH Zürich, Clausiusstrasse 25, NW, 8092 Zürich, Switzerland (*correspondence: rudge@esc.cam.ac.uk)

The double spike technique is a well established method for correcting for instrumental mass fractionation in mass spectrometry [1]. The precision of the technique is controlled by the choices of double spike composition and the proportions in which the double spike and sample are mixed. To make these choices easier, we present a collection of MATLAB codes ("the double spike toolbox") for calculating optimal double spikes for any isotope system. Optimal double spikes are chosen purely on the basis of minimising error propagation on the isotope ratios of the samples, rather than by geometrical methods [2]. In addition, we have produced "cocktail lists" of optimal double spikes for all 33 elements that have 4 or more naturally occurring isotopes, using some sensible default parameters. As examples, we discuss the application of the software to Fe, Pb, and Ca isotopes. The software is freely available at www.johnrudge.com/ doublespike.

[1] Dodson (1963) *J. Sci. Instrum.* **40**, 289-295. [2] Galer (2007) *GCA* **71**, A303.