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INVITED LECTURE - Half lives of nuclides for geological use: 2012 evaluations for ⁸⁷Rb, ²³⁵U and ²³⁴U

Tuesday, 18 September 2012 12:10 (20 minutes)

The IUPAC-IUGS joint Task Group "Isotopes in Gesciences", TGIG, has evaluated the published measurement results for the decay constant (i.e. half life) of 87Rb and updated those of 235U and 234U relative to that of 238U. A significant part of our evaluation was the effort to follow strict metrological criteria (VIM, 2012) in our assessment of the measurement uncertainties according to GUM (2008).
The 87Rb half life was estimated by two groups using totally independent approaches. Nebel et al. (2011) compared Rb-Sr and U-Pb ages of different minerals, whose geological context suggests contemporaneity. This approach, which also applies to the comparison between 238U-206Pb and 235U-207Pb ages mentioned below, assumes that certain natural samples behave "ideally", i.e. all the relevant ages are expected a priori to be equal. This assumption is only as good as the independent control on the samples'petrology, and it is possible to underestimate systematic bias. Rotenberg et al. (2012) measured the radiogenic 87Sr accumulated in a batch of Sr-free Rb salt after 35 years. This approach relies on having performed precise and accurate measurements of the concentration and isotopic composition of the Sr present in the RbClO4 at the time of crystallisation. The two sets of experiments yield indistin¬guishable results, which is a good indication that systematic biases were either coincidentally of the same magnitude and direction in two radically different experimental designs, or negligible altogether. The resulting best estimates are λ87 = (1.395 ± 0.002) x 10-11 a-1 (1s uncertainty), t1/2 = 49.7 ± 0.1 Ga.
The half life of 235U, which we had presented last year at the INCC congress (Villa et al., 2011, and references therein), has been slightly revised. It was brought to the attention of the Task Group that some workers reported a mass-independent fractionation of incompletely understood origin that affects odd- and even-mass isotopes in a different way (e.g. Amelin et al., 2005). Moreover, recent reports on N(238U)/N(235U) number ratio measurements in the same zircon samples used for geochronology (Hiess et al., 2012) indicate an individually variable number ratio, on average lower by (0.031 ± 0.011) % relative to the previously assumed value of 137.88. Including both effects into the 235U half life re-evaluation gives t1/2 = 703.41 ± 0.19) Ma (1s uncertainty), λ235 = 0.98540 ± 0.00027 Ga-1.
These two effects do not modify the 234U half life relative to our 2011 assessment: t1/2 = 245.44 ± 0.16 ka (1s uncertainty), corresponding to λ234 = 2.8241 ± 0.0018 Ma-1.

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GUM (2008) Guide to the expression of uncertainty in measurement. www.bipm.org/en/publications/guides/gum.html
Hiess J., Condon D.J., McLean N., Noble S.R. (2012) 238U/235U systematics in terrestrial U-bearing minerals. Science 335, 1610-1614.
Nebel O., Scherer E.E., Mezger K. (2011) Evaluation of the 87Rb decay constant by age comparison against the U-Pb system. Earth Planet. Sci. Lett. 301, 1-8.
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VIM (2012) The International Vocabulary of metrology –Basic and general concepts and associated terms, 3rd edition, JCGM 200:2012, http://www.bipm.org/vim

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