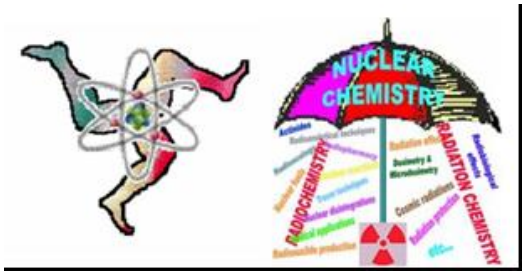

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Half-lives of nuclides for geological use: 2011 evaluations for U-235 and U-234

Tuesday, 20 September 2011 08:50 (20 minutes)

The IUPAC-IUGS joint Task Group "Isotopes in Gesciences", TGIG, has evaluated the published measurement results for decay constants (i.e. half-lives) of U-235 and U-234 relative to that of U-238.
A measurement result is generally expressed (VIM, 2008, entry 2.9) as a single measured quantity value and a measurement uncertainty. A significant part of the present evaluation was the assessment of the measurement uncertainties following strict metrological criteria (GUM, 2008).
Following the counting experiments by Jaffey et al. (1971), which yielded the U-238 half-life still deemed reliable, albeit with a higher uncertainty, the endeavor in the geochronological community (Schoene et al., 2006; Mattinson, 2010) moved to determining the U-235 half-life indirectly, based on U-Pb dating of single crystals of zircon (natural ZrSiO4). The approach is based on the assumption that certain natural samples behave "ideally", i.e. their 238U-206Pb and 235U-207Pb ages (hereafter t-206 and t-207, respectively) are expected a priori to be equal. However, in current practice only the concentration N(U-238) is measured at present, and the concentration N(U-235) is calculated assuming a constant number ratio eta = N(238U)/N(235U) = 137.88.
Recent reports on eta measurements in magmatic rocks (Weyer et al., 2008) indicate that granites and basalts, typical magmatic rocks used for geochronology, have an eta lower by (0.031 ± 0.011)% relative to the NIST standard reference material SRM 950a. In turn, the latter was measured by Condon et al. (2010), who report eta = 137.847 ± 0.012. Combining these two recent re-determinations, the typical granitic zircon grains used for geological sample intercomparisons are predicted to have eta = 137.804 ± 0.021. From these, we calculate a provisional value for the 235U half-life of (703.44 ± 0.23) Ma (1s uncertainty), corresponding to lambda-235 = (0.98537 ± 0.00032) Ga-1.
The 234U half-life (Cheng et al., 2000) was obtained following strict material traceability protocols, and had the explicit goal of ensuring the radioactive equilibrium of natural samples. The eta number-ratios of the NBL CRM 112a and U-500 reference materials that they used as spike and dectector calibrators were subsequently revised (Condon et al., 2010). In particular, recalculating eta in Cheng et al.'s (2000) spike using Condon et al.'s (2010) revised eta for U-500 also accounts for a shift in the eta for NBL CRM 112a. As a consequence, the half-life is modified by + 0.07 % to (245.44 ± 0.16) ka (1s uncertainty), corresponding to lambda-234 = (2.8241 ± 0.0018) Ma-1.

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