Annual Report on the IUGS/IUPAC Joint Task Group "Isotopes in Geosciences"

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Status:

Since the last report in December 2007, e-mail communications among various members were held to discuss various technical details of the project. One of the details involves the standard and the symbol used for the measurement of the half-lives of long-lived radionuclides that are used for age determinations. The standard unit of time for these measurements is the "year". However, the unit of the year is not defined by the International System of Units, the SI.

One of the problems with the year is that it is not commensurate with the day and it is also not a constant. The year decreases by 0.530 seconds per century. In addition, there is the problem of leap seconds used to keep Earth rotation time (UT1) based on the variable rotation of the Earth on its axis coordinated with coordinated universal time (UTC) based on steady atomic clocks. Earth's non-constant rotation period can differ from its average by as much as a few milliseconds because of tidal variations, large scale weather phenomena such as "El Nino" geophysical phenomena and tidal deceleration modified by deglaciation. Leap seconds have been applied once every year and a half, since 1972 to adjust the UTC with the UT1.

If one wishes to use the year as a unit of time interval and the required precision is sufficiently high, you need to explicitly define the year that you are using in terms of the second, which is the SI unit and the ultimate reference for a unit of time.

For the symbol of the time unit, year, the IUPAP's SUN (Symbols, Units and Nomenclature) Commission and the IUPAC's "Green Book" recommended the symbol "a" for the annus (annee), independent of its special definition. Unfortunately, all groups do not follow this usage universally.

For the definition of the year in terms of the second (or the day), there are numerous definitions available. Some examples are as follows:

The Julian Year = 365.25 days = 3.155 760 (10)7 seconds.
The Gregorian Year = 365.2420 days = 3.155 690 88 (10)7 seconds.
The Sidereal Year = 365.256 360 417 days = 3.155 814 954 (10)7 seconds.
Calendar Year (non-leap year) = 365.00 days = 3.1536 (10)7 seconds.
Calendar Year (leap year) = 366.00 days = 3.162 24 (10)7 seconds.

For a publication on a half-life measurement for which no specification is given for the standard unit of the year, the uncertainty could be as large as + 0.07% for a non-leap year measurement, while the uncertainty could be as large as - 0.21% for a leap year measurement merely due to

the uncertainty in the standard. Thus, the quoted half-life value would have an inherent "type B" uncertainty of 0.21% (see the International Organization for Standardization, ISO, Guide to the Expression of Uncertainty in Measurement, GUM), independent of any other type A or type B uncertainties. This could limit the accuracy of age determinations to no better than 0.2%, depending on the half-life measurement used.

Results:

The Task Group has prepared a publication for the Pure and Applied Chemistry journal (PAC). Comments from the editor of PAC are being resolved at the present time.

Future Plans:

Due to the problems associated with the standard unit, year, an effort to reevaluate the major publications on half-lives being used for age determinations will begin to assess the type A and type B uncertainties in these publications.

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