CosmoCalc: An Excel add-in for cosmogenic nuclide calculations

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Today, we are facing a paradoxal situation: on the one hand, a better understanding of cosmogenic nuclide systematics has improved the accuracy of cosmogenic nuclide dating. But on the other hand, the increased sophistication of these method has been an obstacle to their widespread use. CosmoCalc is an add-in to MS-Excel developed with the intention to alleviate this problem. The program as well as a spreadsheet with test data can be downloaded from the CosmoCalc website (http://cosmocalc.googlepages.com).

CosmoCalc presently implements four scaling models: Lal, Stone, Dunai and Desilets. Although the more recent models such as those by Dunai and Desilets are significantly more sophisticated than the early scaling model by Lal, they are just as easy to use in CosmoCalc. It is equally simple to compute topographic, snow and self-shielding factors. The nuclide concentrations and the product of the scaling and shielding factors are the only input required for all further calculations.

CosmoCalc uses the ingrowth equation of Granger and Smith, which is a summation of four exponentials: one for neutrons, two for slow muons and one for fast muons. Default values for the various parameters in this equation are those advocated by Granger, but alternative values can also be set.

Banana plots are sophisticated devices which depend on a large number of parameters, such as the production rates at sea level and high latitude, the scaling model, and the relative proportions of the various production mechanisms. CosmoCalc flexibility allows different kinds of Al-Be and Ne-Be plots to be generated on the fly.

CosmoCalc implements two numerical techniques to solve the non-linear systems of ingrowth equations. The default is Newton's method, which is a very fast and exact algorithm. The Metropolis algorithm is offered as a computationally more intensive, yet also more robust, alternative.

Different scaling models use different kinds of geographic input. For example, Lal's scaling model uses elevation whereas Stone uses atmospheric pressure and Dunai and Desilets atmospheric depth. Furthermore, Lal and Stone use geomagnetic latitude whereas Dunai uses geomagnetic inclination and Desilets cutoff rigidity. To facilitate the comparison of the various scaling models, CosmoCalc provides some easy-to-use conversion tools.

Regardless of the scaling model of preference, it is crucially important to use the same scaling model for the unknown sample and the calibration sites. For this reason, CosmoCalc specifies the production rates not explicitly but implicitly, by specifying the raw measurements of the calibration sites. The program comes with a set of default calibration sites, but this list can be modified by removing and adding new sites.

The 940-864 Ma granites of the Yenisey Ridge and Taimyr foldbelts, western margin of the Siberian Craton: Geochemistry and geodynamics

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The 940–864 Ma granites occur within Meso- to Neoproterozoic greenschist and amphibolite facies metamorphic rocks of the ancient terranes in the Yenisey Ridge and Taimyr accretional belts of the western margin of the Siberian craton (Vernikovsky and Vernikovskaya, 2001; Pease *et al*., 2001; Vernikovsky *et al*., 2007).

In all studied plutons, the granites have slightly peraluminous (rarely metaluminous) chemical compositions with widely variable Sm-Nd and Rb-Sr isotopic data, which allows referring to these rocks as S- and transitional I- to S-types granites. The S-type granites with epsilon $Nd_{(940\text{-}885Ma)}$ = -7.14 – -4.48, $^{87}Sr/^{86}Sr_i$ = 0.71206 – 0.72163 and zircon saturation temperatures (T_{Zr}) approximately 800°C were generated on the early stage of the collisional process from crustal transitional hot- to low-temperature melts, according to Miller *et al*. (2003). The granites of transitional I- to S-type were formed on the final stage of the collisional event from mantle-crustal low-temperature (T_{Zr}.<<800°C) melts with epsilon $Nd_{(894\text{-}864\text{-}Ma)}$ = -2.8 – +0.04 and $^{87}Sr/^{86}Sr_i$ = 0.7070 – 0.7192. On this stage the most evolved granitic melts are formed, having low Ca, Mg and REE contents and enrichment in Si and K.

It is likely that the 940 – 864 Ma granites were part of a microcontinent prior to the accretion and collision of its blocks (or terranes) with the Siberian continent.

References

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