Newsletter

Volume 3
October 2008

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CRONUS-Earth 5th Annual Meeting

By Lisa Majkowski

The CRONUS-Earth 5th Annual Meeting will be held in lovely Berkeley, CA, prior to AGU. The meeting is scheduled for two full days – Saturday, December 13 and Sunday, December 14, 2008, from 9:00 am to 6:00 pm each day. Please plan to arrive on Friday, December 12.

We will be staying once again at the Rose Garden Inn (www.rosegardeninn.com). Please contact me by November 1 to reserve your room for the meeting (lisamt@nmt.edu). I will need to know your arrival and departure dates. The Rose Garden Inn does an excellent buffet breakfast and has a cheery holiday ambiance in December. In addition to the guest rooms, we've also reserved the Fay House meeting room, which will be available for our use in the evenings. A pre-meeting icebreaker is planned for Friday night.

As discussed at last year’s meeting, Kuni generously offered to host the meeting at SSL. We will arrange transportation for the group from the Rose Garden Inn to SSL. Beverages, snacks will be provided throughout the meeting and we’ll have a tasty lunch catered in each day. There will be a group dinner on Saturday night – we’re exploring the options for French cuisine this year.

Fred is developing a preliminary agenda - look for it by the end of October.

CRONUS-Earth Fellow Update

By Brent Goehring

Production Rate Calibrations Sites

In all current scaling models for the production rates of cosmogenic nuclides, the reference production rate is always scaled to sea level and high latitude, potentially introducing uncertainties in the stated production rates. Therefore, what are needed are calibration sites that directly measure the sea level and high latitude production rates of multiple nuclides. While a NSF CRONUS-Earth Fellow, part of my effort has been spent locating and sampling sites appropriate for direct measurement of the sea level and high latitude production rates.

Oldedalen Slide

The first site investigated is a large rock avalanche in Oldedalen, an arm of Nordfjorden in southern Norway (61.6°N, 6.8°E; 97 m a.s.l.). The age of the slide is constrained at 5910±50 yr BP by a conventional radiocarbon date on compressed and fractured tree trunks found underneath a series of house-sized boulders during excavation for a tourist attraction (Nesje, 2002). The current slide surface is highly variable in elevation due to the large boulders and space in between. Boulder size is typically at least 2m x 2m x 2m. Most are moss covered and some have shrubs, but display no evidence of cover by trees. This site also has the advantage that snow cover is unlikely to be an issue, as indicated by farming records dating back to 1500 AD. Boulder lithology has been identified as augen gneiss rich in K-feldspar and quartz, which allow for the measurement of ^{10}Be, ^{26}Al, and ^{14}C, and potentially ^{36}Cl and ^{21}Ne. ^{3}He may also be potentially measured if the appropriate mafic phases can be identified. We collected 15 samples from a variety of locations on the slide and from a range of boulder sizes. I thank Atle Nesje for introducing me to the landowner, Inge Melkovoll, who I must especially thank for letting us sample on his land and his generous hospitality.

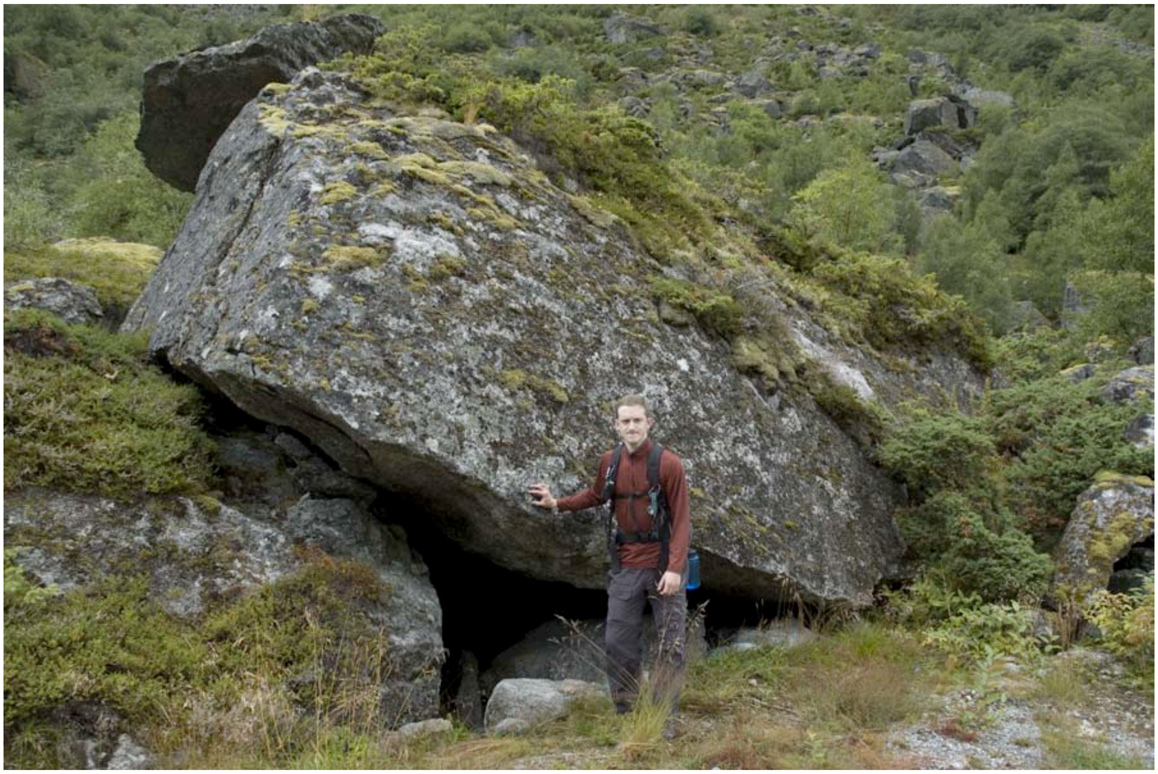


Figure 1. This is an average size boulder on the Olden slide. Some blocks are much larger. In the background you can see part of the run out field and the source of the rockslide, approximately 800 m up the mountainside. Person is approximately 1.8 m tall for scale.

YD Hardangerfjorden Terminal Moraine

The second site investigated for production rate calibration is a large terminal moraine of the Younger Dryas Fennoscandian Ice Sheet near the mouth of Hardangerfjorden (59.8°N, 5.8°E). The moraine is a wide belt of low topography up to ~90 m a.s.l. and in some locations is sub-marine. The marine limit at this location is well constrained at 70 m a.s.l., thus we only sampled boulders above 70 m. Age control of this moraine is well constrained by many radiocarbon analyses on marine shells found below and above the YD till from lakes and bogs. The best estimate age of moraine deposition and ice retreat is 10.7±0.2 ^{14}C kyr (J-I. Svendson, pers. commun.). Unfortunately, many of the largest boulders have been moved for agricultural purposes, but we still were able to sample boulders no smaller than 1.5m x 1.5m x 1.5m, with some much larger (Figure 2). Boulder lithology is somewhat variable, but was typically granitic of mica schist allowing for extraction of at least ^{10}Be, ^{26}Al, and ^{14}C. Twelve samples were collected from the end and lateral portions of the moraine. This work was completed in collaboration with a number of researchers from the University of Bergen, notably Jan Mangerud and John-Inge Svendson, who I thank much for showing me this site.

Figure 2. View looking north along the crest of the YD terminal moraine. The foreground has been heavily modified for agricultural use, but beyond the red house boulders were found undisturbed. We also sampled boulder from the left lateral portion of the moraine on the mainland.

Helium and Neon Production Rates and Web Calculator

In addition to the production rate calibration effort, I have been working to assemble an exposure age and erosion rate calculator for ^{3}He and ^{21}Ne. The calculator is largely based on the ^{10}Be and ^{26}Al calculator of Balco et al. (2008). The calculator is now complete and awaits completion of the new interface before being hosted by NMT. The production rates used in the calculator represent a compilation of previously published ^{3}He and ^{21}Ne production rates in olivine/pyroxene and quartz for ^{3}He and ^{21}Ne respectively. We have included the measurements of Licciardi et al. (2006; 1999), Cerling and Craig (1994), Ackert et al. (2003), Dunai and Wijbrans (2000), and Blard et al. (2006). The resulting production rates are similar to previous efforts, but the use of a reduced chi-squared minimization technique has greatly reduced the uncertainties associated with the ^{3}He production rate. Unfortunately, I could only locate one study reporting ^{21}Ne production rates in quartz (Niedermann, 2000; Niedermann et al., 1994) and use this as the sole estimate.

Ackert Jr, R.P., Singer, B., Guillou, H., Kaplan, M., and Kurz, M., 2003, Long-term cosmogenic ^{3}He production rates from $^{40}Ar/^{39}Ar$ and K–Ar dated Patagonian lava flows at 47°S: Earth and Planetary Science Letters, v. 210, p. 119-136.

Balco, G., Stone, J., Lifton, N.A., and Dunai, T.J., 2008, A complete and easily accessible means of calculating surface exposure ages or erosion rates from ^{10}Be and ^{26}Al measurements: Quaternary Geochronology, v. 3, p. 174-195.

Blard, P., Pik, R., Lave, J., Bourles, D., Burnard, P., Yokochi, R., Marty, B., and Trusdell, F., 2006, Cosmogenic ^{3}He production rates revisited from evidences of grain size dependent release of matrix-sited helium: Earth and Planetary Science Letters, v. 247, p. 222-234.

Cerling, T.E., and Craig, H., 1994, Cosmogenic ^{3}He production rates fro 39°N to 46°N latitude, western USA and France: Geochimica et Cosmochimica Acta, v. 58, p. 249-255.

Dunai, T.J., and Wijbrans, J.R., 2000, Long-term cosmogenic ^{3}He production rates (152 ka-1.35 Ma) from $^{40}Ar/^{39}Ar$ dated basalt flows at 29°N latitude: Earth and Planetary Science Letters, v. 176, p. 147-156.

Licciardi, J., Kurz, M., and Curtice, J., 2006, Cosmogenic ^{3}He production rates from Holocene lava flows in Iceland: Earth and Planetary Science Letters, v. 246, p. 251-264.

Licciardi, J.M., Kurz, M.D., Clark, P.U., and Brook, E.J., 1999, Calibration of cosmogenic ^{3}He production rates from Holocene lava flows in Oregon, USA, and effects of the Earth's magnetic field: Earth and Planetary Science Letters, v. 172, p. 261-271.

Nesje, A., 2002, A large rockfall avalanche in Oldedalen, inner Nordfjord, western Norway, dated by means of a sub-avalanche Salix sp. tree trunk: Norsk Geologisk Tidsskrift, v. 82, p. 59-62.

Niedermann, S., 2000, The 21Ne production rate in quartz revisited: Earth and Planetary Science Letters, v. 183, p. 361-364.

Niedermann, S., Graf, T., Kim, J.S., Kohl, C.P., Marti, K., and Nishiizumi, K., 1994, Cosmic-ray-produced 21Ne in terrestrial quartz: the neon inventory of Sierra Nevada quartz seperates: Earth and Planetary Science Letters, v. 125, p. 341-355.

CRONUS-Earth Fellow Update

By David Argento

Since the last CRONUS meeting, I have been focused on building my models in the MCNPX radiation transport code, of the cosmic radiation cascade through the atmosphere to the upper lithosphere. I have made significant progress in my coding, and the model and results are starting to come closer and closer to accepted values and characteristics. I have also built a number of data analysis tools in Matlab and Excel that allow me to quickly digest the raw flux numbers being generated by MCNPX. In addition to working on the coding, I have also secured more CPU processing time on departmental computers that will allow me to run more initial particles for better statistics, in shorter time.

This summer, I attended a field geology course with my department in Montana. I also attended a field seminar with my department in Sicily. The seminar was organized and run by Jodie Bourgeois, and Charlotte Schreiber, specialists in depositional and evaporitic environments.

Figure 1. Standing at the top of Mount Etna.

I was able to dovetail this field seminar with the AMS-11 Conference, where I presented a poster on the research we are conducting on the ^{36}Cl content of seawater due to meteoric fallout, and neutron activation of ^{35}Cl. The goal of this research is twofold: 1) utilize the ultralow ^{36}Cl/Cl ratio measurement capability of ANU's 14UD Pelletron facility 2) to use the ^{36}Cl as a conservative bomb-pulse tracer of oceanic currents if non-homogeneities can be detected 3) to use the average value of the ^{36}Cl/Cl ratio of seawater to determine a long term average flux of cosmic rays at the surface of the earth. This project will also involve utilizing the MCNPX code to determine the overall cosmic ray albedo of the ocean.

Figure 2. Stromboli erupting.

At the end of November, I will be accompanying John Stone to Australia, where we will analyze many ^{36}Cl samples at ANU's 14UD Pelletron. Once completed, I will be flying to Antarctica's Beacon Valley to join John for the CRONUS muon calibration coring project.

The CRONUS-Earth Inter-comparison Programme

By Dr. Marian Scott and Dr. Tim Jull

As part of the CRONUS-Earth Project, a series of inter-comparison samples have been distributed to explore the comparability of results from the different laboratories and hence generate consensus values for a range of reference materials, to assist laboratories in independently assessing quality and to quantify precision and accuracy. Inter-laboratory comparisons (sometimes also called proficiency trials) are designed to

- assess comparability of measurements made by the different laboratories
- assist in the definition of overall uncertainty when results from different laboratories used.

We often also talk about the *accuracy, bias* and *precision* of measurement.
Accuracy is the closeness of agreement between a measurement and the true value (random and systematic components) while *bias* is the difference between the average of a series of measurements and the true value (systematic). *Precision* is the closeness of agreement between independent measurements. Precision does not relate to the true value and the more precise a technique is the less spread in results. Proficiency trials offer independent means to verify both accuracy and precision.

So that a proficiency trial helps ensure the results from a laboratory are meaningful, contributes to and enhances laboratory's reputation. Participating labs require relevant test material (samples), confidence in homogeneity of test material and confidence in the assigned value.
For CRONUS-Earth, a small number of samples were identified and prepared. These samples do not have assigned values for either Be or Al, but as a result of the trial, we would hope to define such values.

CRONUS samples

(A)ntarctic sample: high in Al-26 and Be-10. Quartz was separated at the University of Vermont, etched 3 times in HF and washed. Approx 37g provided, with a recommendation that 5g be used.
(N)amibia: a low latitude sample, as for sample A, but lower in Al-26 and Be-10. Approx 75g provided, with a recommendation that 20g be used.
For **in-situ C-14**, the same samples were provided in glass vials.

For the **noble gases**, one sample (**P**)yroxene was distributed, prepared at Lamont Doherty.

Participants

Twenty four laboratories in the USA, UK, France, Switzerland, Germany, The Netherlands, Sweden, Australia and Canada received samples A and N. Fourteen laboratories in USA, UK, Switzerland, France and Germany received sample P.

So far results have been received from 9 laboratories for A and N, and 4 laboratories for sample P. Therefore for this preliminary report, sample P has not been summarised.

Preliminary results

The focus on the preliminary analysis has been on the results presented in number of atoms/g. As part of the calculations, there is general consensus on the half-life used for Al, but some variability for Be (1.5, 1.51, 1.36, 1.37 x 10^6 years). Summary tables for each nuclide for each sample report the number of sets of results (typically greater than the number of laboratories), the mean, standard deviation, minimum, maximum and Q1 and Q3 representing the lower (25%) and upper (75%) quartiles of the distribution. The final statistic is the coefficient of variation (mean/stdev *100).

Table A.1: **sample A: Al-26 atoms/g (x 10^8)**

6 sets of results from 4 laboratories

Mean	StDev	Min	Q1	Median	Q3	Max
1.41	0.103	1.24	1.34	1.42	1.49	1.54

Coefficient of variation: 7.3%

Table A.2: Sample A: Be-10 atoms/g (x 10^7)

13 sets of results, from 7 laboratories

Mean	StDev	Min	Q1	Median	Q3	max
3.67	0.181	3.32	3.51	3.73	3.79	3.92

Coefficient of variation: 4.92%

Table N.1: sample N: Al-26 atoms/g(x 10^6)

6 sets of results from 4 laboratories

Mean	StDev	Min	Q1	Median	Q3	Max
1.09	0.100	0.96	1.01	1.07	1.19	1.24

Coefficient of variation: 9.2%

Table N.2: sample N: Be-10 atoms/g (x 10^5)

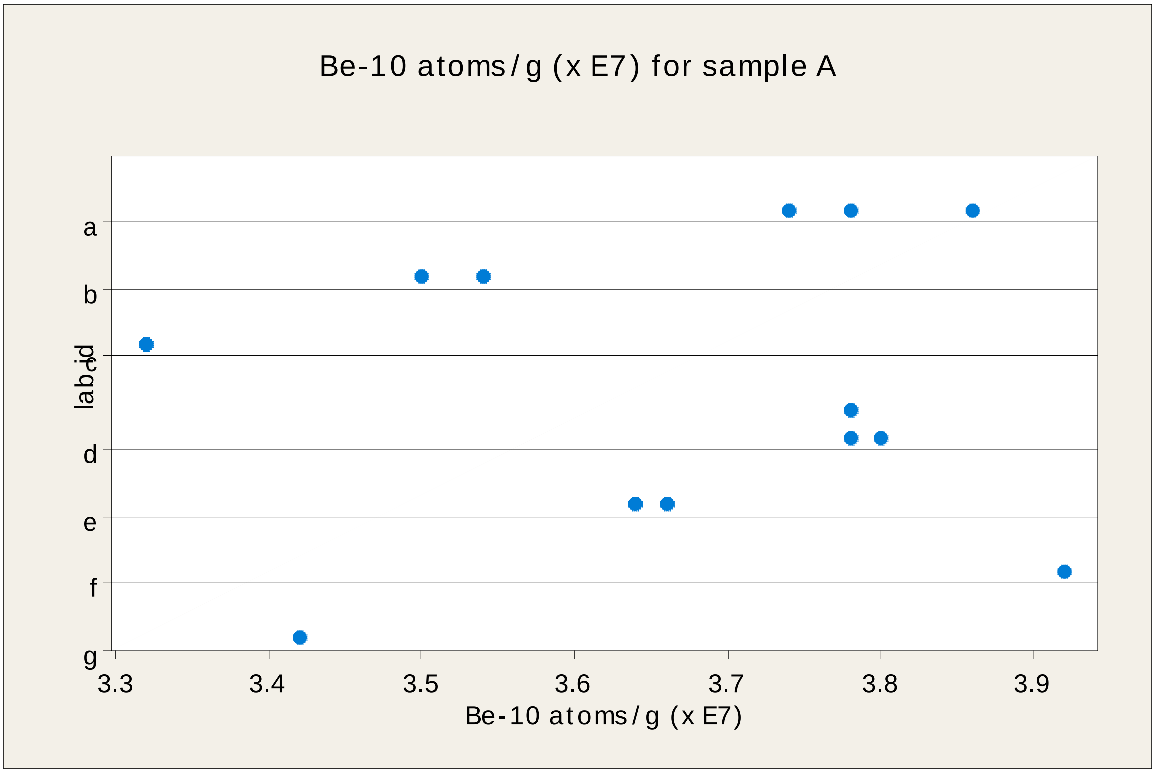
15 sets of results from 7 laboratories

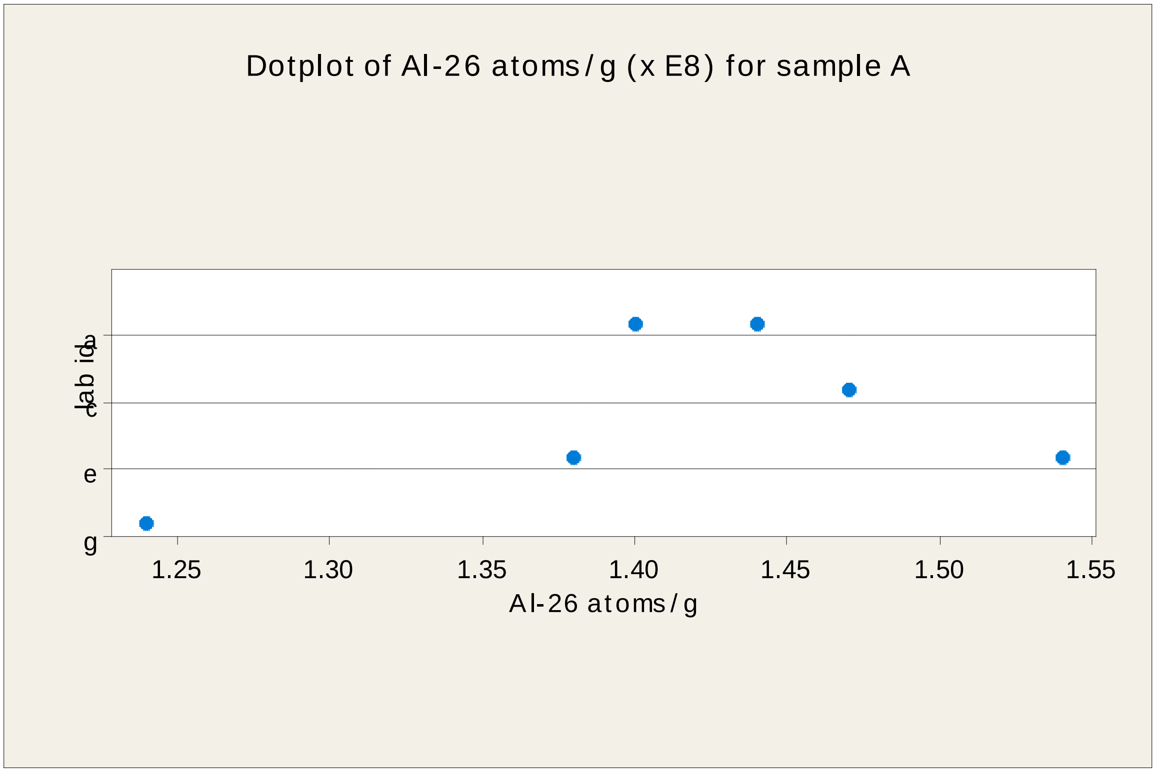
Mean	StDev	Min	Q1	Median	Q3	Max
2.30	0.215	1.70	2.18	2.37	2.43	2.58

Coefficient of variation: 9.3%

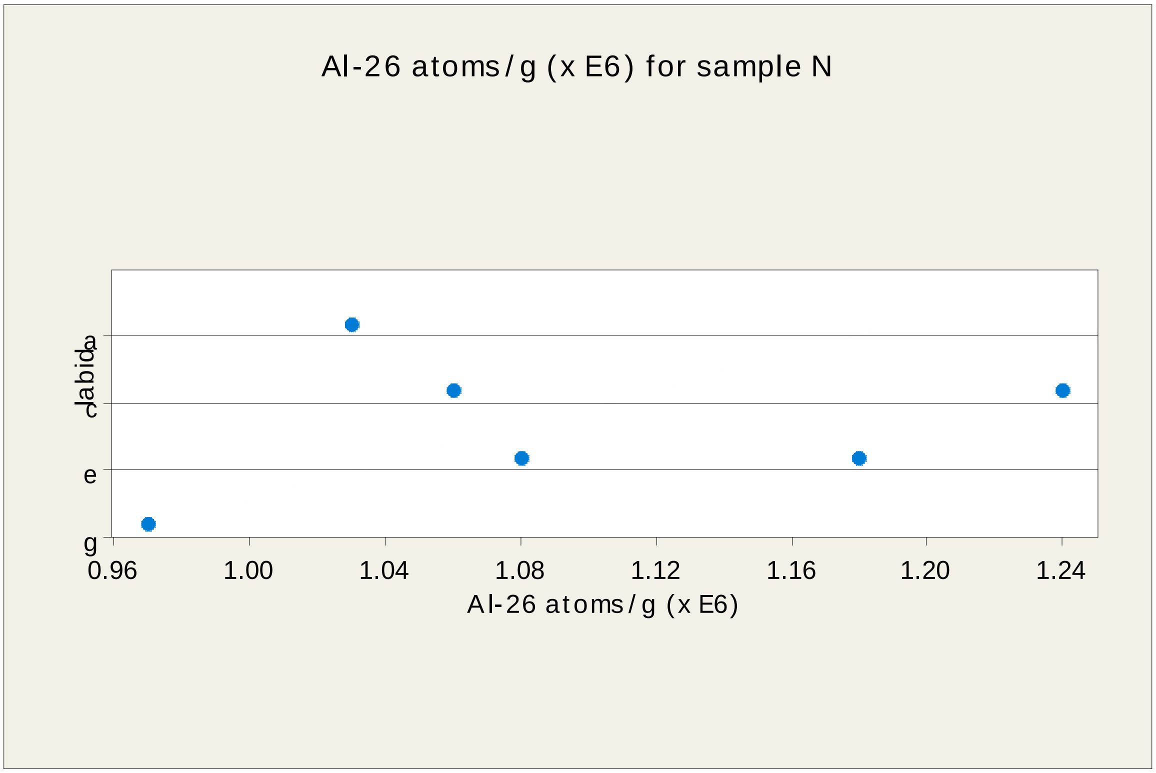
Some graphical representation of the results are shown in the following dotplots, which show individual results and the scatter across laboratories and also within laboratories in the form of replicate results

Sample A

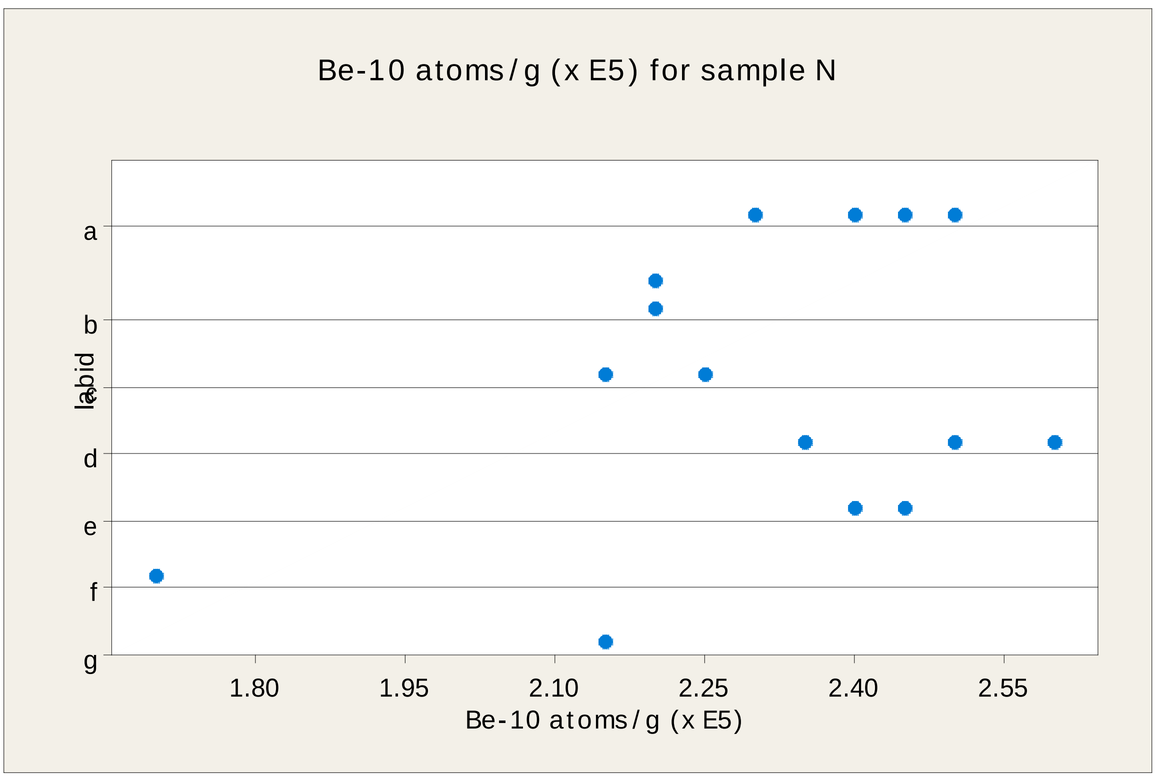

Be-10 atoms/g (x E7) for sample A
a
b
c
d
e
f
g
lab id
3.3
3.4
3.5
3.6
3.7
3.8
3.9
Be-10 atoms/g (x E7)


Dotplot of Al-26 atoms/g (x E8) for sample A
a
c
e
g
lab id
1.25
1.30
1.35
1.40
1.45
1.50
1.55
Al-26 atoms/g

Sample N



Al-26 atoms/g (x E6) for sample N
labid
a
c
e
g
0.96
1.00
1.04
1.08
1.12
1.16
1.20
1.24
Al-26 atoms/g (x E6)



Be-10 atoms/g (x E5) for sample N
labid
a
b
c
d
e
f
g
1.80
1.95
2.10
2.25
2.40
2.55
Be-10 atoms/g (x E5)

Discussion and interpretation

For sample A, there is more variability in the Al-26 results than Be-10, while the opposite is true for sample N. The variability amongst the replicates tends to be much smaller than variability between laboratories and the typical quoted uncertainties are two orders of magnitude lower than atoms/g results

These preliminary results have shown the existence of significant variability, some of which may be attributable to in-homogeneity in samples, laboratory procedures and measurement uncertainty. Inter-comparisons allow estimation of an empirical estimate of measurement uncertainty (both inter and intra- laboratory).

Laboratories that have not yet submitted results are urged to do so as soon as possible, since with an increased number of results it will then be possible to assess both accuracy and precision though calculation of the assigned value (for Be-10 and Al-26) for these samples. Within (replicate measurement) and between (inter-laboratory trials (like the CRONUS inter-comparison)) laboratory variation provide checks on accuracy and precision and help ensure that each measurement has associated with it a realistic uncertainty estimate

In addition , a substantial archive of material has been created, which will be invaluable in further work and which will allow laboratories to routinely measure these materials as part of their in-house quality assurance programme.

Chlorine-36 Web Calculator

By Shasta Marrero

The online calculators for cosmogenic isotopes will provide a lasting contribution to the cosmogenic community after the completion of the CRONUS-Earth project. These calculators are geared towards the average user with a general understanding of the nuclide systematics. For these users, only a minimal number of options are available on the calculator. In all cases, more advanced users may want to perform their own calculations, either using modifications to the calculator codes (provided online) or their own methods.

The chlorine-36 web calculator is designed to be used by non-expert users performing surface exposure dating. The calculator is being modeled after the Be/Al calculator and has the ability to calculate surface exposure ages for multiple samples simultaneously. Currently, it only performs these calculations using the Lal/Stone scaling and the Phillips production rates. This is a temporary version that is in place while we perfect the interface and other functionality. It can be viewed online at www.cronuscalculators.nmt.edu. When finished, the calculator will be able to provide surface exposure ages using the time-dependent scaling schemes as well as other chlorine-36 production rates. A chart of the current and proposed functionality is shown below.

Eventually, we plan to implement erosion and depth profile calculators for chlorine-36. The calculators will also be expanded to include other nuclides as the codes and interfaces are finished. Another goal of this project is to allow the users of any of these calculators to easily upload their data into the EarthChem database for cosmogenic nuclides. We will inform everyone when the next version of the calculator is up and running on the website and ready to be tested. Until then, feel free to send us comments on the current version (Shasta@nmt.edu) so they can be incorporated.

Current Cl-36 Calculator	**Proposed Final Calculator**
Elevation or atmospheric pressure inputs	Elevation or Atmospheric Pressure inputs
Multiple samples simultaneously	Multiple samples simultaneously
Unspiked or Cl-35 spiked samples	Unspiked or Cl-35 spiked samples
Stone formulation for muons	Heisinger equations for muons
AMS data must be in PRIME lab format	Compatibility with multiple AMS labs
	Time-dependent scaling schemes
	Easy upload to the Earthchem database

www.cronuscalculators.nmt.edu

Upcoming Events

CRONUS-Earth 5th Annual Meeting
December 13-14, 2008 (Berkeley, CA)

AGU 2008 Fall Meeting
December 15-19, 2008 (San Francisco, CA)