TALKING POINTS AND HANDY POCKET GUIDE

Basic approach to cosmogenic-nuclide dating in all forms:

If you know WHAT happened to a sample from independent geologic evidence, you can use cosmogenic-nuclide measurements to figure out WHEN or HOW FAST it happened.

But if you don’t know what happened, cosmogenic-nuclide measurements aren’t likely to help you figure it out, because most of the time you can get to the same nuclide concentrations with several different geologic scenarios.

Surface exposure dating:

Surface samples that started life with a zero nuclide concentration. Exposed for a single period of time at the surface with negligible or very low erosion rates:
- Glacial erratics: landslide blocks: shore platforms: others.

Steady erosion rates:

Surfaces that have been eroding steadily at the same rate for long enough that several meters of rock or soil have been removed. Nuclide concentration reaches steady state where production equals loss by decay and/or erosion:
- Outcrops, soil surfaces, or river sediments in unglaciated areas.

Simple burial dating:

Sediment samples that experienced a single period of uninterrupted surface exposure, followed by a single period of burial deeper than a few meters below the surface:
- Fluvially-derived cave sediments; alluvial sedimentary sequences; loess: paleosoils: subglacial bedrock.

Isochron burial dating:

More complex burial scenarios. Sediments that experience multiple episodes of surface exposure and burial, or that are burned at shallow depths:
- River terrace gravels; till-paleosol sequences.

Commonly measured nuclides in brief

<table>
<thead>
<tr>
<th>Nuclide</th>
<th>Half-life</th>
<th>Target element</th>
<th>Production rate</th>
<th>Hasse factor</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>He-3</td>
<td>stable</td>
<td>Anything</td>
<td>Any</td>
<td>120 at/yr</td>
<td>Low</td>
</tr>
<tr>
<td>Be-10</td>
<td>1.4 Ma</td>
<td>dark-colored</td>
<td>O, Si</td>
<td>4.25</td>
<td>High</td>
</tr>
<tr>
<td>C-14</td>
<td>5.7 ka</td>
<td>Quartz</td>
<td>O, Si</td>
<td>15</td>
<td>Highest</td>
</tr>
<tr>
<td>Ne-21</td>
<td>stable</td>
<td>Quartz</td>
<td>Si</td>
<td>17.5</td>
<td>Medium</td>
</tr>
<tr>
<td>Al-26</td>
<td>0.7 Ma</td>
<td>Quartz</td>
<td>Si</td>
<td>30</td>
<td>High</td>
</tr>
<tr>
<td>Cl-36</td>
<td>0.3 Ma</td>
<td>Feldspars, calcite, others</td>
<td>K, Ca</td>
<td>10-20</td>
<td>High</td>
</tr>
</tbody>
</table>

Age-erosion rate equivalency

In this graph, you can see how the concentration of the nuclide at the surface relates to the age of the material.

This is the concentration at the surface of 25 ka or 21 ma.

Production rate calibration

Beryllium-10:
- Calibration data follow global snowline: no data at high elevation near poles or low elevation near equator.
- St and LSDn scaling explain all known calibration data with 6% side-to-side scatter.
- Production rate at SLH is approx. 4.2 at/mg from saturation and 0.01 from muon interactions.

Aluminum-26:
- Calibration data mostly overlap with those for Be-10.
- Scaling performance is not as good as for Be-10, most likely because of poorer measurement precision: side-to-side scatter is 9.5% (LSDn) or higher.
- Production rate at SLH is approx. 29.4 at/mg from saturation and 0.7 from muon interactions.

Helium-3:
- Calibration data are more broadly distributed in latitude at sea level, but not at high elevation. Overall, the calibration data set is much more diverse.
- However, scaling agreement is much poorer for He-3: side-to-side scatter of scaling methods for all calibration data is close to 15%.
- In part, this is most likely the result of inconsistent measurement standardization. Reversing the data set to more recently collected data improves scatter to ca 10%.
- SLH production is near 120 at/mg; more production unknown.