Cosmogenic surprises – Landscape and earthquake dating, and hunting supernova traces

Monday 16 April 2007, 11:00-12:00

The use of cosmogenic isotopes has caused a revolution in the understanding of how landscapes are formed. This has led to totally unexpected insights in the age of landforms: e.g. more than 20 million year-old desert surfaces in the Atacama, Chile. These isotopes also make it possible to precisely reconstruct prehistoric movements of earthquake faults. And, finally, they help settle an argument over traces of a presumed bombardment by supernova debris 3 million years ago.

Quantifying the processes that shape the Earth's surface is central to the Earth and environmental sciences. A key requirement is the ability to establish accurate absolute chronologies and rates of landscape evolution. The development of techniques to measure exceedingly low concentrations of cosmogenic isotopes that accumulate in surface rocks and soils during exposure to cosmic rays has led to an unprecedented ability to establish chronologies of environmental change over the past few thousand to several millions of years.

Cosmogenic isotopes have revolutionised Earth surface sciences over the last decade and they form the cornerstone for the new *quantitative* Earth surface sciences, which are progressively replacing the traditionally qualitative techniques used in such disciplines. Cosmogenic isotopes are now used routinely in a vast range of Earth Science disciplines, including paleoclimatology, paleoseismology, geomorphology, tectonics, volcanology and volcanic hazard assessment. A few examples of where this method was successfully applied and delivered novel insights are to date:

- Age, extension and dynamics of glaciers and ice-sheets – key to understand climate change,
- Timing of response of river systems to climate change or tectonic movements,
- Timing of giant landslides ,
- Process rates and ages of landscapes,
- Rates and ages of earthquake fault displacements ,
- Ages of volcanic eruptions,
- Rates of soil erosion. These provide valuable information about the natural background of erosion from land areas to which human induced, potentially accelerated rates can be compared. This comparison provides potential for a responsible soil-conservation policy.

In North America the use of cosmogenic isotopes has left the realm of specialism and has been fully embraced by the Earth science community to become a universally applied tool. Until recently in Europe the knowledge and application of cosmogenic isotopes was comparatively sporadic and restricted to a few isolated teams. These had the necessary know-how and/or access to analytical facilities, which were often in the USA.

This situation is changing rapidly: new facilities come on-line in Europe, and training programmes of early stage and experienced researchers are ongoing. This is a core task of CRONUS-EU, a EU-funded research a training network aimed at fostering and expanding Europe's ability to make cosmogenic isotope measurements; and train the next generation of young researchers (www.cronus-eu.net).

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Additional information

http://news.bbc.co.uk/1/hi/sci/tech/4437153.stm
http://geology.geoscienceworld.org/cgi/content/abstract/33/4/321
http://www.agu.org/pubs/crossref/2006/2005TC001846.shtml

http://link.aps.org/abstract/PRL/v98/e141103