

1 INTRODUCTION

Terrestrial cosmogenic nuclides form in rock minerals exposed in the upper ~2 m of Earth's surface through interaction with cosmic radiation (Fig. 1). The concentration of cosmogenic nuclides in near surface rocks will increase through time until their production is matched by their losses through physical erosion and radioactive decay. Thus, the concentration of cosmogenic nuclides in rock or sediment is a balance between its exposure time and erosion rate. This knowledge can be applied in a range of settings to quantify dates and rates of Earth surface processes.

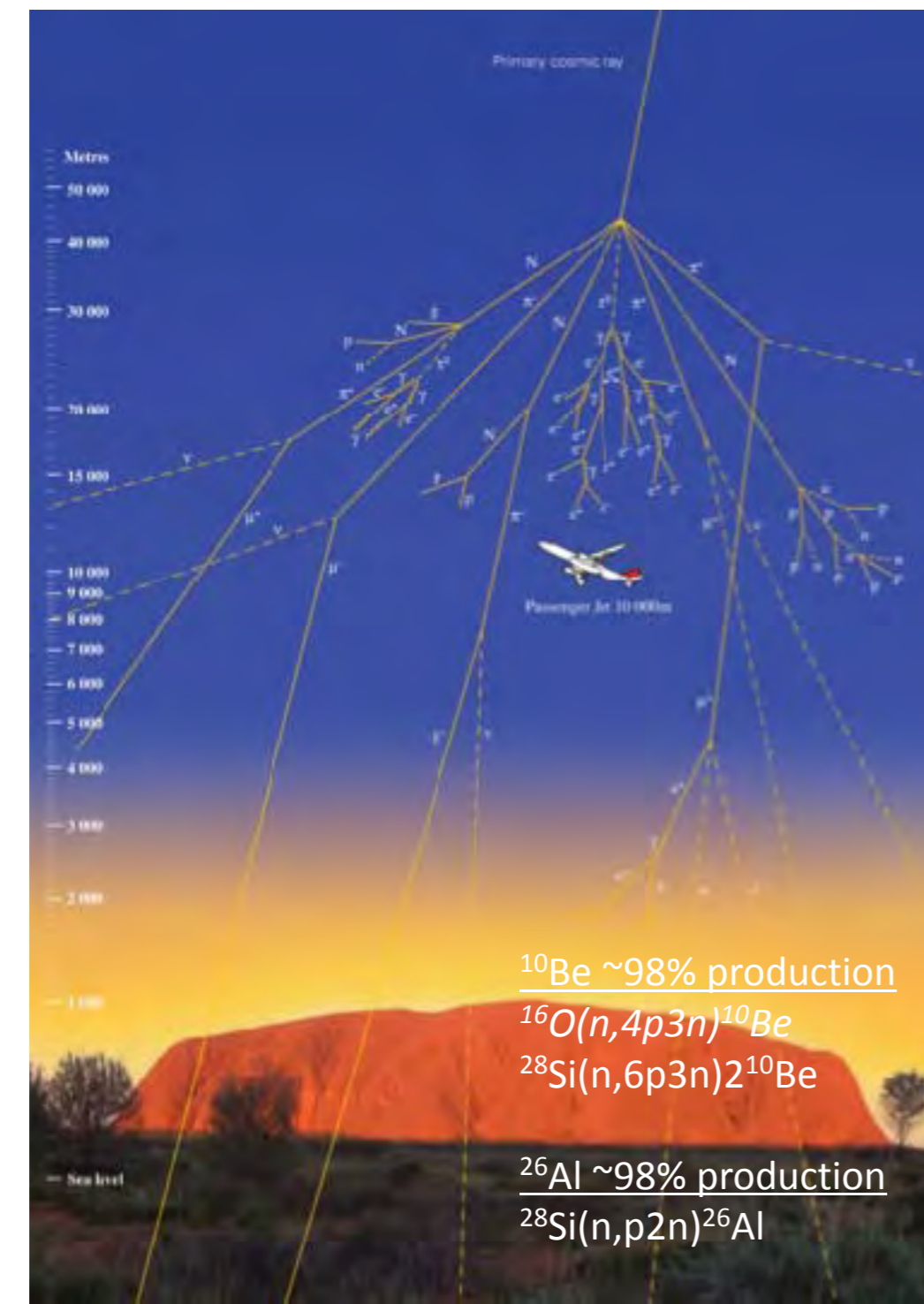
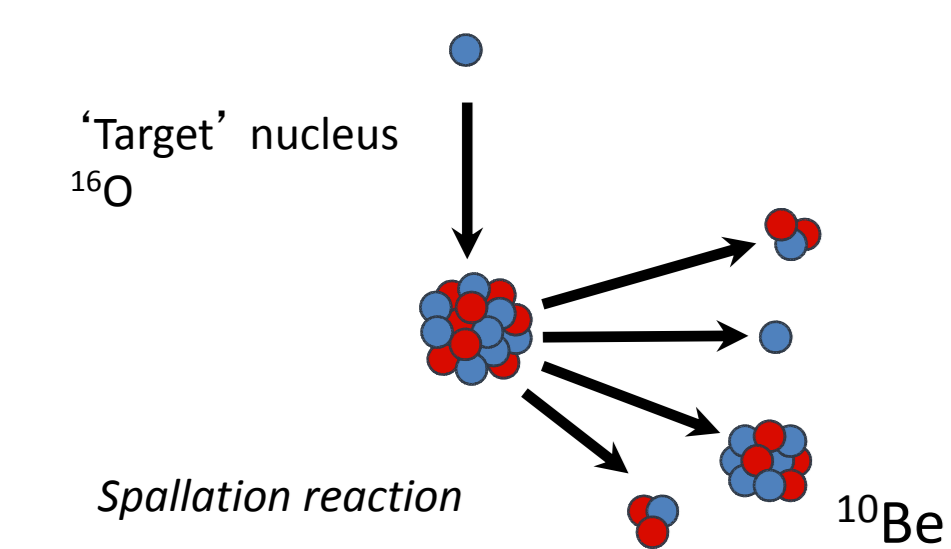
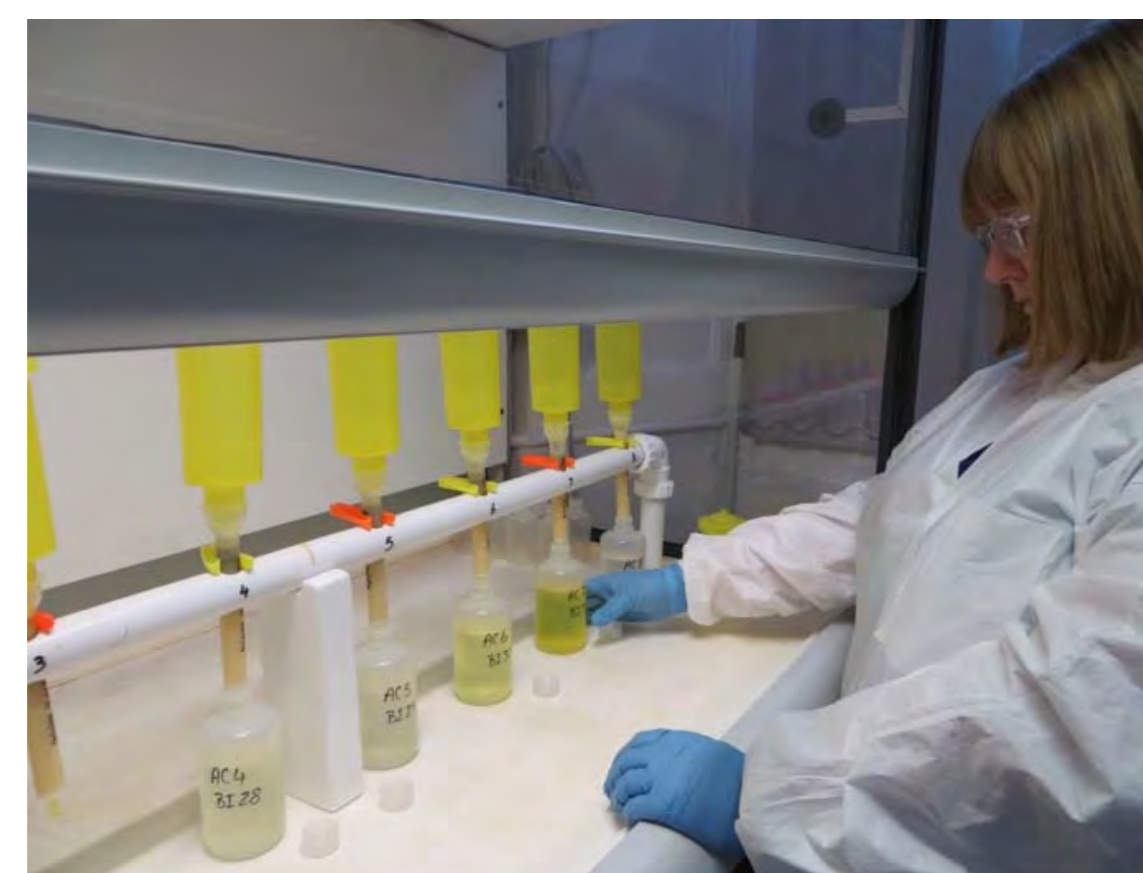


Fig. 1. Cosmogenic nuclide production occurs in near surface rocks, mainly through spallation reactions (left diagram): a fast incoming particle hits the nucleus of an atom. Nucleons (protons and neutrons) are spattered off leaving a lighter residual nucleus behind.



2 FACILITY DESCRIPTION

This facility is designed to make possible the measurement of cosmogenic nuclides in rock and sediment. Here, we chemically extract cosmogenic isotopes from rock and sediment and prepare targets ready for measurement by Accelerator Mass Spectrometry (AMS). We are able to support preparation work for all of the major cosmogenic isotopes including cosmogenic ¹⁰Be, ²⁶Al, ³⁶Cl, ²¹Ne, ³He and ¹⁴C. The AMS or MS analyses are conducted at the Scottish Universities Environment Research Centre or other collaborative institutions.



What can be analysed?

Most nuclides are measured from within quartz minerals. Therefore, any quartz-rich rock or sediment can be analysed. However, chlorine can be measured in nearly any rock, and is particularly useful for carbonate rocks such as limestone.

3 CAPABILITIES



Rock crushing and sieving

- Dedicated lab space
- Disk mill
- Sieves
- Frantz magnetic separator
- Sample splitter

Extraction of quartz from rock/sediment

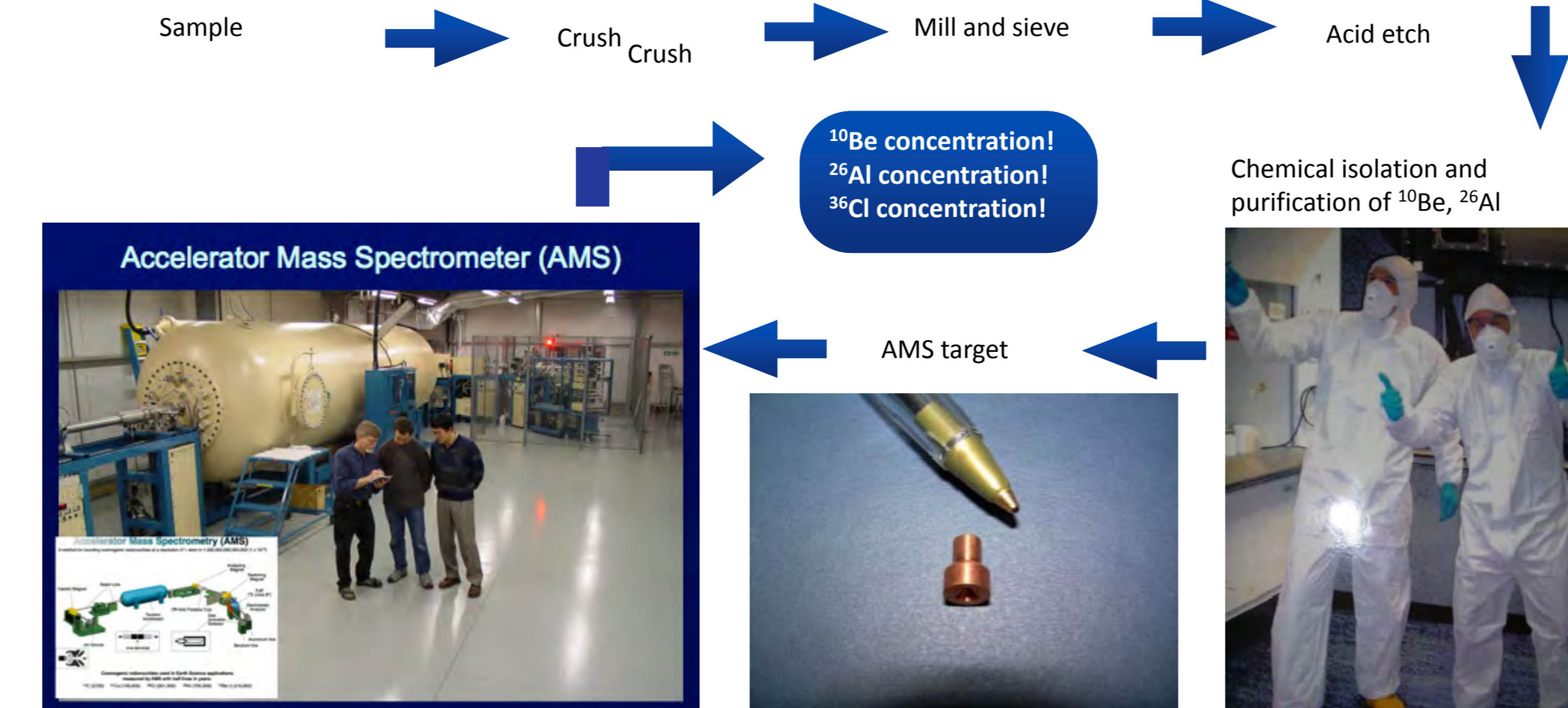
- Dedicated lab space
- Shaker tables
- Ultrasonic baths
- Frantz magnetic separator
- HF-rated fume cupboard with scrubber
- Scales
- Ovens

Preparation of ¹⁰Be, ²⁶Al and ³⁶Cl targets

- 2xDedicated clean labs
- 3xHF/Perchloric acid-rated fume cupboards and scrubbers
- Laminar flow fume cupboard
- Ultrapure water system
- Scales
- Press
- Ovens



4 THE PROCESS



5 APPLICATIONS

Cosmogenic nuclide concentrations are commonly used to determine 'exposure ages' and 'erosion rates'. Some common examples include:

Exposure dating

- Glacier erosion/deposition surfaces: striated bedrock, erratics, moraines
- Fluvial and glaciofluvial terraces
- Buried sediments: caves, glacial till
- Rockfalls
- Fault scarps
- Lava flows
- Flood deposits
- Alluvial fans

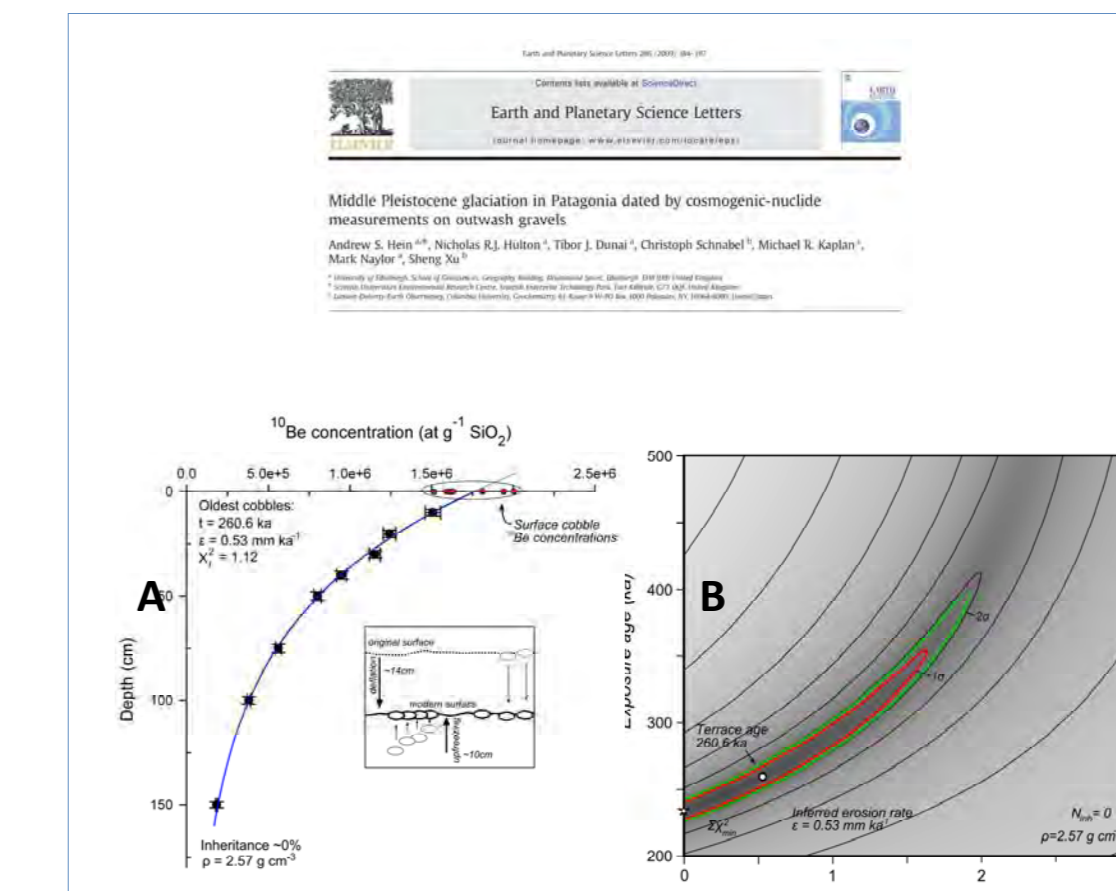


Figure 2. A) Cosmogenic nuclide depth profiles can add valuable information on the age, erosion rate and inheritance. Here a ¹⁰Be depth profile is used to constrain the age of a glacial outwash terrace. B) Modelling can then be used to optimise the best fit to the data (Hein et al., 2009).

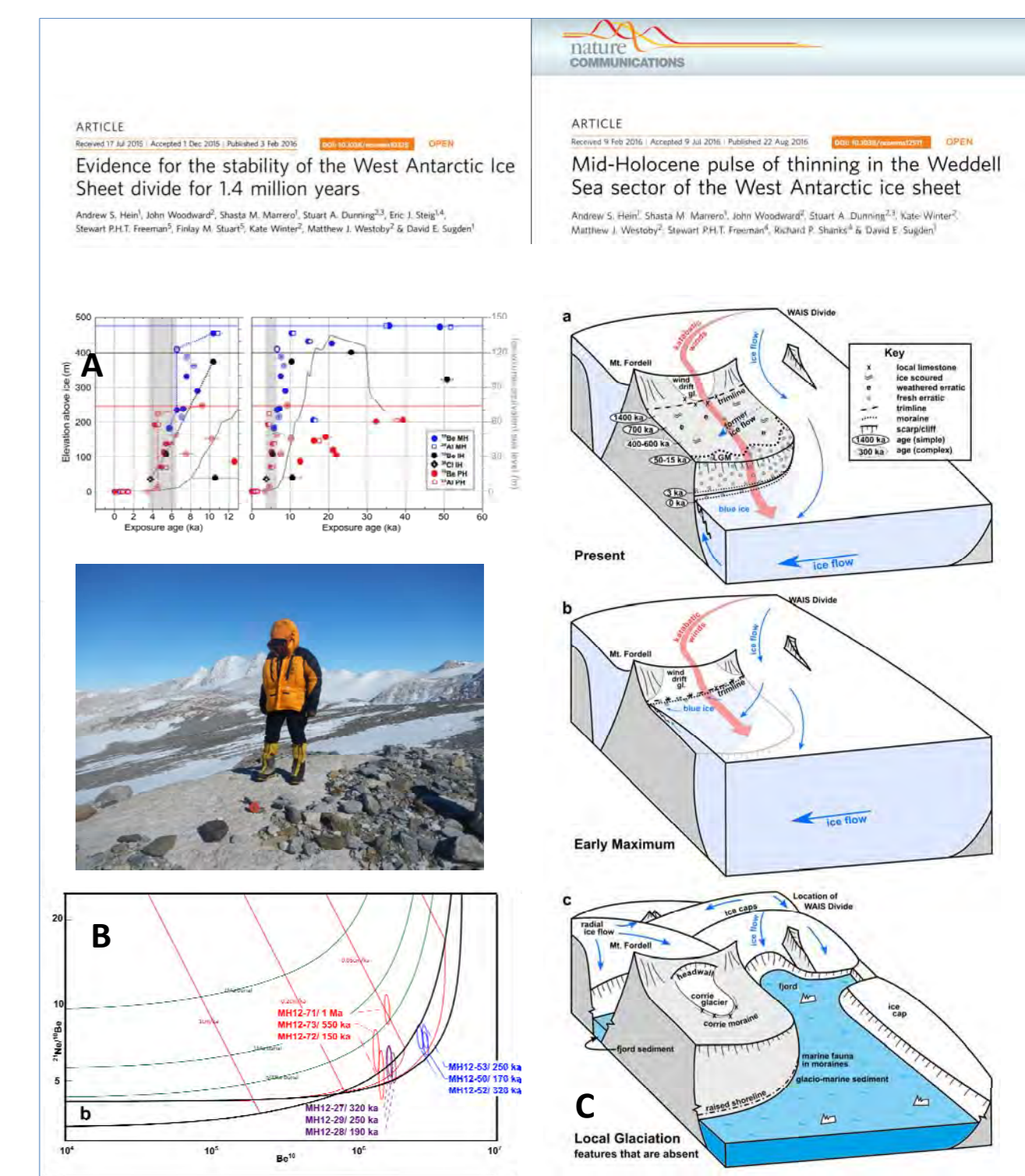


Figure 3. A) Cosmogenic ¹⁰Be dating of glacial erratics to constrain the timing of thinning of the Antarctic Ice Sheet. B) Use of multiple cosmogenic nuclides (²⁶Al, ¹⁰Be and ²¹Ne) can give insight on the exposure history; it is possible to determine if a rock has been continuously exposed, or if it has been buried for a significant period of time. C) We have used this information to constrain the history of the West Antarctic Ice Sheet (Hein et al., 2016a, 2016b).

Rates of landscape change

- Rock surface erosion rates
- Land surface degradation rates
- Basin-wide erosion rates
- River incision rates
- Modern erosion (meteoric ¹⁰Be)
- Fault-slip rates

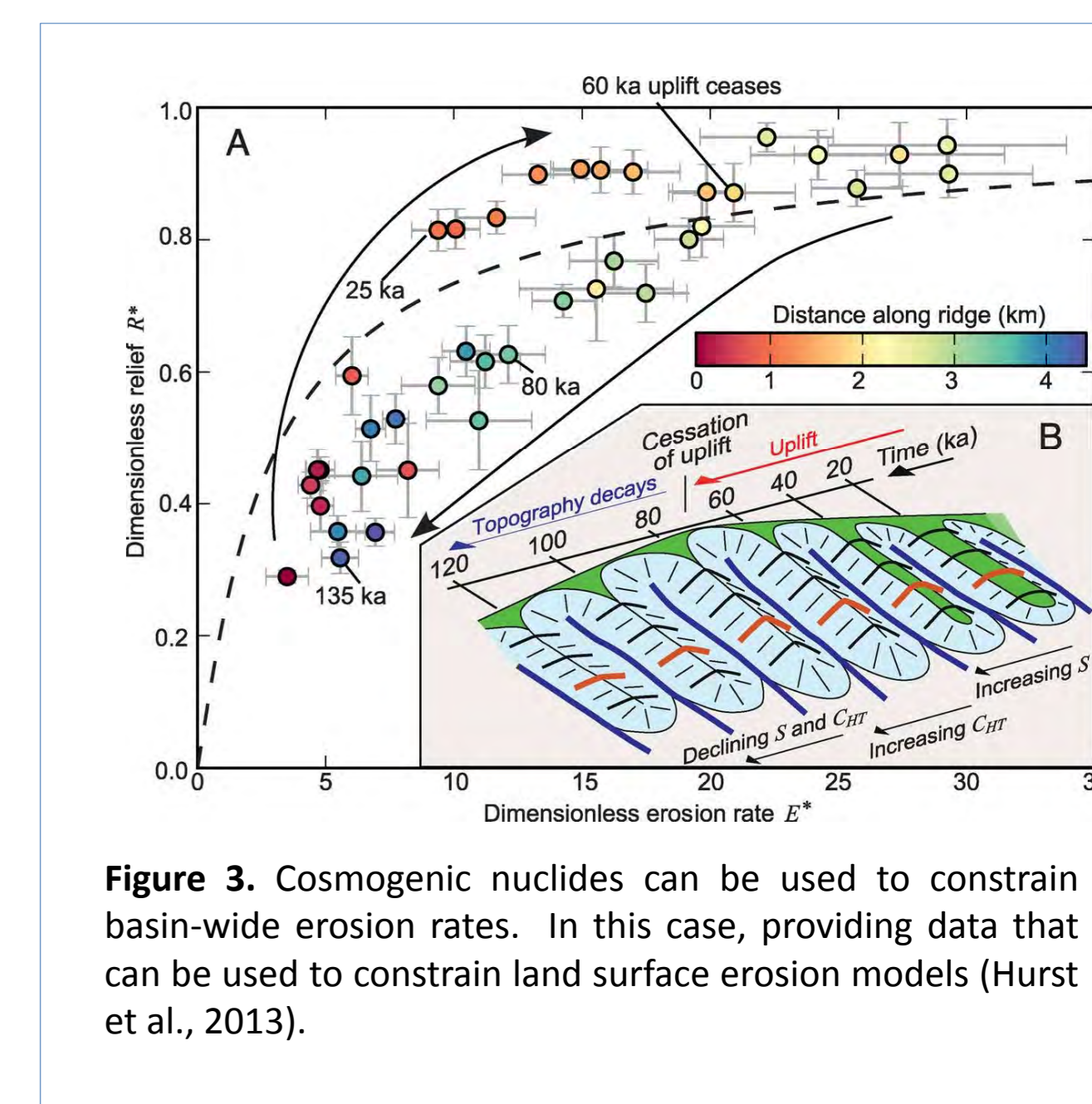
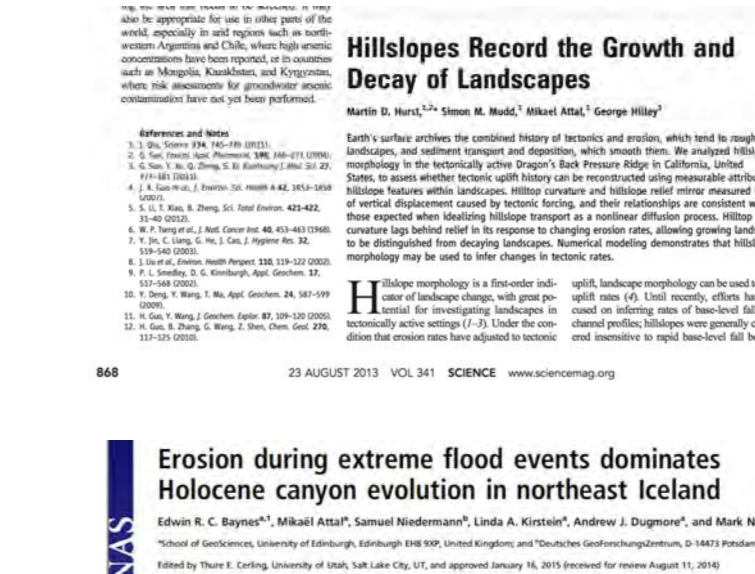


Figure 3. Cosmogenic nuclides can be used to constrain basin-wide erosion rates. In this case, providing data that can be used to constrain land surface erosion models (Hurst et al., 2013).

6 FURTHER INFORMATION

We have a full-time laboratory technician, post docs and PhD students associated with the lab. Charges are set for analyses to recover costs through a model recognised by UK Research Councils. We offer a reduced rate for PhD research projects. If you are considering a project that would involve cosmogenic nuclide analysis, please speak to us!