Using glacier-climate proxies to model the Younger Dryas climate in Europe

An example of a Younger Dryas moraine (the sinuous ridge at the centre of the picture) from the Moroccan Atlas range (image courtesy of Philip Hughes).

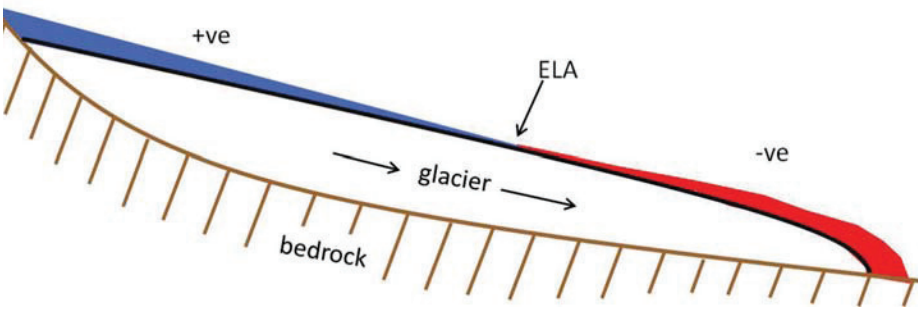
Theory has suggested that future increases in meltwater flux from the Greenland Ice Sheet may have enormous ramifications for regional climate. The increase in meltwater leads to freshening of the ocean surface, possibly impacting the Meridional Overturning Circulation which brings warmth to Europe. An ideal approach to test climate models is to benchmark them using analogues from the past. A North Atlantic freshening event occurred during the Younger Dryas period, approximately 12,800 – 11,500 years BP (before present). This is believed to have resulted from the rapid release of meltwater from the Laurentide Ice Sheet, which still occupied a considerable portion of North America. The freshening event caused a very rapid climate cooling and glacier expansion in the northern hemisphere. This project will investigate the timing and magnitude of the climate response to the change in the North Atlantic Ocean during the Younger Dryas using palaeo-glacier derived climate proxy data. The International Network comprises glaciologists, geochronologists and climate modellers working towards a common objective.

The health of a glacier is fundamentally controlled by the interplay between accumulation (precipitation) and ablation (temperature), with both being equal at the end of the mass balance year at the Equilibrium Line Altitude (ELA) or snowline. Evidence of palaeo-glacier extent (e.g. moraines) can be used to reconstruct former glaciers and calculate palaeo-ELAs. Empirical relationships have been determined which link precipitation and temperature at the ELA and so can be used to derive quantitative estimates of past climate.

The palaeo-glaciers will be reconstructed using field evidence and numerical techniques. This allows either the mean summer temperature or (more importantly) precipitation to be derived. The glaciologists in the Network will develop a robust and consistent data set by applying a common methodology to key sites for which Younger Dryas moraines have been identified and dated. For these sites the geochronologists will re-calibrate dates and consolidate these onto a common timescale to enable correlation across the study area.

Dr Brice Rea
University of Aberdeen

Network partners: Dr Matteo Spagnolo (University of Aberdeen), Professor Hans Renssen (Vrije Universiteit Amsterdam), Professor Jostein Bakke (University of Bergen), Dr Sven Lukas (Queen Mary, University of London), Dr Philip Hughes (University of Manchester), Dr Adriano Ribolini (University of Pisa) and Dr Susan Ivy-Ochs (ETH, Zurich).



A diagram illustrating glacier mass balance. The Equilibrium Line Altitude (ELA) represents the altitude at which the annual mass budget of a glacier equals zero. In each year, above the ELA snow accumulates while below the ELA, snow and ice melt to be replenished by ice flow from above.

(cover) – An example of a Younger Dryas moraine boulder being sampled for cosmogenic dating in the Macedonian Balkans (image courtesy Monica Bini).