Rock studies help crack questions of glacier thinning in West Antarctica

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Boulders the size footballs could help scientists predict the West Antarctic Ice Sheet's (WAIS) contribution to sea-level rise according to new research published this week in the journal *Geology*.

Scientists from British Antarctic Survey (BAS), Durham University and Germany's Alfred Wegener Institute for Polar and Marine Research (AWI) collected boulders deposited by three glaciers in the Amundsen Sea Embayment – a region currently the focus of intense international scientific attention because it is changing faster than anywhere else on the WAIS and it has the potential to raise sea-level by around 1.5 metres.

Analysis of the boulders has enabled the scientists to start constructing a long-term picture of glacier behaviour in the region. An urgent task is to put recent ice sheet changes into a historical context, and determine if these are part of a natural retreat since the end of the last glacial period (about 20 thousands years ago), or if they are a result of recent human-induced climate change.

Lead author Dr Joanne Johnson of BAS says,

"Until now we didn't know much about the long-term history of this part of the West Antarctic Ice Sheet because the region is incredibly remote and inaccessible. Our geological findings add a new piece to the jigsaw and will be used for improving computer models – the most important tools we have for predicting future change."

Initial results show that Pine Island Glacier has 'thinned' by around 4 centimetres per year over the past 5,000 years, while Smith and Pope Glaciers thinned by just over 2 cm per year during the past 14,500 years. These rates are more than 20 times slower than recent changes: satellite, airborne and ground based observations made since the 1990s show that Pine Island Glacier has thinned by around 1.6 metres per year in recent years.

The scientists reached their conclusions by investigating how long the boulders have been exposed to cosmic radiation rather than being shielded by ice or sediment.

Co-author Dr Mike Bentley from the University of Durham said,

"When rocks are left high and dry by thinning glaciers they are exposed to high energy cosmic rays which bombard the rock. This creates atoms of particular elements that we can extract and measure in the laboratory - the longer they have been exposed the greater the build-up of these elements. The discovery that we can place a fix on when rocks were left behind by the ice has revolutionised our understanding of how the Antarctic ice sheet has behaved in the past."

The Amundsen Sea Embayment (ASE) lies on the side of the West Antarctic Ice Sheet (WAIS). It is an area that has always caused glaciologists concern, because here the bedrock beneath the ice is a long way below sea-level and the ice is only kept in place because it is thick enough to rest on the bed. Thinning of the ice around the coast could lead to glacier acceleration and further thinning of the ice sheet. Essentially, the ice sheet may be unstable, and the recent pattern of thinning could be a precursor to wholesale loss of the ASE ice sheet (implying a sea-level rise of around 1.5 m).

Complete collapse of the WAIS would result in a rise of about 5 m in

global sea level. Most scientists working in the area think that complete collapse within the next few hundred years is unlikely, but even loss of one sector of the ice sheet would imply that projections of sea-level rise are at present too low.

The ASE is a notoriously difficult place in which to undertake fieldwork, it is cold, windy and is more than 1400 km from any research station.

Using a helicopter from the German research vessel Polarstern during an expedition led by Karsten Gohl (AWI) BAS scientist Joanne Johnson and colleagues visited remote rock outcrops protruding from Pine Island, Pope and Smith glaciers on the vast West Antarctic Ice Sheet. They collected samples from boulders that have lain ice-free for thousands of years.

Pine Island Glacier is of great interest to scientists worldwide as it has been thinning at a rate of more than 1 m/year and its flow rate has accelerated over the past 15 years. The location at which the glacier starts to float on the sea also retreated at a rate of more than 1 km/year during part of this period.

Cosmogenic isotopes (eg Beryllium-10 and Aluminium-26) are created in rocks when they are bombarded by cosmic rays that penetrate the atmosphere from outer space. The accumulation of these isotopes within a rock surface can be used to establish its ‘surface exposure age’, i.e., how long it has been exposed to cosmic radiation rather than being shielded by ice or sediment.

Source: British Antarctic Survey