Proposed Exploration of Subglacial Lake Ellsworth

Draft Comprehensive Environmental Evaluation

Non Technical Summary

Introduction

A draft Comprehensive Environmental Evaluation (CEE) has been carried out by the British Antarctic Survey (BAS) for the proposed investigation of Ellsworth Subglacial Lake in West Antarctica (referred to hereafter as Lake Ellsworth).

This draft CEE has been prepared in accordance with Annex I of the Protocol on Environmental Protection to the Antarctic Treaty (1998). The guidelines for Environmental Impact assessment in Antarctica (Resolution 4, XXVIII ATCM, 2005) were also consulted. This draft CEE describes the proposed activity, alternatives, the local environment and the likely environmental impact. It recommends preventative and mitigation measures and outlines gaps and uncertainties regarding the proposed exploration programme.

Description of the Proposed Activities

This programme proposes to undertake direct measurement and sampling of Lake Ellsworth to satisfy two fundamental scientific aims:

(1) to determine the presence, origin, evolution and maintenance of life in an Antarctic subglacial lake through direct measurement, sampling and analysis of this extreme environment, establishing whether, and in what form, microbial life exists in Antarctic subglacial lakes, and

(2) to reveal the palaeoenvironment and glacial history of the West Antarctic Ice Sheet (WAIS) including, potentially, the date of its last decay, by recovering a sedimentary record from the lake floor. This is critical to assessing the present-day risk of ice sheet collapse and consequent sea-level rise.

To meet these aims, the proposed exploration will involve accessing the lake using a hot water drill and deploying a sampling probe and sediment corer to allow sample collection. The proposed drilling and sampling exercise will likely last four days. (Following retrieval of the samples, there is an option to deploy a thermistor string which would remain *in situ* connected to the surface via a communication cable allowing ongoing measurements of the lake to be taken).

A field camp providing temporary accommodation and power for ten scientists and support staff will also be established for an estimated eight weeks.

The deployment of heavy equipment has been shown to be possible at this location based on several deep-field reconnaissance studies. This programme will build, test and deploy all the equipment necessary to complete the experiment in a clean and environmentally responsible manner.

Samples will be analysed and split in field laboratories and at the UK's Rothera Station, then distributed to laboratories across the UK.

To meet the scientific aims the programme has the following objectives:

- To produce a CEE describing the potential environmental impacts of the programme and how they can and will be mitigated by conforming with relevant best practice guidance (including the NAS guidelines on environmental stewardship when exploring subglacial lakes and the SCAR Code of Conduct on subglacial aquatic environment access).
- To build a hot water drill capable of drilling cleanly through up to 3.5 km ice.
- To construct a sampling probe capable of measuring and sampling the water column and surface sediment.
- To construct a sediment corer capable of retrieving a 1 m to 3 m sediment core.
- To develop a communications tether that can be used to lower the probe / corer and guide its measurement and sampling strategy.
- To design and deploy a field camp capable of supporting the programme and organise the logistics.
- To access the lake using the hot water drill.
- To deploy and recover the sampling probe into the lake, taking measurements and samples of water and lake floor sediment.
- To deploy and recover the sediment corer into the lake and recover a sediment core.
- To distribute the samples for analysis according to an agreed scientific protocol plan.
- To inform the science community and the wider population of the results.
- To inform future management and exploration of subglacial lakes in Antarctica.

Description of the Environment

Lake Ellsworth is located at 78º58'34"S, 090º31'04"W in West Antarctica. It is positioned within the uppermost catchment of the Pine Island Glacier some 70 km west of the Ellsworth Mountains at an ice-surface elevation of 1895– 1930 m above sea level.

Extensive information on the baseline conditions has been gathered during previous non-intrusive site surveys. These indicate that the lake is located at the bottom of a deep, narrow, subglacial trough and that the lake lies approximately 3-3.25 km below the ice surface.

The lake volume is an approximate 1.4 km^3 ±0.2 km^3. It is likely, although not confirmed, that the lake forms part of an open hydrological system.

The lake bed is comprised of high porosity low density sediments at least 2 m thick.

No flora and fauna habitat is present at or near the drill site. Nor are there any protected areas in the region of the drill site. The microbial diversity within the lake is unknown.

Impact assessment and mitigation measures

A full assessment of potential environmental impacts is included in this draft CEE. This programme has been in a planning and design stage for six years, throughout which environmental protection has been a central and dominant feature.

The most significant impact predicted is the potential for contamination of the lake and subsequent impact on microbial function. The lake's microbial populations are currently unknown (and can only be determined through the exploration). This impact will be mitigated through the use of the hot water drill methodology (using melted ice water heated to 90 °C, filtered to 0.2 μm, and UV treated), and thorough microbial control contamination methods.

Other impacts result from the emissions generated through the combustion of fossil fuels during the logistics and drilling, potential local contamination from minor fuel spills, and from the wastes generated. These will be mitigated through good planning and management on site.

The potential for "blowout" resulting from dissolved gas build up has been rigorously assessed, and the overall risk confirmed as very low.

Alternatives

Alternatives examined include using different techniques for lake access, investigating alternative subglacial lakes,using different methods of microbial control and not proceeding with the project.

All alternative options have been ruled out as they would afford less protection to the environment or not satisfy the scientific goals of the programme. We are extremely confident that there are no realistic alternatives to that proposed in this draft CEE.

Environmental monitoring and management

The environmental monitoring proposes to assess the actual (rather than predicted) environmental impacts and involves reporting on completion of the fieldwork the resulting total emissions and wastes generated. Any environmental incidents (such as fuel or other spills, windblown equipment or wastes, breaches of the waste, fuel handling or bio security protocols) will be reported.

The microbial control methods will be tested during laboratory trials before the equipment is deployed in the field. However, the effectiveness of the microbial control methods can only be assessed after the fieldwork is complete, once the samples of drill fluid that will be collected during

drilling have been analysed in UK Laboratories. The results of these analyses will give an indication of the efficiency of methods used and the potential for any contamination that has arisen. Preliminary analysis of potential contamination can be undertaken on-site using epifluorescence microscopy.

Gaps in knowledge and uncertainties

Given the exploratory nature of this scientific research, there remain unknowns, uncertainties and gaps in current knowledge. The most substantial relate to the following:

- The most sensitive receptor of Lake Ellsworth, the microbial bio-diversity, is unknown and can only be discovered through the execution of this project.

- While it is likely that Lake Ellsworth is part of an open hydrological system, we do not yet know this and there is a low likelihood that the system is closed. This has implications for dispersal of contamination introduced to the lake and for the risk of dissolved gas build-up that could lead under an extreme condition, to surface blowout.

- The microbial control methods proposed for use are subject to further development and trial to confirm they will meet the programme standards.

- Whilst the programme's primary scientific objectives are not dependant on deploying a thermister string, such a deployment would provide an opportunity to obtain the first accurate depth-temperature record of the ice-lake-sediment column. No decision has yet been made on the use of a thermistor string, but if deployed it will meet the programme's rigorous microbial control criteria. However, unlike other equipment it will be left *in situ*.

- The final arrangements for transporting equipment to the site are yet to be decided, therefore the associated atmospheric emissions will be re- calculated with greater accuracy in the final CEE. The figures quoted in this draft represent the worse case scenario emissions.

Conclusion

Having prepared a full CEE and adopted rigorous preventative and mitigation measures, the UK considers that the exploration of Lake Ellsworth will have a less than minor or transitory impact on the Antarctic environment. However, due to the uncertainties inherent in such exploratory science, there is a risk of greater impacts (more than minor or transitory). As the actual impacts can only be assessed after they have already occurred, a precautionary approach has been taken reflecting this risk.

This precautionary approach meets the recommendation of the NAS – EASAE report that "all projects aiming to penetrate into a lake should be required to undertake a Comprehensive Environmental Evaluation".

The UK concludes that the global scientific importance and value to be gained by the exploration of Lake Ellsworth outweighs the impact the proposed programme is predicted to have on the environment and justifies the activity proceeding.

Acknowledgements and further information

This draft CEE has been prepared by the Lake Ellsworth Consortium and reviewed by the programme's Advisory Committee which is made up of internationally based independent scientists and experts.

Particular thanks are given to Peter Barrett, Neil Gilbert, Chuck Kennicutt, Martin Melles and Satoshi Imura for their constructive comments on a preliminary draft of this report.

The draft CEE is made available on www.antarctica.ac.uk/ellsworthcee

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