

Advancing TechNological and ENvironmental stewardship for subglacial exploration in Antarctica (ATHENA)

Proposal for an Expert Group

1. Proposers: Peter Doran (University of Illinois at Chicago, USA: Co-chair), Jemma Wadham (University of Bristol, UK: Co-chair), Carlo Barbante (University of Venice, Italy), Christoph Mayer (Bavarian Academy of Sciences and Humanities, Germany)

2. Proposed Membership (by agreement with SCAR)

We have listed a number of individuals as a provisional membership list for the ATHENA steering committee, drawing on member of the international community who are specialists in either environmental protection or technologies (sensors and drilling capability). We include links to all three funded subglacial lake drilling programmes (Lake Ellsworth, WISSARD and Lake Vostok) via participants.

*Jemma Wadham (UK) and *Peter Doran (US): co-chairs

Christoph Mayer (Germany)

Carlo Barbante (Italy)

*Warwick Vincent (Canada)

*Irina Alekhina (Russia – link to Vostok drilling programme)

Matt Mowlem (UK – link to Lake Ellsworth Exploration Programme)

Alberto Behar (US – link to WISSARD drilling programme)

Alex Pyne (New Zealand – link to ANDRILL)

*also on AG-CCR-SAE (Code of Conduct for the Exploration and Research of Subglacial Aquatic Environments)

3. Introduction

This expert group emerges in the wake of the recently disbanded Scientific Research Programme, SALE. It is not a new version of SALE, but will take subglacial aquatic research in Antarctica in a new and important direction, by coordinating and facilitating collaboration in Antarctic subglacial aquatic science and specifically technologies and environmental stewardship, both of which are required to underpin current and future subglacial aquatic environment exploration. Athena is initially proposed for 2 years of funding as an expert group. After this time period, we aim to apply for an extension or to propose a new PPG.

4. ATHENA Terms of reference

- a. To establish the critical environmental and technological infrastructure for the future access, sampling and monitoring of Antarctic subglacial aquatic environments (SAE)
- b. To work with SCAR action groups, expert groups and research programmes to promote interdisciplinary science on Antarctic SAE, and specifically by developing linkages with research on Antarctic climate (via ACE), Biodiversity (via EBA) and sub-ice geological exploration (via SieGE).
- c. To provide an independent and international forum for the sharing of information and data during the run up to and execution of funded lake access drilling campaigns (e.g. US-WISSARD, UK-Lake Ellsworth and Russia-Lake Vostok).

5. Scientific Background

The importance and role of SAE is recognized as central to many processes that have shaped the polar ice sheets both today and in the past. Subglacial environments include a range of features that differ in geologic setting, age, evolutionary history, hydrological conditions and size. These environments are “natural” earth-bound macrocosms that in some instances trace their origins to a time before Antarctica became encased in ice. In contrast to other habitats, where solar energy is a primary influence, processes in subglacial environments are affected by the flow of the overlying ice, the ice-water boundary layer, basal heat flux and potential thermal or non-thermal fluid transfers, depending on the tectonic conditions. Recent findings suggest that a third control is subglacial hydrology, which enables the exchange of water and associated chemicals and sediments between subglacial systems; now known to be viable life-habitats. The full spectrum of sub-ice environments present beneath the Antarctic continent provides an unparalleled opportunity to explore and study one of Earth’s last frontiers and decipher fundamental earth and life processes. The exploration and study of subglacial environments will advance our understanding of how life, climate, and planetary history have combined to produce the Antarctic continent as we know it today.

The recent funding of three international campaigns to drill into and sample subglacial lake environments (Whillans Ice Stream Subglacial Access Research Drilling (WISSARD), the Lake Ellsworth Exploration and Lake Vostok Drilling Programmes) will result in a dramatic shift in the current understanding of Antarctic SAE via the generation of first time data on subglacial physical, chemical and biological processes. However, they are not an end point for Antarctic subglacial research and the need to maintain communications and coordination between participating groups during and subsequent to the drill phase of these projects is vital. We emphasize that this proposal is not a continuation of SALE but reflects an emergent need to address two specific issues that are paramount as we move into a new era of Antarctic Subglacial Lake exploration. The first regards the development of SAE entry and sampling protocols that are commensurate with the need to protect these pristine

and remote habitats. The second regards the technological developments that are required to ensure that there is maximum data return from current and future Antarctic subglacial missions. Many of the challenges for SAE exploration are technological. Currently funded lake access campaigns are largely oriented towards sample collection and return, with limited in situ analyses and little long-term monitoring of chemical and physical conditions. Part of this approach stems from concerns over environmental protection and the impact of deploying permanent instruments in lakes. However, the single largest factor limiting the acquisition of data using sensors and observatories is the current dearth of sensing technologies of sufficient maturity for deployment to the bed of the Antarctic Ice Sheet. Here, perennial cold, high pressure, low levels of target analytes, remote location and the need to deploy sensors via a borehole create severe challenges for instrumentation. Hence, there is currently a mismatch between the science goals and the status of technologies required to meet these objectives. While the first phase of funded lake access programmes will generate highly novel datasets and a revised understanding of SAE, a significant output from these campaigns will be the generation of new scientific questions and hypotheses that require a second phase of carefully targeted lake exploration. These follow-on drilling campaigns are already at the planning stage in some countries, but cannot be fully realized with the technology status quo.

6. Expert Group rationale and methodologies

SAE have been documented for some time using remote sensing geophysical techniques, but only very recently have plans been devised and implemented to sample and study these environments directly. The long lead in times for the sampling of these lakes is largely related to the technological difficulty of penetrating the overlying ice sheet, but also reflects the cautious approach warranted by the pristine nature of the environments, and their almost completely unknown capacity to sustain viable ecosystems. SCAR (e.g. via SALE) has played a fundamental role in shaping the science priorities and international partnerships in the nascent field of subglacial aquatic research, but now there is an important need for a new path forward that focuses international exchange on the appropriate technology and methodologies required to carry out the science in an environmentally responsible way. The goal of ATHENA Expert Group is to lay the foundations for future SAE exploration via the development of rate limiting Technological and Environmental infrastructure.

7. Group Management

An international steering committee will be established for the ATHENA Expert Group, drawing upon as wide a range of experts across both Science and Engineering, whilst retaining an initially small group to promote focus. Additional key members of the scientific community will be invited to join annual meetings. The ATHENA steering committee will interact with relevant international groups (e.g. SCAR, IASC) and national polar operators to maximise participation across nations. It will plan annual workshops to review, assess and exchange results, and to promote integrated interpretation

and modeling efforts. Thematic symposia will be planned at international meetings, with resultant publications.

8. Initial Implementation Plan for ATHENA (2010-2012)

- a. Encourage continued coordination during the planning stage of the three funded subglacial lake drilling campaigns (e.g. via sessions at Fall AGU meetings, San Francisco)
- b. Convene a cross-disciplinary workshops focussed upon 1) “Clean Technologies for Future Antarctic Subglacial Exploration” aiming to bring together key scientists and technologists engaged in SAE exploration.
- c. Improve the present knowledge on clean access and sample retrieval for chemical and biological characterization of subglacial environments, by collaboration with the AG-CCR-SAE Action Group.
- d. Organise thematic sessions – Fall AGU (2011), SCAR (2012)

Timetable for planned activities during the ATHENA Expert Group phase:

Date	Activity
2010	
August	Presentation of proposal at SCAR OSR – Buenos Aires
September	ATHENA Start Date
December	<i>ATHENA Kick Off Meeting, San Francisco</i>
2011	
July	<i>Steering Committee Meeting – University of Venice</i>
December	Session on “New generation technologies for future Antarctic subglacial environment exploration”, Fall AGU, San Francisco
2012	
March	Proposal for ATHENA extension
July	Oregon: Clean Technologies Workshop <i>Steering Committee Meeting</i> Session on Technologies for Exploring Icy Ecosystems at SCAR OSC

9. Objectives of the proposed ATHENA Expert Group

If approved, ATHENA *will ensure that, by encouraging and facilitating international communication, subglacial aquatic exploration over the next 5-10 years is underpinned by the technological and*

environmental protection infrastructure required to ensure the highest science return possible. It will do this via three groups of actions:

- a. Coordination of international activities linked to funded lake drilling campaigns and other subglacial aquatic environment investigations**
 - Ensure sustained international coordination and data dissemination prior, during and following (assuming extension granted) the three “live” subglacial lake access campaigns (WISSARD, Ellsworth, Vostok), thereby maximising the scientific return of these programmes (e.g. via joint publications, co-convened conference sessions).
 - To facilitate the exchange of knowledge between funded drilling programmes and other aquatic environment investigations.
 - Provide education and outreach materials (via links to externally compiled information) on Antarctic SAE as the three drilling campaigns are undertaken, enhancing the international profile of the scientific findings.
 - Provide a forum for the sharing of information relating to data management by drilling campaigns and associated remote sensing/modelling research.
- b. Environmental protection**
 - Make available a forum and web-based portal for the sharing of information relating to environmental protection protocols that may be used to inform current and future drilling activities in Antarctica
 - Liaise with the existing AG-CCR-SAE (Code of Conduct for the Exploration and Research of Subglacial Aquatic Environments) Action Group to implement and document recommendations on environmental stewardship that may be updated as new information is acquired (e.g. revision of the SCAR-SAE Code of Conduct following lake access and environment characterisation)
- c. Technologies**
 - Stimulate engagement at the international level between scientists driving Antarctic subglacial research and technologists implementing access, sampling and monitoring strategies for subglacial environments. The latter should include members from the deep rock and ocean drilling community (e.g. ANDRILL)
 - Promote the international coordination and planning required to bring the status of deep drilling, sensor and systems technologies to the level required to fully engage in future Antarctic SAE missions (e.g. via annual ATHENA meetings, a small technology themed-workshop and sessions at international conferences such as the Fall AGU/EGU).
 - To conduct the following tasks:
 - 1. Identify common data capture requirements for the future exploration of SAE, to include observatories for long-term monitoring.*

- II. *Identify candidate sensor technologies available for Antarctic subglacial data capture, together with their performance characteristics, and to provide a forum for the sharing of this information*
- III. *Integrate and synthesize data acquired using sensors and sensor platforms from more benign environments with the aim of improving information on system performance in Antarctic SAE.*
- IV. *Consider new ways to address technological provision for subglacial exploration, drawing upon analogues from non-glacial environments e.g. space-flight engineering models.*

We believe that these three themes, discussed within the context of the ATHENA Expert Group will be of strong interest to the SCAR Executive and all SSG’s.

10. Expert Group Budget (est. \$13k over 2 years)

ATHENA will be funded as much as possible from external sources (e.g. national funding agencies). However, we request the following funding from SCAR to support the basic infrastructure of the workshop in 2012, and to contribute to the travel and subsistence costs of steering committee members at the annual meeting in Venice in 2011, which is not associated with an international conference and for which individuals are less likely to have dedicated funding.

Event	Cost	Justification
Clean Technologies Workshop – 2012, Oregon Steering Committee meeting 2012	\$1,000	\$1,000 (event logistics organisation for the workshop) Steering committee attendance to be covered from national funding
Kick Off Meeting 2010, AGU San Francisco	-	Covered from national funding
Steering Committee Meeting 2011, Venice, Italy	\$10,000	Contribution to travel costs for steering committee members
Web site set up	\$2,000	A web site is critical for ATHENA activities to be communicated and shared with the international community. It will also serve as portal for information on environmental protection and technologies for SAE access. We request minor funds to enable us to fund the set up of this site (to be based at one of the participating institutions), using in house support (e.g postgraduate).
TOTAL	\$13,000	