Report of the Subglacial Antarctic Lake Exploration Group of Specialists (SALEGOS)

Meeting - 3

University of California at Santa Cruz, USA

2-3 October, 2002

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SCAR - Subglacial Antarctic Lake Exploration Group of Specialists
SALEGOS

Report of SALEGOS-Meeting - 3
University of California at Santa Cruz, USA, 2 – 3 October, 2002

J Priscu, Convenor, welcomed the members of SALEGOS to the University of California at Santa Cruz (UCSC). He thanked S Tulaczyk for the invitation to host the meeting and to his staff for making the necessary arrangements. S Tulaczyk welcomed the Group and indicated he was available as needed to assist during the SALEGOS meeting.

The following members of SALEGOS were present: J Priscu (Convenor), M Kennicutt II (Secretary), R Bell, S Bulat, V Lukin, C Ellis-Evans, R Powell, JR Petite and I Tabacco. Member H. Miller was absent. Observers included S Tulaczyk of UCSC and A Behar of JPL. The addresses and contact information for SALEGOS members and other meeting participants are included in Appendix A.

1.0 Adoption of Agenda and Appointment of Rapporteurs.

The agenda of the meeting was tabled and accepted. The agenda is provided in Appendix B. Rapporteurs were appointed to assist M. Kennicutt II, SALEGOS Secretary, in recording the meeting's discussions. During the first day of the meeting, 2 October 2002, R Powell, JR Petit, C Ellis-Evans, and I Tabacco recorded the discussions. During the second day of the meeting, 3 October 2002, M Kennicutt II recorded the discussions. Presenters were asked to provide copies of their presentations and brief summaries of their comments.

2.0 Standing Items

2.1 SALEGOS Membership

It was again agreed that additional expertise in glaciology was needed to address all aspects of the Group's terms of reference. This conclusion was stated succinctly in SALEGOS Report 2 and forwarded to the SCAR Executive following the submission of Report 2; as yet, no action by SCAR has been taken. If the need should arise for the discussion of topics outside of the Group's expertise, appropriate experts will continue to be invited to attend meetings.

2.2 SALEGOS Terms of Reference (TOR)

The Terms of Reference (TOR) for SALEGOS were discussed and judged to be appropriate. The TOR are:

1) Refine, expand and embellish the Cambridge 1999 workshop's scientific objectives.

2) Develop the critical requirements/criteria for lake(s) selection.

3) Provide scientific guidance and input to COMNAP deliberations on logistics and drilling technologies for subglacial lake entry and sample retrieval.

4) Develop a set of objectives for technology developments related to the science objectives as opposed to only entry and retrieval.

5) Consider and recommend organizational strategies/models for managing an international exploration program.

6) Delineate information gaps and the sequence or timing that is needed to progress toward the ultimate goal of lake entry and sample retrieval - are there milestones along the critical path and what are they?

7) Consider the environmental ramifications and how the Comprehensive Environmental Evaluation (CEE) and Environmental Impact Assessment (EIA) process needs to be applied for support of subglacial lake exploration and the role of other SCAR and Treaty bodies [Group of Specialists on Environmental Affairs and Conservation (GOSEAC), Committee on Environmental Protection (CEP)].

8) Devise a series of SCAR activities to facilitate and promote the exploration of subglacial lakes such as targeted workshops.

9) Be a proponent of subglacial lake exploration with National Antarctic Programs to garner the financial and logistical resources needed for the program.

Significant progress had been made on each SALEGOS TOR.

2.3 SALEGOS Meeting 2 – Report

SALEGOS members were asked for comments on the second report. The response to the SALEGOS Report - 2 has been very positive. The development of Portfolios in this report was seen as an important move toward implementation of a subglacial lake exploration program.

3.0 Recent Research

SALEGOS members C Ellis Evans, R Bell, S Bulat, JR Petit, and J Priscu gave short updates on recent developments in their research programs related to subglacial lakes. Invited guests from NASA and JPL (C McKay and A Behar) also provide updates on relevant projects.

R Hindmarsh (BAS) and M Siegert (U. Bristol) have just completed an analysis using radar layer data and an inverse ice flow model that constrains the Vostok ice core age-depth relationship. A number of scenarios were modeled and it was concluded that flow models can effectively represent the isochronous structure. Inversions suggested that melt rates were very low – even a few millimeters per year would require very high geothermal heat fluxes (~100mW

m^{-2}). More "normal" heat fluxes (~50 mW m^{-2}) produce melt-rates around 1 mm $year^{-1}$. Such conditions also facilitate a mixture of melting and freezing in areas of extreme topography (a possible explanation for sediment in accreted ice?). The Vostok time scale suggests that a melt rate of around 1 mm $year^{-1}$ produces a good match with the data in the model whereas 5mm yr^{-1} removes the young ice and <1mm leaves too much old ice. Average accumulation of accreted ice was estimated to be ~21 mm $year^{-1}$

V Lee, M Siegert and M Tranter at U. Bristol and C Ellis-Evans (BAS) have begun to employ models from fluid dynamics engineering to study the small scale circulation of the Lake Vostok water column missed by previously employed large scale ocean models. The lake is being modeled and the simulation is currently focusing on a simple three-dimensional structure (not yet scaled up to the full dimensions of the lake) in which the bottom (floor plate) is warmed (simulating geothermal heat) and the top (ceiling plate) is cooled and sloping. The entire box is also slowly revolving to simulate Coriolis forces. The modeling suggests that even weak geothermal heating, such as that expected as background in Antarctica, is sufficient to generate turbulent convective motion. These motions are complex even within these simple models and even without geothermal hot spots and the lake's morphometry, which will potentially add further layers of complexity. The results from this work will be used in future large-scale modeling experiments together with more detailed morphometric data to formulate a definitive model of water flow within Lake Vostok and other subglacial lakes.

S Bulat provided an update on microbiological research on the Vostok ice core. He reported that Vostok drilling fluid from the Vostok 5G-1 borehole (45 RAE) has been tested for bacterial content to establish a 'drill fluid' contaminant database to assist studies of the Vostok ice core. Fluid samples from 2750 m and 3400-3600 m depths were analyzed. Preliminary results show that the drilling fluid contains mostly PAH-degrading and human pathogenic bacteria (Bulat et al., 2002, unpublished). In addition, S Bulat reported preliminary results on the fungal content of Lake Vostok accretion ice. Among the samples studied (3607 m, 3612 m, 3619 m, 3623 m), the 3619 m core (archived as an one-quarter segment according the guidelines of NSF Meeting on France-Russia-US Collaborative Program on the Lake Vostok Ice Core, Arlington, VA, 17-18 April 2002) was most recently processed. The few fungal ITS rDNA signatures detected were considered to be contaminants so there is still no evidence of indigenous fungi (Bulat et al., 2002, unpublished).

J Priscu presented results from recent work conducted in his laboratory on Vostok meteoric and accretion ice. DNA fingerprints obtained of the outer washes of selected ice cores showed the presence of a diverse group of bacteria that, in support of the results of S. Bulat, should be considered as contaminants. The community composition of the wash bacteria varied with core depth indicating that different contaminants exist at different depths. Importantly, the bacterial contaminants found on the outside of the cores were different than those observed in the inner 20 % of an accretion ice core collected from 3590 m implying that decontamination protocols used to obtain the DNA from the inner core were appropriate. GC/MS analysis of hydrocarbon signatures also showed significant contamination on the outer few millimeters of Vostok cores with kerosene based drilling fluid. This type of contamination was also observed in a core collected from 179 m in a borehole that did not use drilling fluid, indicating that physical core handling is a significant source of hydrocarbon contamination. Physical scrapping of the outer 3 mm of the cores followed by ablation with dionized water proved effective in removing the drilling fluid from the cores studied. Priscu, using data from the Vostok 5G borehole, estimated that subglacial lakes and the Antarctic ice sheet contain 1.2 x 10^{25} and 8.8 x 10^{25} prokaryotic cells, respectively. These cell numbers are equivalent to 0.33 x 10^{-3} 2.44 x 10^{-3} petagrams of organic carbon, respectively (1 Pg =10^{15} g). The total bacterial carbon content in Antarctic subglacial lakes and the ice sheet (2.77 x 10^{-3} Pg C) approaches that reported for Earth's combined lakes and rivers (3.63 x 10^{-3} Pg C) making the icy systems of Antarctic a significant organic carbon reservoir that has yet to be considered.

A Behar of the Robotic Vehicle Group of the Jet Propulsion Laboratory (JPL) of the California Institute of Technology provided an update on activities related to the development of robotic devices for subglacial lake exploration. The Ice Borehole Probe, equipped with a camera, was successfully deployed at a number of locations in Ice Stream C, Antarctica; and on Black Rapids, Alaska. The Probe is seen as an exploration tool and a Cryobot instrument test bed; it was first designed to image hot-water drilled boreholes in collaboration with Caltech. In Ice Stream C, the device easily imaged multiple layers of debris encased in clear ice, and a 1.4 m deep basal cavity was explored; such a cavity provides a good analogy for some engineering issues for subglacial lake and Europa missions. Once deployed into the basal cavity a clear-ice/water interface was visible and the structure of ice grain boundaries was clearly apparent. Debris from the borehole itself could be monitored to supply subglacial hydrological information. The ice probe system was again deployed at Black Rapids, AK in May 2002. The deployment was successful and images were captured over a 500 m depth interval. The basal water system was not sufficient to flush the bore hole and glacial debris suspended in the melt water made it difficult to image the lowest part of the bore hole.

The JPL Cryobot thermal probe was assembled and deployed for the first field test in Svalbard in October 2001. JPL continues to develop the Cryobot as a non-disturbing lake entry concept; the key to the application is that the Cryobot entry exposes the subglacial lake to a knowable minimum of disturbance. Additional field tests are planned for the Cryobot in Svalbard and Antarctica. The JPL team is also developing a deep UV fluorescence device for biochemical detection. The device would detect biotic constituents in ice inclusions, inspect the Cryobot water lozenge for organisms, and investigate benthic organism density and even analyze resuspended sediments.

A JPL project in the initial stages is development of a mini-sub explorer equipped with a CTD, a camera, and a mission specific instrument package. It would be used to explore Europa, ultimately, and such terrestrial sites as ice shelves, lakes, subglacial lakes, cave ponds, and hydrothermal vents.

Chris McKay (NASA-Ames) presented a model on potential gas dynamics in Lake Vostok. Owing to the pressure of the system (400 atm), gases will not follow ideal gas laws and have to be modeled accordingly. Using fugacity to determine gas concentrations and assuming that gases equilibrate in the lake between the clathrates and dissolved fractions, Lake Vostok should be supercharged with nitrogen. Dissolved oxygen may also be highly supersaturated (up to 6 g dissolved oxygen/l) if there is no biological oxygen sink. If there is a biological dissolved oxygen sink, dissolved carbon dioxide may become important in the lake. His model showed that clathrates of certain gases will be present and in equilibrium with the dissolved gas fractions. It is imperative that gas dynamics are considered before entering the lake to avoid possible explosive out gassing.

4.0 International Developments

The Convenor reported on presentations by R Bell, R Powell and J Priscu before a joint meeting of SCAR and COMNAP in Shanghai, China. The reports were well received and generated much discussion, particularly regarding a range of environmental issues. An information paper was tabled at the CEP meeting by SCAR summarizing SALEGOS progress to date entitled "Exploring Subglacial Lakes: A SCAR Progress Report" (IP-055-SCAR, Agenda Item ATCM 14, CEP 4c, SCAR).

V Lukin extensively discussed Russian plans for Lake Vostok studies in the next few years. At the XXV Antarctic Treaty Consultative Meeting (ATCM) in Warsaw in September, 2002 the Russian delegation tabled a draft Comprehensive Environmental Evaluation (CEE) before the Committee on Environmental Protection (CEP) entitled "Water Sampling of the Subglacial Lake Vostok" (WP-019-Rus, Agenda Item CEP 4c). The draft CEE included a plan for deepening the present bore hole by 50 m that was previously discussed and commented on by SALEGOS (see Reports 1 and 2). In addition, the draft CEE presented a plan for drilling through the remaining 80 meters of ice and penetrating the lake retrieving water samples. After discussions at the ATCM, the Russian delegation decided to revise the draft CEE by removing the initial 50 m deepening of the borehole and address it in a separate IEE. The final deepening of the bore hole and lake entry will be considered in the revised draft CEE. The CEP formed an Intersessional Contact Group (ICG) to consider the adequacy of the draft CEE. The ICG will be convened by JJ Reyser from France (jjreyser@ifrtp.ifremer.fr). The revised draft CEE will be considered at the next ATCM/CEP meeting in Madrid, Spain in June, 2003.

The proposed timeline for the Russian program is to deepen the borehole by the first 50 meters in 2003 – 2004, deepen the borehole an additional 50 m in 2004 – 2005, and enter the lake in 2005 – 2006. The initial deepening of the borehole will employ previously used technology. The second deepening of the hole and lake entry would require development of alternative technologies. Lake integrity is ensured by drilling into the lake in an under pressured state which should allow lake water to rise into the borehole preventing contamination of the lake. The lake water would be allowed to freeze in place and then be cored to retrieve a sample. V Lukin indicated that the Russian program was receptive to proposals for international collaboration.

4.1 Scientific Meetings

In an effort to promote further scientific interest in subglacial lake research the Group discussed the possibility of sessions devoted to subglacial lake research be proposed for inclusion in future scientific meetings.

J Priscu, as part of the organizing committee for the 2003 American Society of Limnology and Oceanography Aquatic Sciences Meeting, has helped arrange a session entitled "Life In Ice" under the sub-theme "Extreme Environments On Earth and Beyond" (J. Deming convener). J

Priscu is an invited participant in this session and will present an overview of SALEGOS plans for subglacial lake exploration and a scientific justification for pursuing such an endeavor. The meeting will be held in Salt Lake City, Utah (USA) on 8-14 February 2003. Meeting details follow (http://aslo.org/slc2003/index.html):

1. October 1, 2002 - Abstract Submission Deadline
2. November 2002 - Authors Notified
3. December 2002 - Meeting Schedule Posted on Web Site
4. January 2003 - Program Mailing to ASLO Members and Meeting Participants
5. February 8-14, 2003 - Meeting

I Tabacco has been instrumental in implementing a session on subglacial lake research at the International Glaciological Societies Seventh International Symposium on Antarctic Glaciology (ISAG-7) to be held in Milan, Italy (25–29 August 2003). Abstracts are due by 28 February 2003. Details can be found at http://www.igsoc.org/symposia/.

JR Petit has worked successfully with conveners to include a session on subglacial lakes in the upcoming meeting of the EGS-AGU-EUG Joint Assembly, Nice, France, 06-11 April 2003. The program for the meeting includes more than 500 sessions, including Union Symposia, Educational Symposia, Topical Sessions, Short Courses, Workshops, Key Note and Medal Lectures and Townhall Meetings, covering all areas from Geology, Geochemistry, Geophysics and Biogeosciences from the inner part of the Earth to the outer boundary of the Heliosphere. The session (BG2.06) is sponsored by the Biogeosciences Program with co-sponsorship by the Cryospheric Sciences Program. The title of the session is "The search for life in subglacial environments". J Priscu (convener), R Bell (co-convener) and JR Petit (co-convener) will be running this session. The various deadlines for this meeting are (details can be found at http://www.copernicus.org/egsagueug/index.html):

1. Deadline for Support Application: 1 December 2002
2. Deadline for "Early Bird" Registration: 31 December 2002
3. Deadline for Receipt of Abstracts: 15 January 2003
4. Deadline for Pre-Registration: 7 March 2003

5.0 Management Strategies

A McKinnon (Arrow International) provided SALEGOS with a presentation entitled "If you want to predict the future - shape it". The presentation covered the cost planning process, and cost, risk, change and time management for international science programs. The ANDRILL program was presented as a potential model for use in an international program on subglacial lake research. A brief summary of the salient points of his presentation follow. SALEGOS considers the ANDRILL organizational model (see http://andrill-server.unl.edu/index.htm) appropriate for a subglacial lake exploration program since it contains many of the same elements and requirements. The ANDRILL model is also based on the Cape Roberts experience and thus represents a model that is familiar to most countries.

A McKinnon distributed a copy of the ANDRILL Project Plan that provides a detailed plan for implementation. The report included sections on objectives and scope, the program, the cost, environmental assessment, logistics, and risks. Detailed milestone charts and timelines were constructed and cost estimates were refined. As stated in the introduction to the plan: "The Project Plan provides a comprehensive description of the ANDRILL project and its management requirements. It incorporates (at a strategic level) an operator's perspective of project objectives, scope, program, cost, risks, and environmental considerations." This will be an important step in implementing subglacial lake exploration and should be commissioned as soon as a lead country is identified. A document of this type will be important in developing partnerships and as a promotional tool for interested parties.

6.0 Cost Estimates

As part of A McKinnon's presentation to SALEGOS, the methods for arriving at logistics (and related elements) and cost estimates for the ANDRILL Project were presented and discussed. The SALEGOS concluded that it was too early in the process to further refine cost estimates (see SALEGOS Report – 2). For the ANDRILL Project, the refinement of cost estimates occurred after a lead country was identified. The cost estimate was used as part of the lead country's application for management funds to its government.

7.0 Environmental Issues

Probably one of the most contentious and important issues facing the development of a subglacial lake exploration program is stewardship of the environment. SALEGOS continues to address a wide range of environmental issues related to lake entry. To this end personnel from NASA's Planetary Protection Program and the SETI Institute were invited to share their experiences. It was immediately obvious that there were many parallels between how space exploration has proceeded in the face of contamination and cleanliness issues and the issues faced by a subglacial lake exploration program. The following is a brief summary of the salient points of the various presentations provided to SALEGOS.

7.1 Planetary Protection – Lessons Learned

D DeVincenzi, Space Science Division Chief, NASA Ames Research Center provided a presentation entitled "NASA's Planetary Protection Program". It is NASA's policy to preserve planetary conditions for future biological and organic constituent exploration and to protect Earth and its biosphere from potential extraterrestrial sources of contamination. This considers both "forward" and "backward" contamination issues that have been raised in regard to subglacial lake exploration. In the development of environmental protocols it will be necessary to specify acceptable levels of contamination on instruments and/or equipment entering subglacial lakes and protocols for the proper handling of samples retrieved from the lake. In a manner analogous to the Antarctic Treaty, the Outer Space Treaty of 1967 sets the guiding policy related to space exploration. The treaty signatories agreed to avoid harmful contamination and adverse changes in the environment of the Earth that might result from the introduction of extraterrestrial matter.

In an analogous manner, the Antarctic Treaty, its annexes, and the Protocol on Environmental Protection govern the exploration of subglacial lakes. The Committee on Space Research (COSPAR), which was established by ICSU, also coordinates international cooperation in the conduct of space research. The analogous body for subglacial lakes is SCAR. COSPAR interprets, reviews and refines planetary protection policy as needed to reflect scientific and technological advances relevant to exploration within the solar system. Current policies and planetary protection controls depend on the nature of the mission (e.g., orbiter, lander, etc) and on the particular target body (planets, moons, asteroids, etc), and whether it is a location of biological interest and potential. In interpreting COSPAR policies and how they apply to specific missions or types of exploration, NASA has relied heavily on the US National Academy of Sciences (NRC Space Studies Board) to convene groups of experts and issue opinions on various topics including: reduction of biological contamination on outbound spacecraft; constraints on operating procedures; contaminant inventories and restrictions; and quarantine and handling of returned samples. COSPAR generally accepts the recommendations of these groups and incorporates them in policy directives. NASA uses these findings and recommendations to determine appropriate controls and restrictions that are placed on its missions. Missions are categorized according to the mission type and its objectives before determining the level and type of planetary protection controls to be used. Missions are analyzed on a case-by-case basis; i.e., one size doesn't fit all. In general, there are two considerations in setting requirements for spacecraft and equipment: (i) "cleanliness" as related to environmental protection and (ii), science requirements related to the integrity of the scientific results from analyses of experiments on the spacecraft or the samples being retrieved. The requirements can be quite different when life detection experiments are involved and science requirements may be far more stringent than environmental protection requirements.

In summary, the Outer Space Treaty is the guiding international policy for space exploration, COSPAR is the international scientific group that interprets the policies and updates them as needed, and individual nations decide how to implement their missions and adopt specific planetary protection controls and measures that are consistent with the policies and recommendations approved by the international community. NASA uses the NRC Space Studies Board and various scientific workshops to discuss issues and make relevant recommendations that may be used to formulate controls or guidelines for implementation. The NASA Planetary Protection Officer is the official responsible for making sure that NASA missions meet appropriate management policies and directives and are consistent with relevant international guidelines and Treaties. The US NRC Space Studies Board has produced a series of reports outlining this approach to planetary protection (Appendix C) that will be informative when addressing environmental issues during subglacial lake exploration.

M Race, SETI Institute, expanded on the history of planetary protection with a special emphasis on how independent science boards and workshops were crucial for setting objective and credible policy guidelines and how this advice was implemented into study designs. As an introduction, parallels between subglacial lake contamination issues and planning for Mars sample return were drawn. Lessons learned from the Mars sample return planning efforts are (i) that planetary protection considerations must be integral to the earliest phases in the planning process rather than considered add-ons after the mission design is complete, (ii) at times, planners must grapple with ambiguity because of lack of information and knowledge (many unknowns due to the ground breaking nature of the project), and (iii) often, more than just research objectives had to be considered during planning efforts (size, weight and power constraints, technical limitations, etc). Many of the similarities between the two projects are outlined above including an international treaty as a legal framework, the involvement of international science advisory groups such as SCAR and COSPAR, jurisdiction of certain environmental policies, laws and regulations that must be conformed to, and the extensive use of workshops, independent science organizations, and targeted research to assist in planning efforts. Both projects are subject to extensive and intense review in regards to environmental concerns about "forward" and "backward" contamination as well as environmental health and safety issues, both in the area explored and upon return of materials after exploration. National and international legislation will provide the context for these reviews and a road map to be followed during the planning and implementation phases. Analogies were drawn between the list of environmental issues encountered by both projects and include: cleanliness of equipment and sampling arrays; transfer of material during operations such as the introduction of drilling fluids or microbes into the lake during drilling; the need for real-time monitoring of operations to ensure compliance and quality in all phases of the operation; clear guidelines on the decision path and responsibilities when difficulties are encountered; and contingency planning for unforeseen events or developments. M Race also discussed other equally important considerations during planning including: attempts to better understand perceptions of risk (public surveys, focus groups); development of a risk communication plan; plans to deal with potential lawsuits and liability issues; and programs for public education and engagement in the project. She further emphasized that complete documentation of and transparency in the decision making process is essential because the project will attract both scientific and public debate, there is uncertainty in the process and unforeseen events will occur in such complex projects, and the project likely will be scrutinized, challenged and perhaps opposed. Planning must be flexible and allow for incremental decision-making as our understanding of science and the project develops over a period of many years. Among the key lessons learned from space exploration are (i) integrate environmental issues early in planning, (ii) use objective groups for advice and oversight, (iii) communicate early and often to all stakeholders including the public, (iv) pay attention to consensus building (both nationally and internationally), and (v) apply previous experiences tailoring them to the specific needs of each unique project.

While there are analogies with planetary exploration missions, it is not intended to infer that subglacial lake exploration should be subjected to an equivalent degree of concern or precaution. Subglacial lakes by their nature are Earth bound and have been subjected to the steady input of earthly organic materials and microbes for thousands if not millions of years. Cleanliness requirements need to be developed within this context, as pointed out in space exploration policies. Restrictions and requirements must be realistically developed in the context of the specific activities involved, the target of exploration and the mission's objectives. For space missions, research and development is continuing to refine new technologies for use in detecting and quantifying contaminant levels and to improve cleaning and sterilization techniques that are satisfactory for life detection missions. Subglacial lake exploration can learn from these experiences.

Following the principles of planetary protection, SALEGOS suggests that it would be prudent to have an independent scientific body (such as the US NAS) consider the thirty year history of planetary protection of space studies and provide guidance on how these lessons can be applied or adapted in preparing environmental protocols for subglacial lake exploration. It is further recommended that SCAR contact COSPAR and explore ways that these two international organizations could work together to provide the scientific community with advice on these issues.

8. Recommendations

It is the conclusion of SALEGOS members that the Group's discussions and deliberations are sufficiently advanced to begin formulation of a series of recommendations for consideration by SCAR. Within the context of the Group's Terms of Reference we will develop a series of recommendations that will place SCAR in a leadership position in development of an international subglacial lake exploration program. SCAR is well-positioned to establish the framework and guiding principles for such a program and build international consensus.

Whereas, SCAR convened a Group of Specialists (SALEGOS) to consider a range of issues related to the exploration of subglacial lakes,

Recognizing, that SALEGOS has conducted several meetings and conferred with experts as needed,

Therefore, in this first set of what will be a series of recommendations, SALEGOS recommends that:

SALEGOS Recommendation 1 - SCAR adopt the guiding principles for subglacial lake exploration as enunciated in the SCAR/COMNAP workshop in Cambridge, UK, 1999:

- the program be internationally coordinated;
- the program be interdisciplinary in scope;
- minimum disturbance and contamination must be fundamental considerations in program design and execution;
- the ultimate goal should be lake entry and sample return; and
- the ultimate target for study must be large lakes such as Lake Vostok.

SALEGOS Recommendation 2 - SCAR adopt the goals for subglacial lake exploration as enunciated in the SCAR/COMNAP workshop in Cambridge, UK 1999:

- determine the form, distribution, and activity of life in the lake water, the sediments below, and the ice above;
- recover climatic information contained in ice overlying the lake and in sediments underlying the lakes; and
- understand the origins of subglacial lakes and their impact on the evolution of life under the ice.

SALEGOS Recommendation 3 – SCAR coordinate and consult with COMNAP in providing guidance on the technological needs and requirements for safe and clean lake entry and sample retrieval.

SALEGOS Recommendation 4 - SCAR coordinate and consult with COMNAP in considering ways to promote the use of shared logistics to implement a subglacial lake exploration program, and to establish an effective management structure and cost-sharing mechanism.

SALEGOS Recommendation 5 – SCAR encourage National Antarctic Committees in countries with an interest in subglacial lake exploration to form an International Science Steering Committee (ISSC) to promote and organize an international subglacial exploration program.

SALEGOS Recommendation 6 – SCAR encourage National Antarctic Committees in countries with an interest in subglacial lake exploration to form National Science Steering Committees (NSSC) to promote and organize subglacial lake exploration interests within their countries.

SALEGOS Recommendation 7 – SCAR explore a partnership with COSPAR (ICSU) to share expertise and experiences in addressing environmental issues related to "forward' and "backward" contamination during subglacial lake exploration.

SALEGOS Recommendation 8 – SCAR encourage parties interested in subglacial lake exploration to consult with and engage independent and objective scientific bodies to provide guidance on contamination issues in a way analogous to the Space Studies Board and COSPAR.

SALEGOS Recommendation 9 – SCAR explore ways to promote subglacial lake exploration including funding of targeted workshops, news releases, articles, symposia, and planning activities to address key issues.

9.0 Meeting Schedule

The following schedule of meetings is proposed:

Meeting 1 Bologna, Italy, 29-30 November 2001 - **Complete**

Meeting 2 Lamont –Doherty Earth Observatory, 23 – 24 May, 2002 - **Complete**

Meeting 3 Univeristy of California at Santa Cruz, 2 – 3 October, 2002 - **Complete**

Meeting 4 Chamonix, France, April or May, 2003 - **Proposed**

The SALEGOS meeting schedule will be revised as the committee proceeds with its deliberations. Hearing no further items, the meeting was adjourned. The SALEGOS members participated in the National Science Foundation FASTDRILL workshop held from 4 – 6 October in Santa Cruz. The results of FASTDRILL will be reported in a workshop report.

Appendix A

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Appendix B. Agenda for SALEGOS Autumn 2002, University of California, Santa Cruz, Meeting 3
Dates of meeting: 2-3 October 2002
Venue: University of Santa Cruz, Earth and Marine Sciences Bldg. Room A340 (wing A, third floor). We have to swith rooms to C332 (wing C, third floor) at 14:45 H)

Campus directions can be found at: http://maps.ucsc.edu/cmdirections.html

Meeting details DAY 1

02-Oct Wednesday

9:00 - 9:15	Welcome/Introductions; Appointment of reporters: C. Ellis-Evans; I Tabacco; R. Powell; J-R Petit; C. Kennicutt	J. Priscu
9:15 - 9:30	Opening Remarks	J. Priscu
9:30 - 9:45	Overview and discussion of Meetings I and II report and Shanghai SCAR/COMNAP presentation.	C. Kennicutt, J. Priscu
9:45 - 10:40	Update research progress; ~5 min per person	J. Priscu
10:40 - 11:00	COFFEE	
11:00 - 12:00	Update on Russian plans for sampling Lake Vostok and status of draft CEE	V. Lukin, S. Bulat
12:00 - 13:30	LUNCH	
13:30 - 14:45	1) 20 min. presentation by Alan McKinnon (Director, Strategy Management Arrow International) entitled "**If you want to predict the future - shape it**". This presentation will focus on the cost planning process, specifically cost - risk - change - time management. This presentation will be followed by discussion to help us refine our cost assessment and management strategies. 2) Revisit site selection criterion; review TOR; discuss plans for enganging future workshops;	Everyone

	statement paper/book; Integrate COMNAP/SCAR feedback into SALEGOS portfolio.	
14:45 - 15:15	COFFEE	
15:15 - 16:30	Overview of SCAR reorganization and future of SALEGOS(switch rooms to C332; wing C, third floor)	C. Kennicutt, R. Powell, R. Bell, J. Priscu
16:30 - 17:00	FASTDRILL overview	R. Powell, J. Priscu
17:00	Closing remarks, adjourn	J. Priscu
19:00	Dinner to be announced	

Agenda for SALEGOS Autumn 2002, University of California, Santa Cruz, Meeting 3
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<u>Meeting details Day 2</u>

03-Oct Thursday

9:00 - 9:15	Updates and introductions for environmental protection discussion (please review the documents, in particular the NRC report "Preventing the Forward Contamination of Europa", on the SALEGOS website under "Environmental")	J. Priscu
9:15 - 9:35	NASA's Planetary Protection policy	Don DeVincenzi (NASA Ames)
9:35 - 9:55	How NRC reports are implemented into mission design	Margaret Race (SETI Institute)
9:55 - 10:15	Current concepts for subice sampling and planetary protection aspects of sampling	Alberto Behar (JPL)
10:15 - 10:30	Comparison between Europa and subglacial lakes emphasizing the planetary protection and sample handling aspects	Chris McKay (NASA Ames)
10:30 - 10:45	COFFEE	

10:45 - 12:45	Discussion on how NASA's approach (policy and science) to decontamination relates to subglacial lake sampling. How can subglacial lakes be used as analogues for extraterrestrial research?	J. Priscu, moderator
12:45 - 13:45	LUNCH	
13:45 - 14:30	Review, update and revise SALEGOS portfolio presented in Report 2; outline items for Report 3	
14:30 - 15:15	Plans for next meeting; agenda items	J. Priscu
15:15	Closing remarks, adjourn	J. Priscu

17:00	FASTDRILL ice-breaker

Appendix C. NASA Reports on Planetary Protection

Comprehensive Biological Protocol for the Lunar Sample Receiving Laboratory, Baylor University College of Medicine, NASA CR9-2209, Manned Spacecraft Center, Houston, Texas (1967).

Article 1. Overview of Implementation of Quarantine Protocols
(Summarized in report by J.H. Allton, 1997 to MELTSWG)

Orbiting Quarantine Facility (OQF); The Antaeus Report,
D. L. DeVincenzi & J. R. Bagby, Editors, NASA SP-454, NASA, Washington, D.C. (1981).

Biological Contamination of Mars: Issues and Recommendations,
Task Group on Planetary Protection, (Chair: Kenneth Nealson), Space Studies Board, National Research Council, National Academy Press, Washington, D.C., (1992).

Mars Sample Return: Issues and Recommendations,
Task Group on Issues in Sample Return, (Chair: Kenneth Nealson), Space Studies Board, National Research Council, National Academy Press, Washington, D.C., (1997).

Mars Sample Quarantine Protocol Workshop,
D.L. DeVincenzi, J. Bagby, M. Race, and J.D. Rummel, NASA CP-1999-208772, NASA Ames Research Center, Moffett Field, CA, (1999).

Evaluating the Biological Potential in Samples Returned from Planetary Satellites and Small Solar System Bodies,
Task Group on Sample Return from Small Solar System Bodies, (Chair: Leslie Orgel), Space Studies Board, National Research Council, National Academy Press, Washington, D.C. (1998).

Mars Sample Handling and Requirements Panel (MSHARP) Final Report,
M. H. Carr et. al, NASA, Jet Propulsion Lab, Pasadena, CA, NASA TM-1999-209145 (1999).

Size Limits of Very Small Microorganisms: Proceedings of a Workshop.
Space Studies Board, National Research Council, National Academy Press, Washington, D.C. (1999)

Current State of Controversy About Traces of Ancient Martian Life in Meteorite ALH84001,
summary by Allan H. Treiman (L.P.I.) Feb. 2000.

The Quarantine and Certification of Martian Samples, 2001. Committee on Planetary and Lunar Exploration (COMPLEX), Space Studies Board, National Research Council. National Academy Press, Washington, D.C. 132pp.

Mars Sample Handling Protocol Workshop Series:

Workshop 1 Proceedings and Final Report. Race, M.S. and J.D. Rummel (eds.), NASA/CP-2000-209624, Washington, DC (Oct. 2000)

Workshop 2 Proceedings and Final Report , Race, M. S., G.T.A. Kovacs, J.D. Rummel, and S. E. Acevedo (eds.), NASA/CP 2001-210923, Washington, D.C. (2001)

Workshop 2a: Sterilization Workshop, Proceedings and Final Report,
Bruch, C.W., R. B. Setlow, & J.D. Rummel (eds.), Washington, D.C. NASA/CP 2001-210924. (2001)

Workshop 3 Proceedings and Final Report . Race, M. S., K. Nealson, Rummel,J.D. and S. E. Acevedo (eds.), in press, NASA/CP-2001- 211388. Washington, D.C. (2001)

Workshop 4 Proceedings and Final Report. Race, M.S., D.L.DeVincenzi, J.D. Rummel and S.E.Acevedo (eds.), (in press, NASA/CP, 2002-211841. Washington, D.C., 2001)

A Draft Test Protocol for Detecting Possible Biohazards in Martian Samples Returned to Earth. M.S.Race, D.L. DeVincenzi, J.D. Rummel, & S. E. Acevedo (eds.), NASA/CP-2002-XXXX, in press Spring 2002), Washington DC

When Ecologies Collide? Planetary Protection Issues in the Human Exploration of Mars. Workshop Report. (in preparation, Summer 2002). M.E. Criswell, C.P. McKay, and M. Duke (co-chairs and editors).