## APPENDIX 1. CHARGE TO THE SUBCOMMITTEE

## OAC SUBCOMMITTEE ON U.S. ANTARCTIC PROGRAM RESUPPLY

***Background (provided by OPP staff)***

The annual resupply that enables much of the U.S. Antarctic Program's on-Continent research has depended in recent years on two Polar class icebreakers working together to open a shipping channel through the ice to McMurdo Station. From McMurdo supplies then are flown to South Pole Station and our various remote field stations.

The U.S. Coast Guard completed this icebreaking mission for many decades but only with increasing difficulty in recent years. Its two Polar class vessels are within a very few years of their estimated 30-year lifetime and are becoming increasingly difficult and costly to keep in service. In addition, Congressional appropriations to the Coast Guard had been inadequate to meet the maintenance needs of the ships. Thus, two years ago NSF had to divert the *Healy* from the Arctic to provide assistance to the only US Coast Guard Polar class vessel operational at that time. This year NSF had to charter a heavy icebreaker from the Russian Company FESCO to assist the USCGC *Polar Star* as USCGC *Polar Sea* was not in operable condition. The *Polar Sea* will not be back in service until at least 2007, and then only if adequate funds can be found for her repair. It is hoped that last season's damage to the *Polar Star* can be repaired in time for the 2005-2006 season and that a foreign icebreaker can be again chartered to assist her.

The Coast Guard has estimated that it would cost approximately $600 million to refit (SLEP) its two Polar class vessels to the extent that they could provide reliable continued service beyond the next few years. In the meantime the Coast Guard estimates that some $20-25 million will be needed annually for maintenance of the *Polar Star*, *Polar Sea* and *Healy* over and above the $48 million currently in the Coast Guard budget for operations and maintenance. Moreover, the President's budget for FY-06 proposes to transfer funding responsibility for the ships to NSF beginning in FY-06, along with $48 million from the Coast Guard. No matter which Agency ends up with the responsibility it will be extremely difficult to secure Congressional appropriations adequate to fund the deferred maintenance needs and then the $600 million SLEP. It's worth noting that the latter would be by far the largest single expenditure for equipment in NSF's history, and also that there is already a multi-year list of pending projects waiting in queue in the Agency's MREFC program.

Given the above state of affairs a thorough analysis of resupply options is essential both to assure continuity of operations of the U.S. Antarctic Program, and also to assure that the most cost effective and reliable option is implemented.

The Office of Polar Programs initiated a preliminary study of several options last fall. Examples of options identified then or over the ensuing months for study by OPP include:

- Unloading fuel and supplies on the ice shelf rather than at McMurdo Station and transporting them overland to the Station, in order to greatly reduce the icebreaking challenge;
- Continuously milling the channel through the austral winter months using relatively light and much less costly icebreakers;
- Moving the resupply base from McMurdo to a new Station;.
- Establishing one or more additional supply chains as a hedge against "bad-ice" years;
- Airlifting all supplies to McMurdo;
- Direct resupply of South Pole Station by air from New Zealand or elsewhere;
- Establishing a multi-year store of fuel and non-perishable supplies at McMurdo during years of light sea ice combined with some of the above;
- Either purchasing or contracting for a build-to-lease icebreaker tailored to the needs of the USAP;
- Partnering with another country, sharing access to USAP infrastructure in exchange for icebreaking support.

Several of these options have been analyzed in some detail by OPP staff; most have not, and there may well be additional promising options that should be considered.

***Charge To The Subcommittee***

The Advisory Committee to the NSF Office of Polar Programs is responding to this situation by forming a subcommittee to oversee and guide the analysis of options for the resupply of McMurdo and South Pole Stations.

As a steering committee the Subcommittee is tasked to:

- identify the full initial universe of options worth considering;
- assist the working group in focusing on the most promising options in a timely fashion
- monitor progress of the OPP working group analyzing the options; and
- prepare a short summary of the pros and cons of any options the Subcommittee deems worthy of serious further consideration by NSF.

**In carrying out this work the Subcommittee should take into full consideration the potential impacts on the present and future scientific programs, both positive and negative, as well as the potential impacts on safety, environmental protection, reliability, cost, and timeliness**.

An OPP staff member selected by the OPP Director and the Subcommittee Chair will serve as the OPP Point of Contact for the Steering Committee and will have full authority to task OPP staff and contractors for the purposes of this study.

The Steering Committee is asked to provide its report to the OPP Advisory Committee by June 30, 2005, for discussion and adoption by the Advisory Committee in July.

The membership of the Subcommittee is:

Dr James Swift, Chair
Dr. Ed Link, co-chair
Dr. Sridhar Anandakrishnan
Mr. Sam Feola
Dr. Berry Lyons
Dr. Olav Orheim

## APPENDIX 2. LIST OF DOCUMENTS AVAILABLE TO THE SUBCOMMITTEE

Many documents were accessed by the Subcommittee in the course of this study. Most were unpublished notes and data reports. The following is a list of published materials used by the Subcommittee.

### Aircraft and Runways

"USN, DARPA See Blimps & HULAs Rising" 2005 *Defense Industry Daily*, 26 April.

"Application of Fuel Cell Technology at South Pole Station." 2000. Brier, F. and J. Rand. In *Proc. Workshop on Increasing LC-130 Availability in the USAP*, Washington, DC, 14-15 June.

"Consideration of Renewable Energy Sources for South Pole Station." 2000. Rand, J. In *Proc. Workshop on Increasing LC-130 Availability in the USAP*, Washington, DC, 14-15 June.

"Analysis of Commercial Contractor Operations and Maintenance of NSF-Owned LC-130 Aircraft." 2000. Scheuermann, M. and D. Fisher. In *Proc. Workshop on Increasing LC-130 Availability in the USAP*, Washington, DC, 14-15 June.

"Annex B to: Airfield Construction Feasibility Study, Marble Point, Antarctica." 1958. Construction Battalion Reconnaissance Unit, Metcalf and Eddy Engineers. 15 May.

"U.S. Antarctic Research Program: Scientific Support Study: Marble Point Station" C. Arnold. 1972. Bechtel Inc. March.

"Long Range Development Plan, Volume III, Marble Point." 1979. Holmes & Narver, Inc. 25 April.

### Icebreaker Information

"Adequacy of emergency capacity during winter." 2003. Ice Expert Working Group (Finnish contribution), Helinski Commission, Helinski, Finland, 16 June.

"Adequacy of emergency capacity during winter." 2003. Ice Expert Working Group (Swedish contribution), Helinski Commission, Helinski, Finland, 17 June.

### Northern Sea Route

"Arctic Marine Transport Workshop." 2004. Institute of the North, U.S. Arctic Research Commission, and International Arctic Science Committee, 28-30 Sept.

"The Northern Sea Route: Its Development and Evolving State of Operations in the 1990s." 1996. Mulherin, N. CRREL Report 96-3, April.

"Development and Results of a Northern Sea Route Transit Model." 1996. Mulherin, N., D. Eppier, T. Proshutinsky, A. Proshutinsky, L. Farmer, and O. Smith.. CRREL Report 96-5, May.

**Strategic Planning**

"Grim Forecast for a Fading Fleet." Malakoff, D. 2005. *Science* (www.sciencemag.org ),Vol. 307, 21 Jan.

"Shift in Icebreaking Fleet Could Crunch NSF Budget." Mervis, J. 2005. *Science* (www.sciencemag.org), Vol. 307, 4 March.

**Traverse**

"Science advantages of an oversnow traverse to resupply S. Pole." 2001. Prepared by the McMurdo Area Users Committee, 1 July.

**USCG-related Documents**

"USCGC *Polar Star* Deep Freeze 2002 Cruise Report." 2002. US Coast Guard, May.

"USCGC *Polar Sea* Cruise Report: Deep Freeze 2003." 2004. US Coast Guard, Jan.

## APPENDIX 3. CURRICULUM VITAE FOR SUBCOMMITTEE MEMBERS

**Dr. James Swift – Chairperson**
**Ed Link - Co-Chairperson**
**Dr. Sridhar Anandakrishnan**
**Sam Feola**
**Dr. W. Berry Lyons**
**Dr. Olav Orheim**

**JAMES H. SWIFT**

## a. Professional Preparation

| | | | | |
|---|---|---|---|---|
| **Undergraduate Institution:** | Case Western Reserve University | Physics | B.S | 1970 |
| **Graduate Institution:** | University of Washington | Physical Oceanography | M.S. | 1975 |
| | University of Washington | Physical Oceanography | Ph.D. | 1980 |
| **Postdoctoral Institution:** | UCSD/SIO | Physical Oceanography | | 1980-1981 |

## b. Appointments

| | | |
|---|---|---|
| 1998-present | Research Oceanographer | UCSD/Scripps Institution of Oceanography |
| 1987-1998 | Associate Research Oceanographer | UCSD/Scripps Institution of Oceanography |
| 1986-present | Academic Administrator (ODF) | UCSD/Scripps Institution of Oceanography |
| 1988-1990 | Affiliate Associate Professor | School of Oceanography, Univ. of Washington |
| 1985-1988 | Research Associate Professor | School of Oceanography, Univ. of Washington |
| 1981-1985 | Assistant Research Oceanographer | UCSD/Scripps Institution of Oceanography |
| 1980-1981 | Postdoctoral Research Oceanographer | UCSD/Scripps Institution of Oceanography |
| 1972-1979 | Research/Teaching Assistant | School of Oceanography, Univ. of Washington |

## c. Publications

### *i. Five publications most closely related to the proposed project:*


Swift, J.H., K. Aagaard, L. Timokhov and Ev.G. Nikiforov. "Long-Term Variability of Arctic Ocean Waters: Evidence From a Reanalysis of the EWG Data Set." *J. Geophys. Res.*, Submitted, 2004. [May be obtained from ftp://odf.ucsd.edu/pub/jswift/2004JC002312.pdf.]

Carmack, E.C., K. Aagaard, J.H. Swift, R.W. Macdonald, F.A. McLaughlin, E.P. Jones, R.G. Perkin, J.N. Smith, K.M. Ellis and L.R. Kilius. "Changes in Temperature and Tracer Distributions Within the Arctic Ocean: Results from the 1994 Arctic Ocean Section." *Deep-Sea Res.*, 44(8), 1487-1502, 1997.

Swift, J.H., E.P. Jones, K. Aagaard, E.C. Carmack, M. Hingston, R.W. Macdonald, F.A. McLaughlin, and R.G. Perkin. "Waters of the Makarov and Canada Basins." *Deep-Sea Res.*, 44(8), 1503-1529, 1997.

Jones, E.P., L.G. Anderson, and J.H. Swift. "Distribution of Atlantic and Pacific waters in the upper Arctic Ocean: Implications for circulation." *Geophys. Res. Let.*, 25(6), 765-768, 1998.

E.P. Jones, J.H. Swift, L.G. Anderson, G. Civitarese, K.K. Falkner, G. Kattner, M. Lipizer, F. McLaughlin, and J. Olafsson. "Tracing Pacific Water in the North Atlantic Ocean." *J. Geophys. Res.*, 108 (C4), 3116, 2003.

***ii. Five other significant publications:***

R. Dickson, J. Lazier, J. Meincke, P. Rhines, and J. Swift. "Long-Term Coordinated Changes in the Convective Activity of the North Atlantic." *Prog. Oceanog.*, 38(3), 241-295, 1996.

Aagaard, K., J.H. Swift and E.C. Carmack. "Thermohaline circulation in the Arctic Mediterranean Seas." *J. Geophys. Res.*, 90, 4833-4846, 1985.

L.G. Anderson, L.G., G. Bjork, O. Holby, E.P. Jones, G. Kattner, K.P. Koltermann, B. Lijeblad, B. Rudels, and J.H. Swift. "Water Masses and Circulation in the Eurasian Basin: Results from the Oden 91 North Pole Expedition." *J. Geophys. Res.*, 99, 3273-3283, 1994.

U. Schauer, B. Rudels, E. P. Jones, L. G. Anderson, R. D. Muench, G. Björk, J. H. Swift, V. Ivanov, A.-M. Larsson. 2002, "Confluence and redistribution of Atlantic water in the Nansen, Amundsen and Makarov basins." *Annales Geophysicae*, 20(2), 257-273, 2002.

L.G. Anderson, E. P. Jones, and J. H. Swift. "Export production in the Arctic Ocean evaluated from phosphate deficits." *J. Geophys. Res.*, 108(C6), 3199, 2003.

**d. Synergistic Activities**

i. With John Osborne developed Java OceanAtlas (JOA), an oceanographic section/profile data exploration application for Windows (9X/NT), MacOS (9 and X), and Unix/Linux. JOA imports common data types such as spreadsheets, WOCE, NODC SD2, and netCDF and provides common oceanographic plots, all linked, plus powerful data browsing, coloring, and filtering options. Tutorials and a User Guide are available. This free application is widely used in education and research.

ii. Developed the Atlas of Ocean Sections V.2, a free CD-ROM containing more than 2000 oceanographic sections assembled from Joe Reid's collection of high quality oceanographic data, assembled WOCE One-Time Survey sections, subsets and sections extracted from the Levitus WOA98, a collection of Arctic and Nordic Seas data, and the complete Java OceanAtlas application and documentation suite. See http://podaac.jpl.nasa.gov/order/order_displaytools.html.

iii. As Scientific Advisor to the UCSD/SIO Oceanographic Data Facility (ODF) have worked to bring about improvements in data reliability and quality control, improvements in rosette bottles, testing of improved CTD profiling methodologies, development and institution of improved equipment and methods for salinity, oxygen, and nutrient measurements and CTD pressure and temperature calibration, and improved efficiency and lowered costs for production and documentation of reference-quality measurements in seawater. All innovations have been made available to the community.

iv. As Director of the WOCE Hydrographic Program Office have led the effort to gather and assemble the WHP data (≈500 cruises) and documentation, repair the data files for deficiencies, improve adherence to standard format specifications (including creating two new file formats,

WHP-Exchange and WOCE netCDF, which greatly simplify user import of WHP data, make the data widely and freely available, and provide all data and documentation to the WOCE Archive.

v. As Chair of the UNOLS Arctic Icebreaker Coordinating Committee, 1996-2000, provided scientific oversight of Arctic marine science support on US vessels, with primary focus on USCGC Polar Star, USCGC Polar Sea, and the new USCGC Healy. The AICC provides Arctic marine science projects with planning and scheduling assistance, facilitates communications between scientists, science funders and facility providers, and provides oversight and advice to the Coast Guard for the purpose of enhancing facilities and science aboard their icebreaker fleet. Also served *ex officio* on the UNOLS Council.

## e. Collaborators & Other Affiliations

### *i. Collaborators on projects, books, articles, reports, abstracts or papers within last 48 months*

Knut Aagaard, Leif Anderson, John Bullister, Lou Codispoti, Scott Doney, Bill Emery, Kelly Falkner, Dick Feely, Rana Fine, Eric Firing, Chas Flagg, Niki Gruber, John Gunn, Greg Johnson, Peter Jones, Terry Joyce, Bob Key, Bob Knox, Rob Macdonald, Fiona McLaughlin, Robin Muench, Andreas Muenchow, Jon Olafsson, Alex Orsi, Laurie Padman, Bob Pickart, Paul Robbins, Ursula Schauer, Peter Schlosser, Bill Smethie, Dean Stockwell, Lynne Talley, Leonid Timokhov, Martin Visbeck, Rik Wanninkhof, Terry Whitledge, and Rebecca Woodgate.

### *ii. Graduate and Post Doctoral Advisors*

**Graduate Advisor:** Knut Aagaard
**Postdoctoral Advisor:** Joseph L. Reid

### *iii. Thesis Advisor and Postgraduate-Scholar Sponsor*

| | |
|---|---|
| Ilse M. Hamann | (Ph.D., 1990; University of Washington) |
| Michael Alfultis | (M.S., 1987; University of Washington) |
| Diana Lewis | (M.S., 1996; UCSD Scripps Institution of Oceanography) |

**LEWIS E. LINK, PH.D.**

Dr. Lewis E. (Ed) Link is a Senior Fellow on the faculty of the R. H. Smith School of Business and the Burns Academy of Leadership, School of Public Policy, University of Maryland. He is also a Senior Consultant to Toffler Associates where he has been engaged in futures studies involving technology, infrastructure and innovation in government and industry. As a senior executive, he served as the Director of Research and Development and Principal Scientific Advisor to the Chief of Engineers, and Commander, U.S. Army Corps of Engineers, from 1996 to 2002. During this period he led a diverse R&D program exceeding $550M annually, and created and served as the Acting Director of the U.S. Army Engineer R&D Center. He previously served as the Technical Director and Director, U. S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH, from 1986 to 1996. Dr. Link has a broad knowledge of environmental and infrastructure technologies and has pioneered innovative approaches to Army sustainment and logistics, exploitation of environmental dynamics and transformation of military practices to meet constantly changing future needs.

After receiving a BS degree with High Honors in Geological Engineering from North Carolina State University in 1968, Dr. Link earned an MS Degree in Civil Engineering from Mississippi State University in 1973 and a Ph.D. in Civil Engineering from Pennsylvania State University in 1976. He served as an Adjunct Professor of the Graduate School, Mississippi State University and graduated from the Federal Executive Institute in 1985. While at N.C. State he was selected to the National Collegiate All-American Soccer Team, the Tau Beta Pi National Engineering Honor Association and the Phi Kappa Phi National Honor Society.

Dr. Link has served as the chair or member of technical and advisory committees for the American Society of Photogrammetry and Remote Sensing, the American Institute of Hydrology, the American Society of Civil Engineers, the Transportation Research Board, the American Society of Mechanical Engineers, the Society of American Military Engineers, the U. S. Navy, the National Aeronautics and Space Administration, the International Permafrost Association, and the NATO Special Group of Experts on Camouflage, Concealment and Deception. He was a member of the U. S. Antarctic Program External Panel for the National Science Foundation. Dr. Link chaired the Department of Defense Joint Engineers Management Panel and led a number of major studies to create more effective collaboration in engineering and environmental R&D among the military services and across government and industry. He was a member of the senior executive panels overseeing all Army research and development and modeling and simulation activities. He has published more than 80 technical papers and reports.

During his tenure with the Corps of Engineers, Dr. Link received the Department of Army's highest award for research and development achievement in 1982 and 1985. He received the Department of Army Meritorious Civilian Service Award in 1981, 1990 and 1996 and its highest award, the Exceptional Civilian Service Award in 2002. He was honored by the President of the United States as a Meritorious Executive in the Senior Executive Service in 1990 and 1995 and a Distinguished Executive in 1992 and 1999. The Society of American Military Engineers awarded him the Wheeler Medal in 2001. The Army Engineer Association awarded him the

DeFleury Medal, Silver Order, in May 2002, for exceptional contributions to the Army Engineer Regiment.

**SRIDHAR ANANDAKRISHNAN**

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442 Deike Bldg University Park, PA 16802.
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**Professional Preparation:**

Electrical Engineering. Columbia University. Graduated Tau Beta Pi (Engg. Honor Soc.) and Eta Kappa Nu (EE Honor Soc.) 1982 B. S.

Electrical Engineering. Columbia University, 1983 M. S. Geophysics. University of Wisconsin—Madison (1990). Thesis title: *Microearthquakes as indicators of ice stream basal conditions.* 1990 Ph. D.

**Appointments:**

| | |
|---|---|
| 2002-to present | Associate Professor, Pennsylvania State University |
| 1999-2002 | Assistant Professor, University of Alabama |
| 1992-1999 | Research Associate, Pennsylvania State University |
| 1991-1992 | Senior Researcher, Mobil Oil |

**Research Funding**

**Anandakrishnan, S.**, D. A. Wiens, A. Nyblade. NSF–OPP 02–265338 and 99–14567. A Broadband Seismic Investigation of Deep Continental Structure across the EastWest Antarctic boundary. 8/1/00–7/31/04 ($250,000).

**Anandakrishnan, S.**, D. D. Blankenship, and R. B. Alley. NSF–OPP 02–26535 and 98–14774. Characterizing the Onset of ice stream flow: a Ground Geophysical Field Program. 04/01/00–03/31/04. ($370,000).

**Anandakrishnan, S.** NSF–OPP 98–14797. Archiving of West Antarctic Geophysical Data. 03/01/99–02/28/00. $81,000.

**Anandakrishnan, S.** and R. B. Alley. NSF–OPP 97–25708. Forward and Inverse Modeling of West Antarctic ice streams. 04/01/98 – 03/31/00. ($220,000).

**Anandakrishnan, S.** NSF–OPP 02–96200 and 96–15147. Antarctic Network of Unattended Broadband Seismometers (ANUBIS). 04/01/97 – 03/31/02. ($495,000).

**Anandakrishnan, S.** NSF–OPP 96–12536. Antalith Seismic Reflection Program at Central West Antarctica Camp (CWA). 06/01/96–05/31/97. ($32,000)

**Anandakrishnan, S.** NSF–OPP 96–33601. Workshop on Aerogeophysical Research in Antarctica. 06/01/96– 05/31/97. ($15,000)

**Anandakrishnan, S.** NSF–OPP 93–18121. Microearthquake Monitoring of Ice Stream C. 04/01/94–03/31/97. ($330,000)

Dalziel, I. W. D., P. A. Stoffa, D. D. Blankenship, and **S. Anandakrishnan**. NSF–OPP 92–22121. Seismic Traverse of the Byrd Subglacial Basin—Field Test. 04/01/94–03/31/96. ($200,000)

**Peer-reviewed publications:**


**S. Anandakrishnan**. Dilatant till layer near the onset of streaming flow of ice stream C, determined by AVO (Amplitude vs. Offset) analysis. *Ann. Glaciol.*, in press.

D. E. Voigt, R. B. Alley, **S. Anandakrishnan**, and M. K. Spencer. Ice core insights into the flow and shutdown of ice stream C. *Ann. Glaciol.*, in press.

B. R. Parizek, R. B. Alley, **S. Anandakrishnan**, and H. Conway. Subcatchment melt and long-term stability of ice stream D, West Antarctica. *Geophys. Res. Lett.*, 29(8):doi:10.1029/2001GL014239, 2002.

R. B. Alley, E. J. Brook, and **S. Anandakrishnan**. A northern lead in the orbital band: North-south phasing of IceAge events. *Quat. Sci. Rev.*, 21:431–441, 2002.

R. B. Alley, **S. Anandakrishnan**, and P. Jung. Stochastic resonance in the North Atlantic. *Paleooceanography*, 16(2):190–198, 2001a.

R. B. Alley, **S. Anandakrishnan**, P. Jung, and A. Clough. Stochastic resonance in the North Atlantic: Further insights. In D. Seidov, B. J. Haupt, and M. Maslin, editors, *The Oceans and Rapid Climate Change: Past, Present and Future*, Geophysical Monograph 126, pages 57–68. AGU, 2001b.

**S. Anandakrishnan**, R. B. Alley, R. W. Jacobel, and H. Conway. The flow regime of ice stream C and hypotheses concerning its recent stagnation. In R. B. Alley and R. A. Bindschadler, editors, *The West Antarctic Ice Sheet: Behavior and Environment*, Antarctic Research Series, pages 283–296. AGU, 2001.

R. A. Bindschadler, J. L. Bamber, and **S. Anandakrishnan**. Onset of streaming flow in the Siple Coast region, West Antarctica. In R. B. Alley and R. A. Bindschadler editors, *The West Antarctic Ice Sheet: Behavior and Environment*, Antarctic Research Series, pages 123–136. AGU, 2001.

**S. Anandakrishnan**, D. E. Voigt, P. Burkett, Bruce Long, and R. C. Henry. Deployment of a broadband seismic network in West Antarctica. *Geophys. Res. Lett.*, 27(14):2053–2056, 2000.

**S. Anandakrishnan**. Penguins everywhere: GNU/Linux in Antarctica. *IEEE Software*, 16(6):90–98, 1999.

**S. Anandakrishnan**, D. D. Blankenship, R. B. Alley, and P. L. Stoffa. Influence of subglacial geology on the position of a West Antarctica ice stream from seismic measurements. *Nature*, 394:62–65, 1998.

V. Sen, P. L. Stoffa, I. W. D. Dalziel, D. D. Blankenship, A. M. **Smith, and S. Anandakrishnan**. Seismic surveys in central West Antarctica: Data and processing examples from the ANTALITH field tests (1994– 1995). *Terra Antarctica*, 5(4):761–772, 1998.

**S. Anandakrishnan** and R. B. Alley. Stagnation of ice stream C, West Antarctica by water piracy. *Geophys. Res. Lett.*, 24(3):265–268, 1997a.

**S. Anandakrishnan** and R. B. Alley. Tidal forcing of basal seismicity of ice stream C, West Antarctica, observed far inland. *J. Geophys. Res.*, 102(B7):15183–15196, 1997b.

**S. Anandakrishnan**, S. R. Taylor, and B. W. Stump. Quantification and characterization of regional seismic signals from cast blasting in mines: A linear elastic model. *Geophys. J. Int.*, 131:45–60, 1997.

A. J. Gow, D. A. Meese, R. B. Alley, J. J. Fitzpatrick, **S. Anandakrishnan**, G. A. Woods, and B. C. Elder. Physical and structural properties of the GISP2 ice cores. *J. Geophys. Res.*, 102(C12):26559–26576, 1997.

R. B. Alley and **S. Anandakrishnan**. Variations in meltlayer frequency in the GISP2 ice core: implications for Holocene summer temperatures in central Greenland. *Ann. Glaciol.*, 40(135):341–349, 1995.

R. B. Alley, R. C. Finkel, K. Nishiizumi, **S. Anandakrishnan**, C. A. Shuman, G. Mershon, G. A. Zielinski, and P. A. Mayewski. Changes in continental and seasalt atmospheric loadings in central Greenland during the most recent deglaciation: modelbased estimates. *J. Glaciol.*, 41(139):503–514, 1995.

**S. Anandakrishnan**, V. Sen, A. M. Smith, P. A. Stoffa, Ian W. D. Dalziel, and D. D. Blankenship. A multifold high resolution seismic profile in central West Antarctica. In *The Antarctic Region: Geological Evolution and Processes*, Siena, Italy, 10–15 September 1995. Universita di Siena.

W. R. Kapsner, R. B. Alley, C. A. Shuman, and **S. Anandakrishnan**. Dominant control of atmospheric circulation on snow accumulation in central Greenland. *Nature*, 373:52–54, 1995.

C. A. Shuman, R. B. Alley, **S. Anandakrishnan**, James W. C. White, P. M. Grootes, and C. R. Stearns. Temperature and accumulation at the Greenland Summit: Comparison of high-resolution isotope profiles and satellite passive microwave brightness temperature trends. *J. Geophys. Res.*, 100(D5):9165–9177, May 1995a.

C. A. Shuman, R. B. Alley, **S. Anandakrishnan**, and C. R. Stearns. An empirical technique for estimating nearsurface air temperatures in central Greenland from SSM/I brightness temperatures. *Remote Sensing of the Environment*, 51:245–252, 1995b.

R. B. Alley, **S. Anandakrishnan**, C. R. Bentley, and N. Lord. A waterpiracy hypothesis for the stagnation of ice stream C, Antarctica. *Ann. Glaciol.*, 20:187–194, 1994.

**S. Anandakrishnan** and R. B. Alley. Ice stream C, Antarctica, stickyspots detected by microearthquake monitoring. *Ann. Glaciol.*, 20:183–186, 1994a.

**S. Anandakrishnan**, J. J. Fitzpatrick, R. B. Alley, A. J. Gow, and D. A. Meese. Shearwave detection of asymmetric *c*axis fabrics in the GISP2 ice core. *J. Glaciol.*, 40(136):491–496, 1994.

K. M. Cuffey, R. B. Alley, P. M. Grootes, J. F. Bolzan, and **S. Anandakrishnan**. Calibration of the $\delta^{18}$o isotopic paleothermometer for central Greenland, using borehole temperatures: Results and sensitivity. *J. Glaciol.*, 40(135):341–349, 1994.

**S. Anandakrishnan**, R. B. Alley, and E. D. Waddington. Sensitivity of icedivide position in Greenland to climate change. *Geophys. Res. Lett.*, 21(6):441–444, 1993.

**S. Anandakrishnan** and C. R. Bentley. Microearthquakes beneath ice streams B & C, West Antarctica: Observations and implication. *J. Glaciol.*, 39:455–462, 1993.

C. A. Shuman, R. B. Alley, and **S. Anandakrishnan**. Characterization of a hoardevelopment episode using SSM/I brightness temperatures in the vicinity of the GISP2 site, Greenland. *Ann. Glaciol.*, 17:183–188, 1993.

K. M. Cuffey, R. B. Alley, P. M. Grootes, and **S. Anandakrishnan**. Toward using borehole temperatures to calibrate an isotopic paleothermometer in central Greenland. *Global and Planetary Change*, 98:265–268, 1992.

**S. Anandakrishnan**. *Microearthquakes as Indicators of Ice Stream Basal Conditions*. PhD thesis, University of Wisconsin—Madison, 1990.

**S. Anandakrishnan**, D. D. Blankenship, R. B. Alley, and C. R. Bentley. Densitydepth profile determined by seismicrefraction studies: Ice stream B, West Antarctica. *Ann. Glaciol.*, 11:198, 1988a.

**S. Anandakrishnan**, D. D. Blankenship, and C. R. Bentley. Microearthquake source locations and mechanisms: Ice stream B, West Antarctica. *Ann. Glaciol.*, 11:198, 1988b.

C. R. Bentley, S. Shabtaie, D. D. Blankenship, S. T. Rooney, D. G. Schultz, **S. Anandakrishnan**, and R. B. Alley. Remote sensing of the Ross ice streams and the adjacent Ross Ice Shelf. *Ann. Glaciol.*, 9:20–29, 1987.

D. D. Blankenship, **S. Anandakrishnan**, J. Kempf, and C. R. Bentley. Microearthquakes under and alongside ice stream B, detected by a new passive seismic array. *Ann. Glaciol.*, 9:30–34, 1987.

**Other Publications**

C. A. Finn, **S. Anandakrishnan**, J. Goodge, J. Panter, C. Siddoway, and T. Wilson, Remote views and exploration of the Antarctic lithosphere, Eos, in press.

Science and Implementation plan for the Amundsen Sea Embayment Project. Multiple authors, but main authors are R. Bindschadler, **S. Anandakrishnan**, and D. D. Blankenship. http://www.igloo.gsfc.gov/wais/ASEPfinal.pdf

**S. Anandakrishnan**. Oversnow traverse capability for longterm Antarctic research support, report to NSF panel on Antarctic logistics.

**S. Anandakrishnan**, S. R. Taylor, and B. W. Stump. Quantification and characterization of regional seismic signals from cast blasting in mines: A linear elastic model. Technical Report LAUR–96–3747, Los Alamos National Laboratory, Los Alamos, NM 87545, 1996.

**Synergistic Activities:**

(a) Remote/Autonomous seismic instrumentation development (Anubis and Tamseis seismic projects); Autonomous instruments workshop; Advisor to the Dartmouth Autonomous Geophysical Observatory.

(b) Scholarly service: reviews of NSF, NERC, and Italian Antarctic Program proposals; reviews of journal mss.; council member of IGS.

(c) Community service:Chair NSF OPP Office Advis. Cmte; Cmte of Visitors; McMurdo Area Users' Cmte. Education: Taught graduate classes in Seismology, Glaciology; undergrad classes in Intro Geology.

(d) Outreach: talks to local schools, community groups; numerous contacts with press; White House OSTP.

**Collaborators:**

R. B. Alley (PSU), R. Bindschadler (NASA), D. D. Blankenship (UT Austin), H. Conway (U. Washington), C. Holland (PSU), R. Jacobel (St. Olaf's), I Joughin (NASA), E. C. King (BAS), M. A. King (NCL), C. J. Marone (PSU), D. L. Morse (UT Austin), A. Nyblade (PSU), B. Parizek (PSU), A. M. Smith (BAS), D.A. Wiens (Washington U. St. Louis).

**Advisors:**

M. C. Teich (Columbia Univ), C. R. Bentley(UW Madison)

**Students:**

M. S.: Seung Yoo, 1998, Peter Burkett, 2000, Paul Winberry, 2003, Leo Peters, expected 2004, Satyakee Sen, 2004, Ph. D.: Jerry Bowling, expected 2004, T.J. Cho, expected 2005

**Postdoc advisee:**

A Huerta.

**SAMUEL D. FEOLA**
9791 Clairton Place; Highlands Ranch, CO 80126-4526
Email: samfeola@comcast.net

**SENIOR OPERATIONS PROFESSIONAL**

Results-driven professional executive with significant commercial and military experience on domestic and international projects, including:

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| Project Management | Profitable turnarounds |
| Global Logistics | Change Management |
| Global Operations | Multi-tasking |
| Marketing and Business Development | International Company and Project Startups |

## Employment History

SDF Solutions, LLC 2005-Present
*Principal and Consultant*
Consultant to PAE Government Services, Inc., and SNC-Lavalin ProFac as Subject Matter Expert for corporate bids and proposals.

**snc-lavalin pae inc.**
A PAE Government Services Inc and SNC-Lavalin ProFac joint-venture 2003-2005
**General Manager**
General Manager of an American-Canadian joint venture Company to support Canadian Forces deployed overseas. Responsible for executive management of the start-up and sustainment operations of construction and base-maintenance projects in Bosnia and Afghanistan, and project management in Canada.

- Took one employee and zero revenue to 850 employees and $260MM revenue in two years.
- Awarded unprecedented 100% Performance Incentive Fee on a validation exercise resulting in $500MM awards of the Bosnia and Afghanistan contracts.
- Hired to manage transition and operation of incumbent contract; ended up successfully starting up the JV company and 2 separate projects simultaneously, totaling $130MM and 850 employees in a 3-month time span while building a supporting infrastructure.
- Managed the successful construction of a $65MM 2500-man Camp Julien, Afghanistan, from a "green field" to award-winning NATO/ISAF military support camp, on-time and under budget.
- Accomplished transition from hostile incumbent contractor in Bosnia, achieving 96% award fee.
- Given 7.5% profit margin target by Board of Directors– achieved 9.5%.
- Repaid a $25MM loan, reducing interest costs from 10% to 3% through a factoring facility.

- Achieved greater health benefits plan for Expats, at less cost, increasing employee retention.
- Managed war zone turnover to 17%, saving the client $1.2MM in hiring and deployment costs.
- Improved the performance evaluation process and results by 40%, from process-based to service-based output, to more realistically reward efforts through the performance incentive fee.
- Contributed volunteer labor and corporate materials and funding to support local community activities in Bosnia, Afghanistan, and charity events in Canada.

**DISH Network Service Corporation (Echostar)** **2001-2003**
**Manager, Business Systems and Operations Reporting**
Responsible for developing and managing a nation-wide support provider operations team to manage digital satellite TV hardware fulfillment reimbursement; credit program analysis and administration; operations support; and database tools and trending to monitor and report performance metrics and forecast future activity.

- Developed first ever executive management reports and trending analyzes of subcontractors' jobs, inventory accounts, credit limits, and labor and commissions payments, using Oracle databases.
- Successfully transitioned, with zero defaults, 24 subcontractors performing satellite TV systems installations from 1-year promissory notes to net 30-day terms, paying off $7MM in booked accruals.
- Managed $11MM in weekly credit of 24 subcontractors with fast turn-around reimbursements, increasing installations capacity by 30%.
- Developed and managed hardware replenishment inventory program and audit team to track payments and charge backs, resulting in a 40% increase in reimbursement cash-flow.
- Improved efficiency performance of weakest 20% of subcontractors through faster cash flow and credit management of inventory, increasing bottom line customer base by 18%.
- Served as the advocate between subcontractors and corporate executives and corporate business processes, resulting in better business practices, relationships and goodwill.

**Holmes & Narver Services, Inc.** **1978-2000**
*An international service company specializing in operations and maintenance (O&M), logistics support services, engineering, and construction.*

***Director, Logistics, Denver, CO On Loan 1990-2000 to Antarctic Support Associates Joint Venture***
Directed contractor planning, management and operations of logistic and operational support requirements for the National Science Foundation's U.S. Antarctic Program.

- Led 280 civilian full-time, contract, and military personnel in the planning and execution of Antarctic logistics operations in support of 11 internal customer divisions; 4 external customers - a total client base of more than 3,700 customers annually.
- Consolidated and managed passenger, air and ship cargo, logistics, and supply operations for U.S., South America, New Zealand; McMurdo, South Pole and Palmer stations, and two research vessels, saving the U.S. Government more than $30MM annually.
- Project manager for four military functional transitions, adding $90M to the contract baseline.
- Received the company's highest award-fee scores in the 25-year history of the contract.
- Recovered $650K in General Sales Taxes from New Zealand Revenue Department.
- Developed and managed annual $28MM Division budget successfully under budget.
- Started up and operated a separate limited liability company formed in New Zealand to support the U.S. Antarctic Program activities in New Zealand. Replaced a military command of 360 personnel with 75 contractors providing New Zealand operations, facilities, and terminal operations for contractor, scientists and military personnel transiting NZ for Antarctica. Resulting outsourced operations saved the U.S. Government over $10 million annually.

**Holmes & Narver Services, Inc.** **Other Positions**

**1978 to 1989**

Proposal Manager, Orange, CA
Regional Project Manager, Istanbul, Turkey
Traffic Manager, Izmir, Turkey
Special Operations Manager, Honolulu, Hawaii
Port Hueneme Operations Manager, U.S. Antarctic Research Program

**Military Service 1967-1978**

Officer and Aviator, U.S. Navy, Honorable Discharge

**Education**

- Bachelor of Science, Business Administration
  West Virginia Wesleyan College

- Masters equivalent in Aviation (Designated Naval Aviator)
  Naval Aviation Schools Command

**W. B. LYONS**

Byrd Polar Research Center and Dept of Geological Sciences
The Ohio State University, Columbus Ohio

## Professional Preparation

| | | |
|---|---|---|
| Brown University | Geology | A.B., 1969 |
| University of Connecticut | Chemical Oceanography | M.S., 1972 |
| University of Connecticut | Chemical Oceanography | Ph.D., 1979 |

## Professional Appointments

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|---|---|
| 1999-present | Director, Byrd Polar Research Center, and Professor, Geo. Sci., Ohio State University |
| 1993-1999 | Professor, Department of Geology, University of Alabama |
| 1990-1993 | Professor & Director of Hydrologic Sciences Program, University of Nevada, Reno |
| 1986-1990 | Associate Professor, Department of Earth Sciences, University of New Hampshire |
| 1980-1986 | Assistant Professor, Department of Earth Sciences, University of New Hampshire |
| 1976-1980 | Post-doctoral Fellow and Research Scientist, University of New Hampshire |

## Relevant Publications

**Lyons,** W.B., and K.A. Welch. 1997, Lithium in waters of the Polar Desert. *Geochim. Cosmochim. Acta* **61**: 4309-4319.

**Lyons**, W.B., K.A. Welch, A. Fountain, G. Dana, B.Vaughn and D.M. McKnight. 2003. Surface glaciochemistry of Taylor Valley, Southern Victoria Land, Antarctica and its relationship to stream chemistry. *Hydrological Processes* **17**: 115-130.

**Lyons,** W.B., K.A. Welch, K. Neumann, D. Moorhead and D.M. McKnight. 1998., Geochemical linkages among glaciers, streams and lakes within the Taylor Valley, Antarctic. *In: Ecosystem Dynamics in a Polar Desert: The McMurdo Dry Valleys* (ed. J. Priscu), *Antarctica Research Series*, AGU, 77-92.

**Lyons,** W.B., K.A. Welch and P. Sharma. 1998. Chlorine-36 in the waters of the McMurdo Dry Valley lakes, Southern Victoria Land, Antarctica: Revisited. *Geochim. Cosmochim. Acta*

**62**: 185-192. Welch, K.A., W.B. **Lyons**, D.M. McKnight, M. Gooseff, C. Jaros, A. Fountain, T. Nylen and

P.T. Doran. 2003. Climate and hydrologic variations and implications for lake and stream ecological response in the McMurdo Dry Valleys, Antarctica. In Greenland, D., D.G. Goodin and R.C. Smith (eds.), *Climate Variability and Ecosystem Response at Long Term Ecological Research Sites*, Oxford University Press, 174-195.

## Synergistic Activities

- Associate Editor of three journals: Ground Water, Applied Geochemistry, Chemical Geology
- Member, National Academy of Science Polar Research Board, 2003-2005
- Fellow, American Geophysical Union
- Fellow, American Association for the Advancement of Science

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| **Graduate and Postdoctoral Advisors** | W.F. Fitzgerald, Ph.D., University of Connecticut.<br>H.E. Gaudette and D. Chasteen, Postdoctoral Advisors, University of New Hampshire. |

**Students Advised and Postdocs Sponsored:**
*Ph.D.'s:* K. Simmons, R. Lent, B. Ojiambo, K. Johannesson, J. Thomas, K. Neumann (29 total graduate students);
*Postdoctoral:* M. Hines, M.J. Spencer, J. Hayward-Fee, D. Wayne, J-C. Bonzongo, K. Neumann, Z. Yang, K. Conners, C. Dowling

## OLAV ORHEIM

Born 1942. Norwegian national.

### Education and employment

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|---|---|
| 1989-2005 | Adj. Prof., University of Bergen. |
| From 1993 | Managing Director at NPI. |
| 1972-93 | Head, Antarctic Section/Head of research, Norwegian Polar Institute |
| 1972 | Ph. D, Ohio State University, USA, on glaciers and interhemispheric climate change. |
| 1968 | Cand. real, University of Bergen, Norway |

My scientific work has been in the Arctic and the Antarctic, studying a) glacier mass balance and climatic variations, b) ice dynamics and flow, c) ice bergs and interaction between ice and ocean and d) remote sensing and snow surface properties, with a total of around 30 field seasons. In recent years I have also been concerned with climate policy. My approx. 100 publications include 20 articles in refereed international journals where I am sole, or senior, author. I have been a speaker at more than 100 international conferences.

### International positions:

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|---|---|
| 2003-04 | member ICSU/WMO's Planning Group for the International Polar Year (IPY). |
| 1998-2002 | Chair, Committee on Environmental Protection under the Antarctic Treaty, Executive Member/Chair of various bodies including European Polar Board, Forum Arctic Operators, Nordic Polar Committee and International Arctic Science Committee. |
| 1992-96 | Vice President SCAR |
| 1986-89 | Vice President International Glaciological Society |
| 1985-1990, | Chair, SCAR Working Group on glaciology, |

I have been on review panels for polar/Antarctic activities of several countries including Australia, and led the review of the South African Antarctic Programme. I have chaired seven large international confeences, and been involved in the planning and content of numerous other such meetings. In August 2004 I was responsible for the programme and contents of a 36-hour briefing on Arctic climate issues for senators McCain, Clinton, Collins, Graham and Sununu at Svalbard (Spitsbergen).

### National positions:

I have held and hold a large variety of national positions, and is presently chairman of the board of two foundations. In 2003 I was chair of the Norwegian government's expert committee on Northern affairs that produced the analysis document for the government's White Paper to the parliament on Norwegian Arctic foreign policy.

**Further details on antarctic competence:**

**a) Antarctic Treaty relations**

I have been a member of the Norwegian delegations to almost every Antarctic Treaty Consultative Meeting and Special ATCM from 1979 to the present, in recent years as Deputy Head of delegation. I have repeatedly been involved in bringing issues forward to solution within ATCMs, for example:

- Chair of CRAMRA subgroup that negotiated the issue of confidentiality.
- Part of the Norwegian team that developed the text for the Environmental Protocol
- Chairman of TEWG (Transitional Environmental Working Group) at ATCM XXI.
- Was elected as the first Chair of the Committee on Environmental Protection in 1998 and re-elected in 2000.

**b) Experience within Antarctica.**

Altogether seventeen expeditions to Antarctica, mainly studying the ice masses and climate. I worked three seasons at the Antarctic Plateau as visiting scientist with US Antarctic Program, and six seasons in the Antarctic Peninsula area with Argentinean, British, Russian and US colleagues. I was in charge of developing Norway's new Antarctic programme, and from 1976 I have led a number of national expeditions to the Dronning Maud Land/Weddell Sea region, including the establishment of Troll Station.

**c) Experience with other Antarctic organisations**

I have been Norway's representative on COMNAP from 1993-present. At present I chair COMNAP's sub-group on Tourism and non-governmental expeditions (TANGO).
I have been Norwegian delegate to SCAR at most meetings from 1980 to present.