Application for Consent to Conduct Marine Scientific Research in Areas Under National Jurisdiction of

Papua New Guinea

Date: 8/10/09
Updated

1. General Information

1.1 Cruise name and/or #:	Dredging rocks from a large volcanic flow in the Bismarck volcanic arc, Papua New Guinea

1.2 Sponsoring institution:	
Name:	National Science Foundation
Address:	4201 Wilson Boulevard, Arlington, Virginia 22230 Division of Ocean Sciences (GEO/OCE)
Name of Director:	Julie D Morris, Division Director

1.3 Scientist in charge of the project (include CV and passport photo):	
Name:	Eli A. Silver, PhD
Address:	Earth and Planetary Sciences Department University of California, Santa Cruz 1156 High Street Santa Cruz, CA 92064 USA Gary Hoffman, PhD University of California, Santa Cruz Earth and Planetary Sciences Department 1156 High Street Santa Cruz, CA 92064 USA
Telephone:	831-459-2266
Fax:	831-459-3074
Email:	esilver@es.ucsc.edu garyh@pmc.ucsd.edu

1.4 Scientist(s) from coastal state involved in the planning of the project:	
Name(s):	Dr. Steve Sauders Chief Geodetic Surveyor
Address:	Department of Mineral Policy and Geohazards Management Rabaul Volcano Observatory P.O. Box 3386 Kokopo East New Britain Province

1.5 Submitting officer:	
Name and address:	Elizabeth Brenner /Rose M. Dufour Scripps Institution of Oceanography University of California, San Diego

	La Jolla, California 92093-0210
Nationality:	USA
Telephone:	(858)534-2841
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Email:	Shipsked@ucsd.edu

2. Description of Project (Attach additional pages as necessary)

2.1 Nature and objectives of the project:
Dredging rocks from a large volcanic flow in the Bismarck volcanic arc, Papua New Guinea. See below at end of document for more detail .

2.2 Relevant previous or future research cruises:
2004 aboard the R/V Kilo Moana; 2010 aboard the R/V Roger Revelle (current request)

2.3 Previously published research data relating to the project:
(1) Silver, E., Day, S., Ward, S., Hoffmann, G., Llanes, P., Lyons, A., Driscoll, N., Perembo, R., John, S., Saunders, S., Taranu, F., Anton, L., Abiari, I., Applegate, B., Engels, J., Smith, J., and Taglioides, J., 2005, Island Arc debris avalanches and tsunami generation, EOS Transactions American Geophysical Union, 86:485-496. (2) Hoffman, G., Silver, E., Day, S., Morgan, E., Driscoll, N., and Orange, D., 2008, Sediment waves in the Bismarck Volcanic Arc, Papua New Guinea, Geol. Soc. Amer. Special Paper 436, p. 91-126. (3) Silver, E., Day, S., Ward, S., Hoffmann, G., Llanes, P., Driscoll, N., Applegate, B., and Saunders, S., 2009, Volcano collapse and tsunami generation in the Bismarck Volcanic Arc, Papua New Guinea, Journal of Volcanology and Geothermal Research, doi:10.1016/j.jvolgeores.2009.06.013.

3. Methods and Means to be Used

3.1 Particulars of vessel:	
Name:	*R/V Roger Revelle*
Nationality (Flag state):	USA Flag
Owner:	U.S. Navy
Operator:	University of California, San Diego, Scripps Oceanography
Overall length (meters):	84 m. [275']
Maximum draught (meters):	17'
Displacement/Gross tonnage:	3,180 long tons
Propulsion:	Tow 3000 hp Propulsion General Electric Bow Thruster: 1180 hp Azimuthing jet Tyupe Elliot Gill Model 50T 35 Propulsors: Two 3000 hp Z-Drives Lips Type FS 2500-450/1510BO
Cruising & Maximum speed:	12 knots
Call sign:	KAOU
Method and capability of communication (including emergency frequencies):	Email, master@rv-revelle.ucsd.edu Inmarsat-B, Telephone, Indian, 011-873-336780030 Alternate, 011-873-336780020

	Fax, Primary, 011-873-336780031 Alternate, 011-873-336780021 Telex, Primary, 336780033 (AnsBk=KAOU) Alternate, 336780022 (AnsBk=KAOU) Inmarsat-C, 436780010 Radio, Vessels guard standard GMDSS frequencies for calling, distress and dissemination of marine safety information. MMSI #, 367800100 SELCAL #, 71410 Telex, Primary, 336780033 (AnsBk=KAOU) Alternate, 336780022 (AnsBk=KAOU) Inmarsat-C, 436780010 Radio, Vessels guard standard GMDSS frequencies for calling, distress and dissemination of marine safety information. MMSI #, 367800100 SELCAL #, 71410
Name of master:	Tom Desjardins
Number of crew:	22
Number of scientists on board:	No more than 37

3.2 Aircraft or other craft to be used in the project:
none

3.3 Particulars of methods and scientific instruments		
Types of samples and data	Methods to be used	Instruments to be used
Rocks	Dredge sampling	Dredge hauls
Temperature, salinity, Oxygen, currents, meteorological measurements.	Underway measurements from continuously pumped surface seawater and on-board sensors	Thermosalinograph, acoustic doppler sonars ADCP RDI Narrowband and RDI Broadband 150 kHz
Magnetometer if available	Towed Magnetometer.	Marine Magnetics SeaSpy Gradiometer
Bathymetry and sidescan	Swath mapping with multibeam system.	EM120 12 kHz 150 deg swath
Gravity if available	Gravimeter	Gravimeter-Bell BGM-3

3.4 Indicate whether harmful substances will be used:
No

3.5 Indicate whether drilling will be carried out:

No

3.6 Indicate whether explosives will be used:
No

4. Installations and Equipment

Details of installations and equipment (dates of laying, servicing, recovery; exact locations and depth):

5. Geographical Areas

5.1 Indicate geographical areas in which the project is to be conducted (with reference in latitude and longitude):
5 South, 147 East

5.2 Attach chart(s) at an appropriate scale (1 page, high-resolution) showing the geographical areas of the intended work and, as far as practicable, the positions of intended stations, the tracks of survey lines, and the locations of installations and equipment.

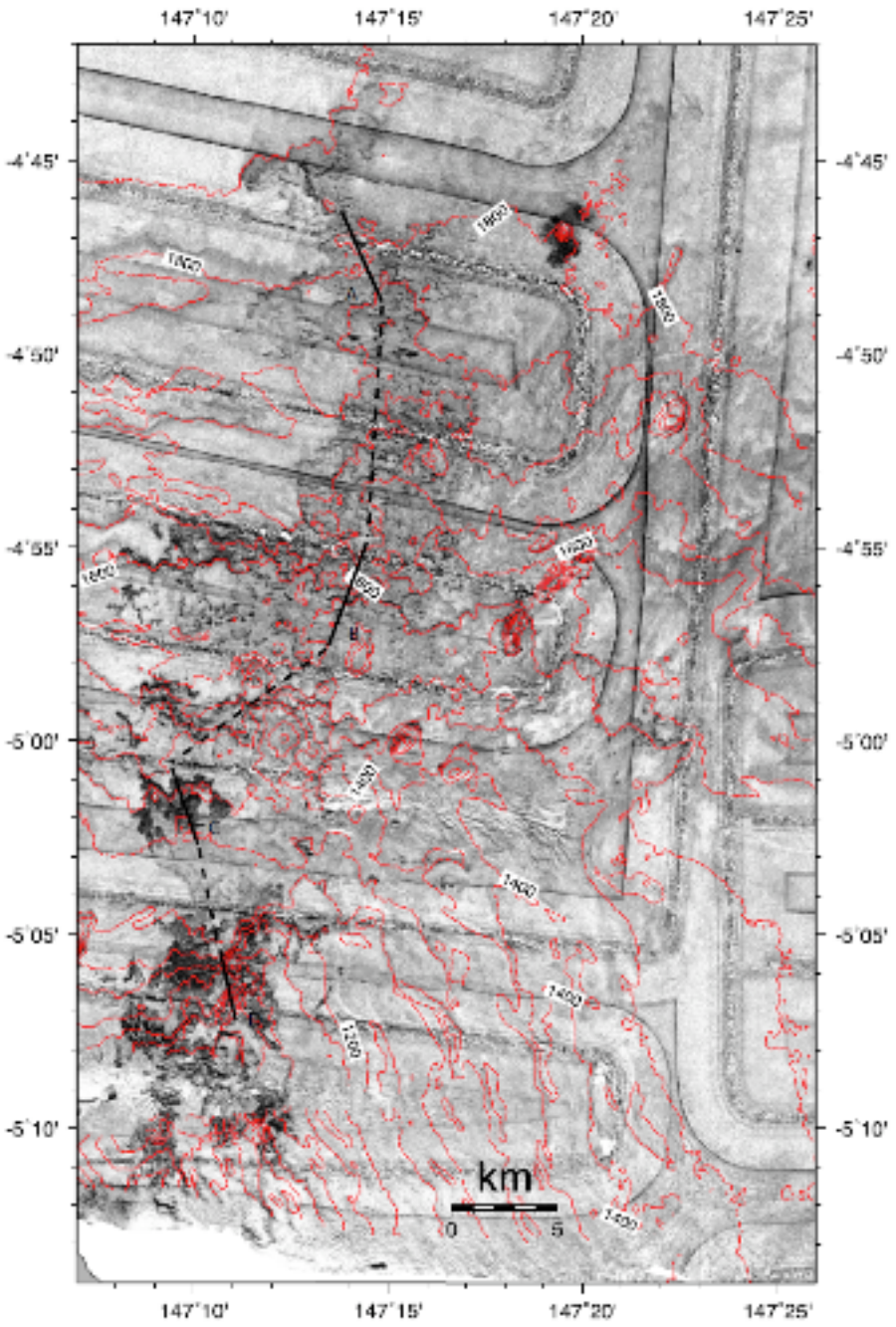

Figure 8. Location of proposed dredge sites, shown as solid lines.

6. Dates

6.1 Expected dates of first entry into and final departure from the research area of the research vessel:
This cruise is will be carried out during a planned transit from Wellington, New Zealand to Kao-hsiung, Taiwan 20 February -16 March 2010. We will make an intermediate stop to transfer personnel in a Papau New Guinea port and date to be determined.

6.2 Indicated if multiple entry is expected:

Not likely.

7. Port Calls

7.1 Dates and names of intended ports of call:
To be determined

7.2 Any special logistical requirements at ports of call:

7.3 Name/Address/Telephone of shipping agent (if available):
To be determined.

8. Participation:

8.1 Extent to which coastal state will be enabled to participate or to be represented in the research project:
There will be participation by the Geological Survey of PNG

8.2 Proposed dates and ports for embarkation/disembarkation:
.Personnel exchange mid cruise (no entry into port)

9. Access to data, samples and research results

9.1 Expected dates of submission to coastal state of preliminary reports, which should include the expected dates of submission of the final results:
June 30, 2010

9.2 Proposed means for access by coastal state to data and samples:
The participant from Papua New Guinea (possibly Dr. Steve Saunders) will work with us on the petrologic analysis. He will subsample each dredge to take rocks back to Papua New Guinea, and he will play a major role at sea in helping to sort, label, and store the samples for shipping. Dr. Saunders participated with us in the first cruise on the Kilo Moana in 2004 when the flow north of Long Island was discovered. The work will also involve participation of a scientist from Papua New Guinea, and will provide the Geologic Survey of PNG with the opportunity to gain greater understanding of submarine volcanic features in a volcanically very active region. Depending on what the flow actually is, we may be contributing to the understanding of a significant geohazard, from an event that may have occurred in the recent past.

9.3 Proposed means to provide coastal state with assessment of data, samples and research results or provide assistance in their assessment or interpretation:
Please see 9.2

9.4 Proposed means of making results internationally available:
Publication in internationally recognized journals

Proposed Research
We propose to obtain a series of 4 dredges from the Arop Flow. We feel that sampling will provide a first-order differentiation between these main alternatives.

1) **Lava flow**. If the flow is a lava flow, then we expect to obtain primarily tholeiitic or high magnesium basalt, as this composition potentially would have a relatively high fluidity, although it appears very unlikely that the whole extent of this feature is a lava flow. Dating the lava would discriminate between a very young flow and older existing sea floor. The latter seems unlikely because of the rapid sedimentation rate in this region (Milliman, 1995), which should cover these deposits in a relatively short time period.

2) **Pyroclastic deposits** should yield welded clasts at the microscopic scale (Cas and Wright, 1987; Kokelaar and Busby, 1992). These may also contain carbonized wood (that could allow 14C dating), ignimbrite deposits, accretionary lapilli tuff, and pyroclastically fragmented debris (Cas and Wright, 1991). Pyroclastic deposits often contain fractured crystals, which are visible microscopically (e.g. Pallister et al., 1996). Pyroclastic deposits observed on Long Island are more siliceous than other rocks on the island, so the composition should provide an indication of possible source.

3) We expect large quantities of pumice if the **flow is pumiceous**, although the presence of pumice would be expected in any case due to recent (300 y) eruptive activity on Long Island (R. Blong, written commun., 2008). If most of the material were pumiceous we would conclude that this alternative is most likely.

4) If the flow is indeed a debris avalanche then we expect to observe andesitic material from the caldera edifice. Our experience with Ritter Island (Silver et al., 2005) is that the distal facies of edifice collapse is made up of debris flows (Fig. 4), many of whose clasts are ripped up from the sea floor as the flow is emplaced. The middle part of the Ritter debris avalanche is composed of matrix-rich facies, including small to intermediate-sized blocks, and the proximal facies are large blocks. Sampling should provide an integrated array of rocks that make up Long Island. In addition, the volume of the flow far exceeds that expected from a local sector collapse of the island. For example, the volume of the Ritter collapse is 4-5 km3 (Ward and Day, 2003; and G. Hoffmann, unpublished studies based on our observations). Our estimate of 14 km3 for the Arop flow would require a significant part of Long Island to collapse. That would suggest an age much greater than the known eruptions of Long Island, raising questions of how sea-flow material with such high backscatter intensities could remain exposed for such long periods.

5) A composite feature would also yield a variety of rock types and rock chemistries, as well as rock ages. The variability in back-scatter intensity along the flow may suggest

different events over time. The higher intensity back-scatter is focused in the southern part of the flow, whereas lower backscatter (though still higher than the surrounding sediment plain) dominates to the north. This alternative then raises the question of why would a variety of events all focus along the same, fairly narrow trend?

Our four proposed dredge sites are shown in Fig. 8. Dredging will begin in the northern, distal end of the flow and continue upslope (southward). These dredges would therefore sample the distal flow, the two forks beyond the middle flow, and the high ridges of the proximal flow. We propose to spend about half a day doing a combination of site location and remapping the flow using the new Kongsberg EM120 multibeam system on the R/V Roger Revelle.

We propose to carry out some straight-forward analyses of the recovered material, including microscopy, geochronology, and geochemistry. Microscopy will focus on evidence of mineralogic composition and textural fabric. Do we see evidence of welding (pyroclastic flow), pyroclastically fragmented debris, quenching of lava, or other dominant textures? We will make a series of thin sections of the recovered samples.

DEPARTMENT OF MINERAL POLICY & GEOHAZARDS MANAGEMENT

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Kokopo
East New Britain Province

RABAUL VOLCANO OBSERVATORY

Telephone: (675) 9821699
Facsimile: (675) 9821004

12th Feb. 2009

To Whom It May Concern:

The proposal by Dr. Silver to sample the submarine deposit to the north of Long Island volcano would help considerably in our understanding of the volcanism of the Bismarck Sea and the submarine behaviour of volcanic flows and/or debris avalanches. Such understanding would enhance our ability to predict and prepare mitigation strategies against such natural hazards. As such the Rabaul Volcano Observatory (RVO) fully supports Dr. Silver's proposed work.

RVO would hope to be included in the work, to have academic input and gain valuable experience. As such we fully supports Dr. Silver's request for funding to facilitate a staff member from RVO participating in the cruise.

Yours Faithfully

Steve Saunders
(Chief Geodetic Surveyor)

Subject: Concerning a proposal to dredge samples from the Arop Flow
From: "Hugh Davies" <hdavies@mra.gov.pg>
Date: Sun, 15 Feb 2009 13:27:58 +1000
To: "Eli Silver" <esilver@pmc.ucsc.edu>

Dear Eli
On behalf of the Geological Survey of PNG I write to confirm our strong support for your efforts to learn more about the massive and unique tongues of material that extend along the seafloor northward from Long Island volcano. The material was very likely the product of a major catastrophic event in the not so distant past, let's say within the last 1000-2000 years. At the same time it is not at all clear what was the nature of this event. It is in the best interests of PNG, and of world volcano and geohazard science, to learn more about the nature, origin and timing of this event or events. You are welcome to pass this message on to the funding agency if you wish.
With best regards
Hugh

Hugh Davies
Executive Manager - GSD
Mineral Resources Authority
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Port Moresby 121
Papua New Guinea

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Website: www.mra.gov.pg

Minerals for Life

Eli A. Silver

Education

1969 Ph.D. Oceanography, Scripps Institution of Oceanography
1964 B.A. Geology, University of California, Berkeley

Memberships in Honorary Societies and Awards

Geological Society of America Fellow, American Geophysical Union, Society of Exploration Geophysicists, Seismological Society of America, American Association for the Advancement of Science

1964 Phi Beta Kappa
1963 James Monroe MacDonald Scholarship

Employment History

1979 – present Professor, Earth Sciences, University of California, Santa Cruz,
2002 - 2005 Associate Dean for Research
2003 - 2007 Founding Director, Center for Remote Sensing
1995 – 2000 Director, UCSC Institute of Tectonics
1994 Acting Dean of Natural Sciences
1973 - 79 Assistant and Associate Professor, Earth Sciences, UCSC
1970 - 73 Geologist, U. S. Geological Survey
1969 - 1970 Post Graduate Research Oceanographer, Scripps Inst. of Oceanography

Recent Activities in Professional Associations

2007 – Member IODP-MI Executive Committee
2006 – Co-Founder, Monterey Bay Area Remote Sensing Consortium
2006 – 2007, Co-Convener, IODP Geohazards Workshop
2006 – 2007, Co-Convener, MARGINS Central America workshop
2006 – 2007, Science Advisory Structure Executive Committee of IODP
2004 – 2006, Science Planning and Policy Oversight Committee of IODP
2002 – Present, Founding Member and Governor, IODP-MI
2000 – 2007, Member, Joint Oceanographic Institutions Board of Governors
2000 – 2004, Member, MARGINS Steering Committee

Recent Cruises: Chief Scientist or co-chief scientist:

2004 – R/V Kilo Moana, Offshore Papua New Guinea, Chief Scientist
2002 – R/V Melville, Offshore Costa Rica, Senior Scientist
2001 – R/V Melville, Huon Gulf, Papua New Guinea, Chief Scientist
2001 – R/V Maurice Ewing, Offshore Costa Rica, Co-Chief Scientist
2000 – R/V Maurice Ewing, Offshore Nicaragua, Co-Chief Scientist

10 Recent Publications

Silver, E., Day, S., Ward, S., Hoffmann, G., Llanes, P., Driscoll, N., Applegate, B., and Saunders, S., 2009, Volcano collapse and tsunami generation in the Bismarck Volcanic Arc, Papua New Guinea, Journal of Volcanology and Geothermal Research, doi:10.1016/j.jvolgeores.2009.06.013

Llanes, P., Silver, E., Day, S., and Hoffmann, G., Interactions between a transform fault and arc volcanism in the Bismarck Sea, Papua New Guinea, Geochemistry, Geophysics, Geosystems, doi:10.1029/2009GC002430.

Morgan, J., Silver, E., Camerlenghi, A., Dugan, B., Kirby, S., Shipp, C., and Suyehiro, K., 2009, Addressing geohazards through ocean drilling, Scientific Drilling, no. 7, doi:10.2204/iodp.sd.7.01.2009.

Webster, J., Braga, J., Clague, D., Gallup, C., Hein, J., Potts, D., Renema, W., Riding, R., Riker-Coleman, K., Silver, E., and Wallace, L., 2009, Coral reef evolution on rapidly subsiding margins, Global and Planetary Change, 66:129-148.

Hoffmann, G., Silver, E., Day, S., Morgan, E., Driscoll, N., and Orange, D., 2008, Sediment waves in the Bismarck Volcanic Arc, Papua New Guinea, Geol. Soc. Amer. Spec. Paper 436, 91-126.
McIntosh, K. D., E. Silver, I. Ahmed, A. Berhorst, C. R. Ranero, R. K. Kelly, and E. R. Flueh, 2007, The Nicaragua convergent margin: Seismic reflection imaging of the source of a tsunami earthquake, Costa Rica, in *The Seismogenic Zone of Subduction Thrust Faults*, ed. T. Dixon and J. C. Moore, Columbia Univ. Press, NY, 257-287.
Silver, E., and 16 others, 2005, Island arc debris avalanches and tsunami generation, *EOS, Transactions, AGU*, 86:485-489.
Silver, E., Costa Pisani, P., Hutnak, M., Fisher, A., DeShon, H., and Taylor, B., 2004, An 8--10 Ma tectonic event on the Cocos Plate offshore Costa Rica: Result of Cocos Ridge collision? *Geophys. Res. Lett.*, v. 31, L18601, GL020272.
Wallace, L., Stevens, C., Silver, E.A., McCaffrey, R., et al., 2004, GPS constraints on active tectonics and arc-continent collision in Papua New Guinea: evidence for edge-driven microplate rotations, *Journal of Geophysical Research*, 109, B05404.
Webster, J.M., Wallace, L., Silver, E., Potts, D., Braga, J.C, Renema, W., Riker-Coleman, K., Gallup, C., 2004, Coralgal composition of drowned carbonate platforms in the Huon Gulf, Papua New Guinea; implications for lowstand reef development and drowning, Marine Geology, 204:59-89.

Gary Hoffmann

Earth and Planetary Sciences Dept.
University of California, Santa Cruz
1156 High St.
Santa Cruz, CA 95064
Telephone: 831-239-7808
Email: garyh@pmc.ucsc.edu

Education:

University of California, Santa Cruz
Ph.D. Marine Geophysics (anticipated, 2009)
Dissertation: Origins and significance of sedimentary and volcanic flows in the Bismarck Volcanic Arc, Papua New Guinea
Advisor: Eli Silver

Rochester Institute of Technology
B.S. Imaging Sciences, Mathematics minor, Literature minor (2003)
With Highest Honors
Thesis: Visual enhancement of the Archimedes Palimpsest using a target detection algorithm
Advisors: Roger Easton and Rolando Raqueno

Teaching Experience:

University of California, Santa Cruz
Teaching Assistant, Geologic Principles (2009)
Teaching Assistant, Remote Sensing (2004–2009)

Professional Affiliations:

American Geophysical Union
Geological Society of America

Publications:

First Author:
Hoffmann, G.D., Silver, E., Day, S., Ward, S., Driscoll, N., Appelgate, B., 2005, Undulating sediment morphology in the Bismarck Sea, Papua New Guinea, Eos Trans. AGU, 86(52), Fall Meet. Suppl., Abstract V21B-0599
Hoffmann, G., Silver, E., Day, S., Driscoll, N., Appelgate, B., 2007, Dynamic implications of drowned reefs and raised coastlines along the Bismarck volcanic arc, Eos Trans. AGU, 88(52), Fall Meet. Suppl., Abstract T51A-0301

Hoffmann, G., Silver, E., Day, S., 2008, Volcanic flow deposits on the flanks of Long Island, Papua New Guinea: lavas or pyroclastics?, Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract V11C-2067

Hoffmann, G., Silver, E., Day, S., Morgan, E., Driscoll, N., Orange, D., 2008, Sediment waves in the Bismarck Volcanic Arc, Papua New Guinea, in Draut, A.E., Clift, P.D., and Scholl, D.W., eds., Formation and Application of the Sedimentary Record in Arc Collision Zones: Geological Society of America Special Paper 436, p. 91–126, DOI: 10.1130/2008.2436(05).

Additional Publications:

Llanes, P., Silver, E., Day, S., Hoffmann, G., Interactions between a transform fault and arc volcanism in the Bismarck Sea, Papua New Guinea, Geochem. Geophys. Geosyst., doi:10.1029/2009GC002430, in press.

Llanes Estrada, P., Hoffmann, G., Silver, E., Day, S., Olaiz-Campos, A., 2007, Strike-slip Tectonics in the Schouten Basin: Western Branch of the Bismarck Sea Seismic Lineation, Eos Trans. AGU, 88(52), Fall Meet. Suppl., Abstract T43A-1101

Morgan, E., Day, S., Elemunop, J., Silver, E., Ward, S., Hoffmann, G., 2005, Tsunami Deposits Related to Volcanic Island Collapses in the Southern Bismarck Sea, Eos Trans. AGU, 86(52), Fall Meet. Suppl., Abstract V21B-0600

Silver, E., Day, S., Ward, S., Hoffmann, G., Llanes, P., and Lyons, A., 2005, Volcanic collapse and tsunami generation in Papua New Guinea – a comprehensive marine geophysical study of Ritter Island and other collapses, Amer. Geophys. Union, EOS, v. 86, n. 47, p. 485–489.

Silver, E., Day, S., Ward, S., Hoffmann, G., Driscoll, N., Appelgate, B., Llanes Estrada, P., Lyons, A., 2005, Volcano Collapse in the Bismarck Volcanic Arc, Papua New Guinea, Eos Trans. AGU, 86(52), Fall Meet. Suppl., Abstract V21B-0598

Silver, E., Ward, S., Day, S., Hoffmann, G., Llanes, P., Saunders, S., 2008, Large Potential Tsunami Run-up Along the North Coast of Papua New Guinea, as Seen by 12 Mapped Sector Collapses, Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract U51A-0016

Schott, J., Lee, K., Raqueno, R., Hoffmann, G., and Healey, G., 2003, A subpixel target detection technique based on the invariance approach, in AVIRIS Airborne Geoscience Workshop Proceedings, February 2003.

Schott, J.R., Lee, K., Raqueno, R., Hoffmann, G., 2002, Use of Physics Based Models in Hyperspectral Image Exploitation, IEEE Proc. of the 31st Applied Imagery Pattern Recognition Workshop (AIPR ’02), pp. 36-42.