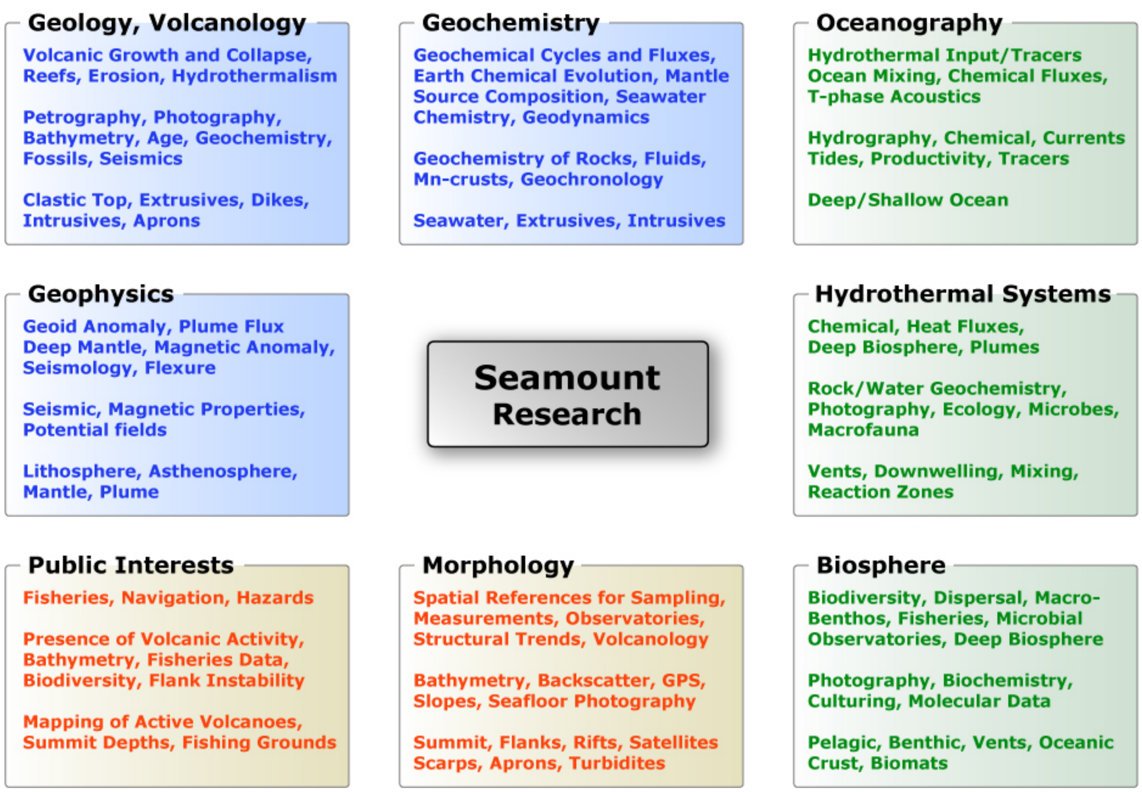
Workshop Volume

Seamounts '09

SEAMOUNTS '09 Workshop

La Jolla, USA
March 19-21, 2009



Hubert Staudigel
Institute for Geophysics and Planetary Physics
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, CA 92093-0225, USA

Anthony Koppers
College of Oceanic & Atmospheric Sciences
Marine Geology and Geophysics
Oregon State University
Corvallis, OR 97331-5503, USA

Tony Pitcher
University of British Columbia
Peter Wall Institute for Advanced Studies
6331 Crescent Road
Vancouver, BC V6T 1Z2, Canada

Bill Lavelle
NOAA
Pacific Marine Environmental Laboratory
7600 Sand Point Way NE Bldg 3
Seattle, WA 98115, USA

Tim Shank
Woods Hole Oceanographic Institution
Biology Department
MS#33 Redfield Laboratory
Woods Hole, MA 02543, USA

Welcome to the SEAMOUNTS '09 Workshop in La Jolla

Thank you for making time to come to **SEAMOUNTS '09**. We have made every effort to make this workshop successful in fostering a multi-disciplinary dialog on seamount sciences, so we become up-to-date on all key issues of seamount sciences and learn from each other. Hopefully this will prepare us to take on the many scientific challenges that seamounts offer and to continue an already impressive record of discoveries made in the many seamount science disciplines.

SEAMOUNTS '09 includes keynotes with lengthy discussion periods, two poster sessions, and a series of breakout sessions. Keynotes will cover seamount sciences, beginning with the Earth science foundation, oceanography, biology, fisheries, and finally the protection of seamount habitats. Half of each keynote period will be devoted to the actual oral presentation and the other half to discussion that is led by an expert and a generalist. The goal of the keynotes is to present the state-of-the-art of a particular field to a broad audience. The goal of the discussion periods is to allow for an open dialog between specialists and non-specialists in order to bring every seamount researcher up to speed with the latest research issues and the grand challenges still ahead of us – regardless of subdiscipline. All poster presentations will be available for viewing and discussion on Thursday and Friday evening. Please feel free to view posters during lunch break and engage the poster presenters in discussions during breaks. They will be happy to talk to you about their work. We have also made room for two breakout sessions during which we will explore some key science infrastructure issues that will help us improve seamount sciences long-term. These breakout sessions are explained in more detail below, but the main goals are to develop a better integrated community of seamount scientists, to provide important infrastructure improvements that will make seamount sciences more effective, and to make its exciting results better known.

Thank you very much for your support !!!

Hubert Staudigel, Anthony Koppers, Bill Lavelle, Tony Pitcher and Tim Shank

The conveners of **SEAMOUNTS '09**

Table of Contents

Workshop Program — Morning

March 19 2009	March 20 2009	March 21 2009
	Continental Breakfast 08:15	
	9:00 – 10:30 Hubbs Hall	9:00 – 10:30 Hubbs Hall
	Welcome and Introduction Workshop Goals and Logistics (2 min by H. Staudigel) Breakout Session Goals (5-10 min by breakout chairs) Introduction to Posters (60 min by grouping)	**Connectivity and Conservation at Seamounts** KN: **Tim Shank** DL: Dave Emerson Al Hoffman
	Coffee Break 10:30 – 11:00	
	11:00 – 12:30 Hubbs Hall	11:00 – 12:30 Hubbs Hall
	Seamounts as a link between geochemistry, geophysics, tectonics, geohazards and bio-evolution KN: **Anthony Koppers** DL: Al Hofmann Tony Pitcher	**Fisheries: On Their Way to Sustainability?** KN: **Tony Pitcher** DL: Malcolm Clark Hubert Staudigel
	Lunch Break 12:30 – 13:30	

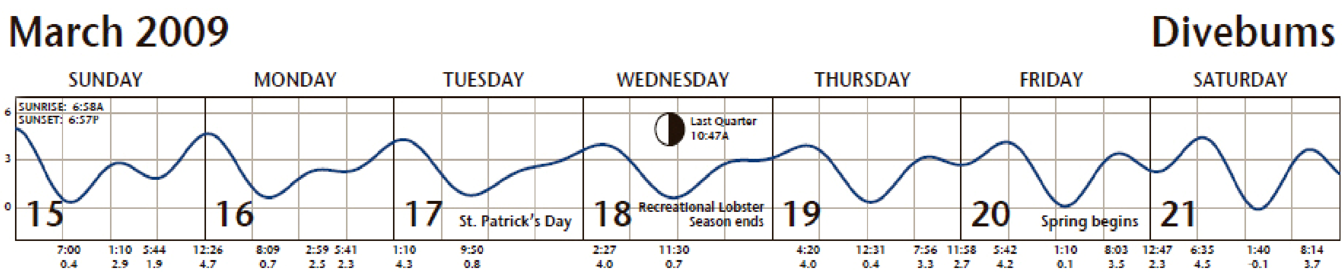
Workshop Program — Afternoon

March 19 2009	March 20 2009	March 21 2009
	Lunch Break 12:30 – 13:30	
	13:30 – 14:30 Hubbs Hall	13:30 – 14:20
	Hydrothermal Circulation, Substrates and Microbial Communities at Seamounts KN: **Dave Emerson** DL: Brad Tebo Stan Hart	**Breakout Session II**
	14:30 – 16:00 Hubbs Hall	14:30 – 15:30 Hubbs Hall
15:00	**Ocean Circulation, Transport and Mixing at Seamounts and Biological Consequences** KN: **Chris Mohn** DL: Lisa Levin Telmo Morato	**Protecting Seamounts for Research: Azores and Hawaii** KN: **Ricardo Serrão Santos** **Brad Barr** DL: Telmo Morato Dave Clague
WORKSHOP REGISTRATION **PUTTING UP THE POSTERS** THEY WILL STAY UP FOR BOTH DAYS	**Coffee Break 16:00 – 16:30**	**Coffee Break 15:30 – 16:00**
17:00	16:30 – 17:30	16:00 – 17:30 Hubbs Hall
POSTER SESSION I **ICE BREAKER RECEPTION** Posters and Video presentation	**Breakout Session I** 17:30 **POSTER SESSION II** **Wine and Cheese Reception** Posters and Video presentation	**PLENARY SESSION** **Breakout Session Synthesis** (15 minutes each, breakout session chairs) **SBN – Quo Vadis** **Hubert Staudigel**

Workshop Program — Evening

March 21 2009
18:00 **Mexican Conference Dinner at Tecolote Canyon** **22:00** **Transportation back to the hotel**

La Jolla Tides Calendar



Breakout Sessions

Breakout sessions address key infrastructure issues in seamount bio-geosciences and conservation. These breakouts will be used to develop new avenues that will bridge the gaps between all seamount science disciplines, to facilitate open access to all types of seamount data, and to find new ways allowing us to be more successful in explaining the value of studying seamounts to the overall science community and our funding agencies, much like how the RIDGE and MARGINS programs made the case for studying the mid-ocean ridges and subduction zones.

Each conference participant will each be asked to participate in one of these five themes for both breakout session time periods. You will find your assignment in the welcoming package. Breakout groups will meet on Friday and Saturday to discuss the topic, propose actions and prepare a report that will be presented and discussed in the final plenary session. At this point all conference participants will contribute to a final recommendation of each breakout group.

When dividing the workshop participants in these groups we tried to balance expertise, experience and scientific diversity. It is inevitable that these assignments may not satisfy everybody's first choice, but experience has shown that this is the most effective way to prepare a meaningful proposal for the plenary session. Everybody will have an opportunity to contribute at that time to the final document, and session chairs will be open to suggestions for issues to be covered in the initial document.

There will be five breakout session themes:

1. Seamount Exploration: Mapping the Unknown Majority

Lead: Paul Wessel and Dave Sandwell

By far the most seamounts have never been charted by any ship. Amongst the few seamounts charted, an even smaller number has any detailed (multibeam) bathymetric charts. This session will explore strategies for how we can most effectively increase the number of charted seamounts.

2. Future Seamount Exploration Strategies

Lead: Anthony Koppers and Lisa Levin

The need for exploring a vast number of unknown seamounts can benefit from a well thought-through strategy for exploration. The goal of this breakout session is to provide guidance for the development of such strategies, optimizing efforts with multidisciplinary scientific yield.

3. International Networking

Lead: Malcolm Clark and Al Hofmann

The vast majority of seamounts are in international waters, and there are many nations engage in seamount research, covering a range of disciplines. Can we better coordinate these efforts, and facilitate data sharing? Can we help each other developing integrated seamount research programs in different nations?

4. Seamount Ecosystem Evaluation Framework

Lead: Tony Pitcher and Tim Shanks

Successful ecosystem modeling depends critically on the availability of a consistent ecosystem evaluation framework. This breakout will discuss such a framework and how it may be improved in terms of the type of data included as well as in terms of its practicality of data acquisition.

5. Outreach and Education

Lead: Cheryl Peach and Shawn Doan

Bringing together such a large number of leading seamount scientists offers an opportunity to develop effective outreach and education strategies. This session will focus on a digital archive of education materials related to seamounts and on creating on a scientific exhibit on seamounts at the Birch Aquarium at Scripps Institution of Oceanography.

Abstracts

Listing in alphabetical order

Logical Structures of the Information for the Seamounts Research by the Internet-Metadata Standard

Asavin, A; Zhuleva, H

The works in ocean ecology, fishery and exploratory, engineering geology use the knowledge about seamounts relief. The creation of Seamounts Internet Database is necessary for data archiving and exchange. The first stage of the Database creation is the system of metadata creation.

We preview that information system provide with historical and genetic analysis of seamount relief and we are include in structure of this catalog morphological data as well as some geophysical and geological information. This extensive compilation contains both text and numerical information across research projects, electronic bathymetric seamounts maps, data archives, diverse libraries and much more.

N of the sign	Contents of the sign	Name of margin
1	Number	NUMBER
2	Name Russian	SEAMOUNT_NAME1
3	International name	SEAMOUNT_NAME2
4	Seamount system name	SEMOUNT_SYSTEME_NAME
5	Seamount type	SEAMOUNT_CHAPE
6	Geographic coordinates	LATITUDE LONGITUDE
7	Form of relief	LOCATION
8	Characteristics of bathymetry	DEPTH_SUMMIT DEPTH_REF DEPTH_PRECISION DEPTH_MAX DEPTH_MIN
9	Characteristics of morphometry	SEAMOUNT_HEIGHT BASIS_AREA BASIS_EXTENSION BASIS_AZIMUT
10	Age	MAX_SEAMOUNT_AGE METHOD_AGE1 MIN_SEAMOUNT_AGE METHOD_AGE2 SEAMOUNT_AGE_RANGE PLATE_AGE

11	Geological and geophysical study	SAMPLING
12	Ore formations	ORE_FORMATIONS
13	Volcanic eruptions	ERUPTION ACTIVITY TYPE
14	Terraces	TERRACE_DEPTH TERRACE_AGE TERRACE_WIDTH TERRACE_HIGHLY
15	Landslides	LANDSLIDES_TYPE LANDSLIDES_SIZE
16	Bibliography	BIBLIOGRAPHY

Table 1. The standard by subject of metadata.

The specialized data bases for seamountains are developed in the Internet within the framework such international programs as: NYC system (OASIS) [http://www.oasisnyc.net/], Seamount SBN [http://earthref.org/SBN/], the project seamount-online [http://seamounts.sdsc.edu/]. There is a great Wessel database for the seamountains of Pacific Ocean is the summary P. Wessel [2001], developed on the basis of the analysis of altimetry data.

As a result the developments of Internet information systems in the field of research of ocean were formed the specific international standards to the technology of access to the data and the metadata standards, as a list of the subject standards of different specialization. At the last conference IMDIS about international marine data and information system (Athens, on March 31 - on April 2, 2008.) were presented about hundreds of diverse European information Internet the systems, dedicated to sea studies, to storage and data processing. The basic purpose of the development of the metadata standard was the composition most complete according to the number of signs of the characteristic of object with the most laconic content pour on.

References

P. Wessel Global distribution of seamounts inferred from gridded Geosat/ERS-1 altimetry // Journal of Geophysical Research, 106, 19,431– 19,441, 2001

The Nature of Tidal Flow over and around Seamounts

Baines, P

Barotropic tidal flow past seamounts causes the generation of internal tides that alter the overall pattern of tidal flow over and around the seamount. In general, this amplifies the tidal flow over the seamount, affecting the environment experienced by biota in this region. These changes depend on the parameters involved – seamount latitude, radius etc., details of which are given in Baines (2007: Deep-Sea Res. I 54(9), 1486-1508). For example, for seamounts near 30° latitude the amplification over the seamount can be large for diurnal tides because of resonance. Here the mechanics of this tidal interaction and the details of the resulting flow field are described, as a function of a range of seamount parameters. These are compared with other factors such as strong steady currents in their impact on the environment over the top of the seamount. Possible inferences of these effects are discussed.

Protecting Seamounts: Examples from North America and Hawaii

Barr, B

Seamounts, and similar features on the seabed, possess significant ecological value, generally exhibiting high biodiversity and endemism. While many seamounts are protected to some degree by their remote location, few are so remote as to be unaffected by human activities. Some form of active management may be required to preserve their ecosystem integrity, structure and function. For seamounts within the boundary of exclusive economic zones, there are a number of potential management alternatives that can be used to provide protection, from imposing activity-specific regulations to establishing marine protected areas. The management toolbox for seamounts in the high seas is limited, and these international mechanisms may be considerably less effective than those for waters nearer shore. Beyond having relevant authority to manage and protect seamounts, sustained and not insignificant financial resources must also be available to support enforcement, permitting, monitoring, and other essential management activities in order to achieve effective protection. Examples will be used from the Pacific Coast of North America and Hawaii to demonstrate the relative strengths and weakness of different management strategies that have been and are being used to protect seamounts and similar submerged topographic features in these areas.

The 2006 Dacitic Eruption of Home Reef, Tonga: Birth and Death of a Volcanic Island and Pumice Raft Voyages

Bryan, S E; Cook, A; Evans, J; Colls, P; Hebden, K; Smith, M; Hurrey, L

Home Reef Volcano (18°S 59.231', 174°W 45.867') is a shoaling island arc volcano in the central Tofua volcanic arc of Tonga. First reported activity was in the mid-19th century, and it has subsequently erupted at least two times in 1984 and 2006 (Venzke et al., 2002-). Each eruption showed similar characteristics in terms of eruptive style (magmatic explosive), explosivity index (VEI ~2), erupted volume (<0.1 km3) of dacitic (~65 wt% SiO2) magma, the short-lived construction of an emergent pumice cone and island, and the generation of pumice rafts. Home Reef has thus made a habit of building new islands only to lose them several months later to wave action.

Due to remoteness of volcanoes in the Tofua arc, the 2006 eruption of Home Reef went unwitnessed. However, it gained considerable media and internet attention thanks to the encounter of the yacht Maiken on August 12 with an extensive pumice raft ~440 km2 in area (Fransson, 2006; 2008; Smithsonian Institution, 2006). Monitoring of the volcano and new island since the eruption has primarily been by satellite (Smithsonian Institution, 2006; Vaughan et al., 2007) with few direct observations. On 7 December, 2006, an overflight by the RNZAF revealed the island had reduced from ~0.25 km2 to ~450 m in diameter and was up to 75 m in elevation, but showed continued fumarolic activity. We inspected the island by boat on February 18, 2007 and found the island had all but disappeared, with only a small (50-75 m diameter), <5 m high, low-relief, wave-reworked "pumice mound" remaining. Large (>1 m diameter), outsized blocks (10-20 in number) were scattered on the mound surface and are interpreted to be lag deposits of ballistic blocks ejected during the eruption. The rapid erosion rate of the island confirmed that it comprised entirely of pumice material with no lava effusion occurring. Venting of volcanic gases, particularly SO2, and hydrothermal plumes within the water column remained a persistent feature at the volcano, 7 months after the eruption. We returned to Home Reef in November 2008 and found the island had now completely disappeared. The summit was at ~10 m depth but the volcano was still actively emitting volcanic gases and hydrothermal plumes. A bathymetric survey undertaken at this time of the shallow summit region (<300 m depth) is shown in Figure 1. The Home Reef summit is elongate in a NNE-direction with a relatively broad and flat-topped region of ~3.9 km2. We suspect the marked depression along the western side of the summit may correspond to the vent area for the 2006 eruption.

The eruption produced a textural variety of pumice (Fig. 2), but which was volumetrically dominated by a grey, highly vesicular (75-85%) and crystal-poor (<5 modal%) dacite (63-65 wt% SiO2; 0.65-0.7 wt% TiO2). A black, moderately vesicular (~50%) dacite pumice (63-65 wt% SiO2; ~0.6 wt% TiO2) was a subordinate but distinctive juvenile product of the eruption. Notably, this pumice type was only observed in strand deposits in Tonga, and has not been reported from pumice raft deposits elsewhere in the Southwest Pacific. Floating experiments confirm that this pumice type becomes negatively buoyant through waterlogging more quickly than the grey pumice. In terms of phenocryst assemblage, both pumices contain predominantly glomerocrysts of anorthitic plagioclase (An92-88), pigeonite, augite and titanomagnetite. The black pumice is mineralogically and chemically overall, very similar to the volumetrically dominant grey pumice, showing only subtle chemical differences, particularly in the REE (eg, La/Yb = 1.24, grey pumice; 1.71, black pumice).

Although the island only lasted for ~7 months, the 2006 eruption has had a more lasting impact across the Southwest Pacific Ocean. Pumice rafts generated by the eruption drifted westwards, reaching eastern Australian waters in March-April 2007, at an average velocity of 20 km/day. Drift trajectories of the pumice rafts have been mapped using observations and sightings of stranded pumice (Smithsonian Institution, 2006) and computed using numerical models of Southwest Pacific wind fields and ocean currents (Fig. 3) as described in Bryan et al. (2004). Relatively strong and persistent trade winds resulted in dismemberment of the pumice raft, particularly early on along the trajectory. The main pumice trajectory passed the Fijian islands and through the region between Vanuatu and New Caledonia to continue on to eastern Australia, while a secondary mass separated approximately a month after the eruption, being dispersed to the southwest into the Lau Basin.

In tropical waters, the pumice quickly became home to a wide range of marine organisms including barnacles, corals, algae, worms, bivalves, gastropods and anemones (Fig. 4). Floating pumice rafts generated by such volcanic eruptions are therefore important for long-distance dispersal of biota. We are currently documenting the diversity of the biological cargo on the pumice. Pumice has generally been considered less important as a rafting agent because of its negligible nutritional value to rafted biota, resulting in a lower rafted faunal diversity (Thiel & Gutow, 2005). Our results are indicating the pumice had a much higher diversity of rafted taxa (>50 species) than previously assumed, and which exhibited a variety of feeding strategies (photosynthetic, filter feeding, grazing and scavenging to predation). Plants (cyanobacteria, algae) and suspension/filter feeders (bryozoa, hydroids, barnacles, serpulids, anemones, sponges, bivalves and corals) predominate, and macroalgal dominance increased with time along the trajectory. This is reflected in the biomass, with the relatively high number of gastropods (59), stalked barnacles (137) and serpulids (43) per 100 clasts, as well as high percentages in occurrence of cyanobacteria (~90%), bryozoa (55%), calcareous algae (43%) and algae (28%) on pumice. Our trajectory modelling further indicates that up to two-thirds of the pumice produced in the eruption reached eastern Australian waters. Consequently, we estimate that for some key populations, 10's of millions (corals, molluscs) to 100's of millions (gastropods, barnacles, serpulids) of individuals were rafted by pumice in to the Great Barrier Reef World Heritage Area in 2007 as a result of a shallow marine explosive eruption at Home Reef volcano seven months previously.

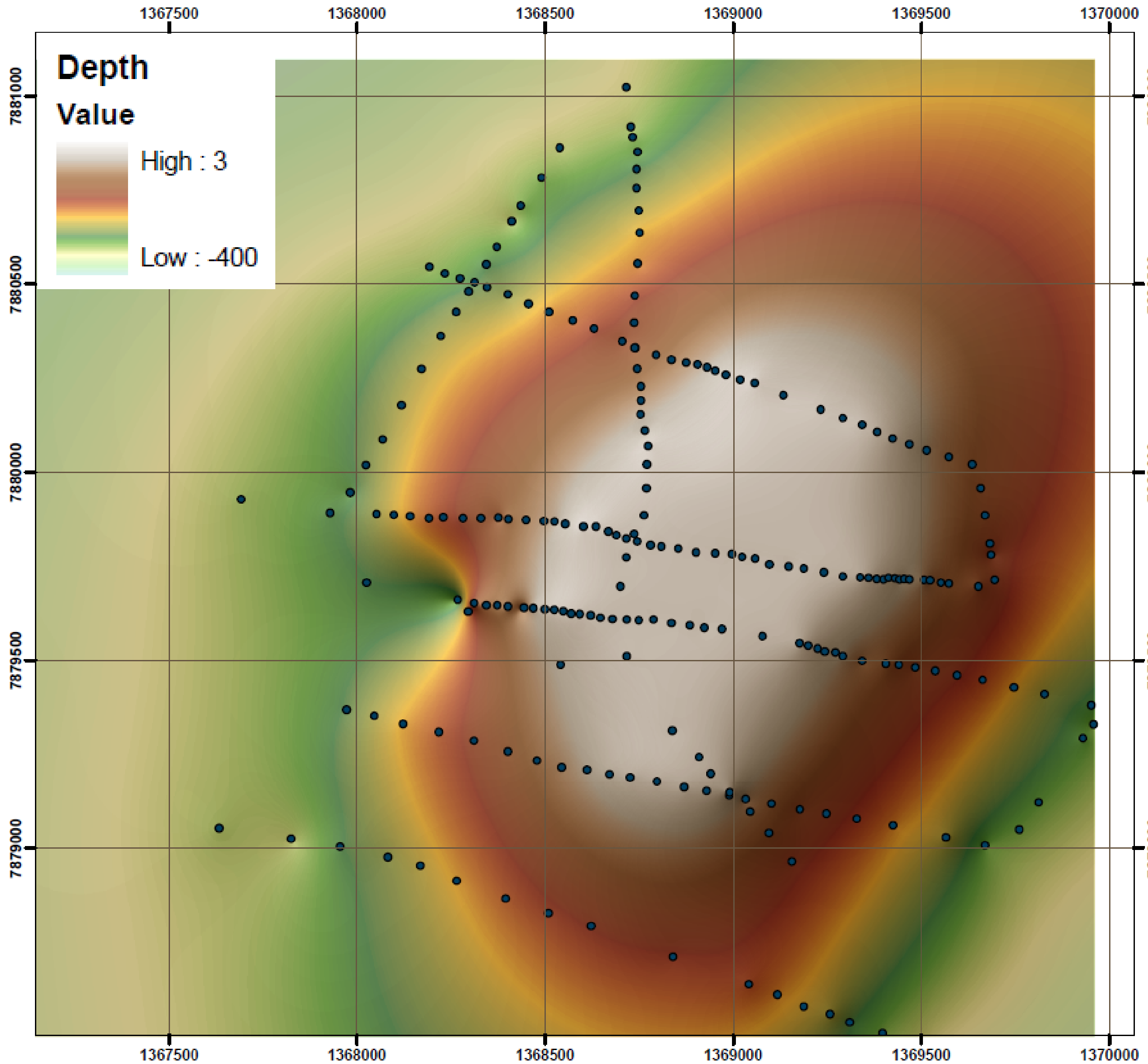


Figure 1. Bathymetric map of Home Reef summit (November 20, 2008) showing overlay of the bathymetric survey and measurement points. Grid coordinates are in UTM60S, depth in metres, and data interpolation involved universal point kriging using a linear model within Surfer 8.

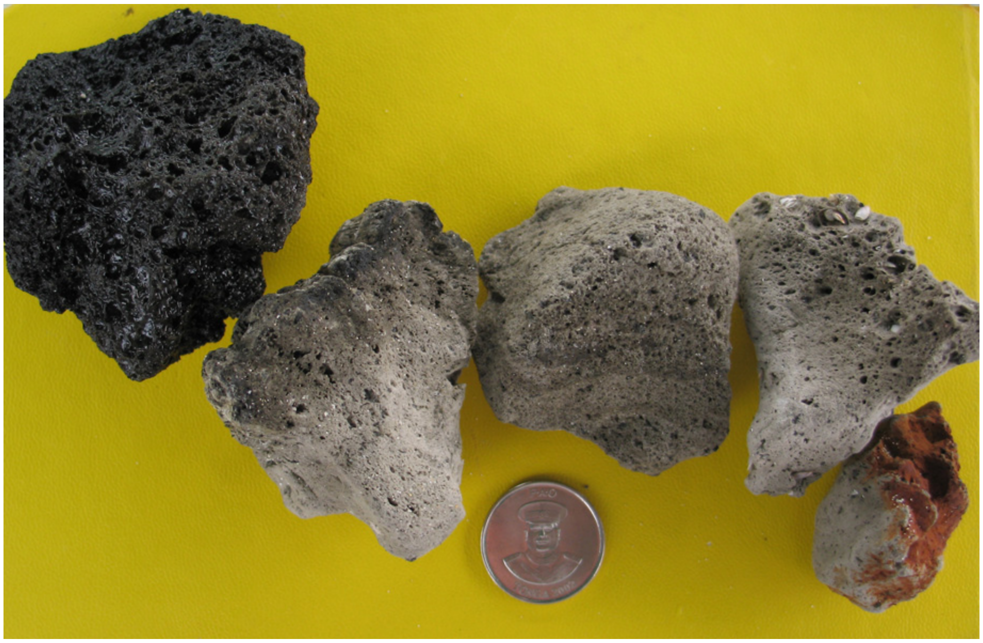


Figure 2. Overview of the pumice textural variation produced by the 2006 Home Reef eruption. From left to right: black, moderately vesicular pumice; 'tube pumice encrusted' grey pumice; banded/streaky pumice; grey, highly vesicular pumice (the volumetrically dominant pumice type) and hydrothermally stained pumice, with hydrothermal alteration occurring within the pumice cone deposits following eruption. Notebook is 20 cm long.

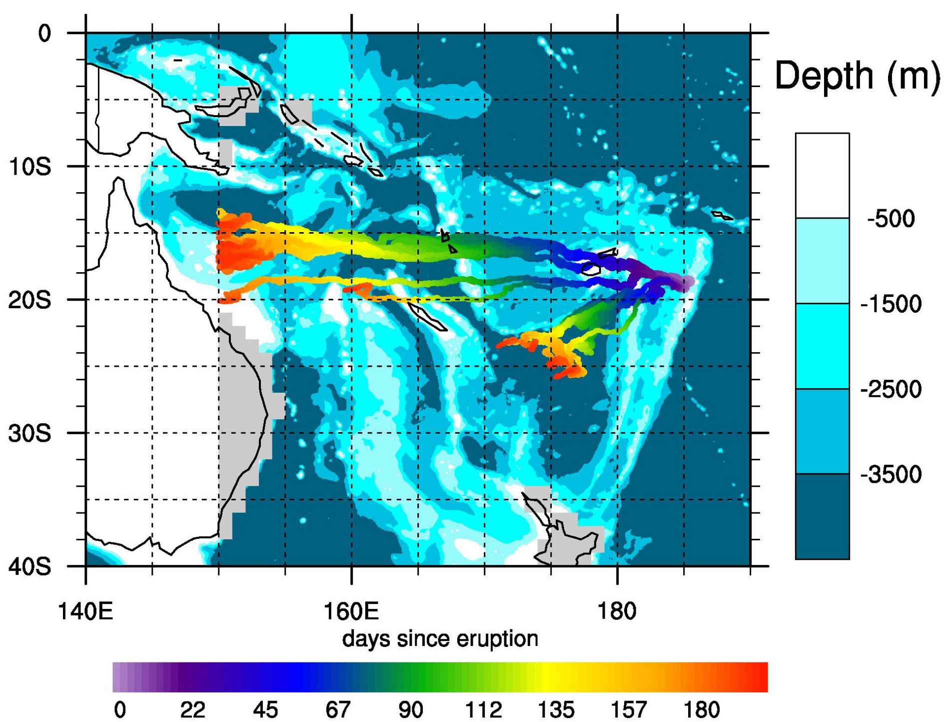


Figure 3. Trajectories of Home Reef pumice following the method of Bryan et al. (2004). Seafloor bathymety for the south-west Pacific is shown and grey area represents continental shelves of <1000 m depth, where geostrophic ocean currents were not calculated.

Figure 4. Closeup of Home Reef pumice collected from the Gold Coast, eastern Australia on December 27, 2008. Two pumice clasts are bound together principally by algae (Caulerpa sp.) and cyanobacteria (Rivularia sp.). Stalked barnacles (Lepas sp.), mollusc (Pteria sp.), corals (Pocillopora sp.), and hydroids are also present. Coin is 2.2 cm diameter.

References

Bryan SE, Cook A, Evans J, Colls, P, Lawrence M, Wells M, Jell JS, Greig A, Leslie R (2004) Earth and Planetary Science Letters 227: 135-154.

Fransson F (2006) http://yacht-maiken.blogspot.com/2006_08_01_archive.html

Fransson F (2008) The day the sea turned to stone! Australian Age of Dinosaurs, 6: 82-83.

Smithsonian Institution (2006) Bulletin of the Global Volcanism Network 31 (9).

Thiel M, Gutow L (2005) Oceanography & Marine Biology: An Annual Review 43: 279-418.

Venzke E, Wunderman R W, McClelland L, Simkin, T, Luhr, JF, Siebert L, Mayberry G, and Sennert S (eds.) (2002-). Global Volcanism Program Digital Information Series, GVP-4 (http://www.volcano.si.edu/reports/).

Monterey Bay National Marine Sanctuary Expands to Include Davidson Seamount: Opportunities for Applied Research and Education in a New Marine Protected Area

Choy, S J; Burton E J; DeVogelaere A P; Barry, J; Lundsten, L; McClain, C R

The Davidson Seamount is now part of the Monterey Bay National Marine Sanctuary (MBNMS). Located 128 km (80 statute miles) southwest of Monterey, Davidson Seamount rises 2,280 m (7,480 ft) above the surrounding ocean floor, measures 42 km (26 statute miles) in length, and yet remains some 1,250 m (4,101 ft) below the sea surface. The inclusion of Davidson Seamount to the MBNMS represents a new and unique opportunity for applied seamount research in a new marine protected area (MPA).

The Davidson Seamount is one of the best-studied seamounts in the world. As a result, there is a wealth of existing information regarding habitat types, marine fauna, geology, and bathymetry of a pristine marine ecosystem, all documented by a wide variety of media. For example, a guide of 237 taxa has recently been completed for the area. In addition, the MBNMS has released an Action Plan for the Davidson Seamount Management Zone (DSMZ), which mirrors the National Oceanic and Atmospheric Administration's (NOAA's) Deep-Sea Coral and Sponge Research and Management Strategic Plan. The DSMZ Action Plan outlines research and conservation objectives, thus providing a launch pad for applied seamount research and novel research questions. The MBNMS is developing resources to support research, as well as programs for outreach and education to highlight research findings to the public. So come to the Davidson Seamount for all of your research needs and seamount education material – we're officially open for business.

Shaping new Paradigms for Seamount Biodiversity and Assessments of the Vulnerability of Seamount Habitats to Anthropogenic Disturbance: the Contribution of the CenSeam Project

Clark, M; Rowden, A; Stocks, K; Consalvey, M

Seamounts have been referred to as oases in the ocean, yet our knowledge is such that this notion can neither be refuted nor accepted. Seamounts can support high levels of biodiversity and endemism, can play an important role in patterns of marine biogeography, and can be highly productive ecosystems acting as feeding grounds. However, our current state of knowledge is such that these observations cannot be taken as generalizations.

Of the estimated global total of 100 000 seamounts (Figure 1), less than 200 have been studied in sufficient biological detail. Recognizing that it is not feasible to sample all of the world's seamounts, future sampling efforts need to be standardized and strategically guided, through assessing the current state of knowledge, to fill critical knowledge gaps and target understudied regions and types of seamounts.

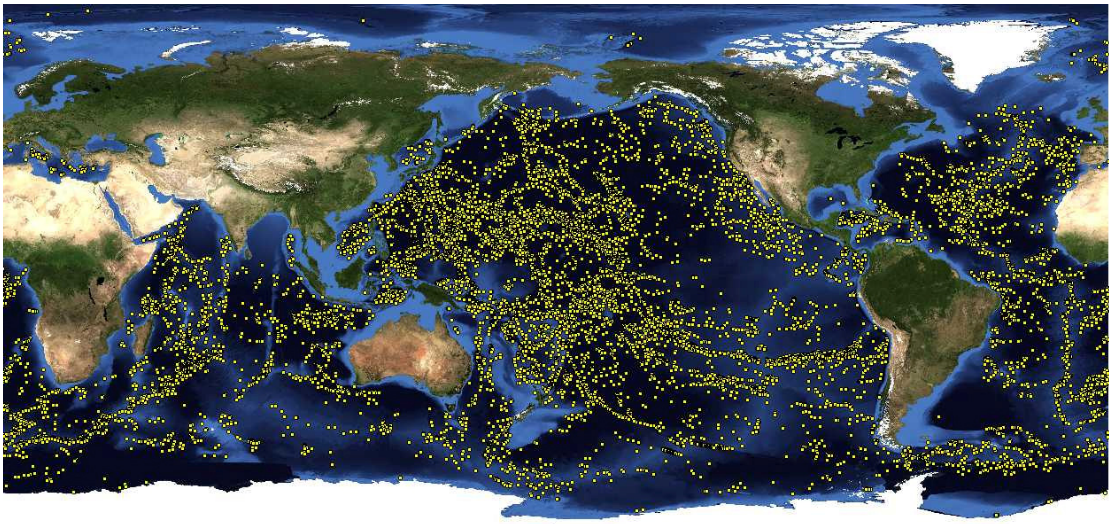


Figure 1. Global distribution of predicted large seamounts
(data courtesy Seas Around Us Project 2004).

The Census of Marine Life (CoML) is a growing global network of researchers in more than 80 nations engaged in a ten-year initiative to assess and explain the diversity, distribution and abundance of marine life in the oceans (past, present and future). Under the umbrella of the Census of Marine Life, field project CenSeam (a global census of marine life on seamounts) commenced in 2005. Aiming to provide a framework to prioritize, integrate, expand, and facilitate seamount research efforts we have established a Data Analysis Working Group (DAWG) and Standardization Working Group (SWG). The working groups operate in tandem to strengthen sampling design, ensure comparative data are collected, carry out subsequent analysis, and publish and publicize results. Each group is designed to act as a "vehicle" which other scientists are invited to join (e.g. to contribute expertise and or advice on particular subjects). We have defined two overarching priority themes, and within these themes more focused key questions have been formulated which will enable the program to deliver more tractable and tangible outcomes:

Theme I: What factors drive community composition and diversity on seamounts, including any differences between seamounts and other habitat types?

(a) Does community composition and diversity differ between seamounts in different regions, and what environmental factors cause large-scale geographic patterns?
(b) How important are differences in dispersal capabilities in producing spatial difference in species composition of the seamount?
(c) What environmental factors (e.g. hydrodynamic regimes, substrate age and type) cause differences in diversity and species composition of the seamount fauna at the scale of individual seamounts?
(d) Are seamounts centers of high biological productivity?
(e) Are they characterized by unique trophic architecture?

Theme II: What are the impacts of human activities on seamount community structure and function?

(a) How vulnerable are seamounts to bottom fishing? But will also seek to address
(b) What are the threats posed by non-trawl fishing (e.g. longlining) activities?

(c) What are the effects of mining on seamount communities?
(d) How resilient are seamount communities to human-induced disturbance?
(e) Are seamounts different from other habitats in their capacity to 'recover' from human-induced disturbance?

To answer these questions on large spatial scales the DAWG first had to devise and implement tools/methods to overcome problems inherent in the types/quality of data available. To date a number of groundbreaking studies have been conducted which have begun to challenge some of the paradigms that existed at the inception of the project e.g., that seamounts are centers of endemism, as well as providing new insight into the forces that shape patterns of biodiversity on seamounts.

The SWG are currently developing a seamount sampling protocols manual, and as part of international efforts to facilitate equipment standardization held a workshop to review existing methods in underwater image acquisition to allow for more comparable data analyses on seamounts from a number of programs. A second training workshop will be held March 2009. Global analyses of seamount sampling to date using the SeamountsOnline database (Figure 2) have highlighted undersampled regions that should be prioritized for future expedition efforts. Three key regions have been identified: the Indian Ocean, the South Atlantic, and the Western and Southern Central Pacific.

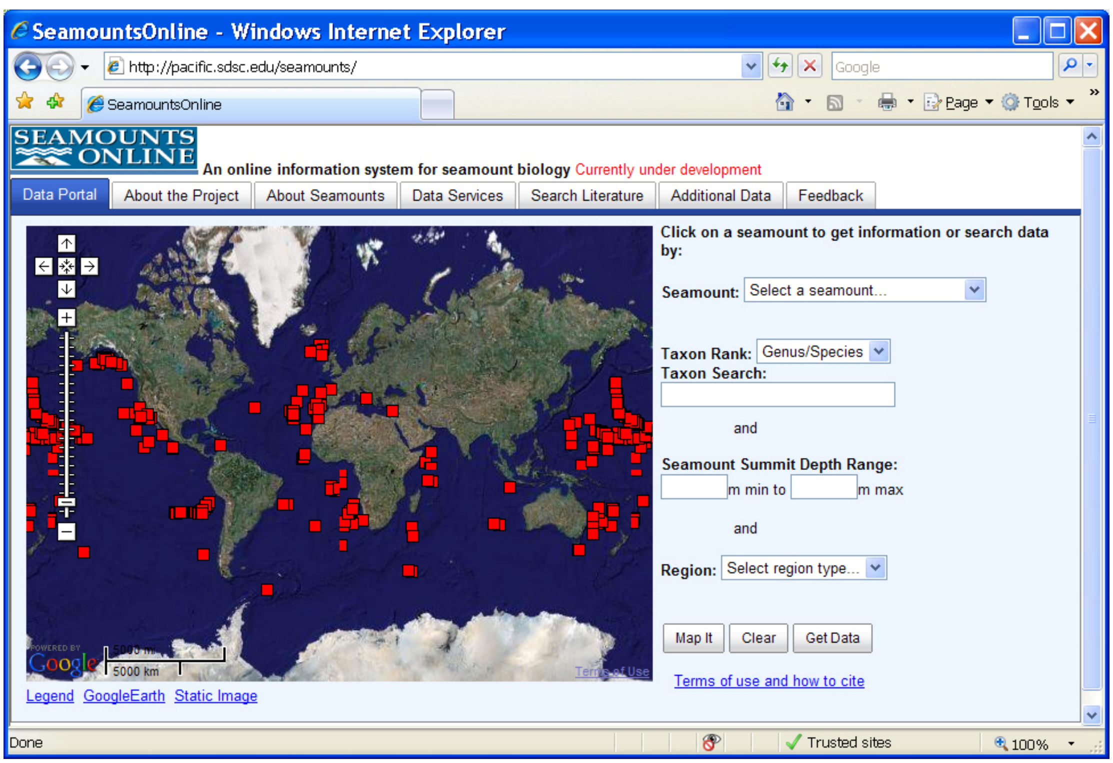


Figure 2. SeamountsOnline database http://seamounts.sdsc.edu/

Investigations of the vulnerability of seamount communities to fishing and mining activities have also been conducted, and the results already used to inform environmental management of seamounts. DAWG researchers have provided specialist advice to individual Governments, the United Nations, FAO, and organizations such as the IUCN, ISA, RMFOs, as well as other deep-sea researchers. CenSeam authors recently contributed to the GOODS report (Vierros et al. 2008 - Global Open Oceans and Deep Seabed biogeographic classification) which presents a revised biogeographic classification for the oceans. Work is ongoing (PEW funded) towards the establishment a global seamount classification system that could subsequently feed into MPA design of conservation networks.

To date CenSeam has served as a platform to bring together researchers from various parts of the world to undertake new studies that will ultimately improve our knowledge of seamount biodiversity. In the coming years CenSeam linked researchers will have increased our understanding of seamounts and their role in the entire marine ecosystem such that seamount researchers can strategically design national and international research programs to maximize efficacy and work towards an improved understanding of human impacts on seamount ecosystems. CenSeam has provided the opportunity to deliver products that can be used to help resource management and ultimately the conservation of seamount habitats.

The Nexus that Thrives: How Hydrology and Geochemistry at Seamounts Provide Habitats for Microbes.

Emerson, D; Fisher, A; Wheat, G; Moyer, C

Seamounts are dynamic refugia in a comparatively static deep ocean that may provide unique habitats that stimulate microbial growth, especially because of the roles seamounts and basaltic outcrops play in guiding seawater circulation through the crust. As seawater circulates through the crust it interacts with the permeable basalt providing a supply of nutrients, and a redox potential suitable for a range of microbial metabolisms. Such seawater circulation systems are driven by a set of distinct hydrodrogeologic classifications (magmatic inputs of heat, lithospheric cooling, and compression) resulting in a range of fluid compositions, from high temperature (400ºC) to cool (2ºC), from acidic (pH 2) to basic (pH 12.5), from reducing to oxygen rich, and from metal rich to metal poor. Despite the potential for these fluids associated with seamounts to host such a wide range of habitats for bacteria and archaea, we know surprisingly little about seamount microbiology. Examples of open questions include, the percentage of seamounts harbor unique microbial communities, or how do hydrothermally-driven microbial communities at seamounts compare to similar communities at mid-ocean ridges? Futhermore, seamounts could make useful natural laboratories for studying such questions as how biogeography may influence microbial diversity.

Loihi Seamount, an active submarine volcano located just SE of the island of Hawai'i, is a well studied seamount, that harbors extensive microbial mat communities that utilize FeII) as a energy source. The Fe-oxidizing microbial populations tend to be dominated by a novel class of Proteobacteria, the 'Zetaproteobacteria'. This type of metabolism and population structure are unique compared to well studied hydrothermal vents on crustal spreading centers, which tend to be dominated by S-oxidizing microbes. However, the same types of communities as found at Loihi appear common at a number of other seamounts scattered around the Pacific Ocean. This is just one example of how the hydrology and geochemistry that is unique to seamounts may provide microbial habitats that are considered unusual only because of our lack of knowledge concerning their existence and abundance.

Mesophotic Alcyonacea on Outer Continental Shelf Banks in the Northwestern Gulf of Mexico

Etnoyer, P J; Hickerson, E L

Deep-water (> 50 m) gorgonians, or sea fans, create complex structural habitat for numerous associated species of fish and invertebrates in an otherwise featureless environment. They are cold and dark adapted, so they are broadly distributed, occurring on continental shelves, slopes, and seamounts throughout the world's oceans wherever suitable substrate exists. Yet, these Alcyonacea are poorly understood. Sea fans have been documented on some of the 130 submerged pinnacles and banks that rise abruptly into the mesophotic zone (50 - 200 m) from a sediment-covered seafloor on the outer continental shelf of the northwestern Gulf of Mexico. Flower Garden Banks National Marine Sanctuary (FGBNMS) is part of this complex. Manned submersible surveys in the 1970's revealed a mesophotic zone (~100 m depth) characterized as sea fan habitat, but taxonomic resolution was poor. Since that time, ~150 remotely operated vehicle transects have been conducted aboard 12 research cruises from 2001-2005. Octocoral species were collected and identified using scanning electron microscopy (SEM) of the diagnostic sclerite morphology. A geo-referenced photo database of ~8500 in-situ images 20-150 m depth was assembled and cross-referenced to voucher specimens, and data were imported to a Geographic Information System at the genus level. ANOVA and Scheffe's test for depth differences indicate a shallow assemblage comprised of Swiftia, Diodogorgia, and Muricea, and a deeper assemblage of Ellisella, Nicella, Hypnogorgia, Caliacis, Thesea, Chironepthya, and Callogorgia. No octocorals occurred shallower than 52 m. We hypothesize that thermal stratification limits the upward boundary of deep growing Alcyonacea. A checklist is provided for 24 octocoral species on FGBNMS and surrounding banks, with plots of relative abundance and depths of occurrence, as well as generic maps of octocoral abundance and diversity.

Seamount Morphology in the South Pacific From Multibeam Bathymetry Data

Jordahl, K

This study investigates the shape, size, and spatial distribution of seamounts in the South Pacific in three study regions: (A) the Rano Rahi Seamount field [Shen et al., 1995; Scheirer et al., 1996; Forsyth et al., 2006], (B) the Foundation Seamounts [Mammerickx, 1992; Devey et al., 1997; Maia et al., 2000], and (C) the Southern Austral Islands [McNutt et al., 1997; Jordahl et al., 2004b].

Bathymetric grids were constructed with a horizontal resolution of 200 m from available multibeam sonar data from over 80 oceanographic expeditions from several countries [Jordahl et al., 2004a] with MB-System [Caress and Chayes, 1996]. Seamounts were identified interactively from bathymetric grids with PICKGUI, a custom graphical user interface in MATLAB. The slope break near the base and summit of each identified seamount was outlined following the methods and criteria of Smith and Cann [1992]. Each seamount is approximated as a truncated cone, the base and summit of which is the circle with area equal to that of the picked polygon for each slope break, centered at the centroid of that polygon. The base and summit circles are not in general concentric. Statistical parameters, including height, volume, flatness and average slope, are calculated for each truncated cone. Area A contains a population of seamounts with generally high flatness (pancake-like), while seamounts in Area B have lower flatness (cone-like). Area C shows a mix of populations, corresponding with the bimodal age distribution of seamounts in the region [McNutt et al., 1997].

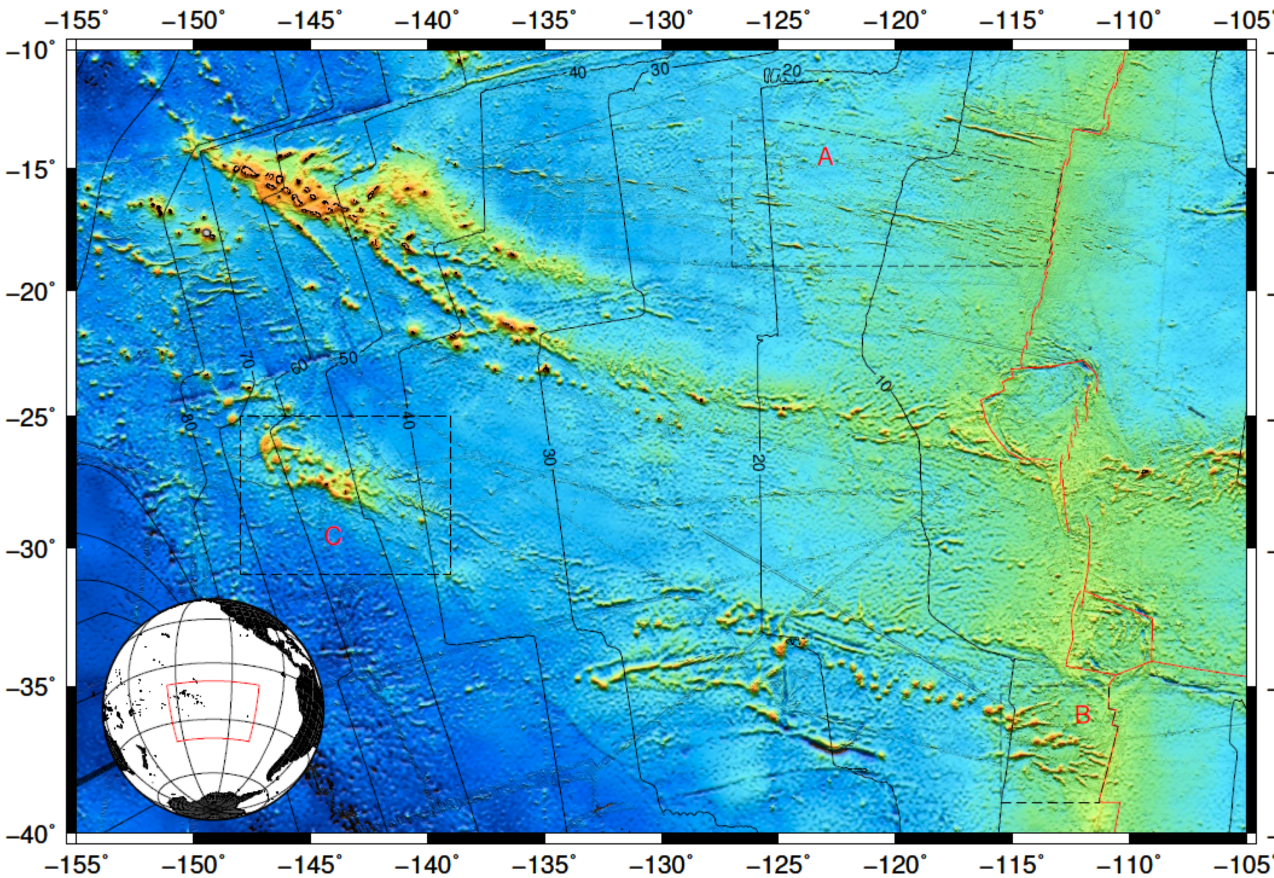


Figure 1. Location map of the three study regions (dashed boxes). Bathymetric map is Smith and Sandwell [1997] predicted topography with multibeam data [Jordahl, 2004]. Seafloor ages [Müller et al., 2008] are contoured in black at 10 Ma intervals, and plate boundaries from Coffin et al. [1998] are shown in red.

Comparison of these results with global datasets of seamounts compiled with satellite altimetry [Wessel, 2001] and with trackline bathymetry [Hillier and Watts, 2007] as well a regional compilation of available datasets for the South Pacific [Allain et al., 2008] allow assessment of the validity of the results, as well as testing the resolution of other databases derived from independent datasets with differing spatial coverage. This study includes 1999 seamounts with heights greater than 100 meters, while the Wessel [2001] database includes 177 seamounts and the Hillier and Watts [2007] database includes 1658 seamounts for the same areas of interest.

The method of manual picking described here is obviously time consuming for large regions, and it would be desirable to combine this method with automated procedures such as those by Kim and Wessel [2008], Hillier [2008], and Behn et al. [2004] in order to extend results to a larger region. Using the bathymetric swaths of the nonrandom ship tracks contained in this study for comparison with statistical distribution of seamounts in the region [e.g., Bemis and Smith, 1993] will require caution.

Acknowledgments: Stephanie Allen and Federico Floridi contributed much of the work of picking seamounts for this study. This work was supported by a grant from the Rose M. Badgeley Charitable Trust to Marymount Manhattan College.

	This Study	*Wessel* [2001]	*Hillier and Watts* [2007]	*Allain et al.* [2008]
Area A Rano Rahi	1056	41	1368	-
Area B Foundation	355	46	125	-
Area C S. Austral	588	90	168	42
Total	1999	177	1658	

Table 1. Comparison of seamount counts with previously published studies. No attempt has been made to normalize by the data coverage within the study areas, so results from different methods are not directly statistically comparable. They should be taken as a minimum count of identified seamounts in each region. Allain et al. [2008]'s compilation does not overlap with study areas A and B.

References

Allain, V., J. Kerandel, S. Andréfoüet, F. Magron, M. Clark, D. Kirby, and F. Muller-Karger (2008), Enhanced seamount location database for the western and central Pacific Ocean: Screening and cross-checking of 20 existing datasets, Deep-Sea Research I, 55, 1035–1047, doi:10.1016/j.dsr.2008.04.004.

Behn, M., J. Sinton, and R. Detrick (2004), Effect of the Galapagos hotspot on seafloor volcanism along the Galapagos Spreading Center (90. 9□–97. 6□W), Earth Planet. Sci. Lett., 217, 331–347, doi:10.1016/S0012-821X(03)00611-3.

Bemis, K. G., and D. K. Smith (1993), Production of small volcanoes in the Superswell region of the South Pacific, Earth Planet. Sci. Lett., 118, 251–262.

Caress, D. W., and D. N. Chayes (1996), Improved processing of Hydrosweeep DS multibeam data on the R/V Maurice Ewing, Mar. Geophys. Res., 18, 631–650.

Coffin, M. F., L. M. Gahagan, and L. A. Lawver (1998), Present-day plate boundary digital data compilation, Tech. Rep. No. 174, University of Texas Institute for Geophysics, 5 pp.

Devey, C. W., R. Hékinian, D. Ackermand, N. Binard, B. Francke, C. Hémond, V. Kapsimalis, S. Lorenc, M. Maia, H. Möller, K. Perrot, J. Pracht, T. Rogers, K. Stattegger, S. Steinke, and P. Victor (1997), The Foundation Seamount Chain: A first survey and sampling, Marine Geology, 137, 191–200.

Forsyth, D. W., N. Harmon, D. Scheirer, and R. Duncan (2006), Distribution of recent volcanism and the morphology of seamounts and ridges in the GLIMPSE study area: Implications for the lithospheric cracking hypothesis for the origin of intraplate, non-hot spot volcanic chains, J. Geophys. Res., 111, B11407, doi:10.1029/2005JB004075.

Hillier, J. K., and A. B. Watts (2007), Global distribution of seamounts from ship-track bathymetry data, Geophys. Res. Lett., 34, L13304, doi:10.1029/2007GL029874.

Hillier, J. K. (2008), Seamount detection and isolation with a modified wavelet transform, Basin Research, 20 (4), 555–573, doi:10.1111/j.1365-2117.2008.00382.x.

Jordahl, K. A., D. W. Caress, M. K. McNutt, and A. Bonneville (2004a), Seafloor topography and morphology of the Superswell region, in Oceanic Hotspots, edited by R. Hékinian, P. Stoffers, and J.-L. Cheminée, pp. 9–28, Springer-Verlag.

Jordahl, K. A., M. K. McNutt, and D. W. Caress (2004b), Multiple episodes of volcanism in the Southern Austral Islands: Flexural constraints from bathymetry, seismic reflection, and gravity data, J. Geophys. Res., 109, doi:10.1029/2003JB002885.

Kim, S. S., and P. Wessel (2008), Directional median filtering for regional residual separation of bathymetry, Geochem. Geophys. Geosyst., 9, doi:10.1029/2007GC001850.

Maia, M., D. Ackermand, G. A. Dehghani, P. Gente, R. Hékinian, D. Naar, J. O'Connor, K. Perrot, J. Phipps Morgan, G. Ramillien, S. Révillon, A. Sabetiand, D. Sandwell and P. Stoffers (2000), The Pacific-Antarctic Ridge-Foundation hotspot interaction: A case study of a ridge approaching a hotspot, Marine Geology, 167, 61–84.

Mammerickx, J. (1992), The Foundation Seamounts: Tectonic setting of a newly discovered seamount chain in the South Pacific, Earth Planet. Sci. Lett., 113, 292–306.

McNutt, M. K., D. W. Caress, J. Reynolds, K. A. Jordahl, and R. A. Duncan (1997), Failure of plume theory to explain midplate volcanism in the Southern Austral Islands, Nature, 389, 479–482.

Müller, R. D., M. Sdrolias, C. Gaina, and W. R. Roest (2008), Age, spreading rates, and spreading asymmetry of the world's ocean crust, Geochem. Geophys. Geosyst., 9, Q04006, doi:10.1029/2007GC001743.

Scheirer, D. S., K. C. Macdonald, D. W. Forsyth, and Y. Shen (1996), Abundant seamounts of the Rano Rahi seamount field near the Southern East Pacific Rise, 15˚ S to 19˚ S, Mar. Geophys. Res., 18, 13–52.

Shen, Y., D. S. Schierer, D. W. Forsyth, and K. C. Macdonald (1995), Trade-off in production between adjacent seamount chains near the East Pacific Rise, Nature, 373, 140–143.

Smith, D. K., and J. R. Cann (1992), The role of seamount volcanism in crustal construction at the Mid-Atlantic Ridge (24˚–30˚ N), J. Geophys. Res., 97, 1645–1658.

Smith, W. H. F., and D. T. Sandwell (1997), Global sea floor topography from satellite altimetry and ship depth soundings, Science, 277, 1956–1962.

Wessel, P. (2001), Global distribution of seamounts inferred from gridded Geosat/ERS-1 altimetry, J. Geophys. Res., 106, 19,431–19,442.

SeaHunt: A Nonlinear Inversion for Seamounts Using the Satellite-Derived Vertical Gravity Gradient

Kim, S S; Wessel, P

Seamounts are ubiquitous manifestations of underwater volcanism that rise above the surrounding ocean floor by more than a few hundred or thousand meters. Any temporal and spatial variations of the underwater volcanic and tectonic processes that formed seamounts can primarily be understood through their geometric characterization and spatial distribution. They passively, but significantly, interfere in ocean currents, propagation of tsunami waves, and water mixing. In addition, they support diverse ecological communities and provide habitats for fish. Some of these volcanic constructs can even pose hazards for underwater navigation. As such, understanding the spatial distribution of seamounts is important for a broad spectrum of scientific and practical interests. Here, we present a nonlinear inversion method to search for seamounts in the satellite-derived vertical gravity gradient data.

Although surface ships have made many exciting discoveries of seafloor morphology, vast areas of the ocean remain uncharted. Additional coverage of ship tracks continues to be made, but a complete global dataset will not be achieved within our lifetime. The most uniform global bathymetry data for the ocean basins are derived from satellite altimetry that measures sea surface heights. The sea surface approximates the geoid, reflecting the mass distribution of sea floor relief. The extra mass of seamounts relative to the surrounding water modifies the gravitational field and causes water to accumulate over seamounts. Such sea surface perturbations can be a few meters high and extend over tens to hundreds of kilometers. While ships cannot detect these signals, orbiting satellites equipped with altimeters can measure them easily. Therefore, processing of satellite altimetry measurements recovers the anomalous gravity signals over seamounts. For our study, we utilize the vertical gravity gradient (VGG, or geoid curvature) version 16.1 derived from satellite altimetry, which gives us better spatial resolution than previous data by a factor of two [Sandwell and Smith, 2005; 2009]. Compared to free-air gravity anomalies, the VGG anomalies over seamounts have stronger amplitudes and readily apparent zero-crossings, making the VGG grid our preferred data set [Wessel and Lyons, 1997; Wessel, 2001].

By approximating the anomalous VGG signals over seamounts by either circular or elliptical polynomial surfaces, we establish a nonlinear inversion problem that seeks to minimize the differences between our model predictions and observations. The model parameters for the circular model are the VGG amplitude, the geographical location of the summit, and the basal radius, while the elliptical model instead needs the major and minor axes of the basal ellipse and the orientation of the major axis. From a sensitivity analysis, we find that this inversion is particularly sensitive to the location and amplitude parameters. Thus, we constrain these parameters using estimates obtained from the observed data and take a step-wise approach for stable inversion, as explained below. The Marquardt method is used for the minimization [Press et al., 1992]. We also impose positivity constraints on the modeled VGG amplitudes and radii using a logarithmic barrier method.

We pre-process the VGG data by performing a regional-residual separation using a spatial median filter with 400 km filter width. Although the VGG data inherently suppress long-wavelength gravity signals caused by deep-seated geological processes, the separation is still a necessary step to isolate small features (i.e., small seamounts) from intermediate-wavelength signals (e.g., Figure 1a). Then, we slice the residual VGG grid horizontally from top to bottom using a small contour increment (i.e., 1 mGal/km) and track how the sliced polygons at the current level change from the previous level. If a potential seamount exists inside the contour, then the sliced polygons are hierarchically overlapping because the lower slices are larger and include all the upper ones. If there is another seamount nearby, a separate set of overlapping polygons will be generated and eventually merged with the other set at the lower contour level. By saving the amplitude that initiates a new set of polygons and the center of the first sliced polygon, we construct the initial estimates for the location and amplitude parameters (Figure 1b). The lowest contour (i.e., base polygon) level is set to 10 mGal/km for this study.

The circular polynomial model is first adopted to predict seamounts in the domain. We examine potential seamounts inside each base polygon separately and test if the inclusion of each seamount results in a statistically significant improvement of the misfit between the data points inside that base polygon and the prediction. Both the unbiased Akaike Information Criterion (AIC) and a standard F-test are employed for the statistical tests. This first inversion solves only for the radii of the seamounts and fixes the other parameters at the initial estimates given by the slicing (Figure 1c). The statistical significance of the seamounts obtained by the first inversion, however, is valid only inside each base polygon. To form a set of statistically significant seamounts at the 95% confidence level, we visit each seamount inside the domain and examine its significance by computing a new misfit that excludes that seamount. The seamount with the lowest score is removed. We iterate this procedure until either of the statistical tests fail. The second inversion takes this set of statistically significant seamounts and solves for the shape parameters of the elliptical polynomial model with fixed location and amplitude. Finally, we refine the given set of seamounts by inverting for all parameters of the elliptical model and arrive at our preferred model for all seamounts studied (Figure 1d).

In summary, this study notably differs from previous methods because it detects seamounts based on statistical criteria in the presence of noise. In addition to the opportunity for finding more seamounts using the improved VGG data, the elliptical polynomial model enables us to approximate seamounts closer to their actual shapes, so that our understanding of the relationships between seamount formation, seafloor age, seafloor fabric and various surrounding tectonic processes can be re-examined. Here we present a preliminary result from a search for seamounts on the Pacific plate. In the near future, this method will be applied to all ocean basins for building a new global seamount database.

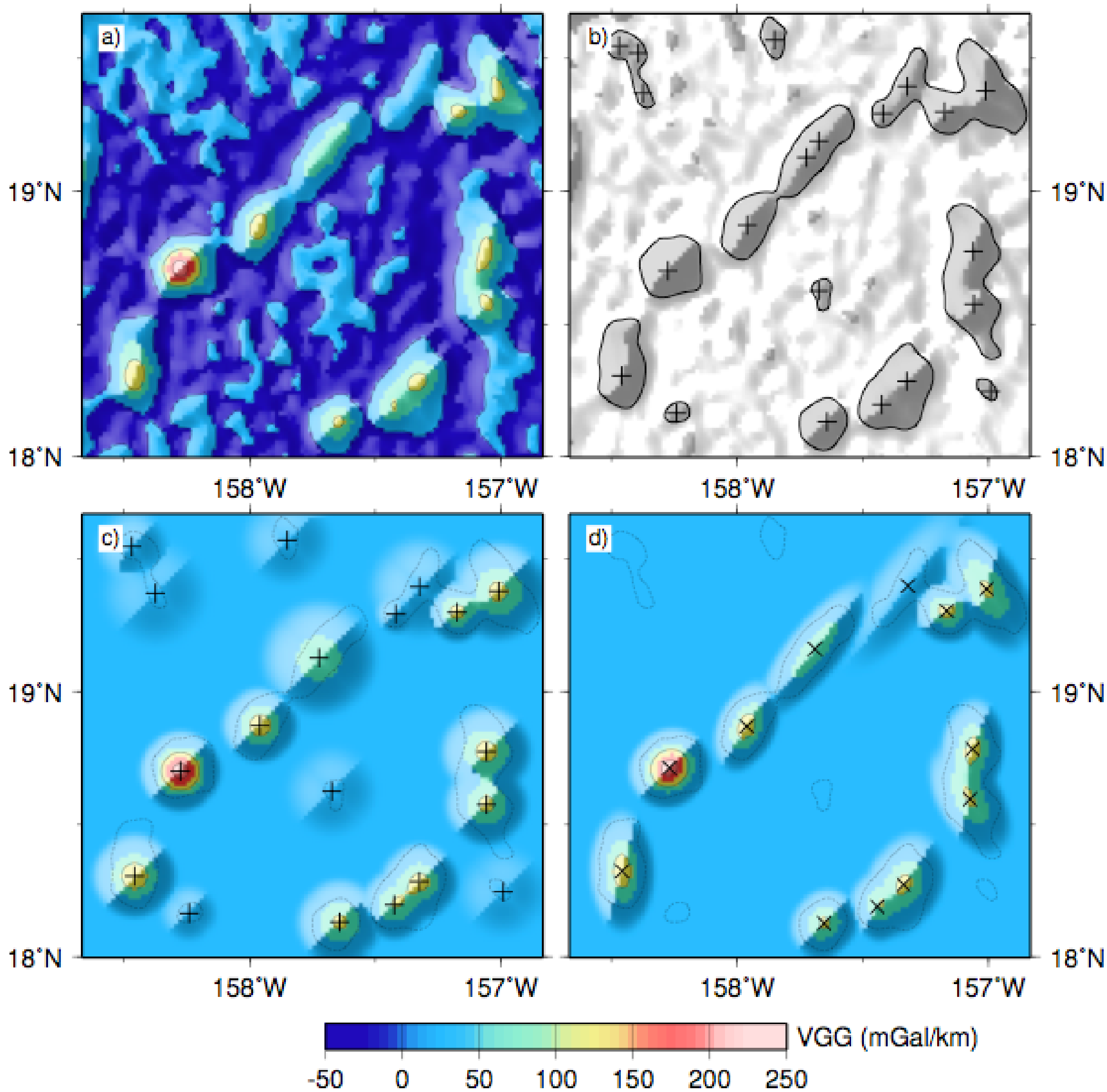


Figure 1. Demonstration of the inversion-based seamount detection method on the Geologists Seamount Group southwest of the Hawaiian Islands. a) Residual vertical gravity gradient (VGG) data. b) Initial locations and amplitudes of potential seamounts generated by the slicing step (see plus marks). The solid lines are the lowest contour level (i.e., 10 mGal/km). Only data points inside these base polygons (gray) are considered when testing for significant seamounts. c) Statistically significant circular polynomial seamounts within their base polygon. Two potential seamounts failed to pass this statistical test (compare plus marks with those in b). d) Elliptical polynomial seamounts. All of the predicted seamounts are statistically significant within the given domain. Their shapes and locations closely approximate the observed data. The dashed lines in c) and d) are the base polygons shown in b).

References

Press, W. H., S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery (1992), Numerical recipes in C: the art of scientific computing, 2nd ed., Cambridge Univ. Press, London.

Sandwell, D. T., and W. H. F. Smith (2005), Retracking ERS-1 altimeter waveforms for optimal gravity field recovery, Geophys. J. Int., 163, 79-89, doi:10.1111/j.1365-246X.2005.02724.x.

Sandwell, D. T., and W. H. F. Smith (2009), Global marine gravity from retracked Geosat and ERS-1 altimetry: Ridge segmentation versus spreading rate, J. Geophys. Res., 114, B01411, doi:10.1029/2008JB006008.

Wessel, P. (2001), Global distribution of seamounts inferred from gridded Geosat/ERS-1 altimetry, J. Geophys. Res., 106, 19,431-19,441.
Wessel, P., and S. Lyons (1997), Distribution of large Pacific seamounts from Geosat/ERS-1: Implications for the history of intraplate volcanism, J. Geophys. Res., 102, 22,459-22,476.

The Role of Seamounts in Unraveling Intraplate Volcanic Processes

Konter, J G

The existence of a large number of linear seamount chains is a testament to the intraplate volcanic activity, taking place in the ocean basins. Although this type of volcanism has been studied in detail mostly on volcanic islands, seamounts provide a much larger number of targets that represent more average erupted volumes of melt. In addition, the seamounts extend our ability to study volcanic activity along volcanic chains from small islands groups to significantly longer chains. Moreover, not every seamount chain contains volcanoes that may be sampled above sealevel, implying a larger number of intraplate volcanic systems may be (and indeed has been) sampled. Since these seamounts also represent examples of smaller volcanoes, their internal structure may be less complicated as well. As a result data gathered from seamounts allows us to investigate intraplate melting over a longer geological time period, while also providing less complicated, or early (single) stages of volcanic development.

Intraplate melting has provided some significant constraints, through a range of geochemical and geophysical data, on both the cause for melting in this setting, and on the overall temporal and geospatial heterogeneity of the mantle. Particularly, some of the longest volcanic chains can provide these types of data. For example, the Hawaiian-Emperor chain yielded a geochemical record of mantle compositions for ~80 Ma, while geophysical data suggest that the actual source location may have migrated through time (Tarduno et al., 2003; Regelous et al., 2003). Therefore, suggestions have been made that melting here may be caused by a migrating mantle plume, or lithospheric cracks, while the source material displayed a range in composition, similar to the Hawaiian islands. An even longer record is available in the discontinuous chains of the SW Pacific, where Cretaceous age seamounts seem to be related to currently active volcanism in the Austral-Cook Islands. The geochemical compositions (Pb-Sr-Nd-Hf) and ages of these seamounts, combined with several absolute plate motion models, suggest that intraplate melting has produced lavas in three compositionally distinct but persistent areas over ~100 Ma (Konter et al., 2008a). Not only do these data provide a record of the geochemical composition of the mantle over ~100 Ma, but we have also suggested that the persistence in composition in the three different areas is most easily explained with a plume instead of lithospheric cracking. Therefore, seamount geochemistry has contributed significantly to the debate on the origin of intraplate volcanism.

Seamount data can also assist in developing a better understanding of the internal structure of intraplate volcanoes. One of the best examples of this role is Loihi Seamount, providing us with an active Hawaiian volcano in the early stages of its development (e.g. Clague and Dalrymple, 1987). However, seamount structure is also important in more complicated settings, such as that of Samoan volcanoes. The Samoan volcanoes seem to consist of a volcanic shield whose age and chemistry fits with a plume origin, while late-stage eruptions might be related to the proximity to the Tonga trench (e.g. Koppers et al., 2007). As a result, interpretation of the magmatic processes at play in a volcano such as Savaii appears relatively complicated in major element compositions, while younger Samoan seamounts seem far less complicated (Figure 1). We have applied a new Fe isotope measurement technique to compliment a major element comparison in order to examine the magmatic history of Savaii (Konter et al., 2007; Konter et al., 2008b). Although Fe isotopes have mostly been used as tracers in low temperature processes, recent data show a fractionation effect during olivine crystallization in Kilauea Iki Lava Lake (Hawaii; Teng et al., 2008). The associated trend in Mg# vs. Fe isotope compositions of the evolving melts provides a basis to explain the otherwise poorly correlated Fe isotope data from Savaii (Figure 2). Olivine addition to the melts displacing the melts from the Mg#-Fe isotope curve provides a reasonable explanation that agrees with observations of some resorbed olivine crystals (Workman et al., 2004) and possible interpretations of major elements (Natland, http://www.mantleplumes.org). Therefore, different stages in the complex Savaii volcano may be interpreted with (major element) compositional comparisons with simpler younger seamounts, and additional constraints from new systems such as Fe isotopes. The younger seamount provides a basic magmatic model that is perturbed in the case of Savaii, where the perturbing process is constrained with abundance and isotopic data.

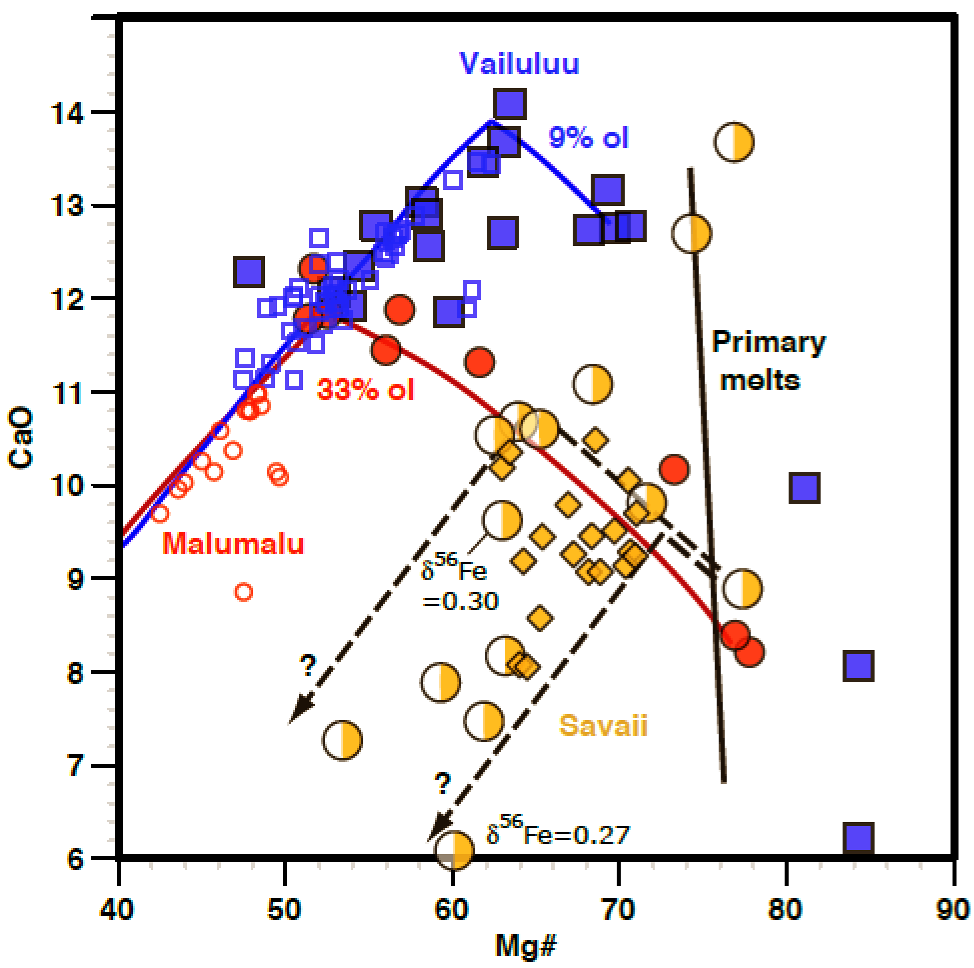


Figure 1. Mg# vs CaO for Samoan lavas. Vailulu'u Seamount suggests olivine (ol) fractionation, followed by clinopyroxene (cpx) and plagioclase (plag). Modeling (%) from Workman et al. (2004) suggest varying degrees of olivine fractionation prior to clinopyroxene saturation. Savaii shows more complicated evolution. Data from Workman et al. (2004) and Jackson et al. (2007); (half-) filled symbols are whole rocks, open symbols are glasses. Yellow diamonds are subaerial lavas, all other submarine.

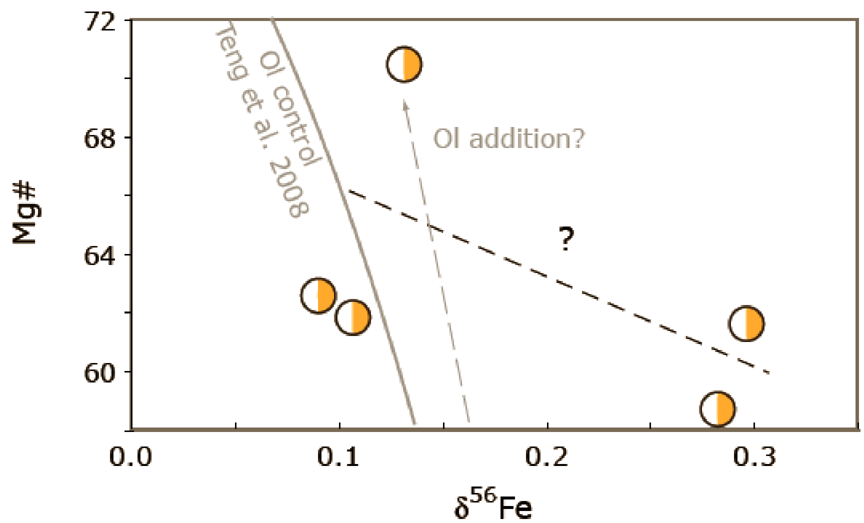


Figure 2. δ56Fe versus Mg# for Savai'i. The direct correlation (black dashed line) is not very good. Data in this δ56Fe-Mg# plot might be explained with deviations from liquid δ56Fe evolution, due to olivine addition. Data (except δ56Fe) from Jackson et al. (2007).

References

Clague, D.A., and G.B. Dalrymple (1987), The Hawaiian-Emperor volcanic chain, Part I: Geological evolution, in Volcanism in Hawaii, U.S. Geol. Surv. Prof. Pap. 1350(1), edited by R. Decker et al., 5-54, U.S. Printing Office, Washington.

Jackson, M.G., Hart, S.R., Koppers, A.A.P., Staudigel, H., Konter, J., Blusztajn, J., Kurz, M., Russell, J.A., 2007, The return of subducted continental crust in Samoan lavas, Nature, 448, 684-687.

Konter, J.G., Pietruszka, A.J., Hanan, B.B., 2008b, Development of a 58Fe-57Fe double spike for Fe isotopic analysis using a Nu Plasma 1700 MC-ICP-MS, Geochimica et Cosmochimica Acta, 72, Supplement 1, A489.

Konter, J.G.; Hanan, B.B., Blichert-Toft, J., Koppers, A.A.P., Plank, T., Staudigel, H., 2008a, One hundred million years of mantle geochemical history suggest the retiring of mantle plumes is premature, Earth Planet. Sci. Lett., 275, 285-295.

Konter, J.G., Pietruszka, A.J., Hanan, B.B., 2007, Fe isotopic analysis by a Nu Plasma 1700 MC-ICP-MS with a 58Fe-57Fe double-spike, Eos Trans., AGU 88(52) Fall Meet. Suppl., Abstract V51B-0567.

Koppers, A.A.P., Russell, J.A., Jackson, M.G., Konter, J.G., Staudigel, H., Hart, S.R., 2008, Samoa reinstated as a primary hotspot trail, Geology, 36, 435-438.

Regelous, M., Hofmann, A.W., Abouchami, W., and Galer, S.J.G., 2003, Geochemistry of lavas from the Emperor Seamounts, and the geochemical evolution of Hawaiian magmatism from 85 to 42 Ma, J. Petrol., 44, 113-140.

Tarduno, J.A, Duncan, R.A., Scholl, D.W., Cottrell, R.D., Steinberger, B., Thordarson, T., Kerr, B.C., Neal, C.R., Frey, F.A., Torii, M., Carvallo, C., 2003, The Emperor Seamounts: Southward motion of the Hawaiian hotspot plume in Earth's mantle, Science, 301, 1064 – 1069,

DOI: 10.1126/science.1086442.

Teng, F.-Z., Dauphas, N., Helz, R.T., 2008, Iron isotope fractionation during magmatic differentiation in Kilauea Iki Lava Lake, Science, 320, 1620-1622.

Workman, R.K., Hart, S.R., Jackson, M., Regelous, M., Farley, K.A., Blusztajn, J., Kurz, M., Staudigel, H., 2004, Recycled metasomatized lithosphere as the origin of the enriched mantle II (EM2) end-member: Evidence from the Samoan Volcanic Chain, Geochem. Geophys. Geosyst., 5, doi:10.1029/2003GC000623.

Seamounts as a Link Between Geochemistry, Geophysics, Tectonics, Geohazards and Bio-Evolution

Koppers, A A P; Watts, A B; Staudigel, H; Clague, D A

Seamounts are prominent geological features found throughout the major ocean basins. There are probably close to 200,000 seamounts of considerable height above the seafloor. Even though only a very small fraction of all these seamounts have been surveyed and studied, seamounts offer a much-used window that has played a major role in defining our views concerning solid Earth geophysics, geochemistry, geodynamics and plate tectonics. However, seamounts remain largely unstudied for their profound interactions on ocean currents, their role in generating geohazards and influencing tsunami wave propagations, the potential substantial geochemical fluxes between seawater and basalt, and the reasons why seamounts attract such a wide range of marine life from microbes to metazoans.

Through recent seamount research key advances have been made in our understanding of (i) how seamounts are formed volcanically, structurally and chemically, (ii) changes in the thermal and mechanical properties of oceanic lithosphere on which seamounts are formed, (ii) absolute plate tectonic motions and relationships between plate motion, plume motion, whole-Earth motion and mantle convection, (iii) partial mantle melting in mid-plate tectonic settings, and (iv) the chemical development and heterogeneity of the Earth's mantle. Current research efforts focus on resolving the fundamental differences between magmas generated by passive mantle upwelling and active deep mantle plumes, on mapping out the different styles of deep mantle upwelling, on reconciling fixed and non-fixed hotspots, and on understanding the long-term evolution of seamount trails, increased heat flow near seamounts, absolute plate tectonic motions, plate extension and mantle convection modes. Seamounts also are gaining renewed interest in studying geohazards related to large-scale collapses of seamount flanks, possibly generating tsunamis, and to seamount subduction, perhaps acting as barriers or triggering large magnitude earthquakes. With more than 6,000 seamounts larger than 1,500 m located in the world oceans, seamount trails may also act to scatter or amplify tsunami waves. Finally, seamounts attract many forms of life that are controlled by yet poorly-understood boundary conditions given by their volcanic or geologic development, their rock and hydrothermal geochemistry, and oceanographic setting.

Many key questions remain unanswered, whereby seamounts play a pivotal role in increasing our overall understanding of the geodynamical and biological Earth. For example, can a single simple model of a hotspot fed by a long-lived and stationary mantle plume explain intra-plate volcanism? Do hotspots move and where in the mantle do plumes originate? What does this mean for mantle convection? Are seamount chains tracing the tail of a mantle plume following the production of large-igneous provinces after plume-heads reached the Earth's surface? Can we use the geochemical history of seamount chains to better understand mantle melting and the causes for mantle geochemical heterogeneity? When seamounts subduct do they contribute significantly to the geochemistry of the subduction zone volcanic factory? Does seamount subduction amplify or diminish the changes of large seismic and tsunami events? Are seamounts the chemical chimneys of the oceanic crust (and underlying mantle) and what are the consequences for the seamount biology? Is there a relationship between the geological and hydrothermal boundary conditions at seamounts and the development of life? Are Seamounts major hosts to a deep ocean crustal biosphere? What are the relations between geological settings on a seamount and the corresponding expressions of life? Can we use these relations to find global estimates for biomass, biodiversity and the overall bio-contribution to chemical fluxes?

Much less than 1% of the roughly 47,000 seamounts taller than 500 m in the world oceans have been mapped by shipboard soundings, sampled or analyzed. Before we can start to answer the multitude of unanswered questions, or start to refine our scientific models, we will have to collect a vast amount of more geochemical, geophysical and biological data. This leaves the oceans wide-open for future seamount exploration!

Ocean Circulation, Transport and Mixing at Seamounts and Biological Consequences

Mohn, C; Lavelle, B

Oceanic seamounts are commonly considered as offshore hotspots of marine life unifying a wide range of biological processes and phenomena at a comparatively small spatial scale. These include aggregations of biomass, locally enhanced biodiversity and increased levels of primary and secondary production. The classical view is that bio-physical coupling mechanisms (e.g. Taylor caps, anti-cyclonic circulation cells, upwelling, increased vertical mixing) may promote extended particle residence times to ultimately support aggregation and retention of biological material. However, there is little direct evidence that such an idealized situation really exists and that it can be maintained over a longer period. Previous studies have shown that the existence and stability of local seamount regimes are highly sensitive to changes in the physical environment: Their retention potential strongly depends on the relative importance of a number of parameters such as forcing amplitude, ambient stratification and seamount height. In addition, the definition of seamount effects should not be restricted to local and small-scale implications. It has to embrace a wider spectrum of biological phenomena associated with the potential influence of seamounts on the larger surrounding ocean on a scale of hundreds of kilometers. In this keynote, we review the major characteristics and basic dynamical concepts of the flow at isolated topography. We also present the sensitivity of the flow at seamounts to changing environmental conditions as well as factors influencing particle residence and patchiness development.

Seamounts Effect on Aggregating Visiting Species

Morato, T et al

It has been suggested that seamounts hold higher abundances of some"visiting" animals, such as tuna, sharks, billfishes, marine mammals, sea-turtles and even seabirds, but this has been based on sparse records, warranting further examination. In this paper we (1) characterized the seamount distribution of the Economic Exclusive Zone of the Azores and (2) examine whether the predicted higher abundances of tuna, marine mammals, sea turtles and seabirds actually occur around those mapped seamounts. Our algorithm showed that peaks and seamounts are common features in this region of the North Atlantic. Sixty three large and 398 small seamount-like features are mapped and described in the Azorean EEZ. Our results indicate that some marine predators (skipjack and bigeye tuna, common dolphin and Cory's shearwater) were significantly more abundant in the vicinity of some mapped shallow-water seamount summits. Our methodology, however, failed to demonstrate a seamount association for bottlenose dolphins, spotted dolphin, sperm whale, terns, yellow-legged gull, and loggerhead sea turtles. Not all seamounts, however, seemed to be equally important for these associations. Only seamounts shallower than 400 m depth showed significant aggregation effects. These seamounts may be considered hotspots of marine life in the Azores and a special effort should be made in order to ensure a sustainable management of these habitats.

Applying an Ecosystem Evaluation Framework for Seamount Ecology, Fisheries and Conservation

Pitcher, T J; Morato, T

Pitcher and Bulman (2007) and Pitcher et al. (2007) developed a two-partEcosystem Evaluation Framework (EEF) for seamounts by pulling together information available from different sources. The first part scores the extent of our knowledge about individual seamounts while the second part assesses the severity of a range of threats to the abundance and diversity of living organisms found at individual seamounts. EEF can be very useful in the context of global seamount research because: 1) it will help identifying important seamount characteristics; and 2) it will identify seamounts in different states of conservation; 3) it will highlight gaps in our understanding of general seamount ecosystems but also at an individual level; 4) it will promote seamount data synthesis; and 5) it will thus use and contribute to extend online datasets such SeamountsOnline.

Fisheries, On their way to Sustainability?

Pitcher, T J

We have only sparse knowledge of the fisheries ecology of seamounts partly because of the difficulty of field research and partly because fishing occurs in remote high seas areas. This paper reviews what we know of the extent, status and prospects for seamount fisheries.

In the 1970s, new technology enabled trawling of small, steep, rough seamount flanks. Since then, serial depletion has been the norm world-wide. A global spatial algorithm estimates annual catches peaking at 1.2 million tonnes in the mid 1990s, while catches of secondary seamount fish, currently 3 million tonnes per year, are still increasing. Catch reconstructions from 29 seamount regions reveal massive historical exploitation by large-scale distant water fleets from the Soviets and Japan. Almost no large-scale seamount fisheries have proven sustainable; the exceptions are a few low volume, high value seamount fisheries in developed countries. Moreover, many fishing operations have serious physical impacts on slow-growing, long-lived organisms forming biogenic habitat, so that recovery from fishing impacts is slow. Desirable sustainability features can be found in small-scale fisheries on seamounts from local island nations, often accompanied by bans on bottom trawls: they catch about 0.25 million tonnes/year.

Trophic web and biogeochemical simulation models suggest that horizontal immigration of allochthonous micronekton may be sufficient to sustain the rich fish communities living on seamounts. Recent field work has supported the hypothesis that these communities are enriched by transient foraging visitors in the form of fish, marine mammals and seabirds. Seamount communities may have a characteristic bimodal trophic signature as a consequence. An integrated method of evaluating the current status of individual seamounts, an Ecosystem Evaluation Framework (EEF), aims to assesses the extent of knowledge and the severity of threats to the abundance and diversity of living organisms found at individual seamounts.

Fishery management responses to serious depletion have been lamentably few: some local no-take and no-trawl zones at a few tens of seamounts implementing an ecosystem approach that covers non-target species and a range of deep-sea habitats. But if nothing more is done, we are sure to see continued depletion, collapses, and disruption of seamount biodiversity and ecosystem function for generations to come. If the world's seamounts were managed sustainably today, what fishery yields might be possible? Preliminary spatial modeling suggests that only about 150,000 tonnes might be extracted annually. If seamounts were to be restored to pre-1970s levels, over a million tonnes might be fished sustainably.

Scientific Research and Conservation of Seamounts in the Azores and the North-East Atlantic Region

Santos, R S; Morato, T; Afonso, P; Porteiro, F; Carreiro e Silva, M; Tempera, F; Menezes, G

The Azores are located at a plateau in the north-east Mid Atlantic Ridge. They are formed by 9 islands, a set of small islets and numerous submerged seamounts, all from volcanic origin back to around 8 million years and active to date. The Azores are also part to the OSPAR Region V or wider Atlantic.

In this presentation we give an overview of the human activies with actual or potential impact in seamounts, mainly fisheries, their actual status and the existing legal framework and special regulations put in place for the management and conservation of seamount habitats and seamount living resources. Reference is made to the OSPAR network of MAPs and their high-seas component.

The EC is now leading a strategic paper "The Deepsea Frontier" which is having consequence on the research funding of the 7Th Frame Work Program. Following important steps initiated by research projects like OASIS and HERMES a new set of new integrated research projects are now in place, following the calls made by EC-DGR, talkling the exploration of seamounts of the wider Atlantic and the Mediterrranean. e.g. MADE, CoralFish, HERMIONE, DEECON, etc.

The Azores are also leading national and bi-lateral research projects, e.g. CORAZÓN and CONDOR. This last one is a plan for the installation of a seafloor and water column observatory at the Condor seamount.

Seamount Laboratories: Enabling the Understanding of Connectivity, Evolution, and Endemism: Challenging Paradigms and Informing Conservation

Shank, T

Seamounts around the world are currently threatened by destructive fishery practices (e.g., trawling and long-lining), placing a premium on understanding the ecological and evolutionary processes structuring the resiliency and connectivity of seamount species. Using seamounts as natural laboratories, we can study the impacts of geographic and hydrographic separation, depth zonation, habitat availability, species-specific physiological limitations and life histories, and ocean circulation patterns on the: 1) connectivity of commercially important species; 2) historical migration of marine fauna in response to climate change and the 3) design of conservation strategies informed by modern rates of genetic connectivity. As part of understanding this approach, the ecological and evolutionary processes that structure and maintain the diversity and evolution of seamount fauna will be discussed in light of established yet young paradigms relating seamounts as: a) islands of endemic fauna, and b) centers of isolation or of decreased connectivity (leading to genetic divergence, speciation, and relict faunas). Recent observations and genetic data are challenging these paradigms and providing new insights and perspectives that will inform the next paradigm to be integrated into future conservation efforts. These results, including ongoing work comparing the co-evolution and co-dispersal of coral invertebrate associates and their coral hosts, whose life histories are directly intertwined, underscore the importance of future decisions by managers concerned with the protection of oceanic biodiversity.

Invertebrate Assemblages of Deep-Sea Corals on Seamounts in the Gulf of Alaska

Shirley, T C; Kilgour, M; Baco, A R

Introduction

Invertebrates associated with deep-sea corals on five seamounts in Kodiak-Bowie seamount chain in the northern Gulf of Alaska were investigated with the DSV Alvin in August 2004 as part of NOAA cruise AT 11-15. Our goals were to compare differences in species richness, composition, and abundance of macroinvertebrates as a function of host coral species and depth, and to compare differences in assemblages between seamounts.

Experimental Methods

Replicate video transects of 500 or 200 m were made with the DSV Alvin at depths of 700, 1700 and 2700 m on each seamount. Summit heights varied from 417 to 1098 m and bottom depths from 2928 to 3660 m. Transect locations were selected from multi-beam mapping to occur along ridges, as corals occur in higher abundance in areas of higher current flow. After completion of video transects, voucher specimens of corals and invertebrates were photographed in situ, then collected at each depth with hydraulic arms, nets, traps and slurp guns; many invertebrate specimens were discovered and collected from corals only aboard ship. Temperature, salinity and dissolved oxygen were collected from Niskin water bottles on the submersible and from CTD casts.

Results and Discussion

At least 12 metazoan phyla were represented from collections on 43 coral species on the five seamounts. Highest abundances of corals and invertebrate assemblages occurred at the shallower depths. Bathymetric zonation of some species was related to oxygen minima zones. Oxygen content decreased abruptly beginning at 200 m, with an oxygen minima zone as low as 4% saturation extending from 500-1500 m; oxygen increased to 30-40% saturation below the minima. Temperature varied from 15 C at the surface to 1 C near the bottom (3000 – 3660 m). Salinity varied slightly, from 32 to 35 near the bottom.

Most invertebrates on corals were presumed to be suspension feeders. Ophiuroids, including unbranched basketstars (Asteronyx sp.) were conspicuous and abundant invertebrates associated with corals, occurring in high densities on some coral species. At least 10 species of asteroids were identified, with 3 species observed consuming corals. Polynoid polychaets (Malmgrenniella sp.) were especially abundant on paragorgid corals. Crustaceans, particularly shrimp (Heptacarpus sp.), chirostylid crabs (Gastroptychus iaspus) and ophiuroids (Amphigyptis sp. and Ophiomoeris sp.) were common epibionts of some corals. Some species, particularly ophiuroids, were restricted to narrow depth ranges, but were replaced by ecomorphs at deeper depths. Some invertebrates were associated only with particular coral taxa. A few invertebrates displayed allopatry: Gastroptychus iaspus and Asteronyx sp. were allopatric except on a single coral species, Paragorgia sp.

Conclusion
Many of the coral and other invertebrate species were new to science or previously poorly known, and many represent range extensions both in latitude and depth. The corals provided habitat complexity and elevated locations above the benthos for a variety of invertebrates. Larger corals generally supported higher numbers of epibionts, however even some small corals supported high densities. One small (15 cm tall) primnoid had >700 Amphigyptis brittle stars. Many invertebrates were only on corals and not observed on surrounding substrate, yet some coral species were free of epibionts. Conversely, some species occurring on rock or sediment substrates were never observed on corals. Many invertebrates displayed strong preferences for particular coral species. The allopatry observed in some epibiont species must result from competitive or agonistic interactions. The oxygen minima zone had pronounced effects on the distribution of some species, however many of the suspension feeders appeared in high density within it.

SeamountsOnline: A Newly- Expanded Community Resource for Seamount Biodiversity Data
Stocks, K I

SeamountsOnline (http://seamounts.sdsc.edu) is an online resource for researchers and managers seeking data on the biodiversity of seamounts. The site brings together data on species that have been sampled or observed from seamounts and makes these data freely available through a searchable website.

Information on the biology of different seamounts is important for supporting both scientific research and good resource management. SeamountsOnline is the database component of the Global Census of Marine Life on Seamounts (CenSeam; http://censeam.niwa.co.nz/), which has the mission "To determine the role of seamounts in the biogeography, biodiversity, productivity, and evolution of marine organisms, and to evaluate the effects of human exploitation on seamounts." SeamountsOnline is also a tool to assist management. Many seamounts are being heavily fished with potentially destructive gear. Managers are making decisions about whether to protect seamounts as special habitats, which seamounts to protect, what management mechanisms will be most appropriate, and on what scales management should occur.

Both research and management need information on what species have been found on different seamounts, but these data can be difficult to find and access. Several hundred seamounts have been sampled biologically, but the results have been published in numerous journals and difficult-to-access reports around the world. The actual data are often published only in summary form, if at all. SeamountsOnline is making these data available by entering them into a standard database and making the database accessible online. The data come from published sources, and also from the electronic datasets of seamount researchers, oceanographic research centers, and natural history collections. All data are fully credited to the original source.

SeamountsOnline has just released a new and expanded data portal. Through this interface, users can search for species records based on the seamount name or location (Fig. 1), a species name or higher taxonomic category, a region such as a particular country's Exclusive Economic Zone (Fig. 2), or by seamount summit depth (an important characteristic when planning future expeditions with equipment that has depth limits). Results are plotted on a map, and provided as downloadable data tables and a browsable taxonomic tree.

SeamountOnline is a work in progress and is continually expanding with new data. The project welcomes contacts from researchers and organizations with seamount biological data that they may be willing to share.

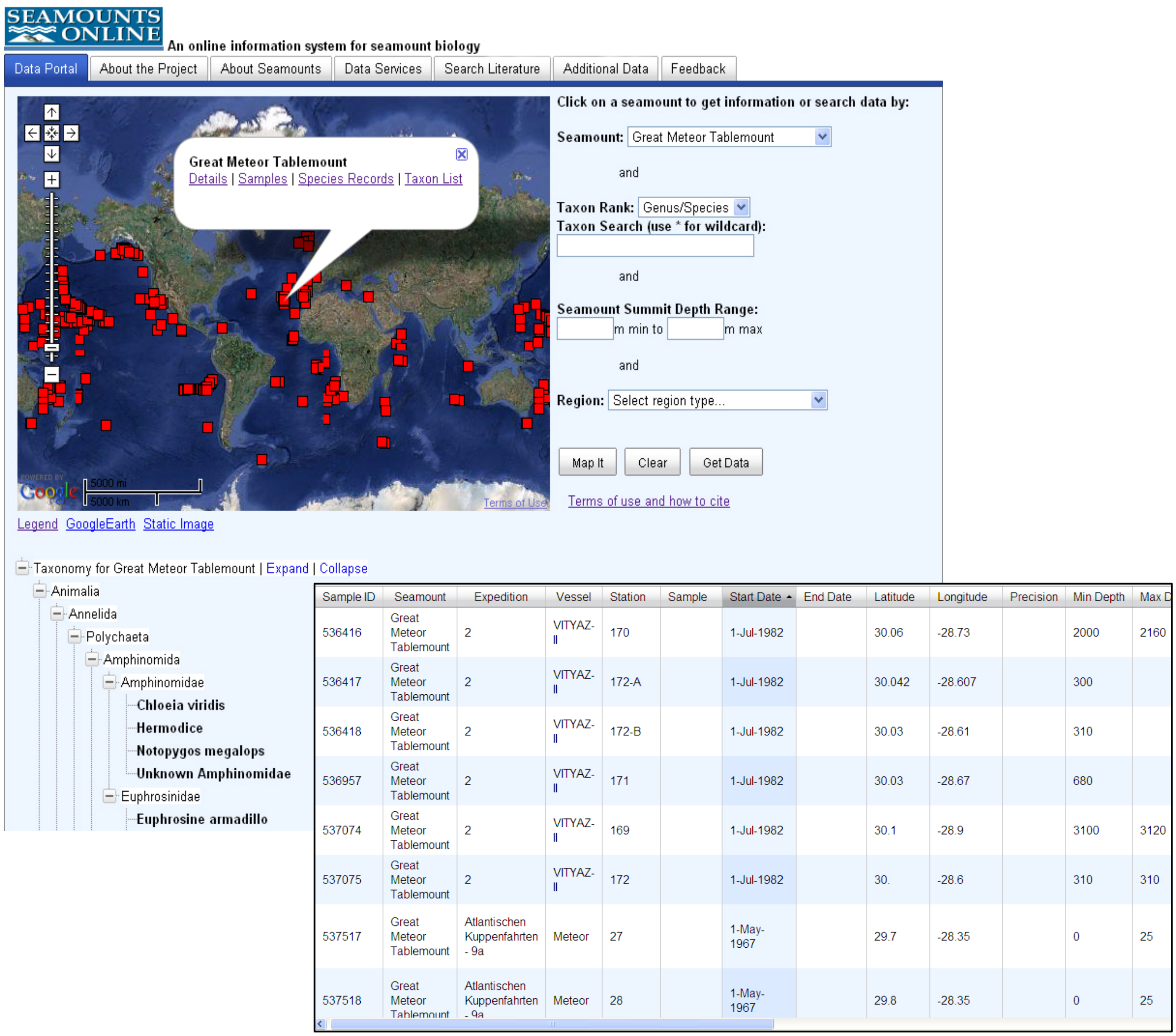
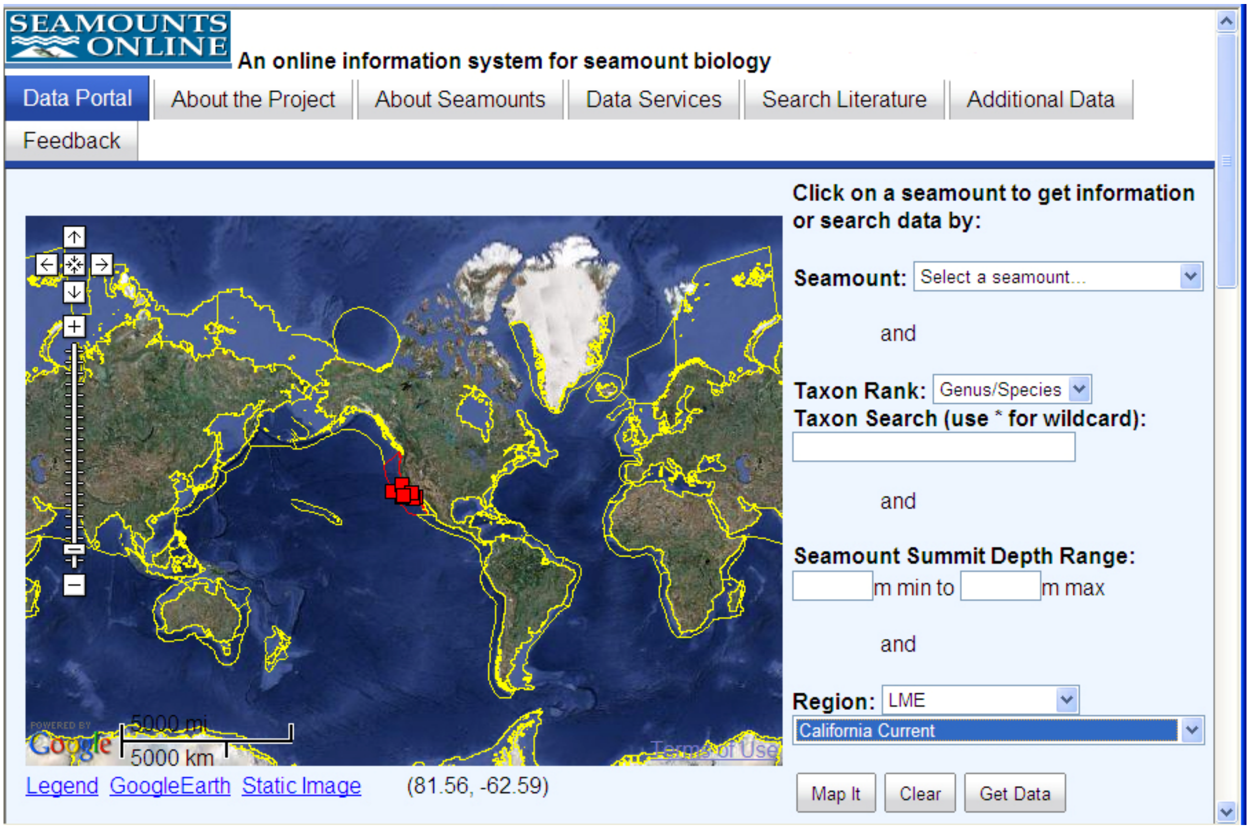


Figure 1. The SeamountsOnline interface, showing the data available for a search on "Great Meteor Tablemount" the taxonomic tree of species found, and a pop-up table of sample information.



Name	Height	Summit Depth	Latitude	Longitude	Region	Notes	Samples	Observations
Davidson Seamount			36	-123	NE Pacific		Samples	Species Found
Ferrel Seamount	2,650	1,370	30	-117	NE Pacific	The seamount volume is 1687km^3 according to [1951].	Samples	Species Found
Fieberling Tablemount	4,150	438	32	-128	NE Pacific	This seamount has a plateau at ~ 500 m with a pinnacle to 438 m. The plateau breaks to steep sloping sides at ~600-1000m [120]. The substrate is comprised of basalt. Near-bottom flow disturbances (turbidity, anticyclonic circulation), don't penetrate to surface; no taylor columns [120]. W edge of the California current, mean flow of 5cm/s. Unstable lrg-scale flow, synoptic time scale 50cm/s meander/shed eddies [597].	Samples	Species Found
Jasper Seamount	3,750	576	30	-123	NE Pacific	This seamount has a plateau diameter of 30km [from Genin et al. 1986 as reported in 1095].	Samples	Species Found
Johnson Seamount			30	-116	NE Pacific		Samples	Species Found
SAUP 6373			31	-122	NE Pacific		Samples	Species Found
Sixtymile Bank	1,600	100	32	-118	NE Pacific	Located where a branch of the CA current turns N to form the cyclonic S.CA Eddy and Countercurrent, currents SE 18cm/s and associated w strong NE-SW gradient in temp and salinity across region [597].	Samples	Species Found
West Bonanza Seamount		2,700	31	-122	NE Pacific	This seamount may be part of Bonanza seamount	Samples	Species Found

Figure 2. The SeamountsOnline interface showing a search of the California Current Large Marine Ecosystem (top) and the seamount data returned from this search.

Geochemistry of Abandoned Spreading Center Lavas Off Baja California: Implications for Intraplate Magmatism in Eastern Pacific

Tian, L; Castillo, P R; Lonsdale, P F; Hilton, D

Abundant volcanism at active spreading centers is caused by adiabatic decompression melting of the upper mantle, but the origin of volcanism at abandoned spreading centers is an enigma. Sara, Rosana, Rosa, and Nithya seamounts are volcanoes built on abandoned spreading centers between 26°N and 29°N in the eastern Pacific, offshore Baja California. We analyzed the major and trace element and Sr, Nd and Pb isotope geochemistry of whole rock samples dredged from these four seamounts during Pheonix 03 SeaBeam Experiment on R/V Revelle in 1992 and Rosa 01 Student Training Expedition on R/V New Horizon in 1993. The main objectives of our study are to constrain the petrogenesis of lavas from abandoned spreading centers and the origin of intraplate magmatism in the eastern Pacific as a whole.

Lava samples from the intraplate seamounts comprise predominantly of mildly to moderately alkalic basalts and their differentiates. All the lava samples are enriched in incompatible trace elements and thus have enriched REE_{CH} patterns, with light REE enrichment up to 300X chondrites. Relative to mid-ocean ridge basalts (MORB) from the East Pacific Rise (EPR), they have higher abundances of incompatible elements and higher highly/moderately incompatible trace element ratios (e.g., Ba/Zr and Nb/Zr). These trace element characteristics combined with their moderately radiogenic Sr, Nd and Pb isotopic compositions indicate they originated from a geochemically enriched mantle source. In detail, the lavas have a moderate range of composition that overlaps with those of lavas from other spreading centers (e.g., Davidson Seamount - Davis et al., 2002), tholeiitic to alkalic seamounts near the EPR (e.g. Niu et al., 2002), and other seamounts offshore southern California (e.g., Pioneer, Rodriguez – Davis et al., 1995, 2002). The $^{87}Sr/^{86}Sr$, $^{143}Nd/^{144}Nd$ and Pb isotopic compositions of Sara, Rosana and Nithya seamount lavas greatly overlap with those of EPR seamount lavas, but those from Rosa seamount lavas are within the HIMU field for ocean island basalts (OIB).

In general, lavas from abandoned spreading centers and from other isolated intraplate volcanoes in the eastern Pacific define a compositional continuum ranging from normal-MORB-like to OIB-like. This compositional continuum indicates that the suboceanic mantle in the eastern Pacific is compositionally heterogeneous. A popular view is that the suboceanic mantle contains volumetrically small and easily meltable components enriched in volatiles, alkalis and other incompatible trace elements that are randomly distributed in a depleted matrix. We propose that the compositional spectrum of intraplate volcanic lavas is due to different degrees of partial melting of this compositionally heterogeneous suboceanic mantle. A relatively large degree and voluminous partial melting of the heterogeneous mantle during vigorous mantle upwelling produces normal-MORB-like melts (e.g., tholeiitic near-ridge seamount basalts), whereas a small degree of partial melting during "weak" mantle upwelling (e.g., bouyancy-driven upwelling) produces OIB-like melts (e.g., alkalic near-ridge seamount and abandoned spreading center basalts).

References

Davis, A., Gunn, S., Bohrson, W., Gray, L.-B. and Hein, J., GSA Bulletinl. 107, 554–570 (1995).
Davis, A., Clague, D., Bohrson, W., Dalrymple, B., and Greene, G., GSA Bulletin, 114, 316–333 (2002).
Niu, Y., Regelous, M., Wendt, I., Batiza, R., and O'Hara, M., Earth Planet. Sci. Lett. 199, 327-345 (2002).

Paleomagnetism of Seamounts in the West Philippine Sea, Shikoku Basin and Western Pacific: New Foundings and Geophysical Implications

Ueda, Y

Sea surface magnetic surveys conducted by the Hydrographic and Oceanographic Department of Japan covering Western Pacific reveal the detailed features of magnetic anomalies accompanied by the edifices of seamounts. Magnetizations of these seamounts located in Sikoku Basin, West Philippine Bain and in western Pacific Basin were estimated by the combined analyses of magnetic anomalies and topographic edifices.

(1) Seamounts in the West Philippine Sea
The results of analysis of 53 seamounts in the West Philippine Sea, show that several seamounts are magnetized westerly in N70°W to N80°W with upward inclinations about 10°. The seamounts in the Kyusyu-Palau Ridge (KPR) also show westerly declination amounting to ~ 30°W. These results are not consistent with a clockwise rotation model of the whole Philippine Sea. Besides, no reversely magnetized seamounts were discovered from the seamounts in the Kyusyu-Palau ridge.

(2) Seamounts in the Izu-Ogasawara arc
Magnetic and topographic features of a large number of seamounts in the Izu-Ogasawara arc were also made apparent. The arc is composed of three volcanic ridges named Sitito-Iozima, Ogasawara ridge, and Nisi-Sitito Ridge. The Nisi-Sitito ridge (NSR), located in the western part of the arc, is the old volcanic ridge ranging in age between the Pliocene and Middle Miocene. The calculated magnetizations of the 38 seamounts in the NSR show that the majority of the seamounts are magnetized in a normal magnetic field direction with a mean value of 2.74±1.07 A/m, although the frequent magnetic reversals would happened during the active period of these seamounts. This polarity bias is hard to explain by only induced magnetization effect. Such a polarity bias is also recognized in the seamounts in KPR. A possible explanation for the polarity bias may be ascribed to the enhanced volcanic activities during normal magnetic epoch.

(3) Seamounts in the Western Pacific Basin
The continental shelf surveys in the western Pacific include the Jurassic magnetic Quiet zone, where numerous seamounts exist. Many seamounts have high density part in the deep zone. Magnetizations of 84 seamounts were estimated from the densely surveyed data by the two layer models. Derived VGPs of these seamounts are generally agree with the VGP curve estimated from DSDP and ODP results(Sager, 2006), however, the seamounts in the Ogasawara Plateau (Hanzawa, Katayama seamounts) show meaningful difference from the VGP curve. Several seamounts show the clustered VGPs around N57, E340, which may suggest the active volcanic activities between 92~112Ma.

References

Sager,W.W., Cretaceous paleomagnetic apparent polar wander path for the Pacific plate calculated from Deep Sea Drilling Project and Ocean Drilling Program basalt cores, Physics of the Earth and Planetay Interors, 156, 329-349,2006.

Ueda,Y., Paleomagnetism of seamounts in the West Philippine Sea as inferred from correlation analysis of magnetic anomalies, Earth Planets Space, 56, 967-977, 2004.

Ueda,Y., Magnetizations of the seamounts in the Izu-Ogasawara arc with special refernce to the origin of their normal polarity biases, Earth Planets space, 59, 897-909,2007.

Ueda,Y., Iwabuchi,Y., Kasuga, S., Crustal structure and geophysical parameters of seamounts in the western Pacific as derived from topography and potential field anomalies, Rept. Hydr. Res., 44, 17-41, 2008 (in Japanese with English abstract).

Crustal Structure of Oceanic Islands and Seamounts

Watts, A B

Seismic refraction data, together with gravity and flexure modeling, provide constraints on the deep structure of seamounts and oceanic islands. Studies of “primary” hotspots such as Hawaii and Reunion reveal a flexed oceanic crust that is underlain by a magmatic underplated body while "secondary" hotspots reveal a mix with some (e.g. Marquesas) underplated while others (e.g. Cape Verde) are not. Both classes of hotspot reveal that seamounts and oceanic islands are underlain by flexed oceanic crust with a normal thickness and P-wave velocity structure. New refraction data over the Louisville Ridge at 25 degrees S, however, indicate that magmatic intrusion is occurring in an intra-crustal rather than a sub-crustal setting. We discuss here these data and their implications for the role that the lithosphere may play in determining whether seamounts and oceanic islands are underplated or not.

Addresses

Name		Institution and Address	Phone - Fax - Email
Asavin	Alex	Vernadsky Institute of Geochemistry and Analitical chemistry Department of Geochemistry 19 Kosygin St GSP 1 Moscow 119991 Russia	+7 095 137 3116 (phone) +7 095 938 2054 (fax) alex@geokhi.ru
Baines	Peter G	University of Melbourne Civil and Environmental Engineering Grattan Street Melbourne Victoria 3010 Australia	p.baines@unimelb.edu.au
Barr	Brad	NOAA Office of National Marine Sanctuaries 384 Woods Hole Road Woods Hole MA 02543 USA	Brad.Barr@noaa.gov
Becker	Joseph J	Becker Engineering 8465 Regents Rd # 432 San Diego CA 92122 1392 USA	jj@becker.com
Bryan	Scott E	Kingston University School of Geography Geology and Environment Penrhyn Road Kingston Upon Thames Surrey Kt1 2EE United Kingdom	s.bryan@uq.edu.au
Choy	Steve	Monterey Bay National Marine Sanctuary Research Team 299 Foam Street Monterey CA 93940 USA	steve.choy@noaa.gov
Clague	David A	MBARI Research 7700 Sandholdt Road Moss Landing CA 95039 USA	+1 831 775 1781 (phone) +1 831 775 1645 (fax) clague@mbari.org
Clark	Malcolm R	National Institute of Water and Atmospheric Research NIWA Deepwater Fisheries Private Bag 14-901 Wellington 6003 New Zealand	+64 4 386 0523 (phone) +64 4 386 0574 (fax) m.clark@niwa.co.nz
Consalvey	Mireille	NIWA 301 Evans Bay Parade Wellington New Zealand	m.consalvey@niwa.co.nz

Davis	Richard	Oregon Health and Science University Environmental and Biomolecular Systems 20000 NW Walker Rd Beaverton OR 97006 USA	davisr@ebs.ogi.edu
Doan	Shawn	Sehome High School 314 Whatcom St. Bellingham WA 98225 USA	shawnsci@yahoo.com
Emerson	David	Bigelow Laboratory for Ocean Sciences 180 McKown Point West Boothbay Harbor ME 04575 0475 USA	+1 207 633 9671 (phone) demerson@bigelow.org
Etnoyer	Peter	Texas A and M University Corpus Christi Harte Research Institute 6300 Ocean Drive Corpus Christi TX 78412 5869 USA	+1 362 825 2031 (phone) peter.etnoyer@tamucc.edu
Hanan	Barry	Department of Geological Sciences San Diego State University San Diego CA 92182 1020 USA	+1 619 594 6710 (phone) +1 619 594 7161 (fax) bhanan@mail.sdsu.edu
Hart	Stanley R	Woods Hole Oceanographic Institute 53 Quonset Road Falmouth Massachusetts MA 02540 USA	+1 508 289 2837 (phone) +1 508 457 2175 (fax) shart@whoi.edu
Hofmann	Albrecht W	Max-Planck Institut fuer Chemie Postfach 3060 Mainz 55020 Germany	+49 6131 305 281 (phone) +49 6131 371 051 (fax) hofmann@mpch-mainz.mpg.de
Jordahl	Kelsey A	Marymount Manhattan College Natural Sciences 221 East 71st St New York NY 10021 USA	+1 212 517 0651 (phone) +1 212 517 0419 (fax) kjordahl@mmm.edu
Keller	Randall A	Oregon State University Department of Geosciences 104 Wilkinson Hall Corvallis OR 97731 USA	+1 541 737 7648 (phone) +1 541 737 1200 (fax) kellerr@geo.oregonstate.edu
Kelley	Christopher	Hawaii Undersea Research laboratory University of Hawaii 1000 Pope Rd, MSB 303 Honolulu HI 96822 USA	+1 808 956 7437 (phone) +1 808 956 9772 (fax) ckelley@hawaii.edu

Kilgour	Morgan	Texas A and M University Corpus Christi Harte Research Institute 6300 Ocean Drive Corpus Christi TX 78412 USA	+1 361 825 2061 (phone) +1 361 825 2050 (fax) morgan.kilgour@tamucc.edu
Kim	Seung-Sep	University of Hawaii Geology and Geophysics 1680 East-West Road POST 832 Honolulu HI 96822 USA	seungsep@hawaii.edu
Konter	Jasper	Department of Geological Sciences University of Texas at El Paso 500 W University Ave El Paso TX 79968 USA	+1 915 747 5507 (phone) +1 915 747 5073 (fax) jgkonter@utep.edu
Koppers	Anthony A P	College of Oceanic & Atmospheric Sciences Oregon State University 104 COAS Admin Bldg Corvallis OR 97331 5503 USA	+1 541 737 5425 (phone) +1 541 737 2064 (fax) akoppers@coas.oregonstate.edu
Lang	Susan	UCSD Geosciences Research Division Scripps Institution of Oceanography La Jolla CA 92093 0244 USA	sqlang@ucsd.edu
Lavelle	William J	NOAA/Pacific Marine Environmental Laboratory 7600 Sand Point Way NE Bldg 3 Seattle WA 98115 USA	+1 206 526 6182 (phone) j.william.lavelle@noaa.gov
Lee	Sang-Mook	Seoul National University School of Earth and Environmental Sciences Sillim-dong Gwanak-gu Seoul 151-747 South Korea	+82 2 880 6745 (phone) +82 2 871 3269 (fax) smlee@snu.ac.kr
Levin	Lisa A	Scripps Institution of Oceanography Integrative Oceanography Division 9500 Gilman Drive La Jolla CA 92093-0218 USA	+1 858 534 3579 (phone) +1 845 822 0562 (fax) llevin@ucsd.edu
Miller	Stephen P	University of California San Diego Scripps Institution of Oceanography GRD La Jolla CA 92037 USA	+1 858 534 1898 (phone) +1 858 534 0784 (fax) spmiller@ucsd.edu
Mohn	Christian	NUI Galway Earth and Ocean Sciences University Road Galway Ireland	christian.mohn@nuigalway.ie

Morato	Telmo	University of the Azores Department of Oceanography and Fisheries Cais de Santa Cruz Horta 9901-862 Portugal	t.morato@gmail.com
Oschmann	Lynn	UCSD 9500 Gilman Dr La Jolla CA 92093-0225 USA	osch@alum.mit.edu
Peach	Cheryl	SIO Birch Aquarium Museum 9500 Gilman Dr La Jolla CA 92093 0207 USA	+1 858 822 5323 (phone) +1 858 534 7114 (fax) cpeach@ucsd.edu
Pitcher	Tony	University of British Columbia Peter Wall Institute for Advanced Studies 6331 Crescent Road Vancouver, BC V6T 1Z2 Canada	pitcher.t@gmail.com
Ren	Xiangwen	First Institute of Oceanography State Oceanic Administration P R China Marine Geology and Geophysics Division 6 Xianxialing Road Qingdao 266061 Shandong Province 266061 China	+00 86 532 88965236 (phone) renxiangwen@163.com
Reuscher	Michael	Texas A and M University Corpus Christi Harte Research Institute 6300 Ocean Drive Corpus Christi TX 78412 5869 USA	michael.reuscher@tamucc.edu
Santos	Ricardo S	University of the Azores Department of Oceanography and Fisheries Cais de Santa Cruz Horta PT-9901-862 Portugal	+35 129 220 0407 (phone) +35 129 220 0411 (fax) ricardo@uac.pt
Shank	Timothy	Woods Hole Oceanographic Institution Biology Department MS#33 Redfield Laboratory Woods Hole MA 02543 USA	+1 508 289 3392 (phone) +1 508 457 2134 (fax) tshank@whoi.edu
Shi	Xuefa	First Institute of Oceanography State Oceanic Administration P R China Marine Geology and Geophysics Division 6 Xianxialing Road Qingdao 266061 Shandong Province 266061 China	+00 86 532 88967491 (phone) xfshi@fio.org.cn
Shirley	Thomas	Texas A and M University Corpus Christi Harte Research Institute 6300 Ocean Drive Unit 5869 Corpus Christ TX 78412 USA	+1 361 825 2030 (phone) Thomas.Shirley@tamucc.edu

Staudigel	Hubert	Scripps Institution of Oceanography University of California, San Diego La Jolla CA 92037-0225 USA	+1 858 534 8764 (phone) +1 858 534 8090 (fax) hstaudigel@ucsd.edu
Stocks	Karen	University of California San Diego San Diego Supercomputer Center 9500 Gilman Drive MC 0505 La Jolla CA 92093-0505 USA	+1 858 534 5009 (phone) kstocks@sdsc.edu
Sudek	Lisa A	UCSD SIO 9500 Gilman Drive La Jolla CA 92037 USA	+1 858 822 3260 (phone) +1 858 774 9244 (fax) lhaucke@ucsd.edu
Tebo	Bradley	Oregon Health and Science University OGI School of Science and Engineering 20000 NW Walker Rd Beaverton OR 97006 USA	+1 503 748 1992 (phone) +1 503 748 1464 (fax) tebo@ebs.ogi.edu
Tian	Liyan	University of California, San Diego Scripps Institution of Oceanography La Jolla, CA 92093-0212 USA	+ 1 858 534 0383 (phone) + 1 858 822 4945 (fax) l1tian@ucsd.edu
Ueda	Yoshio	Former professor of Japan Coast Guard Academy 506,2-16-5, Nagai-Higasi Sumiyoshiku Osaka Japan	yueda10@hotmail.com
Watts	Anthony B	Oxford University Earth Sciences Parks Road Oxford Oxon OX13PR Great Britain	+44 1865 272032 (phone) tony@earth.ox.ac.uk
Wheat	Geoffrey	University of Alaska Fairbanks GURU PO Box 475 Moss Landing CA 95039 USA	+1 831 633 7033 (phone) wheat@mbari.org
Wessel	Paul	University of Hawaii Department of Geology and Geophysics 1680 East West Road Honolulu HI 96822 USA	+1 808 956 4778 (phone) +1 808 956 5154 (fax) pwessel@hawaii.edu
Yang	Yaomin	First Institute of Oceanography State Oceanic Administration No.6 Xianxialing Road Hi-Tech Industry Grade Qingdao Shandong 266061 China	+00 86 532 88966092 (phone) yangyaomin@fio.org.cn