OS71D-0328 0830h POSTER

Getting to the bottom of it: a paleoreconstruction of the − 400 m drowned carbonate platform off northwestern Hawaii

Stacy D Jupiter[1] ((831) 459-5063; jupiter@darwin.ucsc.edu)

David A Clague[2] ((831) 775-1781; clague@mbari.org)

Jody M Webster[3] ((831) 459-2830; jwebster@es.ucsc.edu)

[1]University of California, Santa Cruz, Department of Ecology and Evolutionary Biology A316 Earth Marine Sciences 1156 High Street, Santa Cruz, CA 95064, United States

[2]Monterey Bay Aquarium Research Institute, 7700 Sandholdt Road, Moss Landing, CA 95039-9644, United States

[3]University of California, Santa Cruz, Department of Earth Sciences 1156 High Street, Santa Cruz, CA 95064, United States

Pleistocene sea level oscillations superimposed on volcanic subsidence contributed to the formation and successive drowning of a series of six carbonate platforms off Kohala on the northwest coast of Hawaii. We are using a paleoreconstruction of the − 400 m Kohala platform, based on geomorphology, ecology (species assemblages) and petrology (grain size, dominant microfossils, recrystallization) to refine models of local sea level fluctuations, subsidence rates and volcano growth. A synthesis of analyses of bathymetric and acoustic backscatter data, whole carbonate samples, thin sections and push cores has provided a history of primary and secondary construction, subaerial exposure and drowning signatures. We then evaluate the data in the context of paleogeographic and oceanographic constraints on reef development around Hawaii. ROV video observations suggest that the geomorphic structure of the 400 m platform is predominantly secondary construction: (1) eroded gullies are pervasive throughout the seaward slope of platform; (2) extensive weathering exists along the platform crest and flat; and (3) fissures parallel and normal to the platform slope are prominent features. While coralline-algal bindstones dominate most parts of the platform, the majority of coral samples were restricted to loose talus on the lower seaward slope. These different distributions may reflect: paleoenvironmental determinants of reef growth; sampling biases; and/or preservational biases. Explaining these differences requires accurate determination during collection of the attitude and location of each coral sample, followed by precise dating, to accurately constrain sea level, subsidence and volcano growth models.

OS71D-0329 0830h POSTER

Global Sea-Level Versus Local Control of Middle-Miocene to Recent Sequences on a Current-Swept Divergent Margin: Offshore Canterbury Basin, New Zealand

Hongbo Lu[1,2] (1-512-471-0387; hongbo@ig.utexas.edu)

Craig S. Fulthorpe[1] (1-512-471-0459; craig@ig.utexas.edu)

Paul Mann[1] (1-512-471-0452; paulm@ig.utexas.edu)

[1]University of Texas Institute for Geophysics, John A. and Katherine G. Jackson School of Geosciences, 4412 Spicewood Springs Road, Building 600, Austin, TX 78759-8500, United States

[2]Department of Geological Sciences, John A. and Katherine G. Jackson School of Geosciences, The University of Texas at Austin, Austin, TX 78712-1101, United States

Upper Miocene to Recent sequences beneath the continental shelf and slope of the offshore Canterbury Basin, New Zealand, are mapped using closely spaced, high-resolution multichannel seismic data collected in January 2000. Sequence geometries and morphologies of unconformities reflect competing influences of eustasy, contour-currents, and rate of sediment supply.

Eighteen regional sequence-bounding unconformities form three seismic stratigraphic units: 1) Miocene unconformities U1-8 (>16-5 Ma; all ages are from ODP Site 1119 and Clipper exploration well) have smooth shelves. Onlap can occur on both shelf and slope. Most sequences are progradational and of relatively long duration (>1.4 m.y.). Six additional localized unconformities also occur; each onlaps the underlying regional unconformity and is either truncated basinward by sediment drifts or downlaps onto the underlying unconformity. 2) Pliocene to early Pleistocene unconformities U9-13 (3.6-1.25 Ma) define aggradational sequences with durations ranging from 0.11 to 1.4 m.y. Frequency of onlap decreases up section. Each sequence contains a downlap surface, which onlaps the underlying unconformity and is truncated basinward by the overlying unconformity. 3) Early Pleistocene (∼1.2 Ma) to Recent unconformities U14-18 display shelf channel incision and erosional truncation by currents on the slope. Sequences are progradational and of short duration (<0.4 m.y.). They are downlapped on the shelf and slope failure truncates reflections near their well-defined shelf edges. Five additional local unconformities are truncated to landward by the overlying regional unconformity; most are only preserved on the outer shelf and upper slope.

The most recent unconformities (17 and 18, plus three local unconformities) correlate well with 100 k.y. cycles in the oxygen isotope record (stages 6-14) over the last 500 k.y., suggesting that they are of eustatic origin. Older sequences are of longer duration and encompass multiple oxygen isotope cycles. This could imply local control of older sequences. Alternatively, the sequence stratigraphic record may selectively respond to a subset of the global cycles, or to bundles of Milankovitch-scale cycles.

Currents redistribute deposits, control depocenter locations, generate diachronous unconformities, and influence seismic stacking patterns and morphologies. Multistage sediment drifts contain several sequence boundaries. Drift moats may serve as conduits for downslope sediment transport during relative sea-level falls, reactivating as moats when sea level rises. Large sediment drifts in the north transition southward to conventional progradational geometries, in parallel with a north-to-south increase in slope inclination (from $<2^{\circ}$ to $>5^{\circ}$). Geometries transitional between drifts and clinoform sequences suggest criteria by which current deposition can be recognized on margins without well-defined drifts.

OS71D-0330 0830h POSTER

Drowned Carbonate Platforms in the Huon Gulf, Papua New Guinea; Morphology, Composition and Implications for Reef Development on a Rapidly Subsiding Margin

Jody Webster[1] (jwebste@es.ucsc.edu); Eli Silver[1]; Donald Potts[1] (potts@biology.ucsc.edu); Laura Wallace[4] (L.Wallace@gns.cri.nz); Kristin Riker-Coleman[3] (rike0003@tc.umn.edu); Christina Gallup[3] (cgallup@D.UMN.edu); Bruce Applegate[2] (tba@hawaii.edu); Stacey Jupiter[1] (sjupiter@es.ucsc.edu)

[1]University of California, Earth and Marine Sciences Building, 1156 High Street, Santa Cruz, CA 95064, United States

[2]University of Hawaii, 1680 East-West Road, Honolulu, HI 96822

[3]University of Minnesota Duluth, 1114 Kirby Dr., 229 HH, Duluth, MN 55812, United States

[4]Institute of Geological and Nuclear Sciences, 69 Gracefield Rd, Lower Hutt 30-368, New Zealand

Collision between the South Bismarck Plate and the northern edge of the Australian Plate has produced an actively subsiding foreland basin in the western Huon Gulf. A series of drowned coral reef platforms and pinnacles are preserved on this margin as a result of this rapid subsidence. Previous data and models suggest that these platforms drowned due to the combined affects of rapid relative sea-level rise associated with glacial terminations and continual subsidence (up to 5.7 mm/year) over the last 400 ky. A multidisciplinary cruise on the R/V Melville (Aug-Sep 2001). mapped and sampled nine platforms and pinnacles using; (1) Seabeam 2000; (2) high-resolution side-scan mapping (DSL120) and (3) the ROV Jason for outcrop sampling. Two U-Th ages (348 ka at 1950 mbsl and 60 ka at 240 mbsl) confirm the platforms age and deepen progressively NE towards the Markham Fault. The bathymetric and sidescan data indicates the platforms are composite features, often recording multiple terrace levels and pinnacle structures that probably formed during less dramatic interstadial sea-level fluctuations. The edges of the platforms have experienced substantial lateral modification through fracturing and slumping, producing vertical outcrop exposures, slumped blocks and debris fields. However, the tops of each platform appear to preserve the signature and timing of platform drowning. Coral assemblages and microfacies data indicate there are significant differences in paleoenvironmental settings between the shallow, middle and deep platforms. Prior to drowning, the deeper platforms developed in significantly higher energy reefal conditions compared with the middle or shallow platforms. Thus the paleoenvironmentals conditions have changed substantially through time in the Huon Gulf. The changes may be related a re-organisation of the oceanographic/climatic conditions of the Huon Gulf as a result of; (1) the rotation and uplift of the Huon Peninsular and/or (2) variation in more regional factors such as the position of the Intertropical Convergence Zone (ITCZ) over the last 400 ka.

OS71D-0331 0830h POSTER

Erosional/Depositional History of the Pernambuco Seachannel, South Atlantic Ocean

Douglas W. Edsall[1] (+81 3 3401 8924; edsalld@onrasia.navy.mil)

Norman Z. Cherkis[2] (703-971-3141; fiveoceanscon@yahoo.com)

[1]US Naval Academy, Physics Dept., Annapolis MD 21402, (present address: Assoc Dir for OAS, ONRIFO ASIA, POB 449, UNIT 45002), APO, AP 96337-5002, United States

[2]Naval Research Laboratory, Code 7420, Washington DC 20375 , (present address: Five Oceans Consultants, 6300 Saddle Tree Drive, Alexandria, VA 22310-2915, United States

Multibeam bathymetry and single-channel seismic reflection profiling data collected in the Brazil Basin during Project CENTRATLAN project revealed the existence of a fully incised, meandering and bifurcating seachannel on the South Atlantic Ocean seafloor east of central Brazil. Our examination provides the first comprehensive study of the morphology of Pernambuco Seachannel, which in some ways is similar in appearance to features of terrestrial riverine systems.

Pernambuco Seachannel is the only known example of a geostrophic or contour current created and maintained seafloor channel. It extends northward through the Bahia Seamount Group and into the northern part of the Brazil Basin. Within the Bahia Seamount Group, the course of the channel is partially constrained on the west by eastward-facing slopes of the Brazilian continental margin and on the east by the Bahia Seamounts group. In the northern portion of the study area, just prior to exiting the Bahia Seamounts, a shallower and younger second channel is present.

Three major unconformities are identified on seismic reflection records. On these, older and younger channels occupy the same relative positions with respect to the unconformities which appear to be identical with two of the three unconformities present at DSDP Leg 39, site 355. Using the ages assigned to these unconformities at this DSDP site suggests that erosional activity creating the older Pernambuco Seachannel by northward flowing AABW began in upper Eocene - middle Oligocene times but not before 11.2 M.Y.B.P. The westward migration of the younger channel is associated with the sea level transgression of post middle Miocene time.

OS71D-0332 0830h POSTER

Numerical Investigation of the Effects of Delta Avulsion on Stratigraphy

J. Scott S. Stewart (scotts@colorado.edu)

INSTAAR/University of Colorado, 450 UCB, Boulder, CO 80309, United States

SedFlux3D is a three dimensional numerical basin fill model which simulates the development of stratigraphy over time periods of hundreds to tens of thousands of years. Processes such as distributary avulsion with high spacial heterogeneity are critical to understanding stratigraphic patterns. Recently, a subaerial module has been added to simulate overbanking and flood deposits on the delta plain in addition to sediment deposition in the marine environment. Here, the role of river mouth avulsion on the volume stratigraphic record is investigated, and the effects of different avulsion rates are explored on both the subaerial and marine depositional record.

OS71E MCC: 104 Sunday 0830h

Graduate Education in Ocean Science on the Occasion of the 60th Anniversary *(joint with ED, HG)*

Presiding: **K Hardy,** Scripps Institution of Oceanography**; M Hendershott,** Scripps Institution of Oceanography**; J Hildebrand,** Scripps Institution of Oceanography**; K Melville,** Scripps Institution of Oceanography

OS71E-01 0830h INVITED

The Early Influence of The Oceans on Oceanography Education

John A Knauss (401 874 6141; jknauss@gso.uri.edu)

Graduate School of Oceanography University of Rhode Island, South Ferry Road, Narragansett, RI 02874

At the close of World War II Scripps was the only program in the United States offering formal graduate education and degrees in oceanography. Much early course work was based on The Oceans. All students were required to take introductory courses in biological, chemical, geological and physical oceanography, and one's first oral exams were largely based on those four courses. Many of the founding directors of the growing number of oceanography programs established after World War II in the United States were Scripps graduates. These included directors of programs at the University of Washington, Oregon State, Texas A and M, and the University of Rhode Island. All adopted the Scripps model and The Oceans philosophy in developing their educational programs.

OS71E-02 0845h INVITED

The MIT/WHOI Joint Program in Oceanography and Applied Ocean Science and Engineering: An Ongoing Experiment in Graduate Education and the Sverdrup, Johnson and Fleming Influence.

John W Farrington (1-508-289-2200; jfarrington@whoi.edu)

Woods Hole Oceanographic Institution MS31, 360 Woods Hole Road, Woods Hole, MA 02540, United States

On May 8, 1968 Paul M. Fye, President of Woods Hole Oceanographic Institution and Howard W. Johnson, President of Massachusetts Institute of Oceanography, signed a Memorandum of Agreement of one and one-half pages in which both partner institutions "have each approved the creation of a Joint Graduate Program in Oceanography for which there will be established appropriate graduate degrees to be conferred jointly by the Massachusetts Institute of Technology and Woods Hole Oceanographic Institution." The partnership brought together the MIT experience with formal graduate education in sciences and engineering involving classroom instruction and more traditional academic advising with the less formal one to one "apprenticeship" or European tutorial style of education at WHOI. During the first year the graduate program involved only the physical sciences with the MIT home being in the Earth, Atmospheric and Planetary Sciences Department. Ocean Engineering was added the following year with the MIT home being the Ocean Engineering Department. Biological Oceanography was added in 1970 with the MIT home being the Biology Department.

The existing graduate curricula of the home departments at MIT, the inclusion of ocean engineering, and the fact that several of the early program instructors and advisers at WHOI entered oceanography after formal graduate training in more traditional disciplines such as chemistry, geology, physics, biology and mathematics was not conducive to an automatic adoption of the Sverdrup, Johnson and Fleming paradigm of core courses that predominated in other leading graduate programs in oceanography. Despite this caveat, the Sverdrup, Johnson and Fleming paradigm has influenced the learning environment in the Joint Program. Taking into account lessons learned in the process, some suggestions for the future of graduate education in ocean sciences and ocean engineering will be presented.

OS71E-03 0900h INVITED

Ocean Education for the 21st Century: When Should it Begin?

Marcia McNutt (831-775-1814; mcnutt@mbari.org)

Monterey Bay Aquarium Research Institute, 7700 Sandholdt Road, Moss Landing, CA 95039, United States

The publication of "The Oceans" by Sverdrup, Johnson, and Fleming provided an integrating approach to the field of oceanography that was widely adopted by graduate ocean science programs across the nation as the basis of a core curriculum. Most researchers today would agree that proper graduate-level training across the various sub-disciplines of oceanography is sound pedagogy. It is even more apparent today than it was 60 years ago that the ocean should be viewed as a coupled physical, chemical, biological, and geological system. What is far more controversial is the role of an oceanography curriculum at the undergraduate and high school levels. Some would argue that such courses are a poor substitute for comprehensive courses in the basic disciplines, and that they result in students broadly appreciative of the oceans but inadequately trained to further the frontiers in research. Others argue that the lack of exposure to oceanography at the high school and college level is one reason for the shortage domestic students pursuing graduate work in the ocean sciences. I believe that there is another solution that has not been properly exploited, and that is to teach basic high-school math, physics, chemistry, and biology using examples drawn from oceanography and other allied disciplines of the geosciences whenever feasible. If done properly, this approach would increase general public awareness of ocean issues without compromising the rigor of the curriculum. What is needed is a new generation of textbook writers who will use the oceans to teach math, physics, chemistry, or biology, rather than just teaching oceanography through math, physics, biology, and chemistry.

OS71E-04 0915h INVITED

Sverdrup's Biology

John McGowan ((858) 534-2074; jmcgowan@ucsd.edu)

Scripps Institution of Oceanography/UCSD, 9500 Gilman Dr. m/s 0227, La Jolla, CA 92093-0227, United States

Sverdrup's contribution to Biological Oceanography were more than merely substantial, they were of fundamental importance. His plan for the training of graduate students at Scripps did not recognize the traditional division of the basic disciplines into separate categories of physics, chemistry, biology and geology. He insisted that Oceanography was a multi-disciplinary subject and that all entering students should study all four subjects. Today this is not very unusual but it was in the early 50s when I took those courses. We biologists carried away from those courses an appreciation of the importance of both spatial and temporal scale. It was of clear relevance to problems of oceanic population and community biology.

But there was still more to his biology. He is responsible for a very simple, but very elegant model of the regulation of oceanic primary productivity. The elements of this model are found today in the ten or so highly derivative models. He also published a map predicting global ocean productivity based on the ideas in the model plus some wonderfully intuitive thinking. This map does not differ strongly from those glorious false color ones being published today.

OS71E-05 0930h INVITED

The Oceans not Withstanding: Scripps Geological-Geophysical Expeditions of the Golden Age

Robert L. Fisher ((858) 534-3597; khardy@ucsd.edu)

Scripps Institution of Oceanography/UCSD, 9500 Gilman Dr. m/s 0220, La Jolla, CA 92093-0220, United States

The Oceans: Their Physics, Chemistry, and General Biology, fully recognized and promoted the inherent unity of oceanography, the field itself, and of all components of the oceanic world. It covered well the wet pieces. However, except for sedimentary studies of the California borderland and reconnaissances of the Arctic, Mediterranean, and the South Atlantic, little was presented that could be parent to todays portrayals of marine geology and geophysics. The advances in those areas in the 1950s, 1960s, and early 1970s, by SIO scientists and those of several other institutions resulted from extended expeditionary studies, essential on-the-job field training of confident very young chief scientists, dogged pushing of traditional rough sampling methods to their limits, and the invention and lateral prompt application of precise electronic timing and sensing devices to shipboard observation of deep ocean seafloor/crustal elements.

SIOs multifaceted expeditions of those years were conceived, planned and often lead by graduate students making thesis observations, assisted by their fellows as warm bodies, perhaps with more senior staff scientists making specific collections at key localities. Education was real-time: discovering–reflection–discussion, and mutual tutoring. The principal factor that made such operation scientifically and educationally successful was SIOs then Director, Roger Revelle, a benevolent and trusting, but very perceptive, godfather.

OS71E-06 0945h INVITED

Strange Bedfellows; Physical and Biological Oceanographers

Warren S. Wooster (206-685-2497; Wooster@u.washington.edu)

School of Marine Affairs, University of Washington, 3707 Brooklyn Ave., N.E., Seattle, WA 98105-6715, United States

When I started graduate study at Scripps in 1947, both the text, "The Oceans", and the curriculum - all students took the introductory courses in physics, chemistry, biology, and geology - conspired to create awareness of the interactions among these fields. In their preface, the authors spoke of the book as "an aid to the beginner and specialist alike in the coordination of the various fields of oceanography." Harald Sverdrup, perhaps the best known physical oceanographer of his day, introduced us to the interdisciplinary organization, ICES, wrote an important paper (1953) on "the vernal blooming of phytoplankton", and together with fishery biologist O.E.Sette, launched the world renowned CalCOFI program. Another noted physical oceanographer, Henry Stommel, 1949, teamed up with biologist Gordon Riley in a major study of the quantitative ecology of plankton. At the time, physical and biological oceanographers often seemed to be engaged in the same mission.

The curriculum format, with its four basic courses, spread to most other graduate programs in oceanography, but the forces of specialization also spread. While the biological oceanographers have always seen the need to understand the milieu within which their creatures function, the physicists often seemed to chafe against wasting their time on squishy subjects like biology when there were so many more important and fascinating things to study. Interactions were further complicated by the confusion between "biological oceanography" and "marine biology", and by the status of "fishery biology" which was often disdained by oceanographers of all stripes.

I propose to discuss the evolution of the relationship among these fields during the 60 years since "The Oceans" was first published, concluding with the present marriage of convenience, or at least amicable co-habitation, forced by the widespread concern over the threat of global warming and the need to understand its consequences. It has become clear that understanding the response of marine ecosystems to environmental forcing cannot be achieved without the effective collaboration of these strange bedfellows.

OS71E-07 1020h INVITED

Origin of the "Ocean Bible"

Walter H. Munk ((858) 534-2877; wmunk@ucsd.edu)

Scripps Institution of Oceanography, University of California at San Diego, 9500 Gilman Drive, La Jolla, CA 92093, United States

"The Oceans" is such a landmark for Sverdrup and the Scripps Institution that one ought to take a look at how it came about. The book came very close to NOT being written. Sverdrup was about to decline an invitation by Prentice Hall when his secretary persuaded him to accept. The contract called for 500-600 pages, it ended up with 1087 pages. Royalty was 10% ($0.27 to each author for the copy I purchased in 1943). Sverdrup had estimated a market of 550 copies. By the end of 1965 23,766 copies of the American edition alone had been sold.

The book was completed in the early war years under very trying conditions for Sverdrup personally. When it did appear in print, a year after Pearl Harbor, the distribution was restricted to the continental United States because "...it would be of great aid to the enemy should it fall into his hands."

The book carries the mark of Sverdrup's lifelong emphasis on the synthesis of observations: "we have preferred definite statements to mere enumeration of uncorrelated observations and conflicting interpretations." The result was a coherent presentation of ocean science, a remarkable achievement considering how badly the ocean was undersampled. I will describe my experience as a willing listener while Sverdrup was contemplating of how to organize Chapter XV: The Water Masses and Currents of the Oceans.

OS71E-08 1035h INVITED

The Oceans and the Teaching of Oceanography

Robert H Stewart (979-845-2995; stewart@ocean.tamu.edu)

Texas AM University, Department of Oceanography Room 624 OM Building, College Station, TX 77843-3146, United States

Sverdrup, Johnson and Fleming, the authors of *The Oceans*, were both ahead of their time, and behind their time.

The Oceans built on earlier texts, such as Kummels *Handbuch der Ozeanographie* (1907), that summarized our knowledge of the oceans. It differed principally in its depth and breadth, showing the need for specialized courses of study in biological, chemical, geological, and physical oceanography. Thus, the curriculum at the Scripps Institution of Oceanography was built on this foundation. As a result, no other comparable field of earth science was as well integrated as oceanography. For example, agriculture, which depends in some fundamental ways on weather, climate, and climate change did not include meteorology within its bounds, although it was nearly as broad as oceanography, including the study of soils, chemistry, and biology.

The strengths of The Oceans were also its weakness. By emphasizing the strengths of the separate sub-disciplines of biological, chemical, geological, and physical oceanography the book drew oceanography away from problem-based studies such as those carried out by Bigelow in the Gulf of Maine. Case studies were not part of the basic curriculum. Thus, in 1964, 15 years after the start of the California Cooperative Fisheries Investigation, the most wide-ranging oceanographic study ever attempted, Scripps did not offer a course on the California fisheries. In contrast, other messy sciences, such as medicine, were often based on case studies.

Now, at the start of the 21st century, the circle is nearly complete. Sub-disciplines such as physical oceanography are so broad they cannot be spanned in a single course. And students dont want to learn about important problems until late in their graduate career. To meet their interests, we have begun to offer courses in such topics as global warming or fisheries, bringing in ideas from biological, chemical, and physical oceanography only as needed.

URL: http://oceanworld.tamu.edu

OS71E-09 1050h

Ocean Scientists The Next Generation: Meeting the Changing Needs of Graduate Students

Paula Coble[1] (727-553-1631; pcoble@marine.usf.edu)

Teresa Greely[1] (727-553-3921; greely@marine.usf.edu)

[1]College of Marine Science, University of South Florida, 140 Seventh Avenue South, MSL 119, St. Petersburg, FL 33701, United States

The federal agencies that fund Ocean Science research are increasing the incentives for scientists to take a more active role in public education, both formal and informal. Traditional preparation of graduate students in oceanography combines formal instruction for mastery of content with apprenticeship in field and laboratory research techniques. Few programs also include training in pedagogy, even though evidence abounds that the ability to practice science is not necessarily indicative of an ability to teach science.

Recent findings from education research indicate the need to change the way science is taught in the classroom, and a basic understanding of how people learn is essential to anyone planning to teach at any level.

We have designed a new course to provide science graduate students with a theoretical framework, practical knowledge, and skills required to successfully design, implement, and evaluate an effective learning module for a K-12 audience. Topics included how people learn, national science standards and their implementation, effective assessment techniques, cooperative learning design, and inclusive learning strategies for diversity enhancement.

Starting with an evaluation of what content and skills teachers need to incorporate standards and assessment criteria into their teaching practice, students designed and taught a science based module in a local school. Modules were either classroom or field-based exercises, and emphasized inquiry-based learning experiences, modeled on how science is actually done by researchers.

Blackboard software was used to coordinate the learning environment as well as to evaluate students progress and facilitate communication between all course participants.

In summary, this course was designed to 1) improve teaching and grant writing, and 2) provide experience in K-12 settings and the education profession prior to degree completion.

OS71E-10 1105h INVITED

Graduate Education in Coastal Science: Then and Now

Douglas L. Inman (858-534-4334; dinman@ucsd.edu)

Scripps Institution of Oceanography, 9500 Gilman Drive, La Jolla, Ca 92093-0209, United States

Coastal science began in the early 20th century in geology disciplines with descriptive field studies of ancient shorelines (G. K. Gilbert, 1885) and coastal observations (Douglas Johnson, 1919). World War II placed a strong emphasis on the importance of coastal processes in military operations.

The most profound impact was associated with the interdisciplinary approach to coastal science demonstrated by The Oceans (1942). The first organized graduate program in oceanography opened at Scripps Institution of Oceanography in 1946 and offered courses in marine geology as well as physical oceanography, biology at the sea, chemistry of sea water and applied mathematics. Those first classes and the new Sverdrup curriculum inspired the rapid growth and transfer of knowledge in the new oceanographic sciences. Graduates of these classes established Sverdrup-type interdisciplinary curricula throughout the world.

Research and descriptive understanding of the worlds oceans and coasts burgeoned during the 1950s. The aqualung, introduced to Shepards students in 1948 by Jacques Cousteau, became a new scientific tool for studies in nearshore waters, and instruments were designed for studying waves, currents, and sediment transport. A new quantitative coastal science emerged from the concepts of Bagnold and others. Funding came from the Office of Naval Research, coastal engineering (Beach Erosion Board), and the oil industry.

A significant contribution to the literature of classical nearshore processes was the series of Conferences on Coastal Engineering sponsored by the University of California and edited by Joe Johnson. Starting with the first conference held in Long Beach in 1950, the conferences brought together researchers from diverse backgrounds and published their findings expeditiously. This research soon was synthesized into textbooks such as Shepards Submarine Geology (2nd edition, 1963); Hills 1963 edited volume The Sea v. 3 The Earth Beneath the Sea, with the first discussion of Beach and Nearshore Processes; Wiegels Oceanographical Engineering in 1964; and Ippens Estuary and Coastline Hydrodynamics in 1966. An excellent example of the transition from descriptive to quantitative nearshore processes is given by comparison between the first edition in 1948 and the second edition in 1963 of Submarine Geology, with sections added on the mechanics of waves, currents, and sediment transport.

In the last two decades, the global scale of environmental research and the power of computers have shifted the focus of coastal research to large scale experiments and process modeling.

OS71E-11 1120h

Recent statistics on U.S. academic research and education in ocean sciences.

Sarah E Schoedinger[1] (202.332.0063; sschoedinger@COREocean.org)

Shannon Gordon[1] (202.332.0063; sgordon@COREocean.org)

[1]CORE (Consortium for Oceanographic Research and Education), 1755 Massachusetts Ave., NW, Suite 800, Washington, DC 20036-2102, United States

Recent statistics were collected on behalf of the U.S. Commission on Ocean Policy to ascertain the status of the U.S. academic infrastructure in support of research and higher education in the ocean sciences. The study focused on undergraduate and graduate programs as well as the facilities and funding that support academic research in the field It has provided the most comprehensive coverage of the ocean sciences community to date. The presentation will focus on key indicators of the health of the U.S. research enterprise in relation to the ocean sciences and discuss issues that need to be addressed by the higher education community in ocean sciences.

OS71E-12 1135h

An International Perspective on Post Graduate Education in Physical Oceanography

Jeff Polton[1] (swp98jap@met.reading.ac.uk); Moninya Roughan[2] (moninya@coast.ucsd.edu); T. M. Shaun Johnston[3] (shaunj@soest.hawaii.edu); James Hench[4] (hench@unc.edu); Pierre Testor[5] (testor@lodyc.jussieu.fr); Helen L Johnson[1] (h.l.johnson@reading.ac.uk); Holger Brix[6] ((310) 825 4526; hbrix@igpp.ucla.edu)

[1]Meteorology Dept., Reading University, Earley Gate, Reading RG6 6BB, United Kingdom

[2]Scripps Institution of Oceanography, UCSD Sverdrup Hall, La Jolla, CA 92093-0218, United States

[3]Department of Oceanography, University of Hawaii, 1000 Pope Road, Honolulu, HI 96822-2336, United States

[4]Institute of Marine Sciences, University of North Carolina at Chapel Hill, 3431 Arendell Street, Morehead City, NC 28557, United States

[5]Laboratoire d'Ocanographie Dynamique et de Climatologie, Universit Pierre Marie Curie, 4, place Jussieu, PARIS cedex 05 75252, France

[6]IGPP, UCLA 3845 Slichter Hall, Los Angeles, CA 90095-1567, United States

In June 2002 the inaugural Physical Oceanography Dissertation Symposium (PODS I) brought together 20 young scientists from 13 different countries. During the meeting, it became apparent that the graduate school experience varied markedly amongst the participants. We critically examine these differences, extract the positive aspects, and create recommendations for a post-graduate experience, which better prepares a student for a career in physical oceanography. We present a summary of the length, content, and quality of education for graduate programs in Australia, France, Germany, the UK, and the USA. Also we address the financial, social, and scientific status of graduate students. While individual character largely determines the success of the PhD experience, graduate programs should address the following crucial factors to improve the student's education: solid mentorship, regular progress checks on a departmental level, course work, internal workshops, field work, communication skills, effective scientific writing, scientific and social integration, international exchange, and stable and sufficient funding. We propose a model four year degree structure with one year of coursework, an additional six months at a foreign institution, and at least one month field work (not necessarily related to the project). If however this work was integral to the project then we feel that an additional fifth year would be appropriate.

OS71E-13 1150h

Institute for Exploration Partnership with URI Graduate School of Oceanography Produces Opportunities for Deep Water Archaeological Investigation

Robert D. Ballard[1] (8605725955; rballard@ife.org)

Dwight Coleman[1] (8605725955; dcoleman@ife.org)

[1]Institute for Exploration, 55 Coogan Boulevard, Mystic, CT 06355, United States

The Graduate School of Oceanography (GSO) at the University of Rhode Island (URI) under the auspices of its new Institute for Archaeological Oceanography (IAO) will soon be offering a Ph.D. program in Archaeological Oceanography. Although based within GSO, this new program is being carried out in cooperation with the Departments of History, Sociology and Anthropology, and Engineering, which will provide graduate course work in support of this effort. Students with strong backgrounds in the earth sciences as well as undergraduate course work in the humanities are being sought to apply for this program in 2003/2004 timeframe and beyond. A new family of remotely operated vehicle systems have been developed to support this effort as well as an on-going field program in the Central and Eastern Mediterranean and Black Seas and the Great Lakes. IAO's next major expedition will occur in the Black Sea and Eastern Mediterranean aboard the R/V KNORR in the summer of 2003 including the use of high-bandwidth ship to shore telecommunications to permit shore-based scientists and engineers the ability to participate in the sea-going program."

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The Present Graduate Program at SIO

M. Hendershott (858 534 5705; mhendershott@ucsd.edu)

Scripps Institution of Oceanography, 9500 Gilman Drive m/s 0209, La Jolla, CA‘ 92093-0209, United States

Graduate education in oceanography at the Scripps Institution differs from the Sverdrup model in (i) a much greater degree of disciplinary specialization than in Sverdrup's time, (ii) a much greater breadth of research/instructional material than in Sverdrup's time, some far from traditional oceanography. (iii) the present proximity of SIO to one of the US' most outstanding research universities, (iv) more powerful and complex observational and research technology than in Sverdrup's time, and (v) the relatively recent importance for research funding of very large collaborative programs.

Despite the sheer increase in the volume of knowledge since Sverdrup's time, recognition of the importance of the oceans for life on the earth is now strongly driving education back towards the comprehensive view embodied in "The Oceans." The increasing importance of climate and ecological concerns, the strongly interdisciplinary nature of associated scientific problems, and the intellectual excitement and opportunity of e.g. modern biology all present our students with material that may be far from traditional oceanography. The nearby presence of UCSD adds essential value to SIO's knowledge of the ocean. The sampling and computing technology available today enables us to tackle problems of scope and duration unthinkable in Sverdrup's day, but also requires students to learn complex systems at a level then not imagined. Funding preference for large projects encourages students to work in clearly marked research areas and makes funding for speculative projects difficult to obtain, but it also encourages students and academics to grow outside of their initial areas of specialization.