



# Earth Sciences at Santa Cruz

Alumni Newsletter

Fall 2001

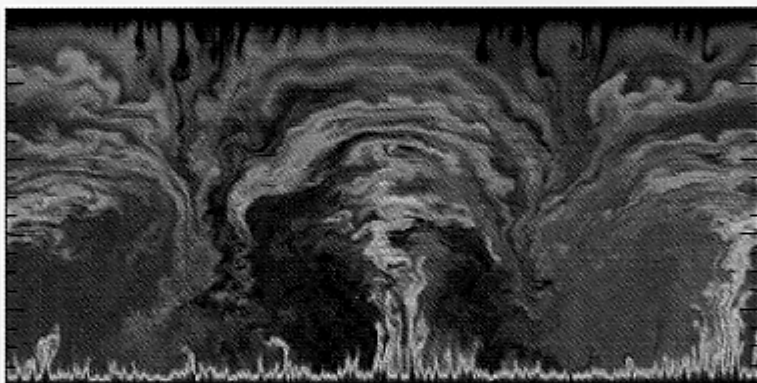
## Earth and Beyond

There is an alphabet soup of acronyms cooking around the Earth Sciences Department, with ingredients that combine to create one of the most dynamic teaching and research menus on campus. IGPP-UCSC, C.DELSI, CODEP, CSIDE—what do they all mean? Here is a break down of research programs that are changing the face of Earth Sciences at Santa Cruz.

The foundation is a multi-campus research unit of the University of California, the Institute for Geophysics and Planetary Physics (IGPP). It has branches at six campuses (UCLA, UCSD, UCR, UCB, UCI, and UCSC), and two national laboratories administered by UC (Lawrence Livermore National Laboratory and Los Alamos National Laboratory). The newly established Institute for Geophysics and Planetary Physics branch at UCSC (IGPP-UCSC) fosters interdisciplinary research activity intersecting the Earth Sciences and is coordinated by three interdisciplinary research centers. Research is carried out through three focused research centers that together cover the Earth, Solar System, and other planetary systems now being discovered.

The research centers are:

- Center for Dynamics and Evolution of the Land-Sea Interface (C.DELSI)
- Center for Origin, Dynamics and Evolution of Planets (CODEP)
- Center for the Study of Imaging and Dynamics of the Earth (CSIDE)



*A snapshot from a computer simulation of turbulent convection produced by Astronomy graduate student Tami Rogers. The light shades represent warm fluid rising and the dark shades cold fluid sinking.*

Thorne Lay, professor of Earth Sciences and director of IGPP-UCSC, is committed to its mission to promote and coordinate basic research on the understanding of the origin, structure, and evolution of the Earth, Solar System, and Universe, and on predicting future changes as they affect human life.

"The primary rationale for IGPP is broaching traditional disciplinary boundaries to pursue quantitative understanding of complex dynamical systems of the Earth and other planets,"

says Thorne. The UCSC branch of IGPP, established in 1999, has stimulated unprecedented interdepartmental coordination on faculty hiring, multidisciplinary research proposals, and research symposia at UCSC. "Enhancing interaction with other UC campuses and National Laboratories is another goal of the research organization" he continues.

Encompassing traditional disciplines of astronomy, Earth sciences, and ocean/atmospheric sciences, IGPP was initially formed at UCLA in 1946 and since then has created revolutions regarding the application of paleontology and microbiology to the study of the origin and evolution of life, the application of modern

spacecraft, computation and visualization to understand Earth's space environment, the application of cutting-edge experimental and theoretical developments to the chemistry and physics of the interior structure of the Earth and planets, and last but not least, global change studies and associated socioeconomic issues.

IGPP-UCSC includes over 50 faculty and researchers and numerous graduate students from nine departments across

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# Beyond

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three campus divisions (engineering, natural sciences, and social sciences). Almost all faculty in Earth Sciences are engaged with one or more IGPP centers at UCSC. IGPP-UCSC is in a five year growth phase, with the addition of 20 faculty positions spread across five departments in the Division of Natural Sciences.

## Center for the Dynamics and Evolution of the Land-Sea Interface (C.DELSI)

One of the most dynamic and important system interfaces is the land-sea interface, where atmospheric and fluvial processes couple marine and terrestrial systems. California's land-sea interface is one of the world's most dynamic—and also one of its most heavily populated and economically fertile coastal regions. As world population continues to grow, pressures mount on the land-sea interface, and a

more quantitative understanding of the physical, geochemical, and biological processes that influence it becomes imperative. UCSC faculty, researchers, and students affiliated with the Center for the Dynamics and Evolution of the Land-Sea Interface are at the forefront of new developments in understanding these processes.

Investigations of Earth's atmosphere, oceans, continents, and the biota that inhabit these environments are at a crossroads. The approach traditionally used to measure and document the

nature of environmental change is rapidly being improved, and will soon be replaced with a new approach that will resolve, model, and explain processes in terms of how and why they occur, and, ultimately, how they impact society. Stimulated by technological advances in data collection and computation, a new intellectual challenge presents itself: to define and quantify complex processes and interactions that occur within and between natural systems.

"The Center for the Dynamics and Evolution of the Land-Sea Interface is here to help cultivate interdisciplinary

reality that the state and nation will have to come to grips with in the very near future" says Zachos. People who study policy and management, such as Brent Haddad, assistant professor of Environmental Sciences, use this information to evaluate how the state might best manage water resources to address eventualities. Another project led by Paul Koch, associate professor of Earth Sciences, and Diane Gifford-Gonzalez, professor of Anthropology, employs a paleoecological approach to investigate the recent history of pinniped populations and historic Native American populations along the

California coast. Their findings suggest that for much of the Holocene (~9 ky), the seal populations were impacted by humans, sometimes dramatically—an important consideration, particularly for ecologists interested in managing and restoring these populations.

The initial 5-year effort of CDELSI focuses on long and short-term dynamics of global and regional scale climate change, and impacts on ocean

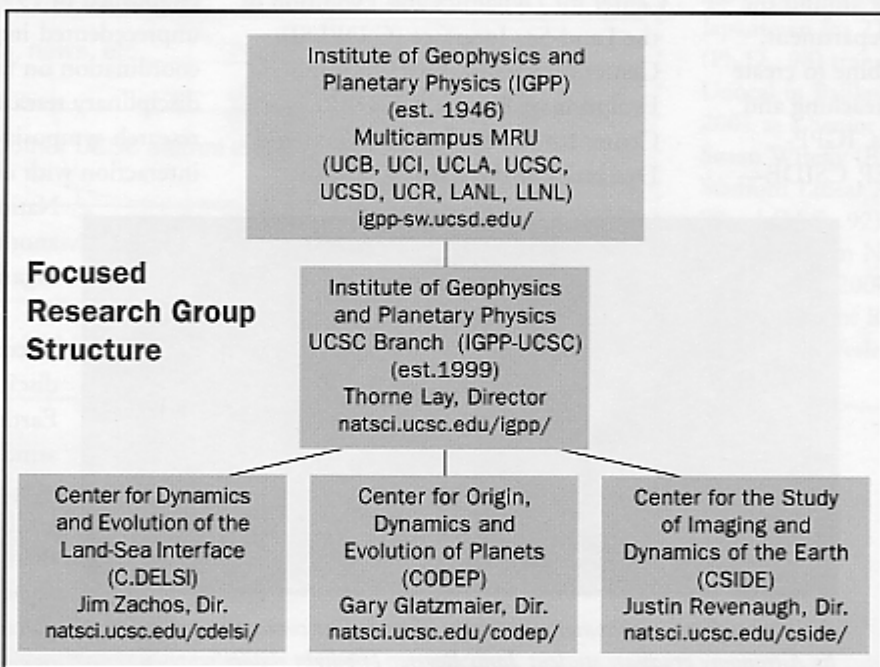
circulation, landscapes, geochemical cycles, and marine and terrestrial ecology at the land-sea interface. As a result of these efforts, UCSC will be at the scientific forefront of research on the dynamics of marine and terrestrial processes, particularly as they relate to the land-sea interface.

## Center for Origin, Dynamics and Evolution of Planets (CODEP)

The primary mission of the Center for Origin, Dynamics and Evolution of Planets is to coordinate and promote

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### Focused Research Group Structure



projects, and to help disseminate this information to the scientific community, policy makers, and general public," says Jim Zachos, professor of Earth Sciences and director of C.DELSI.

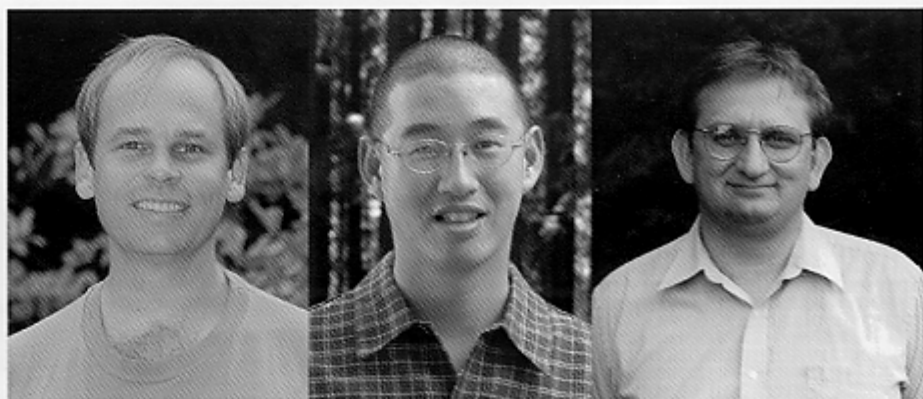
Two projects conducted by C.DELSI scientists illustrate the timely importance of the research and its relationship to policy decisions. Climate modeling work done by Associate Professor Lisa Sloan and her students shows a clear trend toward a reduction in the size of the Sierran snow pack earlier in the year with increased global warming. "This is a

## NEW FACULTY

**Erik Asphaug** joined Earth Sciences as assistant professor in 2000. He received his Ph.D. in Planetary Sciences with a minor in Geophysics from the University of Arizona, Tucson. Erik studies asteroids and comets: their geologic makeup and evolution, their impacts into planets, and their relation to the origin of solar systems. He also investigates impact craters, asteroid hazards, and giant collisions such as that which formed the Moon.

In this decade spacecraft will prospect the resource-rich Near-Earth Objects (NEOs) that sometimes collide with Earth. Erik is deputy leader of a proposed international effort to fly radar and seismic instruments to a number of potentially hazardous asteroids. The mission, named Deep Interior, aspires to determine for the first time the geology of our nearest neighbors in space. Another focus of Erik's research is development of computer hydrocodes which incorporate shock physics, self-gravity, and strength with explicit brittle fracture. These are the "laboratory tools" used to research the complex process of planetary collision. Erik is an affiliate of the Galileo imaging team that studies the satellites of Jupiter and the asteroids that were visited en route. "Although our home is perhaps the most intricate and hospitable of planets, Earth is verily a speck in the landscape of the universe," says Erik. His teaching interests include planetary science, comparative planetology, and planetary discovery.

**Slawek Tulaczyk** joined the Earth Sciences faculty as assistant professor in 2000. Slawek received his Ph.D. in Geology from the California Institute of Technology with a research focus on glaciology and glacial geology, geomorphology, and soil mechanics. At UCSC



*Erik Asphaug*

*Patrick Chuang*

*Slawek Tulaczyk*

he focuses his research on ice sheets and glaciers as dynamic features interacting with geologic, hydrologic, and climatic processes on different timescales. Much of his glaciological work is based on recent behavior of the West Antarctic ice sheet. One of the important current goals of his research is to test the idea that this marine ice sheet may collapse and contribute significantly to ongoing global sea level rise. To test this, he investigates physical controls on ice flow velocity and constructs quantitative models of ice flow dynamics. In addition to elucidating the possible fate of the West Antarctic ice sheet, the work enhances our general understanding of feedbacks between ice-sheet behavior and climate changes. Large ice sheets respond to climate but may play the role of pacemakers of climate fluctuations as well. Behavior of ice sheets is modulated to a significant extent by the underlying geology.

Slawek explores these geologic controls through sedimentological and geochemical analysis of subglacial sediment samples from West Antarctica. He has used a variety of data sources (remote sensing, borehole experiments, and subglacial sediment samples) to constrain the physics of the subglacial environment and its role in controlling ice flow velocities. Slawek's teaching interests include environmental geology, soil mechanics and properties, and glaciology.

**Patrick Chuang** is Earth Sciences's newest faculty member. He received his M.S. and Ph.D. at the California Institute of Technology. Patrick's research is essentially focused on understanding what the atmosphere is made of, how it's changing, what processes are important in transforming it, and what effects will result from these changes. His primary research interest is in the interaction between aerosols (atmospheric particles) and climate, more specifically the interactions between aerosols and clouds, precipitation, radiation, atmospheric chemistry, and human and ecosystem health. His approach is mainly experimental, although he also has interest and experience in theoretical and modeling approaches. He has engaged extensively in field measurements and laboratory experiments, and in instrument design and construction. Spatial scales of interest range from the urban and regional level (e.g. Los Angeles smog) to global scales. The theme of aerosol/cloud interactions is a particularly strong one because it is central to the core issues of radiation (sunlight and longwave), precipitation, and atmospheric chemistry, and also because it is one of the most poorly understood.



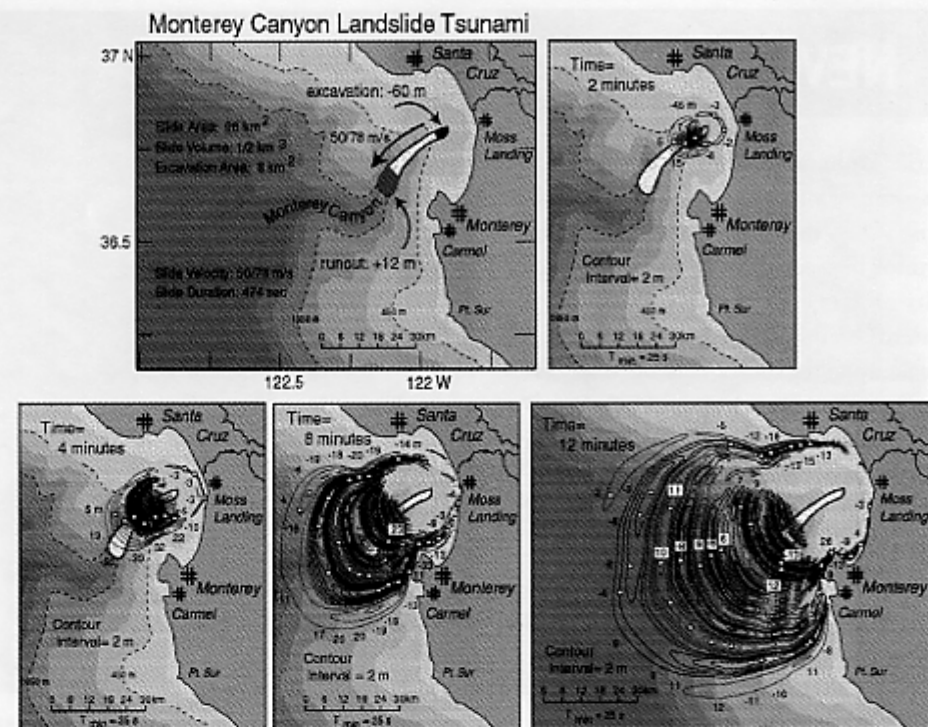
# Beyond

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UCSC activities related to the origin, dynamics and evolution of planetary bodies in our Solar System and around other stars. UCSC scientists are participants in the discovery of extrasolar planets, theoretical modeling of planetary formation, collisional processes, generation of stellar and planetary magnetic fields, and processes in planetary interiors. Their research addresses the existence of habitable environments in the Solar System as well as near other stars.

Planetary science is undergoing dynamic and profound advances as evidenced by the astounding array of new information available. Planets, moons, comets and asteroids are revealed in startling detail by a parade of spacecraft flybys, orbiters and landers. Scientists debate the potential evidence for past life in rocks ejected from Mars, the probability of life in aquifers beneath the Martian surface today, and the possibility of life in brines and waters beneath the ice crust of Jupiter's satellite Europa. As we complete the inventory of our own Solar System, astronomers are characterizing other planetary systems in our galactic neighborhood, some with three detectable planets, and several within the "habitable zone" where liquid water could exist. Complementing these discoveries are fast-paced advances in computer simulations and the hardware on which they run.

The Planetary Sciences research program coordinated through CODEP enables UCSC to take part in the discoveries, missions, and data returns of coming decades. Interdisciplinary approaches are essential; CODEP links two UCSC academic divisions (Natural Sciences and Engineering), broadens graduate research programs, and supports



*This simulation supposes that 1/2 cubic km of material in an excavation 4 km long, 2 km wide and 60 m thick breaks away near the head of the Monterey canyon and deposits in a runout 12 m thick covering 40 square km. The slide extends for 24 km from a depth of 300 m to over 1800 m. The spoils follow a parabolic velocity path with mean speed of 50 m/s and peak speed of 78 m/s. The entire submarine landslide takes 8 minutes to run its course. The slide induces waves nearly 50 m high over the excavation. Waves 15-25 m high reach shore on the Monterey side of the bay and 10-15 m ones beach on the Santa Cruz side. The wave field in this calculation includes periods down to 25 s. In these figures the different shades represent alternating highs and lows of the tsunami waves. The numbers sample wave heights in meters. Simulation by Steven Ward, Earth Sciences research geophysicist affiliated with the Center for the Study of Imaging and Dynamics of the Earth (CSIDE).*

investigations into scientific challenges surrounding planetary formation, dynamics, and evolution. CODEP prepares a new generation of scientists to address planetary topics of a new century.

"Much of the collaboration among CODEP members has been initiated by graduate students," says Gary Glatzmaier, professor of Earth Sciences and CODEP director. For example, Erik Asphaug works on giant planet formation with a student of Peter Bodenheimer, professor of Astronomy and Astrophysics. "One of my students has worked with Doug Lin in the Astronomy and Astrophysics Department on orbital dynamics of extra-solar planets, and

another with Peter Bodenheimer on the interior structure of giant planets." Stan Woosley, Professor of Astronomy and Astrophysics, and Gary are working with two students to simulate thermal convection using the 32-processor Beowulf computer, and will use the 264-processor Beowulf later this year. "Planetary science research in our department includes the high pressure experimental work by Quentin and Elise's student, Henry Scott," Gary explains. "Henry modeled the compositional structure of Ganymede's interior."

**Center for the Study of Imaging and Dynamics of the Earth (CSIDE)**  
CSIDE is successor to the former Institute of Tectonics at UCSC, an organized research unit with a 15-year

history of multidisciplinary research into the dynamics of the Earth system.

"CSIDE is home to a number of world class scientists whose interests, expertise, and energy are important parts of IGPP's success," says Justin Revenaugh, CSIDE director and professor of Earth Sciences. The center promotes interaction between faculty, students, and researchers, fostering and sometimes funding collaborative efforts that amplify members' strengths.

The mission of the Center for the Study of Imaging and Dynamics of the Earth is to conduct basic multidisciplinary research on terrestrial imaging and dynamics of near surface, crust, mantle, and core. In the deep Earth area, scientists participate in geodynamo studies and simulation and the origin of the magnetic field, investigate the nature of the core-mantle boundary and the origin of hot spots, and conduct research in deep evolution of subducted slabs. In crustal and near-surface dynamics, these scientists investigate the structure, physical properties and dynamical behavior of the seismogenic zone, tectonic forcing and evolution of topography, and the dynamics and evolution of fluid, heat and material flux in the lithosphere. In the field of high-resolution imaging and remote sensing, CSIDE scientists conduct research into imaging of crustal fractures and fluids, accurate and efficient waveform modeling and migration schemes, and applications of remote sensing to crustal dynamics.

CSIDE supports basic research and breadth in graduate education in basic disciplines of seismology, geodynamics, tectonophysics, mineral physics, geomorphology, hydrogeology, and geomagnetism. CSIDE also promotes Earth sciences research in applied physics, applied mathematics, and engineering.

## NOTES FROM THE CHAIR

### *Dear Alumni and Friends,*

I hope this year's newsletter conveys to you the sense of excitement in the department generated by the growth of our faculty by three assistant professors in the past two years, the expansion of our program into atmospheric and planetary science, and the establishment of a new IGPP branch at UCSC. In addition to our new faculty who are highlighted in this newsletter, I want to bring to your attention some of the other changes in Earth Sciences. Professor Karen McNally retired effective July 2000: Karen worked tirelessly to establish a world-class geophysics program at UCSC and the Institute of Tectonics (the precursor to the CSIDE branch). Although officially retired, she will continue to teach her lower-division course *Earthquakes, You and Society*. Dr. Gerry Weber has also retired effective July 2001, yet continues his key participation in teaching both *Introduction to Field Geology* and in our *Summer Field Program*. I would like to let you know that in May 2002, the department will be hosting an alumni reunion weekend event on campus. Part of this event will be an opportunity to honor our retiring faculty. It will be sponsored by the UCSC Earth Sciences Alumni Association. More information on this reunion will be available soon: checking our website ([www.es.ucsc.edu](http://www.es.ucsc.edu)) is a good way to keep up to date.

We have also had some changes on the staff side of the Department. Our Instrument Engineer Walter Schillinger retired as of January 2001 (although he too continues to volunteer his time to complete some unfinished projects – our retirees just can't stay away!). We have hired two new technical staff members: Eli Morris (M.S., UCSC

1997) has joined our technical staff as an Instrument Specialist with particular expertise in all aspects of computer interfacing with both lab and field instrumentation. Kellie Townsend is our new Staff Research Associate in charge of a variety of departmental teaching and general use research labs as well as our "webmaster." Kellie is taking over many of Bruce Tanner's job functions: Bruce has, in turn, assumed more research support activities to directly help faculty and students make the most of our lab facilities. This reorganization of the technical staff is a key part of creating and maintaining a vibrant research and teaching environment in the department.

Finally, I would like to thank all alumni, faculty and friends who contributed so generously to our recent solicitation for funds to augment the Aaron Waters Award Endowment. Your contributions, and the University's matching commitment, has enabled us to meet our target of \$24,000! This increase in the endowment will allow us to provide a more substantial fellowship to our yearly winner of the Waters Award for the best Ph.D. dissertation proposal. The Department greatly appreciates your support – as the environment for recruiting excellent graduate students becomes ever more competitive, these kinds of fellowships help us to maintain the quality of our program. I would also like to thank those who have contributed to the Earth Sciences General Needs Fund over the past two years. Your support is particularly valuable for providing funds to enhance the quality of our undergraduate programs. Thank you!

*Elise Knittle  
Chair, Earth Sciences*





## ALUMNI UPDATE

**Bill Bagby** (Ph.D., 79) has a mineral exploration consulting business in San Diego with projects in Nevada and elsewhere. **Sylvia Barry** (BA, 93) is finishing a M.S. in Limnology at Univ. of Minnesota at Duluth. **Rick Behl** (Ph.D., 92) is Associate Professor at CSU Long Beach, and co-taught the CSULB summer field camp at the same site as the UCSC field camp. **Ben Benumof** (Ph.D., 99), in his second year of Law School at Univ. of San Diego, had worked for Cotton, Shires and Associates and Geohazards Consultants International, Inc. **Tom Bertucci** (B.S., 77) is a bridge engineer who designs ferry terminals and marine structures with the Wash. Dept. of Transportation and works on an M.S. in Structural Engineering at Univ. of Washington. **Julie Blue** (M.S., 94) has a faculty position at Oberlin College. **Mark Brandon** (B.S., 75) is Professor at Yale Univ. and a GSA Fellow.

**Sasha Carter** (B.S., 01) has married and attends graduate school at Univ. of Texas, Austin. **Kathleen Campbell** (B.S., 85) is Assistant Professor of Geology at the Univ. of Auckland, Director of Paleontology Collections and serves as liaison for Maori and Pacific Island students. **Kevin Clahan** (B.S., 91) received his M.S. from SJSU in 1998 and is an associate engineering geologist at the California Division of Mines and Geology, Seismic Hazards Mapping Program, San Francisco Office. His son, Ryan Eugene Clahan, was born in 1999. **John Childs** (Ph.D., 82) is self-employed, consulting in metals and industrial minerals exploration; recent research locations include western Romania and Montana. **Paul Crenna** (B.S., 86) is Senior Engineering Geologist, Adapt Engineering. He started the office in 1999.

**Kenneth Ehman** (B.S., 80) is Chief Geologist, Groundworks Environmental, Inc. **Ollie Eisman** (B.S., 98) works for United Space Alliance and is responsible for development and operation of software to monitor space walks on the

shuttle and international space station. His software is used by flight controllers at the NASA-Johnson space center and Russian Space Agency, Moscow. **Laura Fay** (B.S., 99) joined Astro Camp, Idyllwild. **Rich Fink** (B.S., 76) received a M.S. degree from Univ. of Nevada, Reno in 1979. He is with Kleinfelder, Inc., a senior geologist and environmental group manager in the Fresno office. **Genevieve Fire-Halvorsen** (B.S., 79) is owner of Genevieve Fire, P.E., a sole-proprietor civil/environmental engineering company. **Julie Friedman** (B.S., 99) lives in Boulder CO, works for USGS.

**Brian Globberman** (Ph.D., 85) works at Data Dimensions Inc. and is president of UCSC Alumni Association, Seattle Area Chapter. **Saskia Goes** (Ph.D., 95) is on the junior faculty at ETH, Institut fuer Geophysik, in Zurich. **Richard Gordon** (BA, 75) is W. M. Keck Chair of Geophysics at Rice Univ. **Julia Hurbert** (B.S., 99) entered the graduate program at the Univ. of Hawaii in 2000. **Rick Koehler** (BA, 92) is working for the William Lettis company in Walnut Creek. He received an M.S. from Humboldt State in 1997.

**Paul Lawlor** (M.S., 98) has been working for Nielson and Associates in Santa Cruz since 2000. **Mike Liquori** (B.S., 93) is Watershed Scientist with The Campbell Group, which manages 800,000 acres of managed forest in Washington, Oregon, and California and is in the Ph.D. program in Forest Hydrology at the Univ. of Washington College of Forestry. **Bobby Lopez** (Ph.D., 97) is Assistant Professor at West Valley Community College in Sunnyvale. **Craig Lundstrom** (Ph.D., 96), Assistant Professor, Univ. of Illinois, was awarded the 2001 F.W. Clarke Award of the Geochemical Society for an outstanding contribution to geochemistry by early career scientists.

**Brian Martasin** (B.S., 99) works for Ecology Control Industries in their Los Angeles geoscience group. **Brian McAdoo** (Ph.D., 99) is the proud papa of Zoe McAdoo. Brian has been Assistant Professor at Vassar since 1998. **Christopher Metzler** (B.S., 79) is Professor and Physical Science Dept. Chair at Mira

Costa College. **Laura Moore** (Ph.D., 98) is a post-doc with USGS in St. Petersburg, Florida. **Pedro Najar** (B.A., 96), M.S. from the Univ. of Idaho in 1998, works for Schlumberger as Drilling Service Engineer, and lives in Port Harcourt, Nigeria.

**Emily Oatney** (B.S., 94) completed a M.S. in Geology at Oregon State in 1998 and joined Chevron USA as a geologist in the New Opportunities and Lease Acquisitions Team, Deepwater Gulf of Mexico. **Kathleen Ort** (B.S., 81) is Editor in Chief at Mountain Press in Missoula, Montana. In February she was featured in a *Geotimes* article on geologists who use geological knowledge to follow non-traditional careers. **Michael Ort** (B.S., 84) is Associate Professor of Environmental Studies and Geology at Northern Arizona University.

**Taxiarchis Papadopoulos** (M.S., 75) is Associate Professor of Applied Geophysics at Athens Univ., Greece. **Chuck Payne** (B.S., 92), was working for Texaco in Houston, Texas after finishing his M.S. at Oregon State. **Nathaniel Plant** (M.S., 90) received his Ph.D. in Oceanography from Oregon State Univ. and is a post-doc at Delft Hydraulics in The Netherlands. **Tim Redfield** (B.A., 85) is working at Norwegian Geological Survey. **Jeroen Ritsema** (Ph.D., 95) is a Senior Research Fellow at the Caltech Seismo Lab. **Michelle Roberts** (B.S., 98) is a graduate student at Humboldt State Univ., pursuing a M.S. in Quaternary volcanic processes at Mt. Shasta. **James Robinson** (M.S., 88) is a Water Resources Planner at the Montana Dept. of Natural Resources.

**Dellilah Sabbah** (M.S., 88, B.S., 84) is working for Stanford Linear Accelerator Center. **Taryn Sass** (B.S., 98) has a position at PacRim Geotechnical, Inc. **Laurel Savoy** (M.S., 83) is Associate Professor of Geology and Environmental Studies at Mt. Holyoke Univ. in Mass. **David Schleupner** (M.S., 99) married and moved to Los Angeles where he started a web application development company, Quietly Creative Designs, LLC. **Bridget Scott** (B.S., 98) works on

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Dear Alumni,

We like to keep in touch with you. Please take a moment to let us know where you are and what you are doing. Mail, fax, or Email your comments to Roxanne Woodling, Dept. of Earth Sciences, UCSC, 1156 High St., Santa Cruz, CA 95064, (831) 459-3074 fax, roxanne@es.ucsc.edu. Thank you!

Name \_\_\_\_\_

Mailing address (home/business): \_\_\_\_\_

Telephone \_\_\_\_\_ Email address \_\_\_\_\_

Employer \_\_\_\_\_

Responsibilities \_\_\_\_\_

Recent achievements, news, etc. \_\_\_\_\_

Can you tell us about other UCSC alumni in Earth Sciences? \_\_\_\_\_

Suggestions for future activities? \_\_\_\_\_

## Alumni Update (from page 7)

her M.S. degree in Geology at San Jose State Univ. Katie Scott (Ph.D., 93) is with Kinnetic Labs in Watsonville. Larry N. Smith (B.S., 77) is Associate Research Geologist/Professor at the Montana Bureau of Mines and Geology, and Montana Tech. Seth Stiles (B.S., 90) has a position at the Washington Group International in San Francisco, managing environmental remediation projects.

Jim Tait (Ph.D., 95) is Assistant Professor of Geology at Southern Connecticut State Univ. Dennis Taniguchi (M.S., 73) lives in Sebastopol with wife of 19 years and sons aged 13, 17 and 18. He has been director of an art center in Japantown for 22 years. Philip Teas (Ph.D., 98) transferred to a job with Unocal in Balikpapan, Indonesia, in 2001 as a Senior Exploration Geologist. Susan Witeky (B.S., 81) is working for Stanford Linear Accelerator Center. Tim Wood (M.S., 92) is with Geomatrix Consultants in Newport Beach, Ca. Janet Yun (Ph.D., 2000) is Assistant Professor in the Dept. of Earth and Environmental Sciences at Wesleyan University.

## EARTH SCIENCES AT SANTA CRUZ Fall 2001

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