DIRECTORS STATEMENT FOR 91/92

1. Goals of the Unit

The ICS was approved by the UC Regents in May 1987. The mission of the ICS is to achieve an increased understanding of the crust and lithosphere of the earth, both on the continents and under the oceans, by utilizing the approaches of many disciplines and the expertise of scientists in academia, government, and industry.

The function of the ICS is to provide the research leadership, organizational structure and facilities to promote the cooperation of scientists from various research groups and organizations on problems concerning the earth's crust which are on a scale greater than those which can be studied by one investigator, or one group of investigators.

At present the research agenda of the ICS comprises the study of *crustal structure and tectonics*, how the crust is put together and deformed; *crustal materials*, what the crust is made of and what are its physical properties; *earthquakes*, how, when and where they occur in the crust and how strong they are; and, *hazardous waste disposal*, how industrial and nuclear materials can be safely disposed of in the crust.

2. Integration of university educational and research functions

Graduate students and postdoctorals are heavily involved in research activities of the ICS. At the ICS/Hollister Research Center, nine graduate students and six postdoctoral scholars currently have offices. For 1991/92, support was requested for over 18 graduate research assistants on grant applications submitted through ICS. For 1991/92, 17 research assistants were being supported on ICS projects. The Vadose Zone Monitoring Lab activity includes four of these students.

For 1991/92, 19 undergraduate students were employed as lab assistants on ICS projects. These positions range from routine assistance to conducting independent research **(see Figure 1)**.

Our unit has continued our seminar series where both on campus and off campus scientists lecture. During the past year we held 10 seminars at ICS. All seminars were well attended by graduate students, faculty, researchers, staff, and the community.

The ICS has achieved national and international recognition as is evidenced in part by an increasing number of prominent long-term visitors. This past year we hosted visits from MIT, Moscow, the USGS, and the Université de Joseph Fourier, Grenoble, France.

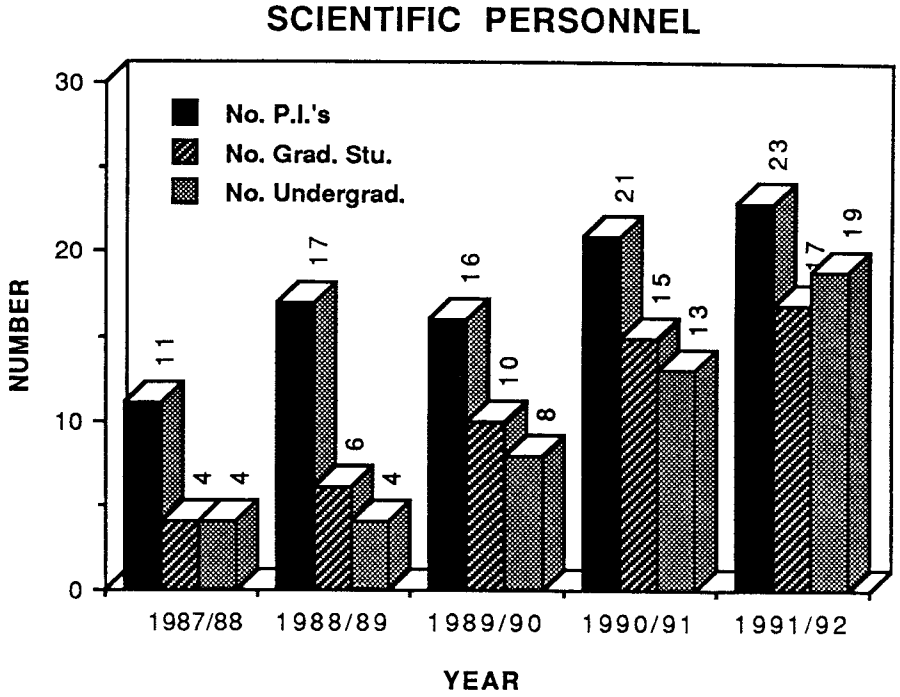

Figure 1: *The number of Principal Investigators and student researchers has increased steadily, with the number of students increasing the fastest. There are now more student researchers than PIs.*

During the first week of September, 1991 ICS hosted a conference on the Eastern California Shear Zone (ECSZ) attended by earth scientists from southern California and Arizona. The ECSZ is that network of active faults which passes east of the San Andreas fault and north to Death Valley. The M 7.4 Landers California earthquake of June 28, 1992 was in this zone.

In February ICS held a workshop for the Southern California Earthquake Center dealing with "Predicting strong ground motion from earthquakes". This was attended by 50 researchers from southern California.

3. Role of ICS in Responding to Needs of the Public

The research agenda of the ICS impacts directly three areas of social concern: *energy and mineral resources*, *public safety*, and *environmental quality*.

Studies in crustal structure and materials concern the makeup of the crust which is the reservoir for oil, gas and mineral deposits. One ICS project is focusing on the deep structure at the south end of the San Joaquin Valley which is a rich petroleum province. In the Yellowknife mining district in Canada ICS researchers have been conducting a project relating faulting and fluid movements to fault zone mineralization processes which

create ore deposits. A similar project is underway in the Mother Lode of The Sierra Nevada. Research in earthquakes concerns both earthquake prediction and estimating ground motion from earthquakes. Expected strong ground motion is being studied at several locations in California, in a project sponsored by the Nuclear Regulatory Commission and the USGS. The movement of hydrocarbons in soils and sediments is studied in our Vadose Zone Monitoring Lab. This project is attempting to define controlling parameters on the migration of liquid and gas hydrocarbons in the crustal layer above the water table (vadose zone). This is applicable to the mitigation of the problems from leaking hazardous waste landfills and underground hazardous liquid storage tanks. The project is funded by the Environmental Protection Agency.

During 1988/89, we organized an Earthquake Advisory Group (EAG) within ICS. This is a group of Principal Investigators who can interface with the public and media on earthquake related issues. We have also prepared maps and displays for use in media interviews. Within the campus phone directory are listed the names and phone numbers of the EAG under the heading "Earthquakes". On June 26, 1992 ICS instituted an earthquake information hotline phone number (893-8421) which plays a recorded message giving current information on significant earthquakes. Ironically, the Magnitude 7.4 Landers and M 6.6 Big Bear earthquakes struck just two days later. ICS gave several press conferences to local television stations concerning the June 28 shocks and also the April Joshua Tree earthquake (M 6.1) which may be a foreshock to the June events. Director Luyendyk appeared live on KEYT news (channel 3 in Santa Barbara) on the evening of June 28.

ICS continued it's active participation in the Southern California Earthquake Center (SCEC), a National Science Foundation Science and Technology Center. ICS is a major partner along with 6 other universities, and the U.S. Geological Survey. This project includes studies by ICS in the areas of regional seismicity, subsurface imaging of earthquake zones, fault zone geology, seismic hazards analysis, and geologic (tectonic) history. Some details of our research through the center are described below.

Researchers from ICS were involved in the filming of a television program by the BBC on the San Andreas fault. This program is being produced for the Open University, a national television university in the United Kingdom.

4. Goals of the ICS for the next 3 year period

We have three broad categories of goals for our research agenda: to increase the multidisciplinary character of our research programs; to build and strengthen research ties with departments, other universities, industry and government agencies; and to strengthen the ICS infrastructure. For the

last goal category, a move of the ICS from it's off-campus Hollister Research Center (HRC) location to on-campus, is of the utmost importance.

Increasing the multidisciplinary character of our research will require more people and projects which cross traditional academic department boundaries. Projects involving Geological Sciences, Geography, Engineering, Materials Science, Environmental Studies and the Institute for Theoretical Physics are specifically targeted. ICS is hoping to attract new members and new research in cross-disciplinary fields. Remote sensing of geology is one of our current research activities which we plan to build upon. Also, our program in vadose zone monitoring is expected to grow significantly. The SCEC project is providing many opportunities for multidisciplinary research on earthquakes. Joint research is underway between ICS and the Institute for Theoretical Physics at UCSB, and between ICS researchers and those at other southern California institutions.

4.1 Continuing development

Perhaps the most important objective, which has the unanimous support of our members, is to move the activities of ICS onto the main campus. Currently our space is focused at two locations, the HRC and the Vadose lab in the Arts building on campus. Most of the principal investigators and students are housed in the geology department on campus, which in effect creates a three-way split. This division is dysfunctional. Although there are some obvious benefits to the space at HRC, the interruption of communication and collegiality between scientists and students clearly outweighs them. It is easiest to understand from a student's viewpoint; location at HRC means limited access to professors and resources such as the library. This same isolation is experienced by any scientist working remotely from their colleagues. At times we all wish for quiet and isolation, but the fermentation of ideas is a group effort.

Like every unit at the UCSB campus, ICS is facing a space squeeze. Most critical, the VZML is working with an inadequate amount of laboratory and office space. Even with additional space and furniture supplied at the expense of other ICS research efforts, the VZML still faces a productivity-limiting space restriction on a day-to-day basis. Relief of space limitations of the VZML is an important ICS goal. Inevitable growth in our research activities and our visitor program are creating further space problems.

ICS is rapidly becoming too thinly staffed in administration considering the growth in the number of researchers and in the number of projects **(see Figure 2)**. To date we have been functioning with temporary and student help. Fortunately, this assistance has been of the highest quality. However, the unit needs a career Senior Typist Clerk to function at its highest efficiency. ICS now has a very sophisticated computing network in operation. Currently we are using a Staff Research Associate part-time to manage our system. ICS needs augmentation of it's UCSB salaries support in order to guarantee that such a person is available to keep our computing

functioning. We have also experienced the loss of top scientific personnel. Drs. Peter Malin and Jonathon Lees left their Professional Research positions here for faculty positions at Duke and Yale. Dr. Steve Richard left for the Arizona Geological Survey. Prof. R. Sibson left to accept the chair in geology at Otago University. These four talented individuals have not been replaced. The ICS needs UCSB funding to attract researchers here. We propose that salary be fully funded for one year by UCSB after which these scientists would have established their own funding program.

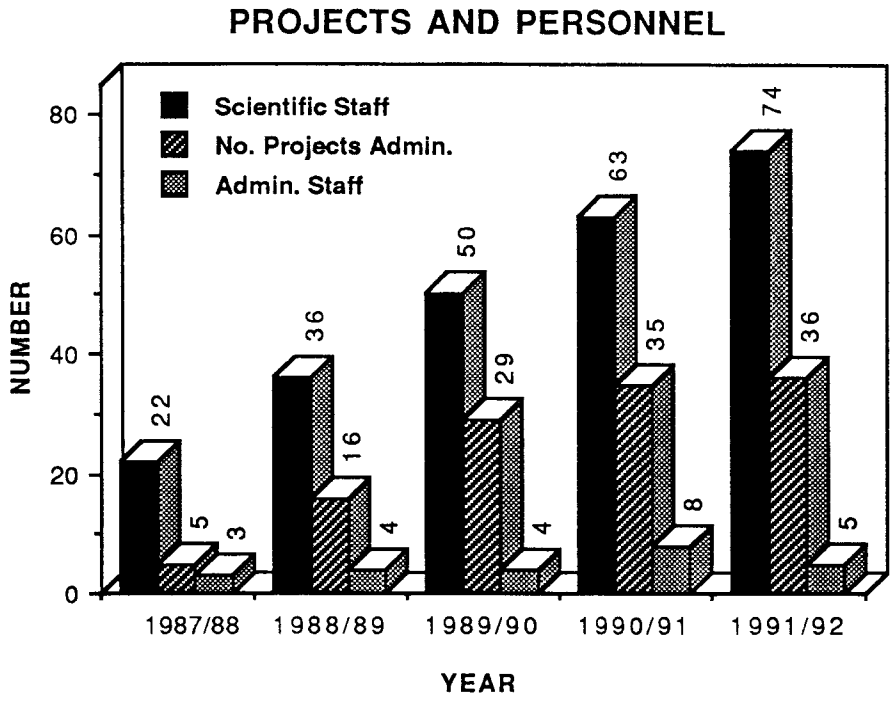

Figure 2: *The number of projects and scientific staff has grown steadily while the number of administrative support personnel has remained constant.*

ICS wants to continue to attract visitors from an international community and to provide them with adequate space and resources to ensure that they and our researchers gain the most from their stay. This is functioning adequately now, but it has reached a limit. We would like to house at least four visitors at one time, one for each research agenda. This will require space commitments from the campus plus additional funding. We are currently exploring an exchange program with The International Institute for Earthquake Prediction Theory and Mathematical Geophysics in Moscow. This is an exciting possibility which will require a sober response of the UCSB administration for the resources required.

4.2 Planned changes in objectives

Research under the earthquake agenda will continue to grow as SCEC attracts more NSF support. An exciting recent development is an expressed interest of the Nuclear Regulatory Commission (NRC) in a combined program of research into seismic hazard and hazardous waste disposal. The problem to be addressed is what are the issues and their importance surrounding the disposal of hazardous wastes in the earth's crust in seismically active areas. This broad question opens possibilities for our scientists in earthquakes and hazardous waste disposal to work directly together.

We have several objectives related to computing which have been put into a coordinated plan of phased acquisition. Two main steps are to implement parallel computing and also extensive use of color display and output. ICS upgraded it's SUN 4/470 to a 4/670 multiprocessor as already mentioned. The implementation of color display is also in progress. Significant and costly items in our plan are a color printer and a unit to write video tapes.

A continuing goal at ICS is for us to develop refined abilities for crustal imageing. This means the ability to handle multiple map view data sets, such as in a Geographic Information System (GIS), and also 3-dimensional subsurface crustal data. Three-D viewing has been developed by the petroleum industry for seismic reflection data. However, other types of 3-D data are also of interest. Also, merging of map and subsurface data is only beginning to be achieved. Our goal is to obtain a hardware/software system which can perform state-of-the-art image construction, and also permit novel applications such as animations.

In the area of hazardous waste disposal, we are beginning major new projects under various sponsorships. These include a remediation research project at Lawrence Livermore National Laboratory, and research on land recovery at municipal sludge dumping sites. In addition, we are in discussions with EPA to be named as a National Center of Excellence, and with the U.S. Navy National Civil Engineering Laboratory on a joint UCSB-NCEL-EPA effort

4.3 Planned steps to achieve objectives

We require new UCSB support and augmentation of UCSB funding to achieve many of our long-term goals and short-term objectives. Specifically:

Move to an on-campus location
Increased administrative staff
Support for technical staff
Funding for postdoctorals
Funding and space to support our visitors program.

Regarding a move to on-campus, the Administration is well aware of this issue and our desires. Further, we have a space plan coordinated with the Geological Sciences Department. We have already made a case to the Administration for increased staff and postdoctorals. Our visitor program has received some support through SCEC.

As we have demonstrated by our aggressive pursuit of extramural support, ICS will continue to seek the vast majority of resources from agencies and foundations. ICS has been in close contact with the UCSB Development Office in regards to an application to the Keck Foundation. This foundation specifically funds projects in earth sciences. Our intention is to request funding for advanced hardware and software for use in crustal imageing. This system would integrate map and subsurface data to produce data volumes of the earth's crust. Advanced software would be used to produce animations and fly-throughs of these volumes. The Keck Foundation has told UCSB that it will not be considering proposals for a year or two. In the meantime, we will be applying to the SUN Foundation for part of the hardware, and seeking donations of software from Wavefront and StarDent.

5. Concluding Remarks

The ICS is a recent UC initiative. The rationale for its formation is to provide a multidisciplinary research unit which can bring together scientists from academia, government and industry to work on several pressing problems in earth sciences. The ICS has focused its research agenda on the earth's crust for several simple reasons. The crust contains our oil and mineral resources, it holds our water supply, mankind disposes its industrial and nuclear waste in the crust, most of the worlds earthquakes occur within the crust, and the crust contains our most tangible record of earth's history. Given the intellectual and social importance of these issues, it is imperative that UC seriously partake in this research enterprise.

Our current funding level of administered projects for our research agenda is roughly four million dollars. ICS has a strong record of funding growth since its inception in 1987/88 **(see Figure 3)**. At that time total awards administered amounted to $496K. This past year we administered $4,116K and with total new awards of $1,618K. Over the past four years the number of administered projects has increased from 5 to 46, or 9-fold, and the number of Principal Investigators has increased by a little over a factor of two, from 11 to 23 while the number of scientific staff (PIs, post-graduate researchers and students) has grown from 22 to 74, or 3-fold **(see Figure 2).** This is in the face of an unchanging number of ICS administrative staff and a decreasing level of funding from the UCSB administration **(see Figures 4 and 5)**. Not only have the PI's been more productive, but obviously the staff has worked harder and more effectively. Our publications in the ICS contributions inventory increased to a total of 135 submitted and published papers since inception of the unit and up to October 1992.

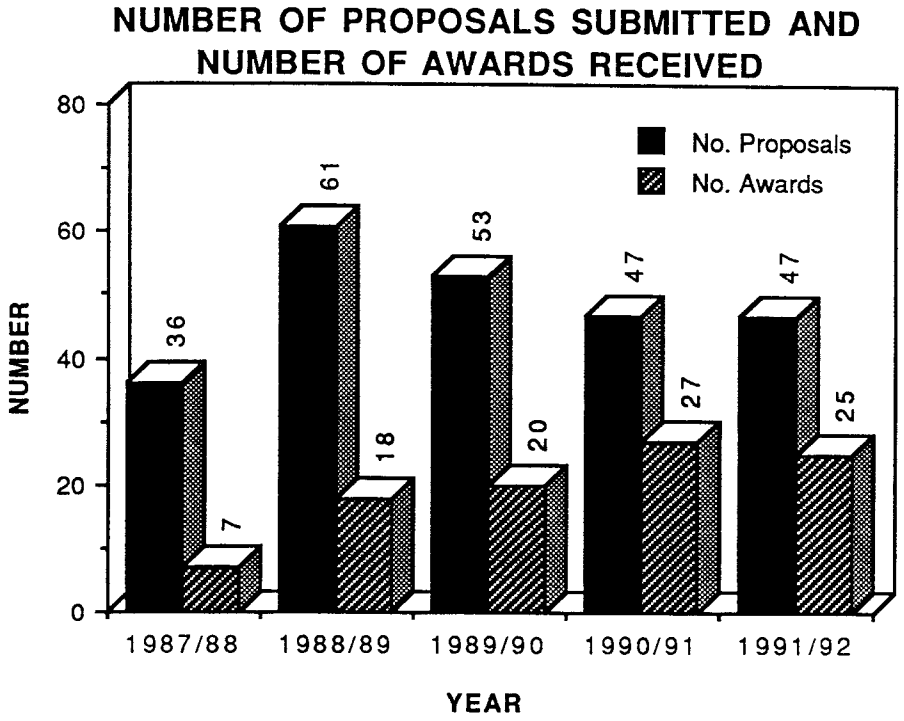

Figure 3: *Our success rate for proposals has increased steadily from 19% to 53%.*

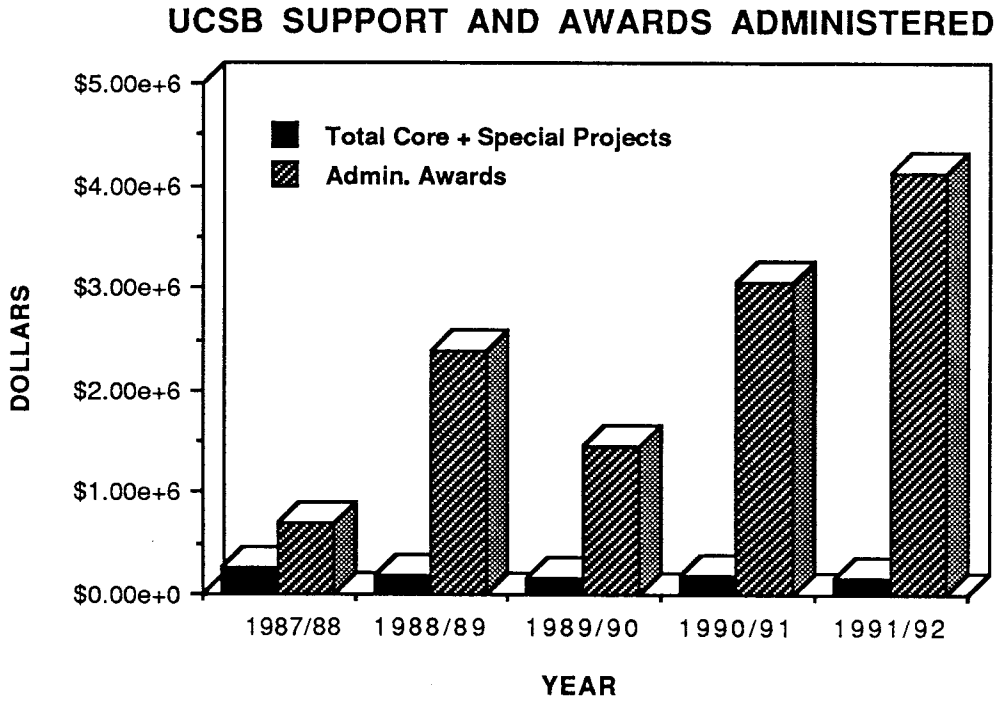

Figure 4: *The dollar amount of awards administered has increased steadily while UCSB support funding has decreased.*

ICS has achieved many of it's goals on several fronts. We have built strong ties between off-campus research agencies and the petroleum industry. We have a cooperative research agreement with the EPA where they have ranked us third out of 100 programs in quality. One of our research projects involves collaboration with the Jet Propulsion Laboratory, Pasadena. The San Joaquin Valley project includes the exchange of information and data with the oil industry, and also graduate student support. Companies we have strong ties with include ARCO, AMOCO, Chevron, and Unocal. A project in Antarctica is cooperative with faculty at San Diego State University, and with the German national Antarctic program. The SCEC activity has developed ties with researchers from across the nation and the world. Last year ICS hosted earthquake researchers from the U.S.G.S., M.I.T. France, and the U.S.S.R. Academy of Sciences.

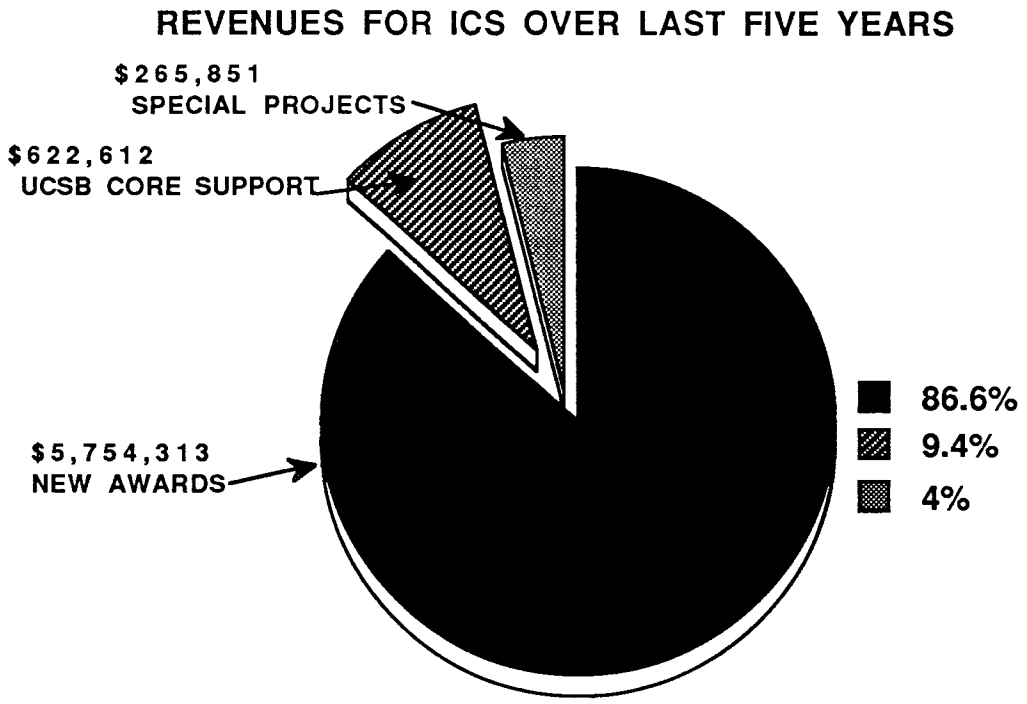

Figure 5: *For the first five years of ICS operation extramural funds provided 87% of our operating revenue.*