

U.S. CONTINENTAL SCIENTIFIC DRILLING PROGRAM

IMPLEMENTATION PLAN

REPORT TO
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
AUGUST 1986

PREPARED BY:
INTERAGENCY COORDINATING GROUP

G. A. KOLSTAD, DOE
J. F. HAYS, NSF
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INTRODUCTION

The policy framework for continental scientific drilling is contained in the Interagency Accord on Continental Scientific Drilling entered into by the Department of Energy, the Department of the Interior and the National Science Foundation on April 2, 1984, and in the Sense of Congress Declaration incorporated in P.L. 98-473 (98 Stat. 875) on October 12, 1984. The Accord is intended to assure that the respective activities of the participating agencies in a number of Federal scientific projects involving continental scientific drilling are appropriately coordinated.

An effective Continental Scientific Drilling Program (CSDP) will open new doors of scientific inquiry through direct sampling and observation of the third dimension of the crust at locations chosen for fundamental scientific interest. By extending the sources of information available to the earth scientist from surface observation to deep subsurface sampling and study in previously unexplored regions of the crust, the Continental Scientific Drilling Program provides an opportunity to address previously unresolvable fundamental scientific questions regarding earthquake mechanisms, stress in the continental lithosphere, state and role of pore fluids in crustal rocks, and the origin, evolution, and present state of crustal thermal regimes. The answers to these questions will provide a better basic understanding of the processes that, through time, have led to the evolution of the chemical properties and physical structure of the earth's continental crust. This understanding will contribute directly to the solution of serious national problems, such as the continuing need to assure supplies of energy, water and chemical resources, the safe isolation of wastes, protection against the hazards of earthquakes and volcanic eruptions, and our national defense and security.

DEPARTMENT OF ENERGY PROGRAM

Underlying Rationale and Scientific Objectives

The objective of Continental Scientific Drilling in DOE is to develop, in areas pertinent to the nation's energy needs, a quantitative and predictive understanding of crustal structure and earth processes along with associated advanced techniques and instrumentation. The continental crust is the primary source of the nation's energy and the primary sink for disposition of wastes from energy use. Thus, increased knowledge of crustal structure and processes is highly important to meeting the nation's future energy needs.

One of the principal topics in DOE's geosciences research is improved understanding of heat and mass transfer processes in various thermal regimes of the earth. Research on this topic is a central focus of DOE's Continental Scientific Drilling. Under the Interagency Accord, DOE has accepted primary responsibility for drilling and related logistical costs in thermal regime areas. Much of the research made possible by the drilling in these areas will also be funded by DOE, but a variety of additional research efforts are likely to be of interest to NSF and USGS and funded by them.

Natural thermal processes are responsible for the formation of coal, oil, gas, and geothermal energy resources, the concentration of elements leading to the formation of mineral resources, and volcanic phenomena with their associated earthquakes. The thermal effects associated with the geologic isolation of high level nuclear wastes are similar to those in the natural thermal regimes studied under the CSDP. Furthermore, there is an opportunity to observe, in situ, processes actively modifying the physical, mechanical, and chemical properties of rocks, minerals, and fluids at depth. These observations provide a sound basis for interpreting the origin and development of resources. Research involving thermal regimes thus provides a focus for many aspects of the CSDP relating to DOE and other Federal agency goals. In addition, since hostile environments such as those encountered in thermal regimes pose formidable technological challenges, we can expect direct industrial applications to stem from new approaches to drilling, logging, sampling, data analysis, and instrument development.

Other major topics in DOE's geosciences research include organic geochemistry and sedimentology which provide understanding important in use of fossil energy resources and in dealing with many energy related wastes. Important opportunities for research in these areas can be expected to arise appropriate for inclusion in DOE's Continental Scientific Drilling program. The samples for this research, at least in the near future, will be obtained through drilling funded by NSF, other agencies, or industry.

CSDP Activities to Date

The earliest activities in DOE related to Continental Scientific Drilling were carried out by the Geosciences program in the Office of Basic Energy Sciences which is under DOE's Director of Energy Research. This program took the initiative within the Federal government in arranging for workshops and establishment of an NAS/NRC Continental Scientific Drilling Committee.

NSF, USGS and ONR also provided support for these efforts. The BES Geosciences program began budgeting explicitly for Continental Scientific Drilling in 1980. Four western DOE laboratories joined together that year in surveys of U.S. thermal regime areas and completed a "Comparative Site Assessment." Emphasis was recommended on studies of the Salton Sea area in California where two continental plates are believed to be spreading apart, and on research on underground heat and mass flow at two of the largest collapsed volcanoes in the U.S.; namely, at Long Valley on the eastern edge of the Sierra Nevada Mountains in California and at the Valles Caldera in the Jemez Mountains in central New Mexico. Over the next several years, site characterization studies and other geochemical and geophysical research projects were carried out at the Valles Caldera in New Mexico and Long Valley in California, aimed in part at defining specific scientific objectives and locations for subsequent drilling.

A program of shallow (< 1 km) scientific drilling was started in 1983 and is continuing this year. Apart from the very ambitious and expensive efforts in the Soviet Union, this scientific drilling program has proved so far to be perhaps the most fruitful in the world. Three principal drilling operations have been completed. Studies of cores and fluid samples are continuing. At the Valles Caldera, drilling penetrated through the major hydrothermal outflow plume where water is flowing underground away from the central volcanic heat source and eventually through a canyon which splits the caldera rim. At Long Valley, three separate holes were drilled at the edge of the valley where a thin sheet of molten rock was intruded from a deep source only 600 years ago. Sheets of igneous rock formed this way are called dikes. When this particular dike was forming, it broke through to the surface at several places to make a line of large, glassy hills of rock called the Inyo Domes. Holes have now been drilled vertically through the edge of a dome, at a slant through the feeder conduit for this same dome, and at a slant through the dike between two of the domes. The samples show some features confirming the conventional picture of volcanic processes and other features which were totally unexpected (e.g., low water contents at depth). The third principal shallow drilling operation now completed was designed to measure heat flow at the southeastern part of the Salton Sea; data analysis is continuing but already clear indications have been found of unexpected asymmetries with respect to the postulated line of spreading.

The BES Geosciences program has also completed a variety of projects to support the overall Continental Scientific Drilling effort. An inventory has been developed of drill holes nationwide as well as comprehensive information data bases for Long Valley, Valles Caldera, and the Salton Sea. Sample curation policies have been developed and a storage facility is in operation for cores and other samples from CSD; samples are available to scientists throughout the U.S. An organization at one of the DOE laboratories has been set up to handle management of drilling operations and related logistics.

The deepest and most ambitious U.S. Continental Scientific Drilling project to date is just being completed as this is written. This project, called the Salton Sea Scientific Drilling Project, is located near the center of the geothermal energy production zone at the southern edge of the Salton

Sea, and is being funded and managed primarily by the Geothermal Technologies Division under DOE's Assistant Secretary for Conservation and Renewable Energy. Funding for the associated research projects is being shared among NSF, USGS, and the BES Geosciences program, and all of the collaborating agencies and scientists have been intimately involved in planning and carrying out the project. The various coordinating and review groups set up to ensure effective collaboration provide a useful model for future collaborations in Continental Scientific Drilling. The hole has now penetrated over 2 miles (3.2 km) and encountered temperatures in excess of 662°F (350°C). Despite the extraordinarily corrosive conditions and rocks poorly suited for retaining drilling fluids, the operation has been fully successful in meeting its targets for depth and recovery of samples for research. Major contributions are expected to understanding the geology of continental spreading centers and, more generally, hydrothermal processes in regions of high heat flow.

Scientific and Management Plan

This implementation plan is concerned with parts of the DOE program approved by the Congress and the Department in FY 1986-87. The projects agreed to and funded by the Department and agreed to by the Interagency Coordinating Group under the Interagency Accord on Continental Scientific Drilling constitute, formally, our Continental Scientific Drilling Program.

Preliminary planning and discussions with regard to drilling and related CSDP studies beyond FY 1987 have not been included since no decisions have yet been made as to the magnitude and direction of DOE's part of this interagency program.

Current emphasis of the thermal regimes sector of CSDP is on three sites that afford an extraordinary opportunity for understanding crustal/thermal relationships: Long Valley, Valles Caldera, and the Salton Sea. Consideration is also being given to in-situ studies of the lower temperature regime affecting organic geochemical processes.

During the remainder of FY 1986, additional shallow drilling is planned at locations within Long Valley and the Valles Caldera. The President's FY 1987 budget request provides \$1.5 million under the BES Geosciences Program for drilling and related operational expenses. Several strong candidate drilling projects have been suggested for consideration in the FY 1987 program. An intensive review is currently underway focused on evaluation of the importance of the scientific issues likely to be clarified as a result of each project. The reviews are to be completed in July of this year.

The Magma Energy program within the Geothermal Technology Division (GTD) plans in FY 1987 to initiate the first 6000-ft step of a 3-stage deep drilling program designed to drill to, or near to, the magma body at Long Valley. If this technology-oriented effort goes ahead, scientists working on the Long Valley part of the CSDP will have an excellent opportunity for experiments using this hole and samples from it.

Figure 1 illustrates the DOE management approach to scientific drilling and its linkage to the overall effort. Key elements of the management/operational plan include:

- o Keeping the primary emphasis for the thermal regimes part of CSD on about 3 different geological areas at this time helps to assure an adequate focus and effective use of available funds. Holes of opportunity will be pursued by "piggy-backing" on holes drilled for technological or other purposes to the extent that the holes are available for scientific study and of sufficient scientific priority. Such opportunities might arise, for example, in the case of holes being drilled during the engineering and development phase of the magma energy project or during the examination of a candidate hydrothermal or geo-pressured resource area.
- o The U.S. effort in continental scientific drilling is coordinated, under the terms of the Interagency Accord on Continental Scientific Drilling, by the Interagency Coordinating Group consisting of representatives designated by each of the participating agencies.
- o The central, continuing DOE effort in continental scientific drilling is funded and administered through the Geosciences Program of the Office of Basic Energy Sciences and coordinated with the Department's technology programs by the DOE CSD Coordinating Group. The Geosciences Program has primary responsibility for coordinating the effort within the DOE and with the other participating Federal agencies. The Geothermal Technology Division is the only other DOE unit up to now which has provided funds explicitly for CSD. It not only managed the Salton Sea Scientific Drilling effort but also plans continuing studies related to SSSDP and to high temperature drilling technologies and instrumentation.
- o A number of outside experts interrelate with the DOE's effort in continental scientific drilling. Workshops provide the key interface between the scientific community and the Department. The workshops for BES Geosciences are planned and implemented by a Geosciences Research Council under terms of a grant to Texas A&M University.
- o Coordination of the DOE scientific and technical planning effort and operations among and between various projects and activities are facilitated by the CSD Review Group; between DOE-funded projects and those of the NSF and USGS by cross-representation on the DOE CSD Review Group and the DOSECC* Advisory Body, SAC**.
- o The responsibility for drilling, engineering and field operations of the DOE continental scientific drilling effort is vested primarily in a drilling operations management group at Sandia National Laboratories for BES projects. Other participating DOE programs, either for "piggy backing" or for "dedicated projects," will implement their drilling and logistics activity in a manner consistent with their normal operations (e.g., GTD used San Francisco Operations Office of DOE for the SSSDP);

* Deep Observation and Sampling of the Earth's Continental Crust (DOSECC, Inc.).

** (SAC) Science Advisory Committee.

- o The responsibility for custody, curation, and distribution of cores, samples and logs from the DOE continental scientific drilling effort is assigned to a curatorial services group at Los Alamos National Laboratory which supervises the DOE CSD core and sample repository in Grand Junction, Colorado; the protocol for the handling and management of samples and data will be coordinated with that developed separately by DOSECC and the two procedures kept as similar as possible.
- o Project coordination and management is delegated to contractors and grantees to the extent practical. Typically, on-site drilling and science operations are carried out under the supervision of Drilling and Science Managers, working together, and an ad hoc Working Group. The degree of formal structure is a function of the size and cost of the overall operation.

Estimates of Obligations

Program obligations, as estimated by the BES Geosciences Program and the Geothermal Technology Division, are shown in Table 1. Actual obligations in FY 1986 and FY 1987 will depend upon the availability of funds to these programs.

Table 1

Estimated DOE CSDP Obligations, FY 1984 - 1987 (\$ Millions)

| <u>DOE CSD Activities</u> | <u>FY1984</u> | <u>FY1985</u> | <u>FY1986^{1/}</u> | <u>FY1987^{2/}</u> |
|---------------------------|---------------|---------------|----------------------------|----------------------------|
| ER/OBES ^{3/} | 4.0 | 4.4 | 4.4 | 5.0 |
| CE/GTD | 5.9 | 1.0 | 1.0 | 1.3 |

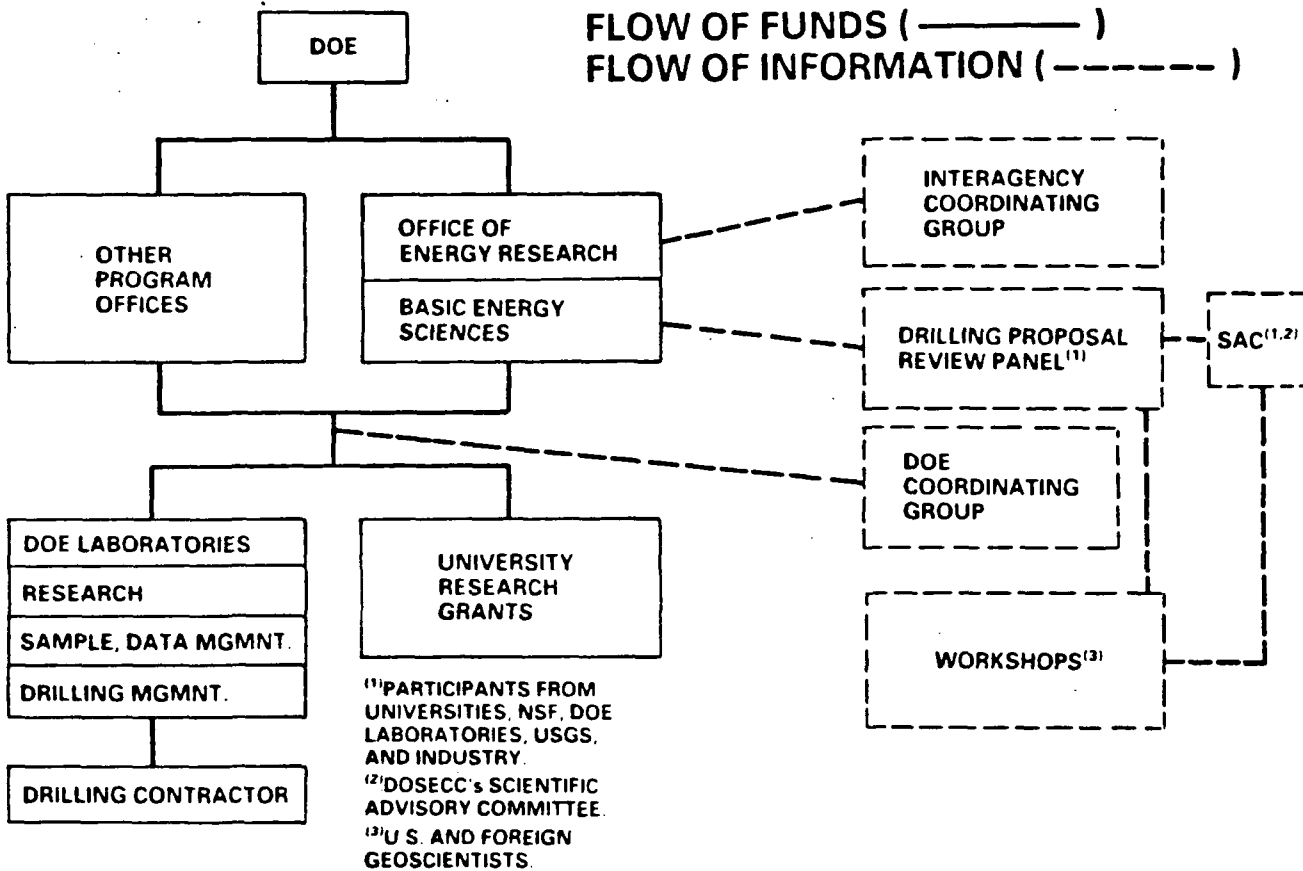
^{1/} Current Budget Plan

^{2/} President's FY 1987 Budget Request

^{3/} About 80% for work by DOE laboratories, 20% by U.S. universities.

Drilling in thermal regimes is currently limited by the availability of suitable measurement and drilling techniques. For example, no known tools or instruments can operate in molten magma under ambient conditions. Special techniques will be required as will new and improved tools and instrumentation. For these reasons, the costs associated with advanced drilling, logging and downhole instrumentation technology are a larger fraction of the total costs of the DOE continental scientific drilling activity than are comparable costs expected for the activities funded by the NSF and the USGS.

MANAGEMENT OF CONTINENTAL SCIENTIFIC DRILLING IN DOE



(FIG. 1)

NATIONAL SCIENCE FOUNDATION PROGRAM

Underlying Rationale and Scientific Objectives

NSF's national role in support of basic scientific research and in strengthening scientific research potential includes an interest in continental scientific drilling activities. Drilling is an especially important tool for scientific exploration of the earth's crust. Continental scientific drilling complements NSF's activities in ocean drilling and in the geological, geophysical and geochemical study of the continental crust.

The National Science Foundation's activities in continental scientific drilling have been undertaken within the context of its Continental Lithosphere Program. This program was established in 1984 in response to recommendations contained in two reports from the National Academy of Sciences/National Research Council: "Opportunities for Research in the Geological Sciences" (NAS/NRC, 1983) and "Research Briefings 1983" (NAS/NRC, 1983). Both reports recommended a broad-based effort to understand the continental lithosphere--an effort in which continental scientific drilling plays an important role in conjunction with seismic studies and other geoscience techniques. Program definition and balance have followed the recommendations of the NSF Ad Hoc Advisory Group on Continental Drilling: "Report to Director, July 1984." The overall budget level of the Continental Lithosphere Program, which includes other geophysical, geological, and geochemical studies in addition to scientific drilling projects, is \$9.7M in FY 1986. A total of \$14.25M is requested for this program in the President's Budget Request for FY 1987.

CSDP Activities to Date

Continental scientific drilling activities supported by the Foundation to date have included:

- o Support of the NAS/NRC Continental Scientific Drilling Committee (1980-1985, \$200,000)
- o Signing of the Interagency Accord on Continental Scientific Drilling (April 2, 1984)
- o Participation in the Salton Sea Scientific Drilling Project (1984-86, \$560,000)
- o Cost analysis and site-characterization for a possible deep core hole in the Southern Appalachians (1985-1986, \$2,000,000)

- o Support for the university consortium "Deep Observation and Sampling of Earth's Continental Crust, Incorporated (DOSECC)" (1985-1986, \$2,800,000)
- o Prior to the establishment of the Continental Lithosphere Program and continuing to the present the Foundation has funded, on a case-by-case basis, unsolicited proposals for basic research involving drilling for scientific purposes on the continents.

Scientific and Management Plan

In July, 1984 the Foundation received a proposal from DOSECC to plan, manage, and carry out a long-term program of continental scientific drilling aimed at an improved understanding of the continental lithosphere. The proposed program was based on the recommendations contained in several NAS/NRC reports. This proposal was widely circulated by DOSECC to members of the academic community, industry, and government. After extensive consultation with USGS and DOE, an award of \$300,000 was made to DOSECC in March, 1985 to establish an advisory and management structure patterned loosely after the JOIDES committee structure that has successfully guided the Foundation's ocean drilling activities.

DOSECC's activities are governed by a cooperative agreement with the Foundation that refers specifically to the Congressional Resolution on Continental Scientific Drilling (P.L. 98-473) and requires coordination and cooperation with drilling programs in industry, other federal agencies, and other countries. DOSECC's role is two-fold. On the one hand, it provides drilling management and logistics services to scientific drilling projects sponsored by NSF and USGS. In addition, it provides a scientific and technical planning and advisory structure to the Foundation in continental scientific drilling. DOSECC's scientific and technical panels include representatives of USGS, the DOE National Laboratories, industry, and academia in an effort to enlist the best available scientific and engineering talent.

In July 1985, DOSECC submitted to NSF both a one-year operating plan for 1986 and a five-year long-range plan for continental scientific drilling. Following scientific peer review of their plans and approval by the National Science Board, funds were awarded to carry out the 1986 plan. The USGS and DOE were consulted in the peer review process, and the USGS contributed \$500,000 to the 1986 funding.

Costs

The table below shows the history of NSF support for continental scientific drilling. The rapid growth to date reflects the high priority NSF attaches to these activities. Further funding in future years will be subject to the Foundation's overall budget and to the needs of other areas of science and engineering.

Table 2

Estimated NSF CSDP Obligations, FY 1984 - 1987 (\$ Millions)

| | <u>FY 1984</u> | <u>FY 1985</u> | <u>1986</u> ^{1/} | <u>1987</u> ^{2/} |
|----------------------------------|----------------|----------------|---------------------------|---------------------------|
| CSDP Activities (\$ Millions) | 0.2 | 2.1 | 2.8 | 4.0 |

^{1/} Current Budget Plan

^{2/} President's Budget Request

USGS PROGRAM

Underlying Rationale and Scientific Objectives

The United States Geological Survey has undertaken projects in continental scientific drilling as a part of its Deep Continental Studies Program. This program is a new element of the larger and more comprehensive Geologic Framework Program which is funded by Congressional appropriation. Originally, a deep crustal studies task of the Framework Program, Deep Continental Studies was renamed in FY 1985 to reflect changes in program content and emphasis. The program to be funded at \$3,000,000 in FY 1986 was developed in response to a report on research briefings in 1983 to the Office of Science and Technology Policy by the Committee on Science, Engineering, and Public Policy, which stated that the Solid Earth Sciences, including Continental Scientific Drilling, is an area of potentially great advances provided that adequate funding can be achieved. The program is designed to promote multidisciplinary research that will expand knowledge of the continental lithosphere and that will focus on the deep crustal environments and processes that control or influence near surface geology. It is clear that there is a large gap in our knowledge between the fine detail provided by shallow geologic exploration and general large-scale knowledge of the deeper continents. Yet it is these deeper zones where many critical mineral deposits form and where earthquakes and volcanoes originate. The potential for rapid progress is particularly strong at this time because of our better understanding of the total framework of the dynamic state and evolution of the earth and because of substantial technical advances that have recently been made in field instrumentation and data processing equipment.

Participation of the USGS in the Continental Scientific Drilling Program is designed to achieve objectives that support the USGS Mineral and Energy Resources programs and the Volcano Hazards and Earthquake Hazards Reduction programs. Activities by the USGS will be closely coordinated with the NSF and DOE, pursuant to the Interagency Accord on Continental Scientific Drilling, and will be developed, whenever practicable, in concert with the scientific and technical program of DOSECC's Science Advisory Committee (SAC) and Advisory Panels. The budget authority available to the Survey for deep continental studies is not sufficient to permit funding of the drilling phase of deep boreholes at this time. The USGS intends, therefore, to maintain a vigorous and visible role in the Continental Scientific Drilling Program by conducting predrilling geophysical, isotopic, and geological site studies and by participating in the science investigations that are attached to each drilling project.

CSDP Activities to Date

Continental scientific drilling activities supported by the USGS to date have included:

- o Support of the NAS/NRC Continental Scientific Drilling Committee (1980-1985, \$200,000)
- o Signing of an Interagency Accord on Continental Scientific Drilling with DOE and NSF (April 2, 1984)
- o Participation in the Salton Sea Scientific Drilling Project (1984-1986, \$600,000)
- o Geological and geophysical site-characteriation for a possible core hole at Creede, Colorado (1984-1985, \$550,000)
- o Support for the university consortium "Deep Observation and Sampling of the Earth's Continental Crust, Incorporated (DOSECC)" (1986, \$500,000)
- o Support of workshops on Scientific Continental Drilling in 1984 and 1985; on drilling at Creede, Colorado, 1984; and on development of protocols for storing and curation of core and for its distribution to the scientific community for research work (\$25,000)
- o Accepted responsibility for curation and storage of core for the DOSECC consortium and for providing laboratory support for handling of core at the drill sites for the period 1986-1988 (1985)
- o Participation in shallow drilling projects in the Mono Inyo Crater, California, project with DOE (1985, \$24,000)

Scientific and Management Plan

Immediate plans during FY 1986 and 1987 include collaboration with the NSF supported DOSECC consortium to deepen the 6,000 foot USGS hole at Cajon Pass, California, to a depth of 16,000 feet to make direct measurements and studies of the San Andreas fault, an area of great active tectonic stresses in the earth's crust. The San Andreas fault is clearly one of the most hazardous structural features in the United States. It is a direct manifestation of plate tectonics and understanding its mechanics is central to developing theories of the driving mechanisms of crustal plates. A proper understanding of the mechanical behavior of the fault must certainly be regarded as having major implications for future efforts toward

earthquake hazard reduction and earthquake prediction. USGS scientists will participate in coordinating and managing the drilling and science program at the drill hole and in performing downhole measurements, sampling, and scientific analyses. They will describe and analyze drill core recovered from the hole and will be responsible for the permanent storage and curation of the core. Following downhole measurements, the USGS will place instruments in the hole to monitor deep earth processes and conditions for earthquake prediction purposes.

During FY 1986 and 1987, USGS will collaborate in the DOSECC project to make preparations to drill two 3,000 foot deep holes in the Creede Mining District to establish the physical connections between the epithermal ores deposited along the top of a deeply circulating hydrothermal system and the roots of that system. The USGS will provide the principal investigator for this project and will undertake geological and geophysical studies and surveys to aid in the selection of drilling sites. These studies will also be valuable in the selection of a site to drill a 15,000 foot deep well into the roots of the hydrothermal system.

Collaboration with DOE will continue in FY 1986 on the Salton Sea Scientific Drilling Project. USGS is providing the on-site Science Manager for the project and is participating in twelve of the downhole sampling and measurement investigations.

The USGS is also working in FY 1986 and 1987 to develop proposals for drilling an active geothermal system at Katmai, Alaska and for drilling a hole near the site of the Parkfield, California, earthquake prediction experiment.

Costs

Because of budgetary constraints arising from concern over the Federal budget deficit, the long term outlook for future funding for Continental Scientific Drilling is uncertain.

Table 3

Estimated USGS CSDP Obligations, FY 1984 - 1987 (\$ Millions)

| <u>CSDP Activities</u> | <u>FY 1984</u> | <u>FY 1985</u> | <u>FY 1986</u> ^{1/} | <u>FY 1987</u> ^{2/} |
|------------------------|----------------|----------------|------------------------------|------------------------------|
| | \$0.3M | \$0.7M | \$1.8M | \$1.3M |

^{1/} Current Budget Plan

^{2/} President's Budget Request

PROGRAM COORDINATION AND INTERACTION

The Interagency Accord on Continental Scientific Drilling recognizes that each participating agency retains its autonomy regarding which drilling projects to undertake or support; there is no lead agency with respect to the science or the scientific objectives of the program. However, coordination and opportunity to participate are assured through frequent meetings of the Interagency Coordinating Group. The group, which includes a representative of each participating agency, meets about once a month with telephone communications at least once a week.

When joint projects are undertaken, ad hoc mechanisms are established to insure an adequate degree of communication and coordination. The degree of formality of the coordination process depends upon the size and nature of the operation: the larger and more complex (and costly) the operation, the greater the requirement for a formal coordinating and cooperative framework. For example, a high degree of formal organization has been used in carrying out the SSSDP (Fig. 2).

On the other hand, the coordination and cooperation in the case of the relatively low cost shallow drilling activities at Salton Sea, Long Valley /Mono and the Valles Caldera have been informal. Both approaches have worked well.

Within each of the participating agencies, the degree and nature of coordination and cooperation will depend on the scientific and technical interests of the various agency programs. Within the Department of Energy, for example, a DOE Continental Scientific Drilling Coordinating Group has been established to bring together the interests of Nuclear Waste Isolation, Fossil Energy, Geothermal Energy and Energy Research. In this way, the agency representative to the ICG can most effectively represent the broad interests of his or her agency.

With the formation of Deep Observation and Sampling of the Earth's Continental Crust, Inc. (DOSECC), a non-profit university consortium, there exists a means for interagency coordination in scientific drilling projects. This organization is jointly funded by the National Science Foundation and the U.S. Geological Survey for the purpose of planning and carrying out projects in continental scientific drilling. DOSECC planning committees contain representatives of universities and industry as well as scientists from the Geological Survey and from DOE-supported National Laboratories. Industry participation on DOSECC committees and in DOSECC-sponsored workshops and meetings has been enthusiastic. DOSECC will employ private-sector contractors for drilling and some logging, but will use university, USGS, and National Laboratory personnel and equipment for scientific experiments. USGS will provide curatorial services for drill cores and drillhole scientific data developed in the DOSECC program. Both the National Science Foundation and the U.S. Geological Survey regard DOSECC as their primary mechanism for participation in continental scientific drilling.

SALTON SEA SCIENTIFIC DRILLING PROGRAM (SSSDP) MANAGEMENT PLAN

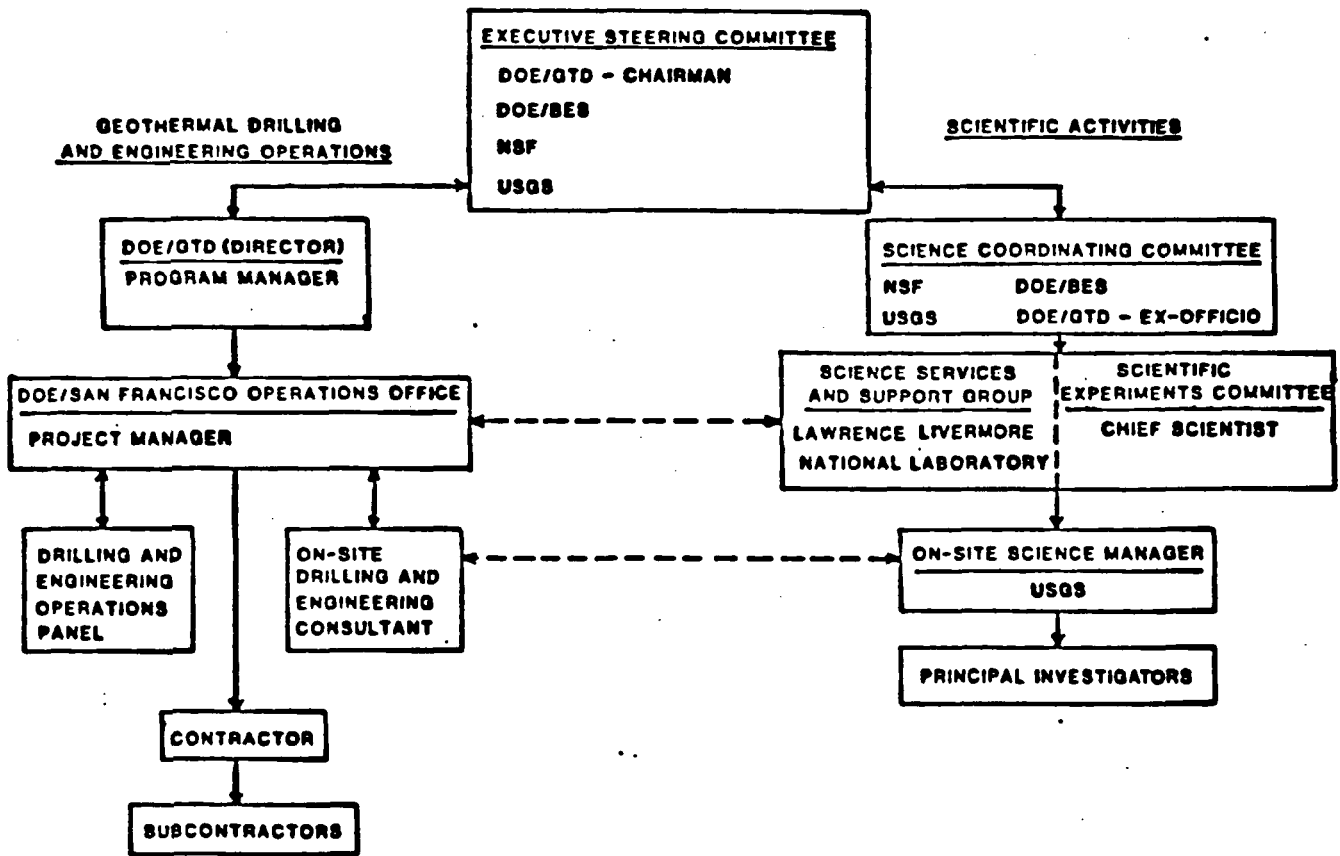


FIG. 2

DOE will continue its in-house overall management of its drilling projects, working in close coordination with the technology program of the Department and in association with its National Laboratories, universities, and industry and DOSECC is maintained through mutual participation in workshops and scientific advisory structures.

Industry has participated in the CSDP through attendance at workshops and meetings, participation in NAS/NRC committees (including the Continental Scientific Drilling Committee) and is currently represented on the duly-constituted groups established by the Department of Energy and NSF. In addition, industrial scientists participate in particular continental scientific drilling activities to which industrial organizations may contribute money or other resources, e.g., in the SSSDP, Kennecott has contributed the use of its land and considerable downhole information to the project.

INTERNATIONAL COOPERATION

In recognition of the world-wide interest and activity in Continental Scientific Drilling, DOE, with the help of NSF and USGS, sponsored, through DOSECC, a week-long symposium on Continental Scientific Drilling in May 1984. That symposium brought together a number of renowned international figures in Continental Scientific Drilling and yielded a statement in support of international cooperation in this important area. Since the 1984 meeting, a U.S. delegation visited the deep drilling project of the USSR on the Kola Peninsula, near Finland, and was briefed on that operation. The French and Germans have held meetings on their drilling plans and activities, to which U.S. scientists were invited.

This is an area of basic research which is essentially global in its nature and a "natural" for international cooperation. Except for occasional bits of "proprietary" information and information from the weapons test area in Nevada, the work is wholly unclassified and non-sensitive. International scientific cooperation in continental scientific drilling is being encouraged.