

CAPABILITIES

Earth Science Laboratory

University of Utah Research Institute
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1985



STATEMENT OF INTEREST AND CAPABILITIES

for the

APPLICATION OF GEOPHYSICAL METHODS

to

ABANDONED COAL MINE LAND PROBLEMS

submitted to

U. S. Department of the Interior
Office of Surface Mining
Ten Parkway Center
Pittsburg, PA 15220

by

UNIVERSITY OF UTAH RESEARCH INSTITUTE
Earth Science Laboratory

391 Chipeta Way, Suite C
Salt Lake City, Utah 84108

December 16, 1985

UNIVERSITY OF UTAH RESEARCH INSTITUTE

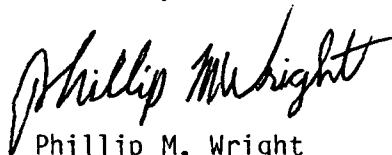
UURI

EARTH SCIENCE LABORATORY
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The Earth Science Laboratory of the University of Utah Research Institute offers contracting and consulting services in geology, geochemistry and geophysics and in computer and electronics applications which support the geosciences. We have a balanced staff whose education and experience qualify us for work in geothermal exploration and development, metallic and non-metallic minerals exploration and development, radioactive and toxic waste disposal and monitoring, environmental and geologic hazards studies, and supervision of drilling operations, among other things. We perform work for private industry and individuals as well as for governmental agencies.

We would be happy to work with you on your next project.

Sincerely,



Phillip M. Wright
Technical Vice President

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EARTH SCIENCE LABORATORY
UNIVERSITY OF UTAH RESEARCH INSTITUTE

CAPABILITIES

INTRODUCTION

The Earth Science Laboratory, University of Utah Research Institute (ESL/UURI) offers contracting and consulting services in geology, geochemistry and geophysics, and in computer and electronic applications which support the geosciences. Professionals of the Earth Science Laboratory have extensive backgrounds in the geosciences and have published widely, especially on the exploration for geothermal resources, electrical geophysical techniques, and geochemical methodology. Various members of the staff are familiar with the state-of-the-art in the major disciplines of geophysics, geology, and geochemistry. Our staff has a broad range of experience in the application of geophysics to geothermal, engineering, environmental, mining and petroleum exploration problems. The ESL/UURI has an established reputation for geoscience research and the timely reporting and publication of technical results, and is prepared to undertake and conclude in-depth studies on a short time frame.

GENERAL STATEMENT

The University of Utah Research Institute (UURI) is a self-supporting corporation organized in December 1972 under the Utah Non-Profit Corporation Association Act. Under its charter, the Institute is separate in its operations and receives no direct financial support from either the University of Utah or the State of Utah. The charter includes provisions for UURI to conduct scientific work for governmental agencies, academic institutions, private industry, and individuals.

UURI is comprised of four divisions as shown in Figure 1: the Earth Science Laboratory (ESL), the Environmental Studies Laboratory (EVSL), the Center for Remote Sensing and Cartography (CRSC) and the Engineering Technology Laboratory (ETL). The Earth Science Laboratory has a staff of geophysicists, geologists, and geochemists who have a broad range of experience in geothermal, mining, petroleum, engineering and environmental projects. The Environmental Studies Laboratory offers a variety of technical services and research capabilities in the areas of air quality and visibility, acid precipitation, surface and groundwater contamination, and environmentally caused stress in vegetation. The Center for Remote Sensing and Cartography is a specialized technical facility created to perform service and applied research across a full range of remote sensing and mapping needs including satellite and airborne imagery processing and interpretation. The Engineering Technology Laboratory is newly formed and is currently studying the interaction of the human body with electromagnetic radiation.

The Earth Science Laboratory of the University of Utah Research Institute provides consulting and contracting services for research and applications of research in a broad range of geoscience topic areas. ESL emphasizes the integration of scientific disciplines and techniques. An optimum, cost-

The University of Utah Research Institute

Organization

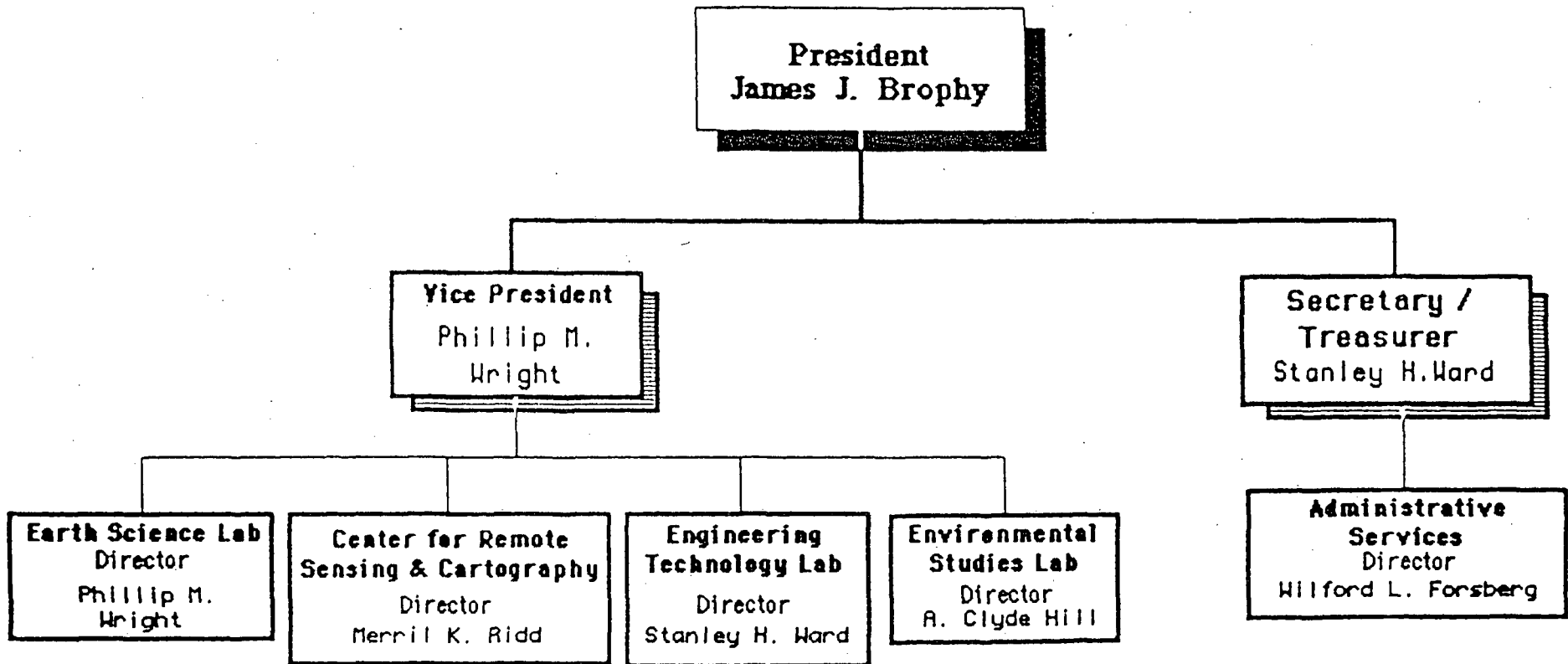


Figure 1

effective combination of techniques from the fields of geophysics, geology, geochemistry, and hydrology can be applied by in-house experts to solve specific problems.

The ESL professional staff is broad and diversified in education and experience (see Table 1). Even though the main portion of a given project may be done by a few scientists, the expertise of this entire staff can be made available as required, and personnel assigned to a project are free to draw upon the talents of other personnel at ESL.

Table 1

EARTH SCIENCE LABORATORY STAFF

Geologists

Ph.D.	1
B.S.	1

Geochemists

Ph.D.	1
M.S.	1
B.S.	1

Geophysicists

Ph.D.	4
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Electronics Engineers

B.S.	1
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Support Staff	<u>14</u>
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Total	24
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Consulting reservoir engineers	Ph.D.	2
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Consulting geophysicists	Ph.D.	2
	B.S.	1

Consulting geochemists	Ph.D.	4
------------------------	-------	---

Consulting isotope geochemist	Ph.D.	1
-------------------------------	-------	---

Consulting geologists	Ph.D.	2
-----------------------	-------	---

RESEARCH EXPERIENCE

The ESL staff has experience mainly along three different lines: 1) applied scientific work, 2) research, and 3) program management. The following paragraphs describe some of our more significant project work.

Geothermal Energy

ESL scientists have acquired extensive field experience in more than 15 high-temperature geothermal systems in the western U.S. and have helped the U.S. Department of Energy (DOE) and the Department of Defense manage several major geothermal programs on which DOE has spent over \$50 million in the past five years. As part of this work, we have performed geophysical, geological, geochemical, and hydrological studies of a regional and site-specific nature for high-, intermediate-, and low-temperature geothermal resources.

ESL has also provided geothermal exploration and evaluation services to industry clients with geothermal properties in Utah, Nevada and California, to the Department of Defense (DOD) at several U.S. military installations and to the United Nations at several foreign sites. This work has included geophysical surveys and interpretation, detailed geologic mapping, and geochemical analyses and their interpretation.

Minerals

Our minerals exploration, evaluation and development experience is broad in topic and is both regional and site-specific in area. ESL geoscientists have worked in sedimentary, intrusive, skarn, and metamorphic environments on disseminated and massive sulfide deposits of base metals, and on precious metals, uranium, iron, coal, diamonds and petroleum. Our professionals have worked in most of the major mineral provinces of the United States and in Australia, Botswana, Brazil, Canada, Cyprus, Haiti, Mexico, South Africa, and Zambia.

Environmental and Waste Hazards Studies

The Earth Science Laboratory has participated in a Phase II study to determine the magnitude and extent of environmental contamination at Hill Air Force Base as part of the Department of Defense Installation Restoration Program. This program included an extended records search, geophysical surveys, soil coring, drilling of hydrologic test holes, chemical analysis of soil and fluid samples and the recommendation of remedial actions.

Other shallow, high resolution geophysical studies include: the delineation of a sewerage effluent plume (California); delineation of acid plumes and industrial waste waters (Utah); and the design of geophysical surveys to delineate the subsurface distribution of mine acid waste waters and leach pond leakage (New Mexico).

Nuclear Waste Disposal

Dr. Howard Ross, ESL, has been active as a member of peer review panels for all of the nation's high level radioactive waste disposal geologic exploration programs. These include:

Geology Review Group - ONWI - Battelle - Salt Program, 1979 - present

Geology Peer Review Group - DOE - Nevada Test Site - 1979, 1981

Geology Overview Committee - Rockwell Hanford, Basalt Waste Isolation, 1979-1983

Through this participation Dr. Ross has worked with various teams of national and local experts in hydrology, geochemistry, geology and geophysics in addressing geologic and environmental problems resulting from hazardous waste isolation. His duties included providing expert geophysical consultation to Battelle for specific work in the salt programs in Utah, Texas, Mississippi, Louisiana and for planning and review of the granitic rocks program in the North Central, Northeastern and Southeastern United States.

ESL has completed detailed model interpretations of induced polarization and electrical resistivity data for the U.S. Geological Survey in support of the nuclear waste disposal program at the Nevada Test Site. This work has been instrumental in delineating faults and potential resource conflicts.

Research

ESL's research experience includes development and implementation of new geophysical, geological and geochemical techniques for geothermal and mineral resources exploration (Table 2). Specialities are: advanced interpretation techniques for electrical, gravity and magnetic data, physical properties studies, and development and implementation of computer algorithms; structural and stratigraphic controls of fluid flow, trace element geochemistry, fluid geochemistry, mineralogy, fluid/mineral equilibrium models.

In-Situ Leaching and Solution Mining Research

ESL has conducted an in-depth evaluation of the state of the art in in-situ leaching and solution mining on behalf of 6 large mining companies, the National Science Foundation and the U.S. Bureau of Mines. This study was aimed specifically at identifying the research problems of highest priority in developing new technologies for in-situ leaching and solution mining.

Soil Geochemistry

ESL has conducted extensive research work and numerous surveys to determine gas and trace element concentrations in soils resulting from the activity of hot subsurface water in geothermal systems and for mineral exploration. We have successfully developed exploration techniques for a number of resource types.

Table 2

MAJOR GEOTHERMAL RESEARCH AND INSTRUMENTATION DEVELOPMENT

Research Accomplishments	Where Applied
<p>1. <u>Resistivity Data Interpretation.</u> Developed new highly sophisticated programs using two-dimensional and three-dimensional models for interpretation of resistivity and induced polarization geophysical data. Complete mathematical formulation had never been done before. Published 6 reports.</p>	<p>Roosevelt Hot Springs, UT Cove Fort/Sulphurdale, UT Beowawe, NV Colado, NV Tuscarora, NV McCoy, NV Lakes District, Ethiopia Olkaria District, Kenya</p>
<p>2. <u>Magnetotelluric Data Interpretation.</u> Developed new and unique computer programs using two-dimensional and three-dimensional models for interpretation of magnetotelluric geophysical data. Mathematical formulation had never been done before. Published 3 reports.</p>	<p>Roosevelt Hot Springs, UT Tuscarora, NV</p>
<p>3. <u>Self Potential Data Interpretation.</u> Developed new and unique methods for interpretation of self potential data. Published 3 reports.</p>	<p>Roosevelt Hot Springs, UT</p>
<p>4. <u>Resistivity and Induced Polarization Instrumentation.</u> Developed a new, state-of-the-art, four-channel field receiver for resistivity and induced polarization data collection. Features are light weight, field programmable computer control, phase and amplitude measurement.</p>	<p>Field tested in Colorado.</p>
<p>5. <u>Magnetotelluric Instrumentation.</u> Developed a new and unique field system for acquisition of magnetotelluric geophysical data. Features are computer control with digital magnetic recording of data. Uses coil magnetometers. For research purposes -- this field system will not be marketed in its present configuration.</p>	<p>Roosevelt Hot Springs, UT</p>
<p>6. <u>Trace Element Geochemistry.</u> Developed new techniques for geothermal exploration and resource evaluation, for siting of drill holes and for gathering data during drilling of holes using trace element geochemistry of surface samples and of drill chips and cores. Conducted major research studies at The Geysers, CA and Roosevelt Hot Springs, Utah. Applied techniques at several other areas. These techniques are currently in use by major geothermal companies in the U.S. Published 7 reports.</p>	<p>The Geysers, CA Roosevelt Hot Springs, UT Cove Fort/Sulphurdale, UT Colado, NV Beowawe, NV McCoy, NV</p>

7. Mercury Geochemistry. Documented relationships between temperature distribution underground and occurrence of mercury in drill chip samples. Showed that mercury geochemistry can be used to site drill holes, guide drilling and locate fluid entries in drill holes. Published 2 reports.
The Geysers, CA
Roosevelt Hot Springs, UT
Beowawe, NV
Colado, NV
McCoy, NV
8. Landslide Monitoring Instrumentation. Develop electronics telemetry and computer analysis of landslide warning monitor system. Assist in installation of instrumentation at remote sites.
Wasatch Mountains, Utah

Workshops and Conferences

ESL has had a great deal of experience in presenting technical workshops, short courses and conferences. These are tailored specifically to the needs of the client. Recent examples of such presentations include:

Geophysical Exploration Workshops

The Self Potential Method as applied to geothermal exploration

Application of Geophysical Methods to Minerals Exploration

Electrical Methods in Oil and Gas Exploration

Geology of Geothermal Systems. Yellowstone Park short course programs.

Application of geothermal geology, geochemistry and geophysics in gold exploration.

DOE Geothermal Direct Heat Program. State Coupled Geothermal Resource Assessment Technical Conferences.

Military Bases

ESL has performed geoscience studies on the following military bases:

China Lake Naval Air Station, California

Hill Air Force Base, Utah

Williams Air Force Base, Arizona

Ascension Auxilliary Airfield, Ascension Island, South Atlantic

Adak Naval Air Station, Alaska

Lackland Air Force Base, Texas

Other Governmental Agencies

In addition to the projects listed above, ESL has performed geophysical survey and/or interpretation work on behalf of: (1) the United Nations in El Salvador, Kenya and Ethiopia; (2) the U. S. Geological Survey at the Nevada

Nuclear Test Site; (3) The Instituto Geologico y Minero de España; and
(4) the Instituto Nacional de Energia, Ecuador.

SUMMARY OF STAFF EXPERTISE AND FACILITIES

Geophysics

The ESL geophysical staff has a broad competence and experience which includes most aspects of the field of geophysics. All ESL geophysicists have completed research studies including physical properties of natural materials, method and/or technique development, instrumentation design and development, theoretical or computer algorithm development and local or crustal scale studies of the earth. Most of our geophysicists also have several years of experience in mineral, geothermal, or petroleum exploration throughout the United States and in many foreign countries. Their experience includes electrical, electromagnetic, magnetic, gravity, magnetotelluric, radiometric, seismic, thermal, well logging, and remote sensing methods.

Recent research at ESL has focused on borehole geophysics and improving numerical interpretation methods for electrical and electromagnetic data. This research is most applicable to geothermal energy research and development, and to mineral exploration.

Applied geophysical work has included survey design, data acquisition, and interpretation for geothermal resources and mineral deposits. Recent work also includes several engineering oriented surveys for chemical and hazardous waste delineation. Specific projects and clients have been described elsewhere.

ESL geophysicists are frequent contributors to the published literature and are particularly well known in the geothermal and mining industries. As a result they often hold responsible committee positions or other assignments. Dr. Ward is the past editor for the journal GEOPHYSICS. Dr. Wright has served as a technical advisor to the Department of Defense for classified military studies, and serves on advisory panels for geothermal energy development. Dr.

Ross has served on review panels for all three national nuclear waste isolation programs. Drs. Ward, Hohmann and Wannamaker are widely known for their work in electrical, electromagnetic, and magnetotelluric methods.

ESL maintains a deep interest in the integrated geological interpretation of geophysical data for a wide variety of resources and for academic studies. ESL has a suite of user-interactive computer programs that operate on the PRIME 2655 computer to facilitate quantitative modeling and interpretation. ESL's research scientists have pioneered in the development of new interpretation techniques for geophysical data and the implementation of these techniques on the computer in a highly cost-effective way. ESL can help its clients develop their in-house computer-based interpretation capabilities and can provide training of personnel in operation of available programs. Dr. Howard P. Ross is manager of the geophysics group. His resume is included.

Geology

Geologic investigations provide essential data for successful completion of a wide variety of earth science projects. The ESL staff has a broad background in design and management of geologic work as well as in application of individual geologic techniques such as field mapping, structural and stratigraphic studies, mineralogy, petrology, and lithologic logging of drill chips and core. ESL's project management experience includes a full spectrum of services from project design and execution to supervision of drilling and evaluation of results. ESL is experienced in formulation of exploration models, regional geologic interpretation, detailed stratigraphic and structural analysis, and development and testing of techniques for specific applications. Dr. Dennis L. Nielson is manager of the geologic group. His resume is included with this document.

Geochemistry

Geochemistry has, during the last decade, become an increasingly essential component of earth science investigations. ESL's broad practical experience and proven exploration and research capabilities allow us to offer services ranging from routine analysis of geologic materials to design, execution and management of fully integrated geochemical exploration programs and from application of existing geochemical techniques to development of new techniques. ESL has made significant contributions to development and application of new geochemical techniques for a wide variety of applications.

A geochemical laboratory designed especially for geothermal and mineral studies has been operational since 1977. The laboratory is equipped with an ARL Inductively Coupled Plasma Spectrometer (ICP), capable of analyzing 37 elements simultaneously, an IL Atomic Absorption Spectrophotometer, a Jerome Gold Film Mercury Detector, an Orion Specific Ion Meter and electrodes, an X-ray diffraction instrument and complete sample preparation facilities. In addition, an electron microprobe, a scanning electron microscope, and K-Ar and fission track age dating are also available. Interactive computer programs available on ESL's PRIME 2655 computer allow statistical treatment and provide geochemical plots of the analytical data. Dr. J. N. Moore is manager of the geochemistry group; his resume is included.

Electronics Engineering

High-quality field data are vital for today's earth scientists. ESL's electronics engineer, Mr. Dale Green, has broad competence and experience in the design and development of a variety of geophysical instruments. The Electronics Laboratory is well equipped for development of microprocessor-integrated geophysical instrumentation. Test, design, and prototype construction facilities are state-of-the-art. The principal activities of the

Electronics Laboratory have been the design and development of electrical geophysical survey instrumentation for private clients, and support for ongoing ESL projects. Recent projects also include hardware and software developed for robotics applications and instrumentation for remote monitoring of landslides.

Supplemental Staff

The regular staff of the Earth Science Laboratory can be supplemented as required to complete the special needs of multi-discipline or urgent project research. A research associate program has recently been instituted through which faculty of the University of Utah and other academic institutions may participate in research projects administered through UURI. Additional specialized experience may be gained through consultants as required. Graduate and advanced undergraduate students of the University of Utah are frequently employed to assist ESL staff on selected projects.

Computer Operations

ESL's computer center offers a broad range of computer services. The group specializes in development and implementation of user-interactive software for display, analysis and interpretation of geological, geochemical and geophysical data. The software can be used either at a client's facility or on a time-sharing basis on ESL's computer via the telephone.

Computer facilities consist of a PRIME 2655 computer system with a link to the University of Utah's UNIVAC 1100/60 computer. The system includes a PRIME 2655 CPU with time-sharing capability and virtual memory, 4 M bytes of main memory, 615 M bytes of disk storage, a 9-track magnetic type drive, a 36-inch Zeta pen plotter, two line printers, 2 Tektronix 4014 graphics terminals with digitizing tablets, a DECwriter terminal and 15 CRT terminals. Three

dial-in phone lines are available to users. The system is specifically oriented to scientific and engineering computation and to handling and interpreting geoscience data.

Geologic Sample Library

The Sample Library provides open-file accessibility and archival storage for field and drill samples as well as reference to analyses done on the samples. We provide proprietary storage for confidential samples as well as storage of samples that are accessible by the public. At present, the Library contains over 80,000 meters of drill chip samples and 3,100 meters of core from about 175 shallow thermal gradient holes and deep holes, mainly in geothermal areas. Samples may be studied at our facility by clients in order to compare their own drill results with samples from other geothermal areas. Complete sample preparation facilities are available and are used to prepare samples for storage and for routine or special chemical or physical analyses. Density and magnetic susceptibility measurements can be done at our facility.

Library Facilities

ESL has an extensive document library that is available for use by research staff and ESL clients. The library has most of the major international journals in the geophysical sciences and important texts in the topics of geology, geophysics, geochemistry, geothermal energy, mining and mineral development and earth science research. The library also includes xerox and microfiche copies of many other selected topics relating to earth science methodology and geothermal energy and numerous topics relevant to Utah. At present the library contains about 12,000 titles.

In addition, ESL has exchange privileges with the complete library

facilities on the University of Utah campus where 2,000,000 titles are available. Computer based bibliographic searches, such as GEOREF and CHEM ABSTRACTS are available and are often used by ESL professionals.

Office Facilities

The main offices of the Earth Science Laboratory are located in Research Park, on the east side of the Salt Lake Valley, adjacent to the University of Utah. There are about 15,000 square feet of laboratory and office space. Located here are the geochemical laboratory, the electronics laboratory, the computer center and our extensive document library as well as offices. The Sample Library occupies 4000 square feet in a small building in suburban Salt Lake City and is accessible to the main offices in a 10-minute drive. The campus of the University of Utah, where the Department of Geology and Geophysics is located, is one mile from ESL's main facilities.

Reporting and publication of research results is aided by in-house NBI System 3000 word processing equipment and a staff of experienced operators. In-house drafting and printing facilities are supplemented by part-time draftsmen and local businesses as required.

Management

The Earth Science Laboratory operates under a matrix management system where a principal investigator is able to draw on members of the geology, geochemistry, geophysics, computer or electrical engineering groups to form a scientific team most qualified to handle a specific project. The principal investigator is then responsible for management and technical guidance of the working group. The principal investigator is responsible to the Associate Director/Technology and the Associate Director/Administration for the technical and financial portions of the contract, respectively. The organization

structure of ESL is shown in Figure 2. Dr. Phillip M. Wright is the Director of ESL and Technical Vice President, UURI. Dr. D. L. Nielson is Associate Director for ESL. Their resumes are included.

ESL ADMINISTRATIVE MANAGEMENT

DIRECTOR
P.M.WRIGHT

ASSOCIATE DIRECTOR
D.L. NIELSON

- **GEOLOGY**
- **GEOCHEMISTRY**
- **GEOPHYSICS**
- **COMPUTER**
- **ELECTRONICS**

Figure 2

PUBLISHED RESEARCH

The dissemination and publication of research results has been an important activity for the Earth Science Laboratory. Technical studies in geophysics, geology, and geochemistry arising from Department of Energy contracts are reported in Earth Science Laboratory/UURI reports which are announced to a mailing list and in trade journals. More than 140 ESL reports have been published since 1978. In addition, staff members have contributed many papers to major technical journals, including: Geophysics; the Journal of Geophysical Research; Transactions, Geothermal Resources Council; Bulletin, American Association of Petroleum Geologists; and Economic Geology. A selected list of recent publications follows. Several papers are currently in press or in review. A more complete list of publications of senior staff members is included in the attached resumes.

Dr. S. H. Ward recently served as the Editor for the journal GEOPHYSICS. Several senior scientists continue to serve as reviewers for various technical journals.

Selected Publications (1980-Present)

"Nature and Occurrence of Geothermal Resources", Wright, P. M., Commercial Uses of Geothermal Heat, Geoth. Resources Council Spec. Report No. 9, 123-134 (1980).

"Electrical, electromagnetic, and magnetotelluric methods", Ward, S. H., Geophysics, v. 45, p. 1659-1666 (1980).

"The relation of regional resistivity structure in S. W. Utah to the tectonics of the Great Basin and Colorado Plateau", Wannamaker, P. E., EOS 61(46), p. 941 (1980).

"An investigation of finite-element modeling for electrical and electromagnetic data in three-dimensions", Pridmore, D. F., Hohmann, G. W., Ward, S. H., and Sill, W. R., Geophysics, v. 46, p. 1009-1024 (1981).

"Interpreted resistivity and IP section, Line W1, Wahomomie Area, Nevada Test Site, Nevada", Smith, C., Ross, H. P., and Edquist, R., U.S.G.S. Open-File Report 81-1350, 8 p. (1981).

"A strategy of exploration for high temperature hydrothermal systems in the Basin and Range Province", Ward, S. H., Ross, H. P., and Nielson, D. L., Bull. AAPG, v. 65, no. 1 (1981).

"Gravity and magnetic methods in mineral exploration", Wright, P. M., Seventy-Fifth Anniversary Volume, Economic Geology, Society of Economic Geologists (1981).

"Seismic methods in mineral exploration", Wright, P. M., Seventy-Fifth Anniversary Volume, Economic Geology, Society of Economic Geologists (1981).

"Overthrust belt of Utah", Nielson, D. L. (ed.), Utah Geological Association Publication 10, 335 p. (1982).

"Stratigraphic permeability in the Baca geothermal system, Redondo Creek area, Valles Caldera, New Mexico", Hulen, J. B., and Nielson, D. L., Geothermal Resources Council, Transactions, v. 6, p. 27-30 (1982).

"Thermal and tectonic history of the Mineral Mountains intrusive complex", Evans, S. H., and Nielson, D. L., Geothermal Resources Council, Transactions, v. 6, p. 15-18 (1982).

"Roosevelt Hot Springs Geothermal System, Utah-Case Study", Ross, H. P., Nielson, D. L., and Moore, J. N., AAPG Bull., v. 66, n. 7, p. 879-902 (1982).

"Interpretation of resistivity and induced polarization profiles with severe topographic effects, Yucca Mountain area, Nevada Test Site", Smith, C., and Ross, H. P., with introduction by D. B. Hoover, U.S.G.S. Open-File Report 82-182, 19 p. (1982).

"Review of well logging in the Basin and Range Known Geothermal Resource Areas", Glenn, W. E., Ross, H. P., and Atwood, J. W., Jour. Petroleum Tech., May, p. 1104-1118 (1982).

"Tracer recovery and mixing from two geothermal injection-backflow studies", Capuano, R. M., Adams, M. C., and Wright, P. M., Proceedings, Ninth Workshop on Geothermal Reservoir Engineering, Stanford University, Stanford, CA, Dec. (1983).

"Stratigraphy of the Bandelier Tuff and characterization of high-level clay alteration in borehole B-20, Redondo Creek area, Valles caldera, New Mexico", Hulen, J. B., and Nielson, D. L., Geothermal Resources Council, Transactions, v. 7, p. 163-168 (1983).

"Geologic model of the Baca geothermal reservoir, Valles caldera, New Mexico", Nielson, D. L., and Hulen, J. B., Proceedings Ninth Workshop on Geothermal Reservoir Engineering, Stanford University, p. 145-150 (1983).

"Resistivity structure of the northern Basin and Range", Wannamaker, P. E., AGU Invited Paper, EOS Transactions, 64(45), p. 693 (1983).

"Electromagnetic modeling of three dimensional bodies in layered earths using integral equations", Wannamaker, P. E., Hohmann, G. W., and San Filippo, W. A., Geophysics, 49(1), p. 60-74 (1984).

"Uses of geochemistry with injection-backflow testing in geothermal reservoir studies", Wright, P. M., Capuano, R. M., Adams, M. C., and Moore, J. N., Geothermal Resources Council, Transactions, vol. 8 (1984).

"Magnetotelluric responses of three-dimensional bodies in layered earths", Wannamaker, P. E., Hohmann, G. W., and Ward, S. H., Geophysics, 49(9), p. 1517-1553 (1984).

"Internal geology and evolution of the Redondo Dome, Valles caldera, New Mexico", Nielson, D. L., and Hulen, J. B., Jour. Geophys. Research Special volume on calderas and associated igneous rocks, v. 89, B10, p. 8695-8712 (1984).

"Exploration strategies for regional assessment of hydrothermal resources", Ward, S. H., Foley, D., Moore, J. N., Nielson, D. L., Ross, H. P., and Wright, P. M., in Geothermal Energy Technology, J. C. Bresee and P. A. Witherspoon, eds. (1985, in press).

"State-of-the-art: Geophysical exploration for geothermal resources", Wright, P. M., Ward, S. H., Ross, H. P., and West, R. C., Geophysics, v. 50(12), p. 2666-2696 (1985).

"On the detectability of crustal magma chambers using the magnetotelluric method", Newman, G. H., Wannamaker, P. E., and Hohmann, G. W., Geophysics, 50(7), p. 1136-1143 (1985).

"Electrical conductivity of water-undersaturated crustal melting", Wannamaker, P. E., J. of Geophys. Res. (submitted-1985).

"Magnetotelluric responses of model two-dimensional oceanic spreading regimes", Wannamaker, P. E., and Filloux, J. H., J. of Geophys. Res., (in preparation-1985).

"Geophysical investigations of the Cove Fort-Sulphurdale geothermal system, Utah", Ross, H. P., and Moore, J. N., Geophysics, v. 50(11), p. 1732-1745 (1985).

"Thermal regimes of the Balcones/Ouachita trend, Central Texas", Woodruff, C. M., Jr., and Foley, Duncan, Gulf Coast Assoc. of Geological Sciences Trans., v. 35, p. 287-292 (1985).

"Fluid flow in volcanic terrains - hydrogeochemistry of the Meager Mountain thermal system", Adams, M. C., Moore, J. N., and Forster, C., Geothermal Resources Council, Trans., v. 9, p. 377-382 (1985).

"Tracer developments: results of experimental studies", Adams, M. C., Ahn, J. H., Bentley, H., Moore, J. N., and Veggeberg, S., Proc. Eleventh Workshop, Geothermal Reservoir Engineering, Stanford, in press.

RESUMES OF KEY PERSONNEL

RESUME

Michael C. Adams

BIRTHDATE: November 11, 1953

POSITION: Geochemist, University of Utah Research Institute, Earth Science Laboratory, Salt Lake City, Utah.

EDUCATION: M.S., Geology, University of Utah, 1983
Thesis: Structure and Stratigraphy of McCoy Geothermal area, Central Nevada
B.S., Geology, 1978, University of Utah

PROFESSIONAL EXPERIENCE:

- 9/84-present Geochemist, Earth Science Laboratory, University of Utah Research Institute. Responsible for geothermal tracer development and use. Duties also include procurement and interpretation of isotopic and geochemical data from geothermal areas, with emphasis on hydrologic implications.
- 9/81-9/84 Associate Geologist, Earth Science Laboratory, University of Utah Research Institute. Responsible for interpretation and acquisition of chemical data from geothermal huff-puff tests. Duties also include geochemical and geologic interpretation of geothermal areas.
- 4/79-9/81 Senior Research Technician, Earth Science Laboratory, University of Utah Research Institute. Conducted detailed geologic mapping and lithologic logging of geothermal systems in volcanic and intrusive terrains of the Great Basin. Duties also included detailed modeling of resistivity data as well as design and implementation of gamma-ray survey.
- 12/78-4/79 Geologic Consultant, Terence Britt. Literature search and compilation of Utah Geology for thrust-belt hinge-line oil survey.
- 6/78-9/78 Geologist, Aminoil USA Inc., Santa Rosa, California. Geologic mapping of known geothermal resource area near Monroe, Utah.
- 1/77-6/78 Organic Geochemical Technician, Dr. R.A. Schroeder, University of Utah, Salt Lake City, Utah. Geochronology and temperature studies utilizing amino acid racimization. Personal research done on dating the Roosevelt KGRA opal dome.
- 6/76-9/76 Junior Geologist, Greatland Exploration, Inc., Anchorage, Alaska. Geologic mapping in search of base metal sulfides with particular attention to gossans, gamma-ray spectrophotometer survey, Seward Peninsula, Alaska.
- 6/75-9/75 Field Assistant, Vertebrate Paleontology, University of Utah, James Madsen. Excavation, preparation, and curation of vertebrate fossils.

PUBLICATIONS:

"K/Ar ages of the pyramid sequence in the vicinity of the San Emidio geothermal prospect, Washoe County, Nevada", S. H. Evans, Moore, J. N., and Adams, M. C., *Isochron/West*, no. 3, p. 19-21 (1981).

"Evaluation of the geothermal resource associated with Auburn and Johnson Hot Springs, Upper Star Valley, Wyoming", Adams, M. C. and Capuano, R. M., *Transactions, Geothermal Resource Council*, v. 6, p. 73-76 (1982).

"Tracer recovery and mixing from two geothermal injection-backflow studies", Capuano, R. M., Adams, M. C., and Wright, P. M., *Stanford Conference on Geothermal Reservoir Engineering*, p. 299-304 (1983).

"Geochemistry of the Meager Creek geothermal field, British Columbia, Canada", Moore, J. N., Adams, M. C., and Stauder, J., *Transactions, Geothermal Resources Council*, v.7, p. 315-319 (1983).

"Stratigraphy and structure of the McCoy geothermal prospect, Nevada", Adams, M. C., Master's thesis, University of Utah (1983).

"Case study of the Wendel-Amedee exploration drilling project, Lassen County, California", Zeisloft, J., Sibbett, B. S., and Adams, M. C., *University of Utah Research Institute, ESL-162*, 97 p. (1984).

"Uses of geochemistry with injection-backflow testing in geothermal reservoir studies", Wright, P. M., Capuano, R. M., Adams, M. C., and Moore, J. N., *Geoth. Res. Council, Trans.*, v. 8, p. 349-354 (1984).

"Geochemistry of the Wendel-Amedee Geothermal System, California", Adams, M. C., *Geothermal Resources Council, Transactions*, v. 8 (1984).

"Tracer stability and chemical changes in an injected geothermal fluid during East Mesa injection testing", Adams, M. C., *Stanford Conference on Geothermal Reservoir Engineering*, p. 247-252 (1985).

"Arsenic geochemistry in geothermal systems", Ballantyne, J. M., Moore, J. N., and Adams, M. C., *Geol. Soc. Amer.*, [abs.], v. 17, p. 518 (1985).

"Chemical analyses of water samples during East Mesa injection-backflow testing", Adams, M. C., Kroneman, R. L., and Yorgason, K. R. (in prep.).

"Tracer recovery curves from the East Mesa injection-backflow tests", Adams, M. C. (in prep.).

"Geologic and geochemical investigations of the Meager Creek geothermal system, British Columbia, Canada", Moore, J. N., Adams, M. C., and Stauder, J. J., *Stanford Conference on Geothermal Reservoir Engineering*, p. 253-258 (1985).

"Fluid flow in volcanic terraines - hydrogeochemistry of the Meager Mountain thermal system", Adams, M. C., Moore, J. N., Forster, C., *Geoth. Res. Council, Trans.*, v. 9, p. 377-382 (1985).

"Tracer developments: Results of experimental studies", Adams, M. C., Ahn, J. H., Bentley, H., Moore, J. N., and Veggeberg, S., Stanford Conference on Geothermal Reservoir Engineering, in press (1986).

"Metamorphism and metasomatism in the Salton Sea geothermal field, California," Moore, J. N., Adams, M. C., and Sibbett, B. S., University of Utah Research Institute (in prep).

RESUME

Duncan Foley

POSITION: Associate Professor, Department of Earth Sciences, Pacific Lutheran University, Tacoma, Washington; Research Associate, Earth Science Laboratory, University of Utah Research Institute, Salt Lake City, Utah

EDUCATION: B.A., Geology, 1971, Antioch College, Yellow Springs, Ohio
M.Sc., Geology, 1973, Ohio State University; emphasis on environmental geology
Ph.D., Geology, 1978, Ohio State University; emphasis on volcanic geology

PROFESSIONAL AFFILIATIONS: 1982, American Association of Petroleum Geologists
1980, Utah Geological Association (Secretary, 1981-1982)
1979, American Geophysical Union
1978, Geothermal Resources Council (President, Basin and Range Section, 1980-1982)
1976, Society of Sigma-Xi
1972, Geological Society of America

PROFESSIONAL EXPERIENCE:

9/85-present Associate Professor, Department of Earth Sciences, Pacific Lutheran University, Tacoma, Washington.

8/85-8/86 Snowbird Institute, Snowbird, Utah. Instructor of "Geology of the Wasatch Mountains," an introductory level class in historical and environmental geology aspects of the mountains.

1/84-8/86 Division of Continuing Education, University of Utah. Teaching "Geology and the Environment" which focuses on identification and strategies for coping with geologic hazards (earthquakes, landslides, avalanche, floods) and geologic aspects of toxic and nuclear waste disposal.

6/79-8/86 Geologist, Project Manager, Earth Science Laboratory, University of Utah Research Institute, Salt Lake City, Utah. Management and technical duties on Federal and private sector projects. Program Manager for U.S. Department of Energy funded low- and moderate-temperature geothermal resource assessment programs in 16 western states, including coordination with U.S. Geological Survey resource assessment programs. Served as technical advisor to DOE, and directed production of geothermal resource maps. Technical tasks include geologic mapping, studies of geothermal systems in Utah, Idaho and Texas (including drilling a deep well); evaluation of exploration techniques in different geologic environments, and assessment of geothermal resource potential at federal facilities and wilderness areas.

- 1979-present Instructor, Yellowstone Institute, for "Calderas and Hydrothermal Systems," a professional level week-long lecture and field course that emphasizes interpretation of ash-flow tuff stratigraphy, caldera evolution, and the geological nature of hydrothermal systems in calderas; taught in Yellowstone National Park.
- 1/78-6/79 Associate Geologist, Earth Science Laboratory. Assisted in management of U. S. Department of Energy funded program of low-temperature geothermal resource assessment in western U. S. Environmental geologist for overview of southern Utah Known Geothermal Resource Areas.
- 9/73-1/78 Research and Teaching Associate, Department of Geology and Mineralogy, Ohio State University. Teaching and research in volcanology, environmental studies, K-Ar geochronology, field geology in central Utah, stratigraphy, and strip mine reclamation.
- 6/71-9/71 and 9/72 Field Assistant, U.S. Geological Survey, Western Mineral Resources Branch, Menlo Park, California. Geologic mapping near Goldfield, Nevada, with emphasis on volcanic stratigraphy.
- 4/69-8/69 Physical Science Aide, U.S. Geological Survey, Pacific Mineral Resources Branch, Menlo Park, California. Mineral separations lab; geochemical sampling of alteration assemblages and detailed geologic mine mapping in Goldfield and Silver Peak, Nevada.
- 9/66-12/66 Assistant, Geology Department, Field Museum of Natural History, Chicago, Illinois. Fossil Invertebrates; curating trilobite collection.

PROFESSIONAL ACTIVITIES:

Presented talks on geologic parameters of geothermal energy to American Association for the Advancement of Science (1980), Industrial Development Research Council (1980), National Rural Electric Cooperative Association (1980), National Water Well Association (1979), U.S. Department of Energy Contractors (1978, 1979, 1980), Intermountain Institute of Food Technologists (1982), and Snake River Section of American Institute of Mining Engineers (twice in 1982). Talks on environmental geology to local groups in Salt Lake City (1984).

Coleader of Geothermal Systems of the Yellowstone Caldera fieldtrip, Geothermal Resources Council (1980); leader of Wyoming Geological Association field trip to hydrothermal systems of northern Yellowstone National Park (1982); leader of field trip for Audubon Society on environmental geology of the Wasatch Front.

Courses and workshops attended: International Snow Science Workshop (1984); Delineation of landslide, flash flood and debris flow hazards in Utah (1984); Governors Conference on Geologic Hazards, avalanche work group (1983); Backcountry Avalanche Seminar (1982); Geothermal energy in the Cascades (1981); Geochemical fundamentals for geothermal exploration and reservoir evaluation (1980); Fission-track age dating (1979), "Direct Utilization of

Geothermal Energy: Development of Four Educational Reports" (1979),
Geothermal Geology of Yellowstone (1978); Volcanic rocks and their vent areas
(1978); Direct utilization of geothermal energy (1978).

PUBLICATIONS:

"Environmental geology and land-use planning on the Big Darby Creek, Ohio,
watershed," Foley, D., unpub. M.Sc. thesis, Ohio State University (1973).

"Geology and Land-Use Planning on the Big Darby Creek, Ohio, Watershed,"
Foley, D. and McKenzie, G. D., Geol. Soc. of Am., Abstracts with Programs, 6,
No. 6, 508 (1974).

"The geology of the Stonewall Mountain Volcanic Center, Nye County, Nevada,"
unpub. Ph.D. dissertation, Ohio State Univ., 139 p. (1978).

"Geology of the Stonewall Mountain Volcanic Center, Nye County, Nevada,"
Foley, D. and Sutter, J. F., Geol. Soc. of Am., Abstracts with Programs, 10,
No. 3, 105 (1978).

"The Essence of Urban Environmental Geology," McKenzie, G. D., Utgard, R. O.,
Foley, D. and McKenzie, D. I., Journal of Geological Education, 26, 32-37
(1978).

"Geology in the Urban Environment," Utgard, R. O., McKenzie, G. D. and Foley,
D., eds., Burgess Pub. Co., Minneapolis, Minn., 355 p., (1978).

"Western States Cooperative Direct Heat Geothermal Program of DOE," Wright, P.
M., Foley, D., Nichols, C. R. and Grim, P. J., Geothermal Resources Council,
2, Section 2, 739-741 (1978).

"Geology Effects," Environmental Overview Report on Utah Geothermal Resource
Areas, Foley, D., in White, K. L., Hill, A. C. and Ursenbach, W. O., eds.,
Lawrence Livermore Lab UCRL-13955, 1, 6.1-6.13 (1978).

"State Coupled Resource Assessment Program - An Update," Foley, D., Wright, P.
M., Struhsacker, D. W., Nichols, C. R., Mink, L. L., Brophy, G. P., Grim, P.
J. and Berry, G. Geothermal Resources Council Transactions, 3, 217-219 (1979).

"Nature and Distribution of Geothermal Energy," Muffler, L. J. P., Costain, J.
K., Foley, D., Sammel, E. A. and Youngquist, W., Direct Utilization of
Geothermal Energy: A Technical Handbook, D. H., Anderson and J. W. Lund,
eds., Geothermal Resources Council Special Report No. 7, 1-1 to 1-15 (1979).

"The State Coupled Program - A New Emphasis," Foley, D., Brophy, G. P., Mink,
L. L. and Blackett, R. E., Geothermal Resources Council Transactions, 4, 779-
781 (1980).

"Geothermal Exploration Program Hill Air Force Base, Davis and Weber Counties,
Utah," Glenn, W. E., Chapman, D. S., Foley, D., Capuano, R. M., Cole, D.,
Sibbett, B. S., Ward, S. H., University of Utah Research Institute, Earth
Science Laboratory, Rept. 34, 77 p. (1980).

"Exploration Strategies for Regional Assessment of Hydrothermal Resources," Ward, S. H., Foley, D., Moore, J. N., Nielson, D. L., Ross, H. P., Wright, P. J., in Witherspoon, P., Bresee, J., eds., in preparation.

"Low-temperature Geothermal Resources in the Central and Eastern United States," Sorey, M. L., Reed, M. J., Foley, D., Renner, J. L., in Reed, M. J., ed., Assessment of low-temperature geothermal resources of the United States-1981: U. S. Geological Survey Circular 892, p. 51-65 (1983).

"Hydrothermal Systems of Central Utah - A Regional Perspective," (abs.), Foley, D., in, Britt, T. L., ed., Program and abstracts for the Utah Geological Association 1982 symposium on the overthrust belt of Utah; Utah Geological Assoc. Pub. 11, p. 18.

"Road logs: West Yellowstone to Canyon Junction, Canyon Junction to Mud Volcano - Sulphur Cauldron Area, Canyon Junction to Tower Junction to Mammoth Hot springs, Mammoth Hot Springs to Norris Junction, Madison Junction to Old Faithful", Foley, D., Nielson, D. L., Nichols, C. R., in Reid, S. G., Foote, D. J., Geology of Yellowstone Park Area: Wyoming Geological Association 33rd Annual Field Conference Guidebook, pgs. 343-352, 356-363 (1982).

"Road Log, Field Trip #3 Emphasizing Geothermal Phenomena," Foley, D., in Goolsby, J. E., ed., Field Trip Road Logs: Wyoming Geological Association 33rd Annual Field Conference, p. 22-24, (1982).

"Tables of Co-located Geothermal Sites and BLM Wilderness Study Areas," Foley, D., Dorscher, M., Earth Science Lab. Open File Report 107, DOE/ID/12079-88, 166 p., (1982).

"Hydrothermal systems of the Wood River District, Idaho," Foley, D., Zeisloft, J., Blackett, R. E., Geol. Soc. of Am., Abstracts with Programs, v. 15, p. 416 (1983).

"Geothermal resources of the Balcones-Ouachita Trend, Central Texas", Foley, D., Zeisloft, J., Woodruff, C. M., Am. Assoc. Petrol. Geol., Bull., v. 68, p. 477 (1984).

"Geothermal systems of the Snake River Plain, Idaho Batholith and Northern Rocky Mountain Transition Zone," Foley, D., and Street, L., Geol. Soc. of Am., Abstracts with Programs, v. 17, p. 218-219.

"Thermal regimes of the Balcones/Ouachita trend, Texas", Woodruff, C. M., Foley, D., Gulf Coast Associated Geological Societies, Transactions, v. 35, p. 287-292 (1985).

RESUME

Dale J. Green

POSITION: Senior Electronics Engineer, Earth Science Laboratory, University of Utah Research Institute

EDUCATION: B.S., Electrical Engineering, 1956, University of Utah.
Graduate Work, Electrical Engineering, 1957, 1962, University of Utah.
Graduate Work, Geophysics, 1963, 1965, University of Utah.

SOCIETY AFFILIATIONS: Society of Exploration Geophysicists

PROFESSIONAL EXPERIENCE;

- 1977-present Senior Electronics Engineer, Earth Science Laboratory, University of Utah Research Institute. Design and program microprocessor-based geophysical instruments including: phase-measuring induced-polarization and electromagnetic receiver; controlled-source and natural field magnetotelluric system; temperature gradient measuring system; Proton-Precession magnetometer; interface with Overhauser effect proton magnetometer; electronics telemetry and computer analysis of landslide warning monitor; assist with design of airborne magnetometer system; interfaced computer with robot to automatically handle ammunitions.
- 1966-1977 Senior Electronics Engineer, Kennecott Exploration, Inc., Geophysics-R&D Division, Salt Lake City, Utah. Designed geophysical prospecting and borehole logging equipment. Designs included Induced Polarization (IP) receivers (one model measured Percent Frequency effect (PFE) and four models measured phase). The last phase receiver employed a computer for data processing and computation of voltage and resistivity; various small IP transmitters; a dual-channel audio magnetotelluric (AMT) receiver; an interface and formatter for a 7-track tape recorder; electromagnetic (EM) transmitters and receivers; and IP, nuclear, temperature and velocity modules for borehole logging. During the last two years, microprocessors were studied for their use in all the above types of instrumentation. Directly supervised four to six technicians. Have travelled extensively stateside and overseas training geophysical crews.
- 1957-1966 Senior Project Engineer, Sperry Utah Company. Design of servomechanisms for radar antennas and the guidance system of the Sergeant guided missile.
- 1963-1965 Teaching and Lab Assistant, Geophysics Department, University of Utah, Salt Lake City. Wrote computer programs, designed and maintained equipment for department.

1961-1962 Research Assistant, Chemistry Department, University of Utah, Salt Lake City. Designed instrumentation for mass spectrometer.

June 1956-
October 1956 Engineer, Autonetics Company, Downey, California. Designed equipment for automatic testing of Navaho missile.

1954-1956 Lab Assistant, Electrical Engineering Department, University of Utah, Salt Lake City, Utah. Repaired and maintained lab equipment for EE Department.

1955 Assistant Engineer, Naval Air Development Center, Johnsville, PA. Designed equipment for distance measuring equipment.

1949-1952 Aircraft Electrician, U. S. Air Force. Maintained aircraft electrical systems.

RESUME

Jeffrey B. Hulen

BIRTHPLACE AND DATE: Anchorage, Alaska, March 18, 1946

POSITION: Geologist, Earth Science Laboratory, University of Utah Research Institute, Salt Lake City, Utah

EDUCATION: B.Sc., Geology, 1969, University of Utah

PROFESSIONAL EXPERIENCE:

May 1977-present Geologist, Earth Science Laboratory Division (ESL), University of Utah Research Institute, Salt Lake City, Utah. Mapped and interpreted surface and subsurface geology and alteration of three high-temperature geothermal areas. Conducted research in sampling and interpretation of drill cuttings from fractured, altered, igneous and metamorphic rocks. Interpreted subsurface stratigraphy and structure of the Baca geothermal system, Valles caldera, New Mexico, utilizing 3-D geologic sections to visualize complex structural blocks penetrated by variably inclined and oriented boreholes. Presently supervising ESL X-ray diffraction laboratory and investigating subsurface hydrothermal alteration in the Valles caldera.

1975-May 1977 Associate Research Geologist, Kennecott Exploration Inc. - Research Division, Salt Lake City, Utah. Assisted in the development of new multi-element geochemical exploration techniques for locating and delineating the high-grade centers of porphyry copper/molybdenum sulfide systems. Completed detailed surface alteration studies, utilizing X-ray diffraction and petrographic methods, of advanced argillic caprocks above deeply concealed porphyry copper deposits.

1970-1973 Exploration Geologist, Bear Creek Mining Company, Reno, Nevada and Spokane, Washington. Responsible for base and precious metal exploration in western Nevada, with emphasis on porphyry copper/molybdenum deposits. Utilized a multi-disciplined approach in the search for these deposits, integrating literature study, geologic mapping (regional and local) alteration mapping, and geochemical investigation. Supervised drilling of target areas selected by this process as most favorable for ore discovery. Discovered a concealed, classically zoned porphyry copper system in western Nevada. Responsible for evaluation of prospect submittals in western Nevada and California.

1969-1970 Assistant Geologist, Great Lakes Exploration Company (Bear Creek Mining Co. Subsidiary), Ladysmith, Wisconsin. Responsible for geologically monitoring a 24-hour per day drilling program designed to evaluate a Precambrian volcanogenic

massive sulfide deposit.

- Summer, 1969 Assistant Exploration Geologist, Bear Creek Mining Company, Reno, Nevada. Studied post-mineral ash-flow tuff stratigraphy within a large area of western Nevada, in order to select, for induced polarization survey, sub-areas within which potentially mineralized bedrock might occur at permissive depth.
- 1968-1969 Research Assistant, Kennecott Exploration, Inc.- Geologic Research Division, Salt Lake City, Utah. Assisted in alteration zoning studies of several western U.S. porphyry copper deposits, primarily through investigation of surface rock samples and drill core by geochemical, X-ray diffraction and petrographic techniques.
- Summer, 1968 Assistant Geologist, Bingham Copper Mine, Utah Copper Division, Kennecott Copper Corporation. Completed detailed geologic, alteration, and sulfide distribution maps of selected portions of the Bingham pit for inclusion in master maps of the mine and immediate vicinity.
- 1966-1969 (Intermittently) Illustrator, Geology Department, University of Utah, Salt Lake City, Utah. Illustrated numerous papers and partially illustrated several textbooks.

PUBLICATIONS:

- "Parting Lineation in Siltstone," Picard, M. Dane, and Hulen, J. B., Geol. Soc. America Bull., 80, p. 2631-2636 (1969).
- "Geology and Alteration of the Coso Geothermal Area, Inyo County, California," Hulen, J. B., Univ. of Utah Research Institute, Earth Science Laboratory, Rept. No. 3 (1978).
- "Stratigraphy and Alteration, 15 Shallow Thermal Gradient Holes, Roosevelt Hot Springs KGRA and Vicinity, Millard and Beaver County, Utah," Hulen, J. B., Univ. of Utah Research Institute, Earth Science Laboratory, Rept. No. 9 (1978).
- "The Geology of Roosevelt Hot Springs KGRA, Beaver County, Utah," Nielson, D. L., Sibbett, B. S., McKinney, D. B., Hulen, J. B., Moore, J. N. and Samberg, S. M., Univ. of Utah Research Institute, Earth Science Laboratory, Rept. No. 12 (1978).
- "A Study of Well Logs from Roosevelt Hot Springs KGRA, Utah," Glenn, W. E., and Hulen, J. B., SPWLA Twentieth Annual Logging Symposium, Tulsa, Oklahoma, paper 22 (1979).
- "Geology and Alteration of the Baltazor Hot Springs and Painted Hills Thermal Areas, Humboldt County, Nevada," Hulen, J. B., Univ. of Utah Research Institute, Earth Science Laboratory, Rept. No. 27 (1979).

"Interpretation of Well Log Data from Four Drill Holes at Roosevelt Hot Springs KGRA," Glenn, W. E., and Hulen, J. B., Univ. of Utah Research Institute, Earth Science Laboratory, Rept. No. 28 (1979).

"A Comprehensive Study of LASL Well C/T-2 (Phillips 9-1), Roosevelt Hot Springs KGRA, Utah With Applications to Geothermal Well Logging," Glenn, W. E., Hulen, J. B. and Nielson, D. L., Los Alamos Scientific Laboratory Rept. (1980).

"Interpretation of Drill Cuttings from Geothermal Wells", Hulen, J. B., and Sibbett, B. S., in Introduction to Geothermal Log Interpretation (Text), Geothermal Resources Council Tech. Training Course No. 7, April 22-23, Reno, Nevada (1981); also published as Univ. of Utah Research Institute, Earth Science Laboratory Rept. No. 57 (1981).

"Exploration Case Study for the Monroe KGRA, Sevier County, Utah," Hulen, J. B., and Sandberg, S. M., Univ. of Utah Research Institute Earth Science Laboratory, Rept. No. 49 (1981).

"Stratigraphy, Structure and Permeability in the Redondo Creek Project Area (Valles Caldera, New Mexico)", Hulen, J. B., in Final Report of the Department of Energy Reservoir Definition Team for the Baca Geothermal Demonstration Project (Goldstein, N. E., Holman, W. R., and Molloy, M. W., Eds.), Lawrence Berkeley Laboratory Rept. LBL-14132, p. 7-14 (1982).

"Stratigraphic Permeability in the Baca Geothermal System, Valles Caldera, New Mexico," Hulen, J. B., and Nielson, D. L., Geoth. Resources Council, Trans., 6, p. 27-30 (1982)

"The Overthrust Belt in Utah" (Associate Editor), Utah Geol. Assoc. Publ. No. 10 (D. L. Nielson, Ed.) (1982).

"Sampling and Interpretation of Drill Cuttings from Geothermal Wells", Hulen, J. B., and Sibbett, B. S., Soc. Prof. Well Log Analysts, Reprint Vol., p. IV3-IV54 (1982).

"Structural Control of the Baltazor Hot Springs KGRA, Humboldt County, Nevada", Hulen, J. B., Geoth. Resources Council, Trans., 7, p. 157-162 (1983).

"Stratigraphy of the Bandelier Tuff and Characterization of High-Level Clay Alteration in Borehole B-20, Redondo Creek Area, Valles Caldera, New Mexico", Hulen, J. B. and Nielson, D. L., Geoth. Resources Council, Trans., 7, p. 163-168 (1983).

"Geologic Model of the Baca Geothermal Reservoir, Valles Caldera, New Mexico", Nielson, D. L., and Hulen, J. B., Ninth Workshop on Geothermal Reservoir Engineering, Stanford University (1983).

"Internal Geology and Evolution of the Redondo Dome, Valles Caldera, New Mexico", Nielson, D. L., and Hulen, J. B., Jour. Geophys. Res., 89, p. 8695-8711 (1984).

"Observations in an Active Hydrothermal System Through Deep Drilling", Valles Caldera, New Mexico", Nielson, D. L., and Hulen, J. B., in Observation of the Continental Crust Through Drilling I (ed. by C. B. Raleigh), Berlin, Springer-Verlag, p. 308-322.

"Subsurface Hydrothermal Alteration in the Baca Geothermal System, Redondo Dome, Valles Caldera, New Mexico", Hulen, J. B., and Nielson, D. L., in Workshop on Recent Research in the Valles Caldera, Los Alamos National Lab. Rept. LA-10339-C, p. 26-28 (1985).

"Structure and Stratigraphy of the Redondo Dome, Valles Caldera", Nielson, D. L., and Hulen, J. B., in Workshop on Recent Research in the Valles Caldera, Los Alamos National Lab. Rept. LA-10339-C, p. 38-39 (1985).

"Hydrothermal Alteration in the Baca Geothermal System, Redondo Dome, Valles Caldera, New Mexico", Hulen, J. B., and Nielson, D. L., Jour. Geophys. Res., 91, p. 1867-1886 (1986).

RESUME

Ruth L. Kroneman

POSITION: Research Chemist, Earth Science Laboratory, University of Utah
Research Institute

EDUCATION: 1954, Western Montana College of Education, Dillon, Montana
B.A., Chemistry, 1956, Carleton College, Northfield, Minnesota

PROFESSIONAL EXPERIENCE:

1978-present Analytical Chemist, Earth Science Laboratory, University of Utah
Research Institute. Set up, operation and maintenance of
Applied Research Laboratories' inductively coupled plasma
quantameter (ICP). Development of procedures for analysis of
rock, water, brines and mineral concentrate samples by ICP and
other methods. Supervision for analytical lab and sample prep
facilities.

1976-1978 Research Chemist, Stauffer Chemical Company of Wyoming.
Nonroutine analytical problems including soda ash impurities,
ore analysis, mineral identification and water analysis.
Upgraded the routine procedures used in the quality control lab
and developed procedures for improved impurity monitoring.
Identifying and solving chemistry related problems of soda ash
production. Set up sampling and analysis procedures to meet EPA
drinking water standards.

1975-1976 Lab Manager, Georesearch Laboratories, Inc. Geochemical and
assay analysis. Preparation and well as analysis, hiring,
training, supervision of personnel and technique development.

1966-1975 Geochemist, Kennecott Exploration, Inc. Analysis of rock, soil
and water samples including classical techniques as well as
instrumental methods. Procedure development was frequently
required, particularly for trace metals by atomic absorption
spectrophotometry. Hired, trained and supervised laboratory
personnel. Major projects; analysis of brine and sediment
samples from the Red Sea, the analysis of ocean water for
synergistic toxic metals, and the analysis of sediments and pore
water from the manganese nodule areas of the Pacific Ocean.
These projects all required technique development to overcome
problems of limited sample size and interference from sodium
chloride.

1964-1966 Research Chemist, Research Institute, Inc. Research on chemical
effects of radiation. Development and operation of a pilot
plant for metallurgical research.

1956-1957 Junior Chemist, Ames Laboratory. Analysis of various materials
for major and trace constituents, some procedure development.

PUBLICATIONS

"Multi-element analysis of geologic materials by Inductively Coupled Plasma--Atomic Emission Spectroscopy", Christensen, O. D., Kroneman, R. L., and Capuano, R. M., Univ. of Utah Research Institute, Earth Science Laboratory Rept. No. 12079-2 (1980).

"Chemical analyses of water samples collected during injection-backflow testing at Raft River, Idaho", Capuano, R. M., Kroneman, R. L., and Yorgason, K. R., Univ. of Utah Research Institute, Earth Science Laboratory Rept. No. 12079-112 (1984).

"Preferred methods of analysis for chemical tracers in moderate- and high-temperature geothermal environments", Kroneman, R. L., Yorgason, K. R., and Moore, J. N., Univ. of Utah Research Institute, Earth Science Lab., Rept. No. 12079-128 (1984).

RESUME

Joseph N. Moore

DATE OF BIRTH: January 21, 1948

POSITION: Geologist/Project Manager and Section Manager of Geochemical Group, Earth Science Laboratory, University of Utah Research Institute, Salt Lake City, Utah

EDUCATION: B.S., Geology, 1969, City College of New York
M.S., Geology, 1972, Pennsylvania State University
Ph.D., Geology, 1975, Pennsylvania State University

SOCIETY AFFILIATIONS: Geological Society of America
Geothermal Resources Council

HONORS AND AWARDS: 1971, Sigma Xi Grant
1971, Paul D. Krynine Fund Award
1972, Sir William Logan Medallion
1973, Phi Kappa Phi Honor Society
1978, American Men and Women in Science

PROFESSIONAL EXPERIENCE:

1979-present Section Manager, the Geochemistry group, Earth Science Laboratory. Responsibilities include management of ESL geochemical programs and analytical facilities as well as the development of new geochemical techniques for use in geothermal exploration.

1977-1979 Geologist, Earth Science Laboratory. Conduct and supervise geologic programs in known geothermal resource areas of the Basin and Range.

1975-1977 Staff geologist, Uranium Division/The Anaconda Co. Primary responsibilities included developing an exploration program in volcanic terrains for hydrothermal uranium deposits and detailed and reconnaissance mapping in the Basin and Range.

1972-1975 Graduate Teaching Assistant, Pennsylvania State University. Duties included preparation of laboratories and laboratory lectures for basic physical geology and mineralogy courses.

1970-1972 Graduate Research Assistant, Pennsylvania State University. Research involved a comparison of igneous and impact breccias.

1971 summer Geologist, Johns-Manville Ltd. Detailed mapping in the Stillwater Complex, Montana.

1968-1969 summers Geologic Field Assistant, U.S.G.S., Dr. Nicholas Ratcliffe, party chief. Assist in detailed bedrock mapping of Taconic geology in southwestern Massachusetts.

1968 Part-Time Laboratory Assistant, Lamont Geological Observatory, Paleomagnetism Section, Dr. Neil Opdyke, supervisor. Duties included cutting, preparation, and magnetic analysis of deep sea drill cores.

PUBLICATIONS:

"Northeast Breccia Pipes and Dikes," Moore, J. N. and Gold, D. P., International Geologic Congress (24th Session) Guidebook, Monteregeian Hills: Diatremes, Kimberlites, Lamprophyres, and Intrusive Breccias West of Montreal (1972).

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"The Roosevelt Hot Springs, Utah Geothermal Resource - An Integrated Case Study," Ross, H. P., Nielson, D. L., Glenn, W. E., Moore, J. N., Smith, Christian and Christensen, O. D., 66th Annual AAPG Meeting, San Francisco, June (1981).

"Geochemical Indicators of a High-Temperature Geothermal System" [abs.], Moore, J. N., Capuano, R. M., and Christensen, O. D., 9th International Geochemical Exploration Symposium, Saskatoon, Canada, May 12-14 (1982).

"An Exploration Case Study of the Roosevelt Hot Springs Geothermal System, Utah, Ross, H. P., Nielson, D. L., and Moore, J. N., Amer. Assoc. of Petrol. Geologists Bulletin, v. 66, p. 879-902 (1982).

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RESUME

Dennis L. Nielson

POSITION: Associate Director, Earth Science Laboratory, University of Utah Research Institute, Salt Lake City, Utah

EDUCATION: B.A., Geology, 1970, Beloit College, Beloit, Wisconsin
M.A., Geology, 1972, Dartmouth College, Hanover, New Hampshire
Ph.D., Geology, 1974, Dartmouth College, Hanover, New Hampshire

SHORT COURSES: Volcanic Rocks and Their Vent Areas, University of Nevada, Reno, 1977
Engineering Management by Objectives for Improving Productivity, University of Utah, 1978
Geothermal and Hydrothermal Systems, Yellowstone Institute, 1978
Economics of Minerals and Energy Projects, AIME, 1981

SOCIETY AFFILIATIONS: American Geophysical Union
Geological Society of America
Geothermal Resources Council
Society of Economic Geologists
Utah Geological Association

HONORS AND AWARDS: Haven Science Prize, Beloit College (1970)
NDEA Title IV Fellowship - Dartmouth College (1971-1974)
American Men and Women of Science
President, Basin and Range Section, Geothermal Resources Council (1979)

PROFESSIONAL EXPERIENCE:

8/85-present Associate Director, Earth Science Laboratory, University of Utah Research Institute. Project manager for a deep geothermal test at Ascension Island, South Atlantic Ocean which is funded at the \$3 million level. Also maintain active research into fracture controls of geothermal systems in the Valles caldera and Cascades.

7/80-8/85 Section Manager - Geology. Earth Science Laboratory, University of Utah Research Institute. Responsible for overall technical quality of geologic work and management of the geologic staff. Principal investigator for the geothermal exploration of Ascension Island, South Atlantic Ocean, under contract to U.S. Department of Energy and U.S. Air Force. This was an integrated exploration program utilizing geological and geophysical methods and over 6000' of thermal gradient drilling. Formulated and helped implement marketing strategies for UURI.

7/79-8/85 Geologist/Project Manager, Earth Science Laboratory, University of Utah Research Institute. Project manager for the

following programs under Department of Energy contracts: Geothermal Exploration and Assessment Technology Program, Industry Coupled Program, M-X/Renewable Energy Systems Program. Responsible for coordinating technical work at Roosevelt Hot Springs KGRA, Utah; and Beowawe; Tuscarora; Colado; McCoy; Soda Lake-Stillwater KGRAs, NV. Formulation and technical review of procurements, contract monitoring, and program design. Participated in a program to assess the state-of-the-art and recommend needed research in an industry sponsored program in solution mining and hydro-metallurgy. Have participated in numerous DOE advisory committees including those concerned with the Baca Geothermal Demonstration Power Plant, Deep Continental Scientific Drilling Program, Hot Dry Rock Project, and Niland loan guarantee.

- 1979-1985 Instructor, Yellowstone Institute, for a course on Calderas and Hydrothermal Systems which concentrates on the formation of calderas, ash-flow tuff stratigraphy, and the geology of hydrothermal systems in the caldera environment.
- 4/78-7/79 Geologist, Earth Science Laboratory, University of Utah Research Institute. Develop case studies for geothermal resource areas in western U.S. Responsibilities include supervision of geologic programs, geologic mapping, synthesis and publication of exploration data, and formation of exploration criteria.
- 6/74-4/78 Staff Geologist, The Anaconda, Co., Salt Lake City, Utah. Uranium exploration in frontier project areas in the United States. Responsible for generating and supervising projects through the initial drilling stages. Experience in Precambrian plutonic and metasedimentary environments and Tertiary volcanic and sedimentary environments. Activities included detailed mapping, quadrangle mapping, regional reconnaissance, interpreting geophysical and geochemical data, supervising rotary and diamond drilling, and land acquisition through leasing and claim staking.
- 1971 summer Field Geologist, Great Lakes Exploration Co. (subsidiary of Bear Creek Mining Co.). Reconnaissance mapping in the Precambrian Shield of the Upper Peninsula of Michigan and northern Wisconsin. The mapping was designed to locate areas having potential for massive sulfide deposits.
- 1970 summer Field Geologist, Great Lakes Exploration Co. (subsidiary of Bear Creek Mining Co.). Quadrangle mapping and geochemical surveys of water wells and soils in conjunction with a massive sulfide exploration program in northern Wisconsin.
- 1968 fall Field Assistant, Bear Creek Mining Co. Base metal exploration in the Upper Peninsula of Michigan and northern Wisconsin. Duties included drafting, supervising diamond drilling, and assisting with field mapping.

PUBLICATIONS:

PAPERS AND TECHNICAL REPORTS

- Nielson, D. L., 1973, Silica diffusion at Ascutney Mountain, Vermont: Contributions to Mineralogy and Petrology, v. 40, p. 141-148.
- Nielson, D. L., Clark, R. G., Lyons, J. B., Englund, E. J., and Borns, D. J., 1976, Gravity models and mode of emplacement of the New Hampshire Plutonic Series, in Lyons, P. C., and Brownlow, A. H. (eds.) Studies in New England Geology: Geological Society of America Memoir 146, 301-318.
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- Sibbett, B. S., and Nielson, D. L., 1980, Geology of the central Mineral Mountains, Beaver County, Utah: University of Utah Research Institute, Earth Science Laboratory, Rept. No. 33, 42 p.
- Ward, S. H., Ross, H. P., and Nielson, D. L., 1981, Exploration strategy for high-temperature hydrothermal systems in the Basin and Range Province: Am. Assoc. Petroleum Geologists Bull., 65/1 p.86-102. Reprinted in Energy Minerals, AAPG reprint Series No. 25, p. 232-248.
- Nielson, D. L., 1981, The bedrock geology of the Hillsboro quadrangle, New Hampshire: N. H. Dept. of Resources and Economic Development Bull. No. 8, 76 p.
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RESUME

Howard P. Ross

BIRTHPLACE AND DATE: Stockbridge, Massachusetts, October 26, 1935

POSITION: Senior Geophysicist/Project Manager, and Manager of Geophysical Group, Earth Science Laboratory, University of Utah Research Institute, Salt Lake City, Utah

EDUCATION: B.A., Geology, 1957, University of New Hampshire
M.S., Geophysics, 1963, Pennsylvania State University
Ph.D., Geophysics, 1965, Pennsylvania State University

Short Course, 1979, Modern Methods of Seismic Data Processing, GeoQuest International, Inc., Houston, October.

PROFESSIONAL AFFILIATIONS: Society of Exploration Geophysicists
American Geophysical Union
European Assn. Exploration Geophysicists
American Assn. Petroleum Geologists
Geothermal Resources Council

HONORS AND AWARDS: DOD Patent Disclosure Award, 1967
Who's Who in the West
Who's Who in Technology Today
American Men and Women in Science
Leading Consultants in Technology
Personalities of the Americas

PROFESSIONAL EXPERIENCE:

- 1/80-present Consultant in Exploration Geophysics. Clients include:
Battelle Memorial Institute, Columbus, Ohio
O.L.A.D.E. (Latin-American Energy Organization), Quito, Ecuador
Thermal Power Co., San Francisco, CA
Tintic Joint Venture, Salt Lake City, UT
Energy Fuels Nuclear, Inc., Denver, CO
Exxon Minerals Co., Tucson, AZ
Dept. of Energy/Nevada Operations, Las Vegas, NV
Kennecott Exploration, Inc., Casper, WY
- 8/77-present Section Head, Geophysics; Senior Geophysicist and Project Manager, Earth Science Laboratory, University of Utah Research Institute, Salt Lake City, Utah. Principal investigator for geophysical survey planning, supervision, and interpretation contracts. Coordinate, interpret, and evaluate geophysical surveys and geologic data to form technical case histories of geothermal exploration/reservoir assessment studies. Provide management assistance and technical evaluation as necessary to Department of Energy. Supervise and conduct geophysical interpretations for industry clients, U.S.G.S., and UN contracts. Design, supervise, interpret geophysical surveys for hazardous waste delineation, geothermal and mineral resources.

- 9/79-present Consultant, Office of Nuclear Waste Isolation (ONWI), Battelle Memorial Institute, Columbus, Ohio. Member of the Geologic Review Group for site characterization studies of the national nuclear waste storage program.
- 9/79-1983 Consultant, DOE/Richland, Washington and Rockwell Hanford Operations. Member Geologic Overview Committee for Basalt Waste Isolation Project.
- 1969-1977 Senior Geophysicist, Bear Creek Mining Company/Kennecott Exploration, Inc., Geophysics Division, Salt Lake City, Utah. Designed, supervised, conducted and interpreted geophysical field surveys in search of porphyry copper and other mineralization-induced polarization, magnetic, and gravity methods. Developed interpretation programs for magnetic data, and magnetic properties studies. Supervised contract aeromagnetic surveys and the geologic interpretation of these data. Presented seminars on the use and interpretation of geophysical data. In-company consultant on remote sensing (SLR and other imagery programs). Group Leader, Interdisciplinary Research Program for skarn research, September 1971 - March 1972. Field experience and interpretative work in New Mexico, Arizona, Nevada, Wisconsin, Minnesota, Montana, Utah and Tennessee.
- 1967-1969 Senior Research Geophysicist, Kennecott Exploration, Inc., Geophysics Division R&D, Salt Lake City, Utah. Conducted research in aeromagnetic interpretation, field rock magnetization studies. Developed first generation computer programs for magnetic interpretation schemes. Programmed electromagnetic coupling problem for IP studies. In-company consultant for remote sensing programs. Detailed and reconnaissance aeromagnetic interpretation. Supervised interpretation of deep-sea magnetic data (manganese nodule research).
- 1965-1967 Research General Physical Scientist, Air Force Cambridge Research Laboratories, Lunar-Planetary Research Branch, Bedford, Massachusetts. Organized and conducted laboratory reflection spectroscopy experiments and telescopic observations of the moon in the 0.2 to 3.0 micron (UV-VIS-IR) region of the spectrum. Pursued theoretical studies of the moon and planets. Developed instrumentation and monitored contracts for their fabrication. Programmed in Fortran IV for the reduction of spectroscopic data, signal-to-noise studies, mathematical models of geologic processes. NASA co-investigator Apollo Application Program (pre ERTS).
- 1961-1965 Graduate Research Assistant, The Pennsylvania State University, Mineral Conservation Section, University Park, Pennsylvania. Planned, executed and interpreted geophysical field surveys conducted each summer to determine if diabase or massive magnetite gives rise to various magnetic anomalies.

1958-1960 Computer and Acting Chief Computer, United Geophysical Corporation, Pasadena, California. Computer for reflection seismic crew engaged in oil and gas exploration; interpreted and processed seismic records; also organized office work, drafting, accounting.

PUBLICATIONS:

"In Situ Determination of the Remanent Magnetic Vector of Two-Dimensional Tabular Bodies," Ross, H. P. and Lavin, P. M., *Geophysics*, 31, No. 5, 949-962 (1966).

"A Bidirectional Reflectance Accessory for Spectroscopic Measurements," Hunt, G. R. and Ross, H. P., *Applied Optics*, 6, No. 10, 1687-1690 (1967).

"A Simplified Mathematical Model for Lunar Crater Erosion," *Jour. Geophysical Research*, 73, No. 4, 1343-1354 (1968).

"A Statistical Analysis of the Reflectance of Igneous Rocks from 0.2 to 2.65 Microns," Ross, H. P., Adler, J. E. M. and Hunt, G. R., *Icarus*, 11, 46-54 (1969).

"Recognition of the Geologic Framework of Porphyry Copper Deposits on ERTS-1 Imagery," Allan, J. W., Andrews, R. K., Ross, H. P. and Wilson, J. C., Kennecott Expl. Inc., Final Report to NASA, September (1975).

"Interpretation of Resistivity and Induced Polarization Profiles, Calico Hills and Yucca Mountain Areas, Nevada Test Site," Ross, H. P. and Lundbeck, J., University of Utah Research Institute, Earth Science Laboratory, Rept. No. 8, to the U.S. Geological Survey, September (1978).

"Numerical Modeling and Interpretation of Dipole-Dipole Resistivity Data, Lakes District, Ethiopia," Ross, H. P., Smith, Christian and Atwood, J. W., University of Utah Research Institute, Earth Science Laboratory, Rept. No. 15, to the United Nations, December (1978).

"Numerical Modeling and Interpretation of Dipole-Dipole Resistivity Data, Olkaria Field, Kenya," Ross, H. P., Smith, Christian, Glenn, W. E., Atwood, J. W. and Whipple, R. W., University of Utah Research Institute, Earth Science Laboratory, Rept. No. 16, to the United Nations, February (1979).

"Geothermal Well Drilling Estimates Based on Past Well Costs," Chappell, R. N., Prestwich, S. J., Miller, L. G. and Ross, H. P., *Geothermal Resources Council Trans.*, September, 3, 99-102 (1979).

"Interpretation of Resistivity and Induced Polarization Profiles With Severe Topographic Effects, Yucca Mountain Area, Nevada Test Site," Smith, Christian and Ross, H. P., University of Utah Research Institute, Earth Science Laboratory, Rept. No. 21, to the U.S. Geologic Survey, October (1979).

"Numerical Modeling and Interpretation of Dipole-Dipole Resistivity and IP Profiles, Cove Fort-Sulphurdale KGRA, Utah, Ross, H. P., UURI/ESL Report, DOE/DGE Contract No. DE-AC07-78ET28392 (1979).

"A Summary of the Geology and Geophysics of the San Emidio KGRA, Washoe County, Nevada, Mackelprang, C. E., Moore, J. N., and Ross, H. P., Geothermal Resources Council Trans., v. 4, p. 221-224 (1980).

"Review of Well Logging in the Basin and Range Known Geothermal Resource Areas, Glenn, W. E., Ross, H. P., and Atwood, J. W., paper SPE 9496, 55th annual meeting, SPE/AIME, Dallas, 16 p. (1980).

"A Strategy of Exploration for High Temperature Hydrothermal Systems in the Basin and Range Province, Ward, S. H., Ross, H. P., and Nielson, D. L., Bull. AAPG, v. 65, no. 1 (1981).

"Interpreted Resistivity and IP section, Line W1, Wahomnie Area, Nevada Test Site, Nevada", Smith, C., Ross, H. P., and Edquist, R., U.S.G.S. Open-File Report 81-1350, 8 p. (1981).

"Exploration Strategies for Regional Assessment of Hydrothermal Resources", Ward, S. H., Foley, D., Moore, J. N., Nielson, D. L., Ross, H. P., and Wright, P. M.: in Geothermal Energy Technology, J. C. Bresee and P. A. Witherspoon, eds. (1984, in press).

"The Cove Fort-Sulphurdale KGRA-A Geologic and Geophysical Case Study", Ross, H. P., Moore, J. N., Christensen, O. D., UURI/ESL Report No. 90, 32 p. (1982).

"Roosevelt Hot Springs Geothermal System, Utah-Case Study", Ross, H. P., Nielson, D. L., and Moore, J. N., AAPG Bull., v. 66, n. 7, p. 879-902 (1982).

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"Review of Well Logging in the Basin and Range Known Geothermal Resource Areas", Glenn, W. E., Ross, H. P., and Atwood, J. W., Jour. Petroleum Tech., May, p. 1104-1118 (1982).

"A Study of Well Logs from Cove Fort-Sulphurdale KGRA, Millard and Beaver Counties, Utah", Glenn, W. E., and Ross, H. P., UURI/ESL Report No. ESL-75, 39 p. (1982).

"Aeromagnetic map of Ascension Island, South Atlantic Ocean", Ross, H. P., Nielson, D. L., and Green, D. J., UURI/ESL Report (1984).

"Electrical resistivity surveys, Ascension Island, South Atlantic Ocean," Ross, H. P., Green, D. J., Sibbett, B. S., and Nielson, D. L., UURI/ESL Report, 30 p. (1984).

"Interpretation of aeromagnetic survey, Ascension Island, South Atlantic Ocean", Ross, H. P., Nielson, D. L., and Green, D. J., UURI/ESL Report, 37 p. (1984).

"Hill AFB, Utah Installation Restoration Program, Phase IIB IRP survey", Belan, R. A., Lessley, S. D., and Ross, H. P., UURI/UBTL Final Report, (1984).

"Borehole electrical geophysical methods", Ross, H. P., and Ward, S. H., UURI/ESL Report 141, 61 p. (1984).

"Supplemental electrical resistivity surveys, Ascension Island, South Atlantic Ocean", Ross, H. P., Mackelprang, C. E., and Dajany, S. F., UURI/ESL Report 142, 27 p. (1984).

"Geophysical investigations of the Cove Fort-Sulphurdale Geothermal System, Utah", Ross, H. P., and Moore, J. N., Geophysics, v. 50, p. 1732-1745 (1985).

"State of the Art - Geophysical Exploration for Geothermal Resources", Wright, P. M., Ward, S. H., Ross, H. P., and West, R. C., Geophysics, v. 50, p. 2666-2696 (1985).

"Detailed Gravity Surveys in Valle De Los Chillos, Ecuador and Gravity Survey Mission for INE", Ross, H.P., UURI/ESL Final Report INE-GRAV-1 to Instituto Nacional de Energia, Ecuador, 34p (1986).

PATENT:

"A Bidirectional Reflection Attachment for a Double Beam Spectrophotometer," Hunt, G. R. and Ross, H. P., submitted October 1966, U.S. Patent No. 3,506,365.

ABSTRACTS AND PRESENTATIONS:

"The Roosevelt Hot Springs, Utah Geothermal Resource - An Integrated Case Study," Ross, H. P., Nielson, D. L., Glenn, W. E., Moore, J. N., Smith, Christian and Christensen, O. D., 66th Annual AAPG Meeting, San Francisco, June (1981).

"Reflection Seismic Surveys for Basin and Range Geothermal Areas - An Assessment," Ross, H. P., Glenn, W. E. and Swift, C. M., Jr., 66th Annual AAPG Meeting, San Francisco, June (1981).

"The Cove Fort-Sulphurdale KGRA - A Geological and Geophysical Case Study (abs.)," Ross, H. P., Moore, J. N. and Glenn, W. E., Geophysics, 46, No. 4, p. 459 (1981).

"An Examination of 2-D Earth Model Resolution With the Dipole-Dipole Resistivity Method (abs.)," Smith, Christian, Glenn, W. E., Tripp, A. C. and Ross, H. P., Geophysics, 46, No. 3 (1981).

"A Strategy of Exploration for High Temperature Hydrothermal Systems in the Basin and Range Province," Ward, S. H., Ross, H. P. and Nielson, D. L., 65th Annual AAPG meeting, Denver, June (1980).

"Review of Well Logging in the Basin and Range Known Geothermal Resource Areas," Glenn, W. E., Ross, H. P. and Atwood, J. W., Paper SPE 9496, 55th Annual Meeting, SPE/AIME, Dallas, 16 p. (1980).

"Dipole-Dipole Resistivity Survey of a Portion of the Coso Hot Springs, KGRA, Inyo County, California", Fox, R. C., Ross, H. P., and Wright, P. M., (abs) Geophysics, v. 44, no. 3, p. 405 (1979).

"Aeromagnetism in Porphyry Copper Exploration," GSA Penrose Conference on Geologic Interpretation of Magnetic Data (unpublished), Reston, Virginia, April (1974).

"An Integrated Magnetic Study of Intrusive and Altered Sedimentary Rock of the Santa Rita, New Mexico Porphyry Copper Deposit," Trans. AIME, Dallas, February (1974).

RESUME

Bruce S. Sibbett

BIRTHPLACE AND DATE: Soda Springs, Idaho, July 29, 1945

POSITION: Geologist, Earth Science Laboratory, University of Utah Research Institute, Salt Lake City, Utah

EDUCATION: B.S., Geology, 1972, Brigham Young University, Provo, Utah.
M.S., Geology, 1976, University of Idaho, Moscow, Idaho

PROFESSIONAL AFFILIATIONS: Utah Geological Association, Geological Society of America.

PROFESSIONAL EXPERIENCE:

- April 1978-present Geologist with the Earth Science Laboratory, University of Utah Research Institute. Assisted with the geologic mapping of Roosevelt Hot Springs, KGRA and the central Mineral Mountains, Utah. Mapped the Colorado and Tuscarora, Nevada geothermal areas. Available drill cuttings from both of these areas were logged and the information integrated with surface geology for the resulting reports. Involved with the case study and well site selection at Wendel Hot Springs, California. Mapped the geology of several geothermal prospects in Nevada and Utah on ESL consulting contracts. Mapped the geology and evaluated the geothermal potential of a mid-ocean volcanic island. Supervised 6,560 feet of core drilling on Ascension Island, So. Atlantic. Mapping projects have covered a total of 425 sq miles at a scale of 1:24,000 or larger, most of this in Utah.
- 1976-1978 Exploration Geologist with Lucky McUranium Corporation (renamed Pathfinder Uranium Exploration). Supervised drilling programs on roll-front uranium properties in Wyoming, designed and carried out a geochemical sampling and reconnaissance exploration program in the Blackhills and the Williston Basin.
- 1975-1976 Graduate assistantship doing library research for the U.S. Bureau of Mines mineral resources inventory system, environment and reserves estimates of metallic mineral deposits in southern Africa.
- 1972-1974 Mineral examiner with the Bureau of Land Management in Arizona and New Mexico. Technical examination and report on mineral patent applications, mining claim validity determinations, environmental impact statement, sand and gravel sales, and mineral resource inventory. A course in mineral deposit evaluation and sampling techniques.

1970-1972 (part-time) Geologic field assistant with Burlington Northern Inc. for two summers and a spring. Geochemical exploration in western Montana. Studied bedded copper, porphyry molybdenum and lead-silver veins.

1966-1968 Two years in the U.S. Army, Vietnam; honorable discharge.

PUBLICATIONS:

Nielson, D. L., Sibbett, B. S., McKinney, D. B., Hulen, J. B., Moore, J. N. and Samberg, S. M., 1978, Geology of Roosevelt Hot Springs KGRA, Beaver County, Utah: University of Utah Research Institute, Earth Science Laboratory, Report No. 12, DOE/DGE Contract EG-78-C-07-1701, Salt Lake City, 121 p.

Nielson, D. L., Sibbett, B. S. and McKinney, D. B., 1979, Geology and structural control of the geothermal system at Roosevelt Hot Springs KGRA, Beaver County, Utah: American Association Petroleum Geologists Bull., 63/5, 836 p.

Sibbett, B. S., 1979, Geology of the Soda Lake Geothermal Area: University of Utah Research Institute, Earth Science Laboratory Report No. 24, DOE/DGE Contract EG-78-07-C-1701, Salt Lake City, 14 p.

Sibbett, B. S. and Nielson, D. L., 1980, Geology of the Central Mineral Mountains, Beaver County, Utah: University of Utah Research Institute, Earth Science Laboratory Report, No. 33, DOE/DGE Contract 78-28392.b.5, 42 p.

Sibbett, B. S. and Nielson, D. L., 1980, The Mineral Mountains Intrusive Complex, Utah: Geological Society of America Abstracts with Programs, Rocky Mountain Section, 12, No. 6, 305 p.

Sibbett, B. S. and Bullett, M. J., 1980, Geology of the Colado Geothermal Area, Pershing County, Nevada: University of Utah Research Institute, Earth Science Laboratory, Report No. 38, 34 p.

Glenn, W. E., Chapman, D. S., Foley, D., Capuano, R. M., Cole, D., Sibbett, B. S. and Ward, S. H., 1980, Geothermal Exploration Program Hill Air Force Base, Davis and Weber County, Utah: University of Utah Research Institute, Earth Science Laboratory, Report No. 34, 77 p.

Hulen, J. B. and Sibbett, B. S., 1981, Interpretation of drill cuttings from geothermal wells: Introduction to Geothermal Log Interpretation, Geothermal Resources Council Tech. Training Course No. 7, April 22-23, Reno, Nevada

Hulen, J. B. and Sibbett, B. S., 1981, Interpretation of drill cuttings from geothermal wells: University of Utah Research Institute, Earth Science Laboratory, Open File Report, 21 p.

- Christensen, O. D., Sibbett, B. S. and Bullett, M. J., 1981, Geochemistry of selected rock samples, Colado Geothermal Area, Nevada: University of Utah Research Institute, Earth Science Laboratory, Report No. 50, 17 p.
- Sibbett, B. S., 1976, Geology of the northeast part of the Loon Creek Mining District, Custer County, Idaho: University of Idaho Master Thesis, 111 p.
- Mackelprang, C. E., Lange, A. L., Sibbett, B. S., and Pilkington, H. D., 1982, Interpretation of a telluric-magnetotelluric survey at the Tuscarora Geothermal Exploration Unit, Elko County Nevada (Abst.): Geophysics, v. 47, no. 4, 421 p.
- Sibbett, B. S., 1982, Geology of the Tuscarora Geothermal Prospect, Elko County, Nevada: Geol. Soc. Amer. Bull., v. 93, p. 1264-1272.
- Sibbett, B. S., Zeisloft, J., and Bowers, R. L., 1982, Geology of MacFarlane's Spring Thermal Area, Nevada: Geothermal Resource Council, Transactions, v. 6, p. 47-50.
- Nielson, D. L., and Sibbett, B. S., 1982, Geothermal potential of Ascension Island, South Atlantic, phase I - preliminary examination: Earth Science Lab. Tech. Rept. Prepared for U. S. Air Force, 79 p.
- Sibbett, B. S. and Glenn, W. E., 1981, Lithology and well study of Campbell "E-2", geothermal test well, Humboldt House Geothermal Prospect, Pershing County, Nevada: University of Utah Research Institute, Earth Science Laboratory, No. 53, 17 p.
- Sibbett, B. S. and Blackett, R. E., 1982, Lithologic interpretation of the De Braga #2 and Richard Weishaupt #1 geothermal wells, Stillwater Project, Churchill County, Nevada: University of Utah Research Institute, Earth Science Laboratory, Report No. 70, 10 p.
- Sibbett, B.S., 1983, Structural control and alteration at Beowawe KGRA, Nevada: Geothermal Resources Council Transactions, v. 7, p. 187-191.
- Hulen, J.B., and Sibbett, B.S., 1983, Sampling and interpretation of drill cuttings from geothermal wells: Society of Prof. Well Log Analysts, Geoth. Log Interp. Handbook, 2nd Edition, p. IV 5-54.

RESUME

Philip E. Wannamaker

PROFESSIONAL POSITION: Scientist (Research Geophysics) at the Earth Science Laboratory, University of Utah Research Institute, Salt Lake City, Utah

BORN: November 24, 1954, Belleville, Ontario, Canada

CITIZENSHIP: Canadian
H-1 Visa Status in United States
Department of Labor Certification approved

EDUCATION: B. Sc., Engineering Geology, Queen's University, Kingston, Ontario, Canada, 1976

Ph.D., Geophysics, University of Utah, Salt Lake City, Utah, 1983

EMPLOYMENT EXPERIENCE:

1974-1976 (summers) - Field Geological/Geophysical Assistant, Cominco (Canada), Ltd

1983-present - Scientist (Research Geophysics), University of Utah Research Institute

RESEARCH INTERESTS:

Electromagnetic theory and practice, numerical modeling, relation of resistivity structure to physiochemical conditions of the earth, tectonism of the western United States

SOCIETY MEMBERSHIPS: American Geophysical Union (1/80-present)
Geothermal Resources Council (1/84-present)
Society of Exploration Geophysicists (1/77-present)

AWARDS:

First Class Honours, Faculty of Applied Science, Queen's University, 1976

ASARCO Fellowship in Geophysics, Dept. of Geology and Geophysics, University of Utah, 1977-1978

Outstanding Ph.D. Research Award, Dept. of Geology and Geophysics, University of Utah, 1982

Invitation by Geothermal Resources Council to review resistivity structure of the Great Basin at the GRC Northern Basin and Range symposium, Reno, Nevada, May 16-18, 1983.

Invitation by EMSLAB consortium to review three-dimensional magnetotelluric interpretation at workshop sponsored by National Science Foundation, Friday Harbour, WA, Sept. 25-28, 1983.

Invitation by American Geophysical Union to review resistivity structure of the northern Basin and Range at AGU annual meeting in San Francisco, CA, Dec. 5-10, 1983.

ADDITIONAL EXPERIENCE:

Geophysical consultant for United Nations, CGG-Geoconsult, Ltd., Sohio Petroleum Co., Phoenix Geophysics Ltd., Wight Engineering Ltd.

PUBLICATIONS: Shuey, R. T., and Wannamaker, P. E., 1978, Discussion on "Applications of the generalized inverse to the inversion of static potential data", by J. Cribb: *Geophysics*, 43(1), p. 194-196.

Wannamaker, P. E., Sill, W. R., and Ward, S. H., 1978, Magnetotelluric observations at the Roosevelt Hot Springs, KGRA, and Minerals Mts., Utah: *Transactions of the Geothermal Resources Council Annual Meeting*, 2, p. 697-700.

Wannamaker, P. E., 1980, The relation of regional resistivity structure in S. W. Utah to the tectonics of the Great Basin and Colorado Plateau: *EOS* 61(46), p. 941.

Wannamaker, P. E., Ward, S. H., Hohmann, G. W., and Sill, W. R., 1980, Magnetotelluric models of the Roosevelt Hot Springs thermal area, Utah: *Univ. Utah/Dept. Geol. & Geophys. Report DOE/ET/27002-8*, 213 p.

Wannamaker, P. E., 1983, Resistivity structure of the Northern Basin and Range, *In The Role of Heat in the Development of Energy and Mineral Resources in the Northern Basin and Range Province*, Geothermal Resources Council Special Rep. 13, p. 345-362.

Wannamaker, P. E., 1983, Resistivity structure of the northern Basin and Range: AGU Invited Paper, *EOS Transactions*, 64(45), p. 693.

Wannamaker, P. E., Hohmann, G. W., and San Filippo, W. A., 1984, Electromagnetic modeling of three dimensional bodies in layered earths using integral equations: *Geophysics*, 49(1), p. 60-74.

Wannamaker, P. E., Hohmann, G. W., and Ward, S. H., 1984, Magnetotelluric responses of three-dimensional bodies in layered earths: *Geophysics*, 49(9), p. 1517-1533.

Newman, G. H., Wannamaker, P. E., and Hohmann, G. W., 1985, On the detectability of crustal magma chambers using the magnetotelluric method: *Geophysics*, 50, 1136-1143.

Wannamaker, P. E., 1985, Electrical conductivity of water-undersaturated crustal melting: *J. of Geophy. Res.*, in press.

Wannamaker, P. E., Stodt, J. A., and Rijo, L., 1985, PW20-
finite element program for solution of magnetotelluric
responses of two-dimensional earth resistivity structure:
Univ. of Utah Research Inst. report ESL-158, 71 p.

Wannamaker, P. E., Stodt, J. A., and Rijo, L., 1985, A stable
finite element solution for two-dimensional magnetotelluric
modeling: Geophy. J. Roy. Astr. Soc., submitted.

Wannamaker, P. E., Stodt, J. A., and Rijo, L., 1985, Two-
dimensional topographic variations in magnetotellurics modeled
using finite elements: Geophysics, submitted.

RESUME

Stanley H. Ward

BIRTHPLACE AND DATE: Vancouver, B.C., Canada, January 16, 1923

POSITION: Professor, Department of Geology and Geophysics, College of Mines and Mineral Industries, University of Utah, Salt Lake City, Utah
Director, Engineering Technology Laboratory, and
Secretary/Treasurer, University of Utah Research Institute, Salt Lake City, Utah

EDUCATION: 1940, John Oliver High School, Vancouver, Canada
B.A.Sc., Engineering Physics, 1949, University of Toronto, Toronto, Ontario, Canada
M.A., Geophysics, 1950, University of Toronto
Ph.D., Geophysics, 1952, University of Toronto

SOCIETY AFFILIATIONS: Fellow, Royal Astronomical Society
Senior Member, Institute of Electrical and Electronic Engineers
Fellow, Geological Society of America
Honorary Member, Society of Exploration Geophysicists
Member, Geothermal Resources Council

Member, European Association of Exploration Geophysicists
Member, Canadian Institute of Mining and Metallurgy
Member, American Geophysical Union
Member, International Union of Geodesy and Geophysics
Member, Society of Sigma Xi
Member, Professional Engineers of the Province of Ontario
Member, Australian Society of Exploration Geophysicists

PROFESSIONAL EXPERIENCE:

8/85-present Secretary/Treasurer, University of Utah Research Institute.
Director, Engineering Technology Laboratory.

4/78-8/85 Director, Earth Science Laboratory, University of Utah Research Institute. Responsible for the management of research activities of a professional staff of 29 and a support staff of 30. Responsible for administration of funds totalling \$20,000,000.

7/73-6/80 Director, University of Utah Seismograph Stations. Responsible for the management of research activities of a professional staff of 6 and a support staff of 8. Responsible for administration of funds totalling \$2,000,000.00.

7/70-present Professor, Department of Geology and Geophysics, University of Utah. Research and teaching concerned with electromagnetic exploration with the objectives including the search for minerals, oil and gas, and geothermal energy, deep probing of the earth's crust, and study of the lunar interior.

1959-1970 University of California, Berkeley, Professor of Geophysical Engineering. Research and teaching concerned with electromagnetic exploration with the objectives including the search for minerals and oil, deep probing of the earth's crust, study of the earth's magnetosphere, and study of the lunar interior.

1958-present Consulting Geophysical Engineer. Consults to mining, petroleum, geothermal, aerospace and instrument companies and to governmental agencies; designs, supervises, and interprets data from exploration campaigns; originates, invents, advises regarding hardware and software utilized in mining exploration, petroleum exploration, and geothermal exploration; primarily concerned with electromagnetic exploration; consults on special government problems; clients have included:

Phelps Dodge Corporation
Kennecott Copper Corp.
Noranda Mines Ltd. - Canada
Placer Development Ltd. - Canada
Brenda Mines Ltd. - Canada
Craigmont Mines Ltd. - Canada
Endako Mines Ltd. - Canada
Scurry Rainbow Oil Co. - Canada
Pure Oil Company
Amax Exploration, Inc.
Commonwealth Scientific and Industrial Research Organization,
Australia
Colonial Sugar Refining Co., Australia
Sinclair Oil and Gas Co.
United States Steel Corp.
Varian Associates
The Bunker Hill Co.
Peerless Gas and Oil Co.
The U.S. Dept. of Justice
Cyprus Mines Corp.
Morrison-Knudson Co., Inc.
The National Aeronautics and Space Administration
Westinghouse Electric Corp.
Universidade Federal Do Bahia Instituto de Geosciencias E
Instituto de Fisico-Brazil
Engenheiros Consultores Associados, S.A. - Brazil
Exxon Corporate Research Laboratory, Newark
Atlantic Richfield Co., Dallas
Greatland Exploration Ltd., Anchorage
McPhar Instrument Corporation, Toronto
Exxon Production Research Laboratory, Houston
Quintana Minerals Corp. Houston
General Electric Corporate Laboratory, Schnectady

CRA Exploration Pty. Ltd., Melbourne
Royal Dutch Shell, Amsterdam
Houston Oil and Gas Corporation, Denver
SERU Nucleaire (Canada) Limitee, Montreal, Canada
Getty Oil Co., Salt Lake City
Anglo American of South Africa, Johannesburg
BP Minerals, Vancouver

1953-1958 Chief Geophysicist, Nucom Ltd. (subsidiary of American Metal Climax Inc.). Supervised geophysical aspects of exploration program involving as many as 275 men; supervised operation of three helicopter-borne electromagnetic prospecting units; supervised gravity, magnetic, electromagnetic surveys; prepared budgets of \$500,000 yearly for research and operations; interpreted data from mining geophysical surveys; collaborated in design of airborne, ground and drill hole prospecting systems; prepared reports on surveys and papers for publication in scientific and professional journals.

1949-1953 Chief Geophysicist, McPhar Geophysics Ltd. Directed operations and research of geophysical contracting firm; interpreted data from mining geophysical surveys; supervised staff of forty engineers, technicians, clerical staff; prepared cost estimates for surveys; collaborated in design of airborne, ground and drill hole electromagnetic prospecting systems; prepared reports on surveys and papers for publication in scientific and professional journals.

PUBLICATIONS

125 Publications

Mainly in geophysical exploration and exploration strategies for minerals and geothermal energy.

RESUME

Phillip M. Wright

BIRTHPLACE AND DATE: Park City, Utah, March 14, 1938

POSITION: Technical Vice President and Director of the Earth Science Laboratory, University of Utah Research Institute, Salt Lake City, Utah

EDUCATION: B.S. (High Honors), Geological Engineering, 1960, University of Utah, Salt Lake City, Utah
Ph.D., Geophysics, 1966, University of Utah, Salt Lake City, Utah,
Title of Ph.D. Thesis: Heat Flow and Geothermal Gradients in Utah

SHORT COURSES: Motivation and Management: Practical Management Associates, Salt Lake City, Utah, 1969 and 1973.

Engineering and Management: University of California at Los Angeles, 1971.

Mineral Deposits and Mineral Exploration: University of Nevada at Reno, 1973.

Geostatistics in the Mining Industry: Colorado School of Mines Alumni Association, Tucson Arizona, 1976.

Geothermal Resources and the Institutional Maze: Geothermal Resources Council, 1979.

SOCIETY AFFILIATIONS: American Geophysical Union
Society of Exploration Geophysicists
Society of Economic Geologists
Geothermal Resources Council
Utah Geological Association

HONORS AND AWARDS: United Park City Mines Scholarship, 1956-1960
United States Steel Foundation Fellowship, 1961-1963
National Science Foundation Regular Graduate Fellowship, 1964-1966

Elected to: Tau Beta Pi, 1960
Phi Kappa Phi, 1960
Phi Beta Kappa, 1960
Sigma Xi, 1965

PROFESSIONAL EXPERIENCE:

8/85-present Director, Earth Science Laboratory

5/84-present Technical Vice President, University of Utah Research Institute. Responsible for administering and directing technical work performed by UURI and for development and maintenance of technical and scientific capabilities within UURI.

- 9/82-12/82 Taught course GG521, Gravity and Magnetic Methods of Exploration, a graduate-level course at the Department of Geology and Geophysics, University of Utah.
- 9/78-5/84 Associate Director for Technology, Earth Science Laboratory Division, University of Utah Research Institute. Reported to Director of the Earth Science Laboratory. Assumed about half of Director's functions during academic year. Coordinated, reviewed and ensured quality of all scientific and engineering work performed at ESL. Responsible for technical work on budgets of about \$3 million per year. Portion of work involved geothermal research and management assistance programs on behalf of the U.S. Department of Energy. Geothermal work encompassed entire U.S. Also worked at the Ahuachapan geothermal field in El Salvador. Another portion of work involved minerals exploration projects, services and research. Project Manager for Solution Mining and Hydrometallurgy project at UURI, supported by industry and designed to improve solution mining technology.
- 5/77-9/78 Senior Geophysicist/Project Manager, Earth Science Laboratory Division, University of Utah Research Institute. Responsible for assembling a multidisciplinary, high-quality earth science staff and installation of appropriate laboratory facilities. Reviewed work of less senior geophysicists on numerous geothermally related projects. Participated in planning for all ESL projects. Project Manager for State Coupled Geothermal Resource Assessment Program under contract to U. S. Department of Energy.
- 1969-5/77 Chief, Geophysics Division - U.S. Operations, Kennecott Exploration, Inc., Salt Lake City, Utah. Reported to Director, Exploration Services and to Vice-President, Exploration. Responsible for budgets up to \$800,000 per year. Supervised professional geophysical staff, field geophysical crews and contract geophysical services. Interacted with worldwide exploration offices to provide geophysical input to exploration programs. Designed, supervised and interpreted broad range of geophysical surveys. Generated exploration targets. Project manager on reconnaissance induced polarization project in Western U.S. and Canada which led to discovery of a new, major covered porphyry copper sulfide system. Managed projects in seismic research, field and office interpretation of large aeromagnetic data base, and others. Field experience and interpretative work in Arizona, New Mexico, Nevada, Utah, Montana, Washington, Wisconsin, Minnesota, Colorado, British Columbia, South Africa and Botswana.
- 1966-1969 Senior Geophysicist, Kennecott Exploration Services, Salt Lake City, Utah. Reported to Chief Geophysicist. Responsible for exploration geophysical programs in Arizona, Nevada and Utah. Worked closely with geologists in Bear Creek Mining Co., a Kennecott subsidiary. Designed, supervised and interpreted geophysical surveys. Generated targets.

- 1956-1966 Undergraduate and Graduate Student, University of Utah, Salt Lake City, Utah.
- 1956-1966 (part-time) United Park City Mines Company, Park City, Utah. Worked as underground miner. Later worked with Chief Engineer and Chief Geologist as assistant. Experienced in all types surface and underground survey work, geologic mapping and interpretation. Directed underground long-hole drilling program which aided in discovery of new lead-zinc mineralization. Ore reserve calculations.
- 1961 (summer) The Anaconda Company, Salt Lake City, Utah. Worked as assistant geologist on a beryllium prospect near Ely, Nevada. Underground geologic mapping sampling. Ore reserve calculations.
- 1957 (summer) Bush and Gudgell, Engineers, Salt Lake City, Utah. Member of survey crew.

PUBLICATIONS:

- "Heat Flow and Precision Temperature Measurements in Boreholes," Costain, J. K. and Wright, P. M., Soc. Prof. Well Log Anal. Annu. Logging Symp., Trans. No. 10, J1 (1969).
- "Heat Flow at Spor Mountain, Jordan Valley, Bingham, and LaSal, Utah," Costain, J. K. and Wright, P. M., J. Geophys. Res., 78, No. 35, 8637 (1973).
- "Annual Review of Geophysics," Mining Engineering, 25, No. 2 (1973).
- "Frontiers of Mining Geophysics," Ward, S. H., Campbell, R. E., Corbett, J. D., Hohmann, G. W., Moss, C. K. and Wright, P. M., Geophysics, 41, No. 2 (1977).
- "Western States Cooperative Direct Heat Geothermal Program of DOE," Wright, P. M., Foley, D., Nichols, C. R., Grim, P. J. and Swanson, Jim, Geoth. Resources Council, Trans., 2, Sec. 1, 739 (1978).
- "Nature, Occurrence and Utilization of Geothermal Energy," Commercialization of Geothermal Resources, Geoth. Resources Council, 1 (1978).
- "Nature and Occurrence of Geothermal Resources," Commercial Uses of Geothermal Heat, Geoth. Resources Council Spec. Report No. 9, 123-134 (1980).
- "State Coupled Resource Assessment Program - An Update," Foley, Duncan, Wright, P. M., Struhsacker, D. W., Nichols, C. R., Mink, L. L., Brophy, G. P., Grim, P. J. and Berry, George, Geothermal Resources Council, Transactions, vol. 3, (1979).
- "Gravity and Magnetic Methods in Mineral Exploration," Seventy-Fifth Anniversary Volume, Economic Geology, Society of Economic Geologists, (1981).
- "Seismic Methods in Mineral Exploration," Seventy-Fifth Anniversary Volume, Economic Geology, Society of Economic Geologists, (1981).

"Tracer Recovery and Mixing from Two Geothermal Injection-Backflow Studies", Capuano, R. M., Adams, M. C., and Wright, P. M., Proceedings, Ninth Workshop on Geothermal Reservoir Engineering, Stanford University, Stanford, CA, Dec., (1983).

"Uses of Geochemistry with Injection-Backflow Testing in Geothermal Reservoir Studies", Wright, P. M., Capuano, R. M., Adams, M. C. and Moore, J. N., Geothermal Resources Council, Transactions, vol. 8, (1984).

"Application of Geophysics to Exploration for Concealed Hydrothermal Systems in Volcanic Terrains", Wright, P. M., and Ward, S. H., Geothermal Resources Council, Transactions, vol. 9, (1985).

"State of the Art - Geophysical Exploration for Geothermal Resources", Wright, P. M., Ward, S. H., Ross, H. P., and West, R. C., Geophysics, 50, (1985).

MAJOR ORAL PRESENTATIONS:

Determining Variations in the Thickness of Recent Cover with Gravity: to AIME Annual Meeting, New York, New York, 1968.

Educating Tomorrow's Earth Scientist for Industry: to Southwest Section, AIME, Las Vegas, Nevada, 1972.

Integration of Geophysical Data into Mining Exploration Programs: to Society of Economic Geologists Annual Meeting, New York, New York, 1975.

Mining Geophysics: taught a one-day mining geophysics course as part of a course entitled "A Total Concept of the Mining Industry", a summer course taught by the Colorado School of Mines, each year 1970-1976.

Dipole-dipole Resistivity of a Portion of the Coso Hot Springs KGRA, Inyo County, California: to Society of Exploration Geophysicists 48th Annual Meeting, San Francisco, California, 1978.

Use of Geophysics in Geothermal Exploration: A short course sponsored by CEL and the United Nations in El Salvador, C.A. for delegates from Central and South American in June 1979.

Geothermal Geophysics: to National Conference on Renewable Energy Technologies, Honolulu, Hawaii, 1980.

Nature and Occurrence of Geothermal Resources: to Geothermal Resources Council Symposium on Commercial Uses of Geothermal Heat, Boise, Idaho, 1980.

Nature and Occurrence of Geothermal Resources in the United States: to the First Sino/US Geothermal Resources Conference, Tianjin, People's Republic of China, 1981.

Geochemistry in Geothermal Exploration: to the First Sino/US Geothermal Resources Conference, Tianjin, People's Republic of China, 1981.

Uses of Geochemistry with Injection-Backflow Testing in Geothermal Reservoir
Studies: to Geothermal Resources Council Annual Meeting, Reno, NV, August,
1984.