GL00837

PROPOSAL FOR GEOLOGIC EVALUATION OF LIMESTONE RESOURCES IN THE DEVIL'S SLIDE, UTAH AREA

Submitted to

Ideal Basic Industries
Devil's Slide Plant,
Utah

By

Earth Science Laboratory
University of Utah Research Institute
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1.0 INTRODUCTION

In response to a request from Ideal Basic Industries, Devil's Slide Plant, the Earth Science Laboratory, University of Utah Research Institute (ESL/UURI) proposes the following resource study. The study includes four areas along the Weber River Canyon, all within seven miles of the Devil's Slide Plant, and a regional study for possible resource rocks within twenty miles of the plant. The study objectives and costs are broken out separately to clearly list the work proposed, and the product for each study area. All data and the conclusions and recommendations generated by the study or furnished to ESL by Ideal Basic Industries will be considered proprietary and the property of the client.

We have assembled a team which will allow the option to pursue the project from the currently proposed geologic evaluation, through drilling to verify the subsurface extent and quality of the limestone, and into the calculation of ore reserves. In addition, supervisory personnel will be assigned to the project to ensure both the timeliness and accuracy of the proposed work.

2.0 STATEMENT OF WORK

2.1 Powder Hollow

2.1.1 Introduction. In Powder Hollow is the southern continuation of the Twin Creek Limestone, middle unit, which is the current source rock for the Devil's Slide plant. As mapped by Mullens and Laraway (1964), the Twin Creek Limestone (Imlay, 1967) forms the lower slope on the west slide of the Powder Hollow drainage, with a strike of S13°W, and a dip of 65° to 78° east. The formation is exposed from the south side of the Weber River, a thousand feet south of the current pit, to about two miles southwest of the plant, where it is covered uncomformably by Cretaceous conglomerate of the Echo Canyon Formation. Vegetation and soil cover is heavier in the Powder Hollow area than in the current mine area because the formation is on a northeast facing slope as compared to the drier south facing slope in the mine area.

2.1.2 Objectives and Methods. The objective in the Powder Hollow area is to determine if the quality and thickness of limestone beds, comparable to the rock currently being mined, continues to the south. If quality and quantity appear to be present, a core drilling program to confirm and better define the resource will be designed.

To meet these objectives the middle unit of the Twin Creek Formation will be mapped in the field using 1:20,000 aerial photographs. Particular attention will be paid to thickness and lateral continuity of limestone beds, extent of shale partings, dip of beds and faulting. At least two, and possibly more, sample traverses along measured geologic sections will be made to determine the rock quality. Four geologic sections will be measured across the formation to define thickness of usable limestone, percent of waste rock and variability of the formation along strike.

2.1.3 Deliverables. The mapping and other data will be compiled on a

1:12,000 scale topographic base, enlarged from the Devil's Slide quadrangle map, and details of the sections measured and sampled will be presented on separate figures. A report will be prepared which will include sample analysis results, resource tonnage estimates, design of the core drilling program (if warranted), and conclusions and recommendations for the Powder Hollow area.

2.2 Katherine Claims

2.2.1 Introduction. The Katherine claims cover about 120 acres underlain by the Humbug Formation in Section 30, T4N, R3E, on the north side of the Weber River, 6 miles west of the Devil's Slide plant. The Humbug Formation, upper member, is a 300-350 foot thick limestone with 5-15 foot thick sandstone beds (Mullens and Laraway, 1973). The formation's strike is near north-south and it dips 53° to 80° to the east. Included with the Katherine claims for this study is the Round Valley Limestone, a unit 400 feet thick, occurring higher in the stratigraphic section and exposed 700 feet to the east of the Humbug Formation (Mullens and Laraway, 1973).

2.2.2 Objectives and Methods. The objective is to better define the quality, thickness and laterial continuity of Humbug Limestone and check the Round Valley Limestone potential on and near the Katherine claims. The effort of this study will be primarily directed toward the Humbug Limestone but a reconnaissance check and sampling of the Round Valley Limestone will be done. If this initial examination of the Round Valley Limestone is encouraging, more effort will be directed toward determining its resource potential. Field mapping in the Katherine area will be done on available 1:20,000 scale aerial photography and compiled on a 1:12,000 scale topographic base map. Emphasis of the mapping will be to define thickness and lateral continuity of high quality limestone beds, dip and possible faults, and extent

of interbedded waste rock. During the initial part of the study, grab samples of the above units will be collected and chemically analysed, and the results used to direct further effort. Two sample traverses to define resource quality and 3 measured sections will be completed in the area. The sample traverses will be along the measured sections.

2.2.3 Deliverables. A geologic map of approximately one and one half square miles will be compiled on a 1:12,000 topographic base. The measured sections will be presented as cross sections. A report will be prepared which will include these figures, sample analysis, tonnage estimates, conclusions and recommendations. Also if the study indicates that a resource is present, a core drilling program to define the resource will be designed.

2.3 Metz Hollow and Taggarts Areas

2.3.1 Introduction. The Metz Hollow and Taggarts areas are grouped here because of the limited effort initially planned for these areas. Metz Hollow is one mile northeast of Morgan, Utah and seven miles west of the Devil's Slide plant. At this location the Lodgepole Limestone forms a ridge crest north of the Weber River. The Lodgepole Limestone has been mapped as an 800-foot thick, dark-gray limestone, locally cherty with variable dips, but generally near 30° southeast (Mullens and Laraway, 1973). The formation crops out in a band 1000 to 2500 feet wide which trends north-south. The limestone was used as a source rock for cement by early pioneers at this location and an old kiln and pit are present.

The Taggarts area is located on the north side of the Weber River, three miles west of the cement plant. Analysis of a talus rock sample from the area indicated some high quality limestone is present. The formation in the Taggarts area is Weber Quartzite, which contains interbedded dolomite and limestone (Mullens and Laraway, 1964). Mapped structure and observations from

the highway indicate near horizontal rocks to the west separated by faults from steep east-dipping beds to the east of Taggarts.

2.3.2 Objectives and Methods. A reconnaissance examination and sampling of rocks from the areas will be done to determine if significant resource rocks are present. In the Taggarts area, the thick beds will be examined to determine if high quality limestone is present. Ideal will be advised as to preliminary findings of this study so that examination of the two areas beyond the initial limited scope as proposed can be considered.

2.3.3 Deliverables. A brief report on the potential for a resource and the sample analysis results including a map of sample location for the Metz Hollow and Taggart areas will be prepared. The study of these two areas may be expanded if so determined by Ideal.

2.4 Regional Reconnaissance

2.4.1 Objectives and Methods. A regional study of potential resource rocks within a twenty-mile radius of the Devils Slide cement plant is proposed to look for a limestone source which would be of higher quality and larger tonnage than the limestone resource at the four sites specified above between Devil's Slide and Morgan. This study would consist of a literature search to identify formations and exposures of limestone with resource potential which could be mined and trucked to the Devil's plant. A follow-up visit will be made to locations identified from the literature search and these areas will be mapped and sampled in reconnaissance fashion.

2.4.2 Deliverables. A report will be written which will contain all data compiled and conclusions and recommendations concerning the potential of new resource locations. Access problems and condition of haulage routes will be noted, and we will recommend any follow-up studies which are required.

2.5 References

Imlay, R. W., 1967, Twin Creek Limestone (Jurasic) in the western interior of the United States: U. S. Geol. Survey Prof. Paper 540, 105 p.

Mullins, T. E. and Laraway, W. H., 1964, Geology of the Devil's Slide quadrangle Morgan and Summit Counties, Utah: U. S. Geol. Survey Map MF-290.

_____1973, Geologic map of the Morgan 7 1/2 - minute quadrangle, Morgan County, Utah: U. S. Geol. Survey Map. MF-318.

3.0 PROPOSED TEAM AND MANAGEMENT

A highly qualified team is proposed for this project. Mr. Bruce S. Sibbett will serve as project manager. He will perform the field investigations and will be the principal contact for Ideal. Mr. Sibbett has extensive experience in geologic mapping and the exploration for natural resources. While working for the U. S. Bureau of Land Management he received training and experience in sampling and evaluation of industrial minerals, including limestone. He also has extensive experience in the planning and implementation of both rotary and diamond drilling programs. His resume is included in section 7.0.

Dr. Dennis L. Nielson will serve in a supervisory role and will review the work done by Mr. Sibbett and provide an alternate contact for Ideal. Dr. Nielson is Section Manager for the geology section at ESL and also has extensive experience in geologic mapping and exploration for natural resources. He reports to Dr. P. M. Wright who is Vice President-Technology at UURI. Dr. Nielson's resume is included in Section 7.0.

Dr. P. M. Wright is Vice President-Technology at UURI. As Chief of the Geophysics Division of Kennecott Exploration, Inc., Dr. Wright was involved in an extensive geophysical program in the vicinity of the Devil's Slide Plant. The purpose of the exploration program was to evaluate the resource potential of non-metallic ores in areas covered by Tertiary conglomerate. Dr. Wright will review the project work and be in a position to suggest geophysical solutions to the assessment of limestone resources. Dr. Wright's resume is included in Section 7.0.

Dr. Howard M. Wells is Professor of Mining Engineering at the University of Utah. He has experience and teaches courses in ore reserve calculations and the economics of mining projects. He will be available to review the

drilling program design and assist with reserve calculations if the core drilling phase is implemented. Dr. Wells' resume is included in Section 7.0

4.0 PROPOSED SCHEDULE OF WORK

The proposed work will proceed as rapidly as possible following contract award. The only potential delay forseen at this time is the lead time necessary for the acquisition of air photos.

5.0 PROPOSED BUDGET

5.1 Project Costs By Area.

As requested, the budget has been broken out to provide costs for each of the areas listed in section 2.0.

Powder Hollow

Salaries		
1. Senior Personnel.		
Bruce Sibbett	12 days	
D. L. Nielson	1 day	
2. Other Personnel		
Draftsperson	1 day	
Secretary	1 day	
Total Salaries		$4,674
Travel		225
Supplies		85
1. Air Photos		
2. Drafting Supplies		
Reporting (Duplication and Binding		38
	Total	$5,022

Katherine Claims

Salaries		
1. Senior Personnel		
B. S. Sibbett	8 days	
D. L. Nielson	1 day	

2. Other Personnel			
Draftsperson	2 days		
Secretary	.5 day		
Total Salaries			$3,474
Travel			225
Supplies			131
1. Air Photos			
2. Drafting Supplies			
Reporting (Duplication and Binding)			38
		Total	$3,868

Metz Hollow and Taggarts Area

1. Senior Personnel			
B. S. Sibbett	2.5 days		821
Travel			56
		Total	$ 875

Regional Reconnaissance

1. Senior Personnel			
B. S. Sibbett	6 days		
2. Other Personnel			
Draftsperson	1 day		
Secretary	.5 day		
Total Salaries			2,211

Travel	563
Supplies	56
Reporting	38
	$2,868

5.2 Analytical Costs

The objective of the project is to determine the quantity and quality of limestone reserves. Thus the prospect evaluation will be guided by geochemical analyses of rock samples collected in the field. The following price list outlines UURI's charges for geochemical analyses. For most samples collected during this project, analyses by Inductively Coupled Plasma (ICP) Spectrometry would be the most efficient and economical. Sample preparation and analytical costs will be $35/sample for 31 elements (see price list for elements and detection limits.)

Also included is a cost schedule for X-ray diffraction services.

CURRENT PRICE LIST

GEOCHEMICAL ANALYSIS OF SOLIDS

1) Analysis by Inductively Coupled Plasma (ICP) Spectrometry. **Cost per Sample**

(a) Standard 31 element analysis. Accuracy and precision are suitable for most exploration applications: $31.00

(b) High-precision 31 element analysis. Accuracy and precision are suitable for many petrologic investigations: $52.00

(c) Metal-rich scales and alloys may require special handling and multiple dilutions. Each additional dilution: . . . $ 8.50

INDUCTIVELY COUPLED PLASMA SPECTROMETER DETECTION LIMITS IN PPM (SOLIDS)

Na	100	Sr	1	Co	1	Pb	10
K	100	Ba	25	Cr	2	Sb	30
Ca	100	Ag	5	Cu	5	Sn	5
Mg	100	As	25	La	5	Te	50
Fe	100	Be	0.5	Li	2	Th	150
Al	100	Bi	100	Mn	10	V	150
Ti	5	Cd	5	Mo	50	Zn	5
P	25	Ce	10	Ni	5	Zr	5

2) Analysis by Atomic Absorption Spectrophotometry

Major element:	$ 7.50
First minor element:	$ 5.00
Each additional minor element:	$ 3.00
Gold-MIBK extraction:	$ 7.75
- with roasting:	$ 9.00
Silver:	$ 6.00

3) Mercury by Gold Film Detector

Samples with concentrations less than 750 ppb (5 ppb detection limit):	$ 6.50
Samples with concentrations greater than 750 ppb:	$12.00

4) Other Determinations

	Detection Limit	
Arsenic:	1 ppm	$ 6.00
Ferrous Iron:	0.08%	$11.00
Fluoride:	100 ppm.	$ 9.00
Loss on ignition:	0.01%	$ 5.50
Silica - Metaborate fusion: . . .	1%	$ 9.50
Silica - NaOH fusion (high metal, sulfides samples):	1%	$11.00
Hydride generation (Se, Sb, and Te each element:	0.5 ppm or less . . .	$ 9.50

5) Sample Preparation

Includes crushing, splitting and pulverizing to -200 mesh in a tungsten carbide shatterbox:	$ 5.00
if not split:	$ 4.00
Preparation of soil samples for mercury analysis:	$ 2.00

X-RAY DIFFRACTION SERVICES

1. **Semi-quantitative XRD Analysis of Bulk Samples:** Sample preparation, XRD scan from 2θ = 2° to 65° at 2°/min, glycolation and scan from 2° to 10° (if necessary), identification of minerals present, and determination of approximate weight percentage of each mineral. Sample amount: 5 gm.

Number of Samples	Cost per Sample
1-15	$70.00
16-30	65.00
> 30	60.00

2. **Qualitative XRD Analysis of Bulk Samples:** Same as semi-quantitative bulk analysis, except minerals are characterized as major, minor or trace constituents. Sample amount: 5 gm.

Number of Samples	Cost per Sample
1-15	$60.00
16-30	55.00
> 30	50.00

3. **Semi-quantitative XRD Analysis of Clay Mineralogy:** Extraction from bulk samples of < 2 micron (or < 5 micron) fraction by light crushing, sonic disaggregation, Stokes Law settling and centrifugation. Resulting slurry, sedimented on glass slides, is X-rayed using standard glycolation and heating techniques. Clay minerals are identified and approximate weight percentages of total layer-silicate fraction determined by comparison of selected peak intensities with those generated by mixtures of standard clay minerals in known percentages. Sample amount: 30 gm (best); 5 gm (min.).

Number of Samples	Cost per Sample
1-15	$115.00
16-30	110.00
> 30	105.00

4. **Qualitative XRD Analysis of Clay Mineralogy:** Same as semi-quantitative clay analysis, except clay minerals are characterized as major, minor or trace constituents of the total layer-silicate fraction. Sample amount: 30 gm (best); 5 gm (min.).

Number of Samples	Cost per Sample
1-15	$105.00
16-30	100.00
< 30	95.00

5. **Bulk XRD Scan with No Interpretation:** Includes sample preparation and scan from 2θ = 2° to 65° at 2°/min. Sample amount: 5 gm.

Cost per Sample
$28.50

Charges quoted above apply to routine XRD analysis of geologic materials. Prices for non-routine analysis will be quoted prior to commencement of work. Prices are subject to change without notice. **For further information, contact Jeff Hulen or Dennis Nielson.**

6.0 QUALIFICATIONS OF EARTH SCIENCE LABORATORY UNIVERSITY OF UTAH RESEARCH INSTITUTE

6.1 General Statement about ESL and UURI

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 financial support from either the University of Utah or the State of Utah. The charter includes provisions for UURI to conduct both public and proprietary scientific work for governmental agencies, academic institutions, private industry, and individuals. In this work UURI has a close technical association with the University and is able to draw upon the talents of faculty and students.

The Earth Science Laboratory (ESL) is a division of the University of Utah Research Institute (UURI) which provides consulting and contracting services in a broad range of scientific areas that includes field programs, data interpretation, research and technique development, geochemical analytical services, custom computer software, development of electronic instrumentation, and training seminars and workshops. ESL emphasizes the integration of scientific disciplines and techniques in solving problems in the earth sciences. An optimum, cost-effective combination of techniques from the fields of geology, geochemistry, geophysics, 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. 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.

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.

6.2 Summary of Staff Expertise and Facilities

6.2.1 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 programs 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.

An X-ray Diffraction Laboratory is used for detailed mineralogical investigation. Large studies have included alteration of active geothermal systems and mineralogy of petroleum reservoirs.

6.2.2 Geochemistry. Geochemistry has, during the last decade, become an increasingly important 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. 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 400 computer allow statistical treatment and provide geochemical plots of the analytical data.

6.2.3 Geophysics. Application of geophysical techniques greatly enhances ESL's ablility to investigate the subsurface. The staff has broad competence and experience in survey design and management and in integrated geological interpretation of geophysical data for a wide variety of resources. ESL has a suite of user-interactive computer programs that operate on the PRIME 400 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 the client to develop their in-house computer-based interepretation capabilities and can provide training of personnel in operation of available programs.

6.2.4 Electronics Engineering. High-quality field data are vital for today's earth scientists. ESL's electronics engineers provide broad competence and experience in instruments for electrical geophysical surveys. The latest hardware and software are available for custom application. The Electronics Laboratory is well equipped for development of microprocessor-integrated geophysical instrumentation. Test, design, and prototype

construction facilities are state-of-the art.

6.2.5 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 400 minicomputer system with a link to the University of Utah's UNIVAC 1100/60 computer. The system includes a PRIME 400 CPU with time-sharing capability and virtual memory, 1256 K bytes of main memory, 460 M bytes of disk storage, a 9-track magnetic type drive, a 36-inch Zeta pen plotter, a Statos electrostatic plotter, two line printers, 2 Tektronix 4014 graphics terminals with digitizing tablets, a DECwriter terminal, 7 CRT terminals, and two Texas Instruments Silent 700 terminals. Three dial-in phone lines are available to users, one at 300 baud and two at 1200 baud data transmission rates. The system is specifically oriented to scientific and engineering computation and to handling and interpreting geoscience data.

6.2.6 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 105,000 meters of drill chip samples and 2,100 meters of core from 171 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.

6.2.7 Document Library. ESL has an extensive document library that is available for use by clients. We have issues of all the important geothermal journals and many other earth science journals as well. Xerox and microfiche copies of many published articles are available. At present the library contains about 12,000 titles.

In addition, ESL has exchange privileges with the complete library facilities of the University of Utah campus where 2,000,000 titles are available.

6.2.8 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. Located here are the geochemical laboratory, the electonics laboratory, the computer center and our extensive document library as well as offices. The Sample Library occupies 450 square meters 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 a 5-minute drive form ESL's main facilities.

6.2.9 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 Vice President-Technology and the Associate Director/-

Administration for the technical and financial portions of the contract respectively.

7.0 RESUMES

Mr. Bruce S. Sibbett

Dr. Dennis L. Nielson

Dr. Phillip M. Wright

Dr. Howard M. Wells

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, Utah and with the writing of the subsequent report. Logged well cuttings from deep geothermal wells at Soda Lake, Stillwater, Dixie Valley and Humboldt House KGRAs, Nevada. Assisted with the mapping of the central Mineral Mountains, Utah and wrote report on the geology. Mapped the Colado 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.

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. Also examined uranium property submittals.

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, mineral resource inventory, preparation of contract stipulations and bonding requirements. 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 and staking claims in western Montana. Worked with 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.

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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.

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RESUME

Dennis L. Nielson

POSITION: Section Manager - Geology, 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:

7/80-present 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.

7/79-present 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. 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. Participated in a program to assess the state-of-the-art and recommend needed research in an industry sponsored program in solution mining and

hydrometallurgy. Have participated in numerous DOE advisory committees including those concerned with the Baca Geothermal Demonstration Power Plant, Deep Continental Scientific Drilling Program, and the Hot Dry Rock Project.

1979-present — 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.

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, Rept. No. 12, 121 p.

Nielson, D. L., 1978, Radon in geothermal exploration, theory and an example from Roosevelt Hot Springs KGRA, Utah: University of Utah Research Institute, Earth Science Laboratory, Rept. No. 14, 31 p.

Nielson, D. L., and Moore, J. N., 1979, The exploration significance of low-angle faults in the Roosevelt Hot Springs and Cove Fort-Sulphurdale Geothermal Systems, Utah: Geothermal Resources Council Transactions, v. 3, p.503-506.

Nielson, D. L. (ed.) 1979, Program Review: Geothermal Exploration and Assessment Technology Program including a report of the Reservoir Engineering Technical Advisory Group: University of Utah Research Institute, Earth Science Laboratory, Rept. No. 29, 128 p.

Foley, D., Nielson, D. L., and Nichols, C. R., 1980, Geothermal systems of the Yellowstone Caldera: Geothermal Resources Council Field Trip No. 1, 69 p.

Glenn, W. E., Hulen, J. B., and Nielson, D. L., 1980, A comprehensive study of LASL Well C/T-2 Roosevelt Hot Springs KGRA, Utah and application to geothermal well logging: Los Alamos Scientific Laboratory, Rept. LA-8686-MS, 175 p.

Nielson, D. L. (ed.) 1980, Geothermal Systems in Central Utah: Geothermal Resources Council Guidebook to Field Trip No. 7, 54 p.

Nielson, D. L., 1980, Summary of the geology of the Roosevelt Hot Springs Geothermal System, Utah: in Nielson, D. L. (ed.), Geothermal Systems in Central Utah, Geothermal Resources Council Guidebook to Field Trip No. 7, p.25-29.

Nielson, D. L., Moore, J. N., and Forrest, R. J., 1980, Road log to geothermal systems in central Utah: in Nielson, D. L. (ed.), Geothermal Systems in Central Utah, Geothermal Resources Guidebook to Field Trip No. 7, p.44-54.

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.

Ross, H. P., Nielson, D. L., and Moore, J. N., 1982, Roosevelt Hot Springs geothermal system, Utah-Case Study: Am. Assoc. Petroleum Geologists Bull., v. 66, no. 7, p. 879-902.

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

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

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

Foley, D., Nielson, D. L., and Nichols, C. R., 1982, Road Logs: West Yellowstone to Canyon Junction, Canyon Junction to Mud Volcano - Sulphur Cauldron Area, Canyon Junction to Tower Junction, Tower Junction to Mammoth Hot Springs, Mammoth Hot Springs to Norris Junction, Madison Junction to Old Faithful, in Reid, S. G. and Foote, D. J. (eds.) Geology of Yellowstone Park Area: Wyoming Geological Association Guidebook.

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

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

ABSTRACTS

Nielson, D. L., 1973, Contact metamorphism and molecular diffusion at Ascutney Mountain, Vermont: Geological Society of America, Abstracts with Programs, Northeastern Section, p.203.

Nielson, D. L., Lyons, J. B., and Clark, R. G., 1973, Gravity and structural interpretations of the mode of emplacement of the New Hampshire Plutonic Series: Geological Society of America, Abstracts with Programs 1973 Annual Meetings, p.750.

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 (abs.): American Association of Petroleum Geologists Bull., v. 63/5, p.836.

Ward, S. H., Chapman, D. S., Evans, S. H., Nielson, D. L., Wannamaker, P. E., and Wilson, W. R., 1979, Roosevelt Hot Springs Geothermal System: Geologic and geophysical models: IAVCEI Abstracts and timetables, IUGG XVII General Assembly, Canberra, Australia.

Nielson, D. L, 1980, Geology of low- and intermediate-temperature hydrothermal systems: National Conference on Renewable Energy Technologies, Proceedings, Honolulu, p.8-3 to 8-4.

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

Ward, S. H., Ross, H. P., and Nielson, D. L., 1980, Strategy of exploration for high temperature hydrothermal systems in the Basin and Range Province (abs.): Am. Assoc. Petroleum Geologists Bull., v. 64/5, p.799.

Ross, H. P., Nielson, D. L., and Glenn, W. E., et al., 1981, Roosevelt Hot Springs, Utah geothermal resource-integrated case study (abs.): Am. Assoc. Petroleum Geolgists Bull., v. 65/5, p. 982.

Nielson, D. L., and Hulen, J. B., Results of deep drilling in the Valles caldera, New Mexico (abstract): Invited paper, International Symposium on Continental Drilling, Tarrytown, N.Y.

WORK IN PROGRESS

Papers in Press

Aleinikoff, J. N., Nielson, D. L., Hedge, C. E. and Evans, S. H., Geochronology of Precambrian and Tertiary rocks in the Mineral Mountains, south-central Utah: U. S. Geol. Survey Professional Paper.

Morris, H. T., Sibbett, B. S., Nielson, D. L., and Steven, T. A., Geologic map of the Bradshaw and Lincoln Mining Districts, Beaver County, Utah: U. S. Geol. Survey Mineral Investigation Series Map.

Ward, S. H., Foley, D., Moore, J. N., Nielson, D. L., Ross, H. P. and Wright, P. M., An exploration strategy for regional assessment of hydrothermal resources, in Bressee, J. C. and Witherspoon, P. A., Geothermal Energy Technology.

Nielson, D. L., and Hulen, J. B., Internal geology and evolution of the Redondo Dome, Valles caldera, New Mexico: Jour. Geophys. Research Special volume on calderas and associated igneous rocks.

Papers in Preparation

Nielson, D. L., Evans, S. H. and Sibbett, B. S., Magmatic, structural, and hydrothermal evolution of the Mineral Mountains intrusive complex, Utah.

Zandt, G., and Nielson, D. L., Active seismicity at Roosevelt Hot Springs geothermal area, Utah.

RESUME

Phillip M. Wright

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

POSITION: Technical Vice President, 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:

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 multidisclipinary, 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 Colombia, 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.

"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. 7, 1984 (in press).

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.

HOWARD M. WELLS, Professor of Mining Engineering
Director of Graduate Studies

APPOINTED: 1977

Time on graduate research and instruction: 50%

Degrees: B.S., M.S. and Ph.D. - University of Witwatersrand

Positions held:

Active military service 1942-46; Field engineer, area supervisor, general manager, managing director, H. H. Fraser and Association (Mining and Management Consultants) 1952-64; contracts manager, managing director, Shaft Sinkers Ltd. (Mining Contractors) 1967-70; Senior Lecturer, University of Witwatersrand 1970-1976; Professor of Mining engineering, University of Utah, 1977—.

Research interests:

Mine economics and valuation, mine administration, geostatistics.

Societies and professional activities:

South African Institute of Mining and Metallurgy (Fellow, Member of Council 1974-77, Corresponding member of Council for U.S.A.); SME of AIME (Member, representative on Utah Engineer's Council, Chairman, University Coordination for Engineer's Week); South African Council of Professional Engineers (Professional Advisory Committee 1975-1976).

Recent Publications:

1. 'Shaft design and shaft sinking techniques,' Wells, H. M. and Wilson. Seventy-fifth Anniversary of the S.A. Mining & Engineering Journal (issued in association with the S.A. Institute of Mining and Metallurgy) 1968.

2. 'The influence of economics in the design of mine shaft systems', Wells, H. M., Journal of the S.A. Institute of Mining and Metallurgy, 1968.

3. 'The economic analysis of raw borehole data and its use as an early aid to open pit planning', Wells, H. M., Proceedings of the 13th International APCOM Symposium, Clausthal, West Germany, 1975.

4. 'The investment decision under uncertainty', Wells, H. M., Journal of the S.A. Institute of Mining and Metallurgy, 1976.

5. 'Optimization of mining engineering design in mineral valuation', Wells, H. M., Mining Engineering, December 1978.

6. 'On the use and validity of probabilistic methods in mine valuation', Wells, H. M., Computer Methods for the 80's in the mineral industry, Alfred Weiss, editor, 1979.

7. 'Mineral leasing on public lands with special reference to tar sand and oil shale development in the State of Utah,' Wells, H. M., The Journal of Energy Law and Policy, University of Utah, College of Law , Vol. 1, 1980.