

The Engineering Geologist



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Geological investigations of Columbia Plateau Basalts as a potential nuclear waste repository

J. A. Caggiano

Rockwell International, Richland, Washington 99352

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A comprehensive geologic investigation is being conducted by Rockwell Hanford Operations for the U.S. Department of Energy to assess the feasibility of constructing a deep geologic repository in basalt on the Columbia Plateau. Engineering geology is playing a major role in this program.

Engineering geologists and geophysicists are conducting a number of investigations to gather the data required for evaluation of basalt as a potential host rock and for selection and evaluation of potential repository sites in the Columbia Plateau. The objective of these studies is to identify target areas having sufficient geologic barriers that will ensure that radiocontaminants will not reach the biosphere. For all candidate sites, geologic studies are planned to determine the dimensions and lithologic characteristics of basalt units, the character of all structures present, and the overall tectonic stability of the area. Geotechnical and hydrologic investigations are being conducted in parallel with geologic studies to gather relevant data on ground-water flow systems and ground-water quality and the physical and chemical properties of basalt.

A twofold approach to geologic investigations is being followed: (1) reconnaissance-level investigations throughout the region, and (2) detailed studies within the Pasco Basin—one of several basins within the Columbia Plateau. The regional effort is concentrating on geologic mapping of basalt and overlying late Cenozoic sediments to determine the extent and stratigraphy of units. These studies are necessary to determine the geologic history and to assess the tectonic stability of the region of the Columbia Plateau.

Within the Pasco Basin, geologic research is being focused on the detailed stratigraphy of the basalt and late Cenozoic sediments and the physical and chemical characteristics of potential host basalt rock. Definition of stratigraphic and structural relationships of basalt flows is being pursued through geologic mapping of basalt units cropping out within and along the basin margin as well as through deep core drilling and geophysical surveys in the interior of the basin. Geologic properties of flows are being studied in cores, outcrops, and thin sections. Chemical, mechanical, and thermal

properties of basalt are also being investigated to determine the effect of inducing stresses through mining of a shaft and emplacement of radioactive waste. Late Cenozoic sediments overlying the basalt are being investigated to ascertain the tectonic history and stability of the area since the last fissure eruption in the Miocene. Reconnaissance mapping of the exposed late Cenozoic sediments is to be supplemented by detailed mapping, paleomagnetic studies, radiometric dating, and characterization of interbedded volcanic-ash horizons to develop a detailed stratigraphy and chronology of units during the past few million years.

Most engineering geologic and geophysical investigations now in progress were initiated in 1978 and will continue through 1985, with preferred disposal sites identified in 1981. In 1981, the program will begin to focus on providing more detailed characteristics of preferred sites identified during the first two years. Documents detailing progress in various aspects of the geologic and geophysical investigations conducted by Rockwell Hanford Operations and subcontractors in the Columbia Plateau may be obtained by writing directly to the National Technical Information Service, Springfield, Virginia 22161. Interested parties should request available publications in the RHO-BWI series from the National Technical Information Service.

EGD functions at San Diego, 1979

Secretary John S. Scott has scheduled the following Division functions for the 1979 annual meeting:

Management Board Meeting, 4 November, 2000–2400 hours,
El Camino Room

Annual Dinner–Business Meeting, 5 November, 1930–2230
hours, Garden Room North

Reception, 5 November, 1830–1930 hours (pre-dinner),
Garden Room North

Review Volume IV in press: *Geology in Siting of Nuclear Power Plants*

The GSA Books Manager reports that Reviews in Engineering Geology Volume IV is in the printing and binding process. The book will be cloth-bound and in the format of Don Coates's Volume III (1977) *Landslides*. It is hoped that the book will be available at the 1979 annual meeting of the Society in San Diego.

Another book manuscript in preparation

Geological Society of America past president and former Engineering Geology Division Chairman Dr. Robert F. Legget sends word that manuscripts are being accumulated and reviewed for submittal to GSA for evaluation and possible acceptance to publish in the Engineering Geology Review series. The tentative title list includes papers dealing with urban geologic framework of the following North American cities: Boston, Chicago, Edmonton, Hermosillo-Mexico City, Kansas City, New Orleans, New York, Los Angeles, San Francisco, Toronto, Twin Cities (Minneapolis-St. Paul), and Washington, D.C. Robert has not informed us of his cutoff deadline for the papers, but your editor believes that he is pressing for early 1980.

New TRP landslide manual available

We all regretted the out-of-print status into which Highway Research Board Special Paper 29 *Landslides and Engineering Practice* (1958) slipped in 1961, after having been in print only three years. Under the editorship of EGD member Robert L. Schuster (USGS, Denver) and Professor Raymond J. Krizek (Northwestern University), a second volume is now available through the Transportation Research Board of the National Academy of Sciences. *Landslides: Analysis and Control*, published late in 1978, is selling for \$14 in hard copy and \$12 in paper cover. Dave Varnes has revised the very useful landslide classification poster (in a pocket) and additional copies of this Figure (2.1) are also available for wall or classroom use at \$2 each. The book contains nine chapters by well-known practitioners and is 234 pages long. We have it that 1,500 copies were printed—it may not even last long! The address for ordering is Publications Office, Transportation Research Board, National Academy of Sciences, 2101 Constitution Avenue NW, Washington, DC 20418.

Correction:

We apologize for misspelling Dr. Evert Hoek's name in our announcement in the August issue of *The Engineering Geologist*. He and Dr. John W. Bray are the winners of the 1979 E. B. Burwell Award.

1979 E. B. Burwell Award for work in rock mechanics

For the second consecutive year our Burwell Award is made to recipients working in rock mechanics. The 1978 award went to Nicholas R. Barton of the Norwegian Geotechnical Institute, Oslo, for his 1976 paper "The Shear Strength of Rock and Rock Joints" that appeared in the *International Journal of Rock Mechanics and Mining Science*, v. 13, no. 9. This year we honor Dr. Evert Hoek, Golder Associates, Vancouver, and Dr. John W. Bray, Imperial College of Science and Technology, London, for their well-received book *Rock Slope Engineering*, published in 1977 by the Institution of Mining and Metallurgy, London. We hope to have at least one of the recipients present with us in San Diego.

Progress toward establishment of a U.S. national group of IAEG

Former EGD Chairman David J. Varnes, U.S. Geological Survey, Denver, has worked diligently for two years now in spearheading a movement to gain U.S. participation in the International Association of Engineering Geologists. The IAEG bulletin *Engineering Geology* (not to be confused with another of the same general title) has become an excellent source document containing, on occasion, color illustrations. For instance, no. 18 (December 1978) contains 242 large-size pages of text. Creation of a U.S. national group would make membership in IAEG available to American engineering geologists for the grand sum of only \$6 per year, in lieu of the already bargain-rate fee of \$12.

Dave has succeeded, on direction of the EGD Management Board, in gaining approval of the National Academy of Sciences through its U.S. National Committee on Geology to bring the U.S. national group into existence. Dave is now working on the implementation of the U.S. national group, in cooperation with AEG President Dick Proctor and EGD Chairman Dick Jahns.

We will continue to report to you concerning progress in this direction. In the meantime, application forms are available through Dave Varnes or your chairman-elect and acting editor, Allen Hatheway.

Dr. Robert F. Legget has also joined in the effort to secure approval of establishment of the U.S. national group through the U.S. National Committee on Geology (Dr. William A. Oliver, Jr., Chairman). Our Canadian colleagues have had an active national group for several years and are now the most numerous of the national bodies, with membership well over 700.

COMMITTEE NEWS

John B. Ivey is serving a 3-year term (July 1, 1978–June 30, 1981) as representative to the GSA-AEG-ASCE Joint Committee on Engineering Geology. John is also vice-president of the AEG.

Report on Engineering Group—Geological Society of London

The Engineering Group of the Geological Society of London, publisher of that fine quarterly journal *Engineering Geology*, has elected its 1979 officer slate and has published its calendar of conferences and meetings for the year. Importantly, there are now nearly 700 members in the group. Membership is open and accessible to qualified persons in the United States, and the advantages are well known to a number of stateside AEG members. An application can be had by writing to The Secretary, Geological Society of London, Burlington House, London W1V 0J0, England.

Oregon issues a useful prototype hazards report

Engineering geologists practicing in the hazards-constraints and environmental mapping disciplines will want to purchase a copy of Oregon Department of Geology and Mineral Industries Bulletin 98, *Geologic Hazards of Eastern Benton County, Oregon*, 1979, 122 p., plus five color-printed quadrangle maps. The bulletin, by James L. Bela, is a fine example of the complementary use of engineering geology, geotechnical engineering, applied geomorphology, and engineering seismology. Jim Bela holds degrees in geology and geotechnical engineering and has put some very reasonable thinking together with good illustrative photography and 1:24,000-scale photogeologic and field mapping, along with compilations of existing classical geology converted to this specialized engineering geologic use. The bulletin sells for \$9 and is recommended as a thoughtful state-of-the-art example of hazards mapping. You can order copies from the Department of Geology and Mineral Industries, 1069 State Office Building, Portland, Oregon 97201.

Papers available—Engineering geology in New England

The record-breaking attendance at the annual meeting of the American Society of Civil Engineers (held in Boston in early April 1979) was treated to an AEG session on Friday, April 6. The opportunity of holding the session was provided by Technical Program Chairman John T. Christian, vice-president of Stone & Webster Engineering Corporation and past chairman of the New England Section, and John H. Peck, consulting geologist, also of Stone & Webster Engineering Corporation. The five papers given at the session have been bound together by ASCE as a 106-page preprint (no. 3602) entitled *Engineering Geology in New England*; it is available for \$5.00 from ASCE at 345 East 47th Street, New York, NY 10017. The papers and AEG-member authors are as follows: "Engineering Geologic Framework of the Boston Basin" by Clifford A. Kaye, "Earthquake Zonation in the Northeastern United States" by Patrick J. Barosh, "Design and Performance: Northfield Mountain Pumped Storage Project" by William F. Swiger, Philip A. Wild, and

Thomas J. Lamb, "The Sanitary Landfill Siting Dilemma in New England" by Arthur G. Lazarus, "Geologic Conditions and Considerations for Underground Construction in Rock, Boston, Massachusetts" by Allen W. Hatheway and William C. Paris, Jr.

More NRC-sponsored seismotectonic studies available

Engineering geologists active in seismic-risk evaluations will be pleased to note that the excellent line of research in regional seismotectonic analyses sponsored by the U.S. NRC has again been expanded. The following reports have become available since our last report to you. (Prices shown are for hard copy [first price] and for microfiche [second price]. All documents are available from NTIS, U.S. Department of Commerce, Springfield, Virginia 22161.)

1. Burchett, R. R., 1978, Regional tectonics and seismicity of eastern Nebraska: NUREG/CR-0053/R6A, 19 p., \$4.00/\$3.00.
2. DuBois, S. M., and Wilson, F. W., 1978, A revised and augmented list of earthquake intensities for Kansas, 1867-1977: NUREG/CR-0294, 56 p., \$5.25/\$3.00.
3. DuBois, S. M., 1978, The origin of surface lineaments in Nemaha County, Kansas: NUREG/CA-0321, 36 p., plus illus., \$5.25/\$3.00.
4. Braile, L. W., Hinze, W. J., Keller, G. R., and Likiak, E. K., 1978, An integrated geophysical and geological study of the tectonic framework of the 38th parallel lineament in the vicinity of its intersection with the extension of the New Madrid fault zone: NUREG/CR-0449, 67 p., \$5.25/\$3.00.
5. Buschbach, T. C., 1978, New Madrid seismotectonic study—Activities during fiscal year 1978: NUREG/CR-0450, 129 p., \$7.25/\$3.00.
6. Wilson, F. W., 1979, A study of the regional tectonics and seismicity of eastern Kansas—Summary of project activities and results to the end of the second year, or September 30, 1978: NUREG/CA-0666, 68 p., \$6.00/\$3.00.
7. Luza, K. V., and Lawson, J. E., 1979, Seismicity and tectonic relationships of the Nemaha uplift in Oklahoma—Part II: NUREG/CA-0875, 81 p., \$6.00/\$3.00.
8. Geraghty, E. P., and Isachsen, Y. W., 1979, Analysis of faults in the Delaware aqueduct tunnel, southeastern New York: NUREG/CA-0882, 28 p., \$4.00/\$3.00.
9. Tyler, D. A., Ladd, J., and Borns, H. W., 1979, Crustal subsidence in eastern Maine: NUREG/CA-0887, 4 p., plus appendix and illus., \$4.00/\$3.00.
10. Isachsen, Y. W., and Geraghty, E. P., 1979, Ground investigations of projected traces of focal mechanisms for earthquakes at Blue Mountain Lake, Raquette Lake, and Chazy Lake, Adirondack uplift, New York: NUREG/CA-0888, 33 p., \$4.00/\$3.00.
11. Geraghty, E. P., and Isachsen, Y. W., 1979, Investigation of selected linear features in the northern Adirondack Mountains, New York: NUREG/CA-0890, 16 p., \$4.00/\$3.00.

Aspects of Engineering Geology at KKMC

Paul Barndt

U.S. Army Corps of Engineers, Hafar Al Batin,
Kingdom of Saudi Arabia

King Khalid Military City (KKMC) is currently under construction near Hafar Al Batin, Kingdom of Saudi Arabia. The city will serve as a cantonment for Saudi Arabian defense forces near borders of the kingdom and, simultaneously, function as a local cultural and commercial hub for a nomadic hinterland. A complete, modern city is under construction that will eventually provide full services for 70,000 people.

The project is located on the southeastern rim of Wadi Al Batin on a lag gravel plain (Dibdiba) about 370 km north-east of Riyadh, the capital. The Wadi Al Batin serves as an infiltration area during periods of sparse rainfall. It is the area's main morphological feature. Summers can be extremely hot (unofficial 135 °F) with rather high winds which, when combined with usual low humidities, result in high evaporation.

The city is located within the Northern Tuwayq Segment of the Arabian Shelf structural province. Preconstruction boreholes for site selection, concrete aggregate exploration, foundation investigations, and freshwater aquifers have revealed the following stratigraphic sequence on site: Quaternary, irregular contact; Neogene complex (Miocene-Pliocene), unconformity; Um Er Radhuma formation (Paleocene), gradational contact; Aruma formation (Upper Cretaceous).

Geologists who were or are involved in planning, design, and construction phases of the city recognize and work with unique characteristics of each stratigraphic unit. Individual rock types have variously affected the project.

The Aruma and Um Er Radhuma formations are the main aquifers for KKMC. Water wells, 300 to 1,200 m deep, have been developed in these units to provide domestic and construction water for the project. Limestones and dolomite from the Um Er Radhuma-Neogene undifferentiated contact zone are a source of coarse aggregate for concrete and base coarse material produced from an openpit quarry.

Neogene undifferentiated and Quaternary deposits, which form the caprock rim of Wadi Al Batin, have been eroded to produce suitable sand for fine concrete aggregate and sandblasting. Most foundations for structures within the project will be constructed in Quaternary-Neogene undifferentiated deposits, and individual characteristics of various rock types within these deposits determine foundation designs.

The geology of the Hafar Al Batin area presents a variety of rock units from which suitable construction materials may be obtained on site. Potentially excessive and expensive haul distances have been greatly reduced through materials surveys. Furthermore, suitable rock types are present upon which concrete buildings can be located without creating unusual and expensive foundation design problems. However, geologists concerned with the site are aware of potential problems inherent to the geologic setting.

Regional structure in the Hafar Al Batin area is controlled by the pre-Neogene deposits that dip gently as a monocline toward the northeast. Erosion, combined with

local variations in the regional structure, has resulted in minor near-surface depressions that function as ponding areas for ground-water infiltration during seasonal periods of sparse rainfall. Geologists involved with early site-location studies recognized these surface depressions as potential areas for solution sinks in underlying limestones. In fact, open sinkholes were observed in similar surface depressions beyond the city limits during early planning stages. However, an early core-drilling program indicated that there were no major solution features on site that would result in unique design problems or require extensive relocation of planned structures within the city. But, the possibility of encountering potential subsurface solution phenomena is recognized as construction phases begin.

There are 10 to 20 m of Neogene undifferentiated rocks that unconformably overlie the Um Er Radhuma formation, and most foundations for the city will be located in this rock unit. Geologists at KKMC recognize the possibility that the contact between the Um Er Radhuma Limestone and overlying Neogene undifferentiated sediments represents a former erosion surface and is a potential area for additional solution features and weathered rock that could adversely affect construction of foundations and utility tunnels. Water from the Um Er Radhuma and Aruma aquifers will be used for surface irrigation; in effect, a near-surface, ground-water table could be eventually created. The adverse impact of potential ground water in leaching the discontinuous marls and sandy limestones of the Neogene undifferentiated sediments, which often have high absorption capabilities, was and is an additional factor considered for foundation design.

Marls and sandy limestones of the Neogene undifferentiated sediments also occur at the openpit quarry site. Such sediments can contain unsound rock that is unsatisfactory, physically and chemically, for concrete aggregate. Selective quarrying methods are required that will identify or avoid areas of unsuitable rock.

Overlying the Neogene undifferentiated sediments is a 0.5- to 3-m layer of Quaternary silt, sand, and gravel deposits derived from sandstone, limestone, quartzite, gneiss, hornfels, diorites, granites, and granodiorites. Gravel trains are found as deposits on the Wadi caprock rim and terrace remnants of Pleistocene fluvial origin. Sands and gravels are derived from both local sources and basement-complex rocks found farther west. The best sand-sized material suitable for concrete fine aggregate usually is located in reentrants to the main Wadi Al Batin. In the reentrants, percentages of fines are less and the deposits contain lower amounts of concrete-deleterious salts. Suitable concrete sand tends to be located in patches above the bottom of the main Wadi whose deposits generally contain larger percentages of material passing the no. 200 sieve.

The geologic setting at KKMC includes a range of suitable construction materials whose location near the project contributes toward more cost-effective construction methods for this modern city to be built from precast concrete. However, geologists and engineering-construction staff members

who work on the project also recognize that there could be certain potentially unfavorable soil and rock conditions encountered owing to the geologic setting. Project planning has allowed for appropriate construction methods should such conditions arise.

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Acknowledgment

I thank the Al Batin District, U.S. Army Corps of Engineers, and the Military Works Directorate, Ministry of Defense and Aviation, Kingdom of Saudi Arabia, for the opportunity to publish this paper. Special acknowledgment goes to Charles Canning and W. Voelker, Corps of Engineers, who have had a long-term association with aspects of engineering geology at KKMC.

Fourth International Tunnelling Association Meeting

This has been an active year for your designated representative on the USNC/TT. I was one of eight U.S. delegates to the 4th meeting of the International Tunnelling Association held in conjunction with the International Tunnel Symposium '78 sponsored by the Japan Tunnelling Association, Tokyo, May 29-June 2, 1978. I also prepared and presented the invited paper "Current Tunnel Design, Construction, and Research in the U.S." I attended the committee meeting of the Working Group on Research and Development and was appointed General Reporter for a one-year study on an international basis of Tunneling with Shields in Soft Ground. This report will be given at the 5th meeting of the International Tunnelling Association to be held in conjunction with the Rapid Excavation and Tunneling Conference in Atlanta in June 1979.

I also attended the annual committee meeting of the USNC/TT as GSA's designated representative. This meeting was held in Fresno, California, August 3-4, 1978. There I reported on the Tokyo meeting and also worked with the ad hoc subcommittee on site investigation. This subcommittee had prepared a proposal for support of a study of "Needs and Opportunities in Site Investigation Programs for Major Underground Construction Projects." Following considerable debate it was agreed to re-structure the proposal for later submittal to funding agencies.

Don U. Deere, GSA Representative,
U.S. National Committee for Rock Mechanics

Geotechnology in Massachusetts— A 1980 conference

Organizer Professor Oswald C. Farquhar (EGD member) of the University of Massachusetts reports that some 35 papers have been offered and tentatively accepted. The conference will likely be held at the Boston campus of the university on 20 and 21 March 1980. Professor Farquhar will continue to accept papers for consideration; send your abstract, according to GSA format, first. Double-spaced drafts are called for by 1 November 1979, but exceptions may be made for late submissions on the basis of production scheduling for the proceedings volume which will be available at the conference.

Papers are especially solicited from those working in other adjacent New England states. Professor O. C. Farquhar may be addressed at Department of Geology and Geography, University of Massachusetts, Amherst, MA 01003.

Short Course
Lecture Notes

ENGINEERING GEOLOGY FOR GEOLOGISTS

Hershey, Pennsylvania
October 14-15, 1978

Geiger, A. F.
and
Hatheway, Allen W.
Editors

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Engineering geology and the GSA Centennial

The year 1988 brings a century of service to mankind and our profession. A GSA planning committee for the Centennial has been active since mid-1978, and the divisions have been asked to propose appropriate contributory volumes and celebration activities for this once-in-a-lifetime opportunity for engineering geologists to make an important statement about their profession. Some of the topics that have been discussed to date are: history of engineering

geology in North America, cities of North America (geological aspects), standards of practice for engineering geology (professional and technical), and field trips: west coast, Rockies, central, east coast. Members are invited to send suggestions to Chairman Dick Jahns or Chairman-elect Allen Hatheway. The division will make formal recommendations to the GSA Executive Committee early in 1980.

William J. Mallio, *retiring Editor*
Allen Hatheway, *acting Editor*



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