

# The Engineering Geologist



THE  
GEOLOGICAL SOCIETY  
OF AMERICA

NEWSLETTER OF THE ENGINEERING GEOLOGY DIVISION OF THE GEOLOGICAL SOCIETY OF AMERICA

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## CHAIRMAN'S MESSAGE

### A QUESTION OF DIRECTION FOR THE ENGINEERING GEOLOGY DIVISION

Beginning back in 1975, then-Chairman Paul L. Hilpman, University of Missouri (KC), undertook to streamline the somewhat cumbersome functions of the division. Many of the standing committees had aged and were drifting without assignment; there were voices that said that perhaps the cornerstones and underpinnings of the division were indeed similar to those of the Association of Engineering Geologists (AEG) and that perhaps EGD, although the predecessor to AEG by some 10 years, had run the course of its usefulness as an entity. Chairman David J. Varnes (1977) carefully inspected the statistics of membership and turnover and brought the issue of survival of the Division to the Management Board. Dave's suggestion was to put the question of continued division activities to the vote of the membership. The result of this poll, held by way of a straw ballot printed in the Newsletter for July 1977, was that some 58% of the membership then felt that continued activity was the desired course of action for the division. These members also overwhelmingly stated that the real purpose of existence of the Engineering Geology Division was communication between engineering geologists and other geologists on the one hand and the more classically trained members of the Society on the other. A second charge was that the division should continue its activities and that it should continue to provide publications in engineering geology, a role not generally provided by AEG, outside of its fine *Bulletin*.

Dave and his successors have striven to bring new life and activity to EGD, in fact, you will have noted that fact in the list of officers and committee activities appearing in the last issue of the *Newsletter*.

The direction for each year's activities comes at the face-to-face meeting of the management board and other interested division members at the annual meeting. For the remainder of the following year, the Chairman conducts business on the directions provided by consensus at the annual meeting of the management board. This year's charge is to investigate the question of embracing or incorporating "environmental geology" within the purview and activities of the Engineering Geology Division. Our first action in this

direction will be to put this question to you, the membership. We are asking that you consider what you personally wish the EGD to do toward involving itself in the myriad activities going on under the diffuse label of Environmental Geology and let us know what your wishes are. If some sort of action is indicated, we will report that to you in the third newsletter of the year, and we will be prepared to act on a developed platform of action at the 1980 annual Management Board meeting, scheduled for Atlanta in November.

The activity of geologists in "environmental" pursuits is quite apparent at the present time: a spate of textbooks and anthologies on the subject, perhaps larger numbers of us employed in hazardous waste and high-level radioactive waste repository siting than were engaged in nuclear plant siting in its peak period, surface mine reclamation, abandoned coal mine and spoil bank remedial treatments and fire abatement, solid waste disposal, dredge spoil permitting, environmental impact reports and statements of a huge variety, the Strategic Petroleum Reserve program, terrestrial oil spill and gasoline leakage problems, siting and licensing regulations for LNG port facilities, dam failures and inspections, and coastal erosion and forestry clearcut management. I am certain that you will think of many activities that I have missed in this accounting. The fact is that these activities by engineering geologists and other applied geologists nearly always involve some component of engineered design in the final treatment of each of the above areas of concern. The only true difference is that the engineering design is not for the purpose of building the traditional structures that we engineering geologists have historically been involved with.

Where does that leave the engineering geologist? Well, for the most part, this above-cited environmental geology is being accomplished largely by those who would call themselves engineering geologists. Some of the work is also being accomplished by well-qualified geologists of other disciplines: geomorphology, geochemistry, remote sensing, mineralogy and petrology, and other classical geological disciplines. Often these people have been called in to assist because they

were known as competent and thorough scientists; sometimes they were residents of the area affected; others have sought to intervene in a regulatory process. Whatever the impetus, these geologists have become enjoined with an issue because they felt that geological knowledge was the key to a clear understanding of the natural forces at work in each of the problem areas that I have mentioned.

Whatever may be the case, there appears to be just too much activity in the environmental circle at the beginning of the 80s for us not to face the issue of what EGD should do to interface with "environmental geology." By now you've also guessed that your chairman is an enthusiast for some sort of increased EGD recognition of "environmental geology."

What the Management Board would like is your straw-vote response to a variety of options. If you will give us this, we will report on the findings in newsletter number three and then formulate a plan of action (or inaction, as you deem most fit) for the 1980 Annual Management Board Meeting. The meeting, of course, will be open to your participation at Atlanta. In the meantime, please let the Board have the benefit of your thinking!

**IF YOU MAKE A COPY OF THE BALLOT,  
THE NEWSLETTER WILL REMAIN INTACT.**



### **Burwell Award Committee members and a call for candidate papers**

Your management board has filled the two present committee vacancies and has appointed Division Secretary Erhard M. Winkler to direct the committee for 1980. The five-person committee, with terms of service are as follows:

Raymond T. Throckmorton	1978-80
Allan L. O'Neill	1978-80
Alice S. Allen	1979-81
Roy J. Shlemon	1979-81
John H. Peck	1980-81
Ellis L. Krinitzky	1980-81

The committee would be delighted to entertain worthy papers in its selection effort for the 1980 recipient of the Burwell Award. You are encouraged to give thought to selection of one or more candidate papers, remembering that all authors are eligible, GSA member or not, and that the papers will be judged for their relevance and contribution to engineering geology. The candidate papers must have been published in or after 1975. It is appropriate for authors to submit copies (preferably six; facsimile copies will be acceptable) to

Erhard M. Winkler  
Department of Geology  
University of Notre Dame  
Notre Dame, IN 46556

Submissions should be made not later than 1 June 1980.

### **Straw Ballot on the Issue of Environmental Geology**

I vote for

- ☐ Status quo—Our meeting sessions are often associated with environmental geology as it is.
- ☐ Increased activity in communication with Society members in environmental geology; this can be accomplished through *GSA News & Information*.
- ☐ Initiation of some committee activity in areas that can be identified as environmental geology; solicit papers and publish case history or review volumes on such subjects.
- ☐ Undertake an effort to increase EGD membership by soliciting affiliation by environmental geologists.
- ☐ Consider changing the name of our division to include environmental geology (this will require a change in division bylaws).
- ☐ My own suggestion, as follows: \_\_\_\_\_

Name (optional) \_\_\_\_\_

Send to Allen W. Hatheway  
Haley & Aldrich, Inc.  
238 Main Street  
Cambridge, MA 02142  
(617) 492-6460

### **Characterization of oxbow lakes**

GSA member Robert A. Lohnes, a frequent contributor to our paper and poster sessions in engineering geology, has embarked on Phase II of a characterization study of Missouri River oxbow lakes, as typified by those in the Decatur (Nebraska) and Onawa (Iowa) segment. Bob is with the Department of Civil Engineering, Iowa State University, Ames, IA 500010, and he produced in 1977 with colleagues M. D. Dougal, M. Johnson, and R. Bachman, a first study which may be of interest to those "working the river." The report details some useful characteristics of oxbow lake geology and hydrogeology. It allows us to design effective exploration programs to verify their particular hydrologic regimes and factors that are crucial to the development and enhancement of the lakes as recreational features. The report would also aid in instances in which the lakes are impacted by proposed highway or developmental construction. The lakes can be fragile and must be treated with care. We presume that a limited number of copies of this report remain for those who are interested.

### **Progress report on *Geology beneath Cities***

Dr. Robert F. Legget, former Chairman of EGD, reports that *Geology beneath Cities*, candidate for Reviews in Engineering Geology, Volume V, is progressing according to his schedule. As of January 8, the papers had begun to flow in, and Dr. Legget is targeting for package submittal of the manuscripts to GSA Science Editor Vernon Swanson by late spring of 1980.

## Monograph series on earthquake engineering

The Earthquake Engineering Research Institute (EERI), of Berkeley, California, has released the first of ten planned monographs on the practice of earthquake engineering. This small-format, bound volume is entitled *Reading and Interpreting Strong Motion Accelerograms*, and it has been compiled by the dean of strong motion compilers, Donald E. Hudson, California Institute of Technology. Dr. Hudson presents a procedural guide, along with basic explanatory notation, for processing and interpretation of accelerograms toward extraction of the acceleration time history parameters that form the basic site-dependent ground motion data for design of critical structures. The volume will be of use to engineering geologists practicing in engineering seismology for its thoughtful discussion of the practical meaning of time-histories and for the basis of prescribing what should be provided by seismologists to the engineering geology-geotechnical engineering-structural engineering team that handles site-specific antiseismic design. The monograph contains 112 pages and sells for \$6.00 through EERI at 2620 Telegraph Avenue, Berkeley, CA 94704. Members of EERI are slated to receive the series as a benefit of their \$50/year dues.

## U.S. membership in ISRM

The International Society for Rock Mechanics (ISRM) was formed in 1962 as the only technical society devoted entirely to fostering the advancement of rock mechanics. In addition to sponsoring congresses and symposia, the Society undertakes its own scientific and technical studies, the results of which are published as commission reports.

United States' interests are represented in the ISRM by a national group, the U.S. National Committee for Rock Mechanics (USNC/RM), which adheres to the Society on behalf of U.S. scientists, engineers, and technologists interested in rock mechanics. One of the functions of the National Group is to provide for individual memberships in the ISRM.

The total membership of the ISRM is approximately 5,000, but the U.S. membership is less than 200, even though there is considerable activity in the field of rock mechanics in this country. The USNC/RM believes that domestic interests would be better served if individual membership in the ISRM were greater and more reflective of the people working in rock mechanics in the U.S.

The 1980 dues for ISRM individual membership through the National Group are \$6.00. Members receive the quarterly *ISRM News*, which includes announcements of forthcoming meetings and a bibliographic section abstracting current literature in rock mechanics and allied fields; reduced subscription rates to *Rock Mechanics*, *The International Journal of Rock Mechanics and Mining Sciences*, *Geomechanics Abstracts*, and *Underground Space*; reduced (usually) registration rates for ISRM congresses and symposia and for separate purchase of proceedings; reduced rates for purchasing reports of ISRM commission; reports of activities conducted by the USNC/RM; and an annual directory of U.S. members of the ISRM.

Application forms for ISRM membership and additional information may be obtained from the USNC/Rock Mechanics, Attn: Barbara S. Adams, National Research Council, 2101 Constitution Avenue NW, Washington, DC 20418; telephone (202) 389-6415.

## Measurement of precursory movements on rock-block landslides

Dr. Bruce R. Clark, Director of Rock Mechanics, at Leighton & Associates in Irvine, California, has developed a ground surface extensometer system for detecting small movements precursory to failure in a rock-block type of landslide. In the Bluebird Canyon Landslide, Laguna Beach, California, a characteristic movement pattern was observed and was used to predict impending failures. The pattern varied, depending upon the location of the extensometer base line relative to the new head scarp, but in each case, the rate of extension changed a few days before final failure.

This surface extensometer system was installed in 1978 to monitor headward migration of the head scarp during remedial grading. Several prehistoric slides in the same materials preceded the 1978 slide, and numerous clay-lined rupture surfaces were available for renewed sliding. During remedial grading operations, and especially during cutting of a shear key earth buttress, the ancient rupture surfaces were left temporarily unsupported. Minor block glides occurred, posing a threat to remaining streets and homes on the hill above the slide.

The extensometer system monitors movements over a 2 to 5 meter base line under rugged field conditions. It consists of an enclosed Invar rod and dial indicator connecting two pins secured at opposite ends of the base line. Relative movement between the pins is sensed directly by the dial indicator. The system has a sensitivity of nearly  $10^{-3}$  strain units. The field data are easily collected by unskilled workers and a minimum of interpretation is required. No expensive electronic or mechanical equipment is left at the site, and although vandalism can be a problem, the instruments are reasonably well protected from accidental damage.

The precursory movements were first observed as dramatic increases in the rate of extension. In some cases, there was already a background level of slow extension occurring in the slope, but the precursory change was clear. The extension can be interpreted as a dilatation of the ground involved in the impending slide. In one example, the extensometer was entirely on the future slide block. After a head scarp crack had formed, the extensometer showed a marked contraction before final failure. A second extensometer adjacent to, but entirely off of a new slide block, showed the same extension and contraction pattern. Thus, dilatancy is apparently a measurable precursory phenomenon in this type of landslide.

Dr. Clark is continuing his work with these instruments on other landslides in southern California.

## Third edition of *Geology and Engineering*

Dr. Robert F. Legget is just now completing his "18 months at hard labor" in making a total revision of the widely acclaimed 1962 second edition of *Geology and Engineering*. Robert speaks about the revision as a "handbook" and it appears that we will want this new edition to stand next to the former edition—not merely a replacement—rather an extension of what will be a fine series of Legget books, counting *Geology of Cities* and *Soils of Canada* (an edited effort). The manuscript is due at McGraw-Hill this spring, and Dr. Legget is a man of his word.

## EDITOR'S CORNER

### The engineering geologist and Clinton's Ditch

Written communication in 1839 between James Hall (State Geologist of New York, 1837-1898) and Alfred Barrett (Chief Engineer of the Erie Canal) recently unearthed in the archives of the New York State Geological Survey indicates that Dr. Hall may have been one of America's earliest engineering geologists. As the two letters reproduced below show, the modern day problems between engineer and contractor, in which the engineering geologist must often ride to the rescue, are really not so modern after all.

Lockport June 8th, 1839

Jas. Hall Esqir  
State Geologist 4th

Dear Sir

I am very desirous of obtaining your opinion of the rock which occurs in the Excavation opposite the present Locks in this village upon the North Side of the Canal. That is its Geological Classification and the constituent parts of the different Classes as nearly as you can judge from their appearance as it presents its self to view Commencing with the Gray lime stone on the surface the rock appears to Change by incensible degrees from the under surface of the grey lime to the bottom of our Excavation Containing a greater proportion of Alumina as we descend the Strata. In Our Original Estimate this Material was called Slate rock & Shale we supposed it would all Come under the head of Shale below the gray lime stone. In observing the face from which the rock has been recently blasted I See that there are very heavy layers of this material with apparently little or no Seams, but on Exposure to the Atmosphere it soon yields and crumbles to pieces in Small Cubes, and by Continued Exposure it becomes decomposed or disintegrates and forms a very tenacious clay. . . . by giving your opinion upon this Subject you will confer a very great favour. . . .

It is fair to state to you that this information is desired to Enable the Canal Commissioner and my self to decide a question raised by the Canal Contractors [unreadable name] in relation to their Contract for the Excavation of this Material. In the Contract they have a price for "Solid rock" and a price for "Slate rock & Shale."

They Claim that the whole is Solid rock. Therefore your professional opinion will be of great Service

I am

Very respectfully

Yours

A. Barrett  
Chief Engineer

Lockport June 9th 1839

Alfred Barrett Esqir  
Chief Engineer &c

Dear Sir,

I have received your favor of yesterday and hasten to give an answer to your inquiries in relation to the rock occurring in the excavation opposite the Locks., I understand you to require the names by which the several rocks are known geologically -

The face of the cliff presents the following rocks in the descending order - 1st about 10 feet of gray, encrinal limestone of a crystalline and compact texture occurring in strata from a few inches to 2 feet thick. Below the limestone are about 6 feet composed of layers of a few inches thickness and alternating with seams of shale. This rock may be termed an argillo-siliceous limestone and probably contains magnesia or a trace of iron and perhaps manganese. It belongs to the variety which are termed hydraulic

limestones, though this term is rather vague in its application. Below the hydraulic limestone are nearly 80 feet in thickness of "calcareous shale" - (The same rock was termed calciferous slate" by Prof. Eaton) with occasional layers of siliceous limestone from one to four inches thickness. In a general description these would scarcely be mentioned as the amount is so small as not to affect the character of the mass as a whole which comes strictly within the denomination of shale, and no other name can properly be applied to it. Where it has never been exposed to the weather it separates into solid blocks which readily cleave into irregular laminae, this is a character common to all our shale rocks. The upper part of this rock is more compact and apparently contains a larger proportion of carbonate of lime than that below which has a more slaty structure. On exposure this shale decomposes into a tenaceous clay which is the condition of much of that portion along the banks or sides of the cliffs below the locks. The change from the shale to a perfect state of decomposition is very gradual and there are so many intermediate stages that it may not be easy to decide the point when one begins or the other ends, yet for all practical purposes the distinction is sufficiently obvious.

I have here stated distinctly my opinions of the characters of these rocks, and the names are those by which they are known to all geologists. I make these statements impartially without reference to individuals or circumstances, regarding only truth. Should there be any points which are not satisfactorily explained I shall give any farther explanation with pleasure. You are aware that there can be nothing assumed or arbitrary on my part as rock terms are suited and in common usage among geologists of Europe and America.

I cannot give an opinion of what constitutes "solid rock" in your contracts it is evident that you have certain specifications attached to it in contradistinction to shale - if the term solid rock is applied to this then there is no farther use of the term "slate rock & shale" except as applicable to the weathered edges of such strata which are partially decomposed. The circumstances of the mass crumbling into cubical or angular fragments denotes the presence of some scalene matter, which in this case is probably sulphate of iron and sulphate or magnesia arising from the decomposition of iron pyrites, the sulphuric acid uniting both with the iron of the pyrites and with the magnesia of the rock.

With regard to hardness this rock is far inferior to the limestone and is one of the softest rocks which occur in any series.

I am very respectfully  
yours

James Hall  
Geologist 4th Dist.

### Tenth Short Course on Geological Engineering

September 2-9, 1980

Asilomar State Conference Grounds  
Pacific Grove, California

To be given by the Geological Engineering Foundation

The program, intended for civil engineers, mining engineers, and engineering geologists, will teach concepts and skills of geological engineering, including methods of investigation of rock masses, design of underground openings, stability analyses of slopes in soil and rock, the application of physical and numerical models in the analysis of structures in jointed rock masses, and geotechnical aspects of earthquakes.

The Geological Engineering Foundation is a nonprofit, tax-exempt educational corporation.

For further information, contact Tor L. Brekke or Richard E. Goodman, The Geological Engineering Foundation, 1847 Yosemite Road, Berkeley, CA 94707; telephone (415) 642-5525.

## A LONG SHORT NOTE

An inexpensive but useful tool being used by several researchers in the NRC Nemaha Uplift study in the central midcontinent are "pseudo" shaded relief maps produced with a technique developed in 1975 by G. R. Hallberg and R. R. Anderson of the Iowa Geological Survey.

A shaded topographic map of Nebraska was published by V. H. Dreezen in 1971. This map was prepared by laboriously hand shading the 1:250,000 scale USGS topographic maps of Nebraska and photographically reducing them to a suitable size. It accentuated drainage and geomorphic features of the state which could be viewed on one map rather than several.

Hallberg and Anderson produced a similar effect with much less effort by reducing the topographic contour line overlays of 1:250,000 USGS National Topographic Series Maps to a scale of 1:1,000,000. Reducing the scale crowds the contours together causing a shaded relief effect. The maps are somewhat more useful than either ERTS or Landsat imagery for studying subtle terrain features because they tend to eliminate most of the masking effects of culture (especially cultivated ground) that are present on the satellite imagery.

J. E. Denne of the Kansas Geological Survey is presently using the Iowa method to make a shaded relief map of Kansas and the Iowa workers are putting together a composite map for the four-state NRC study area.

The midcontinent researchers are presently interested in the causes of long linear ridges and parallel adjacent linear streams with asymmetric tributaries (short on the side adjacent to the ridge) which have been noted on the maps of NW Missouri and SW Iowa. These features extend in several instances for a distance of perhaps a hundred kilometers in terrain underlain by several hundred feet of glacial till. The features appear to be too wide, straight, continuous, and

long to be glacially related, although that has not been ruled out.

In addition to the shaded relief maps, F. W. Wilson of the Kansas Geological Survey is using stream drainage maps to trace known Precambrian and younger linear structural zones from the surface and shallow subsurface of western Missouri into the subsurface of eastern Kansas where deep well control is relatively sparse.

Stream patterns on the 1:500,000 state topographic maps are traced to uniform line width and photographed through a 200 lines per inch ronchi ruling which is rotated before the camera lens a few degrees at a time. A ronchi ruling (pronounced "ronky") is a precisely lined glass diffraction grating which enhances stream segments on the maps that are perpendicular to the rulings and diffuses those that are not. The use of ronchi rulings as a quick and simple method of sorting out linear trends was demonstrated by H. A. Pohn of U.S. Geological Survey at the 3rd International Conference on Basement Tectonics in Durango, Colorado, in 1978.

The lengths, trends, and density of the various aligned segments are then analyzed to determine whether they are related to known joint systems or subsurface structural trends. Wilson has noted that linear stream divides are as important as linear stream segments in delineating subsurface structure. As might be expected, the divides coincide with linear sags, synclines, or grabens and the streams with linear anticlines or horsts. The technique is being used to infer the presence of undrilled or undiscovered subsurface features in order to narrow down areas to be investigated by surface or subsurface studies.

*Frank W. Wilson*  
Kansas Geological Survey

### Report of Long-Range Planning Committee, Engineering Geology Division

(This report was presented verbally to the EGD Management Board at its meeting in Toronto on October 22, 1978.)

The committee recommends for the Management Board's consideration and selection for action the following items without prioritization:

1. Identify interested members and develop lists of potential committee members and officers. This could be done by:
  - a. Checking the list of those who responded to the questionnaire on continuation of the Division.
  - b. Checking the yearly membership list for continuity (Dave Varnes has some information on this and has noted large turnovers in the yearly membership).
  - c. Obtain a list from headquarters of those voting each year for selection of Division officers.
  - d. Look at AEG section leaders.
2. Recruit new members who would be potential officers.
3. Review results of meeting with AEG in Seattle. The majority of the committee feels the Division should suggest that AEG meet in the spring. (Paul Hilpman disagrees and feels the back-to-back meetings in Seattle were effective in permitting attendance at both the AEG and GSA meetings.)
4. Develop a Procedures Guide for Division operations (start with existing lists of duties of Management Board members).
5. Check status of the Division's history (Robert Legget and Garland Hershey have worked on this). Updating and publication may be appropriate for the Centennial.
6. Encourage GSA Section Chairmen to hold sessions on engineering geology at section meetings. To facilitate this, the Management Board should recommend an engineering geologist in each section to assist the section chairman.
7. Continue the Case Histories publications but recognize that delays can double costs and see that editors follow GSA review standards.
8. Set limits on the time of committee service.
9. Coordinate Division plans on sessions with the Joint Committee on Engineering Geology.
10. Possible future sessions could be held on
  - a. Engineering geology aspects of residual stress.
  - b. Engineering geology problems with karst.

Respectfully submitted,

*Paul L. Hilpman*  
*David J. Varnes*  
*Richard E. Gray*

## PUBLICATIONS OF INTEREST

Shelton, D. C., and Prouty, D., 1979, *Nature's Building Codes—Geology and Construction in Colorado*: Colorado Geological Survey, 1313 Sherman Street, Denver, CO 80203, 72 p., \$2.00.

This special publication of the Colorado Geological Survey has been prepared to alert homeowners, architects, planners, builders, investors, and property owners of natural features which affect property values.

The publication, *Nature's Building Codes—Geology and Construction in Colorado*, is particularly appropriate as the state is experiencing an unprecedented land development and building boom, said John W. Rold, CGS director.

"*Nature's Building Codes* is about using land wisely and saving money. It contains some of the natural laws which are not subject to appeals or variances, building codes, or zoning regulations. It deals with them in everyday language. They include collapsing and swelling soils, floods, rockfalls, landslides, subsidence, radiation, earthquakes, mudflows, and similar natural events which cost individuals and Colorado taxpayers millions of dollars annually," Rold said.

He said that studies have shown that up to 85 percent of the costs associated with these natural phenomena are preventable by using sound geologic and engineering practices. The national bill for ignoring Nature's building codes is in the billions of dollars.

Rold said community planners, road builders, developers, planning and zoning boards, and county commissioners should be particularly interested in the "geo-logic" fundamentals since taxpayers must often pick up the bill for ignoring or underestimating geologic factors on private as well as public land.

The 72-page publication was written by David C. Shelton and Dick Prouty. It contains more than 50 illustrations, numerous case histories and appendices offering a home-buyer's inspection guide, an information directory, a summary of geology-related legislation, a guide for preparing engineering geology reports, and other useful reference information.

The report was funded by the U.S. Department of Housing and Urban Development and the Colorado Land Use Commission through the Colorado Division of Planning.

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Boothroyd, J. C., Timson, R. H., Dana, R. H., Jr., 1979, *Geomorphic and Erosion Studies at the Western New York Nuclear Service Center*, West Valley, New York: U.S. Nuclear Regulatory Commission, NUREG/CR-0795, 66 p., \$3.50, GPO Sales, Division T.I.D.C., U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

This report is one in a series of related reports presenting the results of a study to evaluate the containment capability of a low-level, solid radioactive waste-burial ground at West Valley, N.W. This project is the first portion of a detailed geomorphic and erosion study of the reach of Buttermilk Creek adjacent to the waste-burial site.

Buttermilk Creek valley is being actively modified by fluvial transport, lateral channel scour, and landsliding. High surface runoff rates create highly variable but enhanced stream flows that result in coarse-gravel sediment transport within the active channel. The active channel

morphology indicates that braided stream processes are common in Buttermilk, leading to active channel down-cutting and lateral migration. Where lateral migration of the active channel has undercut valley wall slopes, large-scale landsliding enhances valley wall retreat. A major site of historical and recent slide activity lies adjacent to the low-level burial trenches.

Initial, post-glacial Buttermilk Creek incision began before 9920  $\pm$  240 B.P., the age of the oldest dated fluvial terrace. Future evolution of the system is expected to proceed by Buttermilk Valley lowering, tributary and landslide widening, and stream capture.

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GSA member Neil Steuer calls attention to the following new USNRC reports of studies of seismically active regions in the U.S. These will be of interest to engineering geologists working in seismic risk assignments. The reports are all available from the National Technical Information Service (NTIS), Springfield, VA 22161 in microfiche (MF) form or in hard copy (HC). Prices are shown when known.

- Braile, L. W., Hinze, W. J., Sexton, J. L., Keller, G. R., and Lidiak, E. G., 1979, *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-1014, 191 p., (MF, \$3.00).

Contains and extensive bibliography on studies of continental rifts.

- Barosh, P. J. (coordinator), 1979, *New England Seismotectonic Study Activities during Fiscal Year 1978*: NUREG/CR-0939, 178 p. (MF, \$3.00).

A well-illustrated collection of short review articles of new and exciting discoveries of another intensive year of work. A must for those interested in both the seismotectonics and structural geology of New England.

- Racine, D., and others, 1979, *A Seismicity Study of the Pacific Northwest Region of the United States, November 1961–August 1965*: NUREG/CR-0926 (MF \$3.00).

A good supplement to Amendment 23 of the Skagit Nuclear Power Station PSAR which Pacific Northwest specialists have come to rely on.

- Chinnery, M. A., 1979, *Investigations of the Seismological Input to the Safety Design of Nuclear Power Reactors in New England*: NUREG/CR-0563, 72 p. (MF, \$3.00, HC, \$6.00).

- D'Appolonia Consulting Engineers, 1979, *Seismic Input and Soil Structure Interaction*: NUREG/CR-0693, various pages (thick!), (MF, \$3.00, HC, \$12.50).

Deals with mathematical modelling in the discipline linking soil dynamics and structural engineering; many useful charts and diagrams.

- Kenney, R. L., Kirkwood, C. W., Ford, C. K., Robinson, J. A., and Gottlieb, P., 1979, *An Evaluation and Comparison of Nuclear Power Plant Siting Methodologies*: NUREG/CR-0407, 231 p. (MF, \$3.00).

Presents a computer-processed and pattern-printed decision analysis methodology for rating site suitability at a number of locations, according to a list of multidisciplinary factors; software programming not included.

## Good news regarding Atlanta symposia!

In addition to the traditional Engineering Geology Division Annual Symposium (this year, "Engineering Geology in Environmental Planning," scheduled for Atlanta, November 1980), the division reports cooperative involvement in two additional Atlanta symposia. Each symposium was approved by the JPTC for the Atlanta meeting and now stands as follows:

### Symposium I

- Title:** The Joseph F. Poland Land Subsidence Symposium, State of the Art, 1980
- Theme:** State of the art of our ability to predict and our understanding of the mechanics of man-induced land subsidence
- Convener:** *Thomas L. Holzer*  
Project Chief, Fissuring-subsidence Research  
U.S. Geological Survey  
345 Middlefield Road  
Menlo Park, CA 94025
- Speakers:** *Charles C. Thiel and Paul Hartzell*, Federal Emergency Management Agency  
"A national perspective on subsidence issues"  
*Thomas Holzer and Francis Riley*: U.S. Geological Survey  
"Mechanics of deformation in unconsolidated aquifers"  
*Donald Helm*: Lawrence Livermore Laboratory  
"Predictive techniques for land subsidence caused by water-level declines in unconsolidated aquifers"  
*Robert Gabrysich and Earl Verbeek*: U.S. Geological Survey  
"Subsidence and faulting in the Houston-Galveston, Texas, area"  
*John Martin*: Chevron Oil Field Research  
"Subsidence caused by extraction of hydrocarbons"  
*T. N. Narasimhan*: Lawrence Berkeley Laboratory  
"Subsidence caused by geothermal production"  
*John Newton*: U.S. Geological Survey  
"Sinkhole collapse"

*John G. Stephens and Hartwell Allen*  
"Organic soil subsidence"

*Thomas Piper*: BASF, Wyandotte Corp.  
"Subsidence caused by solution mining"

*Richard Gray and Robert Bruhn*: GAI consultants  
"Coal mine subsidence, eastern United States"

*C. Richard Dunrud*: U.S. Geological Survey  
"Coal mine subsidence, western United States"

### Symposium II

**Symposium title/theme:** Geologic Hazards in Founding Offshore Structures

**Name of convener:** Joint ASCE-GSA-AEG Committee on Engineering Geology (contact person: *R. L. Schuster*)

**Titles and names of authors (asterisked names are probable speakers):**

- State-of-the-art of offshore geologic hazard studies  
\**L. E. Garrison*, U.S. Geological Survey  
Submarine sediment instability  
\**J. M. Coleman and D. B. Prior*, Louisiana State University  
Recent sedimentation history offshore of the Mississippi Delta from Carbon 14 and Lead 210 age dating  
\**R. J. Pottorf*, Exxon Company USA  
Effects of mudslides on offshore structures  
\**J. R. Hooper*, McClelland Engineers  
Locating conventional platforms in predominantly mudslide areas, Mississippi Delta  
\**R. E. Smith and J. R. Faulkner*, ARCO Oil and Gas Co.  
Mass movement hazards on the U.S. Mid-Atlantic continental slope  
\**J. C. Hathaway, J. S. Booth, and H. W. Olsen*, U.S. Geological Survey

These papers will be followed by a one-hour panel discussion on the subject of the symposium with the above speakers serving as the panel.

## MINUTES OF THE GSA/ENGINEERING GEOLOGY DIVISION MANAGEMENT BOARD MEETING

El Camino Room, Town & Country Hotel, San Diego, November 4, 1979

The meeting was brought to order at 2020 by Chairman Jahns. Those present were: R. H. Jahns, A. W. Hatheway, D. U. Deere, J. W. Skehan, J. S. Scott, E. M. Winkler, incoming Secretary, was unable to attend the meeting. A provisional agenda had been prepared by the Secretary (Scott) and was distributed to the Management Board for consideration.

**Item 1. Adoption of Agenda:** The provisional agenda was adopted upon inclusion of a modified item as recommended by D. U. Deere. A copy of the revised agenda is attached.

**Item 2. Minutes of the 1978 Management Board Meeting:** The minutes of the 1978 meeting were read by Secretary (Scott). D. U. Deere recommended a minor modification to Item 8 of the minutes and he will be provided with a copy of the minutes in order to effect the necessary corrections. The Board adopted the minutes, with the suggested corrections, as read.

**Item 3. State of the Division:** Jahns reported that he had looked into the 1978 report of the Long-Range Planning Committee which had suggested that a high annual turn-over rate of Divisional membership was occurring. While some turn-over in membership rate was noted, it did not appear to be at a high level on a regular basis. Jahns had

contacted all regional Sections of GSA suggesting that they incorporate more engineering geological papers in their programs. The response to this suggestion was uneven as some sections were quite enthusiastic whereas others were very much less so. The variation in response could be attributed to such factors as strong competition from other engineering geological groups in some Section areas and to the attitudes of Section officers in other areas. It was suggested by Hatheway that the Chairman-Elect contact Section organizers to have papers on engineering geology included in regional Section meetings. Deere reported that he had obtained from GSA Headquarters a list of EGD members by section. He suggested that these lists be sent to Section Chairmen along with a letter explaining that the list could be used to contact members of the Division in regional Sections for the purpose of contributing papers to Section meetings.

Jahns noted that Divisional publications are important to the future of the Division. Therefore, Board members must ensure that this important element of the work of the Division is not neglected.

Jahns also noted that the close proximity in time of the Annual Meeting of AEG and GSA is unfortunate. However, neither Society can make any significant change in its annual meeting date.

It was recommended by Jahns that a brief summary of the duties of the various Divisional officers should be drawn up to aid new officers of the Division in the discharge of their duties.

Jahns reported on his attendance at the Joint Technical Program Committee meeting held last spring in Boulder, Colorado. With respect to the apportionment of time at the GSA Annual Meeting for the various Divisions, the minimum amount of time guaranteed for EGD was for a one half-day symposium and a one half-day technical session. The EGD was also entitled to share an additional one half-day session with other Sections.

With respect to the 1979 symposium on the training of engineering geologists, it was decided to present only the good papers representing the viewpoints of the teacher, student, and practitioner. Each paper would be discussed by a chosen discussant and then be open to general discussion.

Jim Skehan noted that there was an increasing use of engineering geological expertise in coal mining with respect to such matters as mining and reclamation. Thus, an opportunity existed for the Division to effect closer liaison with the Coal Geology Division. It was suggested that Jack Simon of the Coal Geology Division should be contacted to further liaison between the two Divisions.

**Item 4. Report from the GSA Council:** As retiring member of the GSA Council, D. U. Deere noted that the Division will no longer have a direct representative on the Council and presented the following report from his recent attendance at the GSA Council meeting:

- (a) The GSA Council will appoint members to act as liaison officers with the six Divisions of the Society. President Silver did not make such an appointment for 1979, but such an appointment of a liaison officer for the Engineering Geology Division will likely occur in 1980. It is important that this liaison representative be kept informed of Division affairs, attend the Management Board meetings, and be invited to attend the Annual Dinner. At present, it is not known who the liaison representative of Council will be.
- (b) With respect to Penrose Conferences, the Council noted that some decline in interest in these conferences had occurred. However, it was noted that GSA Headquarters will encourage those conferences to be held provided that proposals include an appropriate topic and the identification of the convener. (Hatheway and Scott subsequently discussed the subject of Penrose Conferences with Dr. Frye who will provide Division Executive with guidelines for organization of Penrose Conferences. Dr. Frye's reaction to a conference on the subject of nuclear waste disposal was positive and the Division was encouraged to pursue a proposal for such a conference.)
- (c) Council has formed a new Steering Committee—a Program Review Committee—to develop guidelines for the Joint Technical Program Committee. The report of this committee, chaired by Bill Dickenson, had not been received by the Council, but it did contain the following recommendations: (1) most annual meetings will be held on a four-day format; (2) each formally organized Division of GSA will have a one half-day session available for a symposium if the Division desires; (3) the number of abstracts offered and published over the past three-year period would be used as a guide to the allotment of additional time to Divisions.

The effect of these recommendations upon EGD was discussed. It was noted that the Division has approxi-

mately 1,200 members and is, thus, the largest constituent Division of the Society. However, it appeared that the Division ranked low on the number of abstracts accepted for publication and, thus, would not be entitled to additional program time if the allotment formula proposed by the Program Review Committee were to be accepted by Council.

In view of the relatively large number of engineering geology papers that appear in other sessions, such as Quaternary geology, geomorphology, hydrogeology, etc., the Board could not accept the findings of an apparently low acceptance rate for engineering geological papers. The Board felt it was essential that the Division be accorded more program time than one half-day for a symposium, and it was essential that the Board advise Council of this fact before the end of 1979.

- (d) With respect to the Division's report to GSA Council, it was noted that the fall meeting of Council was the most important and that it was highly desirable for the Division to present a concise report to Council at that time. Since the Division Board meetings were held essentially on an annual basis, reporting to Council was generally out of phase with Council meetings. It was, thus, recommended that the spring report to Council be brief and that a rather more full report be presented to Council in time for the fall meeting. This procedure should be reflected in the duties of the Secretary. The fall report will, thus, include highlights of Divisional activities during the year.
- (e) The Centennial project of the Society will be known as the "Decade of Geology." This project will be guided by an international policy advisory committee to give approval and advice and by a steering committee which will be headed by a Centennial program coordinator. With respect to EGD participation in the Centennial project, Deere commented that he was strongly in favor of a volume on the history of engineering geology that would highlight the development of engineering geology throughout North America. This suggestion was endorsed by all members of the Management Board.

Following upon this suggestion the Management Board requested Jim Skehan to act as a chairman of an ad hoc steering committee to provide the Board with advice on the format and content of a volume on the history of engineering geology. Skehan accepted this assignment and it was recommended that he contact D. R. Coates, G. W. White, George Kirsch, R. F. Legget, and R. R. Proctor as members of his committee.

In keeping with the theme of history of engineering geology, it was suggested that the theme for the 1981 Divisional symposium be "role of government agencies in development of engineering geology." This recommendation was accepted by the Board.

**Item 5. Report on Elections:** Scott reported on the results of the elections that had been provided by GSA Headquarters. A total of 1,115 ballots were mailed to Division members of which 217 had been returned to Headquarters. The results of the elections of officers for 1980 are as follows: Chairman, Allen W. Hatheway; Chairman-Elect, John S. Scott; Secretary-Treasurer, Erhart M. Winkler; Management Board Representative, Harry F. Ferguson. It was noted that the relatively low return of ballots may well have been attributed to the late notification provided by the nominations committee.

**Item 6. Report on Finances:** Scott reported that in the absence of a prepared budget for 1979, no formal financial

report could be presented. Headquarters had been requested to provide the Division with a statement of Divisional finances as of the end of September. However, this report had not been received in time for the Management Board meeting. (A financial statement from Headquarters was subsequently received and is appended.)

**Item 7. Committee and Liaison Reports:**

A. Administrative Committees: Richard E. Gray reported by correspondence that the Long Range Planning Committee had undertaken no actions since submission of a report on 22 October 1978. A copy of this report is to be circulated to all members of the Management Board, and the Board through the Chairman is to respond to the committee regarding its recommendations.

B. Technical Committees: Both the Committee on Construction Materials, chaired by E. M. Winkler, and the Committee on Nuclear Siting, chaired by A. W. Hatheway, have completed their work which has resulted in the publication of reports. Accordingly, the Board agreed that these committees should be discharged.

C. Liaison: D. J. Varnes reported by correspondence on the steps that had been taken to form a U.S. national group on engineering geology that can become affiliated with the International Association of Engineering Geologists. At present, approval of the formation of such a group has been obtained from the U.S. National Committee on Geology and by the National Academy of Sciences. The next step to be taken is the selection of a list of nine candidates and three alternatives to form the nucleus for a national group and to have staggered terms of office over a three-year span. Jahns reported that he had prepared a list of Division members as nominees to the national group which has been sent through AEG for comparison and forwarding to the U.S. National Academy of Sciences. A copy of Varnes' report is attached to these minutes.

Deere had submitted a report on the U.S. National Committee on Tunneling Technology which is attached to these minutes. Deere noted that his term as Divisional Representative to the committee ends on 30 June 1980; thus, a new appointment will have to be made. The names of Howard Coombs and L. B. Underwood were suggested by the Board as possible replacements for Deere. A comprehensive report on the activities of the U.S. National Academy for Rock Mechanics was prepared by F. T. Lee. Unfortunately, this report was not received in time for presentation at the Board meeting but is appended to these minutes.

**Item 8. Publications:** Jahns reported that R. F. Legget has received commitments from about one half of authors of papers for the 1978 Division symposium "Geology beneath Cities." It is expected that further commitments from the authors will be received by 1 January 1980. The Board further discussed the high cost of publication of Divisional volumes in hard cover format and will have further discussions with GSA Headquarters on ways and means for achieving acceptable quality of publications at a reasonable cost.

Hatheway reported that Robert H. Fickies of New York State Geological Survey at Albany had accepted the assignment as Editor of the Division Newsletter. GSA Headquarters had returned issue no. 3 of the current series of the Newsletter to the Divisional Chairman as the copy provided appeared to contain a preponderance of material not directly related to the affairs of the Division. This matter will be discussed further with GSA Headquarters. Hatheway expressed the opinion that the Division should try to publish from three to four newsletters each year. The

Board agreed with this suggestion provided that Divisional funds were adequate to cover the costs.

It was noted by Hatheway that at present no new themes for the case histories series are being planned. Following discussion of this subject by the Board, it was agreed that the Management Board Representative, H. F. Ferguson, be asked to look into new titles for the case history series. It was the opinion of the Board that the subject of stress relief in valleys could well form a suitable topic for the case history series. Scott noted that this subject had been reported on by Kellaway of the Institute of Geological Sciences in England and by Morgenstern of the University of Alberta in Canada.

**Item 9. New Business:** The Board discussed the possibility of inclusion within the Division of GSA members having an interest in environmental geology. It was recognized that much of the work being done in the field of environmental geology is closely related to that of engineering geology, thus, broadening the scope of interest of the Division may well be desirable. Since any change in name of the Division would require approval by Council, it was agreed by the Board that the Division should first obtain opinions from P. T. Flawn, John Frye, and others having a direct interest in environmental geology. It was also suggested that the subject expanding the scope of the Division should be raised in the Newsletter for the purpose of obtaining opinions from the Division membership prior to taking any formal action in this regard.

As a step toward the further integration of environmental geology into the scope of the Division, it was suggested that the theme for the 1980 Engineering Geology Division Symposium be "Engineering Geology in Land Use Planning." This suggestion was accepted by the Board. T. C. Smith, California Department of Parks and Recreation, was asked by the Board to look into the possibility of organizing such a symposium for 1980.

A reminder from GSA Headquarters regarding award nominees and appointments to committees was noted. It was felt that more effective attention to these matters could be achieved through identification of these needs in the description of the duties of the officers of the Division.

There being no other business, the meeting adjourned at 0030 hours, 5 November 1979.

*J. S. Scott*  
(for E. M. Winkler)

**Interim Financial Statement  
Engineering Geology Division  
1/1/79 through 8/31/79**

Balance January 1, 1979	\$1,949.54
Add:	
Dues Revenue 1979	<u>2,282.00</u>
	4,231.54
Deduct:	
Division Expense*	
Member Labels for Newsletters & Ballots	\$ 70.00
Printing Newsletters	189.60
Printing 12-page Brochure	<u>207.00</u>
	466.60
Balance August 31, 1979	<u>\$3,764.94</u>

\*Dues does not include cost of postage and handling yet to be billed.

## Report of International Association of Hydrological Sciences quadrennial meeting at Canberra, Australia

Canberra, Australia, was the site for the XVII General Assembly of the International Association of Hydrological Sciences and of the International Union of Geodesy and Geophysics with which IAHS is affiliated. The meetings took place from December 2 through 15, 1979, on the campus of the Australian National University.

Representing the National Academy of Sciences at the IAHS Assembly was Principal U.S. Delegate A. Ivan Johnson (Woodward-Clyde Consultants, Denver, Colorado) and Alternate Principal Delegate Arthur E. Maxwell (Woods Hole Oceanographic Institution, Woods Hole, Massachusetts). Maxwell also was Principal Delegate to IUGG and Johnson was Alternate Principal Delegate for the NAS. Of the 175 registrants from 26 countries represented at the IAHS Assembly, 17 percent was from the United States. Of the nearly 2,100 registrants from 70 countries represented at the IUGG General Assembly, 24 percent was from the United States.

Meetings of the 1976-1979 Bureau (board of directors of IAHS) and of the new 1980-1983 Bureau were held during the Assembly. Of the 40 new officers of IAHS elected at the final Bureau meeting, nine (23%) were from the U.S. These included the following: IAHS President, Mark F. Meier (U.S. Geological Survey, Tacoma, Washington); IAHS Treasurer, Warren W. Hastings (Consultant, Arlington, Virginia); Third Vice-President, International Commission on Surface Water, David A. Woolhiser (Colorado State University, Ft. Collins, Colorado); First Vice-President, International Commission on Ground Water, Joseph T. Callahan (Consultant, Arlington, Virginia); First Vice-President, International Commission on Continental Erosion, Richard F. Hadley (U.S. Geological

Survey, Denver, Colorado); Secretary, International Commission on Snow and Ice, M. Mellor (U.S. Cold Regions Research and Engineering Lab., Hanover, New Hampshire); Secretary, International Commission on Water Quality, David R. Rickert (U.S. Geological Survey, Reston, Virginia); First Vice-President, International Commission on Water Resources Systems, L. R. Beard (University of Texas, Austin, Texas); and President, International Committee on Remote Sensing and Data Transmission for Hydrology, A. Ivan Johnson (Woodward-Clyde Consultants, Denver, Colorado).

The agenda for the Bureau meetings included discussion of publication policy for symposium proceedings and the Hydrological Sciences Bulletin, participation in the programs of the UNESCO International Hydrological Program and the WMO Operational Hydrological Program, and future symposia and other activities planned by the six IAHS commissions. A number of new symposium or workshop proceedings were announced as printed or in process: Sea Ice—Processes and Models (No. 124), Modeling the Water Quality of the Hydrological Cycle (No. 125), World Glacier Inventory (No. 126), and Hydrology of Areas of Low Precipitation (No. 128); all are available from the Treasurer, IAHS, 2000 Florida Avenue, N.W., Washington, DC 20009. Also discussed by the Bureau were future symposia: Hydrologic Forecasting, April 15-19, 1980, Oxford, England; Influence of Man on the Hydrological Regime, June 23-26, 1980, Helsinki, Finland; Quality of Ground Water, March 23-27, 1981, Noordwijkerhout, Netherlands; Mid-term General Assembly and Symposia, July 19-30, 1982, Exeter, England. The next Bureau meeting is scheduled during the symposium in Helsinki, Finland, June 23-26, 1980.

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### Ground-Water Committee discusses long-range plans

The Ground-Water Committee met on October 25 during the ASCE Convention at Atlanta, Georgia. Those in attendance included Chairman A. Ivan Johnson (Woodward-Clyde Consultants, Denver, Colorado), Contact Member Ronald K. Blatchley (Blatchley Associates, Inc., Denver, Colorado); Douglas James (Proxy for Vice-Chairman J. Paul Riley, Utah State University, Logan, Utah); Past Chairman Donald J. Finlayson (California Department of Water Resources, Los Angeles, California), and Corresponding Member Lloyd C. Fowler (Santa Clara Valley Water District, San Jose, California).

Plans were discussed for future ground-water sessions. Sessions are planned for the Portland, Oregon, Convention (Regional Aquifer Assessment Studies) in April 1980; Boise, Idaho, Specialty Conference in July 1980 (Challenge of Maintaining Ground-Water Quality); Hollywood, Florida, Convention in October 1980 (Ground Water Hydrology of Tropical Regions); New York Convention in May 1981 (International Ground-Water Development); San Francisco Specialty Conference in August 1981 (Central Valley Aquifer System); and Las Vegas Convention in April 1982 (Ground Water Problems in Desert Areas).

The group concluded the committee should take a close look during 1980 at ASCE Manual No. 40 on Ground Water Management in anticipation of revising it within the next 3 or 4 years. It also was concluded that the committee membership should be broadened to obtain better geographic and specialty representation. Engineers interested and experienced in ground water who would like to become a corresponding member of this committee should contact Chairman A. I. Johnson, Woodward-Clyde Consultants, 2909 West 7th Avenue, Denver, CO 80204.

### North-Central Section schedules engineering geology session

A nine-paper session on engineering and environmental geology is being included in the April 1980 annual meeting of the North-Central Section of the Society, according to Donald E. Hattin (Indiana University), Program Chairman. The session is chaired by John Sharp (University of Missouri, Columbia) and Jesse L. Craft (Kent State University).

## International Workshop on Land Subsidence held in Mexico

Because of increasing problems created by land subsidence developing throughout the world, the International Hydrological Program (IHP) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) has had as one of its primary objectives the worldwide communication of information on the occurrence, research, and control of land subsidence. As part of this objective, the first International Workshop on Land Subsidence Due to Ground-Water Withdrawal was held in Mexico City, Mexico, during September 24–28, 1979.

Sponsored by UNESCO and the Mexican government's Ministry of Agriculture and Water Resources and the Mexican National Committee for the IHP, the workshop was designed for scientists from all the world, but in particular for those from developing countries. The workshop objectives were to provide the attendees with information being collected and prepared for publication by the UNESCO Working Group on Land Subsidence Due to Ground-Water Withdrawal, and to exchange knowledge between subsidence specialists and thus develop permanent contact between scientists of the various countries. This brings general benefits through avoidance of duplication of research and applications and through adequate diffusion of the existing, as well as newly developed, information available in the world on the subject of land subsidence. Mexico City was selected as the site for the international workshop because it provided an excellent natural laboratory to observe land subsidence and its effects, as well as being the home of some of the world's most experienced experts on land subsidence.

The workshop program included basic introduction to the types and causes of land subsidence, a summary of known subsidence areas in the world, and the environment of occurrence. Lectures related to the mechanics of land subsidence due to fluid withdrawal included discussions of soil mechanics concepts, transient conditions in a complex aquifer system, the concept of preconsolidation, time-consolidation tests, and excess pore pressures. A discussion of the investigation methodology in subsiding areas was followed by descriptions of subsidence problems in coastal areas such as Venice, Italy, and Houston, Texas. Stresses that cause compaction—geostatic, hydrostatic, neutral, effective, gravitational, and seepage—were discussed at length, and statistical treatment and laboratory tests of soil mechanics parameters were described in considerable detail. Lectures were presented on field measurements of both horizontal and vertical displacement and techniques for estimating future subsidence in subsiding areas or estimating potential subsidence in undeveloped areas.

Case histories were presented by workshop participants for subsiding areas at Mexico City; Ravenna, Poveglia, and Venice, Italy; San Joaquin and Santa Clara Valleys, California, U.S.A.; and Tokyo, Osaka, and Niigata, Japan. Subsidence due to ground-water withdrawal was reported in 17 areas of the United States, with a value of nine metres reported for the west side of the San Joaquin Valley where 13,500 km<sup>2</sup> has subsided and values exceeding one metre reported in Texas, Arizona, Nevada, and other points in California. Japan has the largest number of reported subsiding areas of any country—40 and still increasing—with

nearly five metres subsidence at Tokyo. Mexico City has had nearly 10 metres of subsidence. Additional case histories were presented by workshop attendees from most of the countries represented.

Interesting field trips were taken in the Mexico City main downtown area, earthcrack sites in Naucalpan, and a government soil mechanics laboratory. A tour also was made of the Lake Texcoco area, where Mexico City specialists are developing artificial reservoirs for flood waters by causing up to several metres of subsidence by locally concentrated pumping of ground water.

The UNESCO Working Group on Land Subsidence consists of GSA member Joseph F. Poland, Chairman (U.S. Geological Survey, Sacramento, California, U.S.A.); Germán Figueroa Vega (Water Commission of the Valley of Mexico, Mexico City, Mexico); Laura Carbognin (National Research Council, Venice, Italy); Soki Yamamoto (Rissho University, Tokyo, Japan); A. Ivan Johnson (Woodward-Clyde Consultants, Denver, Colorado, U.S.A., and IAHS Representative); and José A. da Costa, Technical Secretary (Division of Water Sciences, UNESCO, Paris, France). Serving as lecturers and discussion leaders for the workshop were members of the Working Group along with the following additional experts on phases of land subsidence: Donald Helm from Livermore, California; and from Mexico were Raul Marsal, Roberto Graue de Haro, Ignacio Sainz Ortiz, Eulalio Juárez Badillo, Juan José Hanell, and Ismael Herrera. Presiding at the opening session of the workshop was Under Secretary Sr. Ing. Gerardo Cruickshank Garcia, who represented the Secretary of Agriculture and Water Resources (SARH). Ing. Cruickshank is Under Secretary of Planning for the SARH and Executive President of the Mexican National Committee for IHP. Other speakers at the opening session were José da Costa as Representative of UNESCO and Germán Figueroa Vega as member of the working group and local host and organizer of the workshop. Participants in the workshop were from the following 17 countries: Argentina, Bangladesh, Czechoslovakia, Chile, Cuba, France, Honduras, Italy, Jamaica, Japan, Mexico, Netherlands, Peoples Republic of China, Tanzania, Thailand, United States, and Zambia.

In addition to leading the workshop, the UNESCO Working Group spent the previous week preparing a "UNESCO Casebook on Land Subsidence Due to Ground-water Withdrawal," completing most of the first draft of the volume. The casebook is scheduled for publication by UNESCO in 1980. Further details concerning future UNESCO-supported land subsidence activities or casebook orders can be obtained by contacting José da Costa, Division of Water Sciences, UNESCO, 7, place de Fontenoy, Paris, France 75700.

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