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Dewatering of American (Niagara) Falls Planned for Study

T. A. Wilkinson and Captain J. D. Guertin

Present plans are that the American Falls will be "dewatered" during a period from late June to November 1969 for geologic and engineering studies on the preservation and enhancement of the waterfall. Planning has been completed, and a contract awarded for construction of a cofferdam to be built between the American mainland and Goat Island which separates the American and Horseshoe Falls.

Widespread concern has been expressed over the presence of the rock talus at the base of the American Falls by those who feel that it detracts from the scenic spectacle of the falls. The talus has accumulated as a result of major rockfalls (see Fig. 1 and Table 1).

TABLE 1

DATE OF ROCKFALL	SIZE (tons)	LENGTH (ft)	WIDTH (ft)
January 17, 1931	76,000	280	70
July 28, 1954	185,000	360	130
December 4, 1954	15,000	190	40

Mechanism of Rockfalls

Niagara Falls offers a striking example of the type of escarpment formed in nearly horizontal beds by resistant rock layers capping weaker strata. At the American Falls, water flows over a resistant cap rock about 80 feet thick (Lockport dolomite) beneath which is a softer shale formation about 61 feet thick

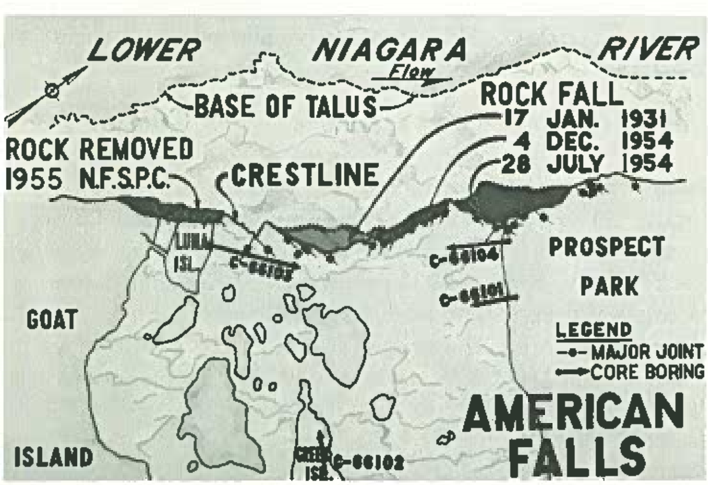

Figure 1. Location of recent rockfalls.

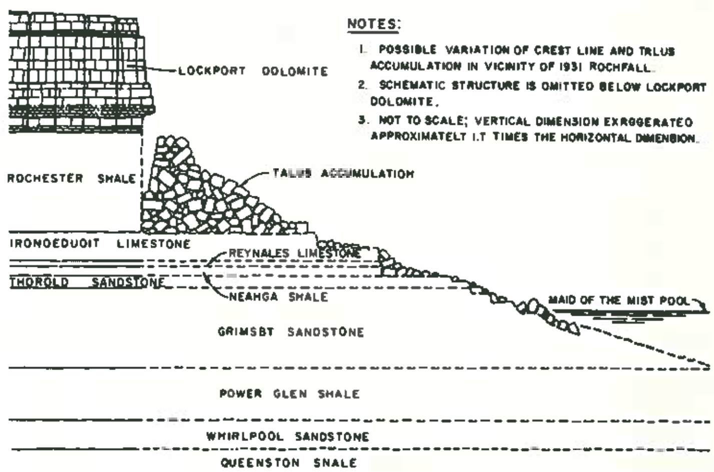

Figure 2. Generalized geologic profile of American Falls.

(Rochester shale). A generalized geologic profile is shown in Fig. 2. The falling water, wind-driven spray, ice accumulation, and joint water seepage all either weather, deteriorate, or, in places, erode the less durable Rochester shale. This apparently happens by abrasion, wetting and drying (?), freezing and thawing, and ice plucking. As a result, the shale is removed or altered and the support for the Lockport dolomite cap rock is undermined.

(Continued on page 4)

Chairman's Column

Are we doing our part to insure the proper and fullest application of geological knowledge to engineering and other environmental problems? We realize that geological advice could and should be used more universally in both private and public developments, but, much educating must be done before the need for geological advice is universally recognized. One thing that we can do to insure maximum application when our advice is requested, is to give more attention to our communications. It is not unusual to hear the criticism that geological data furnished to an engineer or other non-geologist is inadequate. At the same time, the geologist feels that his data are not properly interpreted and used. In many cases, I am sure, this is the result of poor communication.

(Continued on page 6)

Storms Cause of Damage in Ventura County, California

Barry S. Haskell

Ventura County, located between the Pacific Ocean and Los Angeles County, received unprecedented rainfall during three separate storms between January 18 and February 25, 1969. These were: (1) January 18-21, (2) January 24-27, and (3) February 22-25. In each storm, greatest precipitation occurred at summits of coastal mountains as in the eastern Santa Ynez Mountains where more than 55 inches were recorded, while less than 15 inches fell at the coastline some 10 miles away.

The county, geomorphically part of the Transverse Range Province of Southern California, is characterized by an elongate series of mountains and hills separated by intermontane valleys which trend east-west. Relief exceeds 6,000 feet for the Topatopa Mountains and 4,500 feet for the eastern Santa Ynez Mountains. Surface drainage of the Topatopas is accomplished by several youthful, intermittent streams, the largest of which are Sespe, Piru, and Santa Paula Creeks. Slope angles along these streams and other tributaries generally exceed 30 degrees. Because of the east-west trend of the Santa Ynez and Topatopa Mountains, almost all of the north slope runoff is drained by Sespe Creek which flows eastward for approximately 40 miles before turning south to meet the Santa Clara River at Fillmore. On January 25, estimated discharge of Sespe Creek was 60,000 c.f.s. Many similar but smaller youthful, intermittent streams drain the high ridges south of the Santa Clara River.

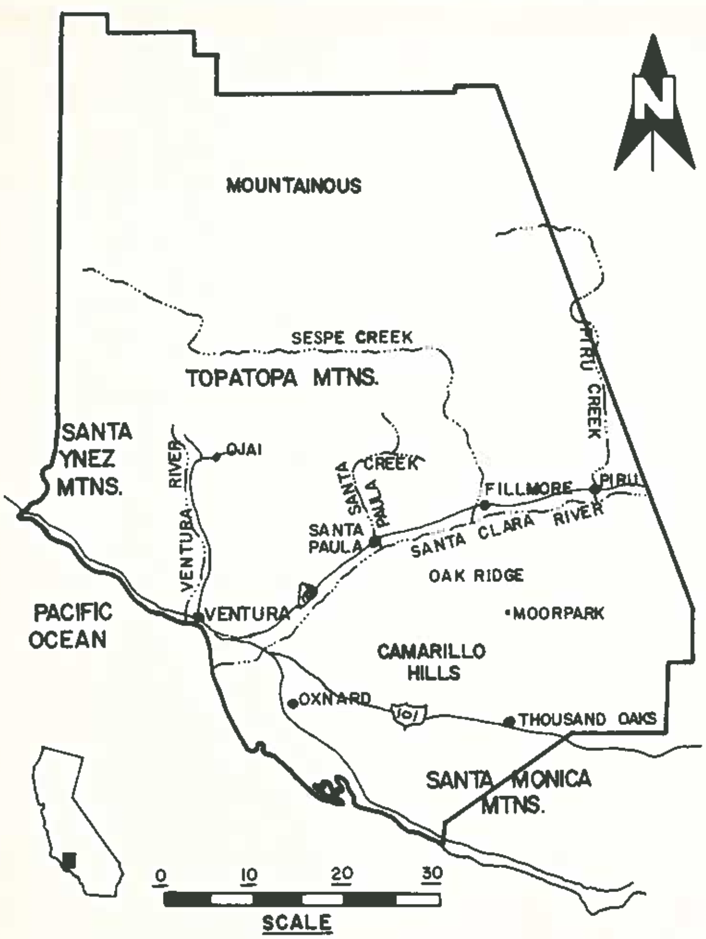

Figure 1. Index Map of Ventura County, California.

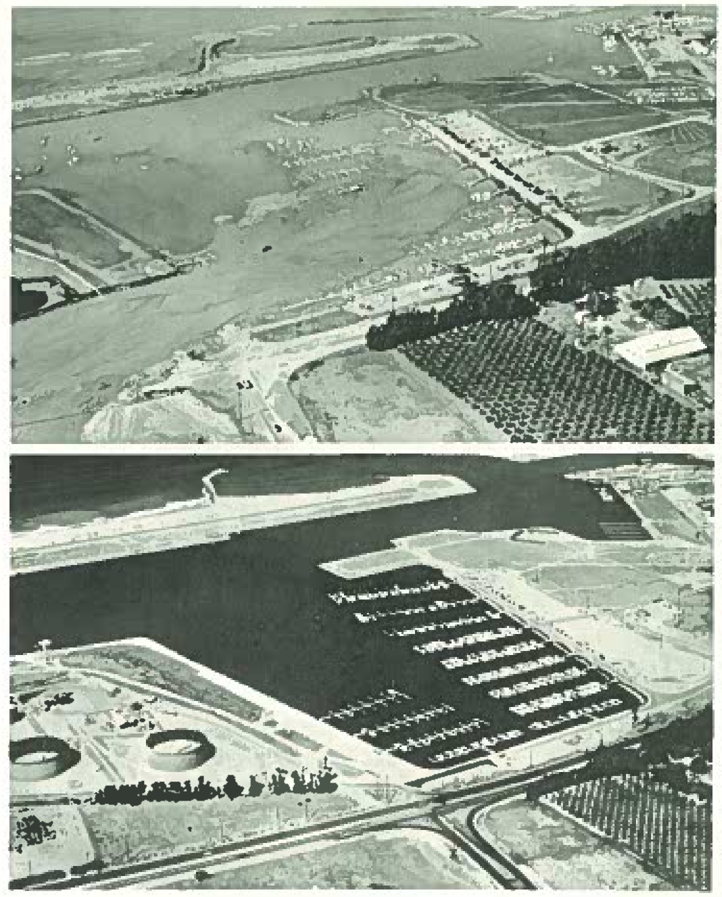

Figure 2. Aerial views of Ventura Marina before and after February 25, 1969. Volume of deposition approximates 600,000 cubic yards.

The storm-ravaged central and southern portions of the county are underlain by folded Tertiary and Quaternary sedimentary rocks, locally interbedded with volcanic rocks, which are approximately 50,000 feet thick. The sequence includes: (1) greater than 4,000 feet of steeply folded, slightly cemented Pleistocene marine silts, sands, and gravels, (2) approximately 13,000 feet of slightly to moderately indurated Pliocene sediments, and (3) interbedded, resistant Miocene flows and intrusions.

Twelve lives were lost, eleven by drowning in floodwaters and one claimed by mudflow. Storm-related damage is estimated to exceed $50,000,000. Only a small portion of the significant events are reported below.

Damage Caused by Stream Deposition

Early on the morning of February 25 the Santa Clara River, with a peak discharge estimated at 150,000 c.f.s. and a height nearly 20 feet above normal, overflowed and broke through a small levee near the eastern end of the Ventura Municipal Golf Course, which was transformed almost immediately into a five-foot deep section of the river flowing toward the Ventura Marina. Power and raw sewage lines were destroyed as the stream crossed Harbor Boulevard and entered the marina. Damage to the marina was due to deposition of approximately 600,000 cubic yards of sand and silt, and destruction of piers and docking facilities. This damage is estimated at $2,000,000. Dredging of the marina by the U. S. Army Corps of Engineers

Figure 3. View upstream of Willard Bridge in Santa Paula, where scour action undermined piers. Oligocene Sespe Formation underlies area of large landslide scar in upper right corner and the flatirons along river.

is scheduled to begin on or about June 1. Estimated cost of dredging is $450,000.

Of the approximately 400 boats harbored in the marina, 100 essentially escaped damage, 200 were severely damaged, and at least 100 sank, were destroyed, or carried out to sea, later to be driven to the shore and destroyed by wave action. Total boat damage and loss is estimated at $2,000,000. Damage to the newly completed golf course, which was almost completely destroyed by deposition of 1-5 feet of sand, is placed at $1,000,000.

Bridge Failures

Major bridge failures coincided with peak discharge. The concrete multispan Willard Bridge at Santa Paula, constructed in 1953, failed on January 25 when the Santa Clara River reached an estimated discharge of 160,000 c.f.s. Available evidence indicates scour undermined three piers which were founded on unconsolidated channel sands; although depth of scour remains undetermined, it probably extended two to three times the floodwater depth, sufficiently below the piers to bring about failure.

Two spans of the Saticoy Bridge plunged into the Santa Clara River on February 25 when discharge reached approximately 150,000 c.f.s. Scour action similar to that at Willard Bridge doubtless occurred. Increased lateral stresses may have been another factor owing to great amounts of floatational debris caught on the upstream ends of the piers.

Landslides and Mudflows

Numerous landslides developed during and after the storms. Most occurred where water-saturated shales daylighted in steep natural slopes or cut slopes adjacent to roadways. These failures have closed many mountain roads. Slow-moving rotational and block-glide failures threaten several homesites in the anticlinal Camarillo Hills, where deep barrancas parallel to the strike of the structure allow bedding to be daylighted.

Potentially more hazardous was a 25,000 cubic yard rotational failure of an 80-foot high, 1½-1 cut along the Conejo Creek Freeway, scheduled for completion in 1969. The cut, completed in slightly cemented conglomeratic sandstones of the early Miocene Vaqueros Formation, was graded to design engineering standards. The slip-plane developed along a steeply dipping 8-inch thick clay shale bed. Arcuate cracks also developed in adjacent freeway cuts. During April, grading operations were initiated to remove existing slide debris and to reduce the slope angles in the slide area and adjacent cuts.

Mudflows commonly occurred where thick residual cohesive soils overlying Tertiary shaly rocks became saturated on slopes steeper than 30 degrees. Damage included closure of several mountain roads where 2-5 foot thick flows descended from the superjacent slopes. Similar flows damaged homes throughout the county, and were responsible for one fatality where mud filled an enclosed backyard, crushed a bedroom wall, and buried the victim.

Summary

Remedial measures, geologic, and engineering studies are now being undertaken to prevent a recurrence of this type of disaster. In addition to marina dredging, landslide debris removal, and road repair, remedial work includes removal of sediments from all major stream channels and improvement of levees.

The fact that storm-related damage was minor in areas where proper flood control systems had been installed prior to the storms may serve to promote greater efforts toward funding of flood control projects within the county. Also, the importance of geological data in the solution of future engineering problems has become more generally recognized. This is significant in terms of over-all future planning because it is estimated that Ventura County will grow in population from the present 500,000 level in 1970 to about 1,500,000 persons in 1985.

Figure 4. Failure of portion of Saticoy Bridge occurred on February 25 when peak discharge reached 150,000 c.f.s. Note large masses of debris caught on upstream end of piers.

AMERICAN FALLS. . . *(Continued from page 1)*

The Lockport contains joints that begin to open up as tension in the overhanging blocks increases. It is interesting to note that visible breaks in the rock were recorded some six weeks before the 1954 rockfall. Water flows along the joints building up hydrostatic pressure. Finally, the cap rock is no longer able to support itself, and it collapses. Fig. 3 shows the rockfall of July 28, 1954 in progress. The failure appears to be a combination of downward shear and outward rotation. The failure occurs generally along the prominent joint planes. As many of the prominent joints cut the line of the gorge at an angle, the lip of the falls has a sawtooth pattern in plain view.

Figure 3. Rockfall of July 28, 1954 in progress.

Present Investigation

The present investigation is under the direction of the International Joint Commission that has established the American Falls International Board, which in turn has established the American Falls International Working Committee. The District Engineer, Buffalo District, Corps of Engineers, is chairman of the U. S. Section of the Working Committee. Both the Board and the Working Committee include landscape architects to study esthetic aspects of the American Falls.

Initial exploratory drilling and testing begun in 1966 indicate that the preservation and enhancement of the American Falls appear feasible from a geologic and engineering viewpoint.

Prior to outlining the proposed engineering geology and rock mechanics approach to the problem, it is desirable to define, in general terms a scheme or schemes that would appear to provide reasonably complete and lasting stability. Such a scheme might include rock reinforcement of the Lockport dolomite, Rochester shale and possibly some of the underlying rock strata, protection of the exposed Rochester shale to prevent undermining, control of the ground water in the rock to prevent excessive hydrostatic pressures, and removal of part or all of the talus accumulation. The following studies and explorations are planned to obtain the necessary data for the report.

Stratigraphic studies. The core will be logged by rig geologists and all pertinent geologic units and characteristics noted and described. A geologic face map of the American Falls will be prepared utilizing a man cage and mobile crane.

Jointing studies. The horizontal surface of the Lockport dolomite will be cleaned by air-water jetting and sandblasting where required for a distance 400 feet upstream of the crestline. Also, several 50-foot wide strips of the exposed face will be cleaned. A detail fracture and joint map will be prepared by conventional survey techniques and by aerial photography. In order to determine the joint sets and systems that cross formational and bedding plane boundaries, the degree that the joints are open with depth, and the conditions of the joint planes, several sets of angle core borings to be drilled from the Lockport dolomite cap rock are planned at each predominant joint set. Also, two series of horizontal or nearly horizontal core borings are planned in the Rochester shale. Those borings will fan out from platforms erected on the talus and will evaluate the condition of "wet wall" and "dry wall" Rochester.

Undermining studies. The extent of undermining will be mapped by instrument survey and/or probing, whichever is feasible under site conditions. A series of vertical core borings located near the exposed Rochester shale face are planned to determine the condition of the Rochester shale away from the exposed face. The processes affecting the deterioration and removal of the shale will be studied.

Permeability studies. Pressure testing, the addition of hydrologic tracers, and borehole photography are planned to obtain data on void conditions and the movement of water in the bedrock.

Talus studies. The talus accumulation will be examined to determine rock type, condition, ledge support, volume, and the degree of protection that the talus affords the Rochester shale. Several angle and vertical core borings are planned.

Rock Mechanics

Early in the planning for the American Falls study it became apparent that in order to understand the mechanism of failure and to define the limits of possible remedial treatments, rock mechanics concepts would have to be considered. The rock mechanics plan of study developed includes field measurements, laboratory testing, and theoretical analyses. The work is described in the following paragraphs.

Safety. A safety instrumentation system has been developed that will give advance warning should a major rockfall appear imminent during the dewatered period. Such an eventuality is considered unlikely; however, the potential hazard to men and equipment in an area which has a history of occasional major rockfalls cannot be ignored.

A simple, reliable, easily installed safety system has been selected consisting of pairs of steel pins grouted into vertical holes on opposite sides of major joints in unstable areas. A portable bar extensometer will be used to measure horizontal and vertical distances between pins on a regular schedule. The pins will be recessed below the surrounding rock surface for protection during the intervals between readings.

Optical surveys will be conducted periodically as an additional check on crestline stability. Established points in the work area will be located with respect to known stable benchmarks.

Rock stresses. Several examples of rock displacement as a result of load release due to excavation have been reported in western New York. The examples include convergences of the walls of canals, hydraulic tunnels, and power plant wheel pits. It has been reported that the movements are time dependent, occurring rapidly at first and decreasing with time. It is

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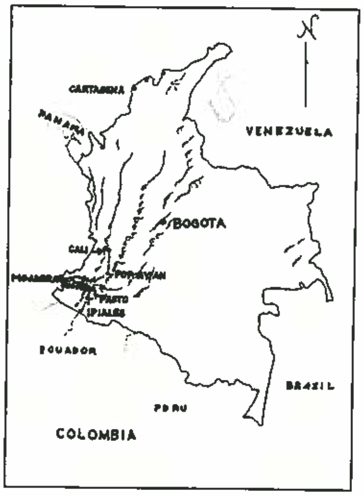
Pan-American Highway Studied for Relocation

Arthur B. Cleaves

Between Cali and the border separating Colombia from Ecuador, just south of Ipiales, the Pan-American Highway is located in the Cordillera Central (the volcanic Andes).



Between Pasto on the south and Popayan on the north many stretches of the two-lane, black-top highway do not meet Pan-American Highway standards. This is in large part due to the occurrence of landslides and subsidence in terrain of extremely rugged relief. In the recent past, these problems have required a great many relocations in topographically restricting places.

The highway is the principal transportation route in this portion of Colombia. As such, it is of great economic value to the country, and with connecting roads to the east and west will open up much of the southeastern area of Colombia. At present much of the access to the region is by mule-train or on foot.

In the region under study, the route lies on the eastern canyon and valley slopes of the Rio Pasto and the Rio Patia. Tributaries to these rivers flow in canyons up to 800 meters in depth. The Juanambu river crossing is such a barrier that, except for exploration, it prevented regional exploitation by the Incas.

The route crossings require long loops up the tributaries to reach sites where economically feasible bridge crossings are possible. In one location, the Verticales, the road will appear to be excavated into a shear canyon wall. Actually the descent of 400 meters from the Pasto Meseta will take advantage of the layering of beds of volcanic ash and beds of volcanic agglomerates which have eroded to provide narrow benches on the agglomerate. Nevertheless, three short tunnels are required in order to get around ridge spurs.

Exploration adits have been made and indicate that the tunnels may be cut in the ash layers with an agglomerate bed above the tunnel arch. Experience in the vicinity strongly suggests that the ash has a long "stand-up" time, hence, is not expected to require temporary supports. The final tunnels will, of course, be lined.

Observations of the volcanic ash in road cuts in this part of Columbia reveal that it stands in essentially vertical slopes, very much the same as road cuts in loess. X-ray analyses indicate the fine silt and clay-sized fractions to be X-ray amorphous. The total sample, all size fractions, shows no significant peaks in the clay mineral domains. Silica is the principal mineral; nevertheless, the moisture content of the ash in place is high, and it is "soft" and yielding to the impact of a hammer or pick. The moisture bond has to be the chief factor responsible for the ability of the ash to stand with vertical slopes. As is true of loess, the ash is easily erodable in flatter slopes.

Landslides are conspicuous in most of the valley and canyon walls, and a first traverse through the area suggests insurmountable problems. Consequently, the line and grade of the proposed road around, over, and under some of these slides present very challenging problems.

The total length of the section under study in 1968 was approximately 85 kilometers. Of this distance, 30 kilometers of road from Pasto north to the Cano Airport has been in operation for some years and requires only modifications. Fifty-five kilometers from Cano Airport to the Rio Patia will be totally new and in the deep canyon country.

The general local relief is about 1000 meters. The road will not exceed a maximum grade of 7 percent, will consist of a 7 meter wide, two lane, asphaltic pavement, and will have 2 meter wide paved shoulders. The road will be designed for a speed of 43.5 kilometers per hour.

In the summer of 1969 an additional stretch of road, 35.7 kilometers from the Rio Patia to Mojarras, will be studied. At Mojarras the proposed new route will rejoin the existing route from Pasto to Popayan. Travel will again be by mule-back with, it is hoped, occasional helicopter support.

Robert Peterson, Authority on Soil Mechanics and Earth Dams Dies Suddenly

The news of the sudden death of Robert Peterson at his home in Saskatoon was received with shock and sorrow by his many friends, colleagues and engineering associates. His quiet, unassuming and friendly manner earned him the affection and respect of all who had met him or had worked with him. The combination of his thorough technical approach and his practical skill brought him the recognition of his profession as an authority, nationally and internationally, in the field of Soil Mechanics and Foundation Engineering, particularly as applied to Earth Dams. At the time of his death, Mr. Peterson was Chief of Soil Mechanics and Materials Engineer for the Prairie Farm Rehabilitation Administration, a position which he had held for 28 years.

Mr. Peterson authored 12 major scientific papers on soil mechanics and earth dam design. Those of us who are engineering geologists working with structures founded in clay-shale all remember the excellent paper by Bob, "Rebound in Bearpaw Shale, Western Canada," published in the GSA bulletin, vol. 69, no. 9, 1958. Recognition of his great work on dam and foundation problems associated with clay-shales brought requests for his services as an authority and consultant on this subject: for problems at the Mangla Dam in Pakistan, and the Panama Canal. He served also as a consultant on major water development projects on the Columbia, Nelson, Winnipeg and Red rivers in western Canada, and the Manicouagan River in Quebec, apart from his duties with P.F.R.A. In addition to the scientific papers and his consulting work, he has contributed oral and written discussions at many international and national symposiums on Soil Mechanics, as well as lectures at Harvard, Berkeley and Saskatchewan Universities.

Fifth Annual Symposium on Engineering Geology Well Attended

About 150 geologists and engineers attended the Fifth Annual Symposium on Engineering Geology and Soils Engineering which met on April 9-11, 1969, on the campus of the University of Idaho in Moscow.

The twenty-two technical papers presented at the three-day conference included theoretical as well as case studies, and covered a wide variety of topics – ground-water problems, waste disposal, frost action in soils and effects on man-made structures, slope stability, foundation engineering, soil creep, and many others. The papers were generally well presented and well illustrated. All of these papers will be published in a Proceedings volume which will be available by mid-October ($5.00, from Bob Charboneau, Idaho Department of Highways, P. O. Box 7129, Boise, Idaho 83707).

American Falls. . .

(Continued from page 4)

believed that these deformations may be due to an abnormally large horizontal stress.

Three field measurement programs are planned to study the stress states in the immediate vicinity of the American Falls. Two of the programs will be direct *in situ* stress measurements, and the third will be measurement of expansion strains of fresh rock core.

The first set of direct *in situ* stress measurements will be made in the Lockport dolomite to establish whether there are significant horizontal stresses in areas not stress relieved by the gorge. Overcoring tests will be performed in vertical boreholes located several hundred feet upstream of the crestline where the Lockport is massive and free from open vertical joints.

The measurements in the Rochester shale will be made in boreholes drilled vertically and horizontally from the Cave of the Winds Tunnel on the northwest end of Goat Island. These overcoring tests will be performed to establish whether there are abnormal horizontal stresses parallel to the gorge wall in an area that is stress relieved by the gorge.

Measurements of time dependent relaxation strains in fresh rock cores obtained at the American Falls will be made to study the reported anelastic behavior of rocks in major cuts.

Joint water. Joint water pressures will be measured by installation of piezometers at bedding planes and joints known to be open. Piezometer locations will be selected based on geologic logs, borehole photography, and pump test data. The instruments will be monitored through several seasonal changes, and the information gathered will be used in analyses of the mechanism of failure and preliminary design of possible remedial treatments.

Laboratory studies. Samples of rock core obtained during the field program will be sent to Corps of Engineers laboratories. Some of the more important laboratory studies planned are: geologic classification to include petrographic analyses, weathering resistance, shear strength of rock joints, and behavior of the rock at low temperatures.

Report

The results of the geologic and rock mechanics aspects of the study will be included in the report of the International Joint Commission, which is scheduled for completion about June 1972.

Chairman's Column . . .

(Continued from page 1)

As Engineering Geologists, one of our major obligations is to convey detailed geological information in clear, concise, and understandable language to the ultimate user. When we are the ultimate users of the geological information in establishing slopes, foundations, or selection of construction materials, our problem of communication is simplified. More often than not, however, the results of our geological studies and recommendations are used by engineers or other non-geologic groups as basic criteria for development of designs for structures or rendering decisions regarding zoning and use of land areas and other actions that affect the life, and social and economic well-being of the public. The importance of proper communication is easily recognized when we consider the possibility of failure of an engineering structure that results in the loss of life and property because the design or construction engineer misunderstands the geologist's report and recommendations. Although not in the same magnitude of seriousness as misunderstandings that result in the loss of life, we should guard against the use of "scare-type" language in situations where we are not well-informed, and the results may be distorted viewpoints and damage to individuals or the community's economic well-being. Direct and honest opinions must be expressed, however, when dangerous situations are revealed by thorough consideration, regardless of the special interests of any individuals or groups.

Our best defense against misunderstanding is to consider our audience or reader when choosing the words to express our ideas. When we are communicating with other geologists, it is all right to use geological terms in lieu of long descriptions to describe conditions. But to insure understanding when communicating with anyone not familiar with our language, we will do better to use several sentences, in language that he understands, to describe the same condition.

When preparing information for the use of persons not familiar with our vocabulary, we should keep in mind that communication of information cannot be accomplished by transmission on the part of the speaker or the writer until comprehension has taken place on the part of the hearer or reader.

W. Harold Stuart

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NEW BOOKS AND LITERATURE IN ENGINEERING GEOLOGY

Raymond E. Whitla

Fookes, P. G., GEOTECHNICAL MAPPING OF SOILS AND SEDIMENTARY ROCK FOR ENGINEERING PURPOSES WITH EXAMPLES OF PRACTICE FROM THE MANGLA DAM PROJECT: Geotechnique, vol. 19, no. 1, p. 52-74, March 1969. This article gives an outline of geological mapping techniques together with an indication of some current interpretation methods for engineering purposes. The emphasis, though, is on engineering geology or "geotechnical" maps, which are maps produced specially for engineering purposes. The author discusses geotechnical mapping during the site investigation stage of a project when the aim is to produce maps showing features of engineering significance and indications of expected engineering behavior of the soil or rock and during construction when the aim is to produce "as built" maps of the foundations for record to enable comparisons to be made of the predicted conditions and the "as found" conditions. The author uses examples from the practice at Mangla Dam in West Pakistan to show some recent developments in engineering geology mapping techniques.

Mayo, Robert S., TUNNELING – THE STATE OF THE ART: Department of Housing and Urban Development, 264 p., January 1968. Available from Clearinghouse for Federal Science and Technical Information, Springfield, Virginia 22151. Price $3.00. This book was prepared for the U. S. Department of Housing and Urban Development by Robert S. Mayo and Associates. It is a review and evaluation of current tunneling techniques and costs with emphasis on their application to urban rapid-transit systems in the U. S. A. An introductory chapter gives a brief history of tunneling, a discussion of sizes and shapes of tunnels, and a discussion of the uses of different types of tunnels. The chapter following the introduction presents a review of representative tunnel projects that were recently completed at the time this book was prepared. Chapter headings indicate the coverage of the book: Rock Tunneling, Soft Ground Tunneling, Secondary Linings of Concrete, Shafts and Hoisting, Control of Soft Ground, Alternatives to Tunneling, Safety in Tunnels, and Recommendations and Conclusions. Appendices at the back of the book present methods of developing cost data for tunnels, and discuss tunnel construction in Japan and in the San Francisco Bay area for rapid-transit systems. The final appendix is a glossary of tunneling terms. The book is well illustrated.

DePuy, G. W., TUNNEL GEOLOGY BIBLIOGRAPHY: U. S. Bureau of Reclamation Bibliography No. 245, 50 p., January 1969. Available from U. S. Bureau of Reclamation, Building 67, Denver Federal Center, Denver, Colorado 80225. Price $2.55. This bibliography lists references that contain or are concerned with geologic information in connection with the design and the construction of tunnels. The references, thus, cover engineering geology investigations in the exploration and the selection of tunnel routes, geologic factors in the design and the construction of tunnels, and descriptions of geology along tunnels. The bibliography is not intended to include references on other aspects of tunnels, such as tunneling methods, tunnel construction, tunnel design, rock mechanics, and stress analysis, although some references on these aspects that appear to contain geologic information also have been included. The references are listed alphabetically by author. Names of the serials or publications in which the references appear are abbreviated, and some guessing must be employed to determine the names of publications with which the user is unfamiliar.

Walker, William R., and **Stewart, Ronald C.**, DEEP-WELL DISPOSAL OF WASTES: American Society of Civil Engineers Proceedings, vol. 94, no. SA5, p. 945-968, October 1968. The use of wells for the disposal of oil-well brines is widely practiced in the petroleum industry, and this method of disposal of other types of fluid wastes is being adopted by a number of industries. Some types of disposal wells are presently in operation in 25 States, and interest has been expressed in disposal wells in 2 others. This paper is the result of a study to investigate deep-well disposal as a method for pollution control. It discusses geological considerations and requirements for such wells, their construction and operation, and legal requirements. A list of 68 references at the end of the article gives sources of additional information on the construction and use of disposal wells.

Farmer, I. W., ENGINEERING PROPERTIES OF ROCKS: E. & F. N. Spon Ltd., 11 New Fetter Lane, London E. C. 4, 180 p. 1968. Distributed in the U. S. by Barnes & Noble, Inc., 105 Fifth Avenue, New York, N. Y. 10003. Price $5.75. This book is intended primarily for civil and mining engineers. It sets out a simple and concise introduction to some of the physical and mechanical properties of rocks that determine their reaction as structural materials. Main topics of the book include rock properties, stress and strain, testing procedures, effects of environment, and design criteria. Although reviewers have expressed commendation for the author for some parts of the book, they have been adversely critical of other parts. Sections with which they have found fault particularly are those dealing with rock testing, the effect of water on rock properties, measurement of stress and strain in rock, and design in rock. The review in *Journal of Geology* considers the book an excellent text to be used as a foundation for a course in introductory rock mechanics, but the review in *Géotechnique* considers the book of negligible assistance to an engineer faced with problems of permissible bearing capacity and the probable factor of safety of the rock structure. I have not had the opportunity to see the book myself.

Lambe, T. William, and **Whitman, Robert V.**, SOIL MECHANICS: John Wiley & Sons, Inc., 605 Third Avenue, New York, N. Y. 10016, 553 p., 1969. Price $14.95.

Gillott, Jack E., CLAY IN ENGINEERING GEOLOGY: American Elseviers Publishing Company, Inc., 52 Vanderbilt Avenue, New York, N. Y. 10017, 305 p., 1968. Price $21.50.

Nelson A., and **Nelson, K. D.**, DICTIONARY OF APPLIED GEOLOGY: Philosophical Library, Inc., 15 East 40th Street, New York, N. Y. 10016. Price $17.50.

Varnes, David J., and **Kiersch, George, Editors**, REVIEWS IN ENGINEERING GEOLOGY, VOLUME II: Geological Society of America, Inc., P. O. Box 1719, Boulder, Colorado 80302, 350 p., June 1969. Price $12.00.

Kiersch, George A., and **Cleaves, Arthur B., Editors**, ENGINEERING GEOLOGY CASE HISTORIES, NUMBER 7: Geological Society of America, Inc., P. O. Box 1719, Boulder, Colorado 80302, 112 p., April 1969. Price $3.75.

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PERMIT NO. 1349

THIRD CLASS

At a recent meeting of the Technical Program Committee for the 1969 Annual GSA Meetings, a number of significant items were reviewed and developed which are important to the Division. The Committee has tentatively approved the Division's session time for Wednesday, 12 November. Selected papers will be presented in the morning followed by the noon luncheon and business meeting, with the afternoon session devoted to a joint ASCE-Engineering Geology Symposium. It was the general opinion that papers should be of 20 minute length rather than shorter, and that the chairman should adhere closely to the schedule. Deadline for abstracts will be 1 August and this date will be enforced. It is suggested that authors submit abstracts well in advance of that date to permit an orderly review and to facilitate scheduling. We are soliciting papers which may have a wide range of interest.

Authors should note that only standard 35 mm projection equipment will be available; however, each session room will be equipped with two projectors and two screens. Dr. George Kiersch is Chairman for the symposium which has a tentative title, "Dynamic Problems in Engineering Geology."

Field Trip No. 5 – Geology of Tocks Island Pennsylvania, New Jersey Area and Yards Creek, Pumped Storage Reservoir, and their engineering significance. One day trip leaving Atlantic City on the evening of 12 November and returning to same place on 13 November. This trip is designed to emphasize the engineering geology and hydrogeologic problems encountered by the field geologist in evaluating construction sites. Estimated cost $40 including transportation, guidebook, motel one night and lunch.

If you have any questions about the program please contact Gordon W. Prescott, Office, Chief of Engineers, Department of the Army, ENGCW-EG, Washington, D. C. 20315.

Coming Events

Sept. 5-10	International Clay Conference, Tokyo. (Organizing Committee, c/o Geological and Mineralogical Institute, Faculty of Science, Tokyo University of Education, 3-chrome, Otsuka, Bunkyo - Ku, Tokyo, Japan)
Sept. 14-18	Society of Exploration Geophysicists, Annual International Meeting, Calgary, Alberta, (Howard Breck, Box 1067, Tulsa, Okla. 74101)
Sept. 17-19	International Computer Applications Symposium, Society of Mining Engineers, Salt Lake City. (Alfred Weiss, 1356 Kennecott Bldg., Salt Lake City, Utah 84111)
Sept. 17-22	International Symposium on Land Subsidence, Tokyo. (A. I. Johnson, Water Resources Div., U. S. Geological Survey, Federal Center, Denver, Colo. 80225)
Oct. 14-16	International Symposium on Remote Sensing of Environment, University of Michigan, Ann Arbor. (Extension Service, Conference Department, University of Michigan, Box 618, Ann Arbor, Mich. 48104)
Oct. 19-22	Clay Minerals Society, Annual Meeting, field trip, Ft. Worth. (E. C. Jonas, Dept. of Geology, University of Texas, Austin, Texas 78712)
Oct. 21-25	Association of Engineering Geologists, Twelfth Annual National Meeting, San Francisco, California. The meeting will be headquartered at the San Francisco Hilton Hotel and will be hosted by the San Francisco Section of the Association. The theme of the meeting will be "Engineering Geology in the Urban Environment." Please direct all inquiries concerning the 1969 National Meeting to Peter Vardy, General Chairman, 1969 Annual Meeting Committee, Association of Engineering Geologists, P. O. Box 985, San Francisco, California 94101, (415) 326-0575.
Oct. 27-31	Conference American Water Resources, San Antonio, Texas. (W. B. Davis, Engineering Division, Texas A&M University, College Station, Texas 78843)
Nov. 10-12	Geological Society of America and Associated Societies, Annual Meeting, Atlantic City (G S A headquarters, Box 1719, Boulder, Colo. 80302)