



THE
GEOLOGICAL SOCIETY
OF AMERICA

Quaternary Geologist and Geomorphologist

NEWSLETTER OF THE QUATERNARY GEOLOGY AND GEOMORPHOLOGY DIVISION OF THE GEOLOGICAL SOCIETY OF AMERICA

Boulder, Colorado

June 1972

The presentation of discussion papers at the annual meeting will again be continued this year. After an auspicious start at Atlantic City, where our division was favored with six discussion papers on the Pliocene/Pleistocene boundary, the response of the membership to this opportunity has rapidly declined. The Milwaukee and Washington meetings each had only a single discussion paper. Apparently some stimulus is needed if our division intends to support the concept of the evening discussion. In my task of representing the division on the 1972 Joint Technical Program Committee, I ask for your help and advice in this matter.

You will recall that the discussion papers, which "may have abstracts up to about 1,000 words with provision for line drawings and tables in place of part of the text," are not presented formally but are instead discussed only informally. Blackboards can be used but not projected illustrations. George Rapp, the 1972 JTPC chairman, says that discussion papers this year will be assembled in two ways: by direct invitation from a sponsoring division, and by selection from papers that stem from individual initiative. Rip himself tends to favor the selection process, because it encourages the membership to come forward, but he recognizes that an invitation to submit discussion papers offers more security.

Once again, we have the chance to give discussion papers at the annual meeting. This opportunity to the membership began with the 1969 meeting, but the response has had its ups and downs. Let's give it a better try this year. If you have a problem close to your heart, technical or philosophical, here's your chance to unload and to pick the brains of your colleagues. Depending on the number who come forward, the topic of your choice could be discussed 30 minutes or longer. Deadline for submission of papers is July 15.

Harold E. Malde
Joint Technical Program Committee

FIELD TRIPS - 1972

Coteau des Prairies Trip Precedes GSA Annual Meeting

*Quaternary Geology and Geomorphology of the
Coteau des Prairies, Eastern South Dakota and Western Minnesota*

Leaders: *C. L. Matsch*, University of Minnesota—Duluth; *R. H. Rutford*, University of South Dakota; *M. J. Tipton* and *F. V. Steece*, South Dakota Geological Survey

Limit: 48 participants

The two-day trip starts at 7 a.m. on Saturday, November 11, 1972, in Watertown, South Dakota, and ends on Sunday evening, November 12, 1972, in Minneapolis, Minnesota. This field trip will transect the eastern flank of the Coteau des Prairies, an impressive topographic high that is rimmed by massive moraines and ice-stagnation complexes of the Wisconsin Des Moines Lobe, and into the southernmost bay of glacial Lake Agassiz. The excursion will then follow the Minnesota River Valley, the southern outlet of Lake Agassiz, a wide and deep trench that exposes up to 200 feet of glacial sediments, as well as Precambrian and Cretaceous bedrock, along its sides. The route has been chosen to show a great variety of features associated with continental glaciation, and therefore should have wide appeal to the general geologist as well as to students of the Quaternary. Several stops will be in the vicinity of Morton, Minnesota, to examine the effects of Cretaceous weathering cycles on the Precambrian Morton Gneiss, the oldest rock yet identified in North America (3.6 b.y.).

International Geological Congress, Montreal

The 24th International Geological Congress will be held in Montreal August 21-30, 1972. Four days of Quaternary papers are planned and Jack Armstrong, secretary-general of the Congress, writes that space is still available on the following field excursions:

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| A-02 | Quaternary Geology of the Southern Canadian Cordillera
10 days — \$300 |
| A-11 | Quaternary Geology and Geomorphology, Yukon Territory
12 days — \$525 |
| C-22 | Quaternary Geology and Geomorphology from Winnipeg to Rocky Mountains
13 days — \$365 |
| A-42 | Quaternary Stratigraphy and Geomorphology of the Eastern Great Lakes Region
11 days — \$300 |
| C-44 | Quaternary Geology and Geomorphology in Southern Quebec
10 days — \$240 |
| A-61, C-61 | Quaternary Geology, Geomorphology, and Hydrogeology of the Atlantic Provinces
11 days — \$295 |

PUBLICATIONS

Listed below are some publications of possible interest to division members. These papers are in no way related to nominations for the Kirk Bryan Award. An attempt has been made to focus on papers and guidebooks published in journals which might escape notice.

- Bass, Margaret A., ed., *Geomorphology cumulative index, 1966-1970: Geo Abstracts*, Univ. of East Anglia, Norwich, England. 1972, 1023 p.
- Curry, R., *Glacial and Pleistocene history of the Mammoth Lakes Sierra, a geologic guidebook*: Dept. of Geology, Univ. of Montana, Missoula. 1971, 49 p.
- Donner, J. J., *Toward a stratigraphic division of the Finnish Quaternary*: Societas Scientiarum Fennica, Helsinki. 1971, p. 281-305.
- Easterbrook, Don J., *Geology and geomorphology of western Whatcom County*: Dept. of Geology, Western Washington State College, Bellingham. 1971, 68 p.
- Easterbrook, Don J., and David A. Rahm, *Landforms of Washington*: Union Printing Co., Bellingham, Washington. 1970, 156 p.
- Flemal, Ronald C., *Pleistocene geology between DeKalb and Danville, Illinois*: Dept. of Geology, Northern Illinois Univ., DeKalb, Illinois. 1972, 48 p.
- Johnson, W. Hilton, and others, *Pleistocene stratigraphy of east-central Illinois*: Illinois State Geol. Survey, Univ. of Illinois, Urbana. 1972, 97 p.
- Kaliser, B. N., *Geologic hazards in Morgan County with applications to planning*: Utah Geol. and Mineral. Surv. Bull. 93, Univ. of Utah, Salt Lake City. 1972, 56 p. plus maps.
- Lewellen, Robert, *Studies of the fluvial environment, Arctic Coastal Plain Province, northern Alaska*: P.O. Box 1068, Littleton, Colorado 80120. 1972.
- Mickelson, David, *Glacial geology of the Burroughs Glacier area, southeastern Alaska*: Inst. of Polar Studies Rept. no. 40, Ohio State Univ., Columbus. 1971, 149 p. plus maps.
- Monroe, Watson H., *Landforms displayed on topographic maps of Puerto Rico*: Econ. Dev. Adm. of Puerto Rico. 1966, 26 p.
- Nichols, Robert L., *Glacial geology of the Wright Valley McMurdo Sound*: AAAS. 1971, p. 293-340.
- Olausson, Eric, *Oceanographic aspects of the Pleistocene*: Geologiska Föreningens i Stockholm Förhandlingar, v. 93, pt. 3, Stockholm. 1971, p. 459-475.
- Rapp, Anders, and G. Michael Clark, *Large nonsorted polygons in Padjelanta National Park, Swedish Lapland*: Geografiska Annaler, 53 A. 1971, p. 71-85.
- Sheridan, Michael F., *Guidebook to the Quaternary geology of the east-central Sierra Nevada*: Lebeau Printing Co., Phoenix, Arizona. 1971, 60 p.
- Squire, Gregg R., *A field guide to the geology of southwestern Michigan*: Dept. of Geology, Western Michigan Univ., Kalamazoo. 1972, 58 p.
- Strahler, Arthur, *The environmental impact of ground water use on Cape Cod*: Assoc. for the Preservation of Cape Cod, Box 636, Orleans, Massachusetts. 1972, 68 p.
- Warne, John E., *Paleoecological aspects of a modern coastal lagoon*: Univ. of California Pub. in Geol. Sci., v. 87, Univ. of California Press, Berkeley. 1971, 131 p.
- Willman, H. B., and John C. Frye, *Pleistocene stratigraphy of Illinois*: Illinois State Geol. Survey Bull. 94, Urbana. 1970, 204 p. plus maps.
- Zaruba, Quido, and Mencl, Vojtech, *Landslides and their control*: Academia, Prague. 1969, 205 p.

CRANDELL WINNER OF KIRK BRYAN AWARD

D. R. (Rocky) Crandell is the 1972 winner of the Kirk Bryan Award for his work with volcanic mudflows on Mt. Rainier, "Postglacial lahars from Mt. Rainier volcano, Washington," U.S. Geol. Survey Prof. Paper 677. Dr. Crandell will receive the award at the annual business meeting of the division in Minneapolis, during the national meeting of The Geological Society of America, November 13-15.

1972 AMQUA MEETING MIAMI, FLORIDA DECEMBER 2-5, 1972

To follow the pattern established for the first meeting of AMQUA in Bozeman, Montana, in 1970, the Miami meeting will focus on a central theme in a 2-day series of symposia, and will be preceded by 2 days of field excursions. The general chairman is Cesare Emiliani, Institute of Marine and Atmospheric Science, University of Miami. The symposia on Monday and Tuesday, December 4 and 5, will be concerned with a comparison of the North American marine Quaternary records, in order to work toward an understanding of broad patterns of climatic change during the Quaternary. The role of man will be considered where it is relevant to problems of environmental change. The symposia will be arranged as follows:

- Dec. 4, AM: The Continental Record: Physical Aspects (*R. V. Ruhe*, chairman)
- Dec. 4, PM: The Continental Record: Biological Aspects (*E. S. Deevey*, chairman)
- Dec. 5, AM: The Coastal Record (*Francis Shepard*, chairman)
- Dec. 5, PM: The Oceanic Record (*O. L. Bandy*, chairman)
- Dec. 5, evening: Round Table Discussion (*R. F. Flint*, moderator)

Each of the half-day sessions will start with a review of the critical aspects of the subject, to be followed by contributions from invited speakers as well as by general discussions. The evening session will involve 6 to 12 scientists from different Quaternary disciplines and will be directed at identifying aspects of the central theme in which research in the immediate future will be most challenging and most rewarding. AMQUA members who wish to present contributions along the lines of the central theme are invited to correspond with Professor Emiliani.

Two 1-day field trips will be conducted on Saturday and Sunday, December 2 and 3:

1. Florida reefs: a visit to the live reefs off Key Largo, followed by a visit to the fossil reef on Windley's Key
2. Sedimentary environments of southeastern Florida: modern (mangrove, tidal flats, beaches) and fossil (Miami Limestone)

(Dr. Robert N. Ginsburg has agreed to supply to participants some of the 114,000 cans of suntan lotion he recently acquired from U.S. Army surplus.)

The meeting will be held in the DuPont Plaza Hotel, Miami, which is a 10-minute drive from the Rosenstiel School of Marine and Atmospheric Science of the University of Miami and a 20-minute drive from the main campus of the University of Miami at Coral Gables.

RESEARCH ACTIVITIES OF DIVISION MEMBERS

H.T.U. Smith is continuing studies of eolian processes using satellite photography and remote sensing techniques. Evidence of eolian deposition in craters has been found on Mariner 6 and 7 photography.

Robert P. Sharp's geomorphological efforts of late have been expended on the surface features of Mars via the Mariner 9 photos. That planet is proving to have a much more varied landscape than earlier anticipated. There has been a complicated interplay of volcanism, faulting, erosion, deposition, sapping, and collapse. The big drawback is the lack of opportunity for field work!

Bill Farrand is finishing a sabbatical year in France after 5 months teaching Quaternary geology to archeology students at the Hebrew University in Jerusalem. This opportunity arose as one result of a five-year program of excavations in the et-Tabun cave (Mount Carmel) in Israel where heavy-mineral and phosphate studies have revealed a major weathering break in the upper part of the sequence, apparently in the early part of the last glaciation. This study is part of a regional study of pre-historic cave and rockshelter sedimentology in Palestine and Lebanon.

Dick Goldthwait set aside research and writing for 6 months to be acting dean of Ohio State's College of Math and Physical Sciences, but turns these administrative duties over to Colin Bull. Editing of three volumes has just been completed and the Pleistocene of Champaign County, Ohio, is just about finished.

John T. Andrews' research in the fiords of northern Cumberland Peninsula, Baffin Island, N.W.T., has documented a very severe climatic change within the course of the last 10 years that is promoting renewed glacierization of the area. Research this summer will include participation by Drs. Fahey and Thomas, Univ. of Guelph, doing work on permafrost; Dr. M. Church, Univ. of British Columbia, looking at fluvial processes and sea level changes; and Dr. G. Boulton, Univ. of East Anglia, conducting preliminary research into problems of moraine formation. Work has also been conducted during 1971 in British Columbia and the San Juan Mountains.

James Zumberge has left his post as Dean of the College of Earth Sciences at the University of Arizona to become Chancellor of the University of Nebraska. The move to Nebraska has resulted in a considerable reduction in time available for geological activities, but interest in antarctic research will continue. The Ross Ice Shelf Project Management Office was established at the University of Nebraska June 1, 1972, and will have the responsibility for planning and executing all phases of the Ross Ice Shelf Project beginning in the 1973-1974 austral summer. This project will be funded by the National Science Foundation and will involve a multidisciplinary field program with a number of participants from other countries. The Ross Ice Shelf Project is a plan to drill through the Ross Ice Shelf and investigate the physics, chemistry, and biology of the ocean and sea floor beneath it. Robert Rutford of the Univ. of South Dakota will be moving to Nebraska to become the co-principal investigator on this project.

Robert K. Fahnestock is working on a long-term project on buried topography in western New York and is collaborating with Rich Madole and Tom Meierding on the glacial geology of the west slope of the Colorado Front Range.

Bob Curry has two ongoing research projects in western Montana attempting to develop rapid methods for delineating "active," 50-year, and 100-year floodplains in rural areas. He's working on a technique based upon ground and photogrammetric surveying of a single spring's flood, of known recurrence interval, in conjunction with aerial photo interpretation and standard U.S.G.S. flood frequency determinations for the Bitterroot and Clark Fork river valleys in western Montana. Research is continuing on hillslopes through compilation of a slope catalog on carefully bench-marked hillslopes in western United States. This work has been ongoing for 5 years. In addition he is studying rates of sea-cliff retreat on the West Coast, using base points in Oregon and California surveyed intermittently over the past 6 years, and is undertaking an attempt at power spectra analysis of geomorphic processes, essentially trying to tie such diverse geomorphic forms as cusped beaches and meandering rivers into an overall energy-based analysis.

Dwight R. Crandell, Donal R. Mullineaux, Jack H. Hyde, and Pete Birkeland will return to Mount St. Helens to continue their study of its history and volcanic hazards. Subdivision of the main postglacial tephra deposits from St. Helens has been resolved, and the results outlined in a GSA abstract. Older tephra deposits will be subdivided in coming field seasons. Probable Mount St. Helens ash has now been reported from as far as British Columbia, Alberta, eastern Washington, and eastern Oregon.

Pete Birkeland and Dan Miller are beginning a detailed look at the southern Wind River Mountains, Wyoming, to re-map the type Temple Lake locality. Using C_{14} , lichenometry, soils, and boulder weathering, they will try to date the deposits and provide data for correlations in the Rocky Mountains. Several key cirque areas will be studied in detail to get an overview of the late Pleistocene and Neoglacial record. Gerry Richmond will join in part of the study.

Bob Black plans to spend the summer in the eastern Aleutian Islands again on an interdisciplinary study of the Aleut ecosystem. He expects to concentrate on Quaternary geology efforts with an archaeologist on a review of all known sites on western Unmak Island.

Larry Lattman is continuing his study of the geomorphology of alluvial fans in Nevada, a study of fan evolution, calichification, and case-hardening of fan deposition. Secondary work includes the application of remote sensing data to analyses of fan processes. The study is supported by the Army Research Office.

Arthur D. Howard, in his first year as Professor Emeritus, has been teaching part time and is engaged in completing a few delayed reports. Two of these deal with aspects of lunar analogs of fluvial landscapes. The fluvial type modification of the maria coasts is attributed to surface streams early in lunar history. The vapors responsible for the surface drainage could have escaped in quantity from the prominent fractures that encircle the maria and which were presumably formed at the same time. The few post-maria *meandering* rills also seem to require water at least as a contributing agent. These, too, however, are ancient features. Apparently the role of water in lunar history is not yet settled.

Measurements of terrain by Harold E. Malde in a semi-arid landscape near Santa Fe, New Mexico, have documented sudden changes caused by recent floods in several arroyos. The changes occurred during successive rainstorms in late July 1971, after a period of prolonged drought. In one arroyo, which was flooded by a storm that severely contaminated the water supply of Santa Fe, changes in the terrain were measured by comparing duplicate photographs that were made by the methods of terrestrial photogrammetry before and after the flood. The flooding of another arroyo by a subsequent storm destroyed the water supply of Los Cerrillos southwest of Santa Fe. Changes in the upper reach of this arroyo, which in one place amounted to more than 34 feet of headward erosion in 30 minutes, were documented by repeated photographs and were measured by engineering surveys before and after the flood. The measurements permit the actual discharge to be calculated. By documenting such changes in terrain, the probable consequences of future rainstorms at Santa Fe can be predicted. Such knowledge is of obvious value in reaching sensible decisions on designs for land use.

Vic Baker is currently writing up research on the paleo-hydraulic implications of Pleistocene fluvial gravels, Golden, Colorado, and on the quantitative morphology of karst drainage basins in east-central New York. Future research projects include studies of modern and ancient fluvial processes and products in Texas as well as the development of geologic-geomorphic mapping techniques for land-use planning. The first chapter of studies of catastrophic Pleistocene flooding in eastern Washington is scheduled for publication as *Geol. Soc. America Spec. Paper 144*.

Troy L. Péwé is working on geology of the terraces of the lower Verde River and Salt River near Phoenix, Arizona, and on environmental geology of the Phoenix Mountains, Arizona. Continuing projects are the geology of the San Francisco Peaks with Randall G. Updike and the geology of the White Mountains, Arizona. Both of these are bedrock geology plus surficial geology, including glacial and periglacial deposits. Another project is rejuvenation of lower reaches of streams in the Basin and Range of the mountains near Phoenix.

Investigations by Aleksis Dreimanis and students range from British Columbia to Newfoundland. Main topics: stratigraphy of the last ice age deposits, urban geology (London, Ontario, and the gravel deposits east of it), indicator tracing in glaciated areas. In the summer Y. A. Lavrushin will visit for a month by arrangement of N.R.C. of Canada.

George W. White has completed final compilation of a glacial geology map of Holmes County, Ohio, to be published by the Ohio Survey, accompanied by an explanatory text. He and Stanley Totten have found anomalous fresh till near the glacial boundary in Coshocton County, Ohio. Lectures on "Discovery of Continental Glaciation in Europe and America" were given at Indiana University, University of Georgia, and Wofford College.

Bill Mathews stepped down as head of the department at the University of British Columbia to return to more scholarly pursuits, and took a sabbatical leave to find out, once again, what geology is all about. This leave has been spent cleaning up old projects and starting again a study of the Quaternary stratigraphy and geomorphology of the Peace River district of British Columbia. The latter study has been expanded into an air photo interpretation of retreat of the last ice sheets (Cordilleran as well as Laurentide) from northeastern British Columbia and adjacent areas.

Since his sabbatical at Scott Polar last year Parker Calkin has been compiling and evaluating radio echo-sounding depth records from Victoria and finishing up a glacial map of the ice-free Wright Valley in Antarctica. In western New York he is continuing a study of glacial stratigraphy and finishing up some similar late Pleistocene studies in western Maine with Hal Borns. Recent projects include evaluation of sand dunes in Antarctica and Idaho with NASA, and some urban geology for a new community being planned by the New York State Urban Development Corporation.

William B. Bull has completed a paper about Holocene land subsidence cracks caused by compaction due to wetting of moisture-deficient deposits, and continues to study subsidence due to artesian-head decline. Some of his Arizona geomorphic studies include the effect of base-level change on drainage basins, and the distribution and mode of movement of rocks on playas.

As in previous years, Archie Stalker worked on Quaternary stratigraphy on the southwestern Canadian prairies with C. S. Churcher, who handled the vertebrate paleontology. During the summer of 1971 they collected bones from Kansan to Recent deposits near Medicine Hat from the Aftonian(?) Wellsch Valley site, near Swift Current, Saskatchewan. Other potential Quaternary vertebrate sites in southern Alberta were surveyed. J. H. McAndrews joined the party for a short time in order to sample the Medicine Hat deposits for pollen and seeds.

Stanley N. Davis is continuing his studies of stratigraphy of loess deposits of northwestern Missouri and dynamic factors affecting the selective solution of caverns.

For the past three years, Oscar Ferrians has been immersed in environmental-geologic-engineering activities related to the proposed 789-mile-long trans-Alaska pipeline. Preliminary engineering geologic maps of the entire pipeline route and the "Final Environmental Impact Statement" have been completed. This summer's field work will be devoted to checking out borrow and quarry sites, realignments, and special problem areas along the proposed pipeline route. In addition, Ferrians is initiating a project to evaluate the applicability of using remote sensing data from the Earth Resources Technical Satellite to aid in the solution of critical engineering-environmental problems in Alaska. The principal objectives are to determine the regional distribution and character of permafrost (perennially frozen ground), and to inventory and monitor large-scale geologic hazards.

Dale F. Ritter is leaving Franklin & Marshall to join the staff at Southern Illinois and plans to continue work along the front of the Beartooth Mountains in southern Montana.

John E. Warme is continuing work in several aspects of coastal and submarine geomorphology. The study of Mugu Lagoon, between Oxnard and Malibu on the southern California coast, has been published as *Paleoecological Aspects of a Modern Coastal Lagoon* (Univ. Calif. Pub. Geol. Sci.). Mugu Lagoon is the last of the relatively unaltered lagoons that were once numerous along this coast. Included are the geomorphic development, sediment distribution, fauna and flora of the lagoon, and observations on the populations, communities, and ecological relationships of paleoecological interest. Present research centers upon bioerosion of submerged outcrops of rock by marine borers in southern California, particularly in the offshore canyons such as at Scripps Institution of Oceanography and also off Texas, Yucatan, and Jamaica. In many localities the work of marine invertebrate rock borers appears more important than physical processes in sculpting the seabed.

--- MORE RESEARCH

J. W. Guyton is investigating former surface connections between lakes of the northwest Great Basin, particularly around Eagle Lake in California. The former connections are of importance to biologists in their efforts to understand the present distribution of fishes and other organisms.

George Crowl remapped part of the "terminal moraine" in northeast Pennsylvania in 1971 and will return in 1972 to continue to the northwest. The late Wisconsinan border has been traced from the Lehigh River west and north to the Appalachian Front. Much of the border is ground moraine; end moraine occurs only locally. "Illinoian" deposits are much more restricted in distribution than as shown on the state geological map. The divergence between early and late Wisconsinan borders lies somewhere to the north in the Appalachian Plateau.

Hal Borns writes that the Institute for Quaternary Studies has been formalized at Maine. This summer he is starting a project to define the sedimentological characteristics of moraines formed along an ice margin standing in the sea. After working with submerged moraines of this origin in coastal Maine for a number of years, but not being able to do much with them because of lack of suitable exposures, he plans to spend a month this summer studying exposures of the Ra moraines on the west coast of Norway with the help of Bjorn Anderson. The now-emerged Ra moraines were formed in the sea and the well-developed and numerous exposures should provide an opportunity to define their sedimentary characteristics.

Don Coates is writing and editing a three-volume series under the general theme title "Environmental Geomorphology and Landscape Conservation." The first volume will be out this summer (1972) and covers the period prior to 1900. The second volume, nonurban regions, should be ready early in 1973 and the third volume, urban areas, should be ready by mid-1973. All are being published by Dowden, Hutchinson & Ross, Inc. This summer he will be working on the south shore of Long Island, New York, doing a geomorphic and environmental impact study. Marie Morisawa will be a co-investigator under the program, which is financed by the National Oceanic and Atmospheric Administration.

Lee Wilson has publications in press concerning some new interpretations of the Langbein-Schumm curve, and a model for understanding seasonal variations in sediment yield.

Joseph F. Poland and Ben E. Lofgren continue their detailed study of land subsidence and the mechanics of aquifer systems in arid basins of western United States. Subsidence is caused by excessive pumping of ground water, and results from the compaction of water-bearing deposits. More than a dozen reports are published or nearing completion. Subsidence of producing geothermal fields is also being studied.

Results of an investigation of the Athabasca Glacier, Jasper National Park, is incorporated in a 15-minute film by Richard Kucera. Using time-lapse and sequence cinematography, this 16-mm film investigates morphological changes that have taken place at the terminus of the glacier since 1967. The film received the Best Science Research Film award in Canada in 1971, and has since appeared at the International Science Film Congress in Kiev, U.S.S.R. This film will be distributed through Encyclopaedia Britannica Films. Other specific studies are continuing using the time-lapse technique including evolution of rills on a beach during ebb-tide and motion studies of miniature mudflows and alluvial fans.

The postglacial history of the western end of the Lake Erie basin is one of Jane Forsyth's present interests, not only the physical history, but the vegetational history as well. She has partly completed an investigation into some post-ice, pre-Maumee l, narrow ice-marginal lakes near Lima, Ohio. A field survey of a species of Potentilla (cirquefoil), which appears to grow only *inside* the glacial boundary in Licking County (central Ohio), is about complete, and a systematic analysis of soil, topographic, and other factors possibly influencing the development of ancient prairie (of the Prairie Peninsula) near Bowling Green is just being begun. Just out is a short popular-style paper on the relation of tree species and substrates in Ohio in the Cleveland Museum's Explorer, and out shortly will be an article on the arboreal vegetation of South Bass Island in Lake Erie.

H. E. Kane, A. C. Samuelson, and H. H. Roepke and students are conducting a boring, seismic, and resistivity study of Pleistocene glacial subsurface stratigraphy and bedrock topography of Delaware County, Indiana.

David Mickelson finished a report on ice-stagnation features forming around the Burroughs Glacier in southeastern Alaska which is available from the Ohio State University Institute of Polar Studies. He will be mapping glacial landforms and stratigraphy in north-central Wisconsin this summer.

During a forthcoming sabbatical leave in 1973 John Elson hopes to start in Arizona and work his way north to Washington looking at talus slopes where the climate is somewhat warmer than in Canada. The intention is to evaluate talus as an indicator of climatic change and establish its limitations for this purpose.

John J. Fisher has instituted a new interdisciplinary course in "Environmental Remote Sensing" drawn from seven departments on campus. Synoptic sedimentological and geomorphological studies of the Cape Cod coast are continuing with input in the form of environmental wave energy data being developed to explain the development of the shoreline and beach geometry. The annual meeting of the American Association of Stratigraphic Palynologists at the University of Rhode Island in October 1972 will include a field trip led by him to this study area.

Dick Ragle, Director, Icefield Ranges Research Project, Y.T., Arctic Institute of North America, begins his twelfth summer research season with fifteen or sixteen investigative groups (about 40 to 50 persons) representing the physical, biological, and social sciences. Also involved is an inventory of glaciers in the St. Elias Mountains in Canada in cooperation with the Inland Waters Branch of the Department of Environment, Canada.

C_{14} dates are beginning to be received by Richard Madole from field work begun last summer (1971) on a palynologic study (palynology being done by Fred Bachhuber) and radio-carbon correlation of stades of glaciation in the Colorado Front Range. Hopefully, 35 to 40 dates will be acquired. During the summer of 1972, coring will be continued at former glacial Lake Devlin. A thick section of varved clay cored there in 1971 is yielding an exciting varve chronology and a paleomagnetic record. Work on the latter is being supervised by Ed Larson. Also planned for this summer is a joint project with Ken Fahnestock and Tom Meierding deciphering the glacial chronology along the west slope of the Front Range between the headwaters of the Colorado and Fraser rivers.

James C. Brice, in connection with a project on air photo interpretation of the form and behavior of alluvial rivers, has obtained early (1937-1940) and recent (1965-1970) vertical air photos of reaches on about 60 different rivers in eastern United States and intends to obtain similar coverage for about 100 more rivers in western United States, including Alaska. Lateral shift and other channel changes during the past 30 years or so are being measured, and morphologic properties of each reach are being tabulated. One objective is to develop a classification of rivers according to morphological properties. At the moment, a paper is being prepared on behavior of meanders on the White River (Indiana), which has shown more rapid meander growth during the past 30 years than any of the 60 rivers in the study group.

R. L. Watson hopes to complete a USGS Prof. Paper on karst features of Puerto Rico during the present year. USGS Water-Supply Paper 1899-K, "A Glossary of Karst Terminology," was published in May 1970 and is being reprinted by the USGS. Tropical land forms, especially as related to the trade winds, are well developed in Puerto Rico and are exceptionally well shown on the topographic maps published by the USGS. A booklet similar to that accompanying the "set of one hundred topographic maps" of the continental United States lists the features shown on 15 of the maps in Puerto Rico. A copy of this booklet, "Landforms displayed on topographic maps of Puerto Rico," can be obtained gratis from W. H. Monroe, GPO Box 2230, San Juan, Puerto Rico 00936, as long as the supply lasts.

Al Cary is concerned with a 7-mile-long railroad tunnel through intensely folded sediments in the Brooks Range. For 8 months of the year water is discharged from the tunnel and will freeze, possibly resulting in icing which would not all melt during the summer season.

Lee Clayton is compiling a 1:500,000 map of the surface geology of North Dakota.

J. R. Williams has been engaged in preparation of water resources appraisals for drainage basins in southeastern Massachusetts. This involves mapping the Quaternary deposits, their saturated thickness, textural changes, and depth to bedrock. The unconsolidated Quaternary deposits are the principal aquifers in this part of the state. Included are: Tenmile and north part Taunton River basins (Hydrol. Inv. Atlas 399, 1968); Taunton River basin (Hydrol. Inv. Atlas 460, in press); Coastal drainage basins of southeastern Mass.; Coastal drainage basins of southeastern Mass., Buzzards and Narragansett Bay area; Bedrock contour map of the Taunton River basin, Mass. (U.S. Geol. Survey Misc. Geol. Inv. Map I-742, in press).

Charles Higgins is still struggling with carbonate beachrock cement, with no end in sight, and is currently studying micro-relief ("mima mounts") on the Arroyo Seco pediment, considering the possibility that these mounds and associated sorted stone nets may be relic Pleistocene permafrost features (!).

John Shelton is making films on the San Andreas fault, on continental drift, on behavior of glaciers and properties of ice, and on hot springs and geysers. They will be available in late 1972 or early 1973.

W. K. Hamblin's research in geomorphology involves several projects associated with the margins of the Colorado Plateau and the Basin and Range. These include (1) the lava dams and Pleistocene lakes in the Grand Canyon, (2) the Pliocene-Pleistocene vulcanism and faulting in the western Grand Canyon region, and (3) landforms resulting from normal faulting along the margins of the Colorado Plateau.

Alan Japling reports that a small laboratory building has been established on a 5-acre plot at Erindale College for experimental research in geomorphology.

Richard Pike recently completed four years of work with lunar terrain morphometry, supporting the NASA Apollo program and the U.S. Geological Survey's lunar mapping efforts. This included prediction of large-scale terrain geometry, analysis of topographic data used as design criteria for the lunar roving vehicle's suspension system, and adaptation of numerical taxonomic methods to topographic classification. Lately, he has been able to return to more genetically oriented research: studies of crater morphometry suggest an impact genesis for most of the larger lunar craters; most terrestrial volcanic craters have an entirely different surface geometry which is, however, similar to that of some smaller craters on the moon.

David D. Smith has become vice president of Woodward-Environ, Inc., an environmental consulting firm.

Richard A. Stephenson is working on three projects: (1) estuarine shoreline morphology (Tar-Pamlico estuarine system, N. C.), (2) spatial analysis of flood frequencies in selected drainage basins of the Southern Blue Ridge Mountains, and (3) the impact of urban industrial growth on the water resources of southeastern United States.

Reginald P. Briggs is now Project Director of the Greater Pittsburgh Regional Studies, one of a number of USGS projects involving land and water studies for environmental analysis of relatively large regions around several urban areas. The GPRS is in effect a junior version of the San Francisco Bay Region Study. The area of chief focus is the six-county region around Pittsburgh, Pennsylvania. However, county boundaries seldom are natural boundaries, so some studies will extend beyond the region. Chief purpose of the studies is to supply a firm physical basis for regional planning.

Ewart M. Baldwin continues interest in the Pleistocene stratigraphy and history of the Willamette Valley and is preparing a paper on the northern Willamette Valley with this in mind. His other interests involve a study of landslide lakes in the Coast Range and river piracy.

During the past year S. C. Happ continued efforts to recover and resurvey sections across valleys tributary to the Yazoo River in north-central Mississippi. The objective is to evaluate flood plain sedimentation and stream channel changes. Most of the valleys have now been affected by stream straightening, and a new epicycle of erosion initiated.

Valmore C. Lamarche, Jr. is presently wrapping up a study of past treeline fluctuations in western United States that can be interpreted as a generalized climatic record for the past few thousand years. More detailed information on summer temperature variations may be obtained from ring-width variations in bristlecone pines near the upper treeline. A study of prehistoric floods in northern California with E. J. Helley was recently completed based on geomorphic and botanical evidence. The feasibility of dating past movements of the San Andreas Fault is being studied with R. E. Wallace. Work in the Alps has shown a close correlation between tree-ring growth and glacial fluctuations due to a similar climatic response. They are now setting up an x-ray densitometric laboratory for studying density variations within the annual rings of trees. These techniques should be directly applicable to study of geomorphic phenomena causing disturbance of trees, such as landslides, valley glaciers, and avalanches.

Zane Spiegel devoted half of 1971 to teaching a graduate course in ground-water hydrology at New Mexico Tech while on leave from the New Mexico State Engineer Office. Recently published is a series of articles on geology and hydrology for the New Mexico Review and Legislative Journal, emphasizing examples of basic concepts of equilibrium processes such as sedimentation above stream obstructions and the balance of ground-water recharge by natural discharge. Conclusions of recent research on Quaternary geology and hydrology of the belt of island remnants from New York to Cape Cod are: (1) geologic units and soils must be examined carefully to explain important local anomalies in phreatic features and natural recharge mechanisms and rates; (2) ground-water discharge to the sea during late glacial and present times has been primarily by stream base-flow, except in the smaller islands and narrow portions of peninsulas; (3) recharge computations must explicitly recognize interception as a significant factor in addition to evapotranspiration in the local water budget wherever there is vegetation taller than mowed grass; (4) average annual natural recharge since periglacial times has probably been almost a linear function of average annual precipitation, and is presently about 17 inches per year (for 43 inches precipitation) on the most permeable soils, but less on heavier soils; and (5) annual recharge during dry (below average) years is nonlinearly related to annual precipitation.

Edith M. McKee is working on beach erosion problems around Pike, Michigan, especially for the Indiana Dunes National Lakeshore. She is also continuing studies on lake bottom terrain and associated geology.

Earl M. P. Lovejoy has been investigating rates of erosion in arid climates in an attempt to use them as criteria for deciphering rates of range uplift. He has also been studying classical criteria and critical locations which have been used to determine rates of range uplift in the Basin and Range province. In many places the geomorphic evidence supplements the structural evidence sufficiently well to permit significant extrapolation in time. Association with detailed structural studies permits coordination and correlation between geomorphic development and tectogenesis.

In the past year (1971), a large part of J. D. Mollard's activities concerned air photo-based terrain mapping of permafrost-affected landscapes extending from Prudhoe Bay, Alaska, well into northern Alberta. In addition, regional hydrogeological studies in the discontinuous permafrost zone (some 50,000 square miles) were carried out. In January and February 1972, he prepared a stereoscopically illustrated manual for 45 participants (geotechnical engineers, geologists, ecologists) who attended a short course titled "Photo Interpretation and the Biophysical Environment" at the University of Saskatchewan, Saskatoon. The large volume contains 13 chapters, 1,370 contact air photos, and 560 stereograms (stereopairs and stereotriplets) along with captions. The volume is titled "Landforms and Landscapes of Canada: A Stereoscopically Illustrated Guide to Airphoto Identification and Interpretation."

Helen L. Foster is compiling a preliminary geologic map of the Eagle quadrangle, east-central Alaska, at 1:250,000. Although it is primarily a bedrock map, it will show some of the moraines from Pleistocene mountain glaciers and some of the high level stream terraces in the Fortymile and Seventymile River drainages. During the coming field season she will continue geologic mapping in the Yukon-Tanana Upland, Alaska, with work in the Eagle and Big Delta quadrangles. Emphasis is presently on bedrock mapping although considerable data is gathered on surficial deposits and physiographic features.

RESEARCH (MORE)

Keith M. Hussey is still worrying about the pediments between northern Wyoming and northern New Mexico. A minimum age for the oldest pediment surface at the southern end of the study area was determined by K-Ar dating of 4.3 million years of a basalt flow on the surface. A paleosol under the basalt, and the relatively large vertical distance between the highest surface and the next younger surface, both indicate a greater difference in age between these two oldest surfaces than between any two successively younger surfaces, suggesting that development of the younger pediments could have taken place in Pleistocene time (assuming the Plio-Pleistocene boundary to be 2.5 to 3.0 million years old).

Howard A. Meyerhoff wrote a section on the geomorphology of the United States for Volume VIII of the Enciclopedia del Petrolie e del Gas Naturale, sponsored by Ente Nazionale Idrocarburi, Rome, Italy. After many years, an interpretation of the post-orogenic development of the Appalachians is finished and an article about it appears in the June issue of the *GSA Bulletin*. Current concerns are with the interrelations of the Grass Plains and Rocky Mountains in Cenozoic time.

P. F. Karrow continued study of glacial Lake Algonquin and Lake Nipissing chronology at various sites east of Lake Huron. Writing resulted in six papers in press. Study of the paleontology of the Toronto interglacial continues with beetles of the Scarborough Formation studied by Post-Doctoral Fellow Anne Morgan, beetles of the Don Formation by Visiting Professor Allan Ashworth, ostracodes by research assistant S. Poplawski. With O. L. White, study of the urban geology of Kitchener and Waterloo, Ontario, is continuing. A federal winter works program this year gave the project a big boost.

Pat Glancy is continuing an erosion study in the Crystal Bay area of Lake Tahoe, Nevada, to provide quantitative information on natural fluvial-sediment transport of several small streams in the area. It compares natural erosion rates with rates in urbanizing areas. First-year results (1970 water year): (1) 10,000 tons of sediment were delivered to Lake Tahoe from an 18-square-mile drainage area; (2) about three-fourths of the delivered load, mostly sand, came from areas in or under development and about one-fourth from the undeveloped area; and (3) estimated annual sediment yield from the developed areas was about 12 times greater than that of the undeveloped areas.

He and Terry Katzer have been collecting data on flash flooding and associated sediment transport that together constitute a serious geohydrologic hazard to man's rapid urban development of western Nevada. This hydrologic process also appears to be significantly instrumental in the present-day formation of alluvial fans in the Great Basin area. Data collected during 1969, an unusually heavy runoff year, allowed quantitative estimates of erosion along the Lower Truckee River near Pyramid Lake, Nevada. The extensive channel erosion was related to both the intense runoff and the nonequilibrium channel conditions caused by a greatly lowered base level resulting from the shrinkage of Pyramid Lake during the last 50 years. Erosion along the lower river reaches was quantitatively compared with net fluvial sediment transport from the Upper Truckee River basin. A forthcoming publication on the study with A. S. Van Denburgh and S. M. Born relates river runoff to erosion and the dissolved chemical load of the river.

Edwin D. McKee completed a study of contorted beds in wet coastal dunes of Brazil, compared with comparable structures in certain dry desert dunes. This investigation was made in collaboration with J. J. Bigarella of Curitiba, Brazil. Also completed was a study on the time of reversal in drainage along the southern margins of the Colorado Plateau in Arizona. This study, made with Edwin H. McKee, involved the dating of basaltic gravels in buried stream channels having northeasterly drainage and the dating of lava flows within canyons in the present southerly drainage system.

Sidney E. White is identifying and mapping three stades of Neoglaciation in the Colorado Front Range, the Temple Lake Stade, and intermediate stade, and the Gannett Peak Stade, from James Peak north through Rocky Mountain National Park. The project was supported by a GSA Penrose Bequest Research Grant for the summer of 1971. Standards for each stade were first based upon degree of soil development, thickness of weathering rims on boulders and size and depth of weathered pits in boulder surfaces, and percent of lichen cover on boulders and rock surfaces. Average of maximum size of thalli of *Rhizocarpon geographicum* are measured over entire moraines and other deposits and applied to the lichen growth curve established for the area. In addition to moraines, the other deposits being mapped and studied are rock glaciers, protalus ramparts, and three types of talus.

E. P. Kiver's current research concerns examination of Neoglacial deposits in the Medicine Bow Mountains, Bighorn Mountains, Sawtooth Mountains, Wallowa Mountains, and other areas. The correlation of Neoglacial deposits in these widespread areas will be attempted using lichenometry and other techniques. Four distinct Neoglacial events are recorded in Colorado and only two or three in other areas.

John A. Reinemund is looking after the overseas geological program of the USGS, which has a lot to do with geomorphology and Quaternary geology; but unfortunately most activities involve setting up opportunities for work by others.

W. D. Brueckner carried out an experiment in large-scale geomorphic mapping using enlarged air photos and topographic maps on a scale of about 1:7,000. A coastal area of about 3 to 4 square miles near St. John's was divided into surfaces with exposed bedrock and surfaces underlain by glacial drift (unmodified or subjected to solifluction), post-glacial slides, scree, beaches, bogs, and swamps.

Olaf P. Jenkins is currently studying a late Pleistocene lake in southern Santa Clara County and San Benito County, California. The 30-mile-long lake extended from Hollister, San Benito County, to Morgan Hill, Santa Clara County, in the late Pleistocene, leaving deposits of lake-bed silt the top elevation of which is 400 feet. The dam which caused the Pajaro-San Benito basin to fill with water at that depth was formed by an offset on the San Andreas Fault of 4 miles as indicated by the present offset of the Pajaro River between its junction with the San Benito River and Pajaro Gap at Chittenden Pass.

Ansel M. Gooding is continuing work on glacial stratigraphy and geomorphology in southeastern Indiana, and getting more and more involved in environmental problems in the area. In press as an Indiana Geological Survey publication is "Characteristics of late Wisconsin tills in eastern Indiana." Recently published is "Postglacial alluvial history in the upper White-water basin, Southeastern Indiana, and possible regional relationships," Am. Jour. Sci.

John A. Raabe is investigating evolution of the drainage in the Winsted-Norfolk area of Connecticut. Mapping of spillways, shores of temporary lakes, and abandoned channels is nearly complete. The original drainage to the south has been reversed with the major stream of the area now flowing due north some six miles, where it joins an adjacent preglacial basin.

Charles G. Groat is mapping surficial geology and depositional history of the Rio Grande delta with emphasis on eolian reworking of abandoned lobes, and is studying drainage net, slope, and sediment-yield studies of two geologically similar but climatically different terranes in far east and northwest Texas.

Kenneth G. Johnson is initiating study of the time-space relationships of depositional environments in the late Pleistocene Hoosic Delta of eastern New York State.

Wakefield Dort reports that he is continuing studies of late Pleistocene and Recent changes in Missouri and Kansas streams, stadial pulsations of early Pleistocene ice sheets, and Quaternary history of Idaho. He is compiling further reports on his arctic work.

Richard O. Stone just completed a study funded by the Office of Naval Research concerned with subaqueous and sub-aerial sand ripples. Also a study of the application to oceanography and geomorphology of orbital photography of the upper Gulf of California was completed for the Bureau of Commercial Fisheries.

Francis Ruellan is particularly active in making geomorphologic and sedimentologic maps of the St. Malo and St. Briec regions, France.

Max W. Reams is completing a study of a gypsum karst area in south-central Kansas. In an early stage of work is a study of the relation between drainage divides and bedrock in Linn County, Kansas. A lengthy study of the distribution pattern of caves in Missouri is in the planning stage.

C. C. Reeves, Jr. is mapping the Tertiary-Quaternary of eastern New Mexico for the State Bureau of Mines, differentiating several new units. Of particular interest is that much of the Ogallala Formation seems to be of eolian rather than fluvial origin. Surface mapping on high-altitude RB-57 transparencies supplied by NASA is also in progress in southwest and west-central Texas. Preparations are under way for ground-truth studies of sites on the southern High Plains selected for the EROS-ERTS A project. A remote sensing laboratory complete with density slicer/edge enhancement was set up and a course in remote sensing offered this spring.

Thor Karlstrom is now phasing out lunar research work and beginning a mapping project in the Sonora Desert near Phoenix, Arizona. Preliminary photogeology and field observations in selected sites indicate a complex pluvial and fluvial record ranging from early Tertiary to Holocene in age. Radiometric and archaeological dating of the pluvial and fluvial deposits may provide a detailed chronologic framework for much of the Cenozoic in the Phoenix region. The major objectives of the project are (1) to provide a detailed geologic study of test site area for both pre- and post-mission evaluations of high-altitude earth-orbiting satellite imagery as potential tools in more rapid and accurate geologic mapping of large regions; (2) to prepare a set of special-purpose maps useful for land classification and urban developmental purposes; and (3) to reconstruct causal factors of past environmental changes that may directly bear on urban planning near Phoenix and in other marginal desert areas.

Frank W. Stapor, James P. May, and William F. Tanner spent December 1971 studying coastal features in the states of Vera Cruz, Tabasco, Campeche, and Yucatán, and in the territory of Quintana Roo, Mexico. They were particularly interested in terrace and berm levels, wave-cut cliffs above present MSL, and accumulations of CaCO_3 debris. An air photo map has been made by Tanner of the dune-and-beach-ridge plain on the Antón Lizardo peninsula, south of Vera Cruz, Mexico. Five generations of dunes, the younger three sets of which show southward migration, are outlined; the eastern edge of the peninsula is marked by a beach-ridge plain with individual ridges having north-south orientation. Alignment of longitudinal dunes, driven by northerly winds, is parallel with alignment of beach ridges produced by waves approaching from the east. Beach cusps develop in the faint map concavity along the northern shore.

Recent rejuvenation of an old erosion surface near the village of Caltepec (south of Tehuacan, Mexico) permits comparison of very young, active, steep hillside slopes (below the old erosion surface) with very old slopes (above the old erosion surface). The younger slopes, all about 35° , are cut on soft Mesozoic sediments, a well-lithified Pennsylvanian conglomerate, and pre-Pennsylvanian crystallines. If these slopes should differ on highly distinctive lithologies, they have not had time to do so yet. The older slopes standing above the old erosion surface are all about 15° or gentler, and largely seem to have attained an equilibrium value close to 15° ; they are all cut on the Mesozoic sediments.

The Río Cazonos (Shark River) slows from the highlands in the southeastern part of the state of Hidalgo, Mexico. On a gradient as steep as that of the Río Cazonos, a downcutting rate across sedimentary rocks might easily be as much as 10 cm per century, in which case the valley could have been excavated in 10^5 years. If an unnecessarily restrictive downcutting rate of 1 cm/century is adopted, the valley could have been cut in 10^6 years. At the faster rate, the material removed as stream load would have been $3 \times 10^3 \text{ cm}^3/\text{sec}$; at the slower rate, $3 \times 10^2 \text{ cm}^3/\text{sec}$. The discharge, however, is close to $10^8 \text{ cm}^3/\text{sec}$, or 4 to 5 orders of magnitude greater than the load, which seems quite reasonable.

Art Bloom spent August 1971 on raised reefs in New Guinea and nearby islands, collecting coral samples for U-series dating with John Chappell. The scenery and the geology terraces are spectacular. Art was host to the Friends of the Pleistocene in Ithaca May 19-21, to visit the "Fernbank" interglacial and early Wisconsin site on Cayuga Lake, where a highly fossiliferous lacustrine section shows an unconformity between beds with interglacial hardwood pollen and a pine-spruce pollen sequence, all more than 50,000 years old. If Thaca grew cold that long ago, one wonders how New Guinea can have emerged reefs that indicate a marine transgression between 35,000 and 50,000 years ago.

James T. Teller is studying the texture and mineralogy of tills in southern Manitoba in an attempt to work out the sequence of glacial events and their relationship to the history of Lake Agassiz.

Hank Waldron is involved in a special project established in response to a request from the Veterans Administration, entitled "VA Hospital Site Evaluations." The purpose of the project is to review the geologic aspects of seismic evaluation reports, prepared by consulting firms, on existing VA Hospital sites (there are something like 55 of them in earthquake zones 2 and 3!!). The program of site evaluations was developed by VA after the collapse of their Sylmar Hospital during the San Fernando earthquake of February 9, 1971.

end.