



Quaternary Geologist and Geomorphologist

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THE QUATERNARY GEOLOGY AND GEOMORPHOLOGY DIVISION

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CURRENT RESEARCH ACTIVITIES

George W. White, Univ. of Illinois, continues field study, map compilation, and report writing of areas in the Allegheny Plateau in northeastern Ohio, supported and published by the Geological Survey of Ohio. Field work in the summer of 1973 with *Stanley Totten* of Hanover College resulted in a report on Mahoning and Columbiana Counties, Ohio. A report by White on Ashland County, Ohio, is now in press. White and Totten continued field work in Ashtabula County, Ohio, in the summer of 1974.

Art Howard, Stanford Univ., still serves on Ph.D. committees involving geomorphology and Quaternary stratigraphy, and teaches winter quarter each year. He is the principal contributor and co-editor (with Irwin Remson, hydrogeology) of a book, well under

way, on geology in environmental planning, intended as an elementary undergraduate text. He spent about five weeks in Belem, Brazil, as consultant on air photos and air imagery of the Amazon.

Robert Sharp, Cal Tech, has been working mostly on the "Quaternary geology" (landforms) of Mars. Included are the so-called channels, at least some of which appear to be erosional in origin and very probably fluvial.

William B. Bull, Univ. of Arizona, is evaluating the interaction of base-level processes such as tectonic uplift, erosion, and deposition in an attempt to define equations and make maps of Quaternary tectonic activity of mountain fronts in parts of the Basin and Range province. The impact of Quaternary-Holocene climatic change within the fluvial systems is also being studied.

Larry Lattman, Univ. of Cincinnati, spent the summer of 1974 in Arizona and New Mexico trying to determine if the types of caliche and controlling factors are the same there as in Nevada (*GSA Bulletin*, September 1973). This work is supported by the U.S. Army Research Office.

A. Dreimanis, Univ. of Western Ontario, London, Canada, is working on two continuing projects: (a) tills and their genetic classification based upon field and laboratory criteria; and (b) correlation of the last glaciation across the northern hemisphere (jointly with A. Raukas from the Geology Institute of the Estonian Academy of Sciences in Tallin). An M.Sc. thesis, "Glacial indicator trains near Gullbridge, Newfoundland," and three other graduate theses are near completion. Dreimanis participated in the 9th INQUA Congress in Christchurch, New Zealand, and presented papers jointly with Raukas and E. A. Francis, as progress reports on the above topics. In 1974-75 he will be on sabbatical leave and will try to complete unfinished mapping projects in southwestern Ontario.

Peter Birkeland, Univ. of Colorado, has recently spent some time in the High Sierras and Wind River Range. He and *Jim Yount*, Scripps, compared late Quaternary rock weathering and soil development of the Sierras with that of the Rocky Mountains and concluded that Sierran rocks are equivalently or more weathered but soils less developed than materials of the same age in the Rockies. Pete spent a month in the field with *Dan Miller*, Colgate Univ., finishing up late Quaternary glacial stratigraphy in the southern part of the range, and with *Ralph Shroba*, he worked on deposits fronting the Dinwoody and Gannett Glaciers in the northern part of the range. One preliminary conclusion is that the Gannett Peak deposits in the northern part are mainly equivalent to the youngest neoglacial deposits recognized in the Colorado Rockies and do not include Audubon deposits. In the summer of 1974, Pete was on southern Baffin Island with *Bill Locke* to put together a rock weathering and soil development story on tills and beach deposits of different ages.

P. P. David, Univ. of Montreal, is continuing research on eolian chronology of Brandon Sand Hills, the stratigraphy of the Great Sand Hills of Saskatchewan, and the glaciation of the Gaspé area of Quebec. A paper on the Quaternary stratigraphy and glacial chronology of northern Gaspé is under preparation. Master's theses recently completed include "Surficial geology of Herschel Island, Yukon Territory," and a study of fluvial terrace deposits and the late-glacial lacustrine and marine deposits of the Ste. Anne River valley of Gaspé.

DIVISION-SPONSORED SYMPOSIA AT MIAMI NATIONAL MEETING

Of particular interest to division members at the Miami national meeting will be sessions on geomorphology (14 papers), Pleistocene geology (13 papers), and geomorphology-Pleistocene (7 papers). In addition, two division-sponsored symposia have been organized and include the following papers:

URBAN GEOMORPHOLOGY

(*Don Coates*, organizer; Monday, November 18, 1300-1640, Le Cafe Room, Carillon Hotel)

Sediment control methods in urban development; some geomorphic implications (*H. Guy*)

Geomorphic constraints on land development in the Front Range urban corridor (*W. R. Hansen*)

Paleogeomorphic analysis in mapping for environmental statements in an urbanizing area (*W. J. Wayne*)

Geomorphology and land use decisions in Maine (*E. D. Koons*)

Beacon Hill end moraine Boston: A new explanation of an important urban feature (*C. A. Kaye*)

Other tentative titles include

Urban effects of Hurricane Agnes (*R. R. Parizek*)

Landslide information for land use planning (*F. B. Leighton*)

Land use model for urban planning (*L. A. Palmer*)

Geomorphology and law in the Binghamton metropolitan area, New York (*D. R. Coates*)

PERIGLACIAL FEATURES INDICATIVE OF PERMAFROST

(*Lincoln Washburn* and *Gerald Richmond*, organizers; Tuesday, November 19, 0815-1200, Imperial A, Carillon Hotel)

Permafrost in relation to climate (*O. J. Ferrians*)

Ice wedges and soil wedges (*R. F. Black*)

Patterned ground other than ice wedges and soil wedges (*R. P. Goldthwait*)

Pingos (*R. C. Flemal*)

Frost creep and gelifluction features (*J. B. Benedict*)

Rock glaciers and block fields (*S. E. White*)

Altiplanation terraces (*T. L. Pewe* and *R. D. Reger*)

CURRENT RESEARCH ACTIVITIES

Meyer Rubin, USGS (now at National Center 971, Reston, Virginia), is using C^{14} as an indicator of pollution source in dissolved organic carbon of rivers and estuaries. The percentage of C^{14} tells how much "dead" carbon (from petroleum sources) got into the water. Sampling involves irradiating 60 gallons of water with high-intensity ultraviolet light.

Parker E. Calkin, State Univ. of New York at Buffalo, is currently involved in projects in Antarctica, Mexico, and western New York. This summer he compiled detailed quadrangle maps and other surficial studies in order to organize the stratigraphy and late Wisconsin history of the Buffalo area. In addition, he is working under a Sea Grant with *Gordon Connally* on coastal erosion and deposition along Erie and Ontario shores in New York. He and *Hal Borns* (Univ. of Maine) are finishing up glacial geologic study of the Flagstaff Lake area in western Maine. The Antarctic work involves a radio echo-sounding study in the southern Victoria Land area (in press with *J. Glaciology*), a study of dunes in Victoria Valley (just published in *Geog. Rev.*) and glacial geologic mapping in Wright and Victoria Valleys with *Colin Bull* (Ohio State Univ.) and *Boß Behling* (Univ. of West Virginia). In Mexico he is studying the active ocean beaches and the beach-dune ridges of the Teacapan Peninsula south of Mazatlan, western Mexico. He and Connally are editing the "New York Glaciogram" and would be happy to receive informal notes for circulation on problems relating to the Quaternary geology of New York.

D. R. Crandell reports that he and *D. R. Mullineaux* (both USGS, Denver) will complete field work at Mt. St. Helens volcano, Washington, this summer and expect to start studies of Holocene eruptive activity soon at Mt. Hood, Oregon, and to continue work at Mt. Shasta, California. Reports on various aspects of Mt. St. Helens and its potential hazards are in preparation. *J. H. Hyde*, Tacoma Community College and USGS, completed a reconnaissance last summer of Holocene volcanic deposits on the east side of Mt. Baker, Washington.

For *Joe Hartshorn*, Univ. of Massachusetts, this past year has been a year of catching up with the vast amount of literature in geomorphology and Quaternary studies at the libraries of the Sedwick Museum and the Department of Geography, Cambridge University. In addition, he has been attending classes with numerous geologists and (British-style) geographers to see what is going on in the current world of geomorphology in Europe. He spent two weeks in Iceland working on proglacial lakes with *Geoffrey S. Boulton*, Univ. of East Anglia. He also lectured on sedimentation in glacial lakes and on the environment in front of the Malaspina Glacier to various groups around England and in Belgium.

M. Gordon Wolman summarizes work at Johns Hopkins as (1) Mapping of the vegetation of Maryland and some associated studies on stratigraphy and palynology of alluvial deposits; (2) Studies of urban stream channels and the removal of debris (as one of the graduate students remarked, the study of the rounding of market carts); (3) Theses: (a) geology and environmental geology of portions of the Front Range, Colorado (a State of Colorado project), and (b) glacial geology and environmental considerations in several quadrangles in Connecticut (a USGS project); (4) Study of the historical characteristics of the lower Susquehanna River; and (5) Recently published studies by *John Costa* on the effects of Hurricane Agnes flooding.

J. T. Andrews, INSTAAR, spent the 1973 summer season in the Padle/Kingnait Fiord area of Cumberland Peninsula, Baffin Island, as part of a larger helicopter-supported study on the Quaternary geology and current geomorphological processes operative within the newly formed Baffin Island National Park. A feature of the area was considerable thicknesses of finely bedded sand/soil sequences on both sides of the present river. The deposits are tentatively interpreted as colluviated loesses interbedded with peat layers. Weathering and soil studies were used to delimit the extent of pre-Wisconsin and Wisconsin glacial ice limits. Marine limits were studied and shells collected for C^{14} dating. Office work in 1973-74 was spent on an NSF grant on the problem of inception of the Laurentide ice sheet. A large number of people are involved in this study.

Jack Ives, INSTAAR, was elected chairman of UNESCO working group 6 of the new international program, "Man and the Biosphere." This summer he visited the northern Torngat Mountains and the north-central interior plateau of Labrador-Ungava with the specific aim of collecting numerous peat monoliths and lake sediment cores to examine the late glacial and postglacial vegetational and climatic history of the peninsula.

G. H. Miller worked along the spectacular trough that leads from southern to northern Cumberland Peninsula, called Pangnirtung Pass. A feature of the area is the tremendous number of buried organic layers—a number of which are currently being dated. In places bedded sands are up to 4 m thick. There is a good neoglaciation sequence in Pangnirtung Pass and late glacial moraines are at, or being overridden by, the current glaciers. Other work included a re-examination of the cliff stratigraphy on eastern Broughton Island and observations on marine limits and weathering in the Merchants Bay area. Further work was hampered by the fact that a polar bear had taken a violent objection to INSTAAR's 22-ft freighter canoe that had been cached for the winter.

Dana Isherwood, INSTAAR, and her husband Bill worked at a number of sites in Cumberland Peninsula on the problem of chemical and physical weathering in an arctic environment. A special interest was the process of tor formation. In addition to studies on the Precambrian rocks, Dana also visited Cape Dyer and examined weathering on the early Tertiary basalts that front Davis Strait.

Larry Williams, INSTAAR, and others are developing a number of different snowmelt models that can be used to simulate current melt processes on glaciers and can then be used to examine the snowmelt processes at the beginning of the last glaciation. A successful model has been developed that is not too demanding on computer time. The model has also been run using Miller's glacier extent data and a "climate" for the late Wisconsin (10,000 to 25,000 BP) based on glaciers with distinct area/elevation properties.

Jim Johnson, INSTAAR, continued his research on the mass and energy balances of the local Front Range Glaciers. A newly acquired stream drill was used to insert a detailed strain and velocity net on the Arapaho Glacier. Mud flows and current rates of geomorphic processes are being studied in the San Juan Mountains by *D. Sharpe*.

Vic Baker, Univ. of Texas, reports work on geomorphic effects of Holocene flooding in central Texas in cooperation with the Univ. of Texas Bureau of Economic Geology. Relatively infrequent, high-magnitude precipitation events induce spectacular channel erosion on the high-gradient streams of the Balcones Escarpment in central Texas. Preliminary work indicates that channel morphology in small drainage basins responds dominantly to infrequent catastrophic floods rather than to the more frequent mean annual flood. A project on relationships between drainage basin morphology and stream flow is supported by NASA using orbital and suborbital remote sensing imagery to map stream network geometry and other geomorphic parameters that can be related to flood potential. Fluvial erosion features on Mars show many morphologic similarities between certain large Martian channels visible on Mariner 9 imagery and the Channeled Scabland. If the analogy is correct, floods involving water discharges of millions of cubic meters per second and peak flow velocities of tens of meters per second may have occurred on Mars. Geomorphic and sedimentologic features of river floodplains in central Texas are being studied in cooperation with *M. M. Penteado*, on a postdoctoral leave from Faculdade de Filosofia, Ciências e Letras, Rio Claro, Brazil. Graduate students are pursuing a variety of topics including shoreline erosion and morphology near Freeport, Texas, quantitative fluvial process studies, quantitative drainage network analysis, and engineering and slope stability studies of a local expansive clay. Future studies are planned concerning the evaluation of geomorphic techniques for floodplain and flood-hazard mapping and studies of glacial geology and stream terraces in northern New Mexico and southwestern Colorado.

Richard Goldthwait, Ohio State Univ., and graduate students have worked out the water table, routing, and pressures within the Burroughs Glacier of Glacier Bay. He will be working on the glacial history south of Brady Glacier next summer. He and *Dave Mickelson* have conclusive evidence as to how the Glacier Bay drumlins formed and he and *Norm TenBrink* hope to work out the astronomic rates of isostatic uplift for Glacier Bay. In Ohio, the complex interlobate area between the Scioto and Miami sublobes is about to be published, and *Mike Quinn* has nearly finished Ross County.

Shore erosion related to careless intrusion by man into the near-shore zone of currents and lake bottom morphology continues to be a major study area for *Edith M. McKee*, Winnetka, Illinois. Detailed bathymetric studies and current studies throughout the near-shore water mass demonstrate what erosion-deposition shore-and-lake-bottom patterns are related to which manmade structures. The studies around Lake Michigan support work being done in marine coastal zones, and can lead to better use of the shore areas and shallow water sectors. Recently the Corps of Engineers announced they now find that 64% of shore erosion is due to manmade structures, with 36% due to natural causes (in spite of the high levels of the lake waters in recent years), quite a change of attitude from even a year ago.

CURRENT RESEARCH ACTIVITIES

Robert Palmquist, Iowa State University, just started mapping of surficial geology of portions of the Bighorn Mountains in Wyoming for environmental and land use planning by the Forest Service. Partially completed with *K. Connor* is analysis of landform distribution on the Des Moines Lake in Iowa relative to bedrock topography and drift thickness. Almost completed with *Nick Van Driel* are a series of computerized land use and resource inventory studies of Story County, Iowa.

Dick Stone, USC, is coauthor of "Geology, Seismicity and Environmental Impact," a book published by the Southern California Section of Engineering Geologists. Among the 49 articles are a dozen or more related either to the Quaternary or to geomorphic features and processes. These include Subsidence, Rebound and Surface Strain Associated with Oil Production Operations at Long Beach; Space-Time Relationships of Landsliding in Palos Verdes; Permafrost and Bank Stability along the Mackenzie River, NW Territories, Canada; Patterns of Ground Rupture in Fault Zones; and Beach Changes in a Low-Energy Coastal Area in Florida. Graduate students at USC are studying evaporite deposits of the Laguna Marmona on the west coast of Baja California and in conjunction with this, the geomorphic features present and the recent history of the lagoon and its sediments; investigating the geomorphic features of the southern portion of the Sierra Mayor in northern Sonora, Mexico, and the Quaternary history of the area; and studying wind directions, sand movement, dune types, and sand encroachment in the southeastern portions of Palm Springs, California.

Donald R. Coates, SUNY at Binghamton, organized the Fifth Annual SUNY Geomorphology Symposium September 27 and 28, 1973, on the theme "Glacial Geomorphology" with 15 outstanding glaciologists, including Bob Legget from Canada and Cuchlaine King and Geoffrey Boulton from England. Opening remarks by Don on "Reappraisal of the Glaciated Appalachian Plateau" show this region to be much more diverse than generally believed, and divide it into ten different sections. The third volume on "Environmental Geomorphology and Landscape Conservation" was scheduled for publication by late summer 1974 and concentrates on urban areas. A correlation of topographic anomalies and glacial deposits that can be made with a theoretically-derived ice model based on a one bar basal shear stress system has recently been prepared. Computer-generated curves, when superimposed on a three-dimensional topographic model, suggest a new approach to the understanding of glaciation in a rugged terrain. The third year of a Sea Grant project—"Coastal Erosion, Stabilization, and Utilization of the South Shore Long Island, N.Y."—is now starting with Don as director and *Marie Morisawa* as coinvestigator. Six environmental booklets for use by high schools that teach environmental science have just been published by SUNY. These materials were developed during NSF Institutes and contain both teacher-resource materials and student projects and experiments. They are now ready for distribution and cover a broad spectrum of environmental affairs. Don is helping to write the Broome County Environmental Master Plan, and writing road aggregate source reports for New York State Department of Transportation.

Ernest L. Kern, Southeast Missouri State Univ., is presently completing a detailed study of the geology of Klump's Cave, a cavern system approximately one mile in total length located in Perry County, Missouri. The focus of the study is the determination of the speleogenesis of the cave, including studies of its stratigraphic position, its origin, development, and orientation relative to geologic structure, surface topography, cave fills, and cave and subsurface hydrology.

Stafford C. Happ, Oxford, Mississippi, is continuing studies of sedimentation, and related erosion, in valleys of Mississippi, Minnesota, and Wisconsin, based on surveys initiated for USDA in 1936-40.

William A. Gallant, Denver, is presently under contract to the Bureau of Indian Affairs to study the historic meander development of a 35-mile length of the Missouri River in Iowa and Nebraska, involving a sedimentation and morphology approach to the problem.

David M. Mark, Univ. of British Columbia, has completed a master's thesis which compared two computer terrain storage systems (regular grids, irregular triangles) with respect to the evaluation of certain geomorphometric parameters. He plans to continue with research into surface analysis and surface behavior. He has also reviewed procedures for analyzing till fabrics and related fabrics, and attempted to relate the statistical results to fabric-forming processes. He is attempting to see whether different environments produce statistically different fabrics, and is working with *John Andrews* to re-analyze his Baffin Island cross valley moraine fabrics and to relate these to earlier results and processes.

Archie Stalker, Geological Survey of Canada, spent about six weeks doing field work in Alberta and Saskatchewan, mostly in further collecting at fossil vertebrate sites. During part of that time he was accompanied by *C. S. Churcher*, vertebrate paleontologist from the Univ. of Toronto. One new bone site, north of Irvine, Alberta, was investigated which is apparently of the same age as the Wellsch Valley site, or straddling the Pliocene-Pleistocene boundary. Work was concentrated on the Wellsch Valley Site (near Swift Current, Saskatchewan) and the Galt Island Site (near Medicine Hat, Alberta) of Mid-Wisconsin age. At the former site, material was screened for rodent bones and teeth, ash samples were gathered for paleomagnetic study and more volcanic ash was collected. At Galt Island, small bones and teeth were collected from a new horizon estimated to be about 35,000 years old. Another bone bed there was 39,000 years old. A still younger one is also present, but unexplored as yet. More information is also being gathered on the gigantic bedrock blocks found between till sheets (some weighing many millions of tons).

W. R. Cowan, Ontario Dept. Natural Resources, is presently mapping Lake Huron and Georgian Bay lobe sediments of Late Wisconsinan age from 43°45' to 44°00' north and from longitude 80°00' west to Lake Huron (approximate longitude 81°45'). Several till sheets of Port Bruce Stadial and Port Huron Stadial affiliation are present as well as one till sheet related to the older Missouri Stadial. Other activities include the investigation of a Middle Wisconsin interstadial site near Woodstock, Ontario, trend surface analysis of four major till sheets in the Brantford-Woodstock area of southern Ontario, and discriminant analysis of textural and lithologic properties of the same till sheets.

Current Quaternary research of *David Branagan*, Univ. of Sydney, is concerned with the origin of widespread patterned rock surfaces in the Sydney region, and Quaternary earth movements in the Sydney Basin, New South Wales.

James R. Underwood, Jr., is concentrating on the study (mapping) of the Acidialium Planitia region, Mars. Interest in the quadrangle is heightened by the fact that the Viking "B" prime landing site, Cydonia, is in this quadrangle.

Present activities of *Kerby E. LaPrade* are still centered on Tertiary-Pleistocene-Recent glacial history and the origin of landforms, Transantarctic mountains, East Antarctica and Ellsworth Land, West Antarctica.

Thornton L. Neathery, Geol. Survey of Alabama, has undertaken research studies to ascertain criteria for the recognition of recent faulting and other structural problems related to engineering geology in the Coastal Plain areas of Alabama. This work is still in the planning stage although several small pilot projects were undertaken and completed last year. During the coming year preliminary investigation into recent structural manifestations in Alabama is scheduled for completion.

Denis E. Marchand, Bucknell Univ., began a study last summer of the chemical weathering of plagioclase in five anorthosite bodies under varying present-day climates. The five anorthosites are located in southern Virginia, the Adirondacks of New York state, southeastern Wyoming, northern Idaho, and southern California. The research will include chemical analysis of bedrock, soils, and groundwater, x-ray diffraction studies of clay mineralogy, and possibly some laboratory investigation of plagioclase weathering. Research is also being continued on the Pleistocene stratigraphy and chronology of the central Susquehanna Valley and on the impact of biological processes and land use on water quality, especially sediment yields and cation concentrations.

John A. Elson spent six months (sabbatical) in the American West getting acquainted with desert phenomena with the objective of getting a feeling for nonglacial Quaternary phenomena. Most striking was the different order of magnitude of time involved in the geomorphic processes. In Canada, processes are thought of in postglacial terms, and the time interval is apt to be 10,000 years, whereas in the Southwest the time is orders of magnitude greater. Research interests were maintained in two areas: that of talus as a cold climate indicator was suggested long ago by Blackwelder—is there a "paleo" talus line similar to former snowlines represented by Pleistocene cirques? The importance of lithology quickly emerged as a major element, since lavas produce talus down to sea level in Mexico. However, sandstones and intrusive igneous rocks probably do show a former climatic talus line. What could emerge from this kind of study is improved information on the resistance of rocks to weathering (mainly chemical). The second research interest was the development of a system of ground level multiband photography using wave lengths ranging from ultraviolet to infrared, to discover if the method could be more useful in airphoto geology

CURRENT RESEARCH ACTIVITIES

than is apparent from the literature. Multiband photos of about 50 types of geological exposures were obtained, ranging from scenes where age relationships might be determined from desert varnish to close views of igneous rocks in the hope of finding textures not otherwise obvious. Nothing magic has appeared, but use of the system may be worthwhile for some specific materials, possibly where carbonates are in a sequence of clastics. Two M.Sc. students are working on the Quaternary geology of southern Quebec and one Ph.D. project on the geomorphology of placers in the north-west territories is moving ahead.

Detlef A. Warnke, Calif. State College, Haywood, is continuing petrographic studies of rocks inhabited by lithophytic (especially endolithic) algae and evaluation of possible geomorphic effects caused by these organisms (with *E. I. Friedman*, Florida State University). He is also working on evaluation of petrographic determinants of pediment evolution in parts of the Mojave Desert and investigation of climatic changes through sediment-petrographic methods, emphasizing studies of quartz-grain surface features by differential-interference microscopy.

J. C. Dionne, Laurentian Forest Research Center, Quebec, is involved in a three-year program of mapping Quaternary deposits in a large area located between latitudes 52°-55° and longitudes 68°-79°. The work is mainly done by photo-interpretation with field checking of units mapped using a helicopter. This mapping program is part of an ecological study of the Department of Canada Environment for the "Societe de Development de la Baie de James" in connection with hydroelectric projects in that area. The region studied includes a large area formerly covered by the Tyrrell Sea and the area where the remnants of the Laurentide ice sheet melt. Hopefully, data collected will allow a better understanding of late-glacial events. Drift ice features along shores, rivers, and lakes are also being studied in that area.

Reginald P. Briggs, USGS, Carnegie, Pennsylvania, is presently working with *William E. Davies* and others of the USGS on a multi-disciplinary program sponsored by the Appalachian Regional Commission, chiefly (but not entirely) aimed at Allegheny County, Pennsylvania. The job includes an earth-disturbance inventory (landslides and landslide susceptibility, strip mines, mine subsidence developments, etc.), groundwater studies, land use mapping, preparation of slope maps, and other facets, and the integration of these into a whole. Parallel work under ARC sponsorship is being done by the Allegheny County Department of Planning and Development and by the Center for the Study of Environmental Policy of the Pennsylvania State University. The goal of this three-part effort (styled LUPRA for Land Use and Physical Resource Analysis) is a firm insertion of factors of the physical environment into the land use planning and decision-making processes. In short, it is a program that starts with basic research on factors affecting, chiefly, slopes of the area and carries on through applied research to application.

Marie Morisawa, SUNY at Binghamton, is working on a variety of problems including (1) hydrologic and geomorphic effects of changing land use, urbanization, and channel modifications in the Binghamton area; (2) land use and open space inventories in Vestal, New York; (3) assessment of wild, scenic and recreational rivers in New York; and (4) coastal erosion and stabilization studies on the south shore of Long Island. Editing and publishing of "Fluvial Geomorphology: Proceedings of the 4th Annual Geomorphology Symposium at Binghamton" is complete. Copies are available from M. Morisawa, Publications in Geomorphology, SUNY, Binghamton, New York 13901.

Jane L. Forsyth, Bowling Green State Univ., reports that study continues on the late Wisconsin history of the western end of the Lake Erie area, with a publication out in the fall issue of the *Compass* of Sigma Gamma Epsilon entitled "Late-glacial and postglacial history of western Lake Erie." An exciting contribution to this subject came through an informal field conference in western and central New York state where drainage channels from the Buffalo area to east of Syracuse were observed. Of particular interest was a gravel pit in which the rounded contents averaged about *three feet in diameter*—nothing but a tremendous flood, of the kind that must have emptied Lake Erie when the ice first retreated far enough north for eastward drainage to occur, could explain such large (rounded) material! Less systematic but just as exciting was a chance to see glaciated landscapes in Scandinavia earlier last summer. Similar observation of Swiss mountain landscape will go on this summer in a class run by botanists from the Univ. of California. This latter trip also relates, in a general way, to the continuing research being done in Ohio on the relationship of plant distribution to geologic substrates. A second paper on a lime-prone thistle (*Carduus nutans*) and a paper on cinquefoil (flower) occurring only inside the glacial boundary are close to completion with other such research in progress. Despite all this work with

plants, glacial geology has not been forgotten; the glacial geology of three different Ohio Counties are also nearing completion.

Irwin Novak, Univ. of Maine, is involved in beach profile monitoring programs in southwestern Maine and a study of the effects of canal building on the morphometry of the Saco River, Maine.

Ronald C. Flemal, Northern Illinois Univ., and three graduate students began a study of dissolved solids in Illinois streams this summer. The project, sponsored by the Illinois Water Resources Center, will attempt to answer both local questions regarding water quality and broader questions concerning anthropogenic effects on stream chemistry, mechanisms of chemical weathering, and rates of denudation. The study will use chemical analyses of stream waters collected by the Illinois State Water Survey over the period of the last 30 years. Flemal is also involved in the 1975 SUNY-Binghamton geomorphology symposium, which will be "Models of Landscape Development." Papers and discussion will present views and reviews of the several differing philosophies of the mechanisms and sequences of landscape development in hopes of bringing into better focus the major points of contention among various schools of geomorphic thought and perhaps resolve some of the discrepancies between their viewpoints. Potential contributors are asked to contact program organizers Wilton Nethorn, Purdue Univ., or Ronald C. Flemal.

Ansel M. Gooding, Earlham College, continues to study soils, glacial geomorphology, and glacial stratigraphy in southeastern Indiana. Present work deals with the early Wisconsinan history. Indiana Geological Survey Bulletin 49, entitled "Characteristics of Late Wisconsinan Till in Eastern Indiana," was recently published and a paper dealing with Kansan and Yarmouthian stratigraphy is in press.

William Tanner, Florida State Univ., and others, have developed a computer program which produces, at intervals of 1 km (or less) along a beach, breaker height, wave approach direction, littoral drift direction, littoral current velocity, littoral component of power, gradient of the littoral component, and quantity of sand expected to be transported. This program and its applications were discussed in detail in a short course which also included *Frank Stapor*. Proceedings of that conference are available at \$20 per copy. Work continuing on C¹⁴ dates now indicates many dates more than about 10,000 years old are actually much older, some 10x as old. A preliminary report was published in the Trans. Gulf Coast Association in 1972. Work with *R. S. Murali* has been enlarged on sediment-wave interactions along beaches where the fetch is severely limited (for example, lakes and lagoons). In such situations, the waves tend to be driven the full width of the water body, whereas open ocean waves are, in many instances, only coasting when they enter near-shore water. The results are quite different. Also finished is the initial phase of a study on beach pads on the shore of Lake Michigan. These sand bodies, larger than beach cusps and shaped distinctively, had littoral velocities of about 50 m/yr. During the summer of 1973 several weeks were spent in the Bucaramanga area, Colombia, studying the sediment-deformation interactions shown in the large Pleistocene fan on which the city was built; a report on this work has been completed and is being submitted for publication. Several weeks were spent along the coast of Brazil, making a preliminary investigation of Holocene beach deposits and associated dune sands. Nearing completion is a project which specifies, in algebraic form, the relationships in a river among bed load grain size, bed load quantity, discharge, bed shear stress, and stream gradient. The derivations have been finished for the limiting case for bed load ("maximum size moved"), the bed load-wash load boundary or transitional strip, the movement of isolated boulders which rest on the bed, and the bedload quantity expression. Work continues slowly—but regularly—on a compilation of data for a Pleistocene history, built primarily, but not exclusively, around sea level changes. Several graduate students are working on Pleistocene-Holocene problems, in the areas of sedimentology and neotectonics.

Chip Beatty, Univ. of Lethbridge, has just finished a study relating postglacial winds and coulee alignment in southern Alberta. Other projects include late- and postglacial slumping on the southern flank of the Cypress Hills, morphologic contrasts on coulee walls of southern Alberta, and glacial features of Milk River Ridge, southern Alberta.

C. C. Reeves, Jr., Texas Tech. Univ., has been mainly involved in coring large pluvial lake basins in West Texas, using basin morphology/drainage to deduce paleoclimatic parameters. Anyone interested in doing some Pleistocene pollen (probably post-Kansan to Early Wisconsin), can contact him and he will ship the core (prepaid!). A book on *Caliches of North America* has been submitted for publication. He traveled throughout the western United States this summer on caliche studies.

Daniel J. Stanley, with associates and graduate students at the Smithsonian Institution's Division of Sedimentology in Washington, D.C., are focusing on problems of sedimentary processes in deep marine environments, including basins in the Mediterranean Sea and the continental margin off the Mid-Atlantic States in the northwest Atlantic. Particular attention is being paid to the origin and dispersal of the unconsolidated Quaternary outer margin sediments including those in straits and on the shelfbreak, canyons, fans, and basin plains in both the eastern and western Mediterranean. Emphasis at present is on distinguishing the different types of deep sea muds (hemipelagic deposits, mud turbidites, etc.), using x-radiographic and mineralogic technology. Preliminary studies show a striking analogy between sedimentation patterns of the Quaternary sections in modern ocean settings and those of turbidite-rich sequences, including flysch facies, preserved in the fossil record.

Dennis N. Nielsen, Winona State College, recently received a research grant for studying Quaternary stratigraphy in southeastern Minnesota. He and students are presently doing field work in the drift regions east of the Mankato drift border where they hope to define specific lithostratigraphic units for the region and attempt to correlate units with others in Minnesota and adjacent areas.

Research activities of *Richard H. Ragle*, Arctic Inst. of North America, include continuing the inventory of glaciers and related features in the St. Elias Mountains of Canada, and, as time permits, continuing study of the drainage history of Kluane Lake, Y.T., and interpreting data from temperature, mass balance, and surface movement measurements of the Kaskawulsh Glacier, Y.T.

M. Artesian Saines, Harza Engineering Co., Chicago, was involved in a prefeasibility level study of the terraced valley-till deposits in the Upper Magdalena Valley of Colombia, South America.

R. J. Pike's morphometric studies of terrestrial and extraterrestrial craters lately have ventured into the realm of multivariate statistics. The impact hypothesis still appears to best explain most craters on the Moon. However, his lunar photogeologic map of the Hyginus Rille area contains a crater that closely resembles Trou-au-Natron volcano in the Tibesti Massif. Other research is directed toward various quantitative descriptors of terrestrial land-form and toward relative-roughness analysis of Mars in preparation for the 1976 Viking lander.

Alan Jopling, Univ. of Toronto, spent a half-year sabbatical leave in Europe in 1973; for part of this time he worked in the Geography Dept., University of Reading, and for the other part in the Geomorphology Laboratory, University of Uppsala. His research at Reading focused on the historical aspects of glaciofluvial sedimentation. He also carried out a flume study of silt transport in the Geomorphology Laboratory at Uppsala.

Joe Creager and others, Univ. of Washington, have been studying modern sediments and benthic foraminifera of the southeastern Bering Sea continental shelf. Extensive acoustic-profiling records have permitted production of a revised bathymetric chart of the southeastern Bering Sea continental shelf. Factor analysis of sediment texture has identified five factors whose distributions and associated sediment characteristics are in accordance with available physical oceanographic data and published sediment transport models. Sediment characteristics in water shallower than 50 to 60 m suggest the influence of active resuspension whereas deeper sediments appear controlled by settling velocity and distance of transport.

Joe Creager and *Mark Holmes*, Univ. of Washington, combined to work on Holocene history of the Laptev Sea continental shelf. The 400-km wide, low gradient Laptev Sea continental shelf consists of flat terracelike features at regular depth intervals from 10 to 40 m below present sea level. The five large submarine valleys traversing the shelf do not continuously grade seaward but contain elongate, closed basins. These terraces and closed basins plus deltaic sediments associated with the submarine valleys quite possibly mark sea level still stands, and enable reconstruction of the paleogeography of the Laptev Sea shoreline at five periods during post-Wisconsin (Holocene) time.

William Dietrich, Univ. of Washington, studies sediment production and transport from a deeply dissected basaltic highland in central coastal Oregon. Field work has consisted of mapping bedrock, landslide, and volume of stored sediment in the Rock Creek watershed south of Yachats, Oregon. Petrographic descriptions of the soils, sand-size stream sediment, and beach sands are in progress.

Darrell Herd, Univ. of Washington, is investigating the glacial and volcanic geology of the Ruiz-Tolima volcanic complex in the central Cordillera Central of Colombia. One of the most extensive inter-related glacial and volcanic records heretofore reported in South America was used to develop a history of volcanic and glacial events in this complex. This chronology, which has been partially dated by

radiocarbon dating and fission-track dating, provides the first radiometric evidence of a late Pleistocene pre-Wisconsin glacial advance in the Andes, and suggests that major late Quaternary climatic fluctuations in the northern Andes were broadly contemporaneous with those of higher latitudes.

William Scott, Univ. of Washington, is working on distribution of heavy metals in Puget Lowland lakes and bogs. Emphasis is on the local changes in heavy metal content of lake and bog sediments during the last few centuries in an attempt to evaluate the effects of human activity (especially smelting of ores) on heavy metal distribution. He is also studying Quaternary geology of the Metolius River area, Oregon. Using weathering and soil characteristics of the drifts and stratigraphic relationships to interglacial volcanic rocks, a sequence of three major Pleistocene glaciations, a late Pleistocene-early Holocene advance, and a twofold late Neoglacial advance has been developed.

Hugh Mills, Univ. of Washington, is investigating the genesis of alpine glacier drift in Washington. Sedimentary parameters under examination include size distribution, fabric, roundness, and shape.

Minze Stuiver and *Stephen Robinson*, Univ. of Washington: As part of the GEOSECS program of the International Decade of Ocean Exploration, high-precision determinations of radiocarbon content are being performed on marine bicarbonate samples from vertical profiles along transects through the Atlantic and Pacific Oceans. These data are being applied to problems of oceanic circulation, mixing, and transfer across the ocean-atmosphere interface. Development work is in progress that will make possible the extension of radiocarbon dating to approximately 70,000 B.P. The method employs isotopic enrichment by the thermal diffusion process.

Minze Stuiver and *Albert I. C. Yang*, Univ. of Washington: Potassium argon dating is being performed on Pleistocene basaltic lavas from Mauna Kea, Hawaii. The results are in agreement with stratigraphy worked out by *S. C. Porter*, who collected the samples, and range from 0.06 to 0.4 m.y. Potassium content of these samples is less than 1.5% and the extracted argon contains an atmospheric contamination of 96 to 98% that is not removable by baking at temperatures as high as 700°C. Consequently, for the younger samples the error in the measured age can be as high as 50%.

Don Tubbs, Univ. of Washington: Landslides included in the Federal disaster records of early 1972 are being field checked to determine the mechanics of failure, stratigraphic controls, and human influences. News accounts of landsliding during the past half century are being compared to climatic records to isolate weather influences and assess the recurrence interval of periods of severe landsliding. Several methods for identifying hazardous areas are being evaluated.

Matsuo Tsukada, Univ. of Washington: The QRC Palynology and Paleocology Laboratory is focusing on selected aspects of Quaternary paleocology of Asia. A vegetation map during the last full-glacial period (25,000~15,000 yr B.P.) in Japan has been compiled from various pollen analytical results. Tsukada and his associates have also collected a 7-m core from the Moat of the Imperial Palace of Japan. The analyses of the pollen and heavy toxic metals in this core will help to elucidate the environmental history of Tokyo, one of the most populous cities in the world.

Lincoln Washburn, Univ. of Washington: A laboratory study of processes responsible for frost sorting and patterned ground has been started and will be eventually extended to include frost creep and gelifluction. The work is being carried out in cold rooms capable of temperatures of as low as -50°C. A unique tilting slab about 3 x 5 m in area and able to contain a 1-m thickness of soil over a simulated permafrost base is being utilized. Advisers who have worked at the laboratory include Dr. Amos Banin and Dr. Akira Higashi. The staff includes Dr. Chester Burrous, Jun Hiyakawa, Tom Pierson, and Philip Taylor.

Van Slyck Williams, Univ. of Washington: Pattern of ongoing tectonic deformation along a portion of the Himalayan Mountain front in eastern Nepal. Evidence from segmented alluvial fans at Dharan and stream terraces in the Sapta Kosi River basin form the main study.

Under the supervision of *R. F. Hadley*, USGS, hydrologic and geomorphic studies are continuing in the prototype oil shale lease areas in the Piceance Creek basin of western Colorado. These investigations include erosion and sediment transport studies in channels and on hillslopes to acquire baseline data prior to mining. Observations on these sites are planned during the mining operations. A report is being prepared on the first two years of the study in cooperation with the Colorado District of the Water Resource Division and is scheduled for completion this spring. Studies involving the potential hydrologic and geomorphic impacts of surface mining of

coal in the Powder River Basin are continuing in the Gillette, Wyoming, and Decker, Montana, areas.

Paul Karrow, Univ. of Waterloo, spent the summer of 1973 mapping the St. Mary's area of southwestern Ontario for the Ontario Division of Mines. This area is contiguous to areas previously mapped to the east and is underlain by Huron lobe tills of the Port Bruce Stadial. Preparations of a final report on the Stratford-Conestogo area is underway for the Geological Survey of Canada and a paper on till stratigraphy will appear in the *GSA Bulletin*. Three students are doing M.Sc. theses on southwestern Ontario: *A. J. Cooper* is studying old tills of the Waterloo area; *E. Frey* is studying Precambrian clast lithology as a provenance indicator for tills; others are comparing the characteristics of Halton and Wentworth tills of the Niagara Peninsula and completing a study of Quaternary history of the Baie Comeau-Sept Iles area of Quebec. Palynological studies of Lake Algonquin, supported by additional dating, are in progress. Plans for this year include continued study of Lake Algonquin and later history east of Lake Huron, including shore erosion studies, additional stratigraphic drilling at key sites with continuous split spoon sampling, completion of work in St. Mary's area, and, with *O. L. White*, compilation of geotechnical information of the Cambridge urban area.

Most of the work last year by *J. D. Mollard*, Saskatchewan, concerned terrain analysis studies carried out in connection with northern pipeline routes. Terrain along about 7,000 miles of northern Canadian routes (and alternate routes) was studied and classified in aerial photographs—mainly from a geomorphic point of view. Several other of the nearly 100 projects worked on dealt with searches and mapping of construction materials—again usually in the north and for sand and gravel. Many of the projects worked on over the year concerned groundwater location, development, evaluation, and pollution monitoring; highway transportation (route studies); and slope-stability studies. A major undertaking was the preparation for publication of the third edition of an airphoto interpretation manual titled "Landforms and Surface Materials of Canada: A Stereoscopic Airphoto Atlas and Glossary."

Ken Ruzyla, Marathon Oil, is working on a subsurface paleogeomorphology study of Upper Cretaceous shallow marine bars in eastern Wyoming and conducting subsurface paleogeomorphology studies on Paleozoic unconformity surfaces in the Salina Basin of Nebraska. The primary goal of both studies is the discovery of oil and gas reserves.

In mapping the southern part of the Westhampton, Massachusetts, quadrangle, *C. R. Warren*, USGS, has found evidence for an even more complex deglaciation history than the 18 stages already recognized. He now subdivides the events of the Wisconsin deglaciation into 25 numbered stages, of which several are known to be multiple (though most of the evidence lies beyond the area he has studied). Several of the stages are recorded by small lateral moraines marginal to the Connecticut Valley ice tongue.

W. Armstrong Price, Corpus Christi, is conducting research on local and world-wide classification of barriers, chenier plains, and deltas, and working on Pleistocene and Holocene sedimentary and environmental history of estuaries of secondary entrenched streams flowing along former Ingleside shoreline barrier-lagoons. In addition, isopach mapping of Holocene overlay on Pleistocene-Holocene unconformity, Corpus Christi area, is under way, and team research on coastal environmental histories and present conditions, mostly on Gulf of Mexico coasts, is proceeding.

Victor Goldsmith, Virginia Institute of Marine Science, has recently completed a map on bathymetry of the Virginia Sea from Cape Henlopen to Cape Hatteras.

Robert E. Wallace, USGS, is studying fault scarp morphology, processes, and rates of degradation as a key to such problems as recurrence of movement and thus of earthquakes. Effort is being concentrated on Holocene and late Pleistocene fault scarps; this year in northern and central Nevada. The study is part of a joint effort by the USGS and Univ. of Nevada to learn more about the central Nevada seismic belt as part of the USGS Earthquake Hazard Reduction program.

John Williams, USGS, Cohasset, Massachusetts, is completing water resources studies of the coastal drainage basins of southeastern Massachusetts between Rhode Island state line and Cape Cod canal—centered around the cities of Fall River and New Bedford. He is also serving on NAS-NEC-NAE Committee on Polar Research Ad Hoc Study Group on Permafrost. In 1973 he delivered a paper on ground water in permafrost regions of North America at an International Conference on Permafrost, Yobutsk, USSR, with *Rovau Everdingen*, Calgary, Alberta.

Randall Updike, Univ. of Wisconsin, is presently concluding a research project which was initiated with *Troy Pewe* in 1966 related to late Cenozoic, and particularly, Quaternary, geology of the San Francisco Peaks, northern Arizona. The study has involved de-

tailed field mapping and laboratory study of the volcanics, glacial geology, and mass movement phenomena associated with the peaks.

Don J. Easterbrook, Western Washington State College, has just completed a report on Environmental Geology of Whatcom County which includes sections on geology, slope stability, percolation rates, relative response to earthquakes, ground water, engineering properties, and interaction of man's activities and natural processes on the Nooksack floodplain and delta. Much of this work is being published as USGS Folio 854. Work continues on the paleomagnetism of Pleistocene sediments in the Puget Lowland and elsewhere and on neoglaciation of the North Cascades near Mt. Baker. Research on stratigraphy and palynology has just been published which ties in with a study of the Olympia nonglacial interval. Continuing are efforts with IGU Correlation Commission to correlate glaciations in Europe and North America.

R. A. Bagnold and *Luna B. Leopold* continued work this spring on their machine to trap all the bed load moving during flood in a medium-sized river, measure it on the stream bank, and return it to the river. Leopold, now retired from the USGS and a professor at Berkeley, continued work this summer in Wyoming on hillslope measurement and processes. *W. W. Emmett* of the USGS, Boise, Idaho, continued his measurements of channel and hydraulic characteristics during flood on Idaho rivers. A manuscript on this subject has been submitted to the Survey for a Professional Paper. Emmett, Leopold, W. B. Bull, Linc Washburn, and Larry Lattman were among the geomorphologists attending a symposium in Israel on desert processes.

John Moss, Franklin and Marshall College, has just finished a paper, "Relation of River Terraces to Glaciation," based on work on the Shoshone River, which flows from the Absaroka Mountains into the Bighorn Basin. This, of course, is the locale of Hoover Mackin's classic papers on graded streams and the origin of the Powell and Cody terraces. The origin of the terraces proves to be somewhat more complicated than Hoover realized. The terraces are traceable with remarkable continuity from moraines in the mountains, through a gorge, and far into the basin. An extremely interesting area in which to study downstream change in morphology, sedimentology, and gradient. Also near completion is a paper on the geologic effects of the Hurricane Agnes flood in the basin of the Conestoga River, a tributary to the Susquehanna in southeastern Pennsylvania. This has involved some interesting problems of why rainfall of only 8 to 9 inches in 51 hours in this drainage basin caused the greatest flood ever recorded. In much of the Susquehanna Basin, where rainfall exceeded 18 inches, the magnitude of the flood and the severe erosion are more easily understood. By contrast, in the Conestoga, despite an enormous increase in discharge from 320 cfs to 88,000 cfs, little widening or deepening of the channel took place nor was there recognizable deposition of sediment on many miles of the long-inundated floodplains.

Current research endeavors of *Richard Williams*, USGS, Reston, Virginia, in association with a number of Icelandic geologists, are directed at a study of different dynamic geological phenomena in Iceland. Types of geological phenomena under study include variations in time of thermal emission from geothermal and volcanic areas, changes in marine geologic and coastal geomorphologic features, variations in ephemeral snow cover, changes in glaciers and related features (for example, moraines, glacier-margin lakes, snowline, etc.), and effects of jokulhlaups. Also under study are regional relationships of geologic structure, tectonic features, and volcanic landforms. This research has been under way since 1966 and is based on field observations (ground and air) and analysis of aerial photographs (black and white, color, and color infrared), aerial thermography (thermal infrared imagery), satellite imagery (ERTS-1 and NOAA-2), satellite thermography (NOAA-2), and previously published maps. For the past two years much of the research emphasis has been directed at analysis of ERTS imagery.

Zane Spiegel, Santa Fe, is evaluating the cumulative effects of past and future groundwater development by wells and drainage in eastern Long Island, particularly with regard to the occurrence of ponds and streams and the prevalence of salt-water intrusion in coastal areas. Drillers logs of thousands of wells are being studied in an effort to determine the extent and hydraulic effects of clay and fine sand beds in a matrix of coarse pebbly outwash of Wisconsin age which is the principal aquifer of the area. The clay beds are locally important controls for leaky perched and semiperched aquifer elements and for lateral salt water intrusion.

Paul K. Grogger, Univ. of Utah, has finished his doctoral study on "Glaciation of the High Uintas Primitive Area, Utah, with emphasis on the northern slope." He verified that there were at least four major glacial advances in the Uinta Mountains: the Little Dry, Blacks Fork, Smith Fork, and Neoglacial. Within the Smith Fork, he added a fourth stage, the Agassiz, to the three stages previously recognized, and he divided the neoglaciation into four stages which he named Dead Horse, Tokewanna, Ostler, and Priord. These four stages he correlated respectively with Temple Lake I and II, the Audubon of the Colorado Front Range, and Gannett Peak.