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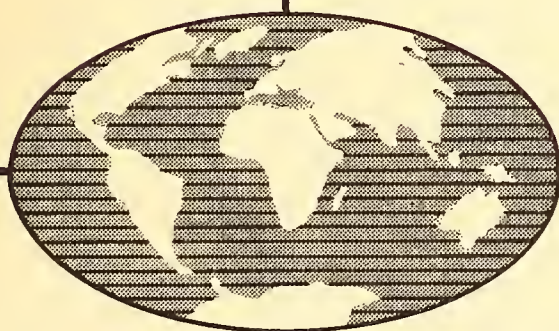




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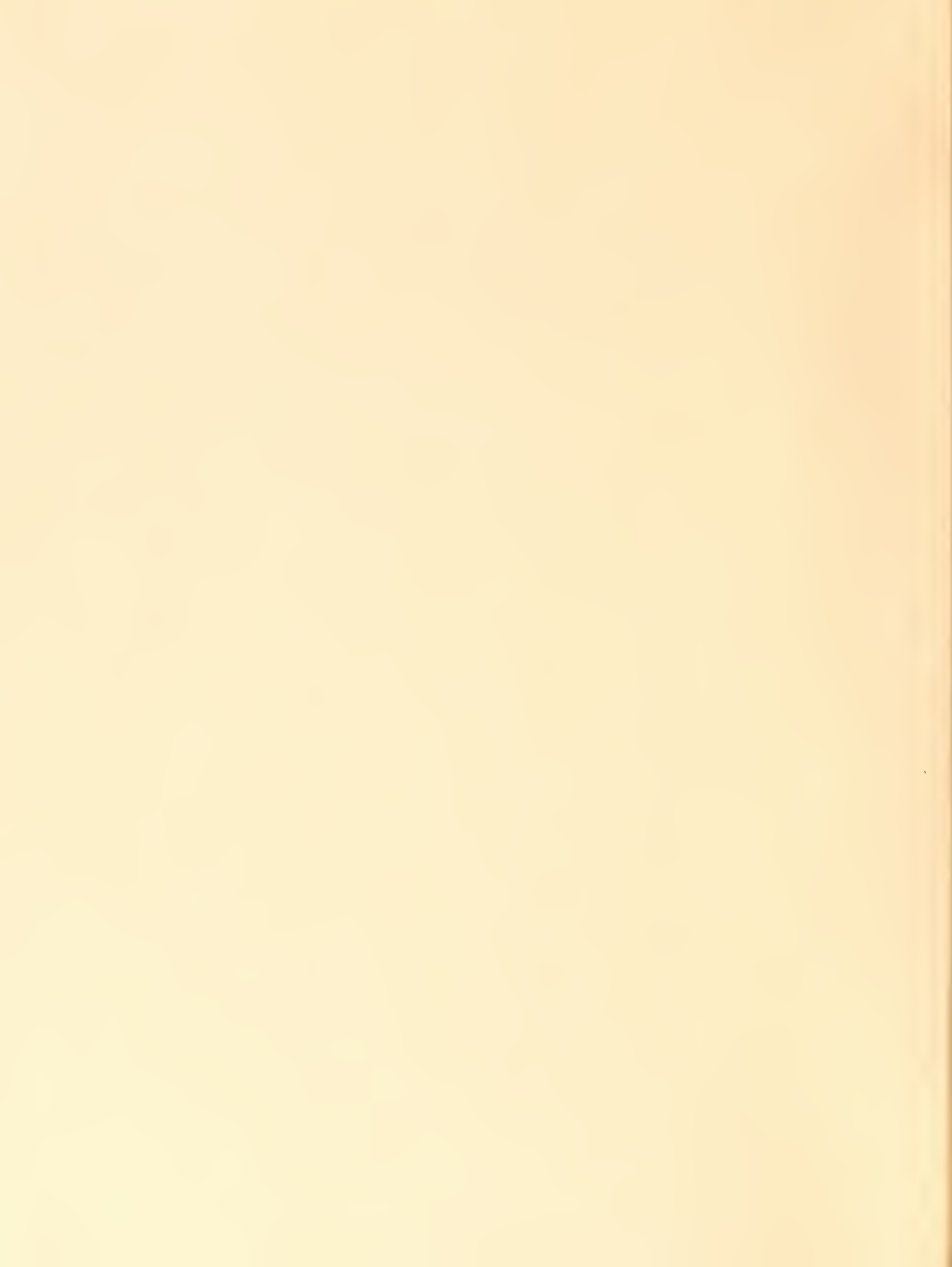
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Department of Geology  
University of Illinois  
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Research Report  
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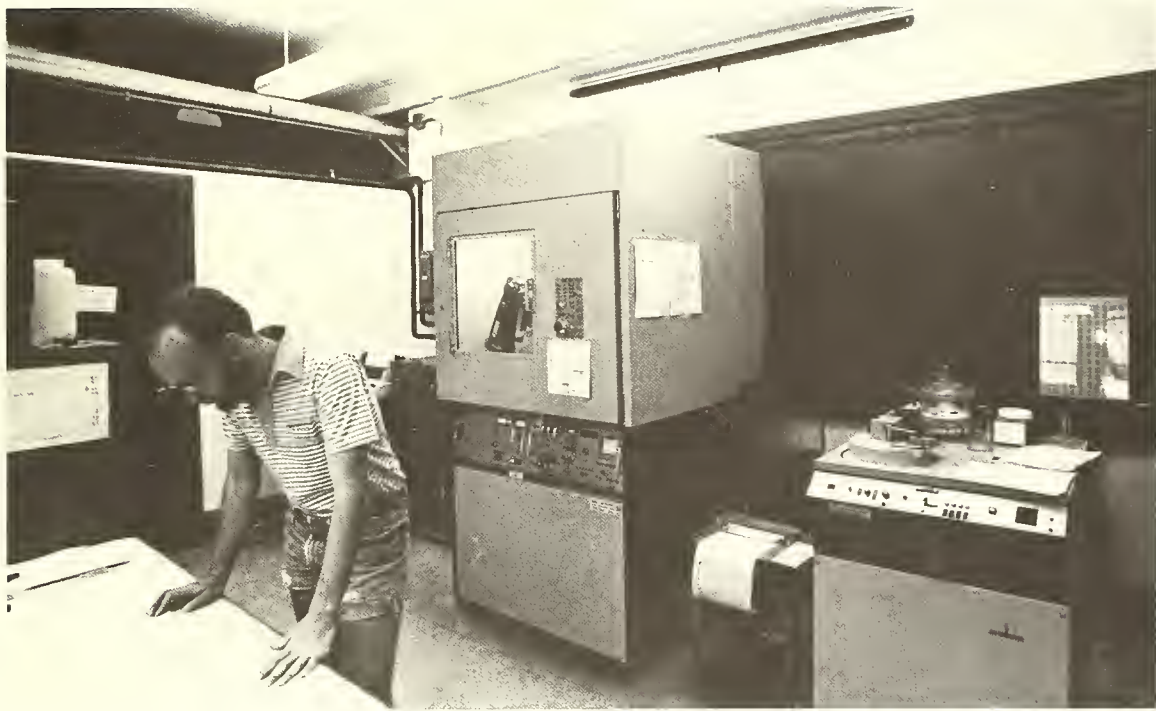
1984-1985 RESEARCH REPORT  
DEPARTMENT OF GEOLOGY  
UNIVERSITY OF ILLINOIS, URBANA-CHAMPAIGN

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(Compiled and edited by S. Marshak and P. Lane)





Rob Lander, a graduate student studying volcanic sediments with Professor Hay, analyzing the output of the X-ray diffraction unit.



## INTRODUCTION

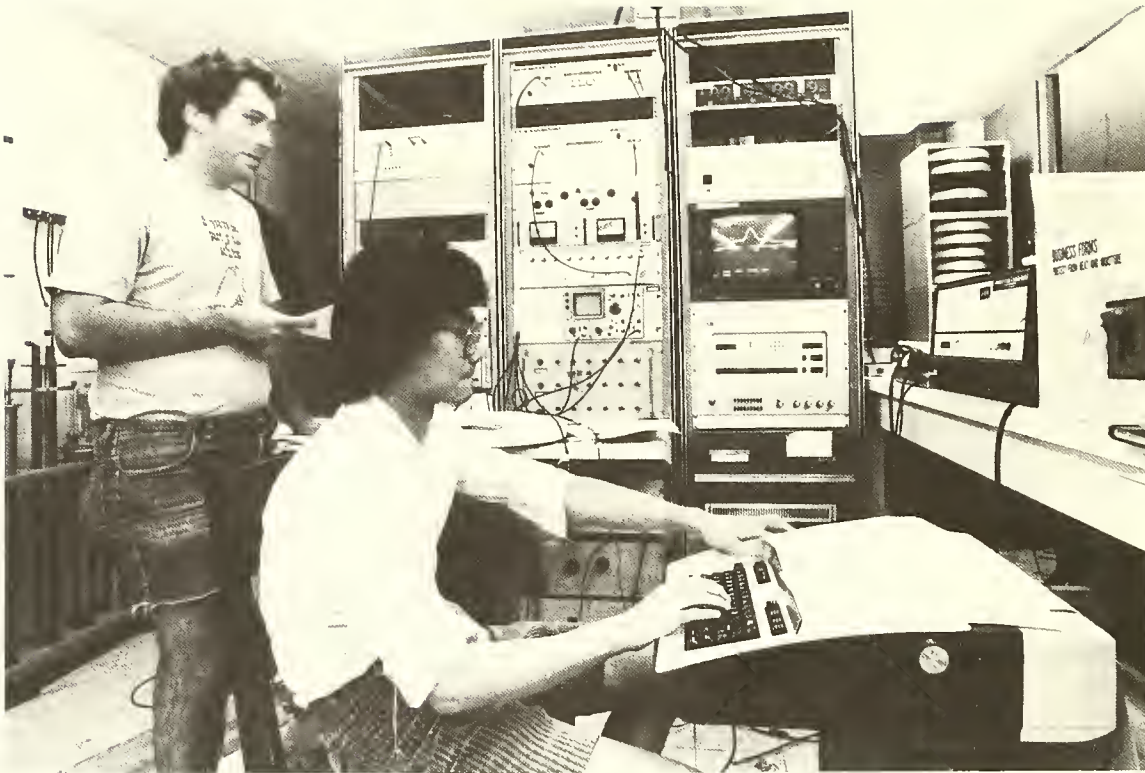
The Department of Geology continues to evolve rapidly with the appointment of six new assistant-professors and the filling of the Ralph E. Grim Chair by Richard L. Hay. One additional appointment in geochemistry/mineralogy will be made during the 1985 academic year.

These new appointments have completed our new research and teaching program in geophysics-seismology as well as reinforcing previous strengths in the areas of groundwater geology, clay mineralogy, geochemistry and the broad study of tectonics, diagenesis, sedimentology, structural geology, and historical geology.

One of the major advantages of the University of Illinois is the easy access to facilities in other Departments. The Department, for example, has access to superb micro-analytical facilities (SEM, high-resolution STEM, SIMS, etc.) in the Center for the Microanalysis of Materials (a National Facility in the Materials Research Laboratory) and the Center for Electron Microscopy and the NMR Center in Chemistry.

The Department is fortunate to share the campus with the Illinois State Geological Survey. Members of the Survey and the Department cooperate in research programs and graduate teaching in areas such as groundwater and environmental geology, clay mineralogy, quaternary geology, coal geology, stratigraphy and paleobiology.

With 60 students, the Department maintains strong programs in graduate research and teaching. The list on the following page outlines some major areas that include a broad coverage of theoretical, experimental and field research. The list is not exhaustive and some cross-disciplinary programs are available.



Geology graduate students, Charles Weiss and Wang-Hong Yang using one of the high-resolution nuclear magnetic resonance spectrometers. These spectrometers are used to examine the structures of a wide variety of crystalline and amorphous materials.



## GRADUATE RESEARCH AREAS IN GEOLOGY

**Clays and Clastic Diagenesis** - S. P. Altaner, T. A. Anderson, C. M. Bethke, R. L. Hay, R. J. Kirkpatrick, G. deV. Klein, R. C. Reynolds, Jr. (adj.)

**Carbonate Rocks and Diagenesis** - T. A. Anderson, A. V. Carozzi, R. L. Hay, P. A. Sandberg

**Engineering Geology and Applied Rock Mechanics** - A. S. Nieto

**Geochemistry** - S. P. Altaner, T. F. Anderson, C. M. Bethke, C-Y. Chen, R. J. Kirkpatrick

**Geomorphology and Quaternary Geology** - W.H. Johnson, L. R. Follmer (adj.), J. E. King (adj)

**Geophysics** - J. D. Bass, W-P. Chen, A. T. Hsui, S. Grand (1986)

**History of Geology** - A. V. Carozzi

**Hydrogeology** - C. M. Bethke, K. Cartwright (ISGS-adj.)

**Igneous/Metamorphic Petrology** - D. E. Anderson, C-Y. Chen, R. L. Hay, R.J. Kirkpatrick

**Mantle Dynamics** - J. D. Bass, C.-Y. Chen, A. T. Hsui

**Mineralogy/Mineral Physics** - S. P. Altaner, J. D. Bass, C.-Y. Chen, R. L. Hay, D.M. Henderson, R.J. Kirkpatrick

**Paleobiology** - D.B. Blake, R.L. Langenheim, P.A. Sandberg, J. King (adj)

**Sedimentary Basin Analysis** - S. P. Altaner, C. M. Bethke, D. B. Blake, A. V. Carozzi, R. L. Hay, A. T. Hsui, G. deV. Klein, R. L. Langenheim, S. Marshak

**Seismology** - W.-P. Chen, S. Grand

**Stratigraphy and Sedimentation** - T. F. Anderson, D. B. Blake, A. V. Carozzi, R. L. Hay, G. deV. Klein, R. L. Langenheim, C.J. Mann, P. A. Sandberg

**Structural Geology, Rock Physics, Tectonics** - D. E. Anderson, J. D. Bass, W-P. Chen, A. T. Hsui, S. Marshak, A. S. Nieto

## UNIVERSITY OF ILLINOIS GEOLOGY DEPARTMENT

### FACULTY PROFILES

The information given below is generalized and conveys only work done in the last few years. For more specific information about courses or research, please contact the individual faculty member at the Department address.

**STEPHEN P. ALTANER, Assist. Professor [1986 Appointment] (B.S., Colgate U. 1979; Ph.D. Univ. of Illinois 1985) - Clays and Diagenesis; Sedimentary Rocks and Stratigraphy**

Stephen Altaner will be setting up a program in clay mineralogic and petrologic research. Among his broad range of interests in clay mineralogy, he plans to investigate conditions of clay mineral formation in sedimentary and diagenetic environments, in soils, and in hydrothermal environments associated with epithermal ore deposits, modern geothermal fields, and acid sulfate systems. Specific research topics will include diffusion in argillaceous rocks, kinetics of diagenetic clay mineral reactions, determination of thermal and burial histories of sediments, and occurrence of ammonium in epithermal ore deposits. Results of this type of research will have applications in the fields of petroleum exploration, mineral prospecting, and nuclear waste disposal. Field relations, petrography, chemical analysis, x-ray diffraction, stable and radiogenic isotope analysis, mathematical modeling, and experimental petrology techniques will be used for this research. Mineralogic research will include examination of mixed-layer and non mixed-layer clay minerals by transmission electron microscopy, by near- and mid-infrared spectroscopy, and by nuclear magnetic resonance (to complement the existing program of R.J. Kirkpatrick).

**DAVID E. ANDERSON, Professor and Head (BSc-Hons., Univ. of Sydney, Australia, 1961; M.S. & PH.D. 1967, Univ. of Sydney, Australia) - Metamorphic and Theoretical Petrology**

Professor Anderson has been department head since 1983. His research involves metamorphic processes and their relationship to the thermal and tectonic history of various metamorphic terranes. Current projects include: 1) Studies (with Stephen Marshak) of the metamorphism of rocks in the Granite Wash and Buckskin Mountains of Western Arizona and the relationship of metamorphism to thrust faults in the region. 2) Compositional and textural zoning in garnets and their relationship to the tectonic history of the Moine Schists of Scotland. 3) Chemical changes associated with shearing and mylonitization of basic igneous rocks in Scotland and Upper Michigan. 4) Theoretical modelling of diffusion processes in aqueous and crystalline electrolytes. Funds are currently being sought jointly by Stephen Marshak and D.E. Anderson for a comprehensive study of the deformation and metamorphism of the Transantarctic Mountains. Professor Anderson teaches graduate courses in thermodynamics (including non-equilibrium thermodynamics) and metamorphic petrology.

**THOMAS F. ANDERSON, Professor (B.S. 1961, DePauw University, Ph.D. 1967, Columbia University) - Stable Isotope Geochemistry**

Professor Anderson's research involves the application of stable isotope variations to investigating the origin and diagenesis of sediments. He collaborates with Dr. John D. Hudson of the University of Leicester on oxygen isotope variations in Phanerozoic carbonates and their implications for diagenesis, paleoclimates, and hydrosphere-lithosphere interactions. Much of the data used is from a continuing joint project with Prof. P. A. Sandberg on textural, chemical, and isotopic characterization of constituents in Phanerozoic limestones. Three Ph.D. students are currently involved in this joint project. Professor

Anderson is also collaborating with Dr. M. A. Arthur (University of Rhode Island) on mass and isotopic balance considerations on the burial of organic carbon and sulfur in marine sediments. The results of this study will improve our general understanding of the role of sedimentary cycles in global redox balancing. One Ph.D. student is conducting research in this area. Professor Anderson also maintains his interests in paleo-oceanographic implications of isotopic variations in Quaternary nannofossils, the origin of ground ice and the sulfur isotope geochemistry of coal. Future plans include the continuation of studies on secular isotope variations (oxygen, carbon, sulfur) in marine sediments, with particular emphasis on mid- and lower-Paleozoic limestones and shales and on oxygen isotope variations in biogenic phosphates. Professor Anderson would also like to resume studies of experimental carbonate diagenesis.

**JAY D. BASS, Assistant Professor (Ph.D. 1982, State University of New York at Stony Brook) - Geophysics; Mineral Physics; Elastic Properties of Minerals**

Jay D. Bass has been at Illinois since August 1984. His major research efforts are in the area of experimental geophysics and laboratory measurements of the physical properties of minerals. Much of his recent work has focused on measurements of elastic wave velocities in minerals and high-pressure polymorphic phases by Brillouin spectroscopy, and this work is being further pursued at Illinois. Brillouin spectroscopy is a light scattering technique that is particularly well suited for measuring wave velocities in microscopic-sized samples, many of which are synthesized at high pressures and high temperatures. The results of such experiments are used to calculate the wave velocities and density of mineral aggregates under the high-pressure and high-temperature environment of the Earth's deep interior. Comparisons with seismological models of velocity versus depth in the Earth provide a powerful constraint upon the chemistry and mineralogy of the Earth's mantle, and this is a prime motivation for measuring elastic properties. In addition to measurements under room conditions, a program will be initiated to perform these experiments at high pressure in diamond-window pressure cells, and at high temperatures. Other research pursuits include: 1) X-ray studies of crystal structures at high pressure, 2) The high-pressure equation of state of oxides and metals which bear on the composition of the mantle and core, using shock-wave techniques (in collaboration with the California Institute of Technology), 3) In-situ measurements of stress in the Earth's crust by holographic interferometry (also with Cal Tech).

**CRAIG M. BETHKE, Assistant Professor (A.B. 1980, Dartmouth College, Ph.D. 1985, University of Illinois) Hydrogeology**

Craig Bethke's primary research interest is study of the groundwater hydrology of sedimentary basins through geologic time, and the effects of groundwater motion on petroleum migration, ore formation, and sediment diagenesis. Recent work includes a theoretical analysis of the role of compaction-driven groundwater flow during subsidence of sedimentary basins, performed on a CRAY supercomputer. He applied this analysis in a study of the relative importance of compaction-driven and gravity-driven groundwater flow over the geologic history of the Illinois Basin, and this work has improved understanding of petroleum migration, as well as the genesis of Mississippi Valley-type ore deposits. Craig also recently completed research on the illitization reaction of smectite, a clay mineral dehydration reaction which is an important contributor of deep fluids and cements in evolving basins. This research was recognized with an award from the Clay Minerals Society. Current work involves construction of a numerical chemical reactor model to study the dynamics of sediment diagenesis, including effects of transport by groundwaters, and study of the origins of geopressed zones in the subsurface. With the support of petroleum and minerals companies and governmental sources, Craig is building a hydrogeology laboratory, complete with supercomputer and interactive computer graphics facilities.



**DANIEL B. BLAKE, Professor (B.S. 1960, University of Illinois, M.S. 1962, Michigan State, Ph.D. 1966, University of California) Invertebrate Paleontology; Biostratigraphy**

Professor Blake continues to study fossil and modern sea stars, and Paleozoic Bryozoa. In recent years, his work has taken him to numerous museums in North America, Europe and Australia. Professor Blake and Dennis Kolata, a geologist at the Illinois Geological Survey, have begun a paleoecological study of a Middle Ordovician carbonate and shale interval which is bounded by K-bentonite (altered volcanic ashes) isochrones. Individual K-bentonites can be recognized from Minneapolis-St. Paul to south of St. Louis and therefore it is possible to characterize coeval paleoenvironments on a subcontinental scale. Professor Blake teaches Introductory Physical Geology, undergraduate Paleontology, and graduate courses in Paleoecology and Principles of Paleontology. Paleoecology includes field trips to Southern Illinois and Kentucky.

**ALBERT V. CAROZZI, Professor (M.S. 1947, University of Geneva; [Geology and Mineralogy] Dr.Sc. 1948, University of Geneva) - Sedimentary Petrography; Petroleum Geology**

Professor Carozzi supervises many graduate students in the department and at the request of one of his major research sponsors, PETROBRAS (The National Oil Company of Brazil) has recently worked with them in setting up and implementing a new educational venture which consists of an MS program by PETROBRAS in association with the Federal University of Ouro Preto (Minas Gerais). This program includes reservoir geology, structural geology, engineering geology and basin analysis. Professor Carozzi taught short courses dealing with the sedimentary petrography of carbonate and siliciclastic rocks, followed by their depositional models applied to oil exploration for the first phase of this program in Brazil. He is presently working on the second phase and the planning of a Ph.D. program. In addition to PETROBRAS research support, TEXACO USA is supporting microfacies work and experimental development of secondary porosity in carbonate rocks under simulated deep burial conditions with application to the Atokan of the Midland Basin and the Smackover of the Gulf Coast.

**CHU-YUNG CHEN, Assistant Professor (B.S. 1977, National Taiwan University, Ph.D. 1983, MIT) Trace Element Geochemistry; Isotope Geochemistry; Igneous Petrology**

Chu-Yung Chen joined the Department in August 1983 and is setting up a neutron activation laboratory and an isotope dilution laboratory for high quality trace-element and isotope analyses. Her research projects include: (1) The geochemical evolution of Haleakala volcano, East Maui. (2) Trace element variations of tholeiites, transitional basalts and alkalic basalts from Mauna Kea volcano, Hawaii. (3) Rare-earth geochemistry of Hilina formation, Kilauea volcano, Hawaii. (4) Pb isotopic geochemistry of Loihi seamount. (5) Sr and Nd isotopes and trace element geochemistry of ultramafic nodules from Mt. Leura, Victoria, Australia. (6) Trace element studies and factor analyses of coal from Freeport and aerosol from Houston. (7) Petrological and geochemical studies of West Maui volcano. (8) Trace element and isotopic (Nd, Sr and Pd) studies of the transition from tholeiitic to alkalic volcanism on Hawaiian islands. (9) Geochemistry of high-MgO basalts from Hawaiian volcanoes. (10) Mineral chemistry of Hawaiian basalts. (11) Ophiolites from Cyprus. (12) Kimberlites and Carbonatites from Illinois. (13) Oxygen isotopic geochemistry of Hawaiian basalts.

**WANG-PING CHEN, Assistant Professor (B.S., National Taiwan University, 1974, Ph.D., MIT, 1979) - Geophysics, Seismology, Tectonics**

The research activity of the earthquake seismology group centers around the quantitative understanding of large scale deformation of the lithosphere. The most important constraints are obtained from the precise determination of depth and source mechanism of earthquakes as well as the gravity and geoid anomalies derived from satellite altimetry observations. Dr. Chen's current research efforts include studying the relationship between seismic activity and the thermal-mechanical properties of the lithosphere, source kinematics of large earthquakes, and the role of strike-slip faulting in the evolution of regions of extensional tectonics. As a spin-off, a seismic study of the Azores-Gibraltar plate boundary is also funded by the NSF. The tectonic setting of this plate boundary is unique because of the presence of divergent, transcurrent, and convergent characteristics along a single boundary; the occurrence of ocean-ocean convergence apparently without a Benioff zone; and the transition from such convergence to continental collision. Dr. Chen was recently an invited speaker at the Regional Assembly of the International Association of Seismology and Physics of the Earth's Interior in India (1984) and visited the Himalaya as a part of his study on the quantitative aspects between seismicity and mountain building.

**STEPHEN GRAND, Assistant Professor [1986 appointment] (B.Sc. 1978, McGill University; Ph.D. 1985, Cal Tech) - Geophysics, Seismology**

Stephen Grand is interested in the elastic fine structure of the mantle. Using synthetic seismogram techniques to understand wave propagation in the mantle, shear waves from earthquakes can be used to determine structure. Using multiple bounce shear waves increases the resolution and applicability of the technique. Recently, using the synthetic seismogram technique, vertical shear profiles were developed for the Canadian shield, the western United States and the northwest Atlantic ocean, showing large differences to 400 km depth. Current research efforts are to derive fully three-dimensional models of the mantle shear structure beneath North America using the tomography technique, developing computer codes to make synthetic seismograms appropriate for propagation through laterally varying structure and investigating deep mantle structure beneath individual tectonic provinces on a world-wide scale. The ultimate goal of this research is to help answer questions such as how deep do continents extend, is the mantle layered and on what scale does convection occur in the earth.

**RICHARD L. HAY, Ralph E. Grim Professor of Geology (B.S. 1947, Northwestern University; M.S. 1949, Northwestern University; Ph.D. 1952, Princeton University) - Stratigraphy; Sedimentary Petrology**

Most of Professor Hay's work has been concentrated on the general fields of stratigraphy, paleo-environment of non-marine sediments, pedogenesis, silicate diagenesis, and volcanoclastic sedimentology. His present major research effort is on spring-related carbonate rocks and Mg-silicate clays (sepiolite, smectite and kerolite) that were chemically precipitated in a Pliocene lake basin in the Amargosa Desert of Nevada-California. By field and laboratory work he and his students are working out the distribution and paleoenvironments of the different types of carbonates and clays. A new research interest, developed at Illinois, is the diagenetic alteration of Ordovician Midcontinent tuffs to K-feldspar and K-bentonite. He is trying to determine when and under what conditions the K-feldspar and mixed-layer illite-smectite were formed. This research is in collaboration with Dennis Kolata of the Illinois Geological Survey.



**DONALD M. HENDERSON, Professor (A.B. 1943, Brown University; Ph.D. 1950, Harvard) - Mineralogy; Crystallography**

Professor Henderson's research interests are in the area of transmission electron microscopic and nuclear magnetic resonance study of the local structures of minerals. He teaches graduate and undergraduate classes in mineralogy, optical mineralogy, structural mineralogy and crystallography.

**ALBERT T. HSUI, Associate Professor (B.S. 1968, Lowell Technological Institute; M.S. 1969, Cornell University; Ph.D. 1972, Cornell University) - Geophysics; Mathematical Modelling; Geodynamics; Planetary Evolution and Borehole Seismology**

Dr. Hsui's research interests include: (a) Planetary differentiation and its effects on mantle evolution and mantle dynamics; (b) Magma dynamics and its relationship to the structure of igneous rocks; (c) investigations on the geodynamics at convergent plate boundaries and (d) a new project to study wave propagation around a borehole. Dr. Hsui teaches a general geology course for science and geology majors, exploration geophysics and two other graduate courses in Geodynamics and Mathematical Methods in Geology.

**W. HILTON JOHNSON, Associate Professor (A.B. 1956, Earlham College, M.S. 1961, University of Illinois; Ph.D. 1962, University of Illinois) - Quaternary Stratigraphy; Glacial Geology**

Dr. Johnson is working on a project, supported by NASA through the Jet Propulsion Lab, to evaluate the use of Shuttle Imaging Radar-B data in the delineation and mapping of glacial geology and meltwater drainage landforms from central Illinois to central Ohio. The radar and other remote sensing data will be integrated with ongoing stratigraphic and sedimentologic studies in making interpretations of the dynamics and interactions of some of the major lobes and sublobes along the southern margin of the Laurentide Ice Sheet. Graduate students under Johnson's supervision are working on a variety of projects including: Quaternary geology and glacial sedimentology in the Precambrian shield terraine of south-central Ontario, late Pleistocene and Holocene fluvial geomorphology, stratigraphy and sedimentology of the lower Illinois River valley region, provenance of Illinoian and pre-Illinoian tills in south-central Illinois, and late Quaternary geology of the Napoleon Hollow Archeological site, Illinois River valley. Dr. Johnson teaches Introduction to the Study of the Earth, Glacial Geology, Quaternary Geology and Geomorphology. Field trips taken locally and to central Wisconsin emphasize glacial geology and stratigraphy, to central and southwestern Illinois focus on glacial stratigraphy, paleosols, late Pleistocene and Holocene fluvial geomorphology and alluvial stratigraphy; trips to Indiana emphasize glacial and bedrock geomorphology of the karst plain near Bedford.

**R. JAMES KIRKPATRICK, Professor (B.S. 1968, Cornell University; Ph.D. 1972, University of Illinois) - Igneous and Experimental Petrology, NMR Spectroscopy**

For several years Professor Kirkpatrick's research has centered on the use of magic-angle sample-spinning nuclear magnetic resonance spectroscopy (MASS NMR) in examining the structures of silicate crystals and glasses (quenched melts). One aim of this work is to better understand the thermodynamic, mechanical, and crystallization behavior of lava and magma and thereby the origin, evolution, and crystallization of igneous rocks. Another major objective is to use MASS NMR to examine the structure of crystalline phases that are too fine grained to be examined by single crystal x-ray or neutron diffraction such as clay minerals. This research program is being conducted in collaboration with Prof. Eric Oldfield of the School of Chemical Sciences, Professor D.M. Henderson and students and post-doctoral fellows in both Geology and Chemistry. Professor Kirkpatrick teaches Igneous and Metamorphic Petrography, Igneous Petrology (Graduate Level) and Geochemical Kinetics.



**GEORGE deVRIES KLEIN, Professor (B.A. 1954, Wesleyan University; M.A. 1957, University of Kansas; Ph.D. 1960, Yale University) Sedimentology; Marine Geology; Sandstone Petrology and Diagenesis; Petroleum Geology of Clastic Reservoirs; Basin Analysis**

Dr. Klein's research interests are focused on several topics. These include (1) Paleogeographic distribution of depositional systems through time, (2) Analysis of the timing of depositional systems and sandstone diagenetic events to the geodynamic and tectonic evolution of sedimentary basins, (3) Correlation of sedimentological, tectonic and volcanic events in back-arc basins of the western Pacific, and (4) Understanding processes of sedimentation, preservation potential and mass balancing of terrigenous sediments delivered from continents to ocean basins. This last project involves analysis of changing turbidite sedimentation history in submarine fans to changes in continental sediment yield, uplift rate and denudation rate, and comparing such data to petrologic data so as to ascertain the role of weathering history, sea level change and tectonics to preservation potential of marine sediments. Analysis of sedimentary basins has focused on back-arc basins and cratonic basins and devising solutions for recognizing ancient basins of controversial origin. Paleogeographic analysis has focused on storm and tidal sedimentary systems.

**RALPH L. LANGENHEIM, JR., Professor (B.S. Geol. Engineering 1943, University of Tulsa; M.S. 1947, University of Colorado; Ph.D. 1951, University of Minnesota) - Stratigraphy, Paleontology, Field Geology, Geology of Energy, Coal**

Professor Langenheim's research centers on Pennsylvanian stratigraphy and biostratigraphy in the Illinois Basin and southern Nevada. Presently major effort is being devoted to determining brachiopod ranges in the Arrow Canyon, Nevada section which has been proposed for several regional and/or world stratotypes. Study of latest Chesterian and early Atokan brachiopods is planned for the immediate future as well as regional study of Atokan and Desmoinesian stratigraphy and biostratigraphy in the southern part of the Cordilleran Miogeocline. He teaches History of the Earth, Geology of Energy and Field Geology at the elementary level; Principles of Stratigraphy at the intermediate level and graduate courses in Stratigraphy. He is Director of the Summer Geology Field Camp which is held in Wyoming.

**C. JOHN MANN, Professor (B.S. 1953, University of Kansas; M.S. 1957, University of Kansas; Ph.D. 1961, University of Wisconsin) - Stratigraphy; Mathematical Geology; Petroleum Geology**

Professor Mann's mathematical geology research work, sponsored by Sandia National Laboratories, attempts to determine probabilities and probability density functions of natural geological events and processes in order to more accurately predict hazards accompanying long-term storage of nuclear waste materials. Dr. Mann is also examining the evolution of stratigraphic sequences in an effort to more accurately determine periodicities and cyclicities which are known to be present as well as to perhaps detect new ones which previously have gone undetected. He teaches Geology for Engineers, General Geology, and Principles of Stratigraphy. These courses include field trips to southern Indiana, Upper Wabash River Valley and San Salvador Island, Bahamas. Studies in the Bahamas are on algal structures in a brackish to hypersaline lake in an attempt to relate structures and lack of structures in the mounds to environmental conditions under which they are growing.

**STEPHEN MARSHAK, Assistant Professor (A.B. 1976, Cornell University; M.S. 1979, University of Arizona; Ph.D. 1983, Columbia University) - Structural Geology and Tectonics**

Dr. Marshak's current research focuses on field analysis of structural geometry and fabrics in fold-thrust belts and in poly-phase deformed metamorphic terranes.

This work presently involves studies in two regions: the Appalachian foreland in New York State and the Sonoran desert of western Arizona. His work on oroclinal bending in the Appalachians is currently being funded by the National Science Foundation. Conditional on funding, Dr. Marshak anticipates beginning a new project (with D.E. Anderson) on basement geology of the Transantarctic Mountains. Student theses in structural geology and tectonics (some of which are shared with D.E. Anderson) at the University of Illinois are on topics such as: structures of the Appalachian fold-thrust belt near Kingston, New York; polyphase deformation of Mesozoic strata in the Granite Wash Mountains, Arizona; mylonite evolution in the Buckskin Mountains, Arizona; petrographic and geochemical changes occurring during deformation of limestone; shear zone development in mafic dikes of northwest Scotland. Dr. Marshak's teaching responsibilities include: introductory structure, advanced structure, and geotectonics. Course field trips have run to northern Michigan, central Wisconsin, and eastern Tennessee. Two new courses are anticipated: Tectonics of the southern Cordillera (with D.E. Anderson), and Rock rheology (with J.D. Bass and W.-P. Chen).

**ALBERTO S. NIETO, Associate Professor (B.S. 1961, San Marcos University; M.S. 1963, Washington University; Ph.D. 1974, University of Illinois) - Engineering Geology; Applied Rock Mechanics**

Dr. Nieto's main professional interests are applied rock mechanics and the geotechnical characterization of large engineering sites such as hydroelectric projects, underground storage caverns, waste disposal sites, surface and underground mines, major highways, foundations for large structures and others. He is presently supervising Ph.D. theses on shear strength of soil-filled discontinuities in rock masses and the analysis of a new model for slope failures that involves a combination of toppling and sliding. Dr. Nieto teaches Geology for Engineers, Principles of Engineering Geology and Practice of Engineering Geology at undergraduate and graduate levels; he also holds a joint appointment in the Civil Engineering Department.

**PHILIP A. SANDBERG, Professor (B.S. cum laude 1960; M.S. 1961, Louisiana State University. Fil. Lic., 1964; Fil. Dr., 1965 University of Stockholm) - Carbonate Sedimentology; Micropaleontology; Historical Geology**

Professor Sandberg's current research is in part on the temporal variation in non-skeletal carbonate mineralogy and its relationship to plate-tectonically mediated chemical changes in the ocean, particularly  $pCO_2$ . Another major research effort is devoted to the study of microcrystalline limestones, including the role of cementation and compaction in lime mud diagenesis, and temporal and environmental variations in lime mud diagenesis and precursor carbonate mud types. Professor Sandberg teaches Carbonate Sedimentology, the SEM portion of Microbeam Analysis (SEM and electron microprobe), Micropaleontology, and an Intersession field course entitled "Introduction to Modern Marine Carbonate Environments" This field group looks at Florida Cenozoic carbonates in the panhandle area, along the west coast and around Miami, then goes to the Florida Keys region to study modern equivalents of ancient carbonates.



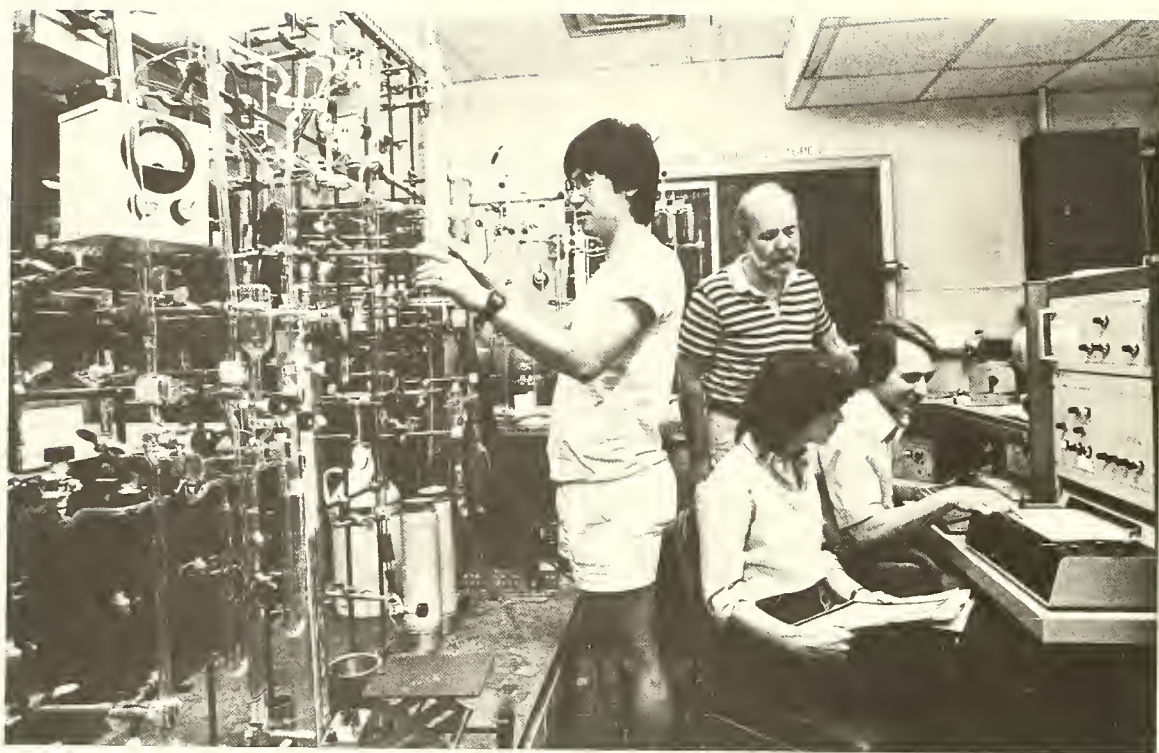
Nina Grimison, a graduate student in geophysics, calibrating a portable seismograph. The globe shows her thesis area in the eastern Atlantic.



## RECENTLY FUNDED PROJECTS

| Principal Investigator | Title  | Agency                                      |
|------------------------|--|---|
| Thomas F. Anderson     | Burial of Organic Carbon and Sulfur in Cretaceous Marine Sediments: Mass and Isotopic Balances   | National Science Foundation                 |
| Jay D. Bass            | Mineral Elasticity by Brillouin Scattering   | National Science Foundation                 |
| Craig Bethke           | Paleohydrologic Modeling of Sedimentary Basins   | ARCO  |
|                        | Techniques of Hydrologic Modeling  | TEXACO                                      |
|                        | Chemical Kinetics of Diagenetic Reactions  | EXXON Production Research                   |
| Chu-Yung Chen          | Petrological and Geochemical Study of the Evolution of West Maui Volcano   | National Science Foundation                 |
| Wang-Ping Chen         | A Study of Intracontinental and Intraplate Intermediate Depth (Sub-Crustal) Earthquakes  | National Science Foundation                 |
|                        | A Seismic Study of the Azores-Gibraltar Plate Boundary   | National Science Foundation                 |
| W. Hilton Johnson      | Interlobate Comparison of Glacial-Depositional Style as Evidenced by Small-Relief Glacial Landscape Features, Illinois, Indiana, and Ohio, Utilizing Shuttle Imaging Radar-B | National Aeronautics & Space Administration |
| R. James Kirkpatrick   | Kinetics of Igneous Processes  | National Science Foundation                 |
|                        | High-Resolution NMR Spectroscopy of Geologically Important Crystals and Glasses  | "   |
|                        | Study of Nuclear Magnetic Resonance (NMR) Spectroscopy of Solids   | Sandia National Laboratories                |
|                        | Study of Nuclear Magnetic Resonance (NMR) Spectroscopy of Solids   | "   |

| Principal Investigator | Title  | Agency  |
|------------------------|--|---|
| George deV. Klein      | Synthesis of Back-Arc Basin Sedimentology Based on DSDP/IPOD Drilling  | National Science Foundation                       |
| Stephen Marshak        | Kingston Arc of Eastern New York: Structural Geometry, Strain and Tectonic Significance of an Oroclinal Bend in the Appalachians | National Science Foundation                       |
| Philip A. Sandberg     | Original Mineralogy in Micrites: Genetic and Diagenetic Implications   | National Science Foundation                       |
|                        | Original Mineralogy in Micrites: Genetic and Diagenetic Implications   | American Chemical Society Petroleum Research Fund |
|                        | Original Mineralogy in Micrites: Genetic and Diagenetic Implications   | AMOCO   |



The stable Isotope Geochemistry Laboratory. Kyung Sik Woo is working on a vacuum extraction line. Professor Tom Anderson, Linda Bonnell and Brian Popp ponder the output of a mass spectrometer.



## LIST OF PUBLICATIONS 1984-1985

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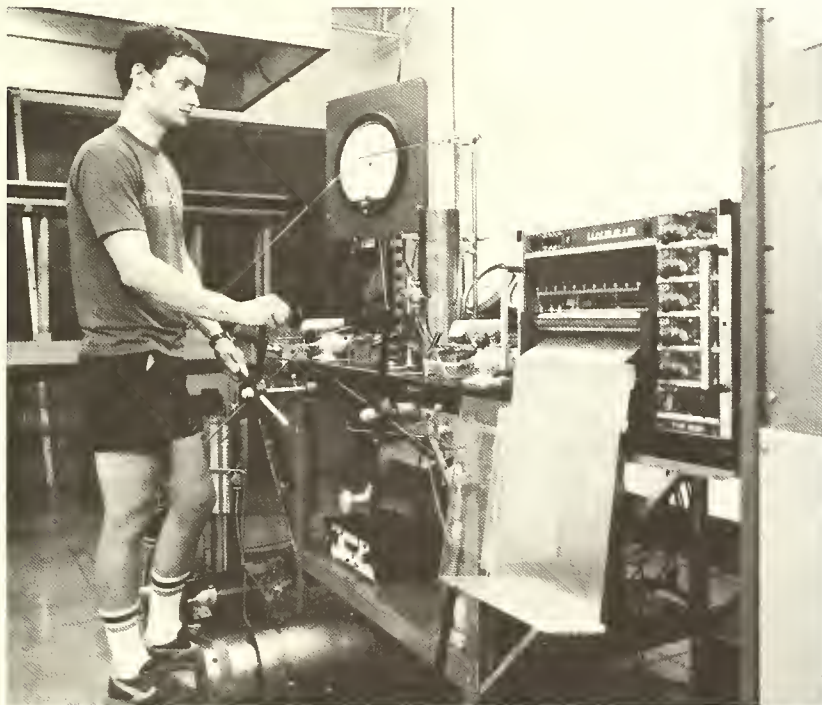


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Graduate student Don Von Bergen, who works with Prof. Carozzi, operating a unique high-pressure triaxial compression apparatus, which allows the circulation of CO<sub>2</sub>-charged water under controlled conditions of temperature and pressure. This apparatus, which simulates burial conditions, is used to study development of secondary porosity in carbonate rocks.

**DEPARTMENT OF GEOLOGY: COURSE OFFERINGS, 1982-1985, & ANTICIPATED**

**Geophysics - Structural Geology - Tectonics**

**Engineering Geology**

|                                    |     |                         |
|------------------------------------|-----|-------------------------|
| Introduction to Geophysics         | 350 | Bass/Chen/Chen          |
| Geophysical Prospecting            | 351 | Hsui                    |
| Physics of Earthquakes             | 397 | W.-P. Chen              |
| Mathematical Methods in Geology    | 480 | Hsui                    |
| Geodynamics                        | 493 | Hsui                    |
| Numerical Methods in Geomechanics  | 493 | Hsui                    |
| Introduction to Seismology         | 493 | W.-P. Chen              |
| Advanced Topics in Seismology      | 493 | W.-P. Chen              |
| Geophysical Inverse Theory         | 493 | W.-P. Chen              |
| Deformation of the Upper Mantle    | 493 | W.-P. Chen/Bass/Marshak |
| Mineral Physics                    | 493 | Bass                    |
| Rheology of Earth Materials        | 493 | Bass/Marshak            |
| Introduction to Structural Geology | 311 | Marshak                 |
| Advanced Structural Geology        | 488 | Marshak                 |
| Geotectonics                       | 489 | Marshak                 |
| Southern Cordilleran Geology       | 493 | D. Anderson/Marshak     |
| Practice of Engineering Geology    | 451 | Nieto                   |
| Principles of Engineering Geology  | 450 | Nieto                   |
| Geology for Engineers              | 250 | Nieto                   |

**Sedimentary Geology - Stratigraphy - Paleobiology**

**Quaternary Geology - Geomorphology**

|   |      |                 |
|---|------|-----------------|
| Principles of Stratigraphy                              | 321  | Langenheim/Mann |
| Advanced Stratigraphic Geology                          | 422  | Langenheim      |
| Selected Topics in Stratigraphy                         | 493  | Langenheim      |
| Introduction to Paleontology                            | 320  | Blake           |
| Paleoecology  | 420  | Blake           |
| Seminar in Paleontology                                 | 493  | Blake           |
| Micropaleontology                                       | 493  | Sandberg        |
| Sedimentology and Arkoma Basin                          | 309  | Klein           |
| Field & Lab Procedures in Sedimentology                 | 310  | Klein           |
| Sedimentary Petrography                                 | 338  | Carozzi         |
| Sedimentary Processes                                   | 437  | Klein           |
| Analysis of Sedimentary Basins                          | 493  | Klein           |
| Sedimentology of Non-Marine Rocks                       | 493  | Hay             |
| Sedimentology of Volcanoclastic Rocks                   | 493  | Hay             |
| Recent Sedimentary Environments                         | 477  | Klein           |
| Introduction to Modern Marine Carbonate<br>Environments | 315F | Sandberg        |
| Carbonate Sedimentology                                 | 438  | Carozzi         |
| Carbonate Sedimentology                                 | 439  | Sandberg        |
| Depositional Models for Petroleum<br>Exploration        | 444  | Carozzi         |
| Carbonate Ultrastructure and Diagenesis                 | 493  | Sandberg        |
| Marine Geology of the Bahamas                           | 315M | Mann            |
| Geochemistry of Sediments and<br>Natural Waters         | 432  | T. Anderson     |
| Oceanography  | 370  | T. Anderson     |

|                             |     |                      |
|-----------------------------|-----|----------------------|
| Electron Beam Microanalysis | 493 | D. Anderson/Sandberg |
| X-ray Mineralogy            | 493 | Altaner              |
| Mineralogy of Clays         | 462 | Altaner              |
| Mineralogy of Clays II      | 463 | Altaner              |
| Coal Geology                | 493 | Damburger            |
| Paleobotany                 | 350 | Phillips             |
| Geomorphology               | 301 | Johnson              |
| Quaternary Geology          | 457 | Johnson              |
| Glacial Geology             | 357 | Johnson              |
| Introduction to Palynology  | 493 | King                 |

**Mineralogy - Igneous & Metamorphic Petrology -  
Geochemistry, Hydrogeology**

|   |     |                                      |
|---|-----|--------------------------------------|
| Mineralogy  | 333 | Henderson                            |
| Petrology   | 334 | Henderson/<br>Kirkpatrick/C.-Y. Chen |
| Optical Mineralogy  | 335 | Henderson                            |
| Petrography & Petrogenesis                                | 336 | Kirkpatrick                          |
| Advanced Igneous Petrology                                | 435 | Kirkpatrick/C.-Y. Chen               |
| Advanced Metamorphic Petrology                            | 493 | D. Anderson                          |
| Theoretical Petrology &<br>Non-equilibrium Thermodynamics | 434 | D. Anderson                          |
| Kinetics of Geological Processes                          | 493 | Kirkpatrick                          |
| Seminar on Melt Structure                                 | 493 | Kirkpatrick                          |
| Structural Mineralogy                                     | 431 | Henderson                            |
| X-Ray Mineralogy  | 493 | Henderson/Altaner                    |
| Crystallography   | 493 | Henderson                            |
| Mineralogy of Clays                                       | 462 | Altaner                              |
| Mineralogy of Clays II                                    | 463 | Altaner                              |
| Electron-beam Microanalysis                               | 493 | D. Anderson/Sandberg                 |
| Introduction to SEM & TEM                                 | 469 | T. Kriven(Ceramics)                  |
| Neutron Activation Analysis                               | 493 | C.-Y. Chen                           |
| Chemistry of the Earth                                    | 360 | T. Anderson/C.-Y. Chen               |
| Geochemistry of Sediments and<br>Natural Waters           | 493 | T. Anderson                          |
| Trace-element Geochemistry                                | 493 | C.-Y. Chen                           |
| Isotope Geology   | 433 | T. Anderson/C.-Y. Chen               |
| Advanced Isotope Geochemistry                             | 493 | C.-Y. Chen                           |
| Introductory Hydrogeology                                 | 397 | Bethke                               |
| Groundwater Hydrology                                     | 455 | Bethke                               |

**Introductory Courses**

|  |          |
|--|----------|
| Introduction to Study of the Earth               | 101      |
| History of the Earth                             | 102      |
| General Geology I & II                           | 107, 108 |
| Regional Field Study (Grand Canyon)              | 115      |
| Physical Sciences in Modern Science              | 142      |
| Geology for Engineers                            | 250      |
| Geology of Energy                                | 105      |
| Field Geology in Rocky Mountains<br>(Field Camp) | 317      |

**See also listings from depts. of Theoretical and Applied Mechanics, Metallurgy, Civil Engineering, Materials Research, and Geography.**

## FIELD-BASED RESEARCH AND INSTRUCTION

The Department of Geology has traditionally maintained a strong emphasis on field-related studies. This tradition has continued through both field-based instruction and field-based research. In many instances, this work is closely tied to state-of-the-art laboratory or theoretical studies. Below, we highlight some of the field areas in which members of our faculty are currently undertaking or recently completed field research or teaching.

### Field Research

- D. E. Anderson: Metamorphic reactions in rocks of northwest Scotland
- J. Bass: In Situ stress measurements in Colorado
- A. V. Carozzi: Minifacies of Mid-Continent Carbonates
- C.-Y. Chen: Geochemical studies in Hawaii basalts and in Cyprus ophiolite
- W.-P. Chen: Central Himalayas, India
- R. L. Hay: Diagenetic studies in California; stratigraphy, diagenesis and early man studies in east Africa
- W.H. Johnson: Quaternary stratigraphy, glacial geology, and geomorphology in Illinois
- R. J. Kirkpatrick: Study of the Cyprus ophiolite
- G. deV. Klein: Submarine sedimentology in the Sea of Japan and the Yellow Sea, Korea
- R. L. Langenheim, Jr.: Stratigraphy and paleontology, Nevada
- C.J. Mann: Stratigraphy of Illinois basin; Bahamas
- S. Marshak: Structural analysis in eastern New York, western Arizona, and the Transantarctic Mountains
- A. S. Nieto: Engineering geology problems in western Canada and Peru
- P. A. Sandberg: Diagenesis in Pennsylvanian carbonates, S. E. Kansas

### Field Teaching

**Carbonate Geology:** Florida Keys

**Engineering Geology:** Pennsylvania; central Wisconsin

**Field Methods:** Bighorn Mountains, Wyoming; western Arizona and southern California; Bahamas; central Wisconsin

**Hydrogeology:** Viburnian-trend mineral district; St. Francois Mountains

**Introductory Geology:** Ozark Mountains, Missouri; Colorado and Northern Arizona; central Wisconsin; east-central Illinois; Colorado, Utah, S. Nevada

**Mineralogy/Petrology:** Northern Michigan; western Arizona and southern California

**Paleontology:** Southern Illinois; Kentucky; Indiana; Wisconsin; Iowa; Minnesota; Missouri



**Quaternary Geology/Geomorphology:** Northern Illinois, southern and eastern Wisconsin; south-central Indiana; east-central Illinois/central, western and southern Illinois

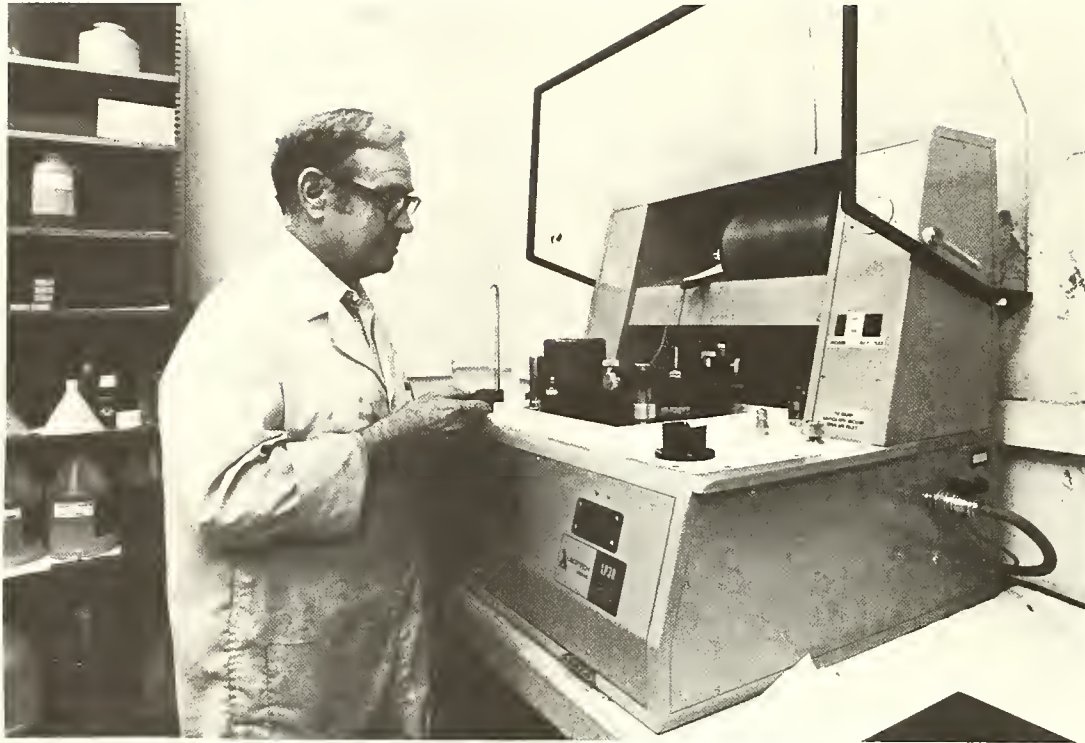
**Sedimentology:** Ouachita Mountains

**Stratigraphy:** Wabash Valley; western Illinois

**Structural Geology:** Northern Michigan; eastern Tennessee; central Wisconsin; western Arizona and southern California



John Tabor, a graduate student in structural geology, about to descend into a quarry to map fold-thrust structures in eastern New York



Jack Pullen, the department's thin-section technician, preparing specimens using the automated Logitech polisher.

## LABORATORY FACILITIES

**Applied Rock Mechanics:** direct shear devices, uniaxial compression column, slaking durability unit, soil testing equipment, base-friction table, and rock-wedge simulator.

**Computer:** University computer services provide: CDC Cyber 175 and 174, IBM 4341, DEC Vax II, Pyramid 90X, and on order, Cray MPX, along with necessary peripherals.

**Electron-Microbeam:** JEOL microprobe, Cambridge SEM, High-resolution SEM/EDAX systems (at the Center for Electron Microscopy), TEM and STEM systems and Argon Mill (at the Center for Materials Research).

**Experimental Petrology:** TemPress cold-seal pressure vessels, Deltech and Lindburg high-temperature furnaces (for synthesis, kinetics, and phase-equilibrium experiments).

**Geochemistry:** Siemens X-Ray Fluorescence and Perkin-Elmer Atomic Absorption Spectrophotometer for bulk-chemical (major, minor, and trace elements) analysis; MAT 250 isotope-ratio mass spectrometer (set up for carbon, oxygen, and sulfur); trace-element Neutron-Activation system (Germanium co-axial detector and multi-channel analyzer) (on order).

**Hydrogeology:** Equipment for accessing campus and remote Cray supercomputers; computer colorgraphics and digitizing equipment.

**Mineral Physics:** (On order) Brillouin spectrometer (laser-light scattering for measuring elastic properties). Diamond-Anvil Pressure Cell (for optical and x-ray measurements on samples at pressures up to 300 kbar).

**NMR Spectroscopy:** High-resolution nuclear-magnetic resonance spectrometers and associated equipment for solution and solid spectroscopy (in Chemistry Building).

**Seismology:** Microfilm library of post-1960 WWSSN seismograms; computer file of post-1980 GDSN seismograms; digital seismic signal processing facilities including dedicated computer, interactive graphics, and record digitizer; portable short-period seismograph.

**Soft-Rock Studies:** Cathode luminescence; microscopes, settling tanks; isodynamic magnetic separator, acid preparation equipment, X-ray radiography.

**Support:** Logitech Automated thin-section preparation equipment; Numerous research-quality petrographic microscopes; photographic darkrooms.

**Triaxial Loading:** Hydraulic equipment for burial simulation and fluid circulation

**X-Ray:** Siemens X-ray powder diffractometer system, X-ray fluorescence analyzer, Philips X-ray diffractometer, Single-crystal and powder cameras, preparation equipment for clay minerals.

## UNIVERSITY OF ILLINOIS GEOLOGY LIBRARY

The Library of the University of Illinois at Urbana-Champaign is the third largest university library in the country; our collection is surpassed in size only by the collections of Harvard and Yale. At present, we have over 6 million books and printed serials, and over 3 million non-book items including microfilms, videotapes, and maps. In 1985 the University of Illinois Library switched to a computer catalog system, which permits the identification of items by authors, titles, or keywords. The new system will also search the collections of affiliated libraries in addition to our own, and will automatically request books for delivery via campus mail. A terminal in the Geology Library permits direct access to **GeoRef** and other online sci/tech databases.

The **Geology Library** is housed in the Natural History Building along with the Department, thereby permitting easy access to books, journals, and maps. The total geology collection of the University includes over 160,000 volumes (of which half are in the Geology Library and the remainder are in the Main Library) and 55,000 catalogued sheet maps. Our holdings are notable for complete sets of all primary and most secondary American and foreign geological journals. The collection also includes a substantial selection of Soviet geological literature.

The University Library's **Rare Books Room** is repository for one of the world's outstanding collections of rare and early geological literature. Included in the collection are, among others, first editions of classic works by Agricola, Steno, Gesner, Biringucci, Smith, Maclure, Hutton, Werner, and Agassiz. We also possess a substantial selection of early American geological works. An annotated 565 page catalog to this collection by D. Ward and A. Carozzi was published in 1984 by the University of Illinois Library.

The Geology Library is managed by full-time staff, headed by Dederick Ward. Mr. Ward is active in national and international geoscience information efforts. He currently serves on the GeoRef advisory committee of the American Geological Institute.





Library Staff member Suzanne Hayes, Librarian Dederick C. Ward and staff member Diana Walter in Geology Library Map Room. The Geology Library houses over 80,000 volumes and 55,000 sheet maps in the Natural History Building.

## COLLOQUIUM PROGRAMS

Students and faculty of the Department of Geology have a broad range of professional specialties, therefore, Colloquium programs are sought to provide topics of interest to all. Colloquia are held on Friday afternoons and begin with informal conversation, coffee and cookies in the lounge with the formal presentation following in the lecture hall. Recent speakers have included:

### FALL 1983

**Dr. GEORGE deVRIES KLEIN** (Dept. of Geology, UIUC) "Tectonics and Sedimentation of the Back-arc Basins of the Western Pacific Ocean."

**MR. RICK SCHULT** (Dept. of Geophysics, Stanford Univ.) "On the Speed of Continents over Hot Spots Since the Jurassic." (special colloq.).

**DR. RICHARD L. HAY** (Dept. of Geology, UIUC) "Fossil Footprints of Laetoli in Tanzania, East Africa."

**DR. HARLAN P. BANKS** (Div. of Biological Science, Cornell Univ.) "Intriguing Aspects of Early Land Plants (Silurian - Devonian)."

**DR. DEREK E. G. BRIGGS** (Geology Dept., Univ. of London, England) "The Soft-bodied Organisms of the Burgess Shale."

**DR. CHU-YUNG CHEN** (Dept. of Geology, UIUC) "Geochemical and Petrologic Systematics in Lavas from Haleakala Volcano, East Maui, Hawaii: Implications for the Origin of Hot-spot Volcanism."

**DR. DONALD J. LEVERENZ** (Construction Eng. Res. Lab., Champaign) "Engineering Problems in the Exploitation of Non-fossil Fuels."

**DR. HAROLD A. ILLICH** (Sun Expl. and Production Co. of Texas) "Significance of Petroleum in Biochemical Evolutionary Studies."

**DR. JOHANNES SCHROEDER** (Geologisch - Palaontologisches Institut, Kiel Univ. at Berlin, Germany) "Multiple Choice in Carbonate Diagenesis." (special colloquium)

**DR. MORRIS W. LEIGHTON** (Chief, Illinois State Geological Survey) "Keys to Recent Significant Hydrocarbon Discoveries in Latin America."

**DR. JOHN M. HAYES** (Dept. of Geology, Indiana Univ.) "Redox Balances in Early Cycles."

**DR. PETER A RONA** (Sr. Res. Geophysicist, AAPG Distinguished Lecturer) "Hydrothermal Mineralization at Sea Floor Spreading Centers."

**DR. MICHAEL A. ARTHUR** (Grad. Schl. of Oceanography, Univ. of Rhode Island) "Biotic Extinction at the Cretaceous-tertiary Boundary: Terrestrial Versus Extraterrestrial Explanations."

**DR. ALEXANDRA NAVROTSKY** (Dept. of Chemistry, Arizona St. Univ.) "Structure of Glasses."

**MS. ANNEMARIE MEIKE** (Univ. of California, Berkeley) "TEM Studies of the Microstructure of Stylolites in Limestone." (special seminar)

**DR. CARL E. JACOBSON** (Dept. of Earth Sci., Iowa St. Univ.) "Structure, Metamorphism, and Tectonic Significance of the Pelona Schist and Vincent Thrust, Southern California."

**DR. RICHARD J. REEDER** (SUNY-Stony Brook, NY) "Carbonate Mineralogy."

**DR. PATRICK BROWNE** (Geothermal Inst., Univ. of Auckland, New Zealand) "Active Geothermal Systems and Ore Deposition."

**DR. MICHAEL J. DeNIRO** (Dept. of Earth and Space Sci., Univ. of California) "Developing Geochemical Methods to Study Anthropologic Problems." (special lecture)

**DR. CARL WOESE** (Microbiology Dept., UIUC) "Early Life: Recent Advances in Knowledge."

#### **SPRING 1984**

**DR. STEPHEN MARSHAK** (Dept. of Geology, UIUC) "The Development and Evolution of Tectonic Cleavage in Limestone."

**DR. HUAN-YEN LOO** (Inst. of Geology, St. Seismological Bur., Beijing, P.R.C.) "Three Dimensional Numerical Modeling of Formation Mechanism of the Shangxi Graben."

**DR. YONG AHN PARK** (Seoul National Univ.) "Late Quaternary Sedimentation on the Continental Shelf Off the Southeast Coasts of Korea."

**DR. CHARLES W. COLLINSON** (Head, Stratigraphy and Areal Geol. Sect., Illinois State Geological Survey) "Littoral Sediment Systems and Lake Level Dynamics in Southern Lake Michigan."

**DR. PAUL McMILLAN** (Dept. of Chemistry, Arizona St. Univ.) "Structural Studies of Silicate Melts by RAMAN Spectroscopy."

**DR. JAMES E. KING** (Head, Scientific Sections; Curator of Paleontology, Illinois State Museum) "Comparison of Terrestrial and Marine Quaternary Paleoenvironmental Records."

**DR. NICHOLAS WOODWARD** (Dept. of Geology, Univ. of Tennessee, Knoxville) "Thrust Deformation Geometries and Structural Lithic Units in Wyoming and Tennessee."

**DR. R. JAMES KIRKPATRICK** (Dept. of Geology, UIUC) "NMR Spectroscopy of Silicate Crystals and Glasses."

**DR. J. BRUNO RISATTI** (Illinois State Geological Survey) "Deep Sea Natural Gas and Origins of Sedimentary Methane."

**DR. JAMES L. WILSON** (Dept. of Geol. Sci., Univ. of Michigan) "Tectonic Positions and Stratigraphy of Basinal and Shelf Evaporites: A World-wide View."

**DR. OTTO W. NUTTLI** (Dept. of Earth and Atmos. Sci., St. Louis Univ.) "Seismicity and Source Mechanics in Midplate Earthquakes."

**DR. WARREN HAMILTON** (Res. Geologist, AAPG Distinguished Lecturer) "Mode of Extension of Continental Crust."

**DR. ALFRED M. ZIEGLER** (Dept. of Geophysical Sci., Univ. of Chicago) "Climates of the Mesozoic and Cenozoic."

**DR. MICHAEL A DUNGAN** (Dept. of Geol. Sci., Southern Methodist Univ.) "The Petrologic Evolution of the Taos Plateau Volcanic Field, Northern New Mexico."

**DR. NORBERT MORGENSTERN** (Dept. of Civil Engineering, University of Alberta, Canada) "Terror of Engineering in the Pleistocene."

#### FALL 1984

**DR. RICHARD G. GORDEN** (Dept. of Geol. Sciences, Northwestern Univ.) "Paleomagnetism and Absolute Plate Motions."

**DR. ROBERT RAISWELL** (Univ. of Leeds) "Carbon and Sulfur Variations in Different Depositional Environments through Phanerozoic Time."

**DR. PAUL GUION** (Oxford Polytechnic, Headington, Oxford, U.K.) "Crevasse Splays in the East Midlands Coalfield."

**DR. EDWARD M. STOLPER** (Div. Geol. & Planetary Science, Cal Tech) 12:00 - "Densities of Silicate Melts at High Pressures by Shock Wave Measurements"; 4:00 - "Volatiles in Magmas."

**DR. GRANT GARVEN** (Dept. of Earth & Planetary Sciences and Dept. of Geography & Environmental Engineering, Johns Hopkins Univ.) "Regional Groundwater Flow and Ore Genesis in Sedimentary Basins."

**DR. PAUL NADEAU** (The Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen, Scotland, U.K.) "Aspects of Interstratified Clays and Clastic Diagenesis."

**DR. NEIL A. CHAPMAN** (British Geol. Survey) "Geological Disposal of Radioactive Waste."

**DR. ROBERT NEWTON** (Dept. of Geophysical Sciences, Univ. of Chicago) "Geobarometry & Geothermometry and their Applications to Tectonic Processes."

**DR. ROBERT NOWACK** (Dept. of Earth, Atmospheric & Planetary Sciences, MIT) "The Two-Dimensional Gaussian Beam Synthetic Method: Testing and Applications."

**DR. THOMAS H. ANDERSON** (Dept. of Geology & Planetary Science, Univ. of Pittsburgh) "Evolution of the Continental Margin, Northwest Mexico."

**MR. STEPHEN ALTANER** (UIUC) "Formation of K-Bentonites by Potassium Metasomatism: Applications to Nuclear Waste Disposal."



**DR. JUNG HOO LEE** (University of Michigan) "Transitions in Clay Minerals during Slaty Cleavage Development: Stem STEM Study of the Martinsburgh Formation Near Lehigh Gap, Pennsylvania."

**DR. R. L. LANGENHEIM, JR.** (Dept. of Geology, UIUC) "Definition of Mid-Carboniferous Boundary."

**MARK R. BAKER** (Exxon Production Research Co., Houston, TX) "Well Log Interpretation for Geotechnical and Coal Quality Assessment."

**DR. DAVID R. JANECKY** (Dept. of Geology & Geophysics, Univ. of Minnesota) "High-Temperature Oceanic Geothermal Systems -- Experimental and Theoretical Considerations with Respect to the Formation of Massive Sulfide Deposits."

**DR. HSIN YI LING** (Dept. of Geology, Northern Illinois University) "Radiolarian Occurrence and its Implication to Plate Tectonics and Paleoceanography."

**DR. LYNN WALTER** (Dept. of Earth & Planetary Sciences, Washington Univ.) "Controls on Relative Rates of Carbonate Dissolution and Precipitation: Insights from Laboratory Experiments."

**DR. DENNIS R. KOLATA** (Illinois State Geol. Survey) "K-Bentonite of the Ordovician Decorah Subgroup, Mississippi Valley: Correlation by Chemical Fingerprinting."

**DR. KEITH RIGBY** (Dept. of Earth Sciences, Univ. of Notre Dame) "Evolutionary Effects of an Asteroid Impact at the End of the Cretaceous."

#### **SPRING 1985**

**DR. JAMES TYBURCZY** (Div. of Geol. & Planetary Science, Cal Tech) "Electrical Conductivity of Melts and the Earth's Low Velocity Zone."

**DR. PETER DAVIS** (Princeton Univ.) "Upper Mantel Structure Inferred from Normal Mode Measurements."

**DR. GERARD BOND** (Lamont-Doherty Geol. Observatory of Columbia Univ.) "New Evidence for a Breakup Chronology of a Late Precambrian Supercontinent, from Subsidence Analysis of Sedimentary Sequences."

**DR. STEPHEN GRAND** (Cal Tech) "Shear Velocity Structure Beneath North America."

**DR. GEORGE ZANDT** (State Univ. of New York, Binghamton) "Lithosphere Structure Determined from Teleseismic Waveforms."

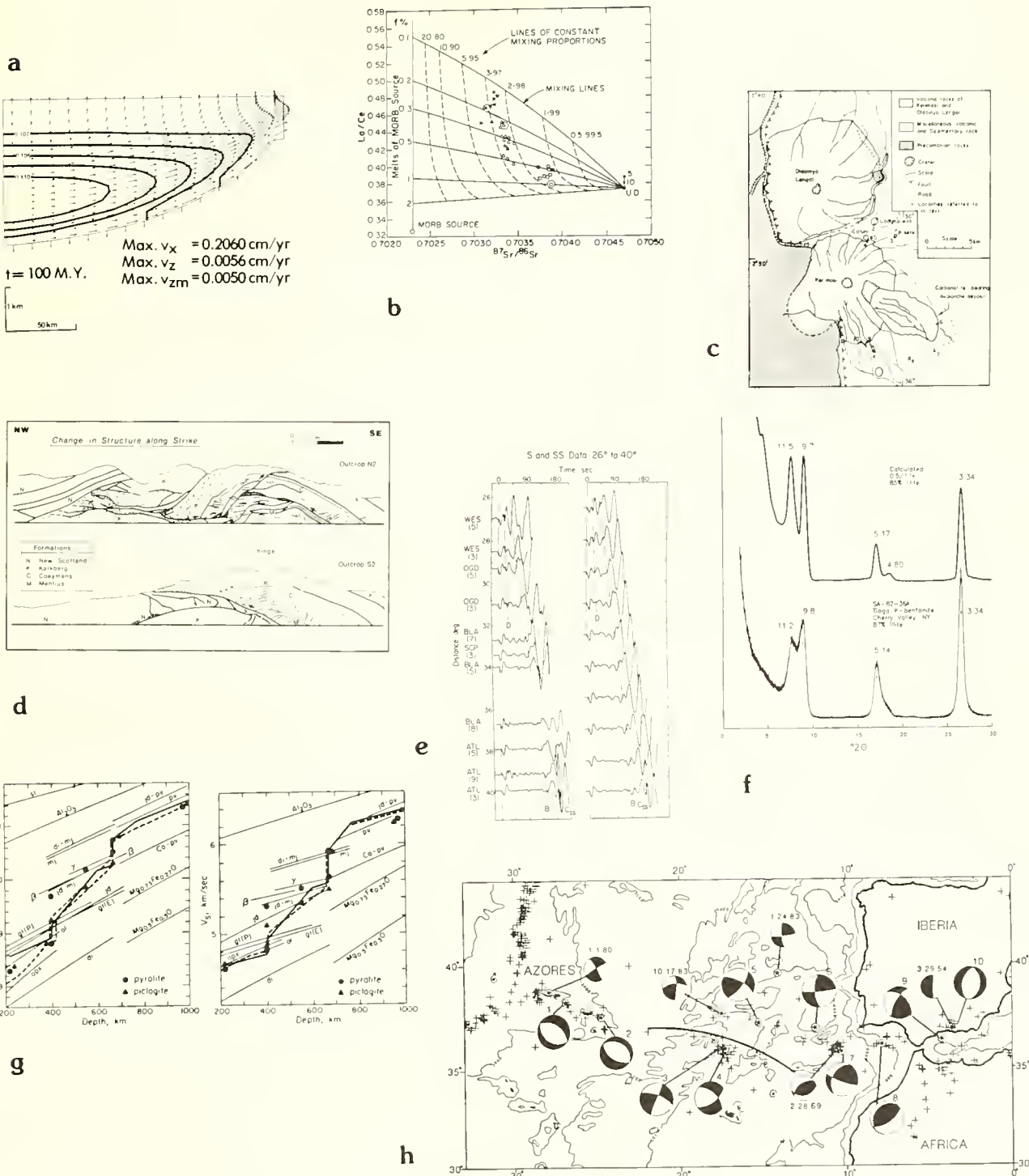
**DR. WALTRAUD KRIVEN** (Ceramic Eng., UIUC) "Transmission Electron Microscopy on Ceramics and Minerals."

**DR. THURE CERLING** (Dept. of Geology & Geophysics, Univ. of Utah) "Soils, Climate and Geochemistry."

**DR. PHILIP C. ENGLAND** (Dept. of Geol. Sciences, Harvard University) "The Tertiary Deformation of Asia."

- DR. LAURA CROSSEY** (Univ. of Wyoming) "Organic Acids and Porosity Enhancement."
- DR. DAVID JANECKY** (Los Alamos Nat. Lab.) "Peridotite-Water Interactions at 200° and 300°C: Experimental and Theoretical Results."
- DR. CHRISTOPHER PAOLA** (Dept. of Geology & Geophysics, Univ. of Minnesota, MN) "Transport of Sand in Suspension."
- DR. DENNIS PREZBINDOWSKI** (Amoco Prod. Co. Research Center) "Evolution of Formation Water."
- DR. ARTHUR L. BLOOM** (Dept. of Geol. Sciences, Cornell Univ.) "Tectonic Geomorphology and Coral Reefs."
- DR. S. KIRBY** (U.S. Geol. Survey, Menlo Park, Calif.) "Rheology of the Lithosphere from Experimental Rock Mechanics."
- DR. MARK REED** (Univ. of Oregon) "Boiling and Oxidation in Epithermal Systems."
- DR. RONALD H. VERNON** (Dept. of Geology, Univ. of New Mexico) 12:00 - "K-Feldspar Megacrysts in Granites - Phenocrysts, not Porphyroblasts." 4:00 - "Metamorphic/Deformational Relationships around the Sandia Granite, New Mexico."
- DR. PHILIP BETHKE** (U.S. Geol. Survey, Reston, VA) "Geothermal Systems and Epithermal Ores: Lessons from Creede, Colorado."
- DR. DAVID DINGLEY** (University of Bristol, England) "Crystal Symmetry Determination in the Scanning Microscope and Applications to Minerals."
- DR. LANIER ROWAN** (U.S. Geol Survey, Denver, CO) "Genesis of Mississippi Valley-Type Ore Deposits."
- DR. ROBERT DIETZ** (Dept. of Geology, Arizona State Univ.) "Creation/Evolution: Did the Devil Make Darwin Do It?"
- DR. G. MUYZER** (Dept. of Biochemistry, University of Leiden, The Netherlands) "Immunology of Macromolecules from Fossil and Recent Shells."
- DR. NOBU SHIMIZU** (Dept. of Earth, Atmospheric & Planetary Science, MIT) "Applications of the Ion Microprobe to Geochemistry and Cosmochemistry."
- DR. FREDERICK FREY** (Dept. of Earth, Atmospheric & Planetary Science, MIT) "Trace Element Geochemistry of Igneous Rocks."
- DR. MIRIAM KASTNER** (Scripps Institution of Oceanography) "Origin of Dolomite and its Spatial and Chronological Distribution - a New Insight."

# RECENT CONTRIBUTIONS OF NEW FACULTY MEMBERS



(Captions are on the reverse side)

- a) Figure 5, from: **Bethke, C. M.**, 1985, A numerical model of compaction-driven groundwater flow and heat transfer and its application to the paleohydrology of intracratonic sedimentary basins: *J. Geophys. Res.*, v. 90, p. 6817-6828. A cross-sectional illustration of fluid velocities relative to the subsiding medium. The solid lines show equipotentials.
- b) Figure 9, from: **Chen, C.-Y.**, 1985, Trace element and isotopic geochemistry of lavas from Haleakala Volcano, East Maui Hawaii - Implications for the origin of Hawaiian basalts: *J. Geophys. Res.*, in press. An illustration of a two-reservoir but multi-component mixing model for the origin of Hawaiian basalts.
- c) Figure 1, from: **Hay, R. L.**, 1983, Natrocarbonatite tephra of Kerimasi volcano, Tanzania: *Geology*, v. 11, p. 599-602. A map of Kerimasi volcano and vicinity showing sample localities of modern carbonatite eruptive rocks.
- d) Figure 8, from: **Marshak, S.**, 1986, Structure and tectonics of the Hudson Valley fold-thrust belt, New York: *Geological Society of America Bulletin*, in prep. Cross-sectional sketches showing the rapid variation in structural geometry that can result from lateral ramping in a fold-thrust belt.
- e) Figure 12, from: **Grand, S. P.**, and Helmberger, D. V., 1984, Upper mantle structure beneath the northwest Atlantic Ocean: *J. Geophys. Res.*, v. 89, p. 11,465-11,475. A comparison of recorded synthetic seismograms for earthquakes in the distance range of 26° to 40°, indicating a small amount of upper mantle heterogeneity.
- f) Figure 12, from: **Bethke, C. M.**, and **Altaner, S.**, 1985, A layer-by-layer mechanism of smectite illitization and application to a new rate law: *Clays and Clay Minerals*, in press. Diffraction pattern resulting from a removed-neighbor model of illitization, at 85% illite layers.
- g) Figure 1, from: **Bass, J.D.**, and Anderson, D.L., 1984, Composition of the upper mantle: Geophysical tests of two petrological models: *Geophys. Res. Letters*, v. 11, p. 237-240. Velocity profiles and density for various minerals based on laboratory measurements. Earth model PREM is shown (heavy solid line) along with a range of velocities from other studies.
- h) Figure 2, from: **Grimison, N.L.**, and **Chen, W.-P.**, 1985, The Azores-Gibraltar plate boundary: Focal mechanisms, depths of earthquakes, and their tectonic implications: *J. Geophys. Res.*, in press. The bathymetric map also shows epicenters of all earthquakes of magnitude > 4.0 in the region of the Azores Islands to Gibraltar in the eastern Atlantic Ocean. Focal mechanisms for fifteen large events are also shown, indicating the complexity of plate interactions in the region.





**GEOLOGY RESEARCH REPORT  
UNIVERSITY OF ILLINOIS - URBANA-CHAMPAIGN  
245 Natural History Bldg.  
1301 W. Green  
Urbana, Illinois 61801**

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Department of Geology  
University of Illinois  
Urbana-Champaign



Research Report  
1986 - 1987





**1986-1987 RESEARCH REPORT**  
**DEPARTMENT OF GEOLOGY**  
**UNIVERSITY OF ILLINOIS, URBANA-CHAMPAIGN**

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Compiled and edited by D. E. Anderson and P. Lane  
Fall 1986



## INTRODUCTION

Recent appointments in the Geology Department have completed our new research and teaching program in geophysics-seismology and mineral physics as well as reinforcing previous strengths in the areas of groundwater geology, clay mineralogy, geochemistry and the broad study of tectonics, diagenesis, sedimentology, structural geology, and historical geology.

A diverse range of research instrumentation is housed within the Geology department including: an automated electron microprobe; gas source mass spectrometer, SEM; 11.7T NMR spectrometer, X-ray diffractometers, XRF and AA units; neutron activation analysis system; seismological laboratory and library; hydrology laboratory with high-speed link to a supercomputer ; Brillouin spectrometer; cold seal and diamond-anvil high-pressure equipment; laboratories for sedimentological and mineralogical studies. Departmental computing facilities include an Alliant FX-8 Supercomputer with a high speed link to CRAY-XMP in the National Center for Supercomputing Applications. An outstanding geology library is located in the Geology building.

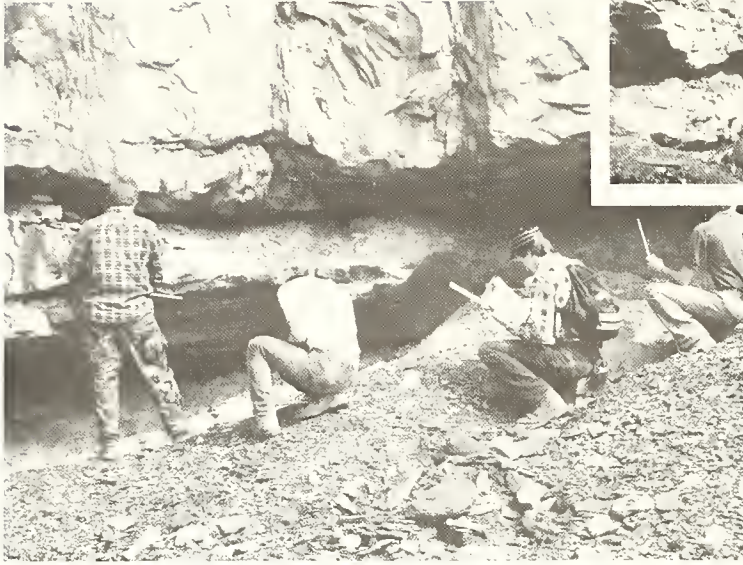
The Department of Geology encourages cooperative research with the departments of Physics, Chemistry, Plant Biology, and Mathematics, the School of Engineering, and the Centers for Materials Research and Electron Microscopy. The extensive facilities in these and other units on campus are readily available and commonly used by Geology faculty and students. Examples include transmission and scanning electron microscopes, ion probes and diffractometers in the Materials Research Laboratory and Center for Electron Microscopy; facilities for NMR, ESR, and IR spectroscopy in the School of Chemical Sciences.

The Department is fortunate to share the campus with the Illinois State Geological Survey, an organization with a rich tradition of research. Members of the Survey and the Department cooperate in research programs and graduate teaching in areas such as groundwater and environmental geology, clay mineralogy, quaternary geology, coal geology, stratigraphy and paleobiology.

With approximately 60 graduate students, the Department maintains strong programs in research and teaching. The list on the following page outlines some major areas that include a broad coverage of theoretical, experimental and field research. The list is not exhaustive and cross-disciplinary programs are available.



# FIELDWORK





## GRADUATE RESEARCH AREAS IN GEOLOGY

**Clays and Clastic Diagenesis** - S. P. Altaner, T. A. Anderson, C. M. Bethke, R. L. Hay, R. J. Kirkpatrick, G. deV. Klein, R. C. Reynolds, Jr. (adj.)

**Carbonate Rocks and Diagenesis** - T. A. Anderson, A. V. Carozzi, R. L. Hay, P. A. Sandberg

**Engineering Geology and Applied Rock Mechanics** - A. S. Nieto

**Geochemistry** - S. P. Altaner, T. F. Anderson, C. M. Bethke, C-Y. Chen, R. Cygan, R. J. Kirkpatrick

**Geomorphology and Quaternary Geology** - W.H. Johnson, L. R. Follmer (adj.), J. E. King (adj)

**Geophysics** - J. D. Bass, W-P. Chen, A. T. Hsui, S. Grand (1986)

**History of Geology** - A. V. Carozzi

**Hydrogeology** - C. M. Bethke, K. Cartwright (ISGS-adj.), A. T. Hsui

**Igneous/Metamorphic Petrology** - D. E. Anderson, C-Y. Chen, R. L. Hay, R.J. Kirkpatrick

**Mantle Dynamics** - J. D. Bass, C.-Y. Chen, A. T. Hsui

**Mineralogy/Mineral Physics** - S. P. Altaner, J. D. Bass, C.-Y. Chen, R. Cygan, R. L. Hay, D.M. Henderson, R.J. Kirkpatrick

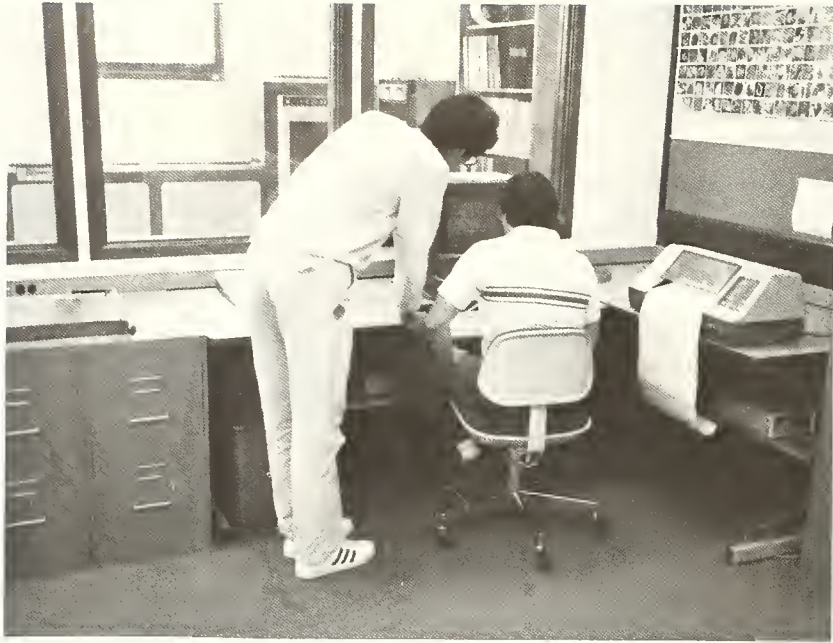
**Paleobiology** - D.B. Blake, R.L. Langenheim, P.A. Sandberg, J. King (adj)

**Sedimentary Basin Analysis** - S. P. Altaner, C. M. Bethke, D. B. Blake, A. V. Carozzi, R. L. Hay, A. T. Hsui, G. deV. Klein, R. L. Langenheim, M. W. Leighton (ISGS-adj.), S. Marshak

**Seismology** - W.-P. Chen, S. Grand

**Stratigraphy and Sedimentation** - T. F. Anderson, D. B. Blake, A. V. Carozzi, R. L. Hay, G. deV. Klein, R. L. Langenheim, C.J. Mann, P. A. Sandberg

**Structural Geology, Rock Physics, Tectonics** - D. E. Anderson, J. D. Bass, W-P. Chen, A. T. Hsui, S. Marshak, A. S. Nieto



**SUPERCOMPUTING**

**AND**

**FIELD TRAINING**



## UNIVERSITY OF ILLINOIS GEOLOGY DEPARTMENT

### FACULTY PROFILES

**STEPHEN P. ALTANER, Assist. Professor [1986 Appointment] (B.S., Colgate U. 1979; Ph.D. Univ. of Illinois 1985) - Clays and Diagenesis; Sedimentary Petrology**

Professor Altaner's main research interests are in the fields of clay mineralogy and clay petrology. He investigates conditions of clay mineral formation in sedimentary and diagenetic environments, in soils, and in hydrothermal environments. Specific research topics in clay petrology include diffusion in argillaceous rocks, kinetics of diagenetic clay mineral reactions, determination of thermal and burial histories of sediments, occurrence of ammonium in rocks and minerals, and clay mineral formation in saline, alkaline lakes. Results of this type of research will have applications in the fields of petroleum exploration, mineral prospecting, and nuclear waste disposal. Field relations, petrography, chemical analysis, scanning electron microscopy, x-ray diffraction, stable and radiogenic isotope analysis, mathematical modeling, and experimental petrology techniques will be used for this research. Mineralogical research will include the structural analysis of mixed-layer and non mixed-layer clay minerals using transmission electron microscopy, near- and mid-infrared spectroscopy, and nuclear magnetic resonance (to complement the program of R.J. Kirkpatrick).

**DAVID E. ANDERSON, Professor and Head (BSc-Hons., Univ. of Sydney, Australia, 1961; M.S. & PH.D. 1967, Univ. of Sydney, Australia) - Metamorphic and Theoretical Petrology**

Professor Anderson has been department head since 1983. His research involves metamorphic processes and their relationship to the thermal and tectonic history of various metamorphic terranes. Current projects include: 1) Studies (with Stephen Marshak) of the metamorphism of rocks in the Granite Wash and Buckskin Mountains of Western Arizona and the relationship of metamorphism to thrust faults in the region. 2) Compositional and textural zoning in garnets and their relationship to the tectonic history of the Moine Schists of Scotland. 3) Chemical changes associated with shearing and mylonitization of basic igneous rocks in Scotland and Upper Michigan. 4) Theoretical modelling of diffusion processes in aqueous and crystalline electrolytes. Funds are currently being sought jointly by Stephen Marshak and D.E. Anderson for a comprehensive study of the deformation and metamorphism of the Transantarctic Mountains. Professor Anderson teaches graduate courses in thermodynamics (including non-equilibrium thermodynamics) and metamorphic petrology.

**THOMAS F. ANDERSON, Professor (B.S. 1961, DePauw University, Ph.D. 1967, Columbia University) - Stable Isotope Geochemistry**

Professor Anderson's principal research interests are in the stable isotope geochemistry of sediments and natural waters. The focus of his current activities is on the significance of stable isotope variations in marine sediments during the Phanerozoic. Investigations in progress in this area include the following: (1) The oxygen isotope record of Paleozoic calcite fossils as implications of the history of oceanic temperatures and hydrosphere - lithosphere interactions. (2) Mass and isotopic burial fluxes of reduced sulfur and organic carbon during the Cretaceous. (3) Chemical and isotopic studies (including oxygen isotopes in biogenic phosphates) on rocks and fossils along a Middle Ordovician depth gradient in the Taconic Foulard Basin. (4) The petrology, Chemistry, and isotopic



composition of sulfides from hydrothermally altered oceanic rocks, with emphasis on the role of sea water - crust interaction in controlling the mass and isotopic cycle of marine sulfate. Professor Anderson is also involved in experimental and theoretical studies of the partitioning of isotopes and trace elements during the dissolution and precipitation of carbonates. Professor Anderson teaches chemistry of the Earth, Oceanography, Isotope Geochemistry, and Sedimentary Geochemistry.

**JAY D. BASS, Assistant Professor (Ph.D. 1982, State University of New York at Stony Brook) - Geophysics; Mineral Physics; Elastic Properties of Minerals**

Jay D. Bass has been at Illinois since August 1984. His major research efforts are in the area of experimental geophysics and laboratory measurements of the physical properties of minerals. Much of his recent work has focused on measurements of elastic wave velocities in minerals and high-pressure polymorphic phases by Brillouin spectroscopy, and this work is being further pursued at Illinois. Brillouin spectroscopy is a light scattering technique that is particularly well suited for measuring wave velocities in microscopic-sized samples, many of which are synthesized at high pressures and high temperatures. The results of such experiments are used to calculate the wave velocities and density of mineral aggregates under the high-pressure and high-temperature environment of the Earth's deep interior. Comparisons with seismological models of velocity versus depth in the Earth provide a powerful constraint upon the chemistry and mineralogy of the Earth's mantle, and this is a prime motivation for measuring elastic properties. In addition to measurements under room conditions, a program will be initiated to perform these experiments at high pressure in diamond-window pressure cells, and at high temperatures. Other research pursuits include: 1) X-ray studies of crystal structures at high pressure, 2) The high-pressure equation of state of oxides and metals which bear on the composition of the mantle and core, using shock-wave techniques (in collaboration with the California Institute of Technology), 3) In-situ measurements of stress in the Earth's crust by holographic interferometry (also with Cal Tech).

**CRAIG M. BETHKE, Assistant Professor (A.B. 1980, Dartmouth College, Ph.D. 1985, University of Illinois) Hydrogeology**

Craig Bethke's primary research interest is study of the groundwater hydrology of sedimentary basins through geologic time, and the effects of groundwater motion on petroleum migration, ore formation, and sediment diagenesis. Craig received a 1986 Presidential Young Investigator Award for this research. Recent work includes a theoretical analysis of the role of compaction-driven groundwater flow during subsidence of sedimentary basins, performed on a CRAY supercomputer. He applied this analysis in a study of the relative importance of compaction-driven and gravity-driven groundwater flow over the geologic history of the Illinois Basin, and this work has improved understanding of petroleum migration, as well as the genesis of Mississippi Valley-type ore deposits. Craig also recently completed research on the illitization reaction of smectite, a clay mineral dehydration reaction which is an important contributor of deep fluids and cements in evolving basins. Current work involves construction of a numerical chemical reactor model to study the dynamics of sediment diagenesis, including effects of transport by groundwaters, and study of the origins of geopressed zones in the subsurface, and investigation of the fluid pressure regimes within fold-thrust belts during orogenies. With the support of petroleum and minerals companies and governmental sources, Craig is building a hydrogeology laboratory, complete with an Alliant FX/8 supercomputer, one of the world's most powerful computers.



**DANIEL B. BLAKE, Professor (B.S. 1960, University of Illinois, M.S. 1962, Michigan State, Ph.D. 1966, University of California) Invertebrate Paleontology; Biostratigraphy**

Professor Blake has recently completed a phylogenetic analysis of all post-Paleozoic asteroids, and a review of asteroid classification and functional morphology. With Thomas E. Guensburg, a former graduate student, he is now studying the water vascular system and functional morphology of Paleozoic asteroids, and with Edward M. Snyder, another former student, he is studying phylogeny of Paleozoic bryozoans. He and his graduate students are working on field and laboratory studies of the paleoecology and biogeography of Carboniferous bryozoans, and a paleoecological analysis of a widely distributed Ordovician interval bounded by two K-bentonite (altered volcanic ash) isochrones. Professor Blake teaches Introductory Physical Geology, undergraduate Paleontology, and graduate courses in Paleoecology and Principles of Paleontology. Paleoecology includes field trips to Southern Illinois and Kentucky.

**ALBERT V. CAROZZI, Professor (M.S. 1947, University of Geneva; [Geology and Mineralogy] Dr.Sc. 1948, University of Geneva) - Sedimentary Petrography; Petroleum Geology**

Professor Carozzi is continuing carbonate microfacies studies in the Paleozoic of the Mid-Continent and with support from TEXACO USA is undertaking experimental studies on the development of stylolitic secondary porosity under simulated deep burial conditions with application to the Atokan of the Midland Basin and the Smackover of the Gulf Coast. He has just completed two books. The first one entitled "Carbonate Rock Depositional Models: a Microfacies Approach" is a worldwide synthesis of his own studies and that of his graduate students over a period of more than 35 years. The volume which has 500 illustrations is scheduled to be published by I.H.R.D.C. Press in Boston in late fall 1986. The second volume was prepared in collaboration with Dr. Chengyun Yang of the Department of Geology, Peking University who was a research associate with Professor Carozzi in this Department in 1982. The book is entitled "Practical Classification and Microfacies Analysis of Carbonate Rocks" and illustrated by 200 plates of photomicrographs. This bilingual (Chinese-English) volume has a preface by Dr. Shicung Guan of Academia Sinica. It will be released late this year by the Printing House of Peking University. It will be the first book on carbonate rocks ever published in the People's Republic of China.

**CHU-YUNG CHEN, Assistant Professor (B.S. 1977, National Taiwan University, Ph.D. 1983, MIT) Trace Element Geochemistry; Isotope Geochemistry; Igneous Petrology**

Chu-Yung Chen joined the Department in August 1983 and is setting up a neutron activation laboratory and an isotope dilution laboratory for high quality trace-element and isotope analyses. Her research projects include: (1) The geochemical evolution of Haleakala volcano, East Maui. (2) Trace element variations of tholeiites, transitional basalts and alkalic basalts from Mauna Kea volcano, Hawaii. (3) Rare-earth geochemistry of Hilina formation, Kilauea volcano, Hawaii. (4) Pb isotopic geochemistry of Loihi seamount. (5) Sr and Nd isotopes and trace element geochemistry of ultramafic nodules from Mt. Leura, Victoria, Australia. (6) Trace element studies and factor analyses of coal from Freeport and aerosol from Houston. (7) Petrological and geochemical studies of West Maui volcano. (8) Trace element and isotopic (Nd, Sr and Pd) studies of the transition from tholeiitic to alkalic volcanism on Hawaiian islands. (9) Geochemistry of high-MgO basalts from Hawaiian volcanoes. (10) Mineral chemistry of Hawaiian basalts. (11) Ophiolites from Cyprus. (12) Kimberlites and Carbonatites from Illinois. (13) Oxygen isotopic geochemistry of Hawaiian basalts.

**WANG-PING CHEN, Associate Professor (B.S., National Taiwan Univ., 1974, Ph.D., MIT, 1979) - Geophysics, Seismology, Tectonics**

The research activity of the earthquake seismology group is focusing on the quantitative understanding of large scale deformation of the lithosphere. We constrain the thermo-mechanical properties of the lithosphere by precisely determining the depth and focal mechanism of earthquakes, and by analyzing the gravity and geoid anomalies derived from satellite altimetry. Our current research projects include: plate coupling and the unbending of the subducted lithosphere, the relationship between earthquake generation and rheology, source kinematics of large earthquake sequences, the nature of strike-slip faulting in regions of extensional tectonics, and the high resolution reflection imaging of a fold-and-thrust belt in the Hudson valley.

**RANDALL T. CYGAN, Assistant Professor (1987) (B.S. 1977, University of Illinois at Chicago, M.S. 1980 and Ph.D. 1983, Pennsylvania State University) - Geochemistry, Mineral Physics**

Randall Cygan is active in research dealing with the mineral equilibria and chemical kinetics of geochemical processes. Of primary interest in his research is the examination of chemical diffusion processes in silicate minerals as a means of extracting the thermal histories of mineral assemblages in crystalline rocks. Experimental research includes the examination of cation diffusion rates in high temperature phases, such as garnet and olivine, using electron and ion microprobe analytical techniques. High temperature measurements of electrical behavior involving the conductivity and dielectric response of silicate minerals are being performed to elucidate the point defect structure of the phase. The type and number of defects will dictate the energies and, ultimately, the rates of ionic transport. Theoretical approaches, including the ionic modeling of silicate mineral structures and physical properties, complement the experimental work and provide insight into the nature of chemical bonding in silicates. His other research interests include the examination of rock-water interactions and the kinetics and mechanisms of mineral dissolution, chemical fractionation and transport processes in magmatic systems, and the nucleation kinetics of silicate minerals.

**STEPHEN GRAND, Assistant Professor [1986 appointment] (B.Sc. 1978, McGill University; Ph.D. 1986, Cal Tech) - Geophysics, Seismology**

Stephen Grand is interested in the elastic fine structure of the mantle. Using synthetic seismogram techniques to understand wave propagation in the mantle, shear waves from earthquakes can be used to determine structure. Using multiple bounce shear waves increases the resolution and applicability of the technique. Recently, using the synthetic seismogram technique, vertical shear profiles were developed for the Canadian shield, the western United States and the northwest Atlantic ocean, showing large differences to 400 km depth. Current research efforts are to derive fully three-dimensional models of the mantle shear structure beneath North America using the tomography technique, developing computer codes to make synthetic seismograms appropriate for propagation through laterally varying structure and investigating deep mantle structure beneath individual tectonic provinces on a world-wide scale. The ultimate goal of this research is to help answer questions such as how deep do continents extend, is the mantle layered and on what scale does convection occur in the earth.



**RICHARD L. HAY, Ralph E. Grim Professor of Geology (B.S. 1947, Northwestern University; M.S. 1949, Northwestern University; Ph.D. 1952, Princeton University) - Stratigraphy; Sedimentary Petrology**

Professor Hay's work has been concentrated on the general fields of stratigraphy, paleoenvironments of semiarid basins, pedogenesis, silicate diagenesis, and volcanoclastic sedimentology. His present major research effort is on spring-related carbonate rocks and Mg-silicate clays (sepiolite, smectite and kerolite) that were chemically precipitated in a Pliocene lake basin in the Amargosa Desert of Nevada-California. He and his students have worked out the distribution, paleoenvironment, and origin of the different types of carbonates and clays. Other research interests are diagenetic alteration of Ordovician tuffs in the Midcontinent to K-feldspar and K-bentonite (with Dennis Kolata of the ISGS and Mingchou Lee of Case Western University), silicate diagenesis in Searles Lake, California (with Sandra Guldman), and carbonatite eruptive rocks.

**DONALD M. HENDERSON, Professor (A.B. 1943, Brown University; Ph.D. 1950, Harvard) - Mineralogy; Crystallography**

Professor Henderson's principal research interests are concerned with local structures in minerals and with their study via such approaches as nuclear magnetic resonance, electron diffraction and transmission electron microscopy. Currently, he is studying ordering and local structures in feldspars. He is interested also in the educational uses of microcomputers. He teaches undergraduate and graduate courses in mineralogy, optical mineralogy, x-ray diffraction, structural mineralogy and crystallography.

**ALBERT T. HSUI, Associate Professor (B.S. 1968, Lowell Technological Institute; M.S. 1969, Cornell University; Ph.D. 1972, Cornell University) - Geophysics; Mathematical Modelling; Geodynamics; Planetary Evolution and Borehole Seismology**

Dr. Hsui's research interests are basically in the pursue of fundamental understanding of the working principles of various geological and tectonic processes. Some of his past and continuing research topics include: (a) investigations of geodynamic processes at convergent plate boundaries; (b) planetary differentiation and its effects on mantle evolution and mantle dynamics; (c) fluid dynamics within magma bodies and their relationships to the formation of igneous rocks. More recently, a few new projects have been formulated. One of the new topics is to study wave propagation around a borehole. This is to improve our present understanding of vertical seismic profiling and to provide improved interpretation of acoustic logging results. Another project is to carry out a comparative analysis of the SEASAT altimetry data and the MAGSAT data to gain better understanding of the crustal and the upper mantle structure of the Earth. Additionally, a new project has been developed jointly with Professor G. deV. Klein to study sedimentation, subsidence, thermal and tectonic evolution of sedimentary basins. Dr. Hsui teaches a general geology course for science and geology majors, exploration geophysics and other graduate courses in Geodynamics and Mathematical Methods in Geology.

**W. HILTON JOHNSON, Associate Professor (A.B. 1956, Earlham College, M.S. 1961, University of Illinois; Ph.D. 1962, University of Illinois) - Quaternary Stratigraphy; Glacial Geology**

Dr. Johnson's research interests are in the areas of geomorphology, glacial geology and stratigraphy. His work is concentrated on the surficial deposits in Illinois in cooperation with colleagues at the State Geological Survey. Currently he is working on relict periglacial features dating from the last glaciation, Wisconsinan stratigraphic correlations and drainage events in northeastern Illinois (with A. K. Hansel), on geomorphic mapping of the Woodfordian drift plain using remote sensing and related methods, and on interactions between the Lake Michigan and Huron-Erie glacial lobes in eastern Illinois and western Indiana (with N. K. Bleuer). Graduate students under Johnson's supervision are working on a variety of projects including: Quaternary geology and glacial sedimentology in the Precambrian shield terrain of south-central Ontario, late Pleistocene and Holocene fluvial geomorphology, stratigraphy and sedimentology of the lower Illinois River valley region, provenance of Illinoian and pre-Illinoian tills in south-central Illinois, and late Quaternary geology of the Middle Fork Vermilion River valley. Dr. Johnson teaches Introduction to the Study of the Earth, Glacial Geology, Quaternary Geology and Geomorphology. Field trips taken locally and to central Wisconsin emphasize glacial geology and stratigraphy; trips to central and southwestern Illinois focus on glacial stratigraphy, paleosols, late Pleistocene and Holocene fluvial geomorphology and alluvial stratigraphy; trips to Indiana emphasize glacial geology and bedrock and Karst geomorphology of the unglaciated area of south-central Indiana.

**R. JAMES KIRKPATRICK, Professor (B.S. 1968, Cornell University; Ph.D. 1972, University of Illinois) - Igneous and Experimental Petrology, NMR Spectroscopy**

For several years Professor Kirkpatrick's research has centered on the use of magic-angle sample-spinning nuclear magnetic resonance spectroscopy (MASS NMR) in examining the structures of silicate crystals and glasses (quenched melts). One major objective of this work is to better understand the thermodynamic, mechanical, and crystallization behavior of lava and magma and thereby the origin, evolution, and crystallization of igneous rocks. Another major objective is to use MASS NMR to examine the structure of crystalline phases that are too fine grained to be examined by single crystal x-ray or neutron diffraction, such as clay minerals. A third major objective is to develop advanced NMR spectroscopic methods to examine solid materials. This research program is being conducted in collaboration with Professor Eric Oldfield of the School of Chemical Sciences, Professor D.M. Henderson, Professor S. P. Altaner, and students and post-doctoral fellows in both Geology and Chemistry. Professor Kirkpatrick teaches Igneous and Metamorphic Petrography, Igneous Petrology (Graduate Level) and Geochemical Kinetics.

**GEORGE deVRIES KLEIN, Professor (B.A. 1954, Wesleyan University; M.A. 1957, University of Kansas; Ph.D. 1960, Yale University) Basin Analysis; Clastic Sedimentology Geology and Sedimentology; Sandstone Petrology and Diagenesis**

Dr. Klein's research activities deal with several aspects of basin analysis and Clastic sedimentary systems. These include (1) Analysis of the timing of depositional systems, diagenetic events, sea level history, global sedimentary cycling and paleoclimatic events to the geodynamic and tectonic subsidence history of sedimentary basins. Research in this area has focused on the Illinois Basin in cooperation with Dr. A. T. Hsui and with the Illinois State Geological Survey, and on back-arc basins of the western Pacific. Analysis of sedimentary basins involving the transition from an active margin into continental crust



is in the planning stage in the Yellow Sea of Korea. (2) Paleogeographic distribution of depositional systems through time. Research in this area has focused on storm depositional systems, tidal sedimentary systems and deep water submarine fans and turbidites. (3) clastic diagenesis. Research in this area has focused on downhole diagenetic changes in response to thermally-driven fluid circulation in back-arc basins, and a current project in the Illinois Basin. (4) Understanding the controls and processes of correlating bedload sediment yield from continents to oceans. This program has focused on bedload sediment yield in active continental margins tying sediment yield and turbidite periodicity in ocean basins to rate of tectonic uplift. Dr. Klein teaches Geology 309 (Sedimentology and Sedimentary Geology), Geology 310 (Field and Laboratory Procedures in Sedimentology; this is a laboratory course which accompanies Geology 309, Geology 477 (Recent Sedimentary Environments). Course field trips are run to the Vermillion River of Illinois (to study point bar evolution), central Indiana (to examine clastic and carbonate facies), and the Arkoma Basin and Ouachita Mountains of Arkansas and Oklahoma to examine Carboniferous clastic depositional systems.

**RALPH L. LANGENHEIM, JR., Professor (B.S. Geol. Engineering 1943, University of Tulsa; M.S. 1947, University of Colorado; Ph.D. 1951, University of Minnesota) - Stratigraphy, Paleontology, Field Geology, Geology of Energy, Coal**

Professor Langenheim's research centers on Pennsylvanian stratigraphy and biostratigraphy in the Illinois Basin and southern Nevada. Presently major effort is being devoted to determining brachiopod ranges in the Arrow Canyon, Nevada section which has been proposed for several regional and/or world stratotypes. Study of Latest Chesterian through Late Morrowan faunas is currently under way as well as a regional study of Atokan and Desmoinesian stratigraphy and biostratigraphy in the southern part of the Cordilleran Miogeocline. He also is involved in the work of the various IUGS subcommittees seeking to define Late Carboniferous stratotypes. He teaches History of the Earth, Geology of Energy and Field Geology at the elementary level; Principles of Stratigraphy at the intermediate level and graduate courses in Stratigraphy. He is Director of the Summer Geology Field Camp which is held in Wyoming.

**C. JOHN MANN, Professor (B.S. 1953, University of Kansas; M.S. 1957, University of Kansas; Ph.D. 1961, University of Wisconsin) - Stratigraphy; Mathematical Geology; Petroelum Geology**

Professor Mann's mathematical geology research work, sponsored by Sandia National Laboratories, attempts to determine probabilities and probability density functions of natural geological events and processes in order to more accurately predict hazards accompanying long-term storage of nuclear waste materials. Dr. Mann is also examining the evolution of stratigraphic sequences in an effort to more accurately determine periodicities and cyclicities which are known to be present as well as to perhaps detect new ones which previously have gone undetected. He teaches Geology for Engineers, General Geology, and Principles of Stratigraphy. These courses include field trips to southern Indiana, Upper Wabash River Valley and San Salvador Island, Bahamas. Studies in the Bahamas are on algal structures in a brackish to hypersaline lake in an attempt to relate structures and lack of structures in the mounds to environmental conditions under which they are growing.

**STEPHEN MARSHAK, Assistant Professor (A.B. 1976, Cornell University; M.S. 1979, University of Arizona; Ph.D. 1983, Columbia University) - Structural Geology and Tectonics**

Dr. Marshak's current research interests are in the area of field structural geology. Along with several graduate students, he has been focusing efforts on two field areas during the past three years. One group has been studying the mechanism of orocline formation in the Appalachian fold-thrust belt near Kingston, New York (the work was supported by NSF). As a result of this work, they have been able to demonstrate that oroclines in thin-skinned domains can develop by reactivation of detachment faults during non-coaxial shear; second-generation movement on such faults results in rotation of hanging-wall folds and in development of complex accommodation structures. One student in the group has also looked in detail at the nature of grain-scale extensional fabrics in cleaved limestone of the fold-thrust belt. He has discovered, by application of Fry strain analysis, that the microlithons between cleavage domains are locally stretched by as much as 80% parallel to cleavage, and thus are not passive during cleavage formation. A second group has been working in the Sonoran desert region of western Arizona. One of the students has just completed a study of poly-phase contractional Mesozoic structures in the Granite Wash Mountains. A second student has been working on the nature of basement/cover relations and on fold evolution and metamorphic history in the mylonite of the Buckskin Mountains "core complex." Another of the structure students is currently working on the relationship between basement structure and seismicity in the central Adirondack Mountains of New York. Contingent on funding, Dr. Marshak anticipates initiating two new projects; the first concerns chronology of tectonism in the mid-continent, and the second concerns the basement tectonics of a portion of the Transantarctic Mountains.

**ALBERTO S. NIETO, Associate Professor (B.S. 1961, San Marcos University; M.S. 1963, Washington University; Ph.D. 1974, University of Illinois) - Engineering Geology; Applied Rock Mechanics**

Dr. Nieto's main professional interests are applied rock mechanics and the geotechnical characterization of large engineering sites such as hydroelectric projects, underground storage caverns, waste disposal sites, surface and underground mines, major highways, foundations for large structures and others. In the last two years he has investigated the precursory, moment-driven deformation of some very large rockslides in Peru, Italy and Canada. He is also studying the role of water (apart from its effect on effective stresses) in the triggering of slope movements in mountainous, semiarid regions. He is presently supervising Ph.D. theses on shear strength of soil-filled discontinuities in rock masses and the analysis of a new model for slope failures that involves a combination of toppling and sliding. Dr. Nieto teaches Geology for Engineers, Principles of Engineering Geology and Practice of Engineering Geology at undergraduate and graduate levels; he also holds a joint appointment in the Civil Engineering Department where he collaborates in research projects in geotechnical engineering.

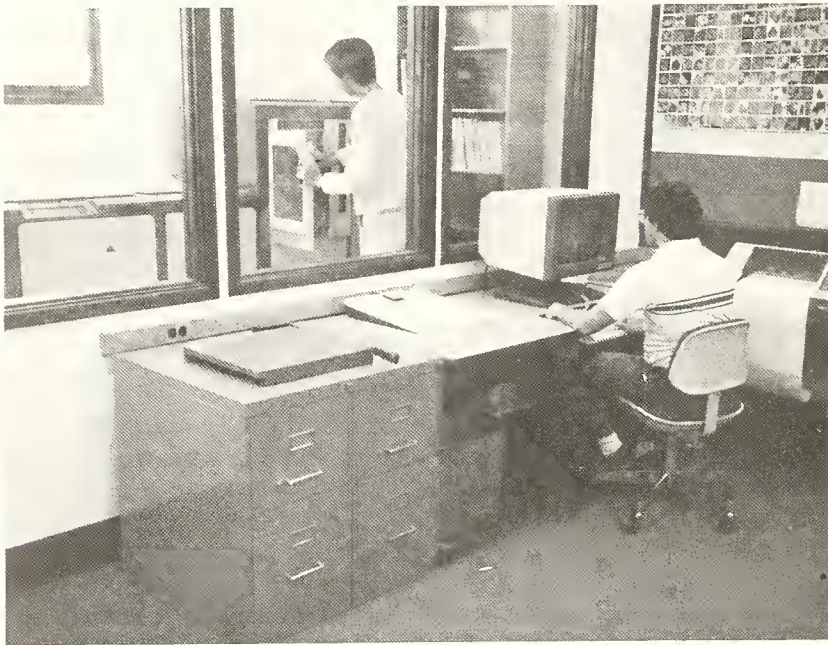
**PHILIP A. SANDBERG, Professor (B.S. cum laude 1960; M.S. 1961, Louisiana State University. Fil. Lic., 1964; Fil. Dr., 1965 University of Stockholm) - Carbonate Sedimentology; Micropaleontology; Historical Geology**

Dr. Sandberg has begun a new research program on application of immunology to carbonate sedimentology and paleontology. This NSF-funded study is a joint effort with Peter Westbroek (a Visiting Professor, in our department, from the Dept. of Biochemistry, Univ. of Leiden, Netherlands). This study will investigate the use of antibodies raised against the matrix of modern carbonate skeletons for determination of source organisms for carbonate sediments and taxonomic affinity of uncertain fossil taxa. In connection with this new research program, Dr. Sandberg has taken coursework in immunochemistry and has been awarded an Associateship in the Center for Advanced Studies (Spring 1987), and a Fellowship in the LAS program of Study in a Second Discipline (Fall 1986). During part of that time, he will be engaged in training and research in Leiden, where an international Center for Geoimmunology is developing. Research on carbonate mud sources and micrite diagenesis is continuing, including textural-compositional studies of ancient micrites, experimental diagenesis (hydrothermal bombs) of carbonate muds, and investigation of trace element-isotopic signatures as indicators of most probable modern carbonate mud contributors. Dr. Sandberg's teaching responsibilities include: Carbonate Sedimentology, the SEM portion of Microbeam Analysis (SEM and electron microprobe), Micropaleontology, and an Intersession field course in the Florida Keys entitled "Introduction to Modern Marine Carbonate Environments".

\* \* \* \* \*

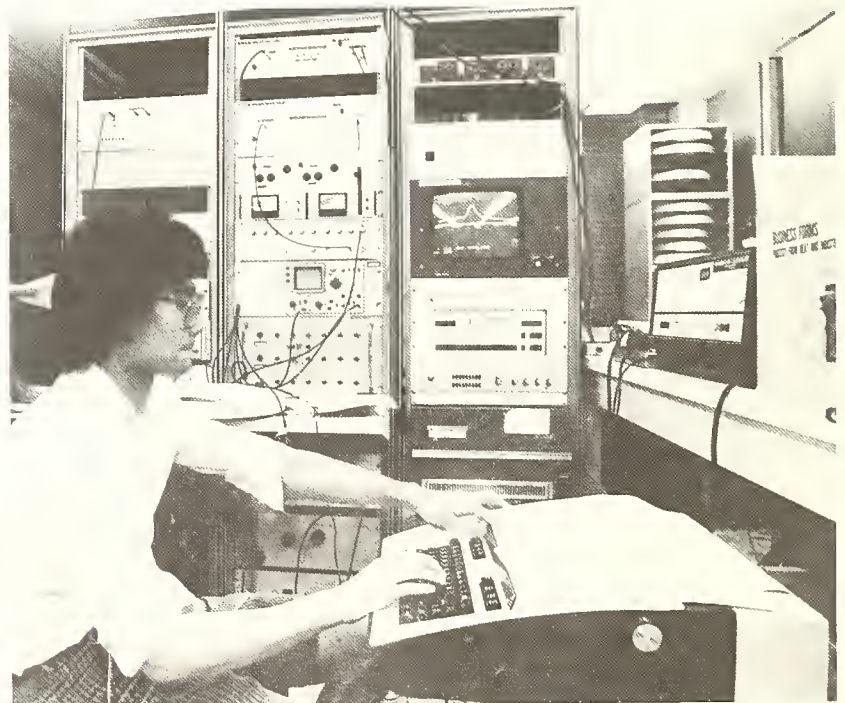
**PLEASE NOTE:** The faculty profile information given above is generalized and conveys only work done in the last few years. For more specific information about courses or research, please contact the individual faculty member at the Department address.





Tom Corbet and Ming-Ku Lee model deep groundwater flow on the Alliant FX-8 in the department's Center for Supercomputing in Hydrogeology. The revolutionary architecture of the FX-8 uses eight parallel computing heads simultaneously to perform at speeds rivaling the world's fastest computer. A fiber optic link connects the FX-8 to other campus computers including a Cray XMP-48.

Wang-Hong Yang using one of the high-resolution nuclear magnetic resonance spectrometers. These spectrometers are used to examine the structures of a wide variety of crystalline and amorphous materials





## RECENTLY FUNDED PROJECTS

| Principal Investigator           | Title  | Agency           |
|----------------------------------|--|------------------|
| Thomas F. Anderson               | Integrated Paleontological, Geochemical and Paleo-Oceanographic Studies on the Taconic Foreland Basin  | NSF              |
|                                  | The Petrology of Sulfides and the Geochemistry of Sulfur in Hydrothermally Metamorphosed Ocean Rocks   | NSF              |
| Jay D. Bass                      | Mineral Elasticity by Brillouin Scattering   | NSF              |
| Craig Bethke                     | Paleohydrologic Modeling of Sedimentary Basins   | ARCO             |
|                                  | Techniques of Hydrologic Modeling  | TEXACO           |
|                                  | Simultaneous Chemical Transport and Reaction   | AMOCO            |
|                                  | Faculty Research Initiation Grant  | SHELL            |
|                                  | Research Initiation Grant  | EXXON            |
|                                  | Theoretical Modeling of Simultaneous Mass Transport and Chemical Reaction during Diagenetic Alteration of Sedimentary Rocks                                | NSF              |
|                                  | Presidential Young Investigator Award  | NSF              |
| Sponsored Research Grant Program | ALLIANT Computer Systems   |                  |
| Albert Carozzi                   | Stylolitization Processes, Natural Stylolitic Porosity, and Experimental Development of Stylolitic Porosity in Carbonate Rocks Under Simulated Deep Burial | TEXACO           |
| Chu-Yung Chen                    | Petrological and Geochemical Study of the Evolution of West Maui Volcano   | NSF              |
| Wang-Ping Chen                   | A Study of Intracontinental and Intraplate Earthquakes   | NSF              |
|                                  | Shallow Seismic Profiling of a Fold-and-Thrust Belt in New York  | AMOCO/<br>TEXACO |

| <b>Principal Investigator</b> | <b>Title</b>   | <b>Agency</b>          |
|-------------------------------|--|------------------------|
| Stephen P. Grand              | Tomographic Inversion for Mantle Shear Structure   | NSF                    |
|                               | Determination of Q as a Function of Depth and Tectonic Province  | DARPA                  |
| Albert T. Hsui                | SEASAT Altimetry Interpretation and Geoid Modelling  | U.S. AIR FORCE         |
|                               | Numerical Modelling of Sedimentary Basin Evolution   | CHEVRON                |
| W. Hilton Johnson             | Interlobate Comparison of Glacial-Depositional Style as Evidenced by Small-Relief Glacial Landscape Features, Illinois, Indiana, and Ohio, Utilizing Shuttle Imaging Radar-B | NASA                   |
| R. James Kirkpatrick          | Kinetics of Igneous Processes  | NSF                    |
|                               | High-Resolution NMR Spectroscopy of Geologically Important Crystals and Glasses  | NSF                    |
|                               | Study of Nuclear Magnetic Resonance (NMR) Spectroscopy of Solids   | SANDIA Nat. Lab.       |
|                               | Study of Nuclear Magnetic Resonance (NMR) Spectroscopy of Solids   | SANDIA Nat. Lab.       |
| George deV. Klein             | Synthesis of Back-Arc Basin Sedimentology Based on DSDP/IPOD Drilling  | NSF                    |
| Stephen Marshak               | Kingston Arc of Eastern New York: Structural Geometry, Strain and Tectonic Significance of an Oroclinal Bend in the Appalachians   | NSF                    |
| Philip A. Sandberg            | Original Mineralogy in Micrites: Genetic and Diagenetic Implications   | NSF                    |
|                               | Original Mineralogy in Micrites: Genetic and Diagenetic Implications   | ACS Pet. Research Fund |
|                               | Original Mineralogy in Micrites: Genetic and Diagenetic Implications   | AMOCO                  |
|                               | Application of Immunology to Carbonate Sedimentology and Paleontology  | NSF                    |

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## DEPARTMENT OF GEOLOGY: COURSE OFFERINGS, 1982-1986

### Geophysics - Structural Geology - Tectonics

#### Engineering Geology

|                                    |     |                         |
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| Introduction to Geophysics         | 350 | Bass/Chen/Chen          |
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| Physics of Earthquakes             | 397 | W.-P. Chen              |
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| Geodynamics                        | 493 | Hsui                    |
| Numerical Methods in Geomechanics  | 493 | Hsui                    |
| Introduction to Seismology         | 493 | W.-P. Chen              |
| Advanced Topics in Seismology      | 493 | W.-P. Chen              |
| Geophysical Inverse Theory         | 493 | W.-P. Chen              |
| Deformation of the Upper Mantle    | 493 | W.-P. Chen/Bass/Marshak |
| Mineral Physics                    | 493 | Bass                    |
| Rheology of Earth Materials        | 493 | Bass/Marshak            |
| Introduction to Structural Geology | 311 | Marshak                 |
| Advanced Structural Geology        | 488 | Marshak                 |
| Geotectonics                       | 489 | Marshak                 |
| Southern Cordilleran Geology       | 493 | D. Anderson/Marshak     |
| Practice of Engineering Geology    | 451 | Nieto                   |
| Principles of Engineering Geology  | 450 | Nieto                   |
| Geology for Engineers              | 250 | Nieto                   |

### Sedimentary Geology - Stratigraphy - Paleobiology

#### Quaternary Geology - Geomorphology

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| Marine Geology of the Bahamas                           | 315M | Mann            |
| Geochemistry of Sediments and<br>Natural Waters         | 432  | T. Anderson     |

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| Electron Beam Microanalysis | 493 | D. Anderson/Sandberg |
| Mineralogy of Clays         | 462 | Altaner              |
| Mineralogy of Clays II      | 463 | Altaner              |
| Coal Geology                | 493 | Damburger            |
| Paleobotany                 | 350 | Phillips             |
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| Quaternary Geology          | 457 | Johnson              |
| Glacial Geology             | 357 | Johnson              |
| Introduction to Palynology  | 493 | King                 |

**Mineralogy - Igneous & Metamorphic Petrology -  
Geochemistry, Hydrogeology**

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| Advanced Igneous Petrology                                | 435 | Kirkpatrick/C.-Y. Chen |
| Advanced Metamorphic Petrology                            | 493 | D. Anderson            |
| Theoretical Petrology &<br>Non-equilibrium Thermodynamics | 434 | D. Anderson            |
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| Seminar on Melt Structure                                 | 493 | Kirkpatrick            |
| Structural Mineralogy                                     | 431 | Henderson              |
| X-Ray Mineralogy  | 493 | Henderson/Altaner      |
| Crystallography   | 493 | Henderson              |
| Mineralogy of Clays                                       | 462 | Altaner                |
| Mineralogy of Clays II                                    | 463 | Altaner                |
| Electron-beam Microanalysis                               | 493 | D. Anderson/Sandberg   |
| Introduction to SEM & TEM                                 | 469 | T. Kriven(Ceramics)    |
| Neutron Activation Analysis                               | 493 | C.-Y. Chen             |
| Chemistry of the Earth                                    | 360 | T. Anderson/C.-Y. Chen |
| Geochemistry of Sediments and<br>Natural Waters           | 493 | T. Anderson            |
| Trace-element Geochemistry                                | 493 | C.-Y. Chen             |
| Isotope Geology   | 433 | T. Anderson/C.-Y. Chen |
| Advanced Isotope Geochemistry                             | 493 | C.-Y. Chen             |
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**Introductory Courses**

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| Introduction to Study of the Earth               | 101      |
| History of the Earth                             | 102      |
| General Geology I & II                           | 107, 108 |
| Regional Field Study (Grand Canyon)              | 115      |
| Physical Sciences in Modern Science              | 142      |
| Geology for Engineers                            | 250      |
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**See also listings from depts. of Theoretical and Applied Mechanics, Metallurgy, Civil Engineering, Materials Research, and Geography.**



## FIELD-BASED RESEARCH AND INSTRUCTION

The Department of Geology has traditionally maintained a strong emphasis on field-related studies. This tradition has continued through both field-based instruction and field-based research. In many instances, this work is closely tied to state-of-the-art laboratory or theoretical studies. Below, we highlight some of the field areas in which members of our faculty are currently undertaking or recently completed field research or teaching.

### Field Research

S. P. Altaner: Diagenesis in coal-rich shale, Pennsylvania

D. E. Anderson: Metamorphic reactions in rocks of northwest Scotland

J. Bass: In Situ stress measurements in Colorado

D. B. Blake: Paleoecology of the Ordovician of the Upper Mississippi Valley; Bryozoa of the Carboniferous of the Illinois Basin

A. V. Carozzi: Microfacies of Mid-Continent Carbonates

C.-Y. Chen: Geochemical studies in Hawaii basalts and in Cyprus ophiolite

W.-P. Chen: Central Himalayas, India

R. L. Hay: Diagenetic studies in California; stratigraphy, diagenesis and early man studies in east Africa

W.H. Johnson: Quaternary stratigraphy, glacial geology, and geomorphology in Illinois

R. J. Kirkpatrick: Study of the Cyprus ophiolite

G. deV. Klein: Submarine sediments off Japan and Korea; Illinois Basin

R. L. Langenheim, Jr.: Stratigraphy and paleontology, Nevada

C.J. Mann: Stratigraphy of Illinois Basin; Bahamas

S. Marshak: Structural analysis in eastern New York, western Arizona, and the Transantarctic Mountains

A. S. Nieto: Engineering geology problems in western Canada, Peru, and Columbia

P. A. Sandberg: Carbonate sedimentology & diagenesis, Florida Keys and Diagenesis in Pennsylvanian carbonates, S. E. Kansas

### Field Teaching

**Basin Analysis and Sedimentary Geology:** Basin Analysis Symposium, Minneapolis, MN

**Carbonate Geology:** Florida Keys

**Engineering Geology:** Pennsylvania; central Wisconsin

**Exploration Geophysics:** Basement structure of the Illinois Basin, Central Illinois

**Hydrogeology:** Viburnian-trend mineral district; St. Francois Mountains

**Introductory Geology:** Ozark Mountains, Missouri; Colorado and Northern Arizona; central Wisconsin; east-central Illinois; Colorado, Utah, S. Nevada

**Mineralogy/Petrology:** Northern Michigan; western Arizona and southern California

**Field Teaching - Cont.**

**Paleontology:** Southern Illinois; Kentucky; Indiana; Wisconsin; Iowa; Minnesota; Missouri

**Quaternary Geology/Geomorphology:** Northern Illinois, southern and eastern Wisconsin; south-central Indiana; east-central Illinois/central, western and southern Illinois

**Recent Sedimentary Environments:** Arkoma Basin and Ouachita Mountains, AK and OK

**Sedimentology and Sedimentary Geology:** East central Illinois and central Indiana

**Stratigraphy:** Wabash Valley; western Illinois

**Structural Geology:** Northern Michigan; eastern Tennessee; central Wisconsin; western Arizona and southern California



WYOMING FIELD WORK

## WYOMING FIELD CAMP

The Summer Geology Field Camp presents a comprehensive instructional program; beginning with teaching the principal techniques of field geology, continuing through semi-independent mapping and problem solving, and culminating in reconnaissance of regional relationships between the Central Stable Region, the Rocky Mountain Foreland, the Paleozoic Continental Margin, the Sevier and Laramide thrust belts and the Yellowstone volcanic province. Students map on topographic base, with aerial photographs and, briefly, with plane table. Stratigraphic sections are measured by several techniques. Mapping ranges from detailed study of intensely deformed rocks, through large scale studies of small areas to reconnaissance mapping of areas in excess of twenty square miles. The program is designed to accommodate students of moderate to little formal geologic background and essentially no knowledge of field geology. It is intended to enable them to begin independent work in the field and to qualify them for entry-level professional work as field geologists.

Field mapping is conducted on the northeastern flank of the Big Horn Mountains which exposes a Cambrian through Paleocene sedimentary sequence resting on a Precambrian crystalline complex. Structural relationships are moderately challenging and exposures range from very good to poor. Regional study involves field trips through the High Black Hills, Yellowstone, Tetons, Beartooth Mtns., Hoback Canyon, Wind River Range, Owl Creek Mtns., and the Big Horn Mountains.

We try to maintain a student staff ratio of 6:1. Our staff is diverse in interests with most of the main branches of field-oriented geology represented. Currently we have operated with three to four senior staff aided by a similar number of graduate teaching assistants.

In addition to its instructional program, the field camp staff maintains a continuing research effort in the field area. Currently the staff is engaged in compiling geologic maps on newly published 7 1/2' quadrangles and in special projects on the Precambrian, the Bighorn Dolomite, the Devonian-Silurian interval, the Tensleep Sandstone, and the uppermost Cretaceous. Six quadrangles with supporting structure sections have been published and another is in press. A paper on Late Ordovician paleontology and stratigraphy is in press. Several presentations have been made at national and local GSA or AAPG meetings. Staff personnel have been active in Penrose Conferences on foreland structure and have made many presentations at meetings of the Wyoming Geological Association. Seven graduate and/or senior theses have been completed since 1980 and one is currently in progress. Investigators from Urbana, as well as from other institutions, frequently seek our aid in gathering data and/or ideas on many aspects of local geology.





Library Staff member Suzanne Hayes, Librarian Dederick C. Ward and staff member Diana Walter in Geology Library Map Room. The Geology Library houses over 80,000 volumes and 55,000 sheet maps in the Natural History Building.



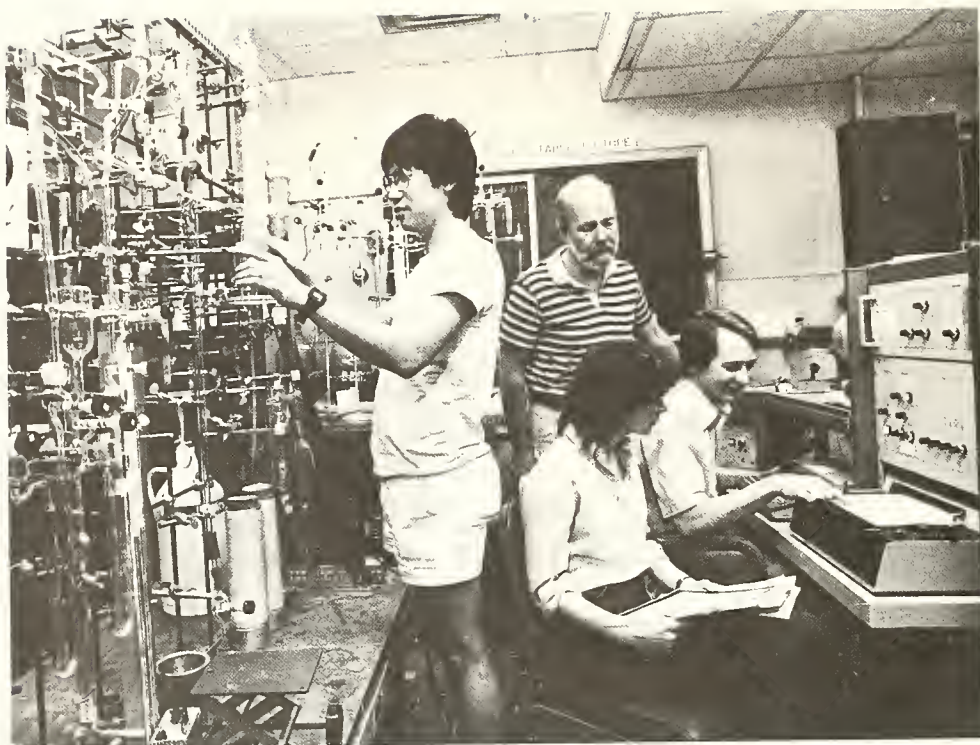
## UNIVERSITY OF ILLINOIS GEOLOGY LIBRARY

The Library of the University of Illinois at Urbana-Champaign is the third largest university library in the country; our collection is surpassed in size only by the collections of Harvard and Yale. At present, we have over 6 million books and printed serials, and over 3 million non-book items including microfilms, videotapes, and maps. In 1985 the University of Illinois Library switched to a computer catalog system, which permits the identification of items by authors, titles, or keywords. The new system will also search the collections of affiliated libraries in addition to our own, and will automatically request books for delivery via campus mail. A terminal in the Geology Library permits direct access to **GeoRef** and other online sci/tech databases.

The **Geology Library** is housed in the Natural History Building along with the Department, thereby permitting easy access to books, journals, and maps. The total geology collection of the University includes over 160,000 volumes (of which half are in the Geology Library and the remainder are in the Main Library) and 55,000 catalogued sheet maps. Our holdings are notable for complete sets of all primary and most secondary American and foreign geological journals. The collection also includes a substantial selection of Soviet geological literature.

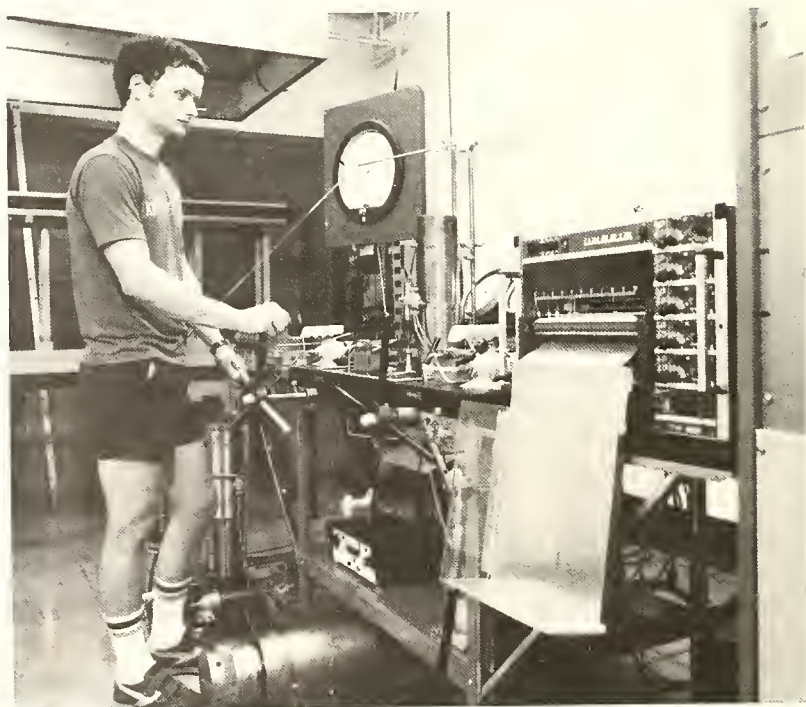
The University Library's **Rare Books Room** is repository for one of the world's outstanding collections of rare and early geological literature. Included in the collection are, among others, first editions of classic works by Agricola, Steno, Gesner, Biringucci, Smith, Maclure, Hutton, Werner, and Agassiz. We also possess a substantial selection of early American geological works. An annotated 565 page catalog to this collection by D. Ward and A. Carozzi was published in 1984 by the University of Illinois Library.

The Geology Library is managed by full-time staff, headed by Dederick Ward. Mr. Ward is active in national and international geoscience information efforts. He currently serves on the GeoRef advisory committee of the American Geological Institute.



The Stable Isotope Geochemistry Laboratory. K-S. Woo is working on a vacuum extraction line. Professor T.F. Anderson, Linda Bonnell and Brian Popp ponder the output of a mass spectrometer

Graduate student Don Von Bergen, who works for Prof. Carozzi, operating a unique high-pressure triaxial compression apparatus, which allows the circulation of CO<sub>2</sub>-charged water under controlled conditions of temperature and pressure. This apparatus, which simulates burial conditions, is used to study development of secondary porosity in carbonate rocks



## LABORATORY FACILITIES

**Applied Rock Mechanics:** direct shear devices, uniaxial compression column, slaking durability unit, soil testing equipment, base-friction table, and rock-wedge simulator.

**Computer:** An Alliant FX/8, a state-of-the-art processor with parallel-vector architecture, has been installed in the hydrogeology laboratory. The geophysics group will have a SUN 3-160 work station. In addition, a CRAY-XMP48 is available on campus at the National Center for Supercomputing Applications. Other University computers available to the Department include: CDC Cyber 175 and 174, IBM 4341, DEC Vax II, Pyramid 90X, along with necessary peripherals.

**Electron-Microbeam:** JEOL microprobe, Cambridge SEM, High-resolution JEOL SEM (JSM-840A) with Kevex microanalyzer, TEM and STEM systems and Argon Mill (at the Center for Materials Research).

**Experimental Petrology:** TemPress cold-seal pressure vessels, Deltech and Lindburg high-temperature furnaces (for synthesis, kinetics, and phase-equilibrium experiments).

**Geochemistry:** Siemens X-Ray Fluorescence and Perkin-Elmer Atomic Absorption Spectrophotometer for bulk-chemical (major, minor, and trace elements) analysis; MAT 250 isotope-ratio mass spectrometer (set up for carbon, oxygen, and sulfur); trace-element Neutron-Activation system (Germanium co-axial detector and multi-channel analyzer) (on order).

**Hydrogeology:** Alliant FX/8 supercomputer; equipment for accessing campus and remote Cray supercomputers; computer colorgraphics and digitizing equipment.

**Mineral Physics:** Brillouin spectrometer (laser-light scattering for measuring elastic properties). Diamond-Anvil Pressure Cell (for optical and x-ray measurements on samples at pressures up to 300 kbar).

**NMR Spectroscopy:** High-resolution nuclear-magnetic resonance spectrometers and associated equipment for solution and solid spectroscopy (in Chemistry Building).

**Seismology:** Microfilm library of post-1960 WWSSN seismograms; computer file of post-1980 GDSN seismograms; digital seismic signal processing facilities including dedicated computer, interactive graphics, and record digitizer; portable short-period seismograph.

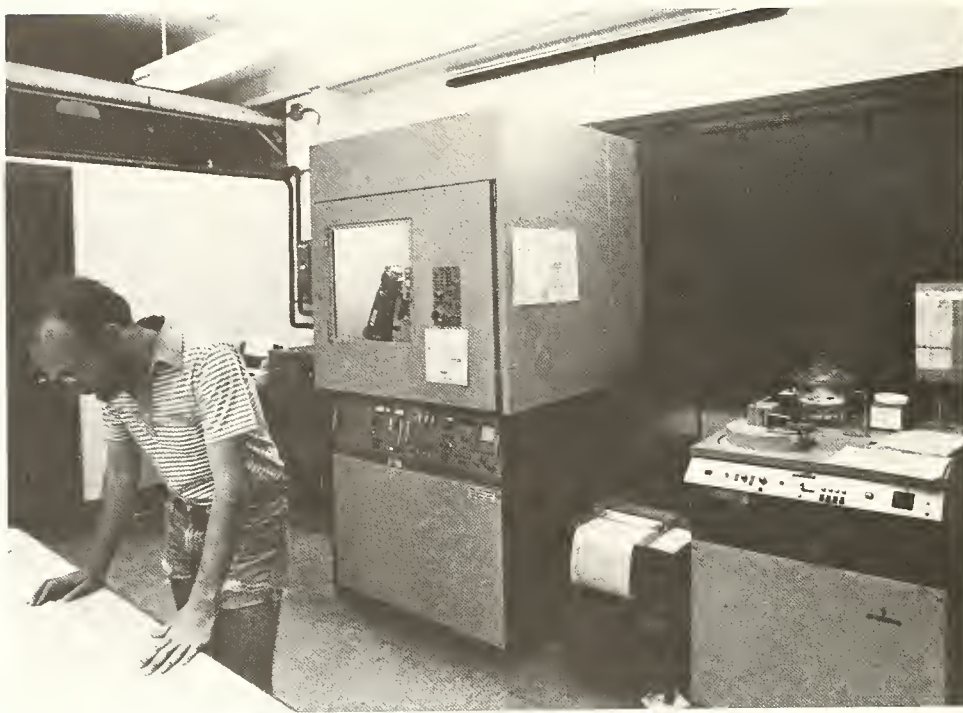
**Soft-Rock Studies:** Cathode luminescence; microscopes, settling tanks; isodynamic magnetic separator, acid preparation equipment, X-ray radiography.

**Support:** Logitech Automated thin-section preparation equipment; Numerous research-quality petrographic microscopes; photographic darkrooms.

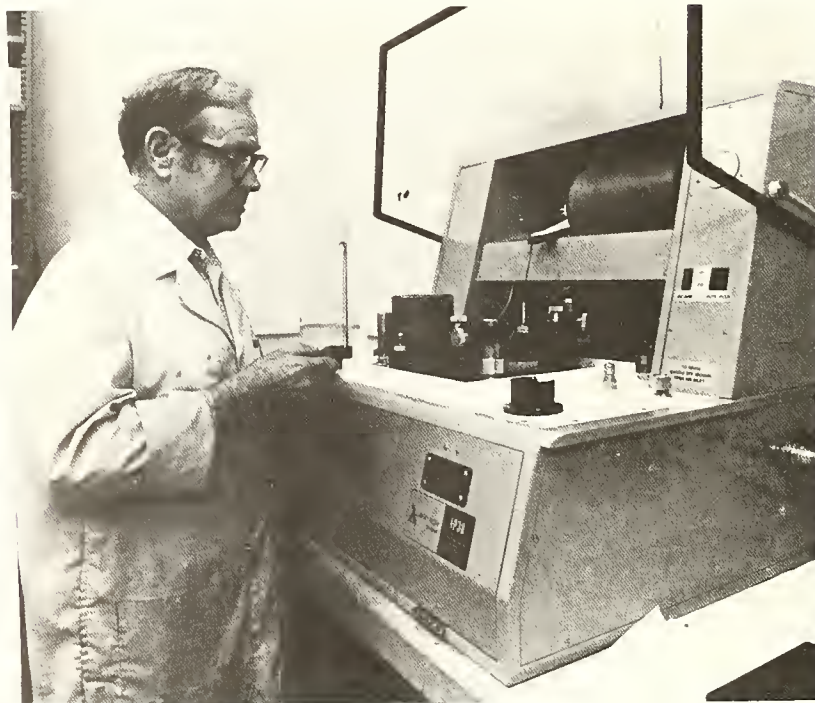
**Triaxial Loading:** Hydraulic equipment for burial simulation and fluid circulation.

**X-Ray:** Seimens X-ray powder diffractometer system, X-ray fluorescence analyzer, Philips X-ray diffractometer, Single-crystal and powder cameras, preparation equipment for clay minerals.





Rob Lander, a graduate student studying volcanic sediments with Professor Hay, analyzing the output of the X-ray diffraction unit



Jack Pullen, the department's thin-section technician, preparing specimens using the automated Logitech polisher



## COLLOQUIUM PROGRAMS

Students and faculty of the Department of Geology have a broad range of professional specialties, therefore, Colloquium programs are sought to provide topics of interest to all. Colloquia are held on Friday afternoons and begin with informal conversation, coffee and cookies in the lounge with the formal presentation following in the lecture hall. Recent speakers have included:

### FALL 1985

**Dr. J. James Eidel** (Illinois State Geological Survey) "The Illinois Superdeep Drillhole."

**Dr. Albert T. Hsui (Dept. of Geology, UIUC)** "The Origin of Trench Curvatures—A New Dynamic Model."

**Dr. Jay D. Bass** (Dept. of Geology, UIUC) "Elasticity of Micro-Crystals and the Chemical Composition of the Earth."

**Dr. Paul Enos** (University of Kansas) "Diagenesis in Mid-Cretaceous Reefs, El Abra Limestone, Mexico."

**Dr. Lewis E. Snyder** (Dept. of Astronomy, UIUC) "Radio Observations of Comets."

**Dr. Sandra J. Lindquist** (AAPG Distinguished Lecturer) "Practical Characterization of Eolian Reservoirs for Development: Nugget Sandstone, Utah-Wyoming Thrust Belt."

**Dr. David W. Houseknecht** (University of Missouri, Columbia) "Tectonic and Sedimentary Evolution of the Arkoma Basin."

**Dr. S. N. Casshyap** (Visiting Professor, University of Chicago) "Changing Patterns of Alluvial Systems Through Time and Coal-Forming Models: Examples from Gondwana Basins of India."

**Dr. Keene Swett** (Dept. of Geology, University of Iowa) "Later Proterozoic Sedimentary Successions in E. Greenland and Spitzbergen: Some Sedimentological and Diagenetic Insights and Some Paleontological Surprises."

**Dr. John Horner** (Montana State University) "Dinosaur Social Behavior."

**Dr. Donald Oltz** (Illinois State Geological Survey) "Petroleum Geology of the Gulf of Suez."

**Dr. Robert R. Loucks** (Dept. of Geosciences, Purdue University) "Zoning and Origin of Epithermal Silver-Gold-Lead-Zinc Veins, Topia, Durango, Mexico."

### SPRING 1986

**Dr. George W. Viele** (Dept. of Geology, University of Missouri-Columbia) "Collision Effects of the Ouachita Orogeny on the Midcontinent."

**Dr. James W. Truran** (Dept. of Astronomy, UIUC) "Element Synthesis in Stars and Supernovae."

**Dr. Stephen P. Altaner** (Dept. of Geology, UIUC) "Geochemistry of Ammonium in Hot Springs Deposits, Western U.S. and Remote Sensing Applications."

**Professor Nikolai I. Christensen** (Dept. of Geosciences, Purdue University) "Sama'il Ophiolite, Oman: A Model for the Oceanic Crust and Upper Mantle."

**Professor Adolf Seilacher** (Geologisch-Paläontologisches Institut) "The Precambrian Ediacaran Fauna: Alien Beings Here on Earth."

**Dr. Terry Engelder** (Dept. of Geosciences, Pennsylvania State University) "The Effect of a Paleozoic Abnormal Pore-Pressure Event on Present-Day Hydrofracture Measurements of Lithospheric Stress."

**Dr. David M. Sherman** (U.S. Geological Survey, Reston, Virginia) "Electronic Structures of Minerals: Applications to the Physics and Chemistry of the Earth."

**Dr. Arthur Bettis** (Iowa State Geological Survey) "Late Wisconsinan and Holocene Landscape Evolution in the Central Des Moines River Valley, Iowa."

**Dr. Charles Kreitler** (Bureau of Economic Geology, University of Texas at Austin) "Hydrogeology of Sedimentary Basins: Palo Duro Basin as an Example."

**Dr. Paul K. Sims** (U.S. Geological Survey, Denver, CO) "Anatomy of the Early Proterozoic Penokean Orogeny."

**Dr. Hugh Hay-Roe** (Murray Assoc. Int., Houston, TX) "Scientific Writing."

**Professor Paul Ribbe** (Virginia Polytechnic Institute, Blacksburg, VA) "Structure and Characterization of Alkali Feldspars."

**Dr. David R. Kingston** (AAPG Distinguished Lecturer) "Worldwide Basin Classification and Oil Play Prediction."

**Dr. Charles Meyers** (Sedona, AZ) "Mineral Deposits Over Geologic Time: 1. Petrologic, Tectonic & Temporal Patterns. 2. Tectonic & Chemical History."

**Dr. Frank A. Podosek** (Dept. of Earth & Planetary Sciences, Washington University) "Application of SR Isotopes to Studies of Carbonate Diagenesis."

**Dr. Daniel Nahon** (Dept. of Geology, University of Marseille-St. Jerome) "Tropical Weathering and Landscape Evolution."

**Dr. Heikki Ignatius** (Geological Survey of Finland) "Geochemical Prospecting in Finland."

**Dr. Jerry Jameson** (Exxon Production Research Company) "Carbonate Facies Models in the Petershill Formation, Mississippian, Midland Valley of Scotland."

**Dr. John V. Walther** (Dept. of Geological Sciences, Northwestern University) "The Role of Fluids in Progressive Metamorphism."



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