GSA news & information

SUPPLEMENT TO GEOLOGY MAGAZINE

NOVEMBER 1977

Penrose Room Completed at GSA Headquarters

The new Penrose Room, located on the publications floor of the GSA headquarters building, offers a cameo view of the life and the varied contributions of the Society's primary benefactor. R.A.F. Penrose, Jr., is perhaps most noted in the history of the Society for his substantial bequest—an endowment that, among other things, made possible the initiation of the Memoir and Special Paper series and helped provide funds for the purchase of the Society's permanent home. During his long-time membership (1889 until his death in 1931), however, his concern for the Society extended well beyond monetary support. He served a term as first vice-president in 1924, established (and endowed) the Penrose Medal for "research in pure geology" in 1927, held the office of president in 1930, and was an active participant on several committees responsible for major developments in the structure of the Society. Whereas Society records document his dedication, the September 1977 completion of the Penrose Room illumines his enthusiasm for knowledge as well as his love of geology.

Nearly all the furnishings in the office-sized room were Penrose's personal belongings and were originally housed in his Philadelphia (Bullitt Building) office. The desk is fashioned of Uruguayan mahogany, and two large bookcases, one with locking glass-front doors, are of similar construction. Several Persian rugs, a metal-sculptured Buddha, and a delicately cast elephant were collected by Penrose during many years of world-wide travel. The globe that occupies one corner of the room is one of a matched pair Penrose shared with his younger brother Spencer.

These mementos of a vibrant life provide the backdrop for Penrose's diverse and historically colorful personal library. The wide-ranging collection on display in the Penrose Room includes classical volumes in geology, accounts of early voyages and explorations, extensive geographical narratives, travel guides, and atlases. As well as maintaining integrity as a working historical library, the collection provides some special insights into the development of Penrose's career.

On the desk, among several of Penrose's own works, stands a copy of *Nature and Origin of Deposits of Phosphates of Lime*, which was published as Bulletin 46 of the U.S. Geological Survey in 1888. Executed under the direction of N. S. Shaler, this was Penrose's dissertation, for which he was awarded the first Ph.D. in Geology issued at Harvard. His travels throughout the phosphate-producing areas of the U.S. and Canada to research this work included a summer (1885) as Shaler's assistant at Mount Desert Island and Martha's Vineyard.

A rough-draft typescript of his "Memoirs" and the complete set of Penrose's field notes provide a unique look at his early field assignments after graduation. From 1888 to 1890 Penrose worked under E. T. Dumble, then state geologist of Texas. Dumble appointed Penrose "Geologist in Charge" of the eastern section of Texas, where he surveyed Tertiary formations along the Gulf Coast. His field notebooks were so meticulously kept that the original version is considered to be in nearly publishable form.

This set of hand-written notes further documents the research Penrose performed under J. C. Branner for the Geological Survey of Arkansas, the assignment that followed his work in Texas. Precise records outline his research on manganese and iron ore deposits throughout Arkansas. In preparation for this assignment, Penrose traveled to manganese deposits from Toronto to Nova Scotia, through New England, the Southern States and into Colorado, Arizona, Nevada, California, and Oregon.

Following this early field work, Penrose accepted an appointment as professor of economic geology to the first faculty of the Department of Geology at the new University of Chicago. The headquarters collection includes Penrose's hand-written lecture notes from these years—some corrected and rewritten four and five times—confirming the thoroughness and clarity Penrose sought in his own work.

During this period Penrose also accepted a position with the U.S. Geological Survey and, with Whitman Cross, was responsible for detailed reports on the gold-mining district of Cripple Creek, Colorado. From the museum at Cripple Creek the Society has acquired several mineral samples with Penrose's handwritten analyses. The interest generated here, coupled with later involvement in the mining industry (especially several ventures in cooperation with Spencer Penrose) provided the basis for the accumulation of a large percentage of the Penrose fortune that eventually benefited GSA.

THEN AND NOW. At left, Executive Secretary's office in GSA's first headquarters building at Columbia University. All furnishings came from Penrose's office in Philadelphia. Right, the Penrose Room at GSA headquarters today.

From 1901 Penrose began to expand his knowledge of ore deposits and mining practices through systematic travels around the world—an itinerary that encompassed sixty countries in twelve years. Another set of notebooks contains thorough descriptions of ore deposits, mines, and methodology from these purposeful tours. Many of the books in the Penrose collection constitute a literary chronology that punctuates his thorough research of the countries he visited between 1881 and 1913. Representative volumes are *Voyages and Travels in all Parts of the World,* John Pinkerton (1812, 17 volumes); *Oriental and Western Siberia*, T. W. Atkinson (1858); *Travels in Tartary, Thibet and China during the Years 1844–5–6*, M. Huc; *Expedition to Borneo of HMS* Dido *for the Suppression of Piracy*, H. Keppel (1846); *History of Java*, T. S. Raffles (1830); *Travels in the Interior of Brazil*, John Mawe (1812); *Travels to Discover the Source of the Nile*, James Bruce (1798); *A Voyage around the World, but More Particularly to the North-West Coast of America*, George Dixon (1789); *Voyages from Montreal*, Sir Alexander Mackenzie (1802). Volumes of exceptional historical value include *Essay on the Theory of the Earth*, Baron G. Cuvier (1827); *Report of the Exploring Expedition to the Rocky Mountains in the Year 1842*, John C. Fremont; *Principles of Geology*, Sir Charles Lyell (1842); *Modern Geography*, John Pinkerton (1804, 2 volumes); *The Mineral Kingdom*, Reinhard Brauns (1912); *Narrative of the Surveying Voyages of His Majesty's Ships* Adventure *and* Beagle, *between the years 1826 and 1836, Describing their Examination of the Southern Shores of South America, the* Beagle's *Circumnavigation of the Globe*, Captain P. Parker King, Captain Robert Fitz-Roy, Charles Darwin (1839).

The final leg of Penrose's first major trip abroad (1901–1902) included Siberia and resulted in another of Penrose's own works *The Last Stand of the Old Siberia*.

Several photographs in the Society's possession further highlight Penrose's travels and activities during this part of his life. One photograph, taken by Penrose, depicts a strip-mining site in Austria. Another portrays those in attendance at the 12th International Geological Congress in Toronto in 1913, to which Penrose was a delegate.

With the outbreak of World War I, Penrose's travels ended. He prepared a 28-page circular "What a Geologist Can Do in War," for the Geological Committee of the National Research Council. The small, hard-bound volume contains as its summation a bit of Penrose philosophy:

> Other Qualities for Usefulness
>
> In addition to the matters already mentioned, the geologist whose work has been in the more newly settled parts of the world, and not in the older settled region where he has lived in civilization, is an efficient scout. His training has been in the wilds among mountains, hills and plains; often without trails, where he has had to take his course by the blazes on the trees or from the stars, the moon or his compass, and often surrounded by hostile natives. He can fight, cook, withstand bad weather and discomfort, and still keep on with his scientific work; he has acquired the woodcraft of the old trapper together with the education of a scientist. Few other men possess this unique combination of accomplishments.

The Penrose Room is intended to be much more than a memorial to the man. The bound volumes, notes, manuscripts, correspondence, and photographs contained here are catalogued and organized for use as a working reference library. R.A.F. Penrose, Jr., dreamed that the Society would be a "clearing house for all things geological." The Society extends an invitation to the membership and to others interested to view and research from this collection, which fulfills a unique facet of that vision.

NEW GSA EXHIBITS


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GSA Headquarters in Boulder has some new unique geologic specimens on display. The headquarters building is located at 3300 Penrose Place. Members are welcome anytime, with guided tours available from 2 to 4 p.m. on Mondays and Thursdays. Here are some of our newest acquisitions. We hope they will inspire you to visit our other excellent displays.

Photographs by Marianne Faber.

1 Grade one, optically pure quartz crystal from Brazil. Weight: 86.6 ± 1 kilograms (191 pounds). Indefinite loan from National Bureau of Standards, Time and Frequency Division, Boulder, Colorado.

2 Selenite crystal collected from the basal Entrada Formation (Jurassic) at Cainesville, Utah, April 12, 1892, by James E. Talmage. Donated by Department of Geology, Brigham Young University, Provo, Utah.

3 Bladed sand selenite crystals from Naica, Chihuahua, Mexico.

4 Pennsylvanian plant impressions in black shale.

5 Maple leaf impressions in Miocene rocks, Douglas Pass, Colorado.

THE OPEN UNIVERSITY

Department of Earth Sciences
The Open University,
Walton Hall, Milton Keynes, MK7 6AA,
England

Telephone: Milton Keynes 74066
Direct Line: Milton Keynes 6

Our Ref: 19 August 1977

STATEMENT: Peter J. Smith and the Geological Society of America

As many of my friends (and, no doubt, enemies) know, it was intended that I should take up the position of Science Editor with the Society. Many people will also know by now, however, that I shall not in fact be becoming the Society's Editor. Since this situation is evidently still causing considerable puzzlement, I would like to explain briefly what happened.

I was offered the position of Science Editor in October 1975; and on 3 November 1975 I began the US visa application process at the US Embassy in London. I soon discovered that it would be necessary to show that no suitable US citizen was available at the time to take up the position of Science Editor; but with the Society's help this formality was completed by April 1976. My file then went to the Immigration Office in Denver where, for no apparent reason, it rested for 10 months. During this period it proved impossible (even with pressure from a Congressman) to induce the immigration people to deal with my case. In February 1977, however, my papers finally emerged and were sent to the US Embassy in London for completion of the formalities at my end.

When this happened, I fully expected that my visa would soon be granted. But this was not to be. It soon became clear that there were still many obstacles to overcome; and so on 3 May 1977, with no firm visa date available and with the visa process apparently stretching to infinity, the President of the Society wrote to me with regret saying that in the best interests of the Society it would be necessary to begin an immediate search for another Editor. Ironically, very soon after receiving this information I received a letter from the US Embassy informing me that my visa would be issued, subject to a medical examination, on 20 June 1977. This news came just 5 weeks too late.

So that is that. I was beaten by US bureaucracy. Now that it is all over, however, I would like to take the opportunity of thanking all those officers, staff and other members of the Society who have shown me great kindness during the 3 years that have elapsed since I was first approached (August 1974) with the suggestion that the position of Science Editor might interest me. It did interest me; and I am bitterly disappointed that things did not work out.

Peter J. Smith

UNESCO and Commission continues publication of Geological World Atlas through 1982

UNESCO and the Commission for the Geological Map of the World have begun issuing maps in their *Geological World Atlas*. The atlas, with 15 sheets of continental areas on a 1:10,000,000 scale, 5 sheets covering the oceans on a 1:36,000,000 scale, and a legend, are scheduled to be published individually, with the last sheets expected to appear in 1982.

The atlas will be issued as a complete set with binder, or as individual sheets currently priced at 120 French francs (about $25) each, directly from the UNESCO Press, 7 Place de Fontenoy, Paris (or for $36.30 per sheet from Unipub, P.O. Box 433, Murray Hill Station, New York 10016).

Although the maps are costly, they are well worth the investment because of their world-wide approach, uniform legend, and excellent definition incorporating sixty tints for sedimentary formations and forty tints for igneous and metamorphic rocks. Workers on boundary areas between two maps will appreciate the large overlap and consistency between adjoining sheets.

The publishers state that "each map, prepared under the supervision of a continental coordinator, incorporates the most recent and often as yet unpublished sources of information." In addition to the overall legend, each sheet includes a legend encompassing the individual map area. Legend groupings are based primarily on the latest information on isotopic dating, rock types, and tectonic history.

The three sheets covering Africa, which were recently issued to initiate the series, offer interesting comparisons with UNESCO predecessors and may serve as an indication to the quality of the rest of the atlas. In 1963 the *Geological Map of Africa* and in 1968 the *International Tectonic Map of Africa* were issued jointly by UNESCO and the Association of African Geological Surveys (ASGA). Both of these maps, on 9 sheets of scale 1:5,000,000 each, have been the prime regional reference maps on Africa to date.

The new atlas series maps, though on a scale half as large, are considerably more detailed than previous efforts. Several large areas, most notably parts of Ethiopia and Somalia, include substantial detail in areas previously undifferentiated. Some structural detail is shown in the new maps, particularly regional faulting, as along the East African rift system and in Southern Africa. Although some regional structural detail is adopted from the International Tectonic Map, most comes from more recent, and in large part, unpublished data. Detail on thicknesses in sedimentary basins has not been included; however, mapping of igneous intrusions includes kimberlites (though those of the Ivory Coast are omitted). In general these maps are noticeably more detailed than any other geological maps on the same scale that I have seen.

This increase in detail is not without cost, however. The scale of the map makes such detail a strain on the eyes after long periods of study. When this initial effort at a geological world atlas is completed, one might hope for the editors to begin on a series of regional atlases on a larger, easier to read, scale.

The coloration of the maps is pleasing from both aesthetic and technical viewpoints. In the 1963 maps, in comparison, the narrow range of colors and their poorly considered assignment to rock types caused considerable confusion, for instance, between some basin sediments and the adjacent outcropping basement. In the maps of the atlas, however, the variety and selection of colors substantially eliminates such confusion.

There are, of course, changes in interpretation from the 1963 geological maps and the current atlas series. For example, the Voltaian formation of West Africa was formerly shown as Infracambrian (as was the Tarkwaian series), while the Togo series was listed as middle Precambrian (as was the Birimian series). The interpretation depicted in the atlas maps has the Buem synchronous with the middle Voltaian ("probably Precambrian and Cambrian") and shows the Togo series as Precambrian B & A nonsubdivided (600–1,800 m.y.). Thus the new map credits the Buem as probably being considerably younger than before, and also allows the Togo series to be younger than the upper age limit given it on the previous map. (It should be noted that this arrangement follows one prominent side of a current controversy over the order of succession in this area.) Such changes in interpretation abound in all three sheets on Africa, reflecting considerable progress in mapping and dating, and changes in viewpoints between the (often conservative) ASGA approach to the 1963 maps and that of the current series' editors.

Perhaps my only major complaint, other than the fact that the scale is uncomfortably small for the detail that is presented, is that information on sources is not included. Although this may be forthcoming on the legend sheet, a list of major sources of information on each sheet would be helpful.

The maps are particularly useful for their continent-wide perspective and for their inclusion of information that has hitherto not been published. The atlas is at a disadvantage for detailed work in areas such as South Africa and the Maghreb, which are already covered by good, large-scale maps. However, detailed local coverage is not the purpose of a world atlas, because the maps are for general use and are not biased towards any particular interest. The atlas series, in conjunction with the International Tectonic Map and the UNESCO Mineral Resources Map of Africa (or hopefully an updated version thereof) gives an invaluable broad perspective of the continent that is much more accurate and informative than has previously been available. Editing, drafting, and printing are to a very high standard, and the completed series should serve the profession as the standard for the next generation.

David A. Hastings
Geological Survey Department
P.O. Box 93
Takoradi, Ghana

Penrose Conference on dinoflagellates scheduled at Vail, Colorado, April 17-21, 1978

A Penrose Conference on "Modern and Fossil Dinoflagellates," sponsored by the Geological Society of America, is scheduled for April 17-21, 1978, in Vail, Colorado. Conveners of the conference are William R. Evitt, Stanford University; Lewis E. Stover, Exxon Production Research Company; and Karen A. Steidinger, Florida Department of Natural Resources.

This conference will provide the first opportunity for active researchers concerned with both fossil and modern dinoflagellates to join in a review of their field and some of the major problems these organisms present. The broad objective of the conference is to increase communication and understanding between two groups of scientists whose interests have been focused heretofore on different parts of the dinoflagellate life cycle and whose contacts and exchanges have been severely limited by contrasting professional backgrounds, affiliations, techniques, and goals. Conference discussions will seek especially to explore those aspects of dinoflagellates that are of interest to both groups of investigators, such as: the dinoflagellate life cycle and cyst-motile stage relationships, morphology of cysts and thecae and classifications based upon them, evolutionary hypotheses based on either comparative studies of modern species or the fossil record, and factors controlling species distribution past and present. Certain topics primarily of interest only to neontologists (for example, culture methodology, physiological studies, and ultrastructure of cell contents) or only to paleontologists (for example, detailed biostratigraphic subdivision and correlation, and analysis of particular fossil assemblages) will be avoided.

Registration fee for the conference is expected to be approximately $275 to $300, including lodging, meals, and transportation from the airport to the meeting site and return. Attendance will be limited to approximately 70. Those interested in participating should apply by writing to W. R. Evitt, Department of Geology, Stanford University, Stanford, California 94305. Applications should include (a) name, position, and affiliation; (b) field of interest pertinent to participation in the conference; (c) topics on which the applicant is prepared to present material as a talk, as a poster display, or in group discussions. Application deadline is February 15, 1978, but earlier inquiry will facilitate planning.

Due to conflict with other meetings, the Penrose Conference on "Magnetization of Sediments and Magnetostratigraphy" by Charles E. Helsley has been postponed. It will be held January 9-13, 1978, in Durango, Colorado. The October 15 application deadline has been extended. Additional applicants can be accommodated during November. For more information, write the convener,

Charles E. Helsley, Director, Hawaii Institute of
Geophysics, 2525 Correa Road, Honolulu, Hawaii
96822 (808) 948-8760

Fulbright-Hays Awards announced

The Board of Foreign Scholarships has announced 482 awards to American scholars for work in 81 countries in a variety of disciplines for the program year 1977-78, and affiliation arrangements on U.S. campuses have been made for a comparable number of scholars from abroad. Lists are available.

There are three awards in geology in widely separated parts of the world.

Gregory S. Horne, Assoc Prof Earth and Environmental Sciences, Wesleyan U, Middletown, Connecticut. Geology, U Trondheim, Norway, 9/77-6/78 (Rt)

Errol Lee Montgomery, Asst Prof Geology, Northern Arizona U, Flagstaff. Hydrogeology, National Civil Engineering Laboratory, Portugal, 10/77-1/78 (R)

Neil Donald Opdyke, Adjunct Prof Geology, Columbia U, New York, New York. Geophysics, Australian Natl U, Australia, 7/77-2/78 (R)

Grant identification: L = Lecturing; R = Research; C = Consultation; j = junior award; t = travel only; r = renewal

The Council for International Exchange of Scholars is reviewing applications for the 1978-79 program year in order to make recommendations to the Board of Foreign Scholarships and overseas Fulbright agencies. The Council has waived deadline requirements in some cases and will accept additional applications for a number of positions—mostly teaching in Africa, Asia, and Eastern Europe, particularly in the fields of American literature, business and economics, science and engineering, linguistics and teaching English as a foreign language. Applicants must be U.S. citizens and have appropriate educational and professional qualifications. Further information is available from the Council for International Exchange of Scholars, Eleven Dupont Circle, Washington, D.C. 20036.

Fulbright-Hays awards for which the Council for International Exchange of Scholars is still accepting applications include GEOLOGY: Ivory Coast and Pakistan.

Necrology

Notice has been received of the following deaths: Aaro Emil Aho, Vancouver, British Columbia, Canada; George Brown Barbour, Cincinnati, Ohio; Alfred Hannam Bell, Urbana, Illinois; Bobby A. Bishop, Greenville, North Carolina; Russell Gibson, San Francisco, California; Bruce Charles Heezen, Piermont, New York; John Harper Melvin, Carroll, Ohio; John H. Moss, Lancaster, Pennsylvania; Nicolas Oulianoff, Lausanne, Switzerland; Robert A. Pasturuszak, Springfield, Massachusetts; Eldon Marion Thorp, Lincoln, Nebraska; Raymond E. Whitla, Little Rock, Arkansas.

International Conference on Geological Information announces call for papers

The International Conference on Geological Information will hold its meeting April 10–12, 1978 at the Imperial College of Science and Technology and the Geological Society of London.

The conference is sponsored and organized by the *Geological Information Group of the Geological Society of London* and the *Geoscience Information Society (USA)* together with the *Australian Geoscience Information Association, Editerra* (European Association of Earth Science Editors), and AESE (Association of Earth Science Editors). It is hoped that UNESCO will sponsor the meeting within the framework of its UNISIST program.

This is the first major attempt to bring together geoscience information specialists from all over the world. The program will include sessions on the history of geoscience documentation and a review of the current situation; brief reviews outlining the state-of-the-art of geoscience documentation in various regional units; publishing and editing; retrieval of information including indexing and abstracting services; documentation in specialized areas, maps, translations, remote sensing; user points of view; networks including national and international cooperation. There will also be a workshop on information handling for economic aspects of geology.

Visits are planned to various libraries including the British Museum (Natural History) and the Institute of Geological Sciences. There will be an exhibition of related publications, both antiquarian and current, and demonstrations of computer-based services.

During the conference, which will be of interest to information specialists, librarians and documentalists in geology and the mining and petroleum industries, a proposal will be made to establish an Internationa Association for Geological Documentation.

Residents in North and South America should address all correspondence relating to the conference to Dederick C. Ward, University Libraries, University of Colorado at Boulder, Boulder, Colorado 80309 All others should write to International Conference on Geological Information, c/o Palaeontology Library, British Museum (Natural History), Cromwell Road, London SW7 5BK, United Kingdom.

1978 NAGT Summer Geology Field Course Scholarship Program

With the generous help of industrial sponsors, NAGT will again operate a Summer Geology Field Course Scholarship Program in 1978. The program will provide scholarships to superior students who take a summer geology field course that is at least four weeks in duration and that engages the student in field work rather than classroom work. The chief criteria for the award is academic excellence.

There will be two application deadlines and announcement dates for the 1978 program. The first deadlines are January 1, 1978 (application deadline) and February 1, 1978 (announcement date). This is the Early Decision category. It is for those students whose decision to attend a summer field camp hinges on the availability of financial aid. The second set of dates are April 1, 1978, and May 1, 1978. This is the Regular Decision category. It is for applicants who are committed to and have been accepted in a summer program. Application blanks are available from college geology departments, the November 1977 issue of the *Journal of Geological Education*, and by writing directly to Dr. Thomas E. Hendrix, Department of Geology, Indiana University, Bloomington, Indiana 47401.

Because of the large number of anticipated applications, a limit of five applicants per school is placed on the 1978 program.

South-Central Section announces slate

The following slate of nominees will be voted on by the voting membership present at the annua business meeting of the South-Central Section on Monday, March 6, 1978, at Tulsa, Oklahoma:

Chairman: Norman F. (Bill) Williams (1979–80)
Vice-Chairman: John C. Gries (1979–80)
Secretary-Treasurer: Melvin C. Schroeder (1979–80)
Management Board (2-year terms, 1978–80):
  Member-at-Large, Kern C. Jackson
  Member-at-Large, Charles J. Mankin
  Member-at-Large, Page C. Twist

The present secretary-treasurer has indicated tha the 1979–80 term is the last he will serve. Suggestions for a nominee should be sent to John A. S. Adams Chairman of the Search Committee. The other members of the committee are John C. Gries and Kern Jackson.

Women Geoscientists Committee offers workshop in Seattle, November 6

The Women Geoscientists Committee of AGI is sponsoring a workshop on "job-hunting techniques' to be held at the Olympic Hotel at 8:30 a.m., Sunday, November 6 (prior to the GSA Annual Meeting) Among topics covered will be resume writing, interviewing, seeking unadvertised jobs, and salary negotiation. Registration is $20 and is limited to twenty participants.

For further information, contact Helen McCammon 9616 Culver Street, Kensington, Maryland 20795 (301) 933-0395 (home) or (301) 353-5549 (office).

Deformation and Deposition between a Foreland Uplift and an Impinging Thrust Belt: Hoback Basin, Wyoming

SPECIAL PAPER 177 — By John A. Dorr, Jr., Darwin R. Spearing, and James R. Steidtmann. 1977. vi + 82 pages, 19 figures, including a geologic map of the Hoback Basin area in color, folded in a pocket inside back cover. ISBN: 0-8137-2177-6. $10.00.

The Hoback Basin of western Wyoming lies in the zone of impingement between ranges of the Idaho-Wyoming thrust belt on the west and the Gros Ventre and Wind River foreland uplifts on the east. These ranges shed synorogenic clastic debris that filled the basin during Late Cretaceous and Tertiary time. The study provides detailed information on the chronologic and geometric relation between these two structural styles. The objectives of the paper are (1) to assemble and review the results of structural mapping, stratigraphic and sedimentologic studies, and paleontologic dating within the area; (2) to integrate and interpret these data in a detailed analysis of the depositional and deformational history of the region; (3) to integrate the geology of this area with that of the Jackson Hole area to the north and the Green River Basin and thrust belt to the south; and (4) to consider some of the regional tectonic cause-effect relationships in light of the specific evidence.

Eastward thrusting in the thick sequence of miogeosynclinal rocks to the west began somewhat earlier than did reverse faulting, which uplifted blocks in the adjacent foreland. Subsequently, however, both areas underwent contemporaneous deformation, so that thrust belt and foreland structures overlap geographically and temporally. Moreover, the last datable movements are the same age for both thrusts and major reverse faults. The Late Cretaceous rise of the ancestral Teton–Gros Ventre uplift and the subsequent rise of the Gros Ventre block provided a high-standing buttress of Precambrian rocks that deflected structures in the eastern part of the thrust belt. Late normal faulting and associated gravity sliding occurred in the thrust belt, and the Hoback and Gros Ventre Ranges acted as an integral block in spite of their previously distinct structural histories. Normal faulting also occurred in the foreland uplifts and, in some places, brought Precambrian rocks to the surface. Local tectonism and associated basin filling ceased by late Pliocene time in the Hoback Basin, and regional uplift initiated the dissection of both the lower Tertiary sedimentary rocks and pediments of parts of adjacent ranges.

Although the intimate spatial and temporal relations of the thrust belt and foreland structural styles do not require a single causal mechanism, they do suggest that thrusting in the thrust belt and uplift in the adjacent foreland were not entirely genetically separate.

CONTENTS: Acknowledgments. Abstract. Introduction: Location and general setting; Previous studies; Scope and procedures. Sedimentary geology: Paleozoic and Mesozoic sedimentary history; Upper Cretaceous rocks in the Hoback Basin (Coaly sequence, Lenticular sandstone and shale sequence, Mesaverde Sandstone, Harebell Formation); Lower Tertiary rocks (Hoback Formation: Main body, Skyline Trail Conglomerate Member; Wasatch Formation: Chappo Member, Lookout Mountain Conglomerate Member; Pass Peak Formation; Eocene arkosic rocks; Stratigraphic relations); Early Tertiary sedimentary tectonic implications (Hoback Formation, Wasatch Formation, Pass Peak Formation, Eocene arkosic rocks); Upper Tertiary rocks (Middle Eocene to middle Pliocene rocks in adjacent areas, Camp Davis Formation); Late Tertiary sedimentary tectonic implications. Structural geology: Tectonic framework; Faults and ranges bounding the Hoback Basin; Structures in the foreland ranges (Cache fault, Skyline Trail fault, Game Hill fault); Structures in the thrust belt (Cliff Creek thrust, Lookout Mountain thrust, Bear thrust, Hoback fault, Thrust belt rotation and paleomagnetism). Quaternary deposits and geomorphic evolution: Drainage development, Glacial deposits. Regional synthesis and summary of geologic history. Discussion of regional tectonic evolution. Summary of observations and interpretations. References cited.

Bathymetry of the East and Southeast Asian Seas

MC-17 — By J. Mammerickx, R. L. Fisher, F. J. Emmel, and S. M. Smith. 1977. On sheet, in color, 42¼" × 46½". Scale at equator, 1:6,442,194 or 1.74 cm (0.685 in.) per degree of longitude. Contour interval: 1,000 m. 50, 100, and 500 m contours added where appropriate. Folded, $5.00; rolled, $6.00.

The map encompasses the region bounded by lat 15°S and 45°N, and long 90°E and 150°E, at a scale of approximately 1.74 cm per degree of longitude (1:6,442,194); overall map size is about 1 by 1.14 m. The bathymetric contour interval is 1,000 m, with contours of 50, 100, and 500 m added where appropriate. The explanation includes a bibliography of charts, list of 10 sources of data, a small outline map showing echo-sounding regions, and a table of values to add to the normal depth (1,500 m/s) to correct for variable velocity of sound in sea water. The map is highly detailed and contains abundant geographic names; shades of blue color are used throughout to denote ranges of sea depth.

November BULLETIN briefs

Brief summaries of articles in the November 1977 Bulletin *are provided on the following pages and aid members who chose the lower dues option to select* Bulletin *separates of their choice. The document number of each article is repeated on the coupon and mailing label in this section.*

• 71101—The surface of Venus as revealed by Soviet Venera 9 and 10.

C. P. Florensky, O. V. Nikolaeva, L. B. Ronca, A. A. Pronin, A. T. Basilevsky, A. M. Trakhtman, G. A. Burba, V. P. Volkov, V. V. Zasetsky, V. I. Vernadsky Institute of Geochemistry and Analytical Chemistry, Academy of Sciences of the USSR, 47-a Vorobjovsko Shosse, Moscow 117334, USSR (permanent address, Ronca: Department of Geology, Wayne State University, Detroit, Michigan 48202). (9 p., 13 figs.)

The soft landers Venera 9 and 10 transmitted information to Earth about conditions on the surface of Venus. Temperature measurements in both locations ranged from 730° to 740°K, and pressure measurements ranged from 88 to 94 atm. Wind velocities were 0.5 to 1 m/sec. The radioactive content of material below the spacecraft was similar to that of Earth's basalt. The hardness of some of the formations was estimated to be comparable to Earth's hard rocks. The density of a hard formation was measured by Venera 10 to be 2.8 ± 0.1 g/cm^3.

Panoramic television cameras provided photographs of the landing areas. The types of computer enhancements to which the photographs were subjected are briefly discussed.

Venera 9 landed on a slope composed of slabs and a fine-grained matrix; Venera 10 landed on a plain composed of scattered outcrops separated by a fine-grained matrix. Detailed descriptions of the landing areas are presented.

The available chemical and dynamic information about the conditions at the surface of the planet indicates that the atmosphere has a high efficiency in lifting and transporting loose small particles but that very little ablation of hard material is to be expected.

Assuming thermodynamic equilibrium between atmosphere and surface materials, solid-gas interaction may occur and produce some disintegration of hard rocks and (or) some lithification of loose material, respectively by the increase in volume of newly formed minerals and by the formation of films or crusts. A vertical thermal gradient and vertical movements of gases or rocks are necessary. It is concluded, however, that the scale of chemical changes may be limited.

The photographs show that at least two types of geomorphic degradation occur. The slabs of Venera 9 appear to be mass wasting downhill, and the outcrops of Venera 10 show evidence of rounding of corners and smoothing of surfaces. The mass wasting is likely to be caused by gravity and perhaps activated by quakes or other geologic processes. The rounding and smoothing processes are probably due to some atmospheric action.

Six possible origins of the slabs and outcrops are discussed: (1) surface lava extrusion, (2) igneous intrusion later exposed by erosion, (3) pyroclastic fall, (4) impact lithification, (5) sedimentary rock lithified at depth and later exposed by erosion, and (6) lithification (or metamorphism) of loose material by atmospheric action at the surface.

A model of the surface geology of Venus is presented in which fine material is gently moved by Venusian winds. Hard material is occasionally formed at the surface, either by lithification through atmospheric processes or by volcanic falls. Removal of loose material by winds will cause some of the lithified units to stand out as positive relief features and be subjected to rounding of corners and smoothing of surfaces. If a slope exists, the lithified units will break into slabs and mass waste downhill.

• 71102—Petrochemistry and tectonic origin of the Ammonoosuc Volcanics, New Hampshire–Vermont.

John N. Aleinikoff, Department of Earth Sciences, Dartmouth College, Hanover, New Hampshire 03755. (7 p., 7 figs., 4 tbls.)

The Middle Ordovician Ammonoosuc Volcanics of the Bronson Hill anticlinorium in the upper Connecticut River valley, New Hampshire–Vermont, is composed of amphibolite, greenstone, and felsic schists. Major-element analyses of rocks believed to have been basaltic flows, such as pillowed greenstones and dense amphibolites, reveal that they are tholeiitic in composition. The felsic schists do not have igneous compositions, therefore indicating contamination by sedimentary detritus. Regional metamorphism appears to have been isochemical. However, sea-floor alteration prior to regional metamorphism probably depleted the basalts in MgO and slightly enriched them in SiO_2 and P_2O_5. On the basis of trace-element discrimination diagrams (Ti-Zr, Ti-Zr-Y, Ti-Zr-Sr), two distinct basaltic populations exist, suggesting an abyssal oceanic affinity for one group and an island-arc affinity for the other. It is proposed that the opening of the proto-Atlantic Ocean (Iapetus) in early Paleozoic time and its subsequent closure during the Taconic orogeny would explain the interfingering of Cambrian to Middle Ordovician abyssal tholeiite, island-arc tholeiite, and eugeosynclinal metasedimentary rocks in the northern Appalachians.

• 71103—Origin and history of upper Pleistocene marine terraces, San Diego, California.

J. Philip Kern, Department of Geological Sciences, San Diego State University, San Diego, California 92182. (14 p., 9 figs., 2 tbls.)

Geomorphic, structural, paleontologic, and stratigraphic analysis of features of emergent marine terraces have been used to reconstruct part of the late Pleistocene paleoenvironmental, paleogeographic, and tectonic history of the San Diego area. The Nestor terrace abrasion platform was cut 120,000 yr B.P. during a marine stillstand 6 ± 4 m above present sea level. Fossil marine invertebrates on this platform reflect slightly higher than present shallow-water marine temperatures, consistent with the slightly higher level of the sea and smaller volume of glacial ice. The 105,000-yr B.P. stillstand 12 ± 3 m lower than present sea level may be recorded in a single very small unfossiliferous terrace remnant. The Bird Rock terrace abrasion platform was cut 80,000 yr B.P. during a stillstand 14 ± 2 m lower than present sea level. Fossil marine invertebrates on this platform reflect slightly lower than present shallow-water marine temperatures, consistent with the slightly lower level of the sea and larger volume of glacial ice. General, rather uniform tectonic elevation of the entire San Diego coastal area has amounted to 19 to 24 m during the past 80,000 yr for a rate of uplift of 24 to 30 cm per thousand years. Just south of the Rose Canyon fault, the Nestor platform was elevated tectonically by approximately 23 m between 120,000 and 80,000 yr B.P. and another 31 m during the subsequent 80,000 yr to a total of 54 m in 120,000 yr, or 45 cm per thousand years.

• 71104—Meiji sediment tongue: North Pacific evidence for limited movement between the Pacific and North American plates.

David W. Scholl, James R. Hein, Michael Marlow, Edwin C. Buffington, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025. (10 p., 4 figs.)

The Meiji sediment tongue is an elongate southeast-trending sedimentary body in the northwestern corner of the Pacific. The tongue is approximately 800 km long, 300 km wide, and as much as 1,800 m thick. It is thickest immediately south of Kamchatka Strait, which separates Kamchatka from the west end of the Aleutian Ridge, and it thins southeastward away from the strait. Studies of the sediment cored at Deep Sea Drilling Project site 192 indicate that the tongue began to form in earliest Miocene time and that most of it is clay-size terrigenous debris derived from eastern Siberia. Pelagic beds, chiefly diatomaceous debris, make up the remainder.

Today, clay-size erosional detritus is presumably swept into the northwestern Pacific by the Kamchatka Current, which flows from the Bering Sea southwestward through Kamchatka Strait. A large part of this flow is presumably deflected to the southeast along the axis of the sediment tongue. The tongue therefore signifies that the current, and presumably the strait, formed at least by earliest Miocene time. In middle Miocene time, the accumulation rate of terrigenous clay (now claystone) at DSDP site 192 (the summit of Meiji Guyot) was 40 to 45 m/m.y. This rate implies that the guyot was near the strait in early Miocene time. Because the guyot is now near the strait, little of the tongue has been subducted beneath, or scraped off against, the Kamchatka continental margin. The Meiji sediment tongue is evidence that during the past 16 (probably 22) m.y. no more than 300 to 400 km of Pacific lithosphere has been subducted beneath Kamchatka (that is, American plate). Another sediment body in the North Pacific, the turbidite beds of the Aleutian Abyssal Plain, signifies that during the past 50 m.y. convergence between the Pacific and American plates has not exceeded about 500 km.

• 71105—Deformation of ooids by compaction in the Precambrian Bhander Limestone, India: Implications for lithification.

S. K. Chanda, Ajit Bhattacharyya, Soumen Sarkar, Department of Geological Sciences, Jadavpur University, Calcutta 700032, India. (9 p., 11 figs.)

Nodules of silicified oomicrite (chert) occur in the upper part of the shallow-water Precambrian Bhander Limestone of central India. The nodules characteristically are surrounded by aureoles, elongated parallel to bedding, of plastically deformed ooids. Both the intensity of deformation and packing density of the ooids in the limestone decrease away from the rigid nodules until a point is reached where there is neither detectable deformation nor condensation (intensification of "closeness" of grains). Lack of pervasive deformation in the limestone is interpreted to suggest that although in places compaction-deformation began early in diagenesis, cementation also began almost simultaneously, preventing the process from affecting the sediment beyond the limits of the aureoles.

Deformation of allochems, particularly nonductile ones, appears to be possible only under unusually intense overburden pressure (or shear stress). Anomalously high stress around rigid nodules of precompaction origin may lead, however, to the deformation of allochems at much lower overburden pressures, and therefore earlier than normally possible. Whereas the presence of deformed allochems proves compaction, the converse may not be true. Sediments do compact, but overburden pressure probably does not normally exceed the load-bearing capacity of the allochems; in such cases, allochems would not be visibly deformed. Within the normal range of lithostatic pressure likely in compaction, sutured micrite fabric and condensation of allochems are therefore more likely than deformed allochems. Cementation may commonly intervene before sufficient overburden pressure is built up to deform allochems. Overemphasis on the presence of deformed allochems as a sign of compaction appears to have overshadowed the importance of compaction in the diagenetic evolution of limestones.

• 71106—Comparison of the bottom nepheloid layer and late Holocene deposition on Nitinat Fan: Implications for lutite dispersal and deposition.

Per R. Stokke, Bobb Carson, Department of Geological Sciences, Center for Marine and Environmental Studies, Lehigh University, Bethlehem, Pennsylvania 18015; Edward T. Baker, Department of Oceanography, University of Washington, Seattle, Washington 98195 (present addresses, Stokke: Continental Shelf Institute, Hakon Magnussonsgt. 1B, 7000 Trondheim, Norway; Baker: Pacific Marine Environmental Laboratory, NOAA, 3711 15th Avenue N.E., Seattle, Washington 98105). (7 p., 12 figs.).

A study of 56 sediment cores and 121 nephelometer profiles from Nitinat deep-sea fan shows variations in Late Holocene accumulation rates and sediment texture which parallel variations in thickness and suspended sediment load of the bottom nepheloid layer. Furthermore, accumulation rates, sediment texture, and nepheloid layer variables all show a substantial degree of correlation with fan topography. In general, the nepheloid layer thickens (>100 m) and suspended sediment loads increase (>100 $\mu g/cm^2$) above Cascadia Channel (the major channel crossing the fan) as well as above the northern flank of the fan. Over levees and the western portion of the fan, the nepheloid layer thins to <50 m, and suspended sediment loads fall below 100 $\mu g/cm^2$. Cascadia Channel and the northern flank of the fan have been loci of rapid sedimentation, with accumulation rates ranging from approximately 5 to greater than 12 $mg/cm^2/yr$. In contrast, the apex and western reaches of the fan have significantly lower accumulation rates: 1 to 5 $mg/cm^2/yr$. Detailed size analysis of bottom sediments shows that areas characterized by rapid sedimentation and a thick, heavily loaded nepheloid layer have more medium to fine silt (5 to 7 ϕ) than the clay-rich (>8 ϕ) sediments from interchannel areas with low accumulation rates and a thin, lightly loaded nepheloid layer. The data suggest that turbid water moves continuously down Cascadia Channel and the northern flank. The transport mechanism is size-selective and topographically controlled, concentrating silt-sized detritus in topographic lows. The data also suggest a positive downward flux of sediment particles within the nepheloid layer, at least when averaged over a significant period of time.

• 71107—Late Quaternary sedimentation and paleoecologic history of Chaco Canyon, New Mexico.

Stephen A. Hall, Department of Geography and Institute of Applied Sciences, North Texas State University, Denton, Texas 76203. (26 p., 13 figs., 3 tbls.)

A stratigraphic and pollen analytical study of a thick sequence of alluvium at Chaco Canyon National Monument has provided a detailed history of late Quaternary alluviation, channel trenching, vegetation, and climate for the eastern Colorado Plateau. The alluvium at Chaco Canyon consists of five informal units, each separated by an erosional unconformity: Fajada (late Pleistocene), Gallo (7000 to 2400 B.P.), Chaco (2200 to 850 B.P.), Post-Bonito (600 B.P. to 1860 A.D.), and Historic (1935 to present). The Fajada paleosol occurs throughout northwestern New Mexico and is radiocarbon dated as older than 6,700 yr.

Pollen analysis of the four younger alluvial units provides evidence for a mid-Holocene interval of aridity that occurs later than recognized elsewhere in the Southwest. Around 5,800 yr ago both pinyon and ponderosa forests were rapidly diminished by a decrease in precipitation. Maximum reduction of the pine forests and woodlands and the greatest aridity of climate persisted from 5600 to 2400 B.P. Ponderosa forests in the mountains adjacent to Chaco Canyon had begun to expand their range by 2200 B.P., and the major expansion of pinyon woodlands in the Chaco area began about 850 yr ago.

The climate at Chaco Canyon when the Basketmaker and Pueblo peoples lived there about 600 to 1150 A.D. was drier and warmer than it is today. The ponderosa pine logs used in pueblo building were obtained from the mountains east, south, or west of Chaco Canyon. Abandonment of the pueblos coincided with the incision of the valley floor by the post-Bonito channel system.

• 71108—Holocene faulting in the western Grand Canyon, Arizona.

Peter W. Huntoon, Department of Geology and Water Resources Research Institute, University of Wyoming, Laramie, Wyoming 82071. (4 p., 4 figs.)

The Toroweap and Hurricane faults and a subsidiary fault in the western Grand Canyon exhibit evidence of Holocene movement. This evidence includes scarps in alluvium and sediments ponded against a fault on the downthrown block. These displacements are the latest in a well-exposed record of recurrent movements along the major faults in the region.

• 71109—Geology of the Sagamore Canyon–Slaughterhouse Spring area, New York Mountains, California.

B. C. Burchfiel, Department of Geology, Rice University, Houston, Texas 77001; Gregory A. Davis, Department of Geological Science, University of Southern

California, Los Angeles, California 90007 (present address, Burchfiel: Department of Earth and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). (18 p., 6 figs., 3 tbls.)

More than 2,000 m of Paleozoic and Mesozoic rocks are present in the Sagamore Canyon–Slaughterhouse Spring area, New York Mountains, California. Although recrystallized to marble, the rocks can be subdivided into formations typical of platform units east of the Cordilleran geosyncline. These formations range from the Cambrian Tapeats Sandstone, which rests unconformably on Precambrian crystalline rocks, to the Upper Mississippian–Pennsylvanian–Permian(?) Bird Spring Formation. A calc-silicate and quartzite unit unconformably overlies the Bird Spring and is tentatively correlated with the Triassic Moenkopi Formation. Mesozoic siliceous metavolcanic and metasedimentary rocks unconformably overlie the Moenkopi(?).

Precambrian crystalline rocks, Paleozoic marble, and Mesozoic(?) calc-silicate rocks and quartzite are thrust eastward over Mesozoic metavolcanic and metasedimentary rocks. The allochthon is structurally complex; it consists of structures belonging to at least 10 deformational events. Correlation of these deformational events with better-dated events in the Clark Mountains suggests that both early and late Mesozoic folding, thrusting, and high-angle faulting affected the allochthonous rocks. All folds and thrust faults are intruded by a Late Cretaceous pluton (K-Ar dated at 71.7 ± 0.8 m.y. B.P.).

Regionally, allochthonous rocks of the New York Mountains probably are in the easternmost thrust plate of the Cordilleran fold and thrust belt, which is in a position analogous to that of the Keystone thrust plate farther north. The thrust plate contains Precambrian crystalline rocks and platform Paleozoic rocks and includes structures of probably both early and late Mesozoic age. These relationships demonstrate the complete crosscutting of the Paleozoic geosyncline by Mesozoic structures.

- 71110—A thrust plate of ophiolitic rocks in the Preston Peak area, Klamath Mountains, California.

Arthur W. Snoke, Department of Geology, University of South Carolina, Columbia, South Carolina 29208. (19 p., 14 figs., 1 tbl.)

In the Preston Peak area, Klamath Mountains, California, a regional thrust fault separates metasedimentary rocks of the Late Jurassic Galice Formation from an overlying plate of older ophiolitic rocks. The ophiolite consists of a basal sheet of ultramafic tectonite overlain and intruded by a heterogeneous mafic complex that in turn is overlain by metabasaltic and metasedimentary rocks.

Field relations indicate that the ophiolite is polygenetic, with a major temporal hiatus separating the tectonitic ultramafic rocks and the associated mafic rocks. Mineral assemblages and textures in the ultramafic rocks suggest high-temperature recrystallization and penetrative deformation. In contrast, diabase and diabase breccia, the most abundant constituents of the mafic complex, are nonschistose rocks metamorphosed to lower greenschist facies. Contacts between ultramafic rocks and rocks of the mafic complex are fault contacts, intrusive contacts, or both. Mafic rocks occur in the ultramafic rocks as diabase dikes with chilled margins and as tectonic inclusions. Piecemeal growth of the ophiolite is also indicated by minor features: scarce jackstraw-textured talc-olivine rocks in tectonitic peridotite, cognate xenoliths of gabbro and olivine clinopyroxenite in diabase, and scattered dikes of intermediate composition in both ultramafic and mafic rocks.

Field aspects of the ophiolite appear more compatible with a primitive island-arc setting than with a spreading oceanic ridge or marginal-basin model. The temporal relations between the ultramafic and mafic rocks, the presence of pyroclastic breccias, and the character of associated epiclastic rocks support this hypothesis. On the basis of this interpretation, the tectonic history of this segment of the Klamath Mountains during late Paleozoic to Jurassic time was dominated by island-arc genesis and westward extensional rifting. The ultimate collapse of this system occurred during the Late Jurassic (Nevadan orogeny) when the Galice Formation (Jurassic island arc and associated sedimentary basin) was thrust beneath the Preston Peak ophiolite, a Permian-Triassic remnant arc.

- 71111—Effects of submarine alteration on K-Ar dating of deep-sea igneous rocks.

David E. Seidemann, Department of Geology and Geophysics, Yale University, New Haven, Connecticut 06520 (present address: Geology Department, Brooklyn College, Brooklyn, New York 11210). (7 p., 2 figs., 4 tbls.)

In an attempt to establish criteria for obtaining reliable K-Ar dates, conventional K-Ar studies of several Deep Sea Drilling Project sites were undertaken. K-Ar dates of these rocks may be subject to inaccuracies as the result of sea-water alteration. Inaccuracies may also result from the presence of excess radiogenic ^{40}Ar trapped in rapidly cooled rocks at the time of their formation. The results obtained for DSDP Leg 34 basalts indicate that lowering of K-Ar dates, which is related to potassium addition by weathering, is a major cause of uncertainty in obtaining reliable K-Ar dates for deep-sea rocks. It could not be determined if the potassium addition to the basalts occurred at the time of formation, t_o, or continuously from t_o to the present. Calculations show that sediment cover is not a significant barrier to the diffusion of potassium into the basalt. ^{40}Ar loss contributes, at least in part, to the lowering of the K-Ar date in rocks that have added potassium. The meaning of the K-Ar results obtained for DSDP Legs 35 and 2 basalts could not be unambiguously established. Because of the problems involved, caution must be used in interpreting the meaning of conventional K-Ar dates for deep-sea rocks.

- 71112—Deformation associated with the movement of the Muddy Mountain overthrust in the Buffington window, southeastern Nevada.

William G. Brock, AMOCO Production Company, Security Life Building, Denver, Colorado 80202; Terry Engelder, Lamont-Doherty Geological Observatory, Palisades, New York 10964. (11 p., 17 figs.)

The Muddy Mountain overthrust, exposed in the Buffington window, southeastern Nevada, consists of a Paleozoic carbonate sheet thrust over Mesozoic Aztec Sandstone, with a molasse filling topographic lows. Evidence suggests that the thrust sheet moved across an erosional surface and that the molasse may have been a forethrust debris. A sharp contact with gouge marks the fault surface. The base of the overthrust sheet is a tectonic breccia containing injections of gouge that are rooted at the contact. Thrust-related changes in the underlying rocks related to proximity of the thrust plane include (1) increase in abundance of microfractures and decrease in grain size due to cataclastic deformation; (2) increase in intensity of macrofracturing parallel and at a low angle to the contact; (3) increase in degree of induration; (4) loss of well-defined bedding planes and color contrast within the Aztec Sandstone; and (5) slabs of dolomite sheared from the upper plate. Laboratory mechanical tests in conjunction with field observations suggest that the shear strength of the undeformed Aztec Sandstone was lower than the frictional strength of the sandstone sliding on quartz gouge. Therefore, cataclastic deformation within a 10- to 100-m-thick zone accompanied the initial advance of the thrust sheet. Following induration, which strengthened the cataclastic sandstone, slip was localized at the thrust contact. During this later stage the high permeability of the fractured upper plate and the Aztec Sandstone suggests that fluid communication with the surface at the leading edge of the thrust was rapid and, therefore, the advance of the thrust could not have been aided by high pore pressure.

- 71113—Macroscopic polyphase folding illustrated by the Toxaway dome, eastern Blue Ridge, South Carolina–North Carolina.

Robert D. Hatcher, Jr., Geology Department, Clemson University, Clemson, South Carolina 29631. (11 p., 12 figs., 1 tbl.)

The Toxaway dome is located in the Blue Ridge of North and South Carolina immediately northwest of the Brevard zone. It is composed of a core exposing banded granitic gneiss (Toxaway Gneiss, formerly Whiteside Granite) and a sliver of Tallulah Falls Formation rocks. The dome is flanked on all sides by rocks of the Tallulah Falls Formation. The Toxaway dome in its general outcrop pattern is an elongate feature that has a steeply northwest-dipping northwest limb and a more moderately inclined southeast limb. At the ends, the structure plunges gently northeast and southwest. Detailed mapping of the core of the dome in South Carolina reveals that the sliver of Tallulah Falls Formation rocks has a hooked outcrop

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pattern, and is completely isolated in outcrop from the main mass of Tallulah Falls Formation rocks surrounding the dome.

At least two episodes of flowage folding have been recognized in the Toxaway dome. The first set is isoclinal and recumbent, trending east to northeast and verging north to northwest. The second set is more upright and may be isoclinal to open, trending northeast and verging northwest. Later mesoscopic crenulation cleavage and macroscopic northeast- and northwest-trending flexural-slip folds are also present.

The Toxaway dome is an F_2 feature produced by refolding of earlier F_1 recumbent isoclines. The structural sequence recognized here is much the same as that observed in the Blue Ridge, Chauga belt, and Inner Piedmont. This is probably also the same structural sequence that can be observed throughout the Blue Ridge.

- 71114—Distribution of large basaltic intrusions in the Icelandic crust and the nature of the layer 2–layer 3 boundary.

Ingvar Birgir Fridleifsson, National Energy Authority, Laugavegur 116, Reykjavik, Iceland. (5 p., 2 figs., 1 tbl.)

Basaltic intrusions more than 20 m thick are relatively rare in Iceland and are mainly associated with central volcanic complexes. A literature survey shows that the majority of large (≥ 1 km^2 in area) basaltic intrusions are intruded into soft and structureless host rocks such as tuffaceous hyaloclastites, sediments, vent and caldera agglomerates, hydrothermally propylitized lavas, and hot and still partly liquid silicic intrusive material. It appears that, upon entering host rock that breaks irregularly, the upwelling magma may expand within the host rock rather than penetrate upward along a narrow fracture to form a dike. This suggests that magma may tend to spread out laterally within the highly altered base of seismic layer 2 (lava layer) rather than penetrate the progressively harder (less altered) lava pile. The boundary of layers 2 and 3 (intrusive layer) could therefore be controlled by a metamorphic front at which the degree of alteration makes the lava pile lose its coherence and accommodate large intrusions. This model is compatible with the correspondence previously observed in Iceland between depths to seismic layer 3 (V_p = 6.5 km/s) and geothermal gradients as measured in bore holes.

- 71115—A former continuation of the Alps: Discussion and reply. (3 p., 1 fig.)

Discussion: *Gil Chabrier, Georges H. Mascle, Universite de Paris VI, Departement de Geologie Structurale, 4, Place Jussieu—Tour 26-E1, 75230 Paris Cedex 05, France.*

Reply: *Walter Alvarez, Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York 10964.*

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