GSA news & information

SUPPLEMENT TO GEOLOGY MAGAZINE

FEBRUARY 1977

Denver Annual Meeting: A thank you to the committee

Some statistics and requests for comments

The Annual Meeting in November in Denver exceeded all expectations, with by far the largest attendance for any GSA meeting. Although the unexpected numbers caused some meeting rooms to be overcrowded, the press of people had the maximum impact on the Welcoming Party.

Total registration was 5,351, which included 3,351 professional registrants, 1,451 students, 381 spouses and guests, and 168 one-day registrants. Those who had preregistered for the meeting totaled 2,797, which included 1,913 professionals, 655 students, and 229 spouses.

The 1976 Annual Meeting was the first four-day affair. In spite of the extra day, the number of concurrent sessions was only reduced from a maximum of eleven at the Salt Lake City meeting in 1975 to a maximum of nine at the Denver meeting.

A total of 825 papers were presented, from a total of 1,110 submitted, in 68 regular sessions and 65 poster presentations. Also, three special symposia were held on Wednesday evening.

It will be a help to future local committees and the Council, as well as to the headquarters staff, if those who attended the meeting will give us their comments about four-day meetings versus three- or three-and-a-half-day meetings as well as about the number of concurrent sessions that seems tolerable.

The Council had approved a maximum of 70 sessions during the meeting—is this too many or not enough? The Council had also approved the use of Sunday preceding the meeting for special sessions of associated societies, but the option was not taken at the Denver meeting. If the regular meeting were three-and-a-half days, the last half day might also be used for such purposes.

In association with the meeting were 22 field trips, conducted by 76 leaders and 15 students; these were attended by 1,141 participants.

A questionnaire was distributed to professional registrants in their packets. Of these, 324 were returned; 235 indicated membership in GSA, and 30 to 50 indicated membership in each of MSA, NAGT, PS, SEG, and GS. The ratings on the technical program were "very good" and "good," tied for first, with a significant number of votes for "fair." The poster sessions were rated "good" and "very good," with "fair" a distant third. For the exhibitors, "very good" drew the largest number of votes, with "good" and "excellent" second and third. The overall rating of the Annual Meeting gave "very good" first vote, followed closely by "good," with "fair" a distant third. Although interesting, such ratings are not greatly helpful to next year's committee.

Like everything else at the Denver meeting, the employment interview services were by far the largest ever. A total of 525 job applicants took part in the program. Of these, 384 had preregistered, and 141 registered on site. As would be expected, those who preregistered were, on the average, served better than those who registered on site. A total of 81 employers were involved with the service: 44 of these used the facilities and interview booths on site and conducted 1,120 interviews; 14 employers interviewed independently by using the printout and message center services; and 23 employers used only the message center and posted job notices.

As always, the local committee, working long and hard behind the scenes, was a key to the success of the meeting. The Society extends thanks and congratulations for a job well done. In case you have forgotten who did the work, the committee membership was as follows: R. Dana Russell, general chairman; William R. (Dick) Keefer, co-chairman and treasurer; Daniel R. Shawe and William C. Bradley, technical program; Rudy C. Epis and Robert J. Weimer, field trips; Mrs. Warren Hobbs, spouse/guest program; John W. Rold, technical services; Peter W. Birkeland, student assistance; Robert B. Johnson, science theater; John Ivey, publicity; John E. Costa, meeting space assignments; Richard H. Pearl, transportation; Edwin B. Eckel and Nick Serbu, Centennial display. We would also like to thank Mitchell W. Reynolds for coordinating the Pick and Hammer Show.

Registration area at Currigan Exhibit Hall. On-site registration numbered 2,554. Total registration for the four-day meeting was 5,351.

Capacity crowd at the Annual Welcoming Party rubbed elbows with new, old, and very old friends.

The 68 technical sessions were well attended.

The 65 poster sessions brought lively discussions to the floor of the exhibit hall.

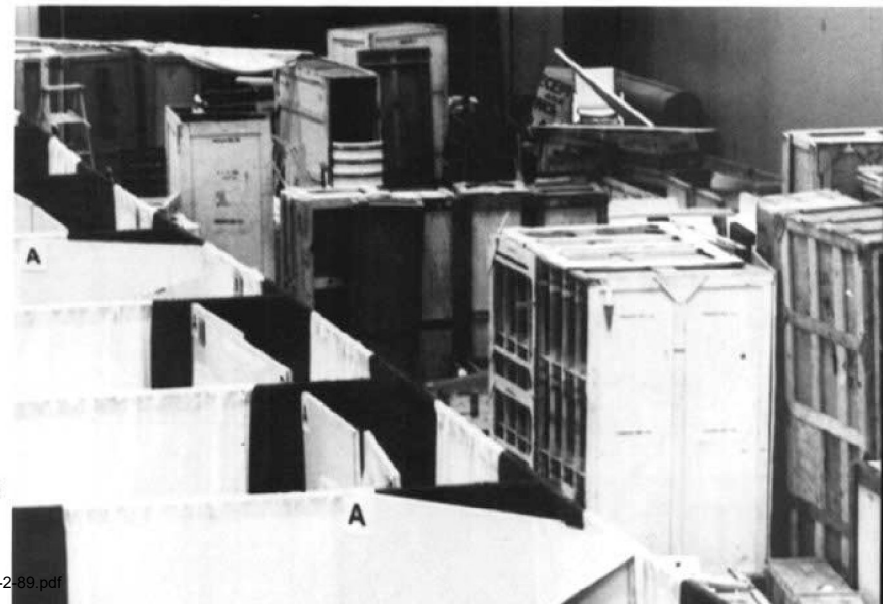
The Sunshine Capitol lived up to its name—meeting participants congregated outside Currigan Hall to take in sun and conversation.

Exhibits were varied and well attended.

The Society's book booth did a bustling business.

.S. Geological Survey's Needles LANDSAT map of the U.S. was among the
ar exhibits at the meeting.

Early-morning Denver in cool Colorado greeted the 1,141 participants departing on GSA field trips.



GSA's Employment Interview Services, which handled 525 applicants, closes up shop and packs up for another year . . .

SEE YOU IN SEATTLE!

THE GEOLOGICAL SOCIETY OF AMERICA

To the members of the Northeastern Section:

Because he has moved from Memorial University in Newfoundland to the Geological Survey of Canada in Calgary, Ward Neale has resigned as vice-chairman of the Northeastern Section.

Joe Hartshorn (recently elected vice-chairman to assume office following the Binghamton meeting next April) has agreed to move ahead a year and assume the vice-chairmanship NOW. As a result, he will become chairman following the Binghamton meeting.

Having thus replaced Neale with Hartshorn, a candidate for vice-chairman was needed. At my request, Lou Pavlides assembled a nominating committee consisting of Elizabeth King, Avery Drake, and Pavlides as chairman. This committee submitted the name of William Poole for vice-chairman effective following the Binghamton meeting. Poole's biographical note, modified from *American Men and Women of Science 1972*, is included below for your information.

To avoid the cost of another ballot mailing, an election by voice vote will be held during the Section's business meeting next April. Plan to attend. Hopefully, we will end up with a set of properly elected officers for 1977–1978.

Poole, William Hope. Born Kimberley, B.C., 2-20-27; married, 2 children; B.A.Sc, British Columbia, 49; Ph.D. (geology), Princeton, 56. Geological Survey of Canada: regional geologist, Yukon 1952-56, Canadian Appalachians 1956- ; Head, Correlation and Standards Subdivision 1974-. Interests: field geology, stratigraphy, structure, igneous and metamorphic geology, mineral deposits, plate tectonics. Address: Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A OE8.

Norman L. Hatch, Jr.
Chairman, Northeast Section

Penrose Conference on the Geology of Subaqueous Volcanic Rocks announced for November

A Geological Society of America Penrose Conference on the Geology of Subaqueous Volcanic Rocks will be held from November 27 to December 1, 1977, at the Miramar Hotel, Santa Barbara, California, located about twenty minutes from the Santa Barbara airport.

The purpose of the conference is to identify problems related to the geology of subaqueous volcanic rocks and to survey the present slate of knowledge on subaqueous volcanic processes. Sessions are planned on three main subjects that should be the focal point of the conference: (1) physical characteristics of subaqueous volcaniclastic rocks, their mechanisms of fragmentation and emplacement; (2) morphology and origin of subaqueous lavas; (3) geochemical interaction of water and effusive lavas and volcaniclastic materials and possible changes through time.

The conference will bring together geologists working on Phanerozoic (mainly Holocene and Tertiary) and more ancient rocks, including Precambrian deposits. This should be a particularly valuable aspect of the conference because it will encourage geologists working in ancient rocks to view their rocks in an actualistic perspective. On the other hand, geologists working in more recent deposits will have the benefit of viewing volcanic complexes in three dimensions which is not possible in the Holocene. The exchange of ideas between Precambrian geologists, more familiar with structure, and geologists working on the Holocene who have a better working knowledge of volcanic processes should be stimulating to both.

The conference will last five days, with a one-day field trip to view Miocene subaqueous volcanic rocks.

The cost of attending the conference is expected to be about $260 per person, which includes registration fee, twin occupancy at the hotel, all meals, and the field trip.

Attendance will be limited to about 75 people. Those interested in attending are invited to contact one of the two convenors: *Richard V. Fisher,* Department of Geological Sciences, University of California, Santa Barbara, California 93106; or *Erich Dimroth*, Sciences de la Terre, Universte du Quebec a Chicoutimi, Chicoutimi, Quebec, Canada G7H 2B1. State if you wish to attend and your main subject of interest.

Research proposals solicited by USGS Earthquake Hazards Reduction Program

The United States Geological Survey requests proposals for research grants/contracts under the continuing Earthquake Hazards Reduction Program. Proposals to initiate or continue research projects concerned with the Palmdale (California) uplift will be considered as part of this program.

The general areas of interest are:

A. Delineation and evaluation of hazards associated with earthquakes, including but not restricted to preparation of geologic and land-use maps, prediction of ground motion, and studies of seismicity induced by reservoirs.

B. Earthquake prediction research and implementation, including but not restricted to studies of precursors, data processing, and investigations of the physical basis of earthquakes including deformation and failure of crustal rocks.

Written inquiries concerning this program, and requests for Proposal Information Package No. RFP 350W, should be addressed to:

Contracting Officer
U.S. Geological Survey
Bldg 1, Room 201, 345 Middlefield Road
Menlo Park, California 94025

Due date for receipt of proposals is April 1, 1977. It is anticipated that funding of selected programs will start on or about October 1, 1977.

AAPG - SEPM

ANNUAL CONVENTION

JUNE 12-16, 1977

FACT
America Uses More Energy Per Capita Than Any Other Nation

With the continued development and use of our finite fossil-fuel supply the problem of future energy resources becomes evermore acute, and the 1977 AAPG-SEPM Annual Convention will address this very problem. The theme of the meeting is entitled, "Fueling the Future."

The technical program will feature a wide variety of topics including oil, oil shale, synthetic and natural gas, coal, nuclear, geothermal, and solar energy, as well as legislative controls related to energy development. To cover this wide spectrum, this year's convention will be 3½ days long rather than the traditional 3 days. Additional session titles are Petroleum Potential of Slopes, Rises, and Plateaus; Computer Applications; six sessions on Energy Minerals; East Coast Continental Shelf; Enhanced Oil Recovery; Federal Regulation and the Geologist; a Geophysical Session, and SEPM Sessions on Paleontology and Sedimentology.

Sunday, prior to the regular meeting, two short courses are scheduled. Edward McFarlan, Jr., and Charles L. Drake will chair a special joint AAPG Continuing Education Committee and Research Committee short course on the "Geology of Continental Margins." The second short course sponsored by AAPG Continuing Education Committee deals with Uranium and is chaired by Richard De Voto. Additionally, there will be approximately 10 research colloquia scheduled for Sunday.

Entertainment will center around two events: the Embassy Row cocktail parties on Wednesday evening in which convention goers will be able to visit and have cocktails at selected foreign embassies; and a musical at the beautiful Kennedy Center scheduled for Tuesday evening. Spouse events will feature a tour of the city including Capitol Hill and the State Department, a tour to the Smithsonian, Hirshorn, and other famous museums, and a tour at the White House (for which pre-registration is required) followed by a trip to Mt. Vernon.

The Geological Society of Washington and the Eastern Section of the AAPG are hosts and have planned a combination of stimulating technical sessions and social entertainment. The entire convention will be housed at two of Washington's finest hotels, the Sheraton-Park and the Shoreham Americana, right across the street from each other.

This is the first AAPG-SEPM annual meeting ever held in our nation's capitol and we hope you plan to attend. The meeting promises to be an outstanding convention and a unique experience.

For further details, please contact:

AAPG Headquarters
Box 979
Tulsa, Oklahoma 74101
Phone: (918) 584-2555

BOOK BRIEFS

This feature is included occasionally in the News & Information section to keep members informed of recent books published by the Society.

Urban Geomorphology

SPECIAL PAPER 174 — edited by Donald R. Coates. iv + 166 p., 53 figures, 17 tables, index. $15.00.

The seven papers in this volume were presented in the Urban Geomorphology Symposium during the Geological Society of America's 1974 Annual Meeting at Miami Beach, Florida.

There are several recurring themes that are either implicit or inferred in all the papers. Geomorphology is a discipline that can contribute to an important data base in the solution of urban-area problems. Such knowledge is useless, however, unless it can be integrated in the decision-making process. Finally, before appropriate decisions can be made, voters and managers must be convinced that predicted benefits far outweigh other costs that may be involved.

Beacon Hill End Moraine, Boston: New Explanation of an Important Urban Feature (Clifford A. Kaye). Geomorphology has its shortcomings in glaciated terrain; Beacon Hill, the old geographic center of Boston, provides a good example of this. The uncertainties of geologic interpretation are particularly great in glaciated terrain because our understanding of both glacial processes and history is so incomplete. Recent construction activities in the eastern part of Beacon Hill, until now classified as a drumlin, have shown that it is better interpreted as an end moraine formed by a Wisconsinan glacial readvance. Instead of the firm till that was anticipated as foundation material, excavations exposed a complex of sand, gravel, and clay, with only minor zones of till. The structure of these deposits strongly suggests that originally they were plates of the glacial bed that froze to the glacier and were transported englacially. Upon deglaciation, the frozen moraine thawed, and slumping formed complex secondary structures on the ridge's lower flanks.

Sediment-Control Methods in Urban Development: Some Examples and Implications (Harold P. Guy). Although only a relatively small area of the United States (about 0.04 percent or 4,000 km^2/yr) is being subjected to new urban development problems, erosion, sediment movement, and sediment deposition in and near the developing areas can be intense.

Sediment-control methods in areas of urban development must be more carefully designed temporally and spacially than methods used in rural areas. An example of adverse effects of attempted sediment control is the use of small sediment-detention basins downstream from a development project when the construction phase will last only a few months. The result is that (1) damage is done to the waterway; (2) little of the fine sediment is trapped and considerable coarse sediment may be lost during a storm; (3) maintenance may be neglected by the contractor, which can cause a failure of the system; and (4) the cost of the sediment detention is passed on to the consumer. The need for such a detention basin might be avoided by designing the facility so as to insure minimum disturbance of the landscape, a reduction in direct overland flow, and better timing of construction to minimize soil exposure during the rainy season.

Urban Landslides: Targets for Land-Use Planning in California (F. Beach Leighton). Estimated losses due to landsliding will be almost $10 billion in California between 1970 and the year 2000, assuming that the level of landslide prevention remains status quo. Nevertheless, urban landslides have been shown to be one of the geologic hazards most amenable to avoidance and reduction by land-use planning. Estimated reduction of damaging failures attainable by investigations at the regional, community, and site levels combined is 95 to 99 percent.

A point system for landslide risk in a planning area can generally be established, based on the following factors: (1) adequacy of landslide data base, (2) landslide stability ratings, (3) records of landslides in area, (4) geologic-engineering codes and standards, (5) implementation and enforcement of the codes and standards, and (6) performance records.

Case histories in the Seal Cove–Moss Beach area of northern California and the Palos Verdes area of southern California serve to show how different the planning of these landslide areas might have been had the fund of geotechnical information, land-use planning techniques, and climate of public understanding approached the level evolved today.

Application of Land-Use Constraints in Oregon (Leonard Palmer). This paper discusses the importance and place of geologic data in the total scope of information required for land-use planning in Oregon. The various geologic factors—such as land stabilities, geohydrology, soil and rock characteristics, landforms, and resources—are defined according to their developmental limitations. Existing land use and trends are then compared to natural limitations to determine conflicting and compatible land uses.

Simple systems of presenting and integrating geologic with nongeologic factors are utilized for improved public understanding and participation in the planning process.

Geomorphic Constraints on Land Development in the Front Range Urban Corridor, Colorado (Wallace R. Hansen). Projections call for an approximate doubling of the population here between 1970 and the year 2000. Some counties in the corridor have nearly doubled in population twice since 1950.

A varied geomorphic setting of plains, valleys, and mountains and a semiarid climate foster a sensitive ecologic balance. Impacts arise when land development disturbs certain fragile soils (such as loess, eolian sand, and expansive clay), when excavation unbalances metastable hillslopes, when the extraction of industrial commodities (gravel, clay, stone, coal) interacts with geomorphic processes, or when urban development alters the hydrologic regime. To minimize adverse environmental impacts, land development should proceed cautiously in areas where geomorphic processes having undesirable results are active or are likely to be activated.

Geomorphology in Legal Affairs of the Binghamton, New York, Metropolitan Area (Donald R. Coates). The Binghamton area provides many examples of the interaction between scientists and land managers. The paper explores typical laws that have led to geomorphic engineering in that metropolitan area and analyzes some court cases that involved geomorphology.

Disastrous Binghamton floods in 1935 to 1936 produced a Federal response through the newly enacted Flood Control Act of 1936. Accordingly, the U.S. Corps of Engineers built the only two dams in the Susquehanna Basin, constructed miles of flood walls, and channelized parts of the Susquehanna and Chenango Rivers. Another public law, enacted in 1954, enabled the Soil Conservation Service to complete 17 of 22 dam projects. Other Federal laws have financed the Riverbanks Improvement Program of Broome County, New York, and led to municipal ordinances that prohibit new occupancy in flood plains.

Construction of interstate highways has altered the Binghamton landscape and has led to much litigation. Lands were condemned that contained gravel deposits, water supplies of contiguous properties have been affected, and proper environmental statements are missing in several design plans.

Geomorphology and Land-Use Decisions in Maine (Donaldson Koons). Maine offers an exceptional opportunity for application of geomorphology in guiding land-use decisions. The conditions are unusual and in some ways unique; they reflect both a Pleistocene-Holocene geologic history, differing from much of New England, and a land-ownership pattern not commonly found elsewhere. Maine is under increasingly heavy pressure to permit development that may include deep-water ports and associated oil terminal and refining facilities, coastal and inland water-oriented recreational housing, and ski-related resorts. The state is 90 percent forested, sparsely populated, and historically penurious in acquisition of inventory data on natural resources.

Three major statutes control developments within the state: (1) site selection, applied statewide to major developments of 20 acres or more; (2) wildland zoning, applied to the Unorganized Towns (mostly privately owned); and (3) shoreland zoning, applied to areas 250 ft from lakes, streams, and coastal waters.

Significant stratigraphic units are end- and ground-moraine complexes; ice-contact features, including eskers, kames, kame terraces, and deltas; outwash, shore and beach deposits, and dune fields; and marine clays. These units are readily identified by the geomorphologist, whose information then provides the basis for first-level land-use decisions.

February BULLETIN briefs

Brief summaries of articles in the February 1977 GSA Bulletin *are provided on the following pages to 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.*

☐ 70201—Pattern recognition applied to earthquake epicenters in California and Nevada. *Peter Briggs, Frank Press, Department of Earth and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139; Sh. A. Guberman, Institute of Applied Mathematics, Academy of Sciences of the USSR, Moscow, USSR.* (13 p., 7 figs., 1 tbl.)

Areas of California and Nevada that are particularly earthquake-prone are identified with a computer by applying a pattern-recognition algorithm to standard geological data. The algorithm, which is designed for varied application, defines suites of characteristic traits and successfully discriminates earthquakes characteristic of the San Andreas fault system from those characteristic of the western Basin and Range province. It also pinpoints areas in California and Nevada that are unlikely to be the epicenters of strong earthquakes. Control experiments to test the predictive ability of this technique have shown imperfect but positive results. Predictions of future earthquake epicenters are made. Features characteristic of earthquake-prone areas emerge that appear physically meaningful in terms of large-scale geology. Some of these characteristics were not obvious before.

☐ 70202—Visual estimation of iron in saprolite. *Vernon J. Hurst, Department of Geology, University of Georgia, Athens, Georgia 30602.* (3 p., 3 figs., 2 tbls.)

Secondary iron compounds are the foremost coloring agents in subtropical and tropical saprolites. Amorphous $Fe(OH)_3$ and goethite are yellow in submicron particles, and coarse goethite is brown. Submicron hematite is red, whereas coarse hematite is gray to black. At most outcrops the color of saprolite is due to the secondary ferric compounds: the hue of the color relates to the mineralogy and particle size of the ferric pigments; value and chroma vary systematically with the proportion of pigment.

The color of the saprolite determined by visual comparison with a Munsell Soil Color Chart and referred to our diagram yields a rapid estimate of total iron, as well as ancillary information about particle size and hydration state of the ferric compounds.

☐ 70203—Patterns of Cretaceous shallow-marine sedimentation, Coalville and Rockport areas, Utah. *Thomas A. Ryer, U.S. Geological Survey, Federal Center, Denver, Colorado 80225.* (12 p., 15 figs.)

Cretaceous strata exposed in the Coalville and Rockpport areas of north-central Utah accumulated in alluvial-fan, fluvial, marginal-marine, nearshore-marine, and offshore-marine depositional environments. Marine sediments were deposited in this region during periods of peak inundation of the Aspen-Mowry, Greenhorn, and Niobrara marine invasions. Deposits of each marine invasion may be divided into a number of depositional sequences, each of which contains a basal disconformity and is bounded above by the disconformity associated with the next overlying sequence. Some of the basal disconformities are identified as ravinements. All depositional sequences are entirely progradational. Retrogradational shallow-marine deposits appear to be completely lacking. Absence of depositional sequences recording marine transgression is attributed primarily to the process of shoreface erosion and to marked reduction of the quantity of sediment introduced to shallow-marine environments by rivers during periods of rising relative sea level. Deposits of major marine cycles of deposition at the western margin of the Interior Cretaceous seaway in north-central Utah do not conform to the simple symmetric transgressive-regressive models of some authors, but they record many back-and-forth movements of the strand.

☐ 70204—Reconnaissance geology of coastal Sonora between Puerto Lobos and Bahia Kino. *R. Gordon Gastil, Daniel Krummenacher, Department of Geological Sciences, San Diego State University, San Diego, California 92182.* (10 p., 6 figs., 1 tbl.)

Coastal Sonora between Puerto Lobos and Bahia Kino can be subdivided into four structural-petrographic subprovinces: an inland subprovince in whhich unmetamorphosed upper Precambrian and Cambrian strata rest on older Precambrian gneiss and three other subprovinces in which Cenozoic volcanic strata rest on metamorphosed strata of post-Precambrian age intruded by granitic rocks of Mesozoic age. One of these latter subprovinces displays basin-and-range fault blocks; a second has northwest-trending strike-slip(?) faults; and the third, Isla Tiburon, shows structure related to the Neogene dilation of the Gulf of California depression.

The pregranitic rocks include upper Precambrian and Cambrian carbonate rocks, a chert-graywacke-volcaniclastic sequence of probable Carboniferous age, and volcanic-volcaniclastic rocks of Jurassic age. The granitic rocks range from gabbro to granite and have K-Ar cooling ages of from 91 to 30 m.y. Dikes of basaltic to dacitic composition and quartz porphyry bodies of late Mesozoic or early Cenozoic age cut the granitic rocks.

The lowermost Cenozoic volcanic strata (pre-22 m.y. B.P.) are predominantly composed of rhyolite and basalt. These are followed by a sequence of predominant andesite (~20 to 18 m.y. old), a sequence of partially marine conglomerate and pyroclastic deposits, and a widespread, predominantly rhyolitic sequence (~14 to 10 m.y.). All strata 10 m.y. old or older are involved in basin-and-range-type tilting. Volcanic strata less than 8 m.y. old are nearly flat-lying.

☐ 70205—Deposition of the Tapeats Sandstone (Cambrian) in central Arizona. *Richard Hereford, U.S. Geological Survey, 601 East Cedar Avenue, Flagstaff, Arizona 86001.* (13 p., 11 figs., 2 tbls.)

Grain size, bedding thickness, dispersion of cross-stratification azimuths, and assemblages of sedimentary structures and trace fossils vary across central Arizona; they form the basis for recognizing six facies (A through F) in the Tapeats Sandstone. Five of these (A through E), present in western central Arizona, are marine deposits containing the trace fossil *Corophioides*; several intertidal environments are represented. The association of large-scale cross-bedding (50 to 300 cm) that is characterized by compound cross-stratification, numerous reactivation surfaces, and herringbone patterns is typical of facies A and generally typical of the finer-grained, thinner-bedded facies B. The sedimentary structures and polymodal distribution of foreset azimuths common to facies A and B probably formed on intertidal sand bars during emergence and late-stage tidal runoff. Facies C consists of well-sorted sandstone, gently cross stratified or with continuous parallel stratification, and foresets tangential to the lower bedding surface. This facies generally occurs where the gradient of the depositional surface increases; it apparently was deposited on a beach by shoaling waves. Facies D and, to a lesser extent, the coarser-grained facies E are sandstones with trough cross-stratification, fining-upward cycles, abundant intercalated thin shale and sandstone, rare flaser bedding, and local bipolar distribution of foreset azimuths. Both facies are tidal flat deposits; facies D was probably produced by meandering tidal channels, whereas facies E was likely produced by migration of braided tidal channels. The sixth facies (F), present in eastern central Arizona, is an arkosic small-pebble conglomerate that lacks trace fossils; low dispersion of foreset azimuths and large-scale (1- to 11-m wide) cut-and-fill structure are typical. Facies F was depposited by bedload streams that transported coarse, poorly sorted sand and gravel westward to the intertidal flats.

☐ 70206—Meander sinuosity and direction variance. *R. I. Ferguson, Department of Geography, The University, Hull HU6 7RX, England.* (3 p., 3 figs., 1 tbl.)

The variance of channel direction along 36 meandering rivers is closely but nonlinearly related to sinuosity. Vari-

ances are greater than for sine-generated curves of the same sinuosity but are well predicted by assuming a normal direction distribution. This relationship may be useful in stochastic meander modeling and for estimating paleochannel sinuosity from fragmentary meander traces.

☐ 70207—Lower Silurian Tuscarora (Clinch) dispersal patterns in western Virginia. *Robert C. Whisonant, Department of Geology, Radford College, Radford, Virginia 24142.* (6 p., 6 figs., 2 tbls.)

The Tuscarora Sandstone (Clinch equivalent) is a basal Silurian orthoquartzitic sandstone prominently exposed in the Valley and Ridge province of western Virginia. Directional analysis of paleocurrent structures and grain size distribution indicates that the Tuscarora-Clinch clastic material was deposited on a paleoslope that dipped uniformly northwestward. The provenance area was an extensive line source located in the Blue Ridge–Piedmont complex eastward of the present outcrop belts. The basin-source contact (paleo-fall line) for the Tuscarora-Clinch deposits was evidently situated some 80 km farther east of the present Valley and Ridge–Blue Ridge boundary prior to late Paleozoic folding and faulting.

☐ 70208—Neotectonic transverse structures of mobile belts: A study of an example of their deep tectonic relationships in the Koryak region, northwest Pacific margin. *G. I. Raskatov, L. T. Shevirov, Voronezh State University, Voronezh, USSR.* (6 p., 6 figs.)

The type transverse structures that trend across mobile belts and into the platform of eastern Europe have in the past been investigated by traditional geological and geophysical methods. Now, however, these methods are becoming integrated with recently developed neotectonic studies that use aerial and Earth-satellite photographs and morphometrically and morphographically processed topographic maps. These integrated studies, both traditional and neotectonic, have revealed deep-seated transverse tectonic features that extend down to and include the basement. Thus, starting from geomorphic anomalies at the Earth's surface, such methods have proved useful in deciphering the deep as well as shallow transverse structures of the Koryak region. This region includes not only transverse Paleozoic and early Mesozoic basement structures but also late Mesozoic and Cenozoic longitudinal structures in which relics of the older transverse structures survive. It also includes new transverse structures that have appeared since the longitudinal Koryak mobile belt evolved.

☐ 70209—Geochemical and petrogenetic study of the Girnar igneous complex, Deccan volcanic province, India. *D. K. Paul, Department of Earth Sciences, The University, Leeds LS2 9JT, England (present address: Department of Geology, McMaster University, Hamilton, Ontario, Canada L8S 4M1); P. J. Potts, Department of Earth Sciences, The Open University, Milton Keynes, MK7 6AA, England; D. C. Rex, Department of Earth Sciences, The University, Leeds LS2 9JT, England; R. D. Beckinsale, Institute of Geological Sciences, Gray's Inn Road, London WC1 8NG, England.* (8 p., 6 figs., 4 tbls.)

Representative rocks of gabbro, diorite, lamprophyre, and syenite from the Girnar complex, Deccan volcanic province, India, and associated silicic porphyritic rocks have been analyzed for major and trace (including rare earth) elements and for strontium and oxygen isotopic composition. Variation diagrams of the major elements against the Fe/Mg index suggest a systematic evolution in the complex. Silicic porphyry, on the other hand, forms a separate group in the variation diagrams. Rare earth elements (REEs) increase in abundance from gabbro to syenite and become increasingly fractionated. REE patterns and Th/Ta ratios in the silicic porphyritic rocks differ from the others. The initial $^{87}Sr/^{86}Sr$ ratios of the rocks show bimodal distribution—that is, silicic porphyry with an average value of 0.7275, whereas the other rocks have a range from 0.7051 to 0.7080. $\delta^{18}O$ values range from +5.37 per mil to +8.68 per mil relative to standard mean ocean water. Variation of the strontium isotopic composition within the gabbro-syenite group is inferred to be related to crustal contamination. The silicic porphyry may be derived by partial fusion of the Precambrian granitic basement. New K-Ar age determinations show a range from 63.8 to 56.2 m.y. and suggest that the igneous complex was emplaced immediately after the eruption of the Deccan basalts.

☐ 70210—Relationships between deformation and garnet growth in Moine (Precambrian) rocks of western Scotland. *J. A. MacQueen, Derek Powell, Department of Geology, Bedford College, Regent's Park, London NW1 4NS, England* (6 p., 10 figs.)

Textural and chemical zoning and the inclusion fabrics displayed by garnet crystals from regionally metamorphosed Precambrian metasedimentary rocks reveal that the relationships between garnet growth and deformation change in space and time. At the margin of part of the Caledonian orogenic belt in northwest Scotland, garnet growth is entirely synchronous with the early phases of the second deformation, whereas toward the interior of the belt, garnet growth becomes progressively earlier relative to the same deformation. It is suggested that garnet growth (metamorphism) and deformation are diachronous through a 15-km thickness of the crust.

☐ 70211—Reconnaissance geochronology of the crystalline basement rocks of the Coastal Cordillera of southern Peru. *E. J. Cobbing, Institute of Geological Sciences, 154 Clerkenwell Road, London EC1R 5DU, England; J. M. Ozard, Defence Research Establishment Pacific, Fleetmail Office, Victoria, B.C., Canada; N. J. Snelling, Institute of Geological Sciences, 64/78 Gray's Inn Road, London WC1X 8NG, England.* (6 p., 3 figs., 2 tbls.)

Granulite-facies gneiss of the Arequipa massif extensively developed along the Coastal Cordillera of southern Peru gives a whole-rock isochron age of 1,811 ± 39 m.y. ($\lambda\ ^{87}Rb = 1.47 \times 10^{-11}yr^{-1}$) and an initial $^{87}Sr/^{86}Sr$ ratio of 0.7086 ± 0.0009. Migmatitic granite within the gneiss is probably of late Precambrian or early Paleozoic age. Mineral ages, both K-Ar and Rb-Sr, from the gneisses and granites are disturbed. Potassium feldspar from the gneiss appears to have been reset by the migmatitization event, whereas mica and potassium feldspar from the migmatitic granite appear to reflect established tectonic-thermal events of Late Devonian and Late Triassic time.

In both metamorphic grade and age pattern, these rocks

are similar to those of the Trans-Amazonian nucleus of the Guianas, Brazil, Uruguay, and the Buenos Aires province of Argentina. We suggest that the Arequipa massif has always been an integral part of the Trans-Amazonian nucleus and that the Andean belt is ensialic, at least in Peru. The manner in which the structural trends in the Arequipa massif strike into the Pacific Ocean leads to speculation concerning the evolution of the Pacific. Simple rifting, tectonic erosion, and major transcurrrent faulting are considered as possible mechanisms to explain the truncation.

☐ 70212—Cenozoic geology of the Yerington district, Nevada, and implications for the nature and origin of Basin and Range faulting. *John M. Proffett, Jr., Anaconda Company, 1849 West North Temple, Salt Lake City, Utah 84116.* (20 p., 18 figs., 1 tbl.)

In the Yerington district, western Nevada, pre-Tertiary rocks are overlain by an Oligocene ignimbrite sequence and Miocene andesites. Basin and Range normal faulting began in Miocene time, as andesitic volcanism died out (17 to 18 m.y. ago), and has continued to the present. The faults dip east and are curved, concave upward, with net displacements in a nearly east-west direction. Movement on the curved faults has resulted in steep westward tilting of the Miocene andesites and of all older rocks. Alluvium and 8- to 11-m.y.-old basalt flows deposited during the period of faulting are tilted gently west. The oldest faults, which dipped steeply east when they were active, are now inactive and dip gently eastward as a result of westward tilting on other faults. Younger faults dip more steeply east, and the youngest faults, those responsible for present Basin and Range topography, are the steepest. More than 100 percent of east-west extension has taken place across the district because of normal faulting. The rate of extension was most rapid between 17 and 11 m.y. ago and was slower after 11 m.y. ago. The extension is deep seated rather than thin skinned and apparently involves thinning of the crust. Several theories of origin for Basin and Range structure can be rejected because of the field data at Yerington, and the theory that Basin and Range structure was caused by a continental spreading axis best fits the data. Basin and Range spreading seems to have been most active between the projections of the Mendocino and Murray fractures. It may have first started south of the Great Basin, when these fractures were farther south relative to the continent and when the oceanic spreading axis that had been between these fractures was interacting with the continent.

☐ 70213—Late Quaternary clay-mineral distribution on the eastern continental margin of Canada. *David J. W. Piper, Departments of Geology and Oceanography, Dalhousie University, Halifax, Nova Scotia, Canada B3H 3J5; Roger M. Slatt, Department of Geology, Memorial University of Newfoundland, St. John's, Newfoundland, Canada A1C 5S7 (present address: Department of Geology, Arizona State University, Tempe, Arizona 85281).* (6 p., 5 figs., 1 tbl.)

Clay-mineral determinations have been made on the less than 2μm size fraction of 116 samples of tills and associated terrestrial sediments, surficial marine sediments, and sediment from deep-sea cores from the eastern continental margin of Canada (Baffin Bay to Nova Scotia).

The mineralogy and geographic distribution of clays in surficial sediment largely reflects the distribution of source lithologies and the local origin of the clays; the influence of climate on clay mineralogy is negligible. An illite-chlorite assemblage predominates in sediments from Newfoundland and Labrador and the adjacent inner continental shelf, whereas kaolinite additionally occurs in parts of the Maritime Provinces. In these areas, illite is most abundant in high-grade metamorphic source terrain, chlorite is relatively more common in low-grade metasedimentary and metaigneous terrain, and kaolinite is relatively more common in areas underlain by Carboniferous-Triassic red beds. Marine sediments from Baffin Bay and the outer continental margin of Newfoundland and Labrador contain kaolinite and montmorillonite, in addition to illite and chlorite, which are derived from underlying Mesozoic-Tertiary coastal-plain strata. On the Nova Scotia margin a similar clay-mineral assemblage is derived from both the red beds on land and submerged coastal-plain strata.

Three clay assemblages are recognized in Wisconsin sediments on the outer continental margin off Nova Scotia and the Grand Banks. These are (1) red clay turbidites enriched in kaolinite that were transported down the Laurentian Channel; (2) sandier, more montmorillonitic turbidites supplied to the Scotian Rise, partly from glacial outwash and partly from erosion of coastal-plain strata in the heads of submarine canyons; and (3) clay turbidites on the Grand Banks margin that contain more chlorite and less kaolinite than those on the Scotian Rise–Laurentian Fan. These assemblages show that downslope dispersion of sediment by turbidity currents was the dominant process. Holocene reworking of local glacial drift on the shelf is supplying sediment to the outer margin, but at a lesser rate.

☐ 70214—Deposition of upper Mesozoic resedimented conglomerates and associated turbidites in southwestern Oregon. *Roger G. Walker, Department of Geology, McMaster University, Hamilton, Ontario, Canada L8S 4M1.* (13 p., 19 figs., 2 tbls.)

The upper Mesozoic sedimentary rocks of southwestern Oregon include turbidites, dark shales, and great thicknesses of resedimented conglomerates. At two localities, these lithologies are arranged in thinning- and fining-upward sequences that begin abruptly with graded conglomerates (individual beds as much as 50 m thick) and pass upward into massive sandstones, classical turbidites, and dark mudstones. Detailed study of the fabric of the conglomerates indicates paleoflow roughly toward the southeast; this direction is confirmed by sole marks on the associated turbidites. The highest angles of imbrication occur at the bases of beds; upward, the imbrication angle flattens, and the preferred alignment of clasts is better developed.

The angle of imbrication is not related to clast size (as expressed by $D/10$, the mean of the ten largest clasts), but $D/10$ is strongly related to conglomerate bed thickness, which indicates that the conglomerates (thickness, 1.85 to 50.0 m; mean, 17.5 m) are probably single flows.

Some of the thinner conglomerates belong to the graded-stratified model described by Walker. The thicker conglomerates are characterized only by normal grading (inverse grading is rare or poorly developed; no stratification), and a new model, the graded bed, is suggested as an inter-

mediate form between the inverse-to-normally graded and graded-stratified models.

The thinning- and fining-upward sequences range from 3.40 to 85.0 m (mean, 31.5 m) and are tentatively interpreted to be the result of progressive channel abandonment on a submarine fan. In this interpretation, the conglomerates, although prominent in the section, are unusual events, transported by flows that were far too big for the scale of the channel. Thus, conglomerates plugged the channel bases, subsequently causing diversion of the normal flows into other channels.

☐ 70215—Water chemistry of a stream following a storm, Absaroka Mountains, Wyoming. *William R. Miller, James I. Drever, Department of Geology, University of Wyoming, Laramie, Wyoming 82071 (Present address, Miller: U.S. Geological Survey, Branch of Exploration Research, Federal Center, Denver, Colorado 80225).* (5 p., 5 figs., 3 tbls.)

Variation in the chemistry of the North Fork of the Shoshone River following a storm cannot be explained simply by dilution of the base flow by rain water. Factor analysis of the variation indicates that during the early part of the flood cycle, the most important control is solution of readily soluble salts from the soil zone. During the later part of the flood, the dominant control is dilution of the base flow. Other significant controls during both parts of the flood cycle are selective weathering of ferromagnesian minerals and leaching of potassium from biological material. Variation in water chemistry during a storm can be used to reveal information about weathering processes occurring at different depths in the soil and weathered rock zones.

☐ 70216—Stepped-bed morphology in arid gravelly channel. *D. Bowman, Department of Geography, Ben Gurion University of the Negev, Beersheva, Israel.* (8 p., 16 figs., 1 tbl.)

The stepping phenomenon indicates systematic channel-bed variations that are not identical to the well-known pools and riffles. Channel beds in the Dead Sea area demonstrate that the main elements in a stepped bed are the regular and the rapid segments, which constitute distinct populations. The bed material of the stepped channel is heterogeneous in size, but significant uniformity prevails within the segment types.

The cyclic spacing of the segment types deviates clearly from that of pools and riffles in that it is at closer intervals. The coarser the sediment, the more pronounced the segmentation. Stepping may produce variations in flow velocities from subcritical to supercritical and causes the overall flow regime to vary. Widening and braiding of the channels downstream does not replace the steps. Megasteps form in the canyons but are not cyclic. Conditions favoring stepping indicate a coarse fluviatile environment.

☐ 70217—Constructional shelf topography, Diamond Shoals, North Carolina. *Robert E. Hunt, Donald J. P.*

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Swift, Atlantic Oceanographic and Meteorological Laboratories, 15 Rickenbacker Causeway, Miami, Florida 33149; Harold Palmer, Dames and Moore, Inc., 7101 Wisconsin Avenue, Washington, D.C., 20014. (13 p., 16 figs.)

The surficial sand sheet seaward of Diamond Shoals on the North Carolina shelf is molded into a series of coast-parallel ridges as much as 10 m high and 5 km apart. An older cohesive substrate is exposed in the troughs. Fields of sand waves as much as 7 m high occur on the ridges and in the troughs. Their crests are normal to the ridges. Sand size varies across the sea floor in sympathy with the ridge topography. The gently inclined landward flanks are coarser grained; the steeper seaward flanks are finer grained.

There is evidence to indicate that the sand ridges, like the sand waves with which they are associated, are responses to flow. However, it is not possible to demonstrate the nature of coupling between fluid motion and substrate morphology on the basis of the existing data.

The landward part of the study area is subjected to a southward water drift that during winter is punctuated by intense southward pulses associated with storms. The seaward part experiences a strong, predominantly northward flow throughout most of the year, and the zone of shear appears to migrate back and forth across the study area. Regional considerations suggest a southward sand transport. However, during the period of observation, water flow and bedform asymmetry indicated northward transport. It seems probably that the transport direction reverses with time.

☐ 70218—Formation of folds, boudinage, and mullions in non-Newtonian materials. *R. B. Smith, Department of Astro-Geophysics, University of Colorado, Boulder, Colorado 80309 (Present address: Department of Geology and Geophysics, Yale University, New Haven, Connecticut 06520)* (9 p., 12 figs.)

Previous work has suggested that the formation of folds, boudins, and mullions by creep is caused by the same general type of instability. The results of Newtonian flow models of this process compare poorly with observation, however. The study reported here extends the analysis to include a general class of non-Newtonian materials restricted only to being incompressible, anelastic (that is, without memory), isotropic, and homogeneous. Although the material is isotropic, the perturbation flow associated with growing structure is found to obey an anisotropic type of flow law. In a strain-rate softening material undergoing pure shear, resistance to additional normal straining is significantly reduced from the background level, whereas resistance to tangential straining is unchanged. This has a profound effect on the formation of geologic structures, increasing the growth rates and altering the dominant wavelengths. Non-Newtonian behavior turns out to be necessary for the formation of boudins and mullions and plays an important role, but not a necessary one, in the formation of folds.

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