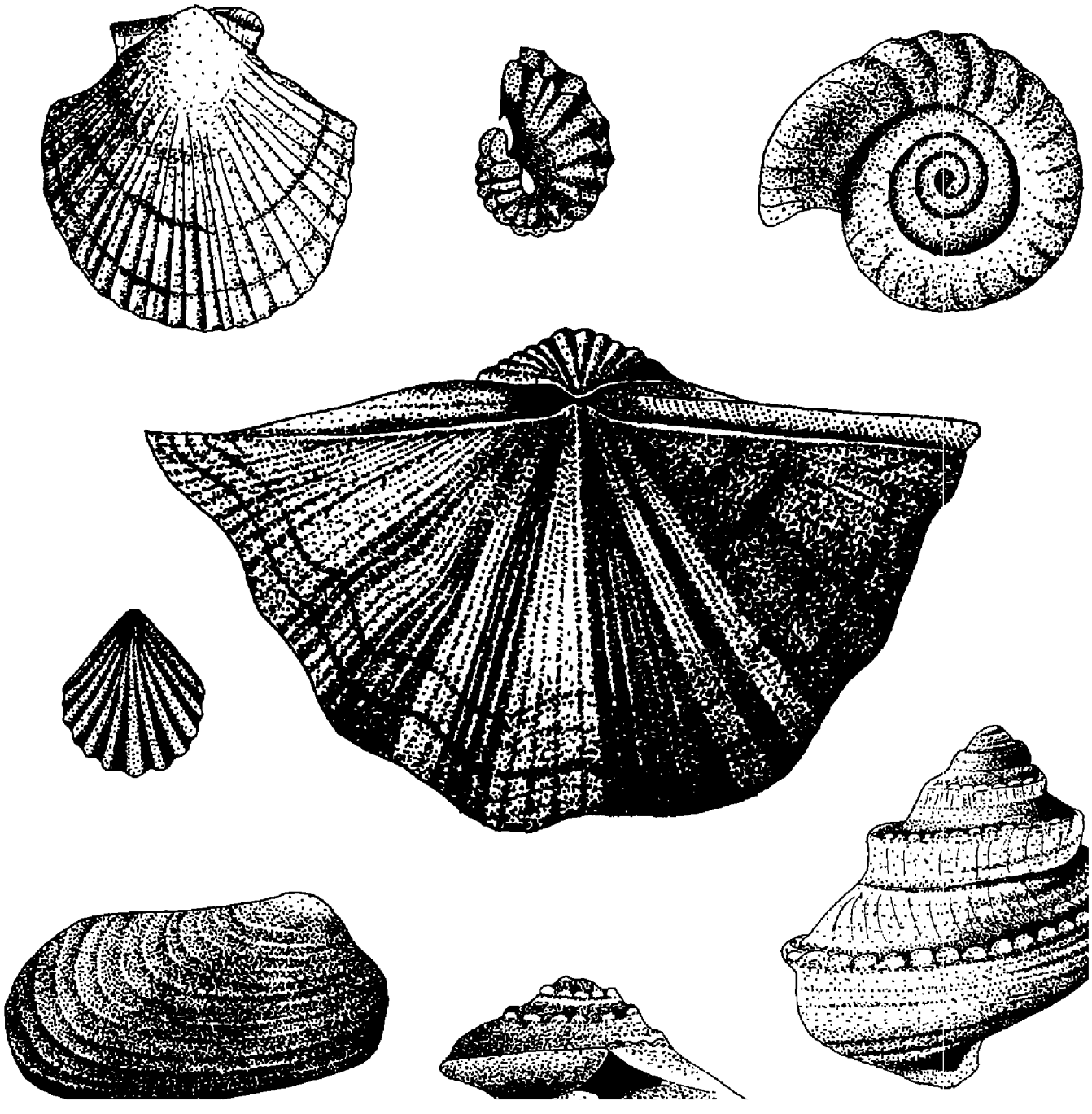
VOL. 41, NO. 4 AUGUST 1981

OKLAHOMA GEOLOGY NOTES

OKLAHOMA GEOLOGICAL SURVEY, THE UNIVERSITY OF OKLAHOMA



On the cover—

Field-Trip Guidebook Issued

The line drawings of fossils pictured on the cover were prepared by recently-retired Oklahoma Geological Survey cartographer Roy D. Davis for inclusion in a new guidebook that has been issued by the Survey as the fourth volume in its educational series.

Prepared by John D. Naff, professor in the Department of Geology at Oklahoma State University, OGS Educational Publication 4, *Guidebook for Geologic Field Trips in North-Central Oklahoma,* covers the 14 counties that extend northward from Canadian, Oklahoma, Lincoln, and Okfuskee Counties to the Kansas border. The guide was designed primarily to provide background information for teachers in planning and conducting field excursions, but the geology and geomorphology in the area are sufficiently diverse and the 42 stop descriptions are sufficiently detailed to make the publication of value to professional geologists, students, and amateur "rock hounds" as well.

With the exception of deposits left by modern and ancestral streams and some concentrations of volcanic ash, rocks exposed in the area are Middle and Upper Pennsylvanian and Lower Permian limestones, shales, and sandstones, and fossils are abundant in some beds. Naff has included illustrations of several of the more typical and commonly found species and gives localities for collecting these fossils and also some mineral specimens.

The fossils shown on the cover comprise: center, *Neospirifer,* a brachiopod from the Neva Limestone in a quarry in Pawnee County; and, clockwise from the upper left corner, *Aviculopecten,* a pelecypod from the Roca Shale in Osage County; two gastropods from the Roca Shale in Pawnee County, *Pharkidonotus* and *Amphiscapha;* two gastropods from the Barnsdall Formation in Osage County, *Worthenia* and *Trepospira; Wilkingia,* a pelecypod from the Roca Shale in Pawnee County; and *Hustedia,* a brachiopod from the Gano Shale in Payne County.

Other guidebooks in this series are Educational Publication 2, which contains a general geologic history of Oklahoma and information on planning and conducting a field trip, and EP-3, a guide to northwestern Oklahoma. EP-1 is a colorful atlas of eight sheets of maps and cross sections showing the geology, geomorphology, and topography, and the water, mineral, and petroleum resources of Oklahoma. Naff suggests that EP-2 be examined by those planning to make a field trip.

The guidebooks will be distributed to teachers at no charge through the Director of Curriculum, State Department of Education, 2500 North Lincoln Boulevard, Oklahoma City, Oklahoma 73105. They can also be purchased from the Oklahoma Geological Survey at the address given below. The price of OGS Educational Publication 4 is $3.

Oklahoma Geology Notes

Editor: Connie Smith
Editorial Staff: Elizabeth A. Ham, William D. Rose

Oklahoma Geology Notes is published bimonthly by the Oklahoma Geological Survey. It contains short technical articles, mineral-industry and petroleum news and statistics, reviews, and announcements of general pertinence to Oklahoma geology. Single copies, $1; yearly subscription, $4. All subscription orders should be sent to the Survey at 830 Van Vleet Oval, Room

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OKLAHOMA GEOLOGY NOTES

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Contents

This publication, printed by the University of Oklahoma Printing Services, Norman, Oklahoma, is issued by the Oklahoma Geological Survey as authorized by Title 70, Oklahoma Statutes, 1971, Section 3310, and Title 74, Oklahoma Statutes, 1971, Sections 231–238. 1,800 copies have been prepared for distribution at a cost to the taxpayers of the State of Oklahoma of $2,381.

LINEAMENTS IN SOUTHEASTERN OKLAHOMA: DETECTION WITH LANDSAT DATA

Stephen J. Walsh,[1] John D. Vitek[2]

Abstract—Satellite imagery is capable of supplementing field mapping and aerial photography in studies of regional geologic structure. Since 1972, satellites (ERTS and now LANDSAT) have sensed reflected data in the visible and near-infrared portions of the spectrum. The data are averaged to 1.12 acres, the resolution of the satellite, whereas the next satellite will improve resolution to 0.25 acre. Detection of regional geologic structure is enhanced with spectral values from the infrared range of the spectrum and the vantage point of earth observation. Lineaments, or linear surface trends, in southeastern Oklahoma were mapped to demonstrate the structural detail available on LANDSAT imagery. Furthermore, the digital data can be enhanced to highlight geologic structure. Lineaments detected on LANDSAT images in other studies have been correlated with mineral and natural-gas deposits. Detailed analyses of the lineaments that were detected in southeastern Oklahoma are possible through use of the computer hardware and software available at the Center for Applications of Remote Sensing, Oklahoma State University.

Introduction

The early geologic surveys of any area were completed slowly as field geologists mapped and interpreted lithology and structure on foot and horseback. The completion of small-scale topographic maps, generally 1:125,000 or 1:62,500, enhanced the acquisition of geologic data. In the 1930's, large-scale aerial photography improved the geologist's view of surface structure. Generalizations of regional structure improved as information from photographs was incorporated into the analysis. Subsurface information from gas, petroleum, and water wells also improved the interpretations of regional structure over the years. A new tool, LANDSAT, provides another method for assessing regional structure. The satellite senses visible and near-infrared electromagnetic radiation from the surface and may reveal forms, patterns, and trends that were obscured on the photographs or were too large to have been observed in the field.

This study presents the detection of linear surface trends in southeastern Oklahoma. Linear surface trends, or *lineaments*, are alignments of regional

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morphological features, such as streams, mountain ranges, and escarpments, and tonal features that may be the surface expressions of fracture or fault zones. Analysis of lineaments has proved useful in studies of mineral resources. The Center for Applications of Remote Sensing (CARS) at Oklahoma State University has provided scientists with the most up-to-date hardware and software for analyses of remotely sensed data, such as this study of lineaments.

LANDSAT Characteristics

LANDSAT (formerly ERTS), initiated by the National Aeronautics and Space Administration (NASA) in 1972, is the name given to a family of earth-orbiting satellites. The program was designed to gather information about earth resources from a near-polar, sun-synchronous orbit 570 miles above the earth. The LANDSAT satellites sense the earth through the visible and into the near-infrared portion of the electromagnetic spectrum. Information from repetitive coverage of approximately the same geographic area every 18 days has been collected since 1972. Computer compatibility of digital data, and a 1.12-acre resolution of the multispectral scanner, promote detection of surface structures.

LANDSAT coverage of Oklahoma is available in image and digital format. LANDSAT color-composite images are composed of data from band 4 (0.5–0.6 microns), band 5 (0.6–0.7 microns), and band 7 (0.8–1.1 microns) of the electromagnetic spectrum. The image is similar in appearance to color infrared aerial photography. Digital data must be processed on a computer system. Computer algorithms provided to CARS by NASA permit preprocessing, image enhancement, and image classification of LANDSAT data for quantitative discrimination of surface features at a 1-acre resolution. Other products, including aerial photography, black and white single-band multispectral scanner images, and return-beam vidicon images, are available at CARS for selected parts of Oklahoma.

Literature Review

LANDSAT images have been used for a number of years to map geologic lineaments. Lineaments are generally defined as composite linear features of a surface whose parts are aligned in a straight or slightly curved relationship. They differ distinctly from the patterns of adjacent features and presumably reflect subsurface phenomena (O'Leary and others, 1976, p. 465). According to Sabins (1978, p. 80) the surface features that make up a lineament may be geomorphic (caused by relief) or tonal (caused by contrast differences). Straight stream valleys and aligned segments of valleys are typical geomorphic expressions of lineaments. A tonal lineament may be a straight boundary between areas of contrasting tone or a stripe against a background of contrasting tones. Differences in vegetation, moisture content, and soil or rock composition account for most tonal contrasts.

Iranpanah and Esfandiari (1980, p. 226) found that black and white im-

ages of bands 5 and 7 highlighted the dissimilarity of structures and rock types. They concluded that more major and minor lineaments can be observed on LANDSAT images than on geologic and tectonic maps compiled from aerial photography. Kayan and Klemas (1978, p. 70) found that band 7 was the most valuable for identifying geologic formations, fault lines, and geomorphic slope contrast. Band 5 supplemented by band 7 provides information on rock-soil boundaries, relationships between vegetation and structure, and vegetational tonal differences between steep slopes and subsurfaces. Miller (1975, p. 619) believed that lineaments and other features are more apparent on the color composite LANDSAT images than on black-and-white images.

Nicolais (1974, p. 786), Ashley and Rea (1975, p. 712), and Gregory and Moore (1976, p. 155) found that low-sun-angle LANDSAT images improved the delineation of geologic lineaments. Discrimination increased in response to changes in phenology of vegetation, occurrence of snow, changes in water level, and increased shadows. Rowan and Wetlaufer (1975, p. 46) found that linear features trending normal to the sun's azimuth are enhanced and highlighted by shadows. Linear features trending parallel with the azimuth are suppressed and difficult to recognize, as are those parallel with the LANDSAT multispectral scanner lines. Segal and Goetz (1977, p. 195) found that dense natural vegetation masks soil and geologic features and alters discrimination. Materials with low albedos are significantly affected by only a 10-percent vegetation cover and may be altered beyond recognition. Aldrich (1979, p. 50) indicated that vegetation striations on LANDSAT images enhance lineament mapping. Rohde (1978, p. 65) found that image enhancement of digitally constructed images increases contrast and sharpness between geologic features. Moreover, edge-enhancement algorithms improve subtle differences in reflectance values along feature boundaries.

Goetz and Rowan (1981, p. 784) stressed that the analysis of LANDSAT images will detect lineaments in areas considered to be well mapped as well as in poorly mapped areas. They described how development of mineral belts in Nevada and a natural-gas system in Kentucky and Virginia have benefited from the identification of lineaments. The most productive gas wells in the system are near fractures, and mineral belts are also related to major lineaments.

In summary, the literature confirms the value of lineament identification. Since this analysis phase is less than a decade old, much remains to be discovered about the visual enhancement of lineaments and the relationship of lineaments to geologic structure.

Lineaments in Southeastern Oklahoma

The geology and structure of southeastern Oklahoma (fig. 1) were compiled with conventional methods for the State geologic map (Miser, 1954). A more recent detailed analysis of structure was presented by L. M. Cline (1968). A LANDSAT color composite image of southeastern Oklahoma was

selected and printed in black and white (fig. 2), to produce a map of lineaments for the region (fig. 3). The color composite was acquired with a low sun angle, which promotes effective mapping and ease of lineament interpretation. The orientation of the lineaments, parallel to the scan direction, is one problem that may detract from lineament enhancement. The slight overexposure of the image was another problem encountered in the analysis. The vegetation type, density, and tonal qualities on this image also added difficulty to lineament mapping.

Data enhancement through digital processing was performed in an effort to improve lineament recognition. A part of southeastern Oklahoma was classified from a LANDSAT digital tape with an unsupervised classification routine (fig. 4). The tape contained digital data identical to the color composite image (fig. 2). The classification routine appraises spectral-reflectance values for every 1.12 acres in the study area. In southeastern Oklahoma, variations in spectral reflectance are caused principally by phenological changes in vegetation, topographic alignment, low sun angle, and shadows. These parameters are appraised collectively during the digital-classification process and provide additional refinement to lineament mapping. Some lineaments are not detected on LANDSAT images because scale, image-exposure problems, dense vegetation cover, and alluvial deposits dominate reflectance data. LANDSAT digital classification, however, improves detection because topographic shadows, vegetation type and density, soil type, and moisture are variables assessed during classification. Moreover, atmospheric and geometric problems can be evaluated during data processing.

Lineament Analysis

The lineaments detected with LANDSAT analysis represent readily discernible trends on the landscape. The size of the area covered, 9,817 km^2 (3,835 mi^2) is difficult to observe on conventional aerial photography. As a result, the number of lineaments confirms the complex structure of the area and presents problems in lineament interpretation. Many lineaments clearly represent morphologic features such as ridges and streams. These lineaments are easily detected, as can be seen by comparing figures 2 and 3. Lineaments that run counter to regional structure, or that are recognizable in areas having uniform topography, represent information gained from LANDSAT analysis.

The techniques used in our analysis were visual assessments of a color composite and computer enhancement of digital data. Analysis problems associated with low sun angle, satellite path, and scan orientation can be overcome through the use of side-looking airborne radar (SLAR). An area can be assessed from multiple directions, thereby increasing lineament detection. SLAR data are relatively expensive, however, compared to LANDSAT data (Goetz and Rowan, 1981, p. 786) and were not procured for this study. SLAR, however, can record surface characteristics through clouds, whereas cloud cover obscures data from LANDSAT.


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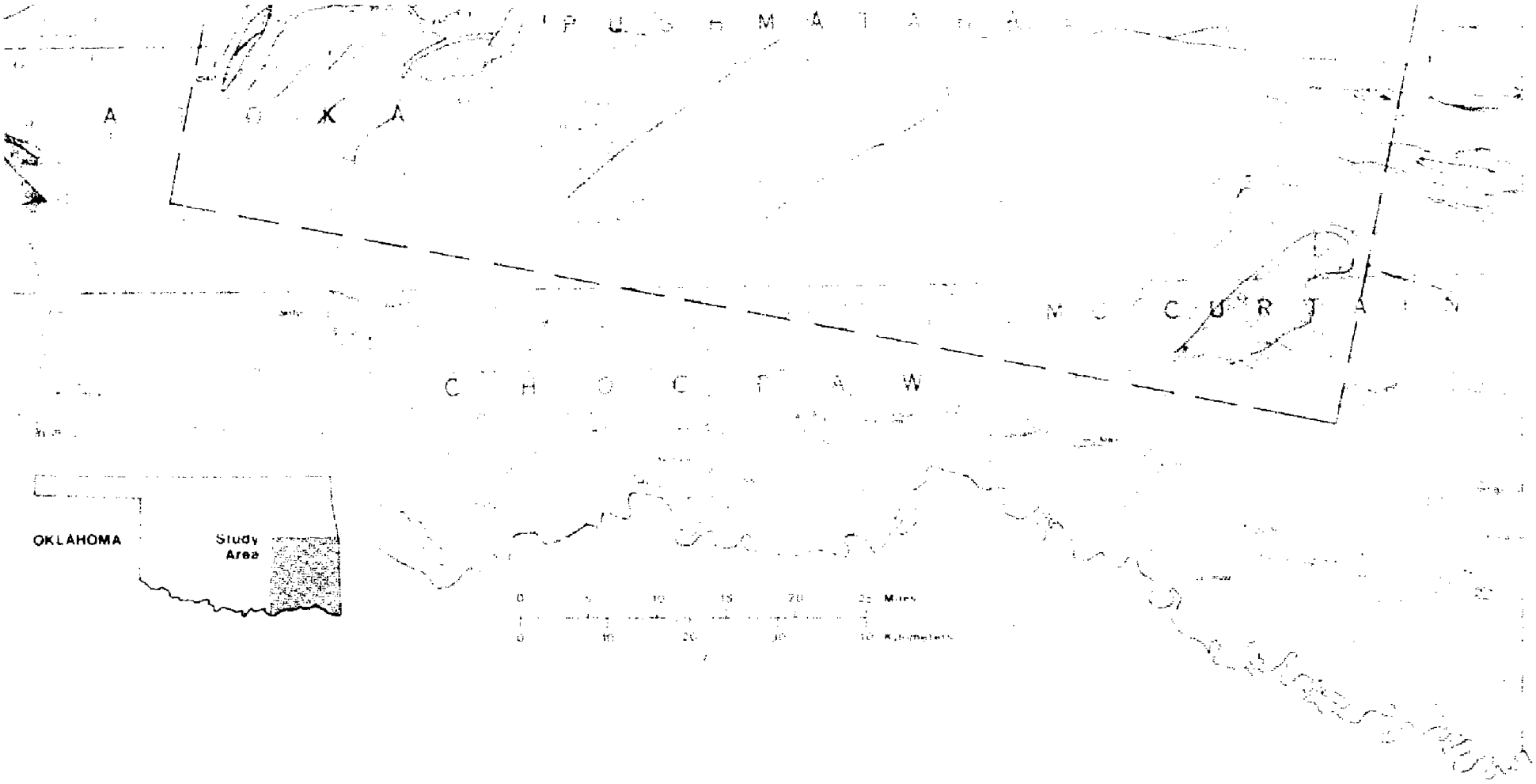

Figure 1. Study area for lineament detection outlined on *Geologic Map of Oklahoma* (Miser, 1954). See original reference for explanation of geology.

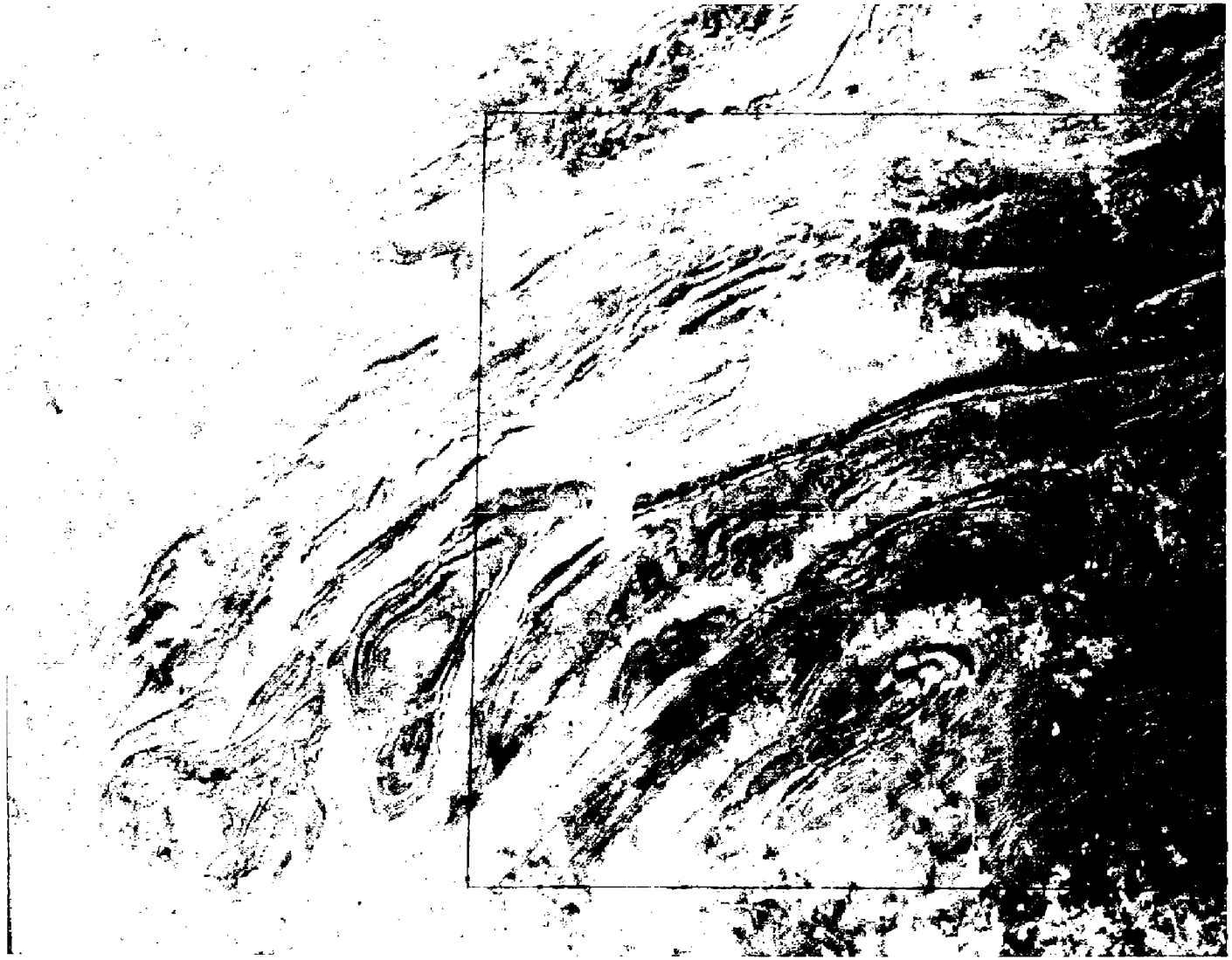

Figure 2. LANDSAT multispectral-scanner color-composite image of bands 4, 5, and 7, acquired November 28, 1972 (ID no. 1128163 00), printed in black and white. Study area delineated by black lines.

Figure 3. Lineaments recognized in southeastern Oklahoma from figures 2 and 4.

Figure 4. Color classification (printed in black and white) of a part of southeastern Oklahoma, with Broken Bow Reservoir at right edge of image. LANDSAT digital tape no. 112816300 (November 28, 1972) provided data for image.

Precise interpretation of the importance of these lineaments to regional structure and mineral deposits is a task that remains to be completed. Moreover, similar analyses could be performed for the entire State of Oklahoma. Although LANDSAT data have been procured for nearly a decade, detailed analysis of the data is now being done in Oklahoma through CARS.

Summary and Conclusions

Geologic lineaments are expressed more clearly on LANDSAT images than on topographic maps. A strong correlation exists between geologic lineaments detected on LANDSAT color composite images and geophysical trends. LANDSAT affords the interpreter a regional perspective, a choice of historical or seasonal data, observations beyond the range of the visible spectrum, and data in analog and digital formats. Computer preprocessing, enhancement, and classification of LANDSAT data provide additional resolution and fidelity in lineament mapping. LANDSAT images remain the most appropriate medium for regional lineament mapping when used in conjunction with classification and enhancement techniques.

The anticipated launch of LANDSAT D will include a new thematic mapper with a 0.25-acre resolution and a narrower range of spectral sensitivity. Increased resolution should be helpful in identifying small-scale lineaments by utilizing soil characteristics, vegetation properties, and topographic variables detectable through digital processing. At Oklahoma State University, CARS maintains state-of-the-art hardware and software to analyze LANDSAT data for multidisciplinary applications.

Acknowledgment

We want to thank Mr. Mark Gregory, CARS research associate, for processing the LANDSAT data for figure 4. Our thanks go also to Dr. Wayne Pettyjohn, OSU Department of Geology, for his comments on a draft of this paper. The lineament map, figure 3, was drafted by Gayle Maxwell and Dave Huey, OSU Cartography Lab.

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AAPG MID-CONTINENT SECTION TO MEET IN OKLAHOMA CITY

The biennial meeting of the Mid-Continent Section of The American Association of Petroleum Geologists will take place in Oklahoma City September 20–22, 1981. Technical sessions will be held September 21 and 22 in the Great Hall of the Myriad Convention Center, and exhibits can be viewed by participants in the adjacent Exhibition Hall. Headquarters hotels will be the Sheraton-Century and the Skirvin Plaza.

Papers to be presented at the technical sessions cover such topics as the Anadarko and Arkoma Basins, the Wichita Mountains, the Washita Valley fault system, the Ouachita facies, geothermal-energy resources, uranium mineralization, coal geology, and enhanced oil recovery.

Several staff members from the Oklahoma Geological Survey are taking an active part in the meeting. Kenneth S. Johnson, OGS associate director, is serving as co-chairman of the program committee. S. A. Friedman, senior coal geologist, and William E. Harrison, petroleum geologist/geochemist, are co-chairing one session each. Thomas W. Amsden, biostratigrapher/lithostratigrapher, is giving a paper on "Arkoma Basin Model: Middle Ordovician through Early Devonian"; and LeRoy A. Hemish, coal geologist, is presenting a paper entitled "Coal Geology of Northern Part of Northeast Oklahoma Shelf Area."

Also, Johnson is collaborating with Salman Bloch, OGS geologist/geochemist, in a paper entitled "Uranium Mineralization in North-Central and Southwestern Oklahoma"; and Harrison is giving a paper jointly with Joseph A. Curiale, doctoral candidate at The University of Oklahoma and research assistant in geochemistry with the OGS, entitled "Hydrocarbon Occurrences in Frontal and Central Ouachita Mountains, Oklahoma."

In addition, M. Charles Gilbert, Virginia Polytechnic Institute and State University, who is a visiting geologist with the OGS, will give a paper entitled "Comments on Structure within Wichita Mountains Crustal Block."

Two pre-meeting field trips will investigate selected Pennsylvanian sandstones and carbonates of eastern Oklahoma and will study the type Holdenville and Seminole Formations, with emphasis on regional correlations and paleoenvironment. A co-leader of the latter trip will be L. R. Wilson, George Lynn Cross research professor emeritus in the OU School of Geology and Geophysics and former part-time geologist with the Survey.

Preregistration for the meeting costs $110; registration at the meeting will be $120. Student registration is $10.

For further information about the meeting, including field trips, contact AAPG headquarters, P.O. Box 979, Tulsa, OK 74101 (phone, 918–584-2555).

THALAMOCRINUS CF. *ELONGATUS* SPRINGER FROM THE HENRYHOUSE FORMATION (SILURIAN) OF OKLAHOMA

H. L. Strimple[1]

The holotype of *Thalamocrinus elongatus* Springer (1926) is an incomplete dorsal cup with a part of the proximal stem attached. Radials and anal X are missing, but the small, quadrangular radianal is preserved. Springer (1926, p. 132) gave the zone and locality as "Linden formation, Helderbergian, Benton County, Tennessee." As noted by Strimple (1963, p. 66) in reporting another specimen of the species from the Henryhouse Formation of Pontotoc County, Oklahoma, strata in Tennessee termed "Linden Formation" are presently divided with the lower half in the Decatur Formation (Silurian) and the upper half in the Lower Devonian. The specimen from Oklahoma does not have radials, anal X, or the radianal preserved, but it does display the broad cup base typical of the species. It is considerably smaller than the holotype.

Extensive collecting through the years in the Brownsport Formation of Decatur County, Tennessee, by the author and his wife, Christina, has yielded many specimens of *Thalamocrinus* but never a specimen in the size range of *T. elongatus*. The assignment of the specimens by Bassler and Moodey (1943, p. 708) to "Sil. (Niagaran–Beech River fm.): Decatur County, Tenn." is not accepted here, although the species is thought to be of Silurian age.

A third specimen assigned provisionally to the species, and collected by Christina Strimple in the upper part of the Henryhouse Formation of Pontotoc County, Oklahoma, is complete except for the anal X and C radial. It is a relatively large specimen but not quite as large as the holotype. None of the species (*T. cylindricus, T. globus, T. ovatus)* reported from the "Beech River formation" (Brownsport Formation of Tennessee) has been reported from the Henryhouse Formation of Oklahoma.

Strimple (1975, p. 252, figs. 2A, B) reported and illustrated an isolated infrabasal circlet of *T. ovatus* that demonstrates the thickened nature of these lowermost plates of the cup. This feature, together with the relatively small stem, suggests a bottom-sitting habitat similar to that adopted by the Chesterian genus *Agassizocrinus*. The large stem of *Thalamocrinus elongatus* presents a slightly different condition. Comparison can be made, however,

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to *Sygcaulocrinus typus* from the Middle Ordovician of Iowa, which was shown by Strimple (1975) to have a solid base. *S. typus* is also thought to have been a "bottom-sitter," even though it has very long proximal columnals.

Systematic Paleontology

Superfamily Gasterocomacea Roemer

Family Sphaerocrinidae Jaekel

Genus **Thalamocrinus** Miller and Gurley, 1895

Type species.—*Thalamocrinus ovatus* Miller and Gurley, 1895, p. 82.

Description.—(After Moore and others, 1978, p. T588–T589.) Cup small, cylindrical; infrabasals large, making up one-third to one-half of cup side; basals higher than wide, pentagonal; radials small, decreasing in width distally, incurved at top, each with narrow, rounded, subhorizontal articular facet; radianal small, rectangular; anal *X* smaller than radials, directly above *CD* basal.

Discussion.—Two corrections to the above description are necessary: (1) the basals are not pentagonal; three (*AB, DE,* and *EA* basals) are six sided, while *BC* and *CE* basals are seven sided; and, (2) the radianal in the holotype of one species (*T. cylindricus*) is five sided by virtue of the presence of a right tube plate (*RX*) in the cup; this is probably abnormal, however, as Strimple (1975, fig. 2F) illustrated a specimen with the typical quadrangular radianal. The occurrence of the genus in Oklahoma was also overlooked in the *Treatise on Invertebrate Paleontology* (see Moore and others, 1975).

In my opinion, *Thalamocrinus* is not closely related to the Sphaerocrinidae but is more likely a member of the Botryocrinidae.

Occurrence.—Silurian, North America (Tennessee, Oklahoma).

Thalamocrinus cf. **elongatus** Springer, 1926

Figure 1, A, B

Description.—Tall dorsal cup with broad base and slight constriction at summit. Infrabasals provide about 44 percent of cup height and expand evenly from columnar cicatrix. Basals are tall, and greatest width of cup is attained just above their midsection. Radials are low, wide elements; articular facets do not fill distal faces and are curved; they bear no diagnostic

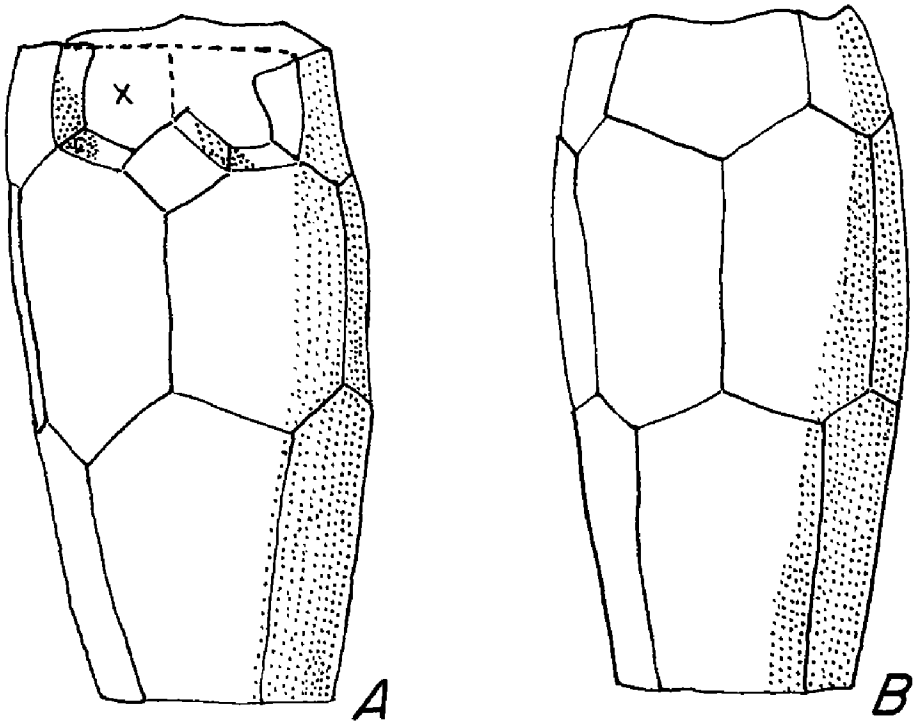

Figure 1. *Thalamocrinus* cf. *elongatus*, SUI 47511, Pontotoc County, Oklahoma. Drawings prepared with aid of a camera lucida.
A, posterior (*CD*) view of cup with position of anal *X* and *C* radial outlined by dotted lines. *B*, anteror view of cup.

fossae. *RA* is equidimensional, quadrangular shaped. Although physically absent, anal *X* was rather large and rested on an oblique distal surface of *CD* basal. Cup height, 20.0 mm; maximum width, 10.0 mm.

Discussion.—The holotype of *Thalamocrinus elongatus* has the infrabasal circlet expanded in midsection and appreciably wider than the basal circlet, which constricts toward its summit. A small hypotype of *T. elongatus* from the Henryhouse Formation previously mentioned also has an incurved basal circlet. The present specimen increases in width to the upper part of the basal circlet. The specimen is referred to *Thalamocrinus* cf. *elongatus*.

Illustrated specimen.—Deposited in Geology Department Repository, The University of Iowa, Iowa City, Iowa, catalog no. SUI 47511.

Occurrence.—Henryhouse Formation, Ludlovian, Silurian; Pontotoc County, Oklahoma (SW¼NW¼NW¼ sec. 33, T. 3 N., R. 6 E.).

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OGS RELEASES REPORT ON "HEAVY" OIL

A report on *Evaluation of Heavy-Oil Potential of Northeastern Craig and Northwestern Ottawa Counties, Oklahoma* has been issued by the Oklahoma Geological Survey as Special Publication 81–4. The report was prepared by William E. Harrison and John F. Roberts, OGS petroleum geologists, and Larman J. Heath, technical project officer for the U.S. Department of Energy's (DOE) technology center at Bartlesville, Oklahoma.

SP 81–4 presents the results for Oklahoma of a three-year, three-state study of "heavy" (or viscous) oil done in cooperation with the geological surveys of Kansas and Missouri, and partially funded by DOE. The publication was released originally by DOE in open file as BETC/1812-1 in June 1979 and has been reissued by the Oklahoma Geological Survey to make the information more readily available.

Heavy-oil deposits occur over an area of approximately 8,000 square miles in the Tri-State region of western Missouri, eastern Kansas, and northeastern Oklahoma. Previous estimates based on extrapolation of the geology have indicated an Oklahoma resource of as much as 30 million barrels of oil in the Pennsylvanian-age Bluejacket (Bartlesville) sandstones and many billions of barrels of oil in place in the Tri-State area.

Data acquired by Harrison, Roberts, and Heath from an 18-hole drilling program in Oklahoma led them to the conclusion, however, that "significant quantities of heavy oil are unlikely in northern Craig and Ottawa Counties" and that the heavy-oil resources of this area are virtually nil. Even in the most promising localities they found discontinuity of sandstones and much variation in reservoir quality and saturation.

The report contains a discussion of the regional geology and stratigraphy of the area, plus data on geochemistry, porosity, permeability, saturation, and lithology. Individual gamma-ray–neutron logs for each borehole are included.

Special Publication 81–4 can be obtained from the Oklahoma Geological Survey at the address given inside the front cover. The price is $4.

Robert C. Moore (*left*), president of the Oklahoma Petroleum Council, and John Steiger, chairman of the council's historical committee, admire the 8-foot-high granite marker erected recently in front of Elk City's Old Town Museum.

MARKER ERECTED AT ELK CITY

The Oklahoma Petroleum Council and the Oklahoma Historical Society, taking note of the significance of the Anadarko Basin, have placed an 8-foot-high granite monument in Elk City to commemorate that basin's role in the petroleum industry and its importance to Oklahoma.

The monument was unveiled and dedicated on May 21, with representatives of the sponsoring organizations and Elk City civic leaders participating. A luncheon sponsored by the Elk City Rotary Club and the local Chamber of Commerce preceded the dedication.

One of the nation's most active and promising regions in the search for oil and gas, the Anadarko Basin covers much of western Oklahoma and part of the Texas Panhandle.

Some of the world's deepest wells have been drilled there, including Oklahoma's deepest producer. The basin ranked second among all of the geological provinces in the United States in drilling and completion expenditures in 1980, with an estimated $2.4 billion spent there, according to Petroleum Information Corp.

The Anadarko Basin is making petroleum-industry news these days, and its potential looms as one of the nation's brightest hopes for solving some of our energy problems.

In 1980, a total of 425 wildcat wells were drilled in the basin, with a success ratio of more than 28 per-

cent, resulting in 56 oil discoveries and 64 gas discoveries. Cities and towns in the area are booming as a result of the activity.

The monument stands on the grounds of Elk City's Old Town Museum. Its text, written by the Oklahoma Petroleum Council's historical committee and approved by the Oklahoma Historical Society, is as follows:

"THE ANADARKO BASIN—The Deep Anadarko Basin of Western Oklahoma is one of the most prolific gas provinces of North America. Wells drilled here have been among the world's deepest.

"The Bertha Rogers No. 1 in Washita County, drilled in 1971 to 31,441 feet, was then the world's deepest well. In 1979 the No. 1 Sanders well near Sayre became Oklahoma's deepest gas producer at 24,996 feet.

"When controls on gas prices were lifted, Anadarko justified the faith and perseverance of The GHK Company and other operators who pioneered in deep drilling.

"The shallow horizons of Greater Anadarko account for much of this nation's proved gas reserves. Deeper sediments below 15,000 feet remain virtually unexplored. Renewed assessment of some 22,000 cubic miles of deep sediments may carry over into the 21st Century.

"For 20th Century's final quarter the Basin remains the frontier of deep drilling technology centered on Elk City, 'Deep Gas Capital of the World'. As gas prices equate more closely to value, the nation's needs may be met increasingly from this massive sedimentary basin, a focal point in drilling innovation and geological interpretation.

"In re-energizing America, Anadarko will not yield its gas easily or briefly. Promised rewards lying beyond the threshold of drilling techniques demand massive investment. In challenging the inventive enterprise of America's energy industry, this Basin will remain the heartland of technology in penetrating the earth's crust—Oklahoma Historical Society, with Oklahoma Petroleum Council, 1981."

CHARLES MANKIN APPOINTED TO GEOLOGICAL SCIENCES BOARD

Charles J. Mankin, director of the Oklahoma Geological Survey and of OU's Energy Resources Center, has been appointed to the Geological Sciences Board of the National Research Council (NRC).

The board, created recently by NRC's Assembly of Mathematical and Physical Sciences, screens geological information that is used as background in national programs of scientific, economic, and environmental importance.

Mankin said that such matters as estimating petroleum and natural-gas resources, the producibility of those resources, investigations of the quantity and quality of water resources, and the disposal of industrial wastes are among the board's concerns.

OKLAHOMA SEISMIC REPORT PUBLISHED

Seismicity and Tectonic Relationships of the Nemaha Uplift in Oklahoma—Part III, by Kenneth V. Luza and James E. Lawson, Jr., has been released by the Oklahoma Geological Survey as Special Publication 81–3.

The document presents results for Oklahoma of the third stage of a five-year, four-state grant program sponsored by the U.S. Nuclear Regulatory Commission (NRC) to investigate seismicity, gravity, and structure along the Nemaha Uplift, a buried, block-faulted ridge that extends roughly southwest-northeast through central Oklahoma and eastern Kansas into southeastern Nebraska and southwestern Iowa. The report was first issued by the NRC as NUREG/CR–1500, and its reissue by OGS was authorized by the Division of the Office of Nuclear Regulatory Research of NRC. The Oklahoma project has been carried forward by Luza, OGS engineering geologist, as principal investigator and by Lawson, geophysicist for the Oklahoma Geophysical Observatory that is operated by the OGS.

The program was established to provide background information to benefit the construction industry in designing large-scale structures such as dams, high-rise buildings, and power plants. The information is used also as a basis for evaluating insurance rates in the Midcontinent.

The report contains structure-contour maps of the top of the Viola Formation (Ordovician), the base of the Pennsylvanian, and the top of the Oswego Formation (Middle Pennsylvanian) in the Enid and Oklahoma City 1° by 2° Quadrangles. Data from more than 20,000 wells were used in preparing the maps. These maps show two complex fault patterns, the westernmost of which is related to the Nemaha Uplift, although the authors state that the "correlation of historical and recent earthquake activity with the Nemaha Uplift structures remains unclear."

Luza and Lawson's report also includes a map of gravity anomalies in the northern part of the area, plus an earthquake inventory, earthquake-location maps, and numerous other seismic data. Methods and equipment used in recovery of these data are described in detail.

OGS Special Publication 81–3 can be obtained from the Oklahoma Geological Survey at the address given inside the front cover. The price is $4.

NOTES ON NEW PUBLICATIONS

GeoRef Thesaurus, Third Edition

The new edition of the *GeoRef Thesaurus* is now available. This updated version reflects changes stemming mainly from an agreement to exchange references with two French organizations (Bureau de Recherches Géologiques et Minières and Centre National de la Recherche Scientifique).

Order from: American Geological Institute, 5205 Leesburg Pike, Falls Church, VA 22041. Price: $45 hardcover, $20 microfiche.

Basins of the Southwest—Phase 2

The North Texas Geological Society has announced the availability of its newest publication, which has eight current papers relating to geology in the southwest.

Three of the eight papers included are: "Migration Pathways Leading to Oil Accumulation in Clastic Sediments," by Robert J. Cordell; "Stratigraphic Trap Possibilities in the Arbuckle Group," by Lloyd E. Gatewood; and "The Geotectonic Evolution of the Wichita Aulacogen, Oklahoma," by Jack L. Walper.

Order from: North Texas Geological Society, 813 Hamilton Bldg., Wichita Falls, TX 76301. Price: $20 per copy. Payment must accompany order.

Lexicon of Geologic Names of the United States for 1968–1975

This lexicon of new geologic names is a record of lithostratigraphic units (in the United States, Puerto Rico, Panama Canal Zone, and American Samoa) introduced into the literature in the years 1968 through 1975. Also included are some names introduced before 1968 but not included in previously published lexicons.

Order B 1520 from: Eastern Distribution Branch, Text Products Section, U.S. Geological Survey, 604 South Pickett Street, Alexandria, VA 22304. Price: $6.50.

Worldwide Directory of National Earth-Science Agencies and Related International Organizations

This publication lists national earth-science agencies for 160 countries and 91 international organizations that are concerned with one or more earth sciences.

Order from: Eastern Distribution Branch, Text Products Section, U.S. Geological Survey, 604 South Pickett Street, Alexandria, VA 22304.

Mechanisms of Continental Drift and Plate Tectonics

Edited by P. A. Davis and S. K. Runcorn, this book draws together current research on the mechanisms of continental drift and plate tectonics. The various theories that have been put forward for the causes of plate motions are critically appraised in the light of existing geophysical, geological, and geochemical data.

Many of the contributions contain new and speculative theories; others are primarily survey articles that are valuable as sources of reference.

Order from: Academic Press, Inc., 111 Fifth Avenue, New York, NY 10003. Price: $72.

Geothermal Systems

Author John Elder has written a book based on studies of global convection, hydrothermal core deposits, and especially measurements made in connection with current geothermal power projects. The book discusses geothermal systems in relation to the origin, mechanism, and behavior in both the natural and exploited state.

The study concentrates on how the heat gets out, dealing with heat and mass transfer in lithothermal and hydrothermal systems deriving their energy from a vigorously convecting mantle, with emphasis on the mechanisms by which energy is delivered to the surface. The author seeks to bridge the gap between large-scale volcanic and small-scale hydrothermal systems, and provides evidence for considering these apparently different kinds of systems together.

Order from: Academic Press, 111 Fifth Avenue, New York, NY 10003. Price: $49.50.

Mount St. Helens Post-Eruption Map

Mount St. Helens and vicinity is the subject of a new map that includes color photographs of the major eruption and aftereffects. Publication of the map was possible through a cooperative effort with the U.S. Department of Agriculture–Forest Service, the Washington State Department of Natural Resources, and the U.S. Geological Survey.

The 36- × 40-inch topographic map, printed in a first edition of nearly half a million copies, is being issued in the single largest printing ever made by the USGS.

Changes in topography and bodies of water, including Spirit Lake, are readily seen when compared to the earlier USGS pre-eruption, special edition "Mount St. Helens and Vicinity" map of April 1980, or the Forest Service map, "Mount St. Helens–Spirit Lake" of 1973.

Presented at a scale of 1:100,000 (1 inch equals about 1.68 miles), the map has been updated from aerial photography taken June 19, 1980. The map denotes land managed by federal and state agencies and includes numerical designations for roads within the Gifford Pinchot National Forest, viewpoints, campgrounds, picnic areas, visitor centers, and other points of interest.

On the reverse side of the map, the Forest Service has presented text and color photographs providing a narrative of recent Mount St. Helens volcanic activities. Included are before and after panoramic views of the devastated area, history and legends of the mountain, and a glossary of volcanic terms.

Maps can be purchased by mail from the Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225. Orders must specify map title, "Mount St. Helens and Vicinity, March 1981," and include check or money order payable to the U.S. Geological Survey. Price: $1.

Copies of the map also can be obtained by mail from the Forest Supervisor, Gifford Pinchot National Forest, 500 West 12th Street, Vancouver, WA 98660. Mail orders must include check or money order made payable to the USDA Forest Service. Price: $1.

Perspectives on Government and Science: Occasioned by the Centennial of the U.S. Geological Survey

The modern government requires scientific information. But how it gets

that information, and how the information is distributed to different people, remain crucial questions.

The GSA symposium at the San Diego annual meeting in 1979, honoring the USGS on its hundredth anniversary, explored these issues from the viewpoints of the mineral industry, geoscience agencies of the government, universities, the Congress, and the observing scientist.

These papers are now available as a report of the GSA Committee on Geology and Public Policy.

Copies of the report can be obtained from: The Geological Society of America, Separates Division, P.O. Box 9140, Boulder, CO 80301.

Uranium Resource Evaluation, Sherman Quadrangle, Texas and Oklahoma

Results of this investigation indicate that environments favorable for sandstone-type uranium deposits are present in the Cretaceous Antlers and Woodbine Formations, Pennsylvanian arkoses, and the Permian Wichita–Albany Group. The authors are D. K. Hobday and F. G. Rose, Jr., Bureau of Economic Geology, The University of Texas at Austin.

Contact: Bendix Field Engineering Corp., P.O. Box 1569, Grand Junction, CO 81502. Evaluation no. PGJ-089(81).

Uranium Resource Evaluation, Oklahoma City Quadrangle, Oklahoma

Results indicate that there are no favorable uranium environments in the quadrangle, although subsurface sandstone, phosphatic shales, and marine black shales could host uranium; these lithologies were unevaluated, however, because of inaccessibility. By J. R. Derby, L. P. Upshaw, E. O. Carter, L. F. Roach, and D. G. Roach, Geological Services of Tulsa, Inc. No. PGJ–091(81).

Contact: Bendix Field Engineering Corp., P.O. Box 1569, Grand Junction, CO 81502.

Uranium Resource Evaluation, Enid Quadrangle, Oklahoma and Kansas

No environments were found to be favorable for uranium, although the upper Arbuckle Group exhibits some favorable characteristics. By R. L. Eutsler, S. Bloch, and K. S. Johnson, Oklahoma Geological Survey. No. PGJ–095(81).

Contact: Bendix Field Engineering Corp., P.O. Box 1569, Grand Junction, CO 81502.

Uranium Resource Evaluation, Clinton Quadrangle, Oklahoma

Five areas of uranium favorability were delineated—two in the coastal-plain facies of the Doxey Shale, two in the marginal-basin facies of the Cloud Chief and Rush Springs Formations, and one in the southern part of the quadrangle characterized by arkosic alluvial-fan and fluvial facies. By S. Bloch, K. S. Johnson, R. L. Eutsler, and J. J. Myers, Oklahoma Geological Survey. No. PGJ–096(81).

Contact: Bendix Field Engineering Corp., P.O. Box 1569, Grand Junction, CO 81502.

Uranium Industry Seminar Proceedings, October 22 and 23, 1980

Topics of discussion dealt with uranium-enrichment plans and policies, uranium-resource-assessment programs, the uranium market and demand, status of the U.S. Department of Energy's National Uranium Resource Evaluation (NURE) program, international uranium activities, uranium reserves and exploration, and uranium supply. The 167-page report is GJO–108(80).

Order from: Bendix Field Engineering Corp., P.O. Box 1569, Grand Junction, CO 81502. Price: $10.

Catalog of Selected Offices of the Office of Surface Mining, Bureau of Land Management, and Geological Survey Relating to Coal, 1981

USGS Circular 840 is available from: Distribution Branch, Text Products Section, U.S. Geological Survey, 604 South Pickett Street, Alexandria, VA 22304.

Estimated Oil and Gas Reserves, Gulf of Mexico Outer Continental Shelf, December 31, 1979

Open-file report 80-1312, by J. E. Hewitt, J. E. Knipmeyer, and E. K. Schluntz, supersedes open-file report 80-644.

Order from: Open-File Services Section, Distribution Branch, U.S. Geological Survey, Box 25425, Federal Center, Denver, CO 80225. Price: $3.50 microfiche; $1.50 paper copy.

USGS Field Studies Map MF-1210

Maps showing kinds and sources of environmental geologic and geophysical data collected by the USGS in the Baltimore Canyon Trough area, by J. M. Robb and J. R. Kirby, 1980.

Order from: Distribution Branch, U.S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202. Price: $3 per set.

Bureau of Mines Research 80: A Summary of Significant Results in Mineral Technology and Economics

Special Publication 1–81, edited by Janice D. Burket, contains 127 pages and 65 figures. This publication outlines the U.S. Bureau of Mines' functions in developing new and improved technology and acquiring statistical and economic knowledge related to mineral materials.

Order from: Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Price: $4.75.

Federal Land Status in the Overthrust Belt of Idaho, Montana, Utah, and Wyoming, 1979

The purpose of this study is to determine the extent of land withdrawals and other restrictions in the Overthrust Belt and to discuss the mineral-resource potential within the study area. Statistics within this report refer to land status on January 1, 1979.

The authors are Otto L. Schumacher, Andrew W. Berg, Fred V. Carrillo, Ronald A. Pense, and Robert B. Davis. The publication contains 22 pages and six figures plus 14 oversized maps.

Order from: Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Price: $12.

Mineral Dependency Versus Mineral Vulnerability

America's increasing mineral dependency on foreign sources of supply has become a major issue. This U.S. Bureau of Mines publication makes distinctions between dependency and "true vulnerability." The Bureau is expanding its capacity to make such analyses, which may be used as a basis for policy formation and to conduct research toward technologies that can increase the nation's mineral self-sufficiency as necessary.

The author of the eight-page publication, SP 3–81, is Lindsay D. Norman.

Order from: Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Price: $1.25 single copy; $14 per 100 copies.

Characterization of Residues From Selected Coal Conversion Processes

E. Martin and G. V. Sullivan have examined the U.S. Bureau of Mines' activity in secondary resource recovery and expansion of the nation's mineral base. The Bureau's Tuscaloosa Research Center made characterization and preliminary beneficiation studies of the waste residues from various coal-conversion processes: from pilot-plant tests of the Synthane process for coal gasification, the Synthoil process for coal liquefaction, and for the solvent-refined coal (SRC) process for sulfur removal from coal.

Order publication RI 8501 from: Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

Physical Principles of Exploration Methods

A. E. Beck's 256-page book contains information on electrical methods, self-potential or spontaneous polarization, induced polarization, magnetic methods, seismic methods, and a number of other topics. The book was published in July of this year.

Order from: Halsted Press, 605 Third Avenue, New York, NY 10158. Price: $39 cloth, $18.95 paper cover.

Economic Geology and Geotectonics

Editor E. H. Tarling provides a geotectonic framework for evaluating the origins and concentrations of petroleum, coal, and ore deposits. The authors also examine the mode of formation of resource deposits, information of importance in the selection of detection and extraction methods. This 300-page book was scheduled for publication in June of this year.

Order from: Halsted Press, 605 Third Avenue, New York, NY 10158. Price: $54.95.

Estimates of Undiscovered Recoverable Resources of Conventionally Producible Oil and Gas in the United States

This 18-page summary, OF 81–0192, is available from: Open-File Services Section, Western Distribution Branch, U. S. Geological Survey, Box 25425, Federal Center, Denver, CO 80225.

Price: $3.50 microfiche; $2.25 paper copy.

Irrigated Cropland, 1978, Texas County, Oklahoma

The cultural-base component of this map, by Bruce Wright, was derived from parts of the USGS 1:250,000-scale topographic maps Dalhart and Perryton, OF 80–0170.

Order from: USGS Mid-Continent Mapping Center, 1400 Independence Road, Rolla, MO 65401.

Land Use and Land Cover and Associated Maps for Dalhart, Texas, Oklahoma, New Mexico, Colorado, Kansas

This data set consists of one map keyed to the Dalhart USGS topographic map, scale 1:250,000; Catalog OF 80-0262.

Order from: USGS, Rocky Mountain Mapping Center, Box 25046, Federal Center, Denver, CO 80225.

OKLAHOMA NAMES APPROVED

The U.S. Board on Geographic Names recently approved five Oklahoma place names that were published in the January through March 1981 issue of *Decisions on Geographic Names in the United States* (Decision List 8101).

Boktuklo Creek was adopted to denote a stream, 26 km (16 miles) long, which heads in the Boktuklo Mountains at 34°30′27″ N, 94°49′42″ W, and flows SE to Mountain Fork at The Narrows 9.7 km (6 miles) SSW of Smithville. "Boktuklo" is a Choctaw Indian word meaning "two creek." The stream is in McCurtain and Le Flore Counties, Oklahoma; sec. 9,T. 2 S., R. 25 E., Indian Meridian; 34°23′27″ N, 94°41′37″ W. **Not**: Bok Tuklo or Boktukola Creek.

Boktuklo Mountains now identifies mountains 29 km (18 miles) long, extending NW from Boktuklo Creek to a point 2.4 km (1.5 miles) SE of Honobia. The mountains are in McCurtain and Le Flore Counties, Oklahoma; 34°31′15″ N, 94°55′35″ W (NW end), 34°23′45″ N, 94°43′30″ W (SE end). **Not**: Boktukola Mountains.

South Boktuklo Creek designates a stream, 14.5 km (9 miles) long, heading 4 km (2.5 miles) NE of North Pole at 34°06′25″ N, 94°50′47″ W, flowing SW to Glover Creek 4.3 km (2.7 miles) WSW of Golden. The creek is in McCurtain County, Oklahoma, sec. 19, T. 6 S., R. 23 E., Indian Meridian; 34°01′22″ N, 94°56′25″ W. **Not**: Bok Tuklo, Boktuklo Creek, Botuklo Creek.

East Boktuklo Creek denotes a stream, 16.1 km (10 miles) long, heading in the Boktuklo Mountains at 34°29'33" N, 94°46'35" W, flowing SE to Boktuklo Creek 11.9 km (7.4 miles) SW of Smithville. The creek is in McCurtain County, Oklahoma; sec. 13, T. 2 S., R. 24 E., Indian Meridian; 34°23'17" N, 94°44'00" W. **Not**: East Bok Tuklo, East Boktukola Creek.

Town Creek was adopted to denote a stream 7.2 km (4.5 miles) long, heading on the E slope of Cavanal Mountain at 35°04'15" N, 94°40'12" W, flowing ESE to The Cutoff E at Poteau, Le Flore County, Oklahoma; sec. 30, T. 7 N., R. 26 E., Indian Meridian; 35°03'22" N, 94°36'18" W.

BRIAN CARDOTT JOINS SURVEY STAFF

Brian Cardott

Brian J. Cardott, a minerals geologist and organic petrographer, is the newest addition to the staff of the Oklahoma Geological Survey.

Cardott, who is currently in the process of completing a Master of Science degree in geology from Southern Illinois University at Carbondale, will be involved in a number of projects at the OGS.

He will work closely with William E. Harrison, OGS petroleum geologist and geochemist, in an investigation of the Woodford Shale as a petroleum source-rock. The study involves an organic-geochemical characterization of this black-shale sequence, which is generally considered to be a major source of hydrocarbons.

In a joint effort with OU's chemistry department, Cardott will work with Dr. Arnulf P. Hagen to compare the petrographic composition of coal that has been treated for transportation in a coal-slurry pipeline with coal that has not been treated.

Cardott will also be involved in determining the petrography of Oklahoma coals.

"Our present knowledge of Oklahoma coals concerns their chemistry and resources. Their petrographic composition, used in the prediction of coal's behavior in various utilization processes, has not been examined in detail," he said.

Cardott began to think about a career in geology after taking an aptitude test in high school.

"I was interested in science, so it was really just a narrowing process. I took courses as a freshman in college and became very interested in geology. I've never regretted that decision," he said.

His first detailed work with coal began when he accepted a position as research assistant at the Illinois State Geological Survey while waiting for his fiancee to finish her degree at the University of Illinois.He found the coal project so interesting that he decided to move into this specialty rather than to remain in the field of paleoecology and biostratigraphy.

Before coming to the OGS, he had been employed for almost 3 years as an assistant manager of the Department of Geology's Coal Characterization Laboratory at Southern Illinois University. He was responsible for sample collection, preparation, and analysis, as well as for maintaining lab equipment, keeping records, and supervising training programs.

Brian and his wife, Kathy, are now living in Norman, and Kathy will be filling in temporarily at the Survey this summer in a proofreading job in the editorial section.

OGS OFFERS REPRINTS OF ARTICLE ON MAPPING GEOLOGIC HAZARDS

The Oklahoma Geological Survey has available for distribution reprints of an article that summarizes Oklahoma programs of mapping geologic hazards.

The paper, prepared by Kenneth S. Johnson, OGS associate director, and Kenneth V. Luza, engineering geologist, was delivered by Johnson at a session of the International Geological Congress that was held last July in Paris, France. The article appeared in a recent issue (no. 23, p. 15–19) of the Bulletin of the International Association of Engineering Geology, which was published in 1981 in Krefeld, Germany.

In their article, Johnson and Luza offer information on such natural hazards in Oklahoma as earthquakes, landslides, expansive soils, flood-prone areas, and areas of potential karst and salt dissolution. Man-made hazards described include underground mines, strip mines and open-pit mines, and industrial-waste disposal in geologic formations.

Single copies of the reprint can be obtained on request from the Oklahoma Geological Survey, 830 Van Vleet Oval, Norman, Oklahoma 73019; phone, (405) 325-3031.

Wayne Furr (center) accepts a certificate for completion of the Supervision/Management Program offered by the OU Personnel Services Training Center. Presenting the certificate are Leonard Harper, OU director of personnel services, and Estelle Waintroob, training coordinator.

FURR RECEIVES CERTIFICATE

Cartographer Wayne Furr, an employee of the Oklahoma Geological Survey for two years, is the first person to complete the core curriculum of OU's Supervision/Management Certificate Program. The program was designed to give additional training to OU employees and to improve their opportunities for advancement.

Furr, who is manager of cartography with OGS, completed the 52 hours of courses required in the core program. Areas of study included basic supervision skills, interviewing and employee selection, time management, communications, motivation and interpersonal relations. He now is working on the intermediate program, which adds 48 hours of study in setting job standards and goal-oriented management, management of prejudice, coaching/delegation, assertive behavior performance evaluations and preparing a budget.

The courses are offered free to all university employees. The certificate program, with its specific guidelines and curriculum, was organized last September.

In addition to the specific seminars offered in the supervision/management sequence, general seminars are presented on such topics as first aid, laboratory safety, employee benefits, career planning, speed reading, listening, grievance procedures and many others.

EARTH SCIENCE EDITORS MEET IN OCTOBER

The annual meeting of the Association of Earth Science Editors, which will be held this year in Denver, October 4–7, should be attractive to a broad spectrum of editors, writers, publishers, and researchers in the earth sciences. Headquarters for the meeting will be the Regency Inn.

The program is organized along the theme of communicating better with a larger public. Specific sessions will focus on the following topics: (1) opportunities for writers and editors, (2) projection of a corporate image, (3) strategies for getting a message across, (4) methods for reaching a larger public—trends in geopublishing, (5) a look at new techniques and practices, (6) developments in journals and libraries, and (7) a workshop on technical communication.

Additional functions include the association's annual business meeting and a field trip to view the environmental geology of the greater Denver area.

A highlight of the meeting will be the annual banquet, at which AESE president Michael Latremouille will present several awards in recognition of outstanding service to the association, including the prestigious AESE Award for Outstanding Editorial or Publishing Contributions. The latest recipient of this award is Brian J. Skinner, editor of *Economic Geology* and a professor of geology and geophysics at Yale University.

AESE members from the Oklahoma Geological Survey planning to attend the meeting are Elizabeth A. Ham, William D. Rose, and Connie Smith. Additional participants from The University of Oklahoma include Jiri Zidek, an associate professor in the School of Geology and Geophysics and curator of vertebrate paleontology at the Stovall Museum of Science and History, and William O. Williams, director of publications at OU.

After some mild arm-twisting by Connie Smith and Bill Rose, Bill Williams agreed to conduct a workshop session on publication design, a field in which he has received wide recognition.

Bill Rose's arm was twisted, in turn, by program chairman Jay Fussell, of the Nebraska Geological Survey, who persuaded Bill to chair the session on strategies for getting your message across. Bill is also serving as this year's chairman of the awards committee.

Jiri Zidek will be displaying the first issue of the new *Journal of Vertebrate Paleontology*, which he helped to establish and which he edits. This quarterly, published at OU, is issued jointly by the School of Geology and Geophysics and the Stovall Museum.

For further information about the AESE meeting, contact John Heller, U.S. Geological Survey, Box 25046, Mail Stop 510, Federal Center, Denver, Colorado 80225 (phone, 303–234-2351).

Paula A. Hewitt accepts a jacket given for her first-place win in a recent printing competition. L. T. McCullers presented the prize for the A. B. Dick Company of Oklahoma City.

HEWITT WINS AWARD

Paula A. (Polly) Hewitt, copy-shop operator for the Oklahoma Geological Survey, was recently awarded first prize in an offset-printing contest sponsored by the A. B. Dick Company of Oklahoma City.

L. T. McCullers, who presented the award for the company, said that although Hewitt was competing against people who used larger presses, the quality of the 209-page book she submitted was more consistent.

"The judge said that, although 95 percent of the pages were printed from paper masters rather than from metal plates, the work was consistently good. He was really amazed," McCullers said.

The contest was judged by John Johnson, a graphic-arts instructor at the Moore-Norman Vo-Tech School.

Hewitt was awarded a jacket for her win in the black and white printing division of the contest. She has been employed at the Survey for eight years.

CONFERENCE TO EXAMINE LEAD–ZINC DEPOSITS

An International Conference on Mississippi Valley-type lead–zinc deposits is scheduled to be held in Rolla, Missouri, October 11–14 of this year. The meeting is being organized by the Department of Geology and Geophysics and the School of Mines and Metallurgy at the University of Missouri–Rolla in cooperation with the U.S. Geological Survey, the Missouri Geological Survey, and the mining industry of the Viburnum trend.

The organizing committee, chaired by Geza Kisvarsanyi, has invited papers on global and regional geology of the Mississippi Valley-type deposits, genetic concepts and models, exploration strategies, and a number of other topics.

Those interested in presenting a paper or attending the conference should send their names and addresses to Dr. Kisvarsanyi, Department of Geology and Geophysics, University of Missouri–Rolla, Rolla, MO 65401.

OKLAHOMA ABSTRACTS

GSA Annual Meeting, South-Central Section San Antonio, Texas, April 13–14, 1981

The following abstract is reprinted from *Abstracts with Programs, 1981* of The Geological Society of America, v. 13, no. 5. The page number is given in brackets below the abstract. Permission of the authors and of John C. Frye, executive director of GSA, to reproduce the abstract is gratefully acknowledged.

Origin of the Intermediate Rocks of the Cold Springs Intrusion Breccia, Wichita Mountains, Southwestern Oklahoma

DANA M. VIDRINE and SHELDON K. GRANT, Department of Geology and Geophysics, University of Missouri–Rolla, Rolla, Missouri 65401; and LOUIS A. FERNANDEZ, Department of Earth Sciences, University of New Orleans, New Orleans, Louisiana 70122

In the Wichita province of southwestern Oklahoma the Cold Springs Breccia Formation, exposed in a 15 km^2 area in Kiowa County, is characterized by

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OKLAHOMA ABSTRACTS is intended to present abstracts of recent unpublished papers relating to the geology of Oklahoma and adjacent areas of interest. The editors are therefore interested in obtaining abstracts of formally presented or approved documents, such as dissertations, theses, and papers presented at professional meetings, that have not yet been published.

blocks and pillows of microdiorite surrounded by a network of pink leucogranite. Intimately associated with the microdiorite–leucogranite network are sill-like bodies of intermediate rocks ranging in composition from quartz monzonite to tonalite (formerly known as Cold Springs Granite). These intermediate rocks have been interpreted as "hybrids", produced by cross-assimilation of microdiorite by "granitic" magma.

Major, minor and trace element data have been obtained on a suite of leucogranites, granites, microdiorites and a variety of intermediate rocks. Q-mode factor analysis, and linear-programming and least squares techniques have been used to test the chemical feasibility of an assimilation model. The results indicate that the intermediate rocks are too enriched in P, Ti, Al, Sr and Fe to be a product of the cross-assimilation of microdiorite by a "granitic" magma.

Based on chemical and field data the quartz monzonite–tonalite series is attributed to fractional crystallization of a primary intermediate magma, modified in part by minor assimilative-reaction of microdiorite. The sequence of events is interpreted as follows: (1) emplacement of microdiorite sills; (2) intrusion of an intermediate melt coupled with minor assimilative-reaction of the microdiorite followed shortly thereafter by (3) intrusion of leucogranite along the same zones of weakness with minor assimilative-reaction at granite–microdiorite and granite–intermediate rock contacts. [264]