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OKLAHOMA GEOLOGY NOTES

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Cover Picture

INFRARED PHOTOGRAPH OF TURNER FALLS

The U. S. Geological Survey is currently engaged in a program of remote-sensor application studies to develop instruments for orbiting satellites and space probes. Various remote-sensing techniques, some long established, some new, give promise of being able to yield much new information about the Earth, as well as about the moon and planets. As part of the program, various experiments being conducted in the Arbuckle Mountains include interpretation of infrared photography, an example of which is on this month's cover.

The photograph is of Turner Falls and was taken on June 19, 1968, at 11:15 A.M. The film was Kodak Ektachrome infrared aerofilm, type 8443. This is a false-color-reversal film sensitive to the visible and near-infrared segment of the electromagnetic spectrum. Normally, the blue portion of the visible region is cut out with a yellow filter, in this case a Wratten 15 Kodak filter.

Near-infrared reflectivity is especially sensitive to variations in vegetation. Thus, for example, healthy deciduous green foliage appears red, whereas diseased foliage appears green or blue. Evergreens, like the cedars in the photograph, appear dark maroon, oaks and elms deep red. The delineation of vegetation types by this method can be a useful tool in many geological investigations.

—*P. Jan Cannon*

(Photograph courtesy of the U. S. Geological Survey)

Pleistocene Stream Piracy in Southwestern Oklahoma

P. Jan Cannon

Recent work on the terrace deposits associated with the major streams in southwestern Oklahoma indicates that the Salt Fork of Red River was once a tributary of the North Fork of Red River. This piracy of a North Fork tributary is evidenced by the distribution of terrace deposits and fluted, or grooved, granite outcrops.

The North Fork and Salt Fork of the Red River drain a 3,800-square-mile area in southwestern Oklahoma (fig. 1). Three major levels of Pleistocene fluvial deposits occur within these drainage basins (Cannon, 1967); deposits of the highest level were formed first and consequently are the oldest; those of the lowest level were formed last.

The deposits of high-terrace material occur as isolated outliers on the drainage divide between the North Fork and the Washita River, well removed from the deposits of the two lower terraces. Their location and physical characteristics indicate that they are not related to the North Fork of Red River.

The middle-terrace level is more extensive; it discontinuously parallels the North Fork, Elm Fork, and northern part of the Salt Fork of Red River. Deposits of the middle-terrace level consist of light-red and reddish-brown sands and varicolored quartzite and quartz gravels. Along the North Fork south of Lake Altus, the deposits also contain arkosic material derived from the igneous rock of the Wichita Mountains.

On the Salt Fork, the middle-terrace deposits extend from Oklahoma's western border with Texas to Mangum in Greer County, where they coalesce with the middle-terrace deposits of the Elm Fork. South of Mangum the Salt Fork is devoid of middle-terrace deposits, which indicates that stream piracy occurred after emplacement of the deposits. Thus, between middle- and lower-terrace times, the southernmost major tributary of the North Fork was pirated by a subsequent stream that eroded northward (fig. 1).

In cases of stream piracy, the pirating stream has a steeper gradient than the pirated one (fig. 2). Before piracy, base level for the eastward-flowing segment of the Salt Fork was the North Fork; after piracy, base level was the Red River. This lowering of base level by piracy resulted in rejuvenation of the pirated segment of the Salt Fork. Evidence of rejuvenation is seen in altitudes of middle-terrace surfaces along the Salt Fork: 180 feet above the North Fork flood plain, 160 feet above the Elm Fork flood plain, and 190 feet above the Salt Fork flood plain. Near Mangum the surfaces of the middle-terrace deposits are at the same elevation on both the Elm and Salt Forks, but the flood plain of the Salt Fork is 30 feet lower than that of the Elm Fork.

Capture of the Salt Fork must have reduced the discharge of the North Fork substantially. Evidence for such a change between middle- and lower-terrace times may have been found. Horizontal flutings cut into the sides of granite hills face the North Fork at several locations

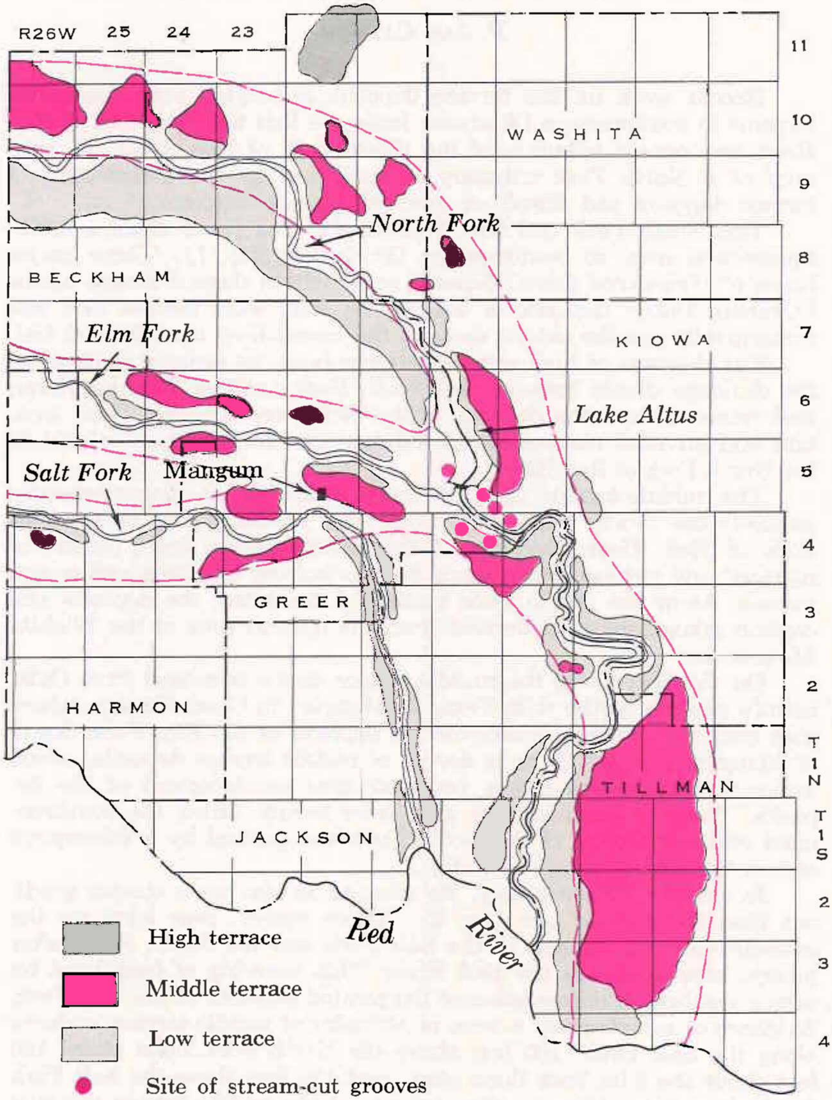

Figure 1. Map of southwestern Oklahoma showing distribution of Pleistocene terraces along the North, Elm, and Salt Forks of Red River. The colored dashed lines show probable limits of the major stream system, as indicated by the distribution of middle-terrace deposits. The present-day stream system is much as it was in low-terrace time.

near Lake Altus (fig. 1). These were first mentioned by G. G. Shumard (in Marcy, 1854), who thought that they were cut by stream action. Taylor (1915), Evans (1929), Tanner (1954), and Merritt (1958) concluded that they were benches cut by waves during the Permian. Two types of fluting are present in the western end of the Wichita Mountains near the North Fork. One type (fig. 3), typically 3 to 5 feet high with a concave surface less than 8 inches deep, is extensive and completely encircles the hills. This fluting is commonly

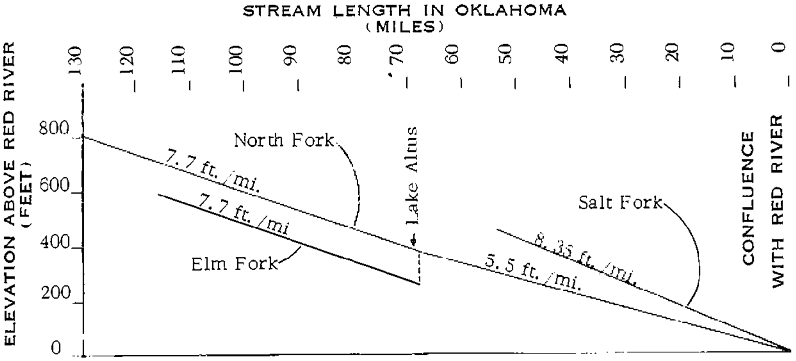

Figure 2. Gradients of the North, Elm, and Salt Forks of Red River in Oklahoma. The steeper gradient of the Salt Fork was brought about by rejuvenation due to stream piracy.

Figure 3. Fluting in the granite hills of the Wichita Mountains east of Lake Altus. This type of fluting appears to have been cut by waves.

associated with broad rock platforms, pocked with potholes, that are being exhumed from Permian redbeds. It appears to have been cut by waves. The other type (figs. 4, 5) is 2 to 13 inches high, 2 to 6 inches deep, and discontinuous. This type is found in areas that face the North Fork or are covered with middle-terrace material. It occurs on subfresh granite promentaries that are not found more than 180 feet above the North Fork; many have polished surfaces. Along the the North Fork or are covered with middle-terrace material. It occurs North Fork, large boulders are circumscribed with this second type of fluting (fig. 5). The boulders are asymmetrical, with a gently sloping side in the upstream direction of the North Fork and a blunt side facing downstream.

The writer concludes that the second type of fluting is not characteristic of wave-cut benches and, on the basis of location, association, and physical appearance, that these flutings are stream-cut grooves of Pleistocene age, cut by the North Fork during middle-terrace time when its discharge was greater.

The lowest of the three terrace deposits parallels the present channels of North Fork, Elm Fork, and Salt Fork for most of their lengths. The low-terrace surface is 60 feet above the North Fork flood plain, 55 feet above the Elm Fork flood plain, and 80 feet above the Salt Fork flood plain. The greater height above the Salt Fork flood plain is due to rejuvenation caused by stream piracy.

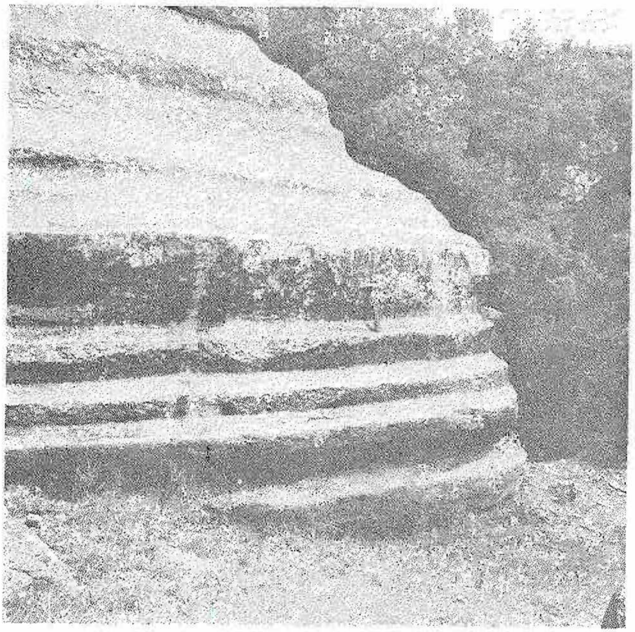

Figure 4. Fluting in granite rocks east of the North Fork of Red River. This type of fluting appears to have been cut by the North Fork during middle-terrace time.

Figure 5. Fluted granite boulder on north side of the North Fork of Red River near Lake Altus. The circumscribed grooves are similar to those shown in figure 4 and are stream cut. The North Fork, in the background, flows from right to left; the boulder has a gently sloping upstream end and a blunt downstream end.

The process of stream piracy continues to be an active element in the geological evolution of this area. A small northward-eroding tributary of the Salt Fork in the Mangum area could behead the Elm Fork within a short time, geologically speaking.

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Progress of Topographic Mapping in Oklahoma

Carl C. Branson

The U. S. Geological Survey continues to publish 7½-minute topographic maps at a rapid rate. All maps since 1964 have been on a scale of 1:24,000. The latest *Index to Topographic Maps of Oklahoma* is dated April 1968 and shows 310 published 7½-minute sheets and the equivalent of 295 7½-minute sheets published as 15-minute sheets.

Present information shows 239 sheets in progress, of which 33 are in advance proof and can be expected to be published within a few months, most of them probably by the time this article appears. Two of the scheduled 13 revised sheets (Bixby and Broken Arrow) have been issued as "photorevised." On these maps the changes in culture and drainage since the original survey are shown by purple overprint. The current rapid rate of urban, highway, and artificial-lake construction makes many maps partially out of date within a few years. The new type of map should be of great use to city planners in particular.

New Oklahoma Topographic Quadrangles

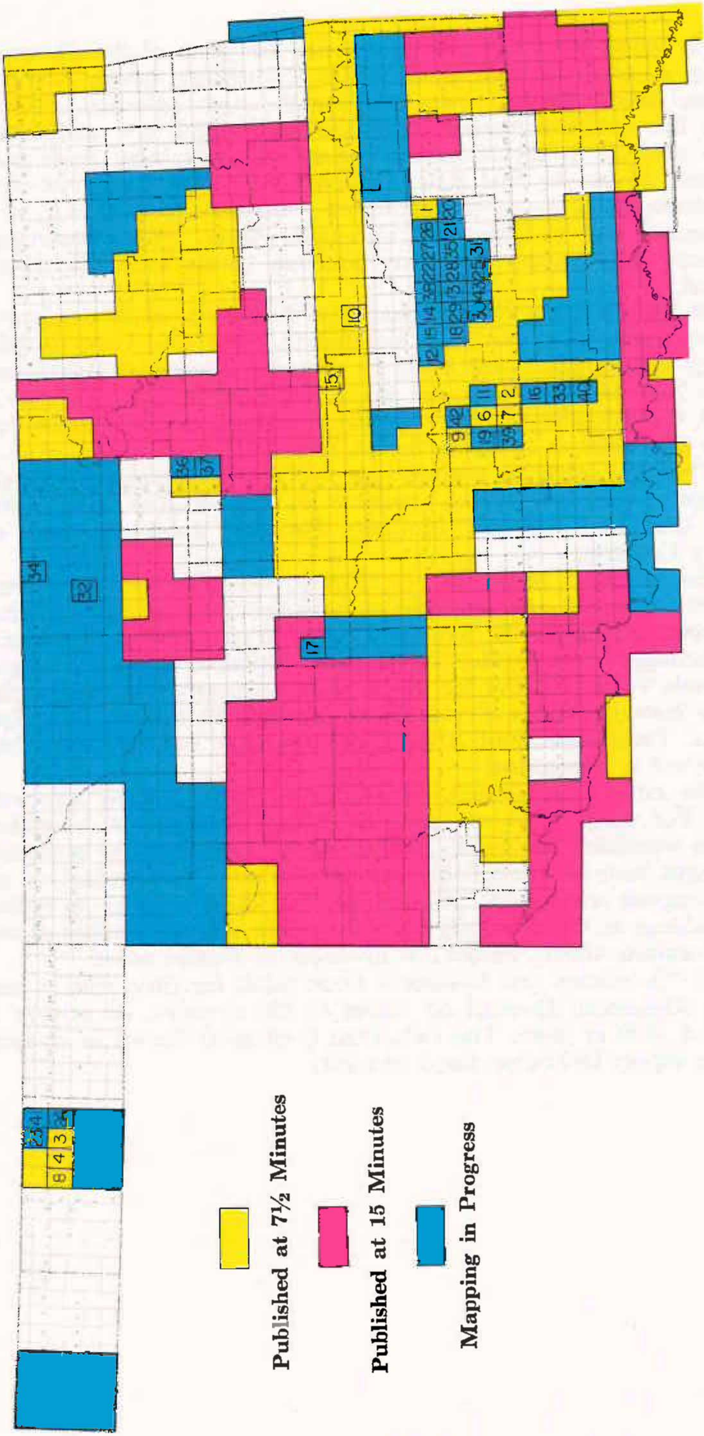
(Numbers refer to map, opposite page.
County names are in parentheses.)

Quadrangles Published Since September 1968

1. Adamson (Pittsburg)
2. Fittstown (Pontotoc)
3. Hooker (Texas)
4. Optima (Texas)
5. Prague NE (Okfuskee, Seminole)
6. Roff N (Pontotoc)
7. Roff S (Pontotoc, Murray)
8. Straight SW (Texas)
9. Stratford (Garvin, Pontotoc, McClain)
10. Weleetka (Okfuskee, Hughes)

Quadrangles in Advance Proof

11. Ahloso (Pontotoc)
12. Allen (Hughes, Pontotoc, Seminole)
13. Ashland (Pittsburg, Hughes, Coal)
14. Calvin E (Hughes)
15. Calvin W (Hughes)
16. Connerville (Johnston)
17. Fort Reno SW (Canadian)
18. Gerty (Hughes, Coal)
19. Hart (Garvin, Pontotoc, Murray)
20. Hartshorne (Pittsburg, Latimer)
21. Hartshorne SW (Pittsburg)
22. Haywood (Pittsburg)
23. Hooker NW (Texas)
24. Hooker SE (Texas)
25. Keota (Pittsburg, Atoka)
26. Krebs (Pittsburg)
27. McAlester (Pittsburg)
28. McAlester SW (Pittsburg)
29. Non (Hughes, Coal)
30. Parker (Coal)
31. Pittsburg (Pittsburg)
32. Pond Creek (Grant)
33. Reagan (Johnston)
34. Renfrow (Grant)
35. Savanna (Pittsburg)
36. Stillwater N (Payne, Noble)
37. Stillwater S (Payne)
38. Stuart (Pittsburg, Hughes)
39. Sulphur N (Murray, Pontotoc)
40. Tishomingo (Johnston, Marshall)
41. Tyrone (Texas)
42. Vanoss (Pontotoc)
43. Wardville (Coal, Pittsburg, Atoka)


Published at 7½ Minutes
Published at 15 Minutes
Mapping in Progress

No maps are scheduled or planned for parts of the State comprising in area the equivalent of 316 7½-minute sheets. Along the Missouri border the four shared 7½-minute quadrangles are published. Along the Arkansas border 16 of the quadrangles are published, of which two are in the 15-minute format; the remaining three are in progress. Along the Red River on the border with Texas, 24 of the 7½-minute quadrangles are published (two date from 1915), 14 are in progress, and 40 appear on 15-minute sheets. With completion of the maps in progress, the entire southern border area will then be mapped.

Of the 40 maps needed along the Texas Panhandle border, two have appeared in a 15-minute quadrangle, eight have been issued on the 7½-minute scale, and 6 are in progress. None of the four maps on the New Mexico border nor any of the eight in Colorado have appeared. Quadrangles along the Kansas border number 60, and, of these, 22 are published at 1:24,000, five at 1:62,500.

When the maps in progress are published, complete topographic coverage at 1:24,000 will be available for Rogers, Kay, Grant, Oklahoma, Cleveland, Haskell, McClain, Pontotoc, Johnston, Coal, and Murray Counties.

The outdated 30-minute (1:125,000) quadrangles are all more than 50 years old and are only of historical interest. Most of these have been superseded or will be shortly. Those to be replaced soon are Montague, Gainesville, Tishomingo, Atoka, Stonewall, Coalgate, and Pauls Valley. Others for which no replacement is currently planned are Nowata, Vinita, Pryor, Siloam Springs, Tahlequah, Okmulgee, Nuyaka, Tuskahoma, and Alikchi; only parts of some of these have been or will be remapped.

The citizen, in ordering topographic maps, has an increasing choice. For many years one has had a choice of maps with or without a green woodland overprint. For six years maps that are essentially base maps have been available without contours. Two published and 11 in-progress sheets are "photorevised" to show changes in culture and drainage in the relatively few years since the topographic survey. One 15-minute sheet (Bethel) is available in shaded relief.

All 7½-minute and 15-minute maps retail for fifty cents a map, with a 20-percent discount on orders of $20 or more, 40 percent on orders of $100 or more. The Oklahoma Geological Survey is an agent and can supply Oklahoma maps promptly.

Dolese Quarry Among Largest in Nation

The large limestone-quarry operation of the Dolese Brothers Company, about 12 miles north of Lawton, Comanche County, is the largest in Oklahoma and among the largest in the nation, according to the trade journal, *Rock Products*.

An article published in the October 1968 issue of *Rock Products* describes the 100 largest quarries in the United States. The largest quarry by far is the captive plant of the United States Steel Company at Rogers City, Michigan; it produces 14.0-million tons of crushed limestone per year, which is double the production of the second-ranked quarry. The third-ranked quarry produces about 5.25-million tons per year.

With an annual production of about 2.25-million tons, the Dolese Brothers quarry is the 23rd largest in the country. The description of the operation is reprinted below, with the permission of the editor of *Rock Products*.

> Excavation of stone from Dolese Brothers Company quarry at Richards Spur, Oklahoma, began in 1907 from a domelike peak of limestone ranging in height up to 212 feet. The quarry floor is now about 70 feet below the base of this former dome structure.
>
> Material from 2½-inch maximum down to 200 mesh is produced, although 6-inch aggregate has been supplied for special applications. Annual production of crushed stone is about 2.25-million tons. Plant design capacity for dry stone is 750 tons per hour. About 400 tons per hour of the product is washed.
>
> Richards Spur is about 90 miles southwest of Oklahoma City and is located on a spur line of the Rock Island Railroad. The plant services areas in a 100-mile radius, including Oklahoma City, Wichita Falls (Texas), North Texas, and the nearby Texas Panhandle. About 40 percent of shipments are made by rail and the other 60 percent by truck.
>
> Processing facilities at the plant are composed of the following production areas: primary crushing station, washing station, limestone-sand installation, secondary-crushing building, screening and blending plant. Most operations are controlled from a central control room.
>
> The quarry deposit is of the Arbuckle limestone . . . and gives a hard, durable limestone of about 90 percent calcium carbonate equivalent. End-dump 30-ton capacity trucks, loaded by a 4- or 6-cubic-yard electric shovel, haul the load to the primary crusher at the plant.
>
> The primary crusher is a 42-inch gyratory unit. There are seven secondary crushers: two 5½-foot standard cones, three 4-foot standard cones, one 5½-foot Shorthead cone, and one 4-foot Shorthead cone. The screening system contains 14 vibrating screens: two 5x10½-foot triple-deck and twelve 5x14-foot double-deck units.
>
> Three screens, two rotary scrubbers, and a surge bin are installed in the wash-plant section. The limestone-sand section contains a 6x16-foot triple-deck screen, two spiral classifiers, and a scalping-classifying tank.

—W. E. H.

CHESTER A. REEDS
OKLAHOMA GEOLOGIST

Chester Albert Reeds, a pioneer in Oklahoma geology, died on October 4, 1968, at Ghent, New York, at the age of 86. Reeds was a member of the Oklahoma Geological Survey when it was established in 1908 under C. N. Gould and was one of the four assistant geologists in 1910, his last of four field seasons in the Arbuckle Mountains. His report on resources of the Arbuckle Mountains is a 69-page book issued in 1910 as Oklahoma Geological Survey Bulletin 3. In that report he first described the Lawrence uplift and the Franks graben and summarized the mineral resources of the area.

Reeds' doctoral dissertation resulted in part from his Survey work and was published in 1911. It was a remarkably fine study of the Hunton Group, until then little known. In the 1911 publication he named and described the Haragan "shale," the Bois d'Arc Limestone, the Henryhouse "shale," and the Chimneyhill Limestone, the principal units recognized today. He recognized and described, but did not name, three members of the Chimneyhill. In a 1927 article he named and described the Frisco Limestone. T. W. Amsden has pointed out the high quality of the stratigraphic work and the extensive fossil identifications.

Reeds was born in La Cygne, Kansas, on July 20, 1882. The family moved in 1885 to a ranch near Silver City in the Chickasaw Nation and made the run in 1889 to settle near present Wheatland. In 1898 they moved to Norman, where the four boys starred on The University of Oklahoma football teams of 1898 to 1911.

Chester Reeds graduated in geology (1905) from The University of Oklahoma and received his master's (1907) and doctor's (1910) degrees from Yale. After leaving Oklahoma he taught at Bryn Mawr and then went to the staff of the American Museum of Natural History for 25 years, where he held several curatorial positions and wrote about glacial deposits, meteorites, and earthquakes. He retired in 1938 and became a consultant in later years.

Reeds was a fellow of the Geological Society of America and the Paleontological Society; a member of the Seismological Society, American Geographic Society, and New York Academy of Science; and an honorary member of Societé de Geographie de Colombia.

—*Carl C. Branson*

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OKLAHOMA ABSTRACTS

GSA Annual Meeting, Mexico City, Mexico

November 11-13, 1968

The following are abstracts of papers related to Oklahoma geology presented at the 1968 Annual Meeting of the Geological Society of America and Associated Societies; they are reproduced photographically from the program of the meeting. Permission of the authors and of Jo Fogelberg, managing editor of the Geological Society of America, to reproduce these abstracts is gratefully acknowledged.

Oklahoma Geology Notes should not be given as the primary source in citations of or quotes from the abstracts. The correct citation is Geol. Soc. America and Assoc. Socs., 1968 Ann. Mtg., Program, P. __. Page numbers are given in brackets at the lower right of each abstract.

OKLAHOMA ABSTRACTS is intended to present abstracts of recent unpublished papers on Oklahoma geology. 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.

Paleoecologic Inferences From Pollen Distribution in the Flowerpot Formation (Permian) of Oklahoma

CLAPHAM, WENTWORTH B., JR., *Department of Geology, Case Western Reserve University, Cleveland, Ohio 44106*

Pollen and spores have been recovered from the topmost 10 to 35 feet of the Flowerpot Formation (lower Guadelupian) over its entire outcrop in Oklahoma. Of 71 species of palynomorphs recognized, 46 are pollenites and 25 are sporites.

The distribution of these taxa gives an indication not only of the distribution of floras around the Anadarko Basin but also of the nature of these floras. There are two distinct pollen assemblages. One is the normal upper Permian assemblage dominated by *Lueckisporites virkkiae;* it is found at several levels and in most samples. The other assemblage is rich in cryptogamic spores, both triletes and monoletes, and is found in a single dark horizon which can be followed over a great distance in both the north-central and southwestern portions of the state. The former is probably derived from the flora inhabiting the uplands; the latter seems to represent a salt-marsh or swamp flora which developed as the result of a widespread but rather minor regression.

A factor analysis was performed on the generic counts to determine the nature of these two floras. The upland flora consisted of conifers producing bisaccate pollen and existed continuously over the broad upland surface. The lowland flora, on the other hand, was dominated by gymnosperms of several types, but also includes a significant proportion of cryptogams. It was restricted to sea-margin, flood-plain, and other wet environments during periods of transgression but expanded during periods of regression to contribute a significant portion of the total spore assemblage. [54]

Sedimentary Model for Pennsylvanian Missourian Rocks of the Midcontinent

COCKE, J. M., *State Geological Survey, The University of Kansas, Lawrence, Kansas 66044*

A sedimentary model based on southerly subsidence and differential sediment supply offers reasonable explanation for repetitive sequences and regional facies patterns in Pennsylvanian Missourian rocks of the midcontinent. The model requires acceptance of several conditions: (1) Beds are diachronous along the outcrop. (2) Widespread transgressions and regressions, resulting from eustatic changes or tectonic forces, are not necessary to explain repetitive beds: seas probably remained on the Kansas shelf throughout Missourian deposition, although shorelines migrated. (3) Regional unconformities are unlikely, although local channeling was common near shorelines. (4) The southerly slope of the basin was modified by advancing clastics, producing sea-floor slopes of differing directions.

Clastics, originating to the south and east, migrated northward and westward across the subsiding basin and impinged on the Kansas shelf carbonates. Sediment migration as fluvial and deltaic complexes was sporadic and controlled by subsidence rates and sediment supply. Fluctuation in sediment supply resulted mainly from shift of fluvial systems. Algal-mound complexes formed southern boundaries to thin shelf limestones and perhaps were temporary barriers to clastics. Thick unfossiliferous clastics that occur between the thin limestones are predominantly marine units formed in a prodelta environment. Carbonate sedimentation on the Kansas platform was continuous, and basic facies control was slope of basin floor as reflected by water depth. Along the northern margin of the platform, varicolored shales, derived in part from western or northern sources, and supratidal calcilutites reflect persistently shallow water. [57-58]

Geochemistry of Some Iodide-Rich Anadarko Basin Brines

COLLINS, A. GENE, *Bartlesville Petroleum Research Center, Bureau of Mines, U. S. Department of Interior, Bartlesville, Oklahoma 74003*

This study was made to determine the geochemical relationships between the subsurface fluids and some of the geologic strata in the Anadarko Basin. Samples of brines, cores, and petroleums from sediments of Pennsylvanian and Mississippian age were obtained. The brines were analyzed to determine their *p*H, E*h*, their concentrations of organic acids, oxygen-18, and deuterium. They were also analyzed for these ions: lithium, sodium, potassium, rubidium, cesium, magnesium, calcium, strontium, barium, ferrous iron, ferric iron, boron, ammonium, bicarbonate, sulfide, sulfite, thiosulfate, sulfate, chloride, bromide, and iodide. The oils were analyzed for sulfur, nitrogen, gasoline, naphtha, distillates, residuum, and iodide. The cores were analyzed to determine mineral type, micropaleontology, and concentrations of these elements: iodine, silver, copper, silicon, aluminum, iron, manganese, calcium, magnesium, and sodium. The resultant data were interpreted in reference to the geologic environment from which the samples were taken. The iodide concentrations were 1400 mg/1 in some of the brines, 30 ppm in some of the cores, and less than 0.05 mg/1 in the oils. It was concluded that the high concentrations of iodide in the brines were related to an abundant shallow-water ancient biota which was preserved by rapid sedimentation. [58-59]

Environment of Deposition of a Pennsylvanian "Black Shale" (Heebner) in Kansas and Adjacent States

EVANS, JOHN K., *Pan American Petroleum Corporation, 444 7th Ave., S. W., Calgary 2, Alberta, Canada*

Evidence derived from an investigation of certain aspects of the stratigraphy, petrology, paleontology, and geochemistry of the Heebner Shale Member is not compatible with the paludal origin which has been suggested for this thin but extensive stratum.

The limited depth of water implied by a marine-swamp origin makes it difficult to account for the continuous existence of such a milieu throughout an area of nearly 150,000 square miles. Examination of the contact between the Heebner Shale and the underlying marine limestone reveals that this limestone was not subjected to pre-Heebner erosion, effectively precluding a major regression prior to the deposition of the Heebner Member.

In northern Oklahoma, stratigraphic and faunal evidence indicate that the "black shale" passes southward into normal marine shales which are replaced, in turn, by continental deposits. Such a distribution of facies is difficult to reconcile with a paludal origin.

The presence of numerous very thin phosphate partings, which appear to be primary sedimentary features, suggests that the substrate was not disrupted by a well-developed root system or any attached forms of vegetation.

Regional variations in organic content, oil yield ratio, and radioactivity have been related to lateral differences in the redox level of the environment, which can be explained most easily in terms of progressive shoreward shallowing of a restricted marine basin.

[92-93]

Basic Facies Pattern of Outcropping Upper Pennsylvanian Limestones in the Midcontinent

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Most Missourian (lower Upper Pennsylvanian) limestone units exhibit the same regional facies pattern along the Midcontinent outcrop from Iowa to Oklahoma. Repetition of this pattern vertically in successive limestone units defines 4 major facies belts or restricted geographic areas of similar facies composition.

(1) In the central region of outcrop around northeastern Kansas most limestones consist mainly of skeletal calcilutite, with local calcarenitic shell concentrations. Fossils constitute a diverse assemblage of invertebrates reflecting the normal open marine environment.

(2) Northward in Iowa and Nebraska the marine facies is less dominant as *Osagia* calcarenite and barren laminated dolomitic calcilutite become significant. Both represent more restricted conditions, and the laminated dolomitic calcilutite indicates intertidal to supratidal environments.

(3) Southward from the open marine facies belt most limestone units thicken into phylloid algal-mound complexes centered largely in southeastern Kansas. Mounds are quasibiohermal developments consisting mainly of phylloid algae-dominated calcilutite. Many mounds are capped by skeletal calcarenite or oölite representing turbulent environments associated with the mounds.

(4) Algal-mound complexes thin abruptly southward into brachiopod-, crinoid-, and calcisponge-rich impure calcilutite, calcarenite, and oölite interbedded with greatly thickened clastic units in a clastic facies belt in the Kansas-Oklahoma border region.

Carbonate environments ranged from very shallow water and supratidal in the north through open marine to biohermal and finally clastic-dominated on the south. The same environmental pattern was established repeatedly during Late Pennsylvanian carbonate deposition in roughly the same location, although with some lateral shifting, in the Midcontinent outcrop region. [132]

Clay Mineralogy of Cottonwood Limestone

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Vertical and lateral distributions of clay mineral assemblages in the Cottonwood Limestone (Permian) from southern Nebraska to northern Oklahoma support the paleogeographic model proposed by Imbrie and others (1959). The clay fraction was concentrated by partial dissolution of carbonate for several hours in 0.3-molar acetic acid. Clay minerals were identified by X-ray diffraction of random powder and oriented mounts that were glycolated, heated, and treated with 6N HCl.

Two clay mineral facies occur along the 240-mile belt of this thin (5 to 7 feet) and laterally persistent member of the Beattie Limestone. The northern facies, from southern Nebraska to central Kansas, has a constant ratio of 3:1 of illite to randomly interstratified chlorite and vermiculite. The southern facies, from central Kansas to northern Oklahoma, contains an assemblage of illite, chlorite, randomly interstratified illite-montmorillonite, regularly interstratified clay minerals, and, near the south, kaolinite. Although illite is dominant in both facies, two types were recognized by comparing intensities of first- and second-order basal reflections. Type 1 illite of the northern facies has a (001):(002) ratio that is larger than 2; type 2 illite of the southern facies has a ratio smaller than 2.

The northern clay-mineral facies coincides with the fusuline and bioclastic facies of Laporte (1962); the southern clay-mineral facies occurs with the platy algal, shelly, and *Osagia* facies. Clay-mineral assemblages of the Cottonwood Limestone are mainly products of source area and depositional environment. [301]

Conodonts and Biostratigraphy of the Lower Arbuckle Group (Ordovician), Arbuckle Mountains, Oklahoma

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Lower Arbuckle strata (McKenzie Hill, Cool Creek) have yielded a moderately large conodont fauna (over 2000 identifiable specimens). The various elements have been assigned to 55 species distributed among 17 genera.

Conodonts from the McKenzie Hill comprise an unusual grouping of highly distinctive and apparently locally restricted forms. Individual faunal elements are small in size and occur in stable proportions below the contact with the Cool Creek Formation. Faunal compositions are in sharp contrast between the two Arbuckle formations. McKenzie Hill conodonts show no dominant group but contain a significant assortment of species, including *Chosonodina herfuthi* Müller, *Loxodus bransoni* Furnish, and *Trichonodella* n. sp. Cool Creek conodonts are dominated by an overwhelming number (60 percent of the total Arbuckle fauna) of scolopodids. These include, in order of importance, *S. quadraplicatus* Branson and Mehl, *S. triangularis* Ethington and Clark, *S. triplicatus* Ethington and Clark, and *S. filosus* Ethington and Clark. The predominance of these species strongly suggests partial faunal equivalence of Cool Creek beds with the El Paso Formation of western Texas; three of the most abundant scolopodid species were first described from the latter formation. **[211]**

Recognizing Ancient Deltaic Deposits

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Modern sedimentation studies suggest that a majority of all clastic sediments were laid down as deltas. Very few ancient deltas have been fully described, and the physical criteria for the recognition of deltaic deposits need to be determined. The Bartlesville-Bluejacket Sandstone of northeastern Oklahoma is a particularly good example of an ancient deltaic complex, and it exhibits many characteristics which can be used to develop a general deltaic model.

Closely spaced outcrop and subsurface control in the Bartlesville-Bluejacket delta provides an opportunity to relate paleocurrent data and sedimentary structures as well as textural, mineralogical, and petrophysical data to vertical and areal depositional patterns. Criteria useful in recognizing specific environments within the deltaic complex can thus be determined. Meander-belt sand units can be identified by their sedimentary structures and textural sequences, barrier bars by their bedding sequences and textural variations, and the main distributaries within the deltaic plain by their textural changes and their vertical and lateral relationships. Clay mineral variations provide an approximate indicator of the salinity, and the shapes of the grain-size distributions distinguish the different transportation mechanisms involved in the deposition of single sand units.

Integration of several independent physical criteria provides the basis for identification of delta complexes and the interpretation of local environments within the delta. A single well or outcrop section may sometimes provide enough of these criteria to recognize a deltaic sand body. **[304-305]**

Earth Science Editors Meet in Norman

The Second Annual Meeting of the Association of Earth Science Editors was hosted by the Oklahoma Geological Survey and held October 14-15 at the Oklahoma Center for Continuing Education. The conference was attended by 47 editors (13 from state surveys), representing 34 publications.

Moderator Howard A. Meyerhoff, of the Committee to Investigate Copyright Problems, opened the initial panel discussion, which examined "The Copyright Problem." Of great concern to all publishers, this problem involves the new copyright bill, still pending in Congress, and the definition of "free use" of copyrighted material. Panelists included William M. Passano, president of Williams & Wilkins Company; A. F. Spilhaus, Jr., of the American Geophysical Union; and Carl H. Savit, editor for the Society of Exploration Geophysicists.

Concurrent discussion groups were held on current policies and practices, publication economics, and style manual needs. Each discussion group later presented resolutions concerning their findings.

"Procedure and Problems in Editing," the last panel topic, was moderated by Gerald Friedman from the Journal of Sedimentary Petrology. Panel members were E. B. Eckel from the Geological Society of America, W. D. Rose from the Kentucky Geological Survey, and Melba W. Murray from Esso Production Research Company.

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