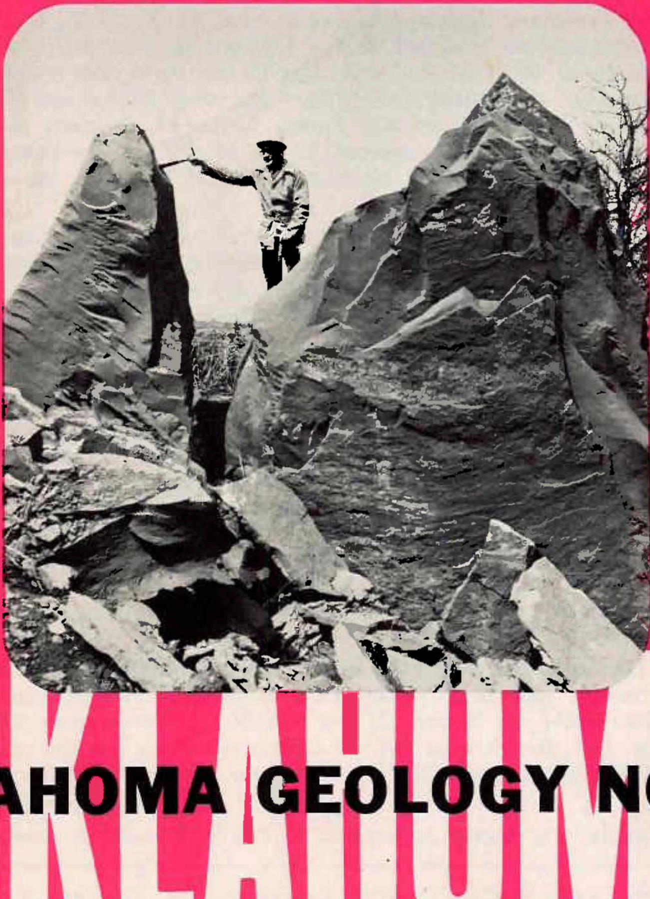
TWO DOLLARS PER YEAR FIFTY CENTS PER COPY



OKLAHOMA GEOLOGY NOTES

VOLUME 33 NUMBER 2 APRIL 1973

Cover Picture

THE ELK CITY BLOWOUT

February 23, 1973, the Oklahoma Geological Survey received a telephone inquiry about huge rocks that appeared to be sprouting from smooth pasture land owned by James Walter about 5 miles south of Elk City, Beckham County, Oklahoma (sec. 22, T. 10 N., R. 21 W.). Initial investigation revealed that a blowout had occurred, resulting in a hole about 30 by 50 feet wide and 15 feet deep plus several large cracks parallel to a creek bed. Fifty- and even 100-pound blocks of red siltstone and shale of the Doxey Shale of Permian age were thrown as far as 75 feet, several 30-ton boulders were lifted to an upright position (cover picture), and 15-foot trees in the vicinity were tilted 45°.

The blowout site is about 2,000 feet south of Shell Oil Company's Yelton LPG well, where liquefied petroleum gas (LPG), mostly propane, has been pumped into a pear-shaped storage cavity dissolved from salt of the Blaine Formation of Permian age at a depth of 1,360 1,411 feet (see *Oklahoma Geology Notes,* v. 19, no. 2, Feb. 1959, p. 32-34). After personnel from Shell and the U.S. Bureau of Mines detected 1 to 2 percent or more of total hydrocarbons, including 75 to 85 percent propane, emanating from the cracks at the blowout site, Shell tested the storage system for leakage and found that approximately 30 gallons of propane per day was escaping.

So the blowout was apparently caused by the escaping propane —not from the storage cavity itself but from a leak in the well bore. The propane must have moved laterally along a thief zone or zones in the shallow subsurface until it had built up sufficient pressure to cause a noncombustible eruption at the topographically lowest point in the area, the creek bed.

In late March, Shell evacuated the remaining propane from the storage cavity and began operations to pinpoint the source of the leak. Meanwhile, on March 12, the boulders pictured were bulldozed to rubble and the blowout feature destroyed. Thus the strange emergence of the rocks near Elk City has been relegated to history.

—*Robert O. Fay*

(Photograph of Survey geologist R. O. Fay by Kenneth S. Johnson)

Editorial staff: William D. Rose, Rosemary Croy, Elizabeth A. Ham

Oklahoma Geology Notes is published bimonthly by the Oklahoma Geological Survey. It contains short technical articles, mineral-industry and petroleum news and statistics, an annual bibliography of Oklahoma geology, reviews, and announcements of general pertinence to Oklahoma geology. Yearly subscription, $2.00. All subscription orders should be sent to the address on the front cover.

Short articles on aspects of Oklahoma geology are welcome from contributors. A set of guidelines will be forwarded on request.

Bibliography and Index of Oklahoma Geology 1972[1]

Prepared by Elizabeth A. Ham[2] and William D. Rose[2]

Bibliography

Adams, J. A. S., *see* Schwarzer, T. F., and Adams, J. A. S.

Allen, P. B., *see* Goss, D. W., Ross, A. R., Allen, P. B., and Naney, J. W.

1. Altenbaumer, Perry, 1972, The Viola and Simpson Formations, *in* Paleozoic geology of the Arbuckle Mountains, Oklahoma: Commerce, Texas, East Texas State University, Earth Science Department, p. 17-20, illus.
2. American Gas Association, 1972, Gas facts, a statistical record of the gas utility industry in 1971: American Gas Association, Department of Statistics, 204 p.
3. American Gas Association, 1972, Reserves of crude oil, natural gas liquids, and natural gas in the United States and Canada and Canada and United States productive capacity as of December 31, 1971: American Gas Association, American Petroleum Institute, Canadian Petroleum Association, v. 26 (May 1972), 248 p.
4. American Petroleum Institute, 1971, Petroleum facts and figures (1971 edition): 604 p.
5. Amsden, T. W., and Klapper, Gilbert, 1972, Misener Sandstone (Middle-Upper Devonian), north-central Oklahoma: American Association of Petroleum Geologists Bulletin, v. 56, p. 2323-2334, 8 figs., 1 table.
6. Apostol, Fontaine, 1972, A view of Alexander: Oklahoma Underground, Central Oklahoma Grotto, v. 5, no. 1, p. 15-19, illus.
7. Armstrong, F. E., and Heemstra, R. J., 1972, Radiometrics proposed for exploration (part 2): Oil and Gas Journal, v. 70, no. 24 (June 12), p. 152-161 (incl. ads), 2 figs. (Ceres pool, Noble County, cited.)

Atkins, R. L., *see* Glover, H. A., Atkins, R. L., Reece, B. B., Yee, B. Q., Grove, R. E., McUsic, J. M., and Cope, R. F.

8. Babitzke, H. R., 1972, Germanium, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 1217-1218, 1 table.
9. Baker, D. R., 1972, Organic geochemistry and geological interpretations: Journal of Geological Education, v. 20, p. 221-233, 9 figs.

Baker, D. R., *see* James, G. W., and Baker, D. R.

[1]Includes some earlier listings.
[2]Oklahoma Geological Survey.

Barnes, C. R., *see* Sweet, W. C., Ethington, R. L., and Barnes, C. R.

10. Bayless, Glen, 1972, Post-construction performance of P-18 bridge abutments and approach fills, eastern Oklahoma, *in* Kellner, Rosemary, and Rose, W. D. (editors), Proceedings of the 22nd Annual Highway Geology Symposium: Oklahoma Highway Department, Oklahoma Geological Survey, p. 53-67, 11 figs., 1 table.

Beck, K. C., *see* Weaver, C. E., and Beck, K. C.

11. Becker, V. J., Bennett, J. H., and Manuel, O. K., 1972, Iodine and uranium in sedimentary rocks: Chemical Geology, v. 9, no. 2, p. 133-136, 2 tables. (Refers to Anadarko basin and Kingfisher County.)

Bedwell, J. L., *see* Norden, J. A. E., Bedwell, J. L., Blair, A. J., II, Kaupp, C. B., III, Marchetti, J. W., Jr., and Markas, J. M.

12. Begemann, F., 1972, Argon 37/argon 39 activity ratios in meteorites and the spatial constancy of the cosmic radiation: Journal of Geophysical Research, v. 77, p. 3650-3659, 4 figs., 3 tables. (Includes Lost City, Oklahoma, meteorite.)

Bekure, S., *see* Eidman, V., and Bekure, S.

13. Bellis, W. H., 1972, Clay products in Oklahoma: Oklahoma Geology Notes, v. 32, p. 157-168, 10 figs.

14. Bellis, W. H., 1972, Clay and shale products in Oklahoma [abstract]: Oklahoma Geology Notes, v. 32, p. 97-98.

Bennett, J. H., *see* Becker, V. J., Bennett, J. H., and Manuel, O. K.

Bennett, J. H., *see also* Collins, A. G., Bennett, J. H., and Manuel, O. K.

15. Benton, J. W., 1972, Subsurface stratigraphic analysis, Morrow (Pennsylvanian), north central Texas County, Oklahoma (part 1): Shale Shaker, v. 22, p. 192-204, 11 figs.

16. Benton, J. W., 1972, Subsurface stratigraphic analysis, Morrow (Pennsylvanian), north central Texas County, Oklahoma (part 2): Shale Shaker, v. 23, p. 4-19, 12 figs.

17. Benton, J. W., 1972, Subsurface stratigraphic analysis, Morrow (Pennsylvanian), north central Texas County, Oklahoma [abstract]: Oklahoma Geology Notes, v. 32, p. 22.

18. Berry, W. B. N., 1972, Early Ordovician bathyurid province lithofacies, biofacies, and correlations—their relationship to a proto-Atlantic Ocean: Lethaia, v. 5, p. 69-83, 3 figs. (Includes Arbuckle Mountains.)

Berryhill, H. L., Jr., *see* Dickinson, K. A., Berryhill, H. L., Jr., and Holmes, C. W.

19. Bittinger, M. W., 1972, Survey of interstate and international aquifer problems: Ground Water, v. 10, no 2, p. 44-54, 2 figs. (Includes Oklahoma aquifers.)

Blair, A. J., II, *see* Norden, J. A. E., Bedwell, J. L., Blair, A. J., II, Kaupp, C. B., III, Marchetti, J. W., Jr., and Markas, J. M.

20. Bleakley, W. B., 1972, Engineers hear about developments in improved oil-recovery techniques: Oil and Gas Journal, v. 70, no. 17 (April 24), p. 65-72, 9 figs., 1 table. (Bartlesville Sandstone, Nowata County.)

Bobick, T. G., *see* Irani, M. C., Thimons, E. D., Bobick, T. G., Deul, Maurice, and Zabetakis, M. G.

Bogard, D. D., *see* Wright, R. J., Reynolds, M. A., and Bogard, D. D.

Branson, C. C., *see* Johnson, K. S., Branson, C. C., Curtis, N. M., Jr., Ham, W. E., Marcher, M. V., and Roberts, J. F.

21. Breeze, A. F., 1971, Abnormal-subnormal pressure relationships in the Morrow sands of northwestern Oklahoma [abstract]: American Association of Petroleum Geologists Regional Meeting, Mid-Continent Section, Sept. 29-Oct. 1, 1972, technical program and convention calendar, p. 15-16. (Reprinted in Oklahoma Geology Notes, v. 32, p. 19.)

22. Breisch, R. L., 1972, Caves of gypsum karst: Oklahoma Underground, Central Oklahoma Grotto, v. 5, no. 1, p. 7-9.

23. Brown, B. C., 1972, Cement, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 267-293, 19 tables.

24. Burgess, W. J., 1968, Carbonate paleoenvironments in the Arbuckle Group West Spring Creek Formation, Lower Ordovician, in Oklahoma [abstract]: Oklahoma Geology Notes, v. 32, p. 54-55. (Reprinted from Dissertation Abstracts International, pt. B, v. 32, no. 1, p. 376-B.)

25. Camp, C. L., and others, 1972, Bibliography of fossil vertebrates, 1964-1968: Geological Society of America Memoir 134, 119 p.

Chase, E. B., *see* Rima, D. R., Chase, E. B., and Myers, B. M.

26. Chin, E., 1972, Magnesium, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 675-681, 7 tables.

27. Chin, E., 1972, Gallium, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 1216-1217.

28. Chow, T. J., and Earl, L. J., 1972, Lead isotopes in North American coals: Science, v. 176, no. 4034, p. 510-511, 1 fig., 1 table.

Clark, D. L., *see* Ethington, R. L., and Clark, D. L.

29. Clarke, R. G., 1972, Abrasive materials, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 153-164, 1 fig., 14 tables.

30. Cleaver, David, 1972, The Simpson Group, *in* Paleozoic geology of the Arbuckle Mountains, Oklahoma [guidebook]: Commerce, Texas, East Texas State University, Earth Science Department, p. 13-16.

31. Cohee, G. V., and Wright, W. B., 1971, Changes in stratigraphic nomenclature by the U.S. Geological Survey, 1971: U.S. Geological Survey Bulletin 1372-A, 28 p. (Includes Kessler Limestone Member of Bloyd Formation, Pennsylvanian.)

Cole, J. W., *see* Schroeder, H. J., and Cole, J. W.
Coleman, H. J., *see* Rall, H. T., Thompson, C. J., Coleman, H. J., and Hopkins, R. L.

32. Collier, F. J., 1971, Catalog of type specimens of invertebrate fossils: Conodonts: Smithsonian Contributions to Paleobiology, no. 8, 256 p., 1 fig.
33. Collins, A. G., Bennett, J. H., and Manuel, O. K., 1971, Iodine and algae in sedimentary rocks associated with iodine-rich brines: Geological Society of America Bulletin, v. 82, p. 2607-2610, 2 figs., 2 tables. (Includes Paleozoic specimens from Kingfisher County.)
34. Collinson, Charles, Rexroad, C. B., and Thompson, T. L., 1971, Conodont zonation of the North American Mississippian, *in* Sweet, W. C., and Bergstrom, S. M. (editors), Symposium on conodont biostratigraphy: Geological Society of America Memoir 127, p. 353-394, 8 figs., 1 table.
35. Connor, J. J., and Ebens, R. J., 1972, Geochemical variation in Pennsylvanian shale [abstract]: Geological Society of America Abstracts with Programs, v. 4, p. 314-315. (Includes data on Pennsylvanian rocks in Oklahoma. Reprinted in Oklahoma Geology Notes, v. 32, p. 125.)

Cope, R. F., *see* Glover, H. A., Atkins, R. L., Reece, B. B., Yee, B. Q., Grove, R. E., McUsic, J. M., and Cope, R. F.

36. Covington, M. D., 1972, Oil fields in Criner Hills area, south central Oklahoma, *in* Paleozoic geology of the Arbuckle Mountains, Oklahoma [guidebook]: Commerce, Texas, East Texas State University, Earth Science Department, p. 61-63, sketch map.
37. Cox, Ennis, 1972, Surface and reservoir control of injection water in the Hewitt Unit waterflood: Journal of Petroleum Technology, v. 24, p. 426-430, 8 figs., 1 table.
38. Crane, H. R., and Griffin, J. B., 1972, University of Michigan radiocarbon dates XV: Radiocarbon, v. 14, no. 1, p. 195-222. (Includes data on Spiro site, Oklahoma, p. 210.)

Creath, W. G., *see* Stehli, F. G., Creath, W. G., Upshaw, C. F., and Forgotson, J. M., Jr.

39. Crow, F. R., and Hottman, S. D., 1972, Network density of temperature profile stations and its influence on the accuracy of lake evaporation calculations [abstract no. 50]: American Geophysical Union Transactions, v. 53, p. 985. (Studies made at Lake Hefner, Oklahoma.)

Curtis, N. M., Jr., *see* Johnson, K. S., Branson, C. C., Curtis, N. M., Jr., Ham, W. E., Marcher, M. V., and Roberts, J. F.
Daly, Eleanor, *see* Olson, E. C., and Daly, Eleanor.

40. Dapples, E. C., 1972, Some concepts of cementation and lithification of sandstones: American Association of Petroleum Geologists Bulletin, v. 56, p. 3-25, 3 figs. (Includes Pontotoc Formation.)
41. Dation, Emen, 1972, Devil's Kitchen controversy, *in* Paleozoic geology of the Arbuckle Mountains, Oklahoma [guidebook]:

Commerce, Texas, East Texas State University, Earth Science Department, p. 94.

42. Davis, H. G., 1971 [1972], The Morrow-Springer trend, Anadarko basin, target for the 70's: Shale Shaker, v. 22, p. 64-73, 10 figs.

43. Davis, H. G., 1972, The Morrow-Springer trend, Anadarko basin: Mid-America Oil and Gas Reporter, v. 15, no. 2, p. 29-39, 10 figs.

44. Dawes, R. E., 1972, Gypsum, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 559-566, 9 tables.

45. Deas, Dorothy, and Sturdivant, Virginia, 1972, Petroleum aspects of southern Oklahoma, *in* Paleozoic geology of the Arbuckle Mountains, Oklahoma [guidebook]: Commerce, Texas, East Texas State University, Earth Science Department, p. 89-93, sketch map.

46. Deere, D. U., and Gamble, J. C., 1972, Durability-plasticity classification of shales and indurated clay, *in* Kellner, Rosemary, and Rose, W. D. (editors), Proceedings of the 22nd Annual Highway Geology Symposium: Oklahoma Highway Department, Oklahoma Geological Survey, p. 37-52, 6 figs., 1 table. (Includes sample analysis from McCurtain County, Oklahoma.)

Delevaux, M. H., *see* Doe, B. R., and Delevaux, M. H.

47. Derby, J. R., Lane, H. R., and Norford, B. S., 1972, Uppermost Cambrian-basal Ordovician faunal succession in Alberta and correlation with similar sequences in the western United States: International Geological Congress, 24th session, Section 7, Paleontology, p. 503-512. (Abstract in International Geological Congress, 24th session, Abstracts, p. 221. Refers to faunal sequences in southern Oklahoma.)

Deul, Maurice, *see* Irani, M. C., Thimons, E. D., Bobick, T. G., Deul, Maurice, and Zabetakis, M. G.

48. Dickinson, K. A., Berryhill, H. L., Jr., and Holmes, C. W., 1972, Criteria for recognizing ancient barrier coastlines, *in* Recognition of ancient sedimentary environments: Society of Economic Paleontologists and Mineralogists Special Publication 16, p. 192-214, 14 figs. (Includes Verden Sandstone.)

49. Docekal, Jerry, 1970, Earthquakes of the stable interior with emphasis on the Midcontinent. (Volume 1: Text. Volume 2: Catalogue) [abstract]: Oklahoma Geology Notes, v. 32, p. 58-59. (Reprinted from Dissertation Abstracts International, pt. B, v. 31, no. 8, p. 4777-B.)

50. Doe, B. R., and Delevaux, M. H., 1972, Source of lead in southeast Missouri galena ores: Economic Geology, v. 67, no. 4, p. 409-425, 8 figs., 6 tables. (Refers to Tri-State lead and zinc district.)

51. Doe, B. R., and Smith, D. K., 1972, Studies in mineralogy and Precambrian geology, a volume in honor of John W. Bruner: Geological Society of America Memoir 135, 348 p.

52. Donovan, T. J., 1971, Surface mineralogical and chemical evidence of buried hydrocarbons and the vertical migration of oil and gas, Cement field, Oklahoma [abstract]: American Association of Petroleum Geologists Regional Meeting, Mid-Continent Section, Sept. 29-Oct. 1, 1971, technical program and convention calendar, p. 11-12. (Reprinted in Oklahoma Geology Notes, v. 32, p. 18-19.)

53. Drake, H. J., 1972, Sand and gravel, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 991-1007, 11 tables.

54. Drake, H. J., 1972, Stone, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 1039-1057, 19 tables.

55. DuBois, R. L., and Wolfman, Daniel, 1972, Recent archeomagnetic results for the United States [abstract]: Geological Society of America Abstracts with Programs, v. 4, p. 277-278. (Reprinted in Oklahoma Geology Notes, v. 32, p. 126-127.)

DuBois, R. L., *see* Lawson, Jim, and DuBois, R. L.

Earl, J. L., *see* Chow, T. J., and Earl, J. L.

56. Easterling, Doris, 1972, The Arbuckle Group, *in* Paleozoic geology of the Arbuckle Mountains, Oklahoma [guidebook]: Commerce, Texas, East Texas State University, Earth Science Department, p. 10-12.

Ebens, R. J., *see* Connor, J. J., and Ebens, R. J.

Ehmann, W. D., *see* Santoliquido, P. M., and Ehmann, W. D.

57. Eidman, V., and Bekure, S., 1972, Irrigation development in the central basin of the Ogallala Formation—the past and the future: Oklahoma Current Farm Economics, v. 45, no. 1, p. 3-13, 1 fig., 7 tables.

58. Elkins, L. F., 1972, Uncertainty of oil in place in unconsolidated sand reservoirs—a case history: Journal of Petroleum Technology, v. 24, p. 1315-1319. (Oil Creek sand in Southeast Pauls Valley field.)

59. Engleman, Rolf, 1972, Comments on the Boktukola syncline and its setting in southeastern Oklahoma: Shale Shaker, v. 22, p. 128-142, 5 figs.

60. Ethington, R. L., and Clark, D. L., 1971, Lower Ordovician conodonts in North America, *in* Sweet, W. C., and Bergstrom, S. M. (editors), Symposium on conodont biostratigraphy: Geological Society of America Memoir 127, p. 63-82, 2 figs., 2 pls.

Ethington, R. L., *see* Sweet, W. C., Ethington, R. L., and Barnes, C. R.

Fanelli, L. L., *see* Harper, W. B., and Fanelli, L. L.

61. Fisher, W. L., 1971, Stratigraphic and geographic variation of population characteristics of fusulinids in the upper Hughes Creek Shale: University of Kansas M.S. thesis.

62. Fleury, M. G. R., 1972, The size distribution of quartz in mudrock [abstract]: Oklahoma Geology Notes, v. 32, p. 23.

63. Ford, Gary, 1972, Report on Back-Fire Cave: Oklahoma Underground, Central Oklahoma Grotto, v. 5, no. 1, p. 13-14.
Forgotson, J. M., Jr., *see* Stehli, F. G., Creath, W. G., Upshaw, C. F., and Forgotson, J. M., Jr.
64. Foster, P. H., 1972, Using long period earth potentials as strain indicators [abstract]: Geological Society of America Abstracts with Programs, v. 4, p. 279. (Includes recordings from Leonard Observatory, Leonard, Oklahoma. Reprinted in Oklahoma Geology Notes, v. 32, p. 127.)
65. Friedman, S. A., 1972, Coal exploration and development in Oklahoma [abstract]: Oklahoma Geology Notes, v. 32, p. 96-97.
66. Friedman, S. A., 1972, A new coal-investigations program in Oklahoma: Shale Shaker, v. 22, p. 152-156, 5 figs.
67. Friedman, S. A., 1972, A new program of coal investigations in Oklahoma [abstract]: Geological Society of America Abstracts with Programs, v. 4, p. 279-280. (Reprinted in Oklahoma Geology Notes, v. 32, p. 127-128.)
68. Frodesen, E. W., 1971, Petrology and correlation of the Chickasaw Creek Formation (Mississippian), Ouachita Mountains, Oklahoma: University of Wisconsin M.S. thesis.
69. Frohlich, R. K., 1972, Near vertical reflections from the upper mantle in the Midwest of the United States [abstract]: American Geophysical Union Transactions, v. 53, p. 1044, abstract S26. (Recordings taken at Tulsa.)
Gamble, J. C., *see* Deere, D. U., and Gamble, J. C.
70. Gary, Margaret, McAfee, Robert, Jr., and Wolf, C. L., (editors), 1972, Glossary of geology: American Geological Institute, Washington, D.C., 805 p. (plus bibliography, 52 p.).
71. Glover, H. A., Atkins, R. L., Reece, B. B., Yee, B. Q., Grove, R. E., McUsic, J. M., and Cope, R. F., 1971, Oklahoma oil and gas development 1970, *in* Production, *pt. 2 of* International oil and gas development: International Oil Scouts Association, v. 41, pt. 2, p. 300-384, 2 maps.
72. Golden, Julia, and Nitecki, M. H., 1972, Catalogue of type specimens of fossil brachiopods in Field Museum of Natural History: Fieldiana Geology, v. 25, 307 p.
73. Golden, Julia, and Nitecki, M. H., 1972, Catalogue of type and referred specimens of fossil Crinozoa (Eocrinidae, Paracrinidae and Crinoidea) in Field Museum of Natural History: Fieldiana Geology, v. 27, 266 p.
Goodwin, P. W., *see* Ravindra, S. T., and Goodwin, P. W.
74. Goss, D. W., Ross, A. R., Allen, P. B., and Naney, J. W., 1972, Geomorphology of the central Washita River basin: Oklahoma Academy of Science Proceedings, v. 52, p. 145-149, 3 figs., 1 table.
75. Green, Grace, 1972, The Hunton Group, *in* Paleozoic geology of the Arbuckle Mountains, Oklahoma [guidebook]: Commerce, Texas, East Texas State University, Earth Science Department, p. 21-26, illus.

76. Griesemer, A. D., 1972, Fossil assemblages and their distribution in the Ervine Creek Limestone (Late Pennsylvanian) of the Midcontinent [abstract]: Geological Society of America Abstracts with Programs, v. 4, p. 280. (Reprinted in Oklahoma Geology Notes, v. 32, p. 128.)

77. Griesemer, A. D., 1972, Paleoecology of the Ervine Creek Limestone (Late Pennsylvanian) in the Midcontinent region [abstract]: Oklahoma Geology Notes, v. 32, p. 59-60. (Reprinted from Dissertation Abstracts International, pt. B, v. 31, no. 8, p. 4778-B.)

Griffin, J. B., *see* Crane, H. R., and Griffin, J. B.

78. Griffith, C. E., 1972, Geologic history of the Criner Hills, southern Oklahoma, *in* Paleozoic geology of the Arbuckle Mountains, Oklahoma [guidebook]: Commerce, Texas, East Texas State University, Earth Science Department, p. 54-60, illus.

79. Griffith, C. E. (chairman), 1972, Paleozoic geology of the Arbuckle Mountains, Oklahoma [guidebook]: Commerce, Texas, East Texas State University, Earth Science Department, 105 p., illus. (incl. colored geologic map).

Grove, R. E., *see* Glover, H. A., Atkins, R. L., Reece, B. B., Yee, B. Q., Grove, R. E., McUsic, J. M., and Cope, R. F.

80. Gustavson, S. A., 1972, Clays, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 305-325, 15 tables.

81. Ham, W. E., and Rowland, T. L., 1971, Burial cementation in the Wapanucka Limestone (Pennsylvanian) of Oklahoma, *in* Carbonate cements: Johns Hopkins University Studies in Geology no. 19, p. 198-204, illus.

Ham, W. E., *see* Johnson, K. S., and Ham, W. E.

Ham, W. E., *see also* Johnson, K. S., Branson, C. C., Curtis, N. M., Jr., Ham, W. E., Marcher, M. V., and Roberts, J. F.

Ham, W. E., *see also* McMahan, A. B., and Ham, W. E.

82. Haney, F. R., 1972, Sycamore Limestone and Caney Shale, *in* Paleozoic geology of the Arbuckle Mountains, Oklahoma [guidebook]: Commerce, Texas, East Texas State University, Earth Science Department, p. 27-30.

83. Harlton, B. H., 1972, Faulted fold belts of southern Anadarko basin adjacent to frontal Wichitas: American Association of Petroleum Geologists Bulletin, v. 56, p. 1544-1551, 4 figs.

84. Harp, J. F., and Laguros, J. G., 1972, A dimensionless parameter study of groundwater recharge, phase II: Oklahoma University Research Institute PB-211 278, 33 p., 4 figs., 6 tables. (Available from National Technical Information Service. Includes data from 15 observation wells in Oklahoma.)

85. Harp, J. F., and Laguros, J. G., 1972, Dimensionless parameters in groundwater recharge: Oklahoma Academy of Science Proceedings, v. 52, p. 101-104, 1 fig., 3 tables.

86. Harper, W. B., and Fanelli, L. L., 1972, Natural gas, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 737-764, 14 tables.

87. Harper, W. B., and Fanelli, L. L., 1972, Natural gas liquids, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 765-782, 15 tables.

88. Harris, R. W., Jr., 1971, Palynology of the Sand Branch Member of the Caney Shale Formation (Mississippian) of southern Oklahoma: University of Oklahoma Ph.D. dissertation. (Abstract in Oklahoma Geology Notes, v. 32, p. 60-61. Reprinted from Dissertation Abstracts International, pt. B, v. 31, no. 11, p. 6694-6695B.)

89. Harvey, R. L., 1972, West Campbell (Northeast Cedardale) gas field, Major County, Oklahoma, *in* King, R. E. (editor), Stratigraphic oil and gas fields—Classification, exploration methods, and case histories: American Association of Petroleum Geologists Memoir 16 (Society of Exploration Geophysicists Special Publication 10), p. 568-579, 7 figs.

90. Hayes, C. J., 1972, Engineering classification of highway-geology problems in Oklahoma, *in* Kellner, Rosemary, and Rose, W. D. (editors), Proceedings of the 22nd Annual Highway Geology Symposium: Oklahoma Highway Department, Oklahoma Geological Survey, p. 8-21, 8 figs., 7 tables.

91. Heckel, P. H., 1972, Recognition of ancient shallow marine environments, *in* Recognition of ancient sedimentary environments: Society of Economic Paleontologists and Mineralogists Special Publication 16, p. 226-286, 15 figs. (Includes Pennsylvanian of Oklahoma.)

Heemstra, R. J., *see* Armstrong, F. E., and Heemstra, R. J.

92. Hefner, R. A., III, 1972, Natural gas and the deep Anadarko basin: Mid-America Oil and Gas Reporter, v. 14, no. 10, p. 27-31.

93. Henderson, B. C. (editor), 1972, Directory of geoscience departments: American Geological Institute, Washington, D.C., 220 p.

94. Hewett, D. F., 1972, Manganite, hausmannite, braunite: features, modes of origin: Economic Geology, v. 67, p. 83-102, 5 figs., 6 tables. (Includes Oklahoma deposits on p. 89.)

95. Heyl, A. V., 1972, The 38th parallel lineament and its relationship to ore deposits: Economic Geology, v. 67, p. 879-894. (Includes Tri-State mineral district.)

96. Hills, J. M., 1972, Late Paleozoic sedimentation in west Texas Permian Basin: American Association of Petroleum Geologists Bulletin, v. 56, p. 2303-2322, 13 figs. (Includes Oklahoma.)

97. Hogan, J. V., Jr., and Rose, W. D., 1972, Bibliography and index of Oklahoma geology, 1971: Oklahoma Geology Notes, v. 32, p. 27-49.

98. Holm, L. W., 1972, Oil saturation measurements in the Bartlesville sand after waterflooding and after propane flooding: Journal of Petroleum Technology, v. 24, p. 1411-1416, 10 figs., 3 tables.

Hopkins, R. L., *see* Rall, H. T., Thompson, C. J., Coleman, H. J., and Hopkins, R. L.

Hottman, S. D., *see* Crow, F. R., and Hottman, S. D.

Hunahashi, Mitsuo, *see* Kim, C. W., and Hunahashi, Mitsuo.

99. Iglehart, C. F., 1972, Oil and gas development 1971, *in* Exploration, *part 1 of* International oil and gas development: International Oil Scouts Association, v. 42, pt. 1, p. 436-455.

100. Irani, M. C., Thimons, E. D., Bobick, T. G., Deul, Maurice, and Zabetakis, M. G., 1972, Methane emission from U.S. coal mines, a survey: U.S. Bureau of Mines Information Circular 8558, 58 p., 12 figs.

101. Irwin, R. A., Tucker, C. W., and Schwartz, H. E., Jr., 1972, A case history of the Postle area—computer production control and reservoir simulation: Journal of Petroleum Technology, v. 24, p. 775-784, 3 figs., 2 tables.

102. James, G. W., and Baker, D. R., 1972, Organic geochemistry of a Pennsylvanian black shale (Excello) in the Midcontinent and the Illinois Basin, *in* Kellogg, J. A. (editor), Short papers on research in 1971: State Geological Survey of Kansas Bulletin 204, pt. 1, p. 3-10. (Includes Pennsylvanian of northeastern Oklahoma.)

Jeppesen, J. A., *see* West, R. R., Jeppesen, J. A., Pearce, R. W., and Twiss, P. C.

103. Johnson, K. S., 1972, Gypsum and salt resources in Oklahoma: Industrial Minerals, no. 62, p. 33-39, 9 figs., 3 tables.

104. Johnson, K. S., 1972, Gypsum and salt resources in Oklahoma [abstract]: Oklahoma Geology Notes, v. 32, p. 95-96.

105. Johnson, K. S., 1972, Northwest Oklahoma, *book 2 of* Guidebook for geologic field trips in Oklahoma: Oklahoma Geological Survey Educational Publication 3, 42 p., 54 figs.

106. Johnson, K. S., 1972, Preparation of non-technical guidebooks for conducting geologic field trips: 24th International Geological Congress, Section 17, Geological Education, p. 101-104. (Abstract in 24th Geological Congress Abstracts, p. 477.)

107. Johnson, K. S., Branson, C. C., Curtis, N. M., Jr., Ham, W. E., Marcher, M. V., and Roberts, J. F., 1972, Geology and earth resources of Oklahoma—an atlas of maps and cross sections: Oklahoma Geological Survey Educational Publication 1, 8 p. (Maps and cross sections of Oklahoma in color at a scale of 1:2,000,000.)

108. Johnson, K. S., and Ham, W. E., 1972, Permian copper-shale deposits of southwestern Oklahoma [abstract]: Geological Society of America Abstracts with Programs, v. 4, no. 7, p. 555.

109. Johnson, K. S., and Mankin, C. J., 1971 [1972], Geology of Oklahoma—a summary, *in* Proceedings of the 22nd Annual Highway Geology Symposium, p. 1-7, 6 figs.

Johnson, K. S., *see* Southard, L. G., Johnson, K. S., and Roberts, J. F.

Karvelot, M. D., *see* Shelton, J. W., Terrell, D. W., Karvelot, M. D., and Oklahoma State University Sedimentologic Study Group.

Kaupp, C. B., III, *see* Norden, J. A. E., Bedwell, J. L., Blair, A. J., II, Kaupp, C. B., III, Marchetti, J. W., Jr., and Markas, J. M.

110. Keller, G. R., 1972, A possible Paleozoic subduction zone along the Texas Gulf Coast interpreted from Rayleigh wave dispersion and gravity data [abstract]: American Geophysical Union Transactions, v. 53, p. 1144, abstract T4. (Concerns theory of origin of Ouachita system.)

111. Kellner, Rosemary, and Rose, W. D. (editors), 1972, Proceedings of the 22nd Annual Highway Geology Symposium: Oklahoma Highway Department, Oklahoma Geological Survey, 123 p., 74 figs., 14 tables. (Includes geology and engineering in Oklahoma.)

112. Kennedy, J. L., 1972, Record-shattering well went according to plan: Oil and Gas Journal, v. 70, no. 12 (March 20), p. 59-67, illus. (incl. ads). (Lone Star Producing Co. 1 Baden Unit, Beckham County, Oklahoma.)

113. Kennedy, Marie, 1972, A strange phenomenon: Lapidary Journal, v. 26, no. 1, p. 102, 104, 106, 108, illus. (Geodes and nodules from red beds of Oklahoma.)

114. Kidder, Gerald, and Reed, L. W., 1972, Swelling characteristics of hydroxy-aluminum interlayered clays: Clays and Clay Minerals, v. 20, p. 13-20, 4 figs., 4 tables. (Tests on Camargo bentonite.)

115. Kim, C. W., and Hunahashi, Mitsuo, 1972, Chronological aspects in granites: Lithos, v. 5, no. 3, p. 241-254. (Includes Tishomingo Granite.)

116. Kincheloe, R. L., and Painter, John, 1972, World's deepest well has record: World Oil, v. 174, no. 4 (March), p. 48-50, illus. (Lone Star Producing Co. 1 Baden Unit, Beckham County, Oklahoma.)

117. King, R. E. (editor), 1972, Stratigraphic oil and gas fields—Classification, exploration methods, and case histories: American Association of Petroleum Geologists Memoir 16 (Society of Exploration Geophysicists Special Publication 10), 720 p., 535 figs., 28 tables.

118. Kirby, J. G., and Moore, B. M., 1972, Crude petroleum and petroleum products, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 815-923, 60 tables.

Klapper, Gilbert, *see* Amsden, T. W., and Klapper, Gilbert.

Kumar, S., *see* Laguros, J. G., and Kumar, S.

119. Laguros, J. G., and Kumar, S., 1972, Predictability of shale behavior, *in* Kellner, Rosemary, and Rose, W. D. (editors), Proceedings of the 22nd Annual Highway Geology Symposium: Oklahoma Highway Department, Oklahoma Geological Survey, p. 22-36, 9 figs., 1 table. (Applications in Oklahoma.)

Laguros, J. G., *see* Harp, J. F., and Laguros, J. G.

120. Lane, H. R., Merrill, G. K., Straka, J. J., II, and Webster, G. D., 1971, North American Pennsylvanian conodont biostratigraphy, *in* Sweet, W. C., and Bergstrom, S. M. (editors), Symposium on conodont biostratigraphy: Geological Society of America Memoir 127, p. 395-414, 4 figs., 1 pl.

Lane, H. R., *see* Derby, J. R., Lane, H. R., and Norford, B. S.

121. Lanier, Robert, 1972, Timbered Hills Group, Colbert rhyolite porphyry, *in* Paleozoic geology of the Arbuckle Mountains, Oklahoma [guidebook]: Commerce, Texas, East Texas State University, Earth Science Department, p. 6-9, illus.

122. Lara, J. M., 1971, The Altus Reservoir sediment survey: U.S. Bureau of Reclamation Research Center Report REC-ERC-71-21, March 1971, 41 p., 52 figs., 4 tables.

123. Lawson, Jim, and DuBois, R. L., 1972, Amchitka blast recorded at OU's Leonard Observatory: Oklahoma Geology Notes, v. 32, p. 11-15, 3 figs.

124. Lee, M. J., 1972, Clay mineralogy of Havensville Shale [abstract]: Geological Society of America Abstracts with Programs, v. 4, p. 283-284. (Reprinted in Oklahoma Geology Notes, v. 32, p. 128-129.)

125. Levings, G. W., 1972, A groundwater reconnaissance study of the upper Sugar Creek watershed, Caddo County, Oklahoma [abstract]: Oklahoma Geology Notes, v. 32, p. 20.

126. Lintz, Joseph, Jr., 1972, Remote sensing for petroleum: American Association of Petroleum Geologists Bulletin, v. 56, p. 542-553. (Examples from Oklahoma.)

Linville, Bill, *see* Spencer, J. D., and Linville, Bill.

127. Lochman-Balk, Christina, 1971, Cambrian of the craton of the United States, *in* Holland, C. H. (editor), Cambrian of the New World, *v. 1 of* Lower Paleozoic rocks of the world: New York, John Wiley and Sons, 456 p., numerous figs.

128. Lockwood, M. G., 1972, An ecoevaluation of the Francis Formation near Ada, Oklahoma, through cluster analysis [abstract]: Geological Society of America Abstracts with Programs, v. 4, p. 284-285. (Reprinted in Oklahoma Geology Notes, v. 32, p. 129.)

129. Loeblich, A. R., Jr., and Tappan, Helen, 1971, Two new Orthosphaeridium (Acritarcha) from the Middle and Upper Ordovician: American Microsc. Society Transactions, v. 90, p. 182-188, illus. (Two new species from Oklahoma and Indiana.)

Loeblich, A. R., Jr., *see* Tappan, Helen.

130. Looney, J. M., 1970, Two caves in one; the Duncan field system, Oklahoma [abstract]: National Speleological Society Bulletin, v. 32, no., 2, p. 42.

131. Looney, J. M., 1972, Lake Eucha caves: Oklahoma Underground, Central Oklahoma Grotto, v. 5, no. 1, p. 22-26.

132. Lyon, G. M., 1971, Subsurface stratigraphic analysis, lower "Cherokee" Group (Pennsylvanian), portions of Alfalfa,

Major and Woods Counties, Oklahoma: University of Oklahoma M.S. thesis.

McAfee, Robert, Jr., *see* Gary, Margaret, McAfee, Robert, Jr., and Wolf, C. L.

133. McMahan, A. B., and Ham, W. E., 1970, The mineral industry of Oklahoma, *in* Area reports: domestic, *v. 3 of* Minerals yearbook 1968: U.S. Bureau of Mines, p. 597-613, 22 tables.

134. McMahan, A. B., and Ham, W. E., 1971, The mineral industry of Oklahoma, *in* Area reports: domestic, *v. 3 of* Minerals yearbook 1969: U.S. Bureau of Mines, p. 599-617, 19 tables.

135. McMahon, A. D., 1972, Zinc, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 1175-1204, 36 tables.

136. MacMillan, R. T., 1972, Salt, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 981-990, 15 tables.

McUsic, J. M., *see* Glover, H. A., Atkins, R. L., Reece, B. B., Yee, B. Q., Grove, R. E., McUsic, J. M., and Cope, R. F.

137. Manger, W. L., 1972, The stratigraphy of the Hale Formation (Morrowan) in its type region, northwestern Arkansas [abstract]: Oklahoma Geology Notes, v. 32, p. 132-133. (Reprinted from Dissertation Abstracts International, pt. B, v. 32, no. 9, p. 5258-B.)

138. Mankin, C. J., 1972, A challenge to Oklahoma's minerals industry: Oklahoma Geology Notes, v. 32, p. 71-72.

139. Mankin, C. J., 1972, Oklahoma Geological Survey, annual report, July 1, 1971-June 30, 1972: Oklahoma Geology Notes, v. 32, p. 139-147.

Mankin, C. J., *see* Johnson, K. S., and Mankin, C. J.

Manuel, O. K., *see* Becker, V. J., Bennett, J. H., and Manuel, O. K.

Marcher, M. V., *see* Johnson, K. S., Branson, C. C., Curtis, N. M., Jr., Ham, W. E., Marcher, M. V., and Roberts, J. F.

Marchetti, J. W., Jr., *see* Norden, J. A. E., Bedwell, J. L., Blair, A. J., II, Kaupp, C. B., III, Marchetti, J. W., Jr., and Markas, J. M.

140. Mellen, F. F., 1972, Regional Paleozoic stratigraphy in Mississippi between Ouachita and Appalachian Mountains [discussion]: American Association of Petroleum Geologists Bulletin, v. 56, p. 2457-2458.

Merrill, G. K., *see* Lane, H. R., Merrill, G. K., Straka, J. J., II, and Webster, G. D.

Meyers, T. L., *see* Zanier, A. M., Timko, D. J., and Meyers, T. L.

141. Miller, J. F., 1971, Conodont evolution and biostratigraphy of the Upper Cambrian and lowest Ordovician (Texas, Oklahoma, Nevada and Utah): University of Wisconsin Ph.D. dissertation.

142. Monlux, A. W., Schoeppel, R. J., Pearson, C. C., and Waller, G. R., 1971, The effect of oil field pollutants on vegetation

and farm animals: Journal of American Veterinary Medical Association, v. 158, p. 1379-1390.

Moore, B. M., *see* Kirby, J. G., and Moore, B. M.

143. Moore, R. C., and others (editors), 1971, Mollusca 6—Bivalvia, *v. 3 of part N of* Treatise on invertebrate paleontology: Geological Society of America and University of Kansas, p. *N*953-*N*1224, illus.

144. Moore, R. L., 1972, Ground-water levels in observation wells in Oklahoma, 1969-70: U.S. Geological Survey Open-File Report, prepared in cooperation with Oklahoma Water Resources Board, 85 p., 2 figs., 2 tables.

145. Morris, R. C., 1972, Carboniferous rocks of the Ouachita Mountains, Arkansas—a flysch facies [abstract]: Geological Society of America Abstracts with Programs, v. 4, no. 2, p. 95. (Reprinted in Oklahoma Geology Notes, v. 32, p. 53-54.)

146. Moulds, D. E., 1972, Lead, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook: U.S. Bureau of Mines, p. 637-665, 31 tables.

147. Mullens, M. C., and Roberts, A. E., 1972, Selected annotated bibliography on asphalt-bearing rock of the United States and Canada, to 1970: U.S. Geological Survey Bulletin 1352, 218 p., 5 figs., 1 table. (Includes references and abstracts on Oklahoma asphalt.)

148. Murphy, R. P., and Owens, W. W., 1972, a new approach for low-resistivity sand log analysis: Journal of Petroleum Technology, v. 24, p. 1302-1306, 5 figs., 2 tables. (Includes Bromide sand, Oklahoma.)

149. Murray, C. R., and Reeves, E. B., 1972, Estimated use of water in the United States in 1970: U.S. Geological Survey Circular 676, 37 p., 12 figs., 18 tables.

Myers, B. M., *see* Rima, D. R., Chase, E. B., and Myers, B. M.

Naney, J. W., *see* Goss, D. W., Ross, A. R., Allen, P. B., and Naney, J. W.

150. Nedland, D. E., 1971, Stratigraphy of the Chickasaw Creek Formation, upper Stanley Group (Mississippian), central Ouachita Mountains, Oklahoma: University of Wisconsin M.S. thesis.

151. Newton, G. B., 1972, The Rhabdomesidae of the Wreford megacyclothem (Wolfcampian, Permian) of Nebraska, Kansas, and Oklahoma [abstract]: Oklahoma Geology Notes, v. 32, p. 56-57. (Reprinted from Dissertation Abstracts International, p. B, v. 32, no. 1, p. 380-B.)

152. Nicks, A. D., 1971, Agriculture research service precipitation facilities and related studies: Chickasha, Oklahoma: Agricultural Research Service Report 41-176, p. 71-81, 5 figs., 2 tables.

Nicoll, R. S., *see* Rexroad, C. B., and Nicoll, R. S.

153. Nieberding, Velma, 1972, Old Peoria: a mother of mining camps: Chronicles of Oklahoma, v. 50, p. 142-155.

154. Niem, A. R., 1972, Patterns of flysch deposition of lower Stan-

ley Group (Mississippian), Ouachita Mountains, Oklahoma and Arkansas [abstract]: American Association of Petroleum Geologists Bulletin, v. 56, p. 642. (Reprinted in Oklahoma Geology Notes, v. 32, p. 98.)

155. Niem, A. R., 1972, Stratigraphy and origin of tuffs in the Stanley Group (Mississippian), Ouachita Mountains, Oklahoma and Arkansas [abstract]: Oklahoma Geology Notes, v. 32, p. 63. (Reprinted from Dissertation Abstracts International, pt. B, v. 32, no. 7, p. 4013-B.)

Nitecki, M. H., *see* Golden, Julia, and Nitecki, M. H.

Noltimier, H. C., *see* Spall, Henry, and Noltimier, H. C.

156. Norden, J. A. E., Bedwell, J. L., Blair, A. J., II, Kaupp, C. B., III, Marchetti, J. W., Jr., and Markas, J. M., 1972, Vertical-intensity magnetic map of McClain and southern Cleveland Counties, central Oklahoma: Oklahoma Geological Survey Map GM-16, scale 1:63,360.

Norford, B. S., *see* Derby, J. R., Lane, H. R., and Norford, B. S.

157. Norris, F. A., 1972, Evaluation of salt water disposal into potential ground-water resources: Oklahoma Corporation Commission, Oklahoma City, Environmental Protection Agency Water Pollution Control Research Series, Feb. 1972, 18 p., 1 fig., 1 table.

Offield, T. W., *see* Watson, Kenneth, Rowan, L. C., and Offield, T. W.

158. Oil and Gas Journal, 1972, Historic Oklahoma test bests 30,000 ft: Oil and Gas Journal, v. 70, no. 10 (March 6), p. 68-69, 1 photo. (Lone Star Producing Co. 1 Baden Unit, Beckham County, Oklahoma.)

159. Oklahoma State Department of Health, 1969, Rules and regulations governing the operation of water pollution control facilities, 5 p., 1 table.

Oklahoma State University Sedimentologic Study Group, *see* Shelton, J. W., Terrell, D. W., Karvelot, M. D., and Oklahoma State University Sedimentologic Study Group.

160. Oklahoma Underground, 1972. Christian School study cave: Oklahoma Underground, Central Oklahoma Grotto, v. 5, no. 1, p. 1-21, 1 map.

161. Oklahoma Water Resources Board, 1972, Appraisal of the water and related land resources of Oklahoma—Region Ten: Oklahoma Water Resources Board Publication 40, 137 p., illus.

162. Oklahoma Water Resources Board, 1972, Behind Oklahoma's water: Oklahoma Water Resources Board, 1972 annual report, 35 p., 29 figs.

163. Olson, E. C., 1972, *Fayella chickashaensis*, the Dissorophoidea and the Permian radiations: Journal of Paleontology, v. 46, p. 104-114, 4 figs., 1 pl.

164. Olson, E. C., 1972, *Diplocaulus parvus* n. sp. (Amphibia: Nectridea) from the Chickasha Formation (Permian: Guadalupian) of Oklahoma: Journal of Paleontology, v. 46, p. 656-659, 3 figs.

165. Olson, E. C., and Daly, Eleanor, 1972, Notes on *Gnathorhiza* (Osteichthyes, Dipnoi): Journal of Paleontology, v. 46, p. 371-376, 3 figs., 1 pl. (Includes specimens from the Hennessey Formation.)

Owens, W. W., *see* Murphy, R. P., and Owens, W. W.

166. Padgett, Ward, 1972, Sixty-third annual report, Department of Mines, Chief Mine Inspector, year ending December 31, 1971: Oklahoma Department of Mines, 71 p.

Painter, John, *see* Kincheloe, R. L., and Painter, John.

167. Parsley, Ronald, 1972, The Belemnocystitidae: Solutan homeomorphs of the Anomalocystitidae: Journal of Paleontology, v. 46, p. 341-347, 1 fig., 1 pl. (Includes species from Bromide Formation.)

168. Pashuck, R. J., 1972, Geologic history of the Arbuckles, *in* Paleozoic geology of the Arbuckle Mountains, Oklahoma [guidebook]: Commerce, Texas, East Texas State University, Earth Sciences Department, p. 3-5.

169. Pashuck, R. J., 1972, Regional setting and history of the Pennsylvanian System in the Ardmore basin, *in* Paleozoic geology of the Arbuckle Mountains, Oklahoma [guidebook]: Commerce, Texas, East Texas State University, Earth Science Department, p. 80-88, sketch map.

170. Patrick, D. M., 1972, Alteration of Tertiary volcanic ash, western Oklahoma [abstract]: Geological Society of America Abstracts with Programs, v. 4, no. 7, p. 622.

171. Patrick, D. M., 1972, Alteration zones in volcanic glass: Oklahoma Geology Notes, v. 32, p. 26.

Pearce, R. W., *see* West, R. R., Jeppesen, J. A., Pearce, R. W., and Twiss, P. C.

172. Peebler, R. P., 1972, Formation evaluation with logs in the deep Anadarko basin: Mid-America Oil and Gas Reporter, v. 15, no. 8, p. 60.

173. Pittman, E. D., 1972, Diagenesis of quartz in sandstones as revealed by scanning electron microscopy: Journal of Sedimentary Petrology, v. 42, p. 507-519, 8 figs. (Specimens from Oklahoma.)

174. Rall, H. T., Thompson, C. J., Coleman, H. J., and Hopkins, R. L., 1972, Sulfur compounds in crude oil: U.S. Bureau of Mines Bulletin 659, 187 p., 99 figs., 49 tables. (Includes data on samples from Velma field.)

175. Rascoe, Bailey, Jr., 1972, Late Mississippian epeirogeny and the Wichita orogeny in the Mid-Continent [abstract]: American Association of Petroleum Geologists Bulletin, v. 56, p. 646-647. (Reprinted in Oklahoma Geology Notes, v. 32, p. 99-100.)

176. Ravindra, S. T., and Goodwin, P. W., 1972, Lower Ordovician conodonts from the Stonehenge Formation of Pennsylvania and Maryland [abstract]: Geological Society of America Abstracts with Programs, v. 4, p. 352-353. (Reprinted in Oklahoma Geology Notes, v. 32, p. 126. Correlation with Oklahoma deposits.)

Reece, B. B., *see* Glover, H. A., Atkins, R. L., Reece, B. B., Yee, B. Q., Grove, R. E., McUsic, J. M., and Cope, R. F.

177. Reed, A. H., 1972, Lime, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970, U.S. Bureau of Mines, p. 667-674, 9 tables.

Reed, L. W., *see* Kidder, Gerald, and Reed, L. W.

178. Reeder, L. R., 1972, Feasibility of underground waste disposal in northeastern Oklahoma [abstract]: Geological Society of America Abstracts with Programs, v. 4, p. 289-290. (Reprinted in Oklahoma Geology Notes, v. 32, p. 130.)

Reeves, E. B., *see* Murray, C. R., and Reeves, E. B.

179. Rexroad, C. B., and Nicoll, R. S., 1971, Summary of conodont biostratigraphy of the Silurian system of North America, *in* Sweet, W. C., and Bergstrom, S. M. (editors), Symposium on conodont biostratigraphy: Geological Society of America Memoir 127, p. 207-225, 2 figs., 2 pls.

Rexroad, C. B., *see* Collinson, Charles, Rexroad, C. B., and Thompson, T. L.

Reynolds, M. A., *see* Wright, R. J., Reynolds, M. A., and Bogard, D. D.

180. Ridge, J. D., 1972, Annotated bibliographies of mineral deposits in the Western Hemisphere: Geological Society of America Memoir 131, 681 p. (Includes references on Tri-State area.)

181. Riding, Robert, and Toomey, D. F., 1972, The sedimentological role of *Epiphyton* and *Renalcis* in Lower Ordovician mounds, southern Oklahoma: Journal of Paleontology, v. 46, p. 509-519, 3 figs., 2 pls.

182. Rima, D. R., Chase, E. B., and Myers, B. M., 1971, Subsurface waste disposal by means of wells—A selective annotated bibliography: U.S. Geological Survey Water-Supply Paper 2020, 305 p. (References to Oklahoma injection units, injection wells, etc.)

Roberts, A. E., *see* Mullens, M. C., and Roberts, A. E.

183. Roberts, J. F., 1972, Statistics of Oklahoma's petroleum industry, 1971: Oklahoma Geology Notes, v. 32, p. 103-110, 4 figs., 4 tables.

Roberts, J. F., *see* Johnson, K. S., Branson, C. C., Curtis, N. M., Jr., Ham, W. E., Marcher, M. V., and Roberts, J. F.

Roberts, J. F., *see also* Southard, L. G., Johnson, K. S., and Roberts, J. F.

184. Rock Products, 1972, Cement: shipments from mills may set new record: Rock Products, v. 75, no. 12, p. 54-57. (Includes data on Oklahoma Cement Co. at Pryor.)

Rose, W. D., *see* Hogan, J. V., Jr., and Rose, W. D.

Rose, W. D., *see also* Kellner, Rosemary, and Rose, W. D.

Ross, A. R., *see* Goss, D. W., Ross, A. R., Allen, P. B., and Naney, J. W.

185. Ross, J. S., 1972, Geology of central Payne County, Oklahoma [abstract]: Oklahoma Geology Notes, v. 32, p. 21.

Rowan, L. C., *see* Watson, Kenneth, Rowan, L. C., and Offield, T. W.

Rowan, L. C., *see also* Watson, R. D., and Rowan, L. C.

186. Rowland, T. L., 1972, St. Clair Lime Company expands Marble City facility: Oklahoma Geology Notes, v. 32, p. 67-70, 2 figs.

187. Rowland, T. L., 1972, General survey of carbonate mineral deposits in Oklahoma: Oklahoma Geology Notes, v. 32, p. 73-89, 13 figs., 1 table.

188. Rowland, T. L., 1972, Chemical and physical properties of selected Oklahoma crushed-stone products: Oklahoma Geology Notes, v. 32, p. 151-155, 1 fig., 1 table.

Rowland, T. L., *see* Ham, W. E., and Rowland, T. L.

189. Russell, J. L., 1972, Distribution of several lithologies in late Paleozoic sedimentary rocks of the northern Midcontinent [abstract]: Geological Society of America Abstracts with Programs, v. 4, p. 293-294. (Reprinted in Oklahoma Geology Notes, v. 32, p. 130-131.)

190. Santoliquido, P. M., and Ehmann, W. D., 1972, Bismuth in stony meteorites and standard rocks: Geochimica et Cosmochimica Acta, v. 36, p. 897-902, 3 tables. (Data on Lost City meteorite.)

191. Saunders, W. B., 1972, Upper Mississippian (Chesterian) ammonoids from the Imo and Rhoda Creek Formations, Arkansas and Oklahoma [abstract]: Oklahoma Geology Notes, v. 32, p. 57-58. (Reprinted from Dissertation Abstracts International, pt. B, v. 32, no. 3, p. 1737-B.)

192. Sawyerr, O. A., 1972, Subsurface stratigraphic analysis, lower Hoxbar Group (Pennsylvanian), Dutton-Verden-Norge trend, Caddo and Grady Counties, Oklahoma: Shale Shaker, v. 23, p. 72-97.

193. Sawyerr, O. A., 1972, Subsurface stratigraphic analysis, lower Hoxbar Group (Pennsylvanian), Dutton-Verden-Norge trend, Caddo and Grady Counties, Oklahoma [abstract]: Oklahoma Geology Notes, v. 32, p. 62.

194. Schroeder, H. J., and Cole, J. W., 1972, Copper, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 467-500, 47 tables.

Schwartz, H. E., Jr., *see* Irwin, R. A., Tucker, C. W., and Schwartz, H. E., Jr.

195. Schwarzer, T. F., and Adams, J. A. S., 1972, Rock and soil discrimination by low altitude airborne gamma-ray spectrometry in Payne County, Oklahoma [abstract]: Geological Society of America Abstracts with Programs, v. 4, no. 7, p. 658.

196. Scott, R. W., 1972, Molluscan diversity gradients and biomes in late Albian (Cretaceous) Gulf Coast province [abstract]: Geological Society of America Abstracts with Programs, v. 4, p. 295. (Reprinted in Oklahoma Geology Notes, v. 32, p. 131.)

197. Sewell, C. R., 1972, Metallic mineral occurrences in Oklahoma [abstract]: Oklahoma Geology Notes, v. 32, p. 95.
198. Shakely, S. F., 1970, Petroleum pollution abatement: Oklahoma Academy of Science Proceedings, v. 50, p. 155-158. (From Oklahoma Corporation Commission.)
199. Shelton, J. W., 1972, Correlation sections and log maps in determination of sandstone trends: American Association of Petroleum Geologists Bulletin, v. 56, p. 1541-1544, 3 figs. (Contains information on Bartlesville Sandstone.)
200. Shelton, J. W., Terrell, D. W., Karvelot, M. D., and Oklahoma State University Sedimentologic Study Group, 1972, Genesis and geometry of sandstones: Oklahoma City Geological Society, 66 p., 105 figs.
201. Sheridan, E. T., 1972, Coke and coal chemicals, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 423-455, 45 tables.
Smith, D. K., *see* Doe, B. R., and Smith, D. K.
202. Smith, R. B., 1972, Carbon black, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 255-265, 11 tables.
203. Soffel, H., 1972, Possibility of paleomagnetic measurements on Precambrian rocks: Geologisches Rundschau, v. 61, no. 1, p. 16-33. (Abstract in Petroleum Abstracts, v. 12, no. 49, p. 2069. Includes Wichita Mountains.)
204. Southard, L. G., 1972, The mineral industry of Oklahoma in 1971 (preliminary): Oklahoma Geology Notes, v. 32, p. 3-4, 1 table.
205. Southard, L. G., Johnson, K. S., and Roberts, J. F., 1972, The mineral industry of Oklahoma, *in* Area reports: domestic, *v. 2 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 569-584, 13 tables.
206. Spall, Henry, and Noltimier, H. C., 1972, Some curious magnetic results from a Precambrian granite: Astronomical Society Geophysical Journal, v. 28, no. 3, p. 237-248, illus. (Abstract in EOS American Geophysical Union Transactions, v. 52, no. 11, p. 822, 1971.)
207. Spencer, J. D., and Linville, Bill, 1972, Bureau of Mines energy program, 1971: U.S. Bureau of Mines Information Circular 8551, 102 p.
208. Squires, R. L., 1972, Paleoecology, biostratigraphy, and faunal chemistry of a Pennsylvanian age asphaltic limestone, Arbuckle Mountains, Oklahoma [abstract]: Geological Society of America Abstracts with Programs, v. 4, no. 7, p. 675.
209. Stehli, F. G., Creath, W. G., Upshaw, C. F., and Forgotson, J. M., Jr., 1972, Depositional history of Gulfian Cretaceous: American Association of Petroleum Geologists Bulletin, v. 56, p. 38-67. (Includes part of southeastern Oklahoma.)
210. Steinmetz, Richard, 1972, Sedimentation of an Arkansas River sand bar in Oklahoma: a cautionary note on dipmeter interpretation: Shale Shaker, v. 23, p. 32-38, 16 figs.

211. Straka, J. J., II, 1972, Conodont evidence of age of Goddard and Springer Formations, Ardmore basin, Oklahoma: American Association of Petroleum Geologists Bulletin, v. 56, p. 1087-1099, 4 figs.

Straka, J. J., II, *see* Lane, H. R., Merrill, G. K., Straka, J. J., II, and Webster, G. D.

212. Strimple, H. L., 1972, The genus *Parazophocrinus* from the Henryhouse Formation (Silurian), Pontotoc County, Oklahoma: Oklahoma Geology Notes, v. 32, p. 119-121, 1 fig.

213. Strimple, H. L., 1972, Crinoids of the Savanna Formation (Pennsylvanian) Wagoner County, Oklahoma: Oklahoma Geology Notes, v. 32, p. 147-148, 1 fig.

214. Strimple, H. L., 1972, Occurrence of *Tundracrinus* in Oklahoma: Journal of Paleontology, v. 46, p. 598-599, 1 fig.

215. Strimple, H. L., 1972, Porosity of a fossil crinoid ossicle: Journal of Paleontology, v. 46, p. 920-921, 2 figs. (A crinoid from Dewey Limestone, Oklahoma.)

Sturdivant, Virginia, *see* Deas, Dorothy, and Sturdivant, Virginia.

216. Sturdivant, V. L., 1972, Pennsylvanian conglomerates of the Arbuckle Mountains, Oklahoma, *in* Paleozoic geology of the Arbuckle Mountains, Oklahoma [guidebook]: Commerce, Texas, East Texas State University, Earth Sciences Department, p. 31-36, illus.

217. Sweet, W. C., Ethington, R. L., and Barnes, C. R., 1971, North American Middle and Upper Ordovician conodont faunas, *in* Sweet, W. C., and Bergstrom, S. M. (editors), Symposium on conodont biostratigraphy: Geological Society of America Memoir 127, p. 163-193, 3 figs., 2 pls.

218. Tanaka, H. H., 1972, Geohydrology of the lower Verdigris River valley between Muskogee and Catoosa, Oklahoma: U.S. Geological Survey Water-Supply Paper 1999-A, 23 p., 4 figs., 2 pls., 5 tables.

219. Tappan, Helen, and Loeblich, A. R., Jr., 1971, Surface sculpture of the wall in Lower Paleozoic acritarchs: Micropaleontology, v. 17, p. 385-410, 11 pls. (Ordovician and Silurian acritarchs from Oklahoma.)

Tappan, Helen, *see* Loeblich, A. R., Jr., and Tappan, Helen.

220. Taylor, J. D., 1972, Upper Mississippian (Chesteran) ammonoids from the Pitkin Formation in Arkansas [abstract]: Oklahoma Geology Notes, v. 32, p. 133. (Reprinted from Dissertation Abstracts International, pt. B, v. 32, no. 12, p. 7120-B.)

Terrell, D. W., *see* Shelton, J. W., Terrell, D. W., Karvelot, M. D., and Oklahoma State University Sedimentologic Study Group.

Thimons, E. D., *see* Irani, M. C., Thimons, E. D., Bobick, T. G., Deul, Maurice, and Zabetakis, M. G.

221. Thomas, W. A., 1972, Regional Paleozoic stratigraphy in Mississippi between Ouachita and Appalachian Mountains:

American Association of Petroleum Geologists Bulletin, v. 56, p. 81-106, 14 figs., 5 tables.

222. Thomas, W. A., 1972, [Regional Paleozoic stratigraphy in Mississippi between Ouachita and Appalachian Mountains] Reply [to Frederic F. Mellen]: American Association of Petroleum Geologists Bulletin, v. 56, p. 2459-2460.

223. Thomasson, E. M., 1972, Helium, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 567-570, 7 tables.

Thompson, C. J., *see* Rall, H. T., Thompson, C. J., Coleman, H. J., and Hopkins, R. L.

224. Thompson, T. L., 1972, Conodont biostratigraphy of Chesterian strata in southwestern Missouri: Missouri Geological Survey and Water Resources Report of Investigations 50, 49 p., 5 figs., 1 pl. (Includes correlations with Oklahoma Goddard and Caney Shales.)

Thomson, F. J., *see* Vincent, R. K., and Thomson, F. J.

Thomson, Fred, *see* Vincent, R. K., and Thomson, Fred.

Timko, D. J., *see* Zanier, A. M., and Timko, D. J.

Timko, D. J., *see also* Zanier, A. M., Timko, D. J., and Meyers, T. L.

225. Toetz, D. W., 1972, Observations on the nitrogen-fixing potential of the plankton of two farm ponds: American Midland Naturalist, v. 87, p. 555-559, 3 tables. (Two farm ponds in central Oklahoma.)

226. Toomey, D. F., 1972, The biota of the Pennsylvanian (Virgilian) Leavenworth Limestone, Midcontinent region. Part 3: distribution of calcareous Foraminifera: Journal of Paleontology, v. 46, p. 276-298, 5 figs., 4 pls. (Includes Oklahoma specimens.)

Toomey, D. F., *see* Riding, Robert, and Toomey, D. F.

Tucker, C. W., *see* Irwin, R. A., Tucker, C. W., and Schwartz, H. E., Jr.

Twiss, P. C., *see* West, R. R., Jeppesen, J. A., Pearce, R. W., and Twiss, P. C.

Upshaw, C. F., *see* Stehli, F. G., Creath, W. G., Upshaw, C. F., and Forgotson, J. M., Jr.

227. U.S. Board on Geographic Names, 1972, Decisions on geographic names in the United States, January through March 1972, Decision List no. 7201: U.S. Department of the Interior, 32 p. (Names and defines numerous Oklahoma lakes.)

228. U.S. Board on Geographic Names, 1972, Decisions on geographic names in the United States, April through June 1972, Decision List no. 7202: U.S. Department of the Interior, 32 p. (Names and defines Cunneo Tubby Creek, Latimer County, and Gilbert Creek, Harper County.)

229. U.S. Bureau of Mines, 1972, Analyses of tipple and delivered samples of coal, collected during fiscal year 1971: U.S. Bureau of Mines Report of Investigations 7588, 20 p., 1 table.

230. U.S. Geological Survey, 1971, Ground-water levels in the United States 1965-69, South-central states: U.S. Geological Survey Water-Supply Paper 1979, 158 p., 5 figs.
231. U.S. Geological Survey, 1972, Bibliography of North American geology, 1969: U.S. Geological Survey Bulletin 1269, 1434 p.
232. U.S. Geological Survey, 1972, Lower Mississippi River basin and western Gulf of Mexico basins, *parts 7, 8 of* Quality of surface waters of the United States, 1967: U.S. Geological Survey Water-Supply Paper 2014, 814 p., 1 fig.
233. Vincent, R. K., and Thomson, F. J., 1971, Discrimination of basic silicate rocks by recognition maps processed from aerial infrared data, *in* International Symposium on Remote Sensing of Environment, 7th: Ann Arbor, Michigan, Willow Run Laboratory, Proceedings, v. 1, p. 247-252, illus. (Includes Mill Creek, Oklahoma.)
234. Vincent, R. K., and Thomson, Fred, 1972, Spectral compositional imaging of silicate rocks: Journal of Geophysical Research, v. 77, p. 2465-2472, 4 figs., 1 table. (Experimental ratios measured for a sand quarry near Mill Creek, Oklahoma.)
235. Vincent, R. K., and Thomson, Fred, 1972, Recognition of exposed quartz sand and sandstone by two-channel infrared imagery: Journal of Geophysical Research, v. 77, p. 2473-2477, 3 figs. (Results of flight of infrared detector over a sand quarry near Mill Creek, Oklahoma.)
236. von Almen, W. F., 1970, Miospores from Devonian-Mississippian boundary, Carter County, Oklahoma, U.S.A., *in* Colloque sur stratigraphie du carbonifère: Liège Univ. Colloq., v. 55, p. 423-427, illus.
237. von Almen, W. F., 1972, Palynomorphs of the Woodford Shale of south central Oklahoma with observations on their significance in zonation and paleoecology [abstract]: Oklahoma Geology Notes, v. 32, p. 55-56. (Reprinted from Dissertation Abstracts International, pt. B, v. 31, no 8, p. 4894-B.)
238. Vozoff, Keeva, 1972, The magneto-telluric method in the exploration of sedimentary basins: Geophysics, v. 37, p. 99-141, 36 figs. (Includes data from Anadarko basin.)
239. Watson, R. D., 1972, Spectral reflectance and photometric properties of selected rocks: Remote Sensing of Environment, v. 2, no. 2, p. 95-100, 13 figs. (USGS Mill Creek, Oklahoma, remote-sensing test site.)
240. Watson, Kenneth, Rowan, L. C., and Offield, T. W., 1971, Application of thermal modeling in the geologic interpretation of IR images, *in* International Symposium on Remote Sensing of Environment, 7th: Ann Arbor, Michigan, Willow Run Laboratory, Proceedings, v. 3, p. 2017-2041, illus. (Mill Creek, Oklahoma.)
241. Watson, R. D., and Rowan, L. C., 1971, Automated geologic mapping using rock reflectances, *in* International Symposium on Remote Sensing of Environment, 7th: Ann Arbor,

Michigan, Willow Run Laboratory, Proceedings, v. 3, p. 2043-2052, illus. (Mill Creek, Oklahoma.)
242. Weaver, C. E., and Beck, K. C., 1971, Clay water diagenesis during burial: How mud becomes gneiss: Geological Society of America Special Paper 134, 66 p., 24 figs., 8 tables. (Contains information from Ouachitas and Anadarko basin.)
Webster, G. D., *see* Lane, H. R., Merrill, G. K., Straka, J. J., Jr., and Webster, G. D.
243. Wells, J. R., 1972, Feldspar, nepheline syenite, and aplite, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 505-512, 8 tables.
244. West, J. M., 1972, Silver, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 1013-1029, 13 tables.
245. West, R. R., 1972, Relationship between community analysis and depositional environments: An example from the North American Carboniferous: 24th International Geological Congress, Section 7, Paleontology, p. 130-146. (Abstract in 24th International Geological Congress Abstracts, p. 250. Concerns Wewoka Formation.)
246. West, R. R., Jeppesen, J. A., Pearce, R. W., and Twiss, P. C., 1972, Crouse Limestone: its stratigraphy and depositional environments, *in* Stratigraphy and depositional environments of the Crouse Limestone (Permian) in north-central Kansas: Geological Society of America, South-Central Section, Field-Trip Guidebook for Sixth Annual Meeting, p. 81-89.
247. Westerstrom, L. W., 1972, Coal—bituminous and lignite, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 327-389, 49 tables.
248. Wilson, L. R., 1972, Geomorphology of Tesesquite Creek valley, Cimarron County, Oklahoma: Oklahoma Geology Notes, v. 32, p. 195-208, 11 figs.
249. Withrow, P. C., 1972, Star-Lacey field, Blaine and Kingfisher Counties, Oklahoma, *in* King, R. E. (editor), Stratigraphic oil and gas fields—Classification, exploration methods, and case histories: American Association of Petroleum Geologists Memoir 16 (Society of Exploration Geophysicists Special Publication 10), p. 520-531, 10 figs.
Wolf, C. L., *see* Gary, Margaret, McAfee, Robert, Jr., and Wolf, C. L.
Wolfman, Daniel, *see* DuBois, R. L., and Wolfman, Daniel.
250. Wood, H. B., 1972, Fluorspar and cryolite, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 519-528, 11 tables.
251. Woodmansee, W. C., 1972, Uranium, *in* Metals, minerals, and fuels, *v. 1 of* Minerals yearbook 1970: U.S. Bureau of Mines, p. 1139-1161, 18 tables.
252. Wright, A. D., 1972, The relevance of zoological variation studies to the generic identification of fossil brachiopods: Lethaia,

v. 5, no. 1, p. 1-13, 5 figs., 1 table. (Includes specimens from Oklahoma.)

253. Wright, R. J., Reynolds, M. A., and Bogard, D. D., 1972, Depth variation in cosmic ray spallation produced noble gases in a 150 Kg chondrite, Keyes [abstract]: Eos American Geophysical Union Transactions, v. 53, no. 4, p. 437.

Wright, W. B., *see* Cohee, G. V., and Wright, W. B.

254. Wroblewski, E. F., 1972, Exploration in Oklahoma and Panhandle of Texas in 1971: American Association of Petroleum Geologists Bulletin, v. 56, p. 1269-1272, 1 fig., 2 tables.

Yee, B. Q., *see* Glover, H. A., Atkins, R. L., Reece, B. B., Yee, B. Q., Grove, R. E., McUsic, J. M., and Cope, R. F.

Zabetakis, M. G., *see* Irani, M. C., Thimons, E. D., Bobick, T. G., Deul, Maurice, and Zabetakis, M. G.

255. Zanier, A. M., and others, 1972, Solving drillings utilizing well logs; a case history: Society of Professional Well Log Analysts, Annual Logging Symposium, Transactions no. 13, paper W, 9 p., illus.

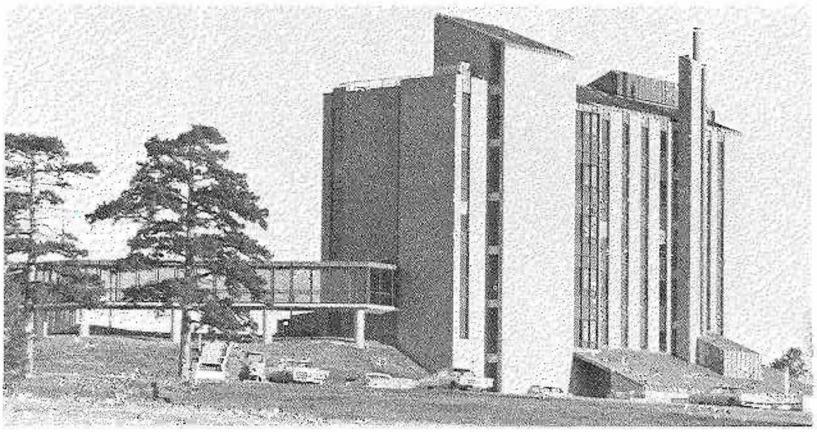
256. Zanier, A. M., and Timko, D. J., 1971, Prediction of Morrow sand performance and geological environment by well log salinity, *in* Drilling and production practice, 1970: American Petroleum Institute, p. 225-231, illus.

257. Zanier, A. M., Timko, D. J., and Meyers, T. L., 1972, Electric well logs help solve Wilburton field drilling problems: Oil and Gas Journal, v. 70, no. 23 (June 5), p. 73-75, 11 figs., 1 table.

258. Zidek, Jiri, 1972, Oklahoma paleoichthyology, part 1: A review and commentary: Oklahoma Geology Notes, v. 32, p. 171-187, 3 tables.

INDEX

Kansas Survey Opens New Building and Honors Raymond C. Moore



View of new 6-story building occupied by the State Geological Survey of Kansas.

The State Geological Survey of Kansas has just moved into its new building on the west campus of The University of Kansas in Lawrence. The new $1,350,000 building was named Raymond C. Moore Hall in recognition of Dr. Moore's long and honored position as geology teacher, department chairman, and state geologist. The 6-story structure's 34,000 square feet of floor space affords ample "elbow room" for the 70 full- and part-time survey staff members. Equipment in the new facility is valued at $450,000.

A ribbon-cutting ceremony on February 2, 1973, gave friends of the survey and the public a splendid excuse to visit the new building en masse and tour the facilities. More than 200 visitors arrived at the appointed hour to see Dr. Moore and Governor Robert B. Docking cut the ribbon. William W. Hambleton, state geologist and survey director, introduced both Dr. Moore and Governor Docking as well as Frank C. Foley, director emeritus of the survey, and other dignitaries from the university community. Drs. Moore, Foley, and Hambleton have reason to be proud of this moment of accomplishment, for they each had a part in building the new facility: the three geologists have directed the survey since 1916 and have guided it to its present position as one of the best in the country.

Formal dedication of the building is scheduled for September 28-29, 1973, and will feature a symposium on "Elements of a National Energy Policy." Among the participants will be Rogers C. B. Morton, secretary of the U.S. Department of the Interior, Robert D. Ray, governor of Iowa, and Vincent E. McKelvey, director of the U.S. Geological Survey.

—*Kenneth S. Johnson*

Ribbon-cutting ceremony, with (from left) Dr. Raymond C. Moore, Governor Robert B. Docking, and Dr. William W. Hambleton. (Photographs courtesy of State Geological Survey of Kansas.)

The Late Early Ordovician Gastropod *Ceratopea* in the Arbuckle Mountains, Oklahoma[1]

Ellis L. Yochelson[2]

Abstract — The gastropod **Ceratopea,** best known from its massive operculum, is an important fossil for differentiating zones within the Kindblade and West Spring Creek Formations and for correlating to other regions. A summary of the occurrence of species of **Ceratopea** was published in 1957, but no details were presented. In the present work, the geographic localities and stratigraphic positions of collections made by the late W. E. Ham are given for the first time.

INTRODUCTION

The Early Ordovician gastropod *Ceratopea* is important to stratigraphic studies of the Arbuckle Group. This gastropod is characteristically represented by its massive operculum rather than by its shell. The operculum may be replaced by silica and can be readily etched from the limestone. Vertical distribution of *Ceratopea* species provides a useful stratigraphic framework (fig. 1) for subdividing the great thickness of limestones in the Arbuckle Mountains. A general summary that included a description and the stratigraphic distribution of species of *Ceratopea* in Oklahoma was published by Yochelson and Bridge in 1957. The present note provides details about the collection used to write the summary.

HISTORY OF THIS NOTE

Ceratopea was named by E. O. Ulrich in 1911. Although Ulrich did not describe species from Oklahoma at that time, he and Josiah Bridge began a major study of the genus in the early 1930's, and this study included specimens from the State. The incomplete manuscript based on the study was modified by Bridge and P. E. Cloud, Jr., to include material from the Llano uplift of Texas, but it was not completed. After Bridge's death on April 30, 1953, the manuscript was eventually turned over to Yochelson, who revised it for publication (Yochelson and Bridge, 1957).

In January 1950, the late William E. Ham of the Oklahoma Geological Survey submitted a large number of Arbuckle Mountain *Ceratopea* to Bridge, who reported on them 2 months later. I did not consult with Bridge on the *Ceratopea* manuscript, but a great deal of information was transmitted to me indirectly via his report. The Ham collections were exceptionally well documented as to geographic and stratigraphic position; details as shown on the original labels are given in tabular form in this note. Most specimens were well preserved, all having been etched free from the matrix. However, after the zonal arrangement had been worked out, Ham placed increasing reliance

[1]Publication authorized by the director, U.S. Geological Survey.
[2]Geologist, U.S. Geological Survey, Washington, D.C.

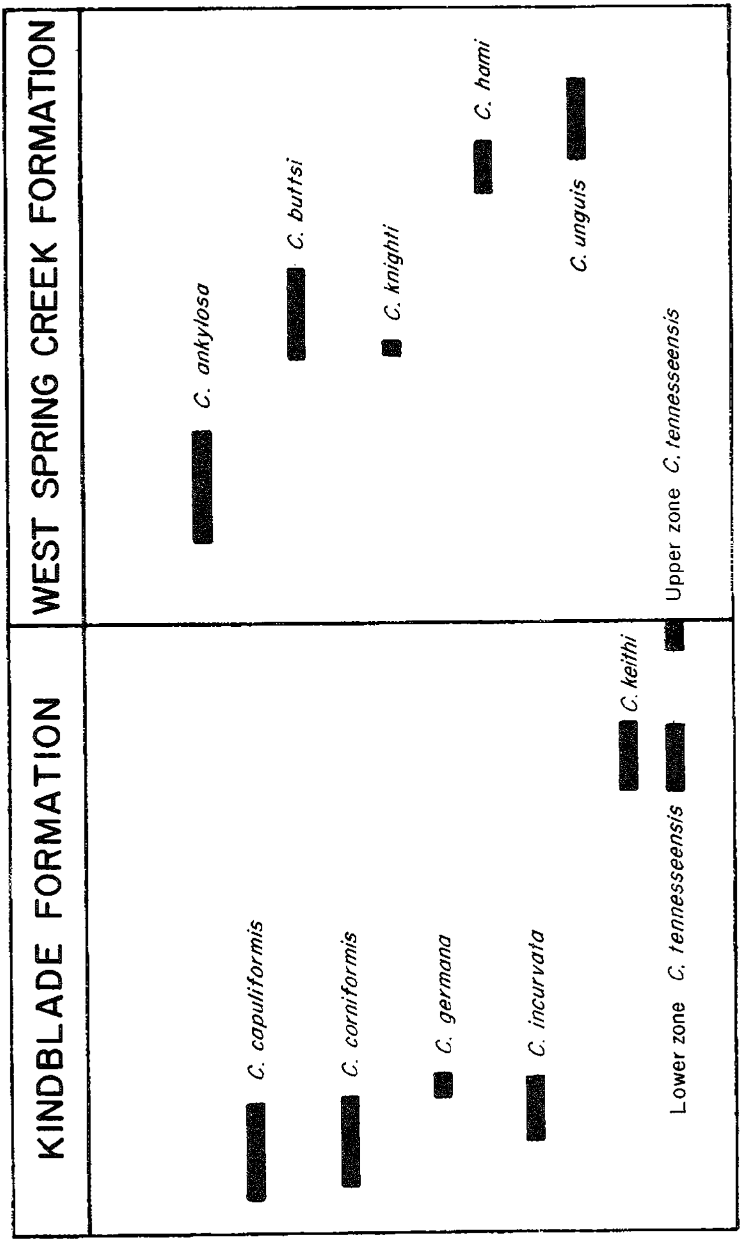


Figure 1. General range of Ceratopea species in Arbuckle Mountains (modified from Yochelson and Bridge, 1957, fig. 103, column 3).

on outcrop identification of species. Thus, the Ham collections, although extremely important, do not provide a fully accurate guide to relative abundance or detailed geographic distribution of specimens in the Arbuckle Mountain region.

Ham and Yochelson agreed that it would be useful to give more specific details about *Ceratopea* in the Arbuckle Mountains than could be presented in the summary work (Yochelson and Bridge, 1957). To this end, a short manuscript was prepared by Yochelson, but the press of other duties led Ham to other projects and he could not complete the work. The present study is limited mainly to raw data on occurrence, identification, and number of specimens in the 1950 Ham collections.

Recently, there has been considerable work in later Early Ordovician rocks of Arkansas by O. A. Wise, Jr., and E. E. Glick. As a result of their efforts, large collections of *Ceratopea* opercula and some accompanying shells have been accumulated. In connection with their study, the Ham material was reexamined. The zonal scheme remains unmodified, but some of the clear-cut zones in Oklahoma are not quite so clear-cut in Arkansas. In part, this may be the result of faster sedimentation in the miogeosyncline, relative to the shelf, so that ranges are stratigraphically longer and therefore less likely to overlap. In part, it may be that the barren zones of the Arbuckle Group constitute a facies unfavorable to *Ceratopea*. In part, this may be a consequence of the Arbuckle collections being smaller, and, because they were prepared in the laboratory, not subject to modification in shape and weathering on the outcrop. The zonal arrangement still holds, but much remains to be learned about *Ceratopea* in terms both of individual variation and range of its various species.

By and large, my determinations of species in 1955 and again recently have been the same as those of Bridge in 1950; only a few minor changes have resulted. Possibly, further collections from the Arbuckle Group might require additional changes in the concept of a particular species.

Although this paper is based on collections more than two decades old, the data provided are still pertinent to understanding the stratigraphy of the Arbuckle Group in its type area. This note is respectfully dedicated to the memory of Jo Bridge and Bill Ham, who, among other things, taught me to appreciate *Ceratopea*.

KINDBLADE FORMATION

In a summary section compiled early in 1955, Ham plotted the Kindblade occurrences of *Ceratopea* through an interval of 1,300 feet. On an apparently earlier plot, found among Ham's manuscript papers, he shows these occurrences through a 1,450-foot interval, noting that the Kindblade may be 1,000 to 1,450 feet thick but that the greater thickness was the average for the Tishomingo and Arbuckle anticlines. This formation does show some change in thickness from east to west (Ham, 1955, p. 2, fig. 1). Most of the "extra" thickness is in the middle of the formation where no *Ceratopea* were collected. I have used the shorter plot, but where additional details or notes were available on the earlier version I have added them. This plot is given in figure 2; positioning and annotations are from Ham's sections. The Kindblade is readily divided into two zones where *Ceratopea* opercula are moderately common; these zones are separated by a wider interval, where they are virtually unknown.

The lower zone carries opercula of four species: *C. capuliformis* Oder, *C. incurvata* Yochelson and Bridge, *C. germana* Yochelson and Bridge, and *C. corniformis* Yochelson and Bridge. The first three opercula are easy to identify, being relatively short, strongly curved in the early growth stage, and inflated but having a sharp carina. They are also easy to distinguish among themselves on the degree of curvature and on the degree of twisting out of a plane of symmetry. In the Arbuckle Mountains, *C. germana* is far less common, and, judging from other areas, it is generally rare.

The operculum of *C. corniformis* is much more elongate and thus resembles those in the overlying West Spring Creek Formation; it differs from the younger forms in being generally smaller and in having a more circular cross section. The occurrence of opercula of *C. corniformis* and *C. capuliformis* together in three collections (Ok 106, 120, 121) is definite. Its marked difference in shape from the other opercula strongly suggests that *C. corniformis* might represent a somewhat different stock within the *Ceratopea* complex.

Though Ham did not attempt to distinguish any subzones, the available material indicates that the lower 50-200 feet of the Kindblade is characterized by *C. capuliformis* and *C. corniformis*, occurring either separately or together. The interval from 250 to 375 feet above the base is characterized by *C. incurvata* or *C. germana*, again occurring separately or together (Ok 104). More collections from the lower part of the Kindblade might help prove whether *C. germana* is a true biologic species. As noted, elsewhere in Early Ordovician rocks *C. germana* is exceedingly rare. It is certainly closely related to *C. incurvata*, and there is a possibility that it may be a spurious form, modified by solution or wear. At this time, however, I consider it a distinct species.

The upper zone of the Kindblade is characterized by *C. tennesseensis*. The operculum of this species is short, broad, flattened, and virtually uncurved. It is shaped like a crude arrowhead and is readily distinguishable from all four older species. So far as can be determined, there is no difference between the specimens above and below the apparent gap at the 1,100-1,200-foot interval.

Ok 128, the only occurrence in the barren zone, presents special problems. It is plotted at the stratigraphic interval indicated on Ham's earlier section and is in approximately the same relative position on his shorter section (fig. 2). Were the position plotted at 850 feet above the base of the shorter section, it would fall only a short distance below the lower of the two subzones of *C. tennesseensis*. Clearly, this locality should be reinvestigated to see if the distances from the top and from the base of the section are correct, or, alternatively, if minor faulting is involved.

The last species in the Kindblade is *C. keithi*, known only from Ok 123. This operculum is essentially like that of *C. tennesseensis*,

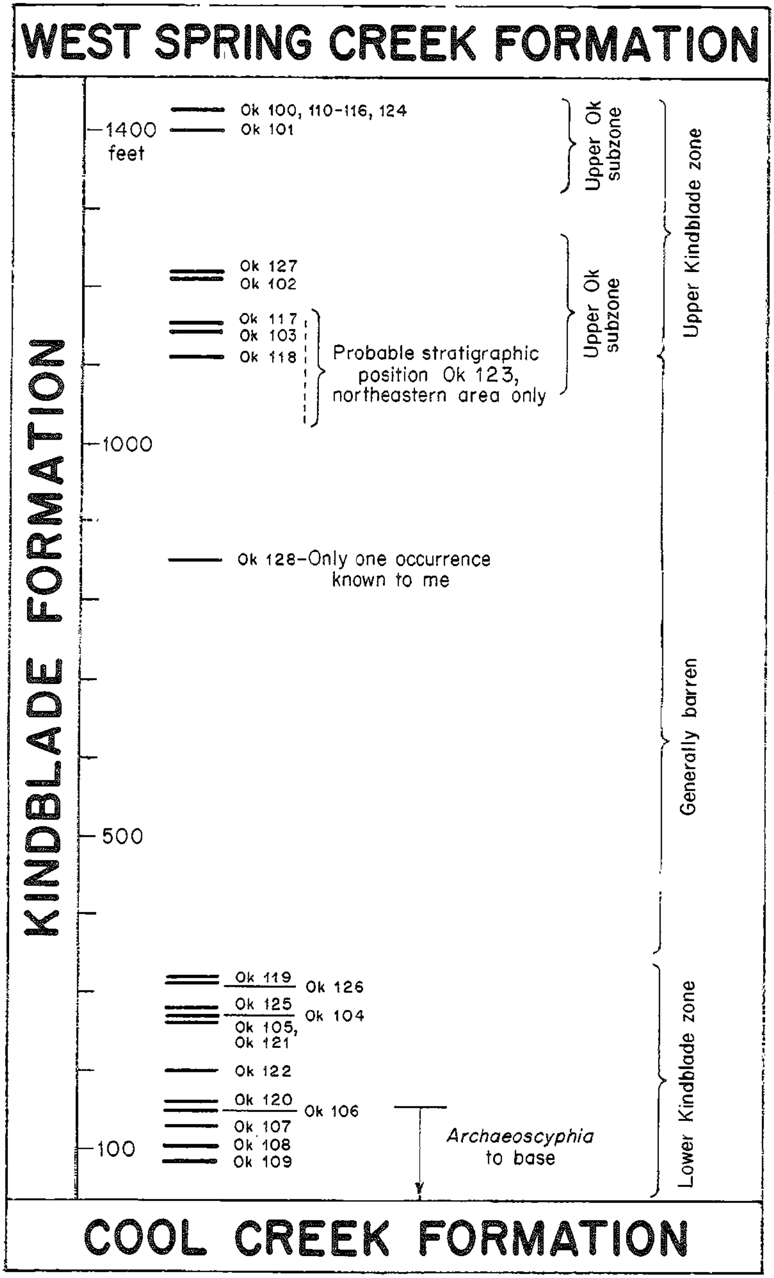


Figure 2. Occurrences of Ceratopea opercula collected by Ham in Kindblade Formation, Arbuckle Mountains (from W. E. Ham, unpublished section).

except somewhat longer. Its possible range in position is indicated by a bracket on figure 2. Placing it within or near the zone of *C. tennesseensis* is reasonable and is comparable with occurrences in Georgia (Charles W. Cressler, Calhoun, Georgia, oral communication, 1970). However, on the earlier chart, Ham indicated 60 feet below Ok 118 as the approximate horizon of *C. keithi.* There is a notation "at two localities in Hunton anticline only." Again, reinvestigation seems desirable.

No gastropod shells or shell fragments that might be attributed to *Ceratopea* opercula occur in the Kindblade Formation. Locality details for the Kindblade collections follow.

COLLECTION NUMBER	GEOGRAPHIC LOCALITY	STRATIGRAPHIC POSITION	NUMBER OF SPECIMENS	SPECIES IDENTIFIED
Ok 100	150 feet N., 150 feet W. of SE. corner sec. 4, T. 2 S., R. 1 W., Murray County	30 feet below top	5	**C. tennesseensis**
Ok 101	200 feet N., 200 feet W. of SE. corner sec. 4, T. 2 S., R. 1 W., Murray County	50 feet below top	16	**C. tennesseensis**
Ok 102	1,400 feet W., 2,100 feet N. of SE. corner sec. 4, T. 2 S., R. 1 W., Murray County	243 feet below top	7	**C. tennesseensis**
Ok 103	1,300 feet W., 2,050 feet N. of SE. corner sec. 4, T. 2 S., R. 1 W., Murray County	304 feet below top	7	**C. tennesseensis**
Ok 104 (Holotype, USNM 128186)	200 feet E., 1,400 feet S. of NW. corner sec. 3, T. 2 S., R. 1 W., Murray County	279 feet above base	1 20	**C. germana** **C. incurvata**
Ok 105	200 feet E., 1,350 feet S. of NW. corner sec. 3, T. 2 S., R. 1 W., Murray County	265 feet above base	4	**C. incurvata** (*Orospira* sp. also in collection)
Ok 106	2,000 feet E. of SW. corner sec 3, T. 2 S., R. 1 E., Murray County	160 feet above base	6 2	**C. capuliformis** **C. corniformis**
Ok 107	1,000 feet N., 900 feet W. of SE. corner sec. 4, T. 2 S., R. 1 E., Murray County	140 feet above base	8	**C. capuliformis**
Ok 108 (Hypotype, USNM 128181)	2,400 feet E., 2,150 feet N. of SW. corner sec. 6, T. 2 S., R. 1 E., Murray County	100 feet above base	1	**C. corniformis**
Ok 109	2,300 feet E., 400 feet S. of NW. corner sec. 11, T. 2 S., R. 1 E., Murray County	75 feet above base	7	**C. capuliformis**
Ok 110	SE¼ sec. 5, T. 1 S., R. 1 W., Murray County	30 feet below top	9	**C. tennesseensis**
Ok 111	2,550 feet W., 2,250 feet N. of SE. corner sec. 30, T. 1 S., R. 1 W., Murray County	30 feet below top	2	**C. tennesseensis**
Ok 112	NE¼NW¼ sec. 4, T. 2 S., R. 1 W., Murray County	30 feet below top	9	**C. tennesseensis**
Ok 113 (Hypotype, USNM 128188)	SE¼ sec. 10, T. 2 S., R. 1 W., Murray County	30 feet below top	5	**C. tennesseensis**
Ok 114	NE¼NW¼ sec. 30, T. 2 S., R. 1 W., Murray County	30 feet below top	5	**C. tennesseensis**
Ok 115	1,250 feet S. of NW. corner sec. 23, T. 2 S., R. 2 E., Carter County	34 feet below top	7	**C. tennesseensis**
Ok 116	2,400 feet E., 50 feet N. of SW. corner sec. 18, T. 2 S., R. 4 E., Murray County	29 feet below top	4	**C. tennesseensis**
Ok 117	650 feet W., 600 feet N. of SE. corner sec. 18, T. 2 S., R. 4 E., Murray County	298 feet below top	5	**C. tennesseensis**
Ok 118	1,000 feet W., 700 feet N. of SE. corner sec. 18, T. 2 S., R. 4 E., Murray County	343 feet below top	1	**C. tennesseensis**

Ok 119 (Holotype, USNM 128129; paratype, USNM 128180)	1,650 feet W., 250 feet N. of SE. corner sec. 17, T. 2 S., R. 4 E., Murray County	328 feet above base	4	**C. germana**
Ok 120	1,400 feet W., 300 feet N. of SE. corner sec. 17, T. 2 S., R. 4 E., Murray County	174 feet above base	2 2	**C. capuliformis** **C. corniformis** (**Archeoscyphia** sp. also in collection)
Ok 121	250 feet E., 500 feet N. of SW. corner sec. 4, T. 3 S., R. 4 E., Johnston County	265 feet above base	8 3	**C. capuliformis** **C. corniformis**
Ok 122	600 feet E., 400 feet N. of SW. corner sec. 4, T. 3 S., R. 4 E., Johnston County	198 feet above base	1	**C. capuliformis**
Ok 123	1,100 feet N., 700 feet W. of SE. corner sec. 26, T. 1 N., R. 5 E., Pontotoc County	About 200 feet below top	76	**C. keithi**
Ok 124	350 feet S., 1,600 feet W. of NE. corner sec. 4, T. 1 S., R. 5 E., Johnston County	30 feet below top	5	**C. tennesseensis**
Ok 125	1,000 feet N., 1,700 feet W. of SE. corner sec. 14, T 2 S., R. 7 E., Johnston County	282 feet above base	3	**C. incurvata**
Ok 126	1,050 feet N., 1,600 feet W. of SE. corner sec. 14, T. 2 S., R. 7 E., Johnston County	318-320 feet above base	7	**C. incurvata**
Ok 127	750 feet E., 2,000 feet S. of NW. corner sec. 19, T. 2 S., R. 2 E., Carter County	236 feet below top	3	**C. tennesseensis**
Ok 128	800 feet E., 400 feet N. of SW. corner sec. 17, T. 2 S., R. 4 E., Murray County	607 feet below top; 852 feet above base	1	**C. tennesseensis** (**Tritoechia** cf. **T. delicatula** also in collection)

WEST SPRING CREEK FORMATION

In contrast to the opercula in the underlying Kindblade, those in the West Spring Creek are not readily distinguishable from each other. The problems of stratigraphic utility are compounded by more pronounced differences between the fossils of the Arbuckle-Tishomingo anticline and those from outcrops in the eastern Arbuckle Mountains. Again, in the Ham papers there is a plot of the stratigraphic positions in which collections from these two areas were distinguished (apparently earlier than the one used by Yochelson and Bridge in 1957). I have reproduced the plot in figure 3, except for the eastern collection numbers that were duplicated on the Arbuckle-Tishomingo anticline column. Eastward thinning of the West Spring Creek is more pronounced than in the Kindblade (Ham, 1969, p. 33, fig. 27).

In figure 4, the part of the summary sheet in which Ham attempted to place the eastern collections in presumed proper stratigraphic sequence is reproduced. A great deal depends here on the interpretation of the species concept. I now believe that this correlation of the two areas may not be entirely correct. It may be that the 150 feet or so of strata between Owsc 109 and Owsc 110 is approximately the same as the 350 feet between Owsc 123 and Owsc 120 (as shown in fig. 3); it may be that the species in the eastern facies coexisted with a different species in the Arbuckle-Tishomingo anticline area. Alternatively, it may be that the ranges of individual species are shorter but that the species are not so readily distinguished. Without additional collections, this problem cannot be resolved. In any event, the data do support the notion that the western sections are thicker.

The lowest group of collections in the formation, fortunately, are

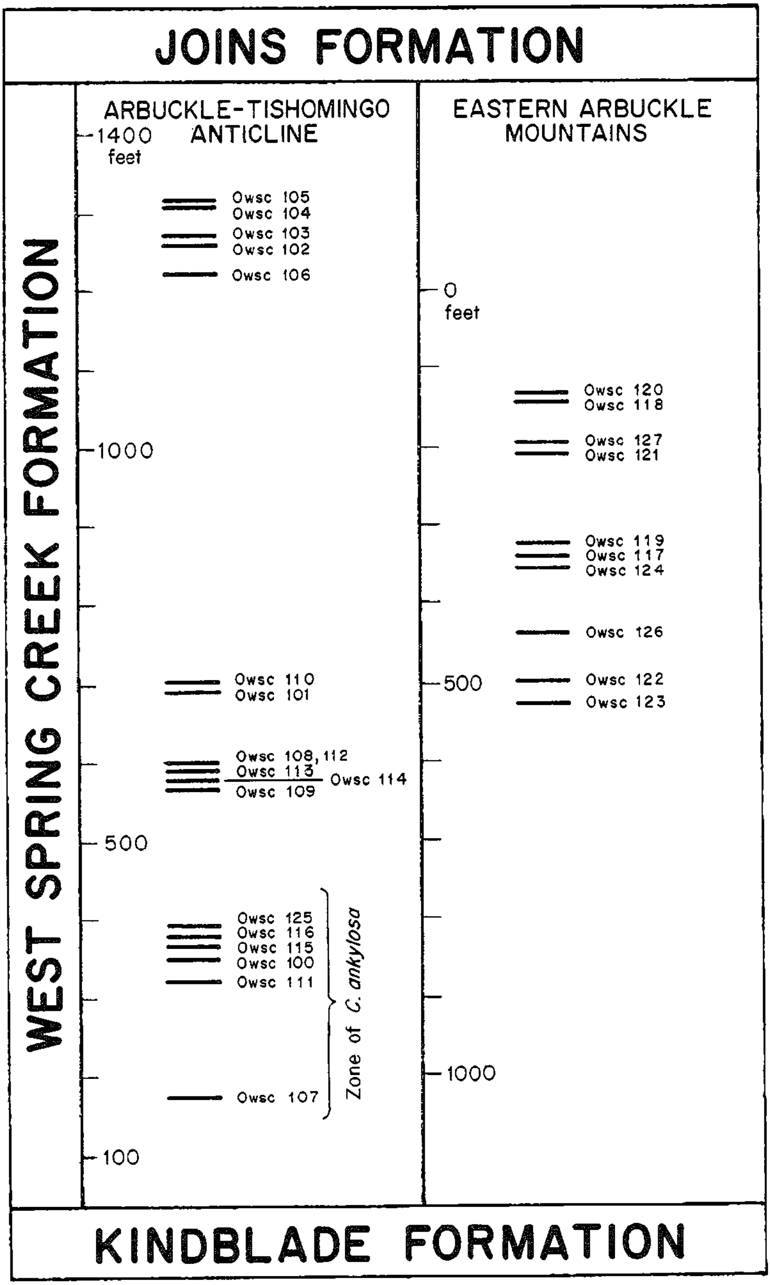


Figure 3. Occurrences of Ceratopea opercula collected by Ham in two outcrop areas of West Spring Creek Formation, Arbuckle Mountains (from W. E. Ham, unpublished section).

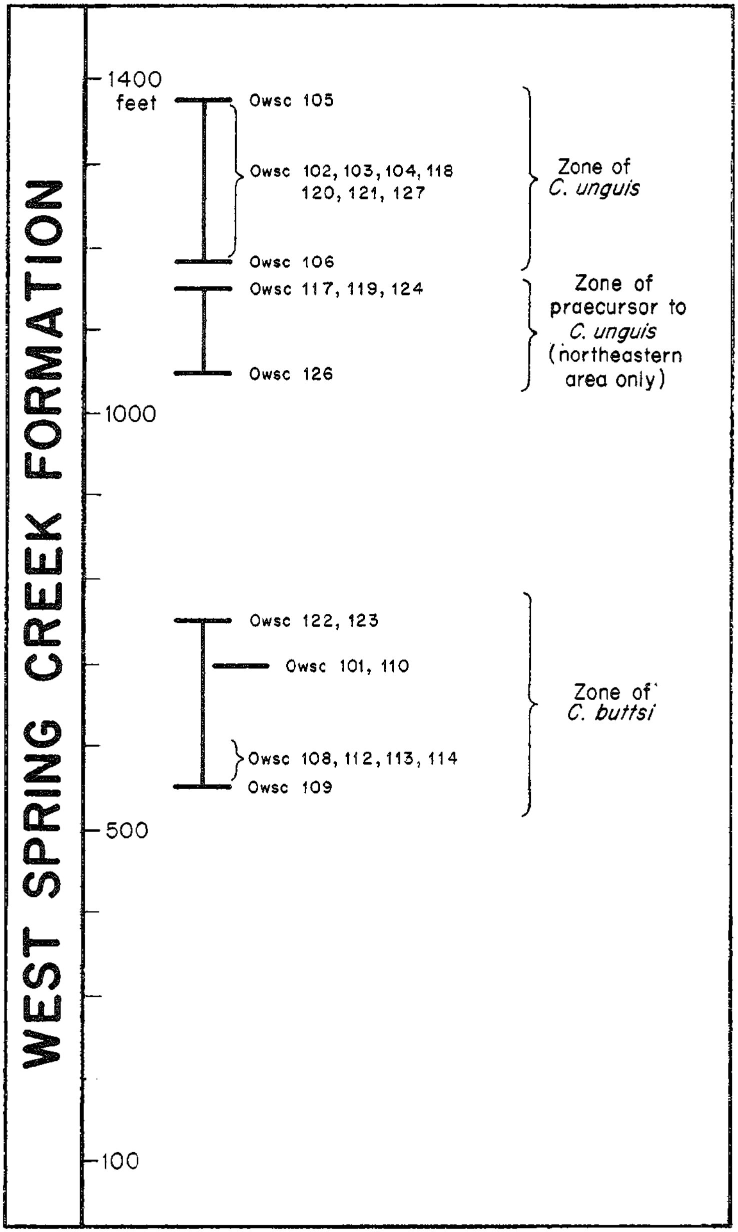


Figure 4. Combined stratigraphic position of Ceratopea collections in upper two-thirds of West Spring Creek Formation in eastern and Arbuckle-Tishomingo anticline areas of outcrop, as suggested by Ham in 1956 (from W. E. Ham, unpublished section).

not involved in any uncertainty. All specimens in the lowest six collections are referred to *C. ankylosa* Cullison. This is a wide, flattened, short, abruptly expanding hooked form, having two muscle pits connected with a groove. Its range is separated by almost 200 feet of presumably unfossiliferous strata from the next younger group of collections. In passing, it must be pointed out that Bill Ham noted a drafting error in Yochelson and Bridge (1957, p. 293, fig. 103); *C. ankylosa* does not occur near the top of the section in the El Paso Limestone.

Above the occurrence of *C. ankylosa,* five collections from the Arbuckle-Tishomingo anticline area contain opercula of *C. buttsi.* This is a long (thick) form, very little curved, and expanding gradually in width; it has one deep pit within the general muscle-attachment area. The position of Owsc 112 is given as the same as that of Owsc 108; there is a discrepancy between the plotted position and the stratigraphic data in these two collections. One additional collection from the eastern areas of outcrop, Owsc 122, is assigned to this species.

Within this interval, collection Owsc 114 contains a single specimen, the holotype of *C. hami* Yochelson and Bridge. Although it is not the intent of this paper to modify the systematics of *Ceratopea* substantially, upon reexamination I do not find it feasible to differentiate between that species and *C. knighti* Yochelson and Bridge, directly overlying in Owsc 113. Accordingly, *C. knighti* is herewith placed in the synonymy of *C. hami.*

My current view of *C. hami* is that this is a far more variable species than could be surmised from the lone original specimen. Opercula of this species are broadly hook shaped, though some opercula of *C. buttsi,* which are more strongly curved, approach them in shape. The opercula are relatively wider and higher than those of *C. buttsi* but not commonly as long. The attachment surface bears a pit almost as prominent as that of *C. buttsi.* However, there may be a second shallow pit—this is a variable feature—with a connecting ridge, so that small worn specimens appear similar to *C. ankylosa.* I now think that some specimens collected from the eastern facies should be identified as *C. hami.* A group of these were considered by Ham (fig. 4) as a "zone of praecursor to *C. unguis*"—quite a reasonable assignment.

However, two specimens in Owsc 122 constitute what might be an undescribed species; they are stratigraphically below two other poorly preserved specimens in Owsc 127 that might be identified as *C. hami.* If one assumes that the occurrence of *C. buttsi* in the eastern outcrops is at about the same level as its lowest occurrence to the west, the resulting correlation indicates that the section to the east is thinner but has fossiliferous beds extending through a greater thickness. The two youngest collections, Owsc 118 and Owsc 120, each contain a few rather large, sturdy opercula. They are differentiated with difficulty from *C. hami* but seem to show more of the features of *C. unguis,* the youngest species. The transitional form of these specimens is further complicated by erosion of their exterior. Once again, it would be desirable to have a larger collection for study.

With the eastern facies specimens assigned, with varying degrees of assurance, to several species, the specimens from this general interval in the Arbuckle-Tishomingo anticline are assigned to *C. unguis* Yochelson and Bridge. The operculum is another large form. It is more strongly curved than that of *C. buttsi* and slightly less strongly curved than typical *C. hami* opercula, though in this feature there is overlap between the two. Opercula of *C. unguis* seem to widen at a slightly slower rate than those of *C. hami* and at a slightly faster rate than those of *C. buttsi,* though again there is overlap. The prime distinguishing feature of the operculum is a deep cup-shaped muscle-attachment surface which contains one deep pit. Although this is distinctive, incomplete specimens can be confused with the other two elongate forms of opercula in the West Spring Creek.

Although *C. unguis* can be distinguished from the underlying *C. buttsi* and *C. hami,* care should be taken that one is not misled by poor material. In the Arbuckle-Tishomingo anticline area, *C. unguis* marks the upper part of the formation and has a wide stratigraphic separation from underlying species.

Shell fragments are known along with opercula of *C. hami* from Owsc 117. Well-preserved shells were found by Ham and Yochelson with opercula that are probably conspecific with the type of *C. buttsi.* These were collected 400 feet west and 200 feet north of the E¼ corner sec. 17, T. 5 S., R. 1 E., Carter County, Oklahoma (Yochelson and Bridge, 1957, pl. 37, figs. 27, 30, 31, 33, 34). Not unexpectedly, these are similar to the one in a life association of *C. unguis* shell and operculum found at Smithville, Arkansas (Yochelson and Wise, 1972). Locality details for the West Spring Creek collections follow.

COLLECTION NUMBER	GEOGRAPHIC LOCALITY	STRATIGRAPHIC POSITION	NUMBER OF SPECIMENS	SPECIES IDENTIFIED
Owsc 100	NE¼NE¼ sec. 9, T. 2 S., R. 1 W., Murray County	354 feet above base	1	**C. ankylosa**
Owsc 101	750 feet W., 1,550 feet S. of NE. corner sec. 9, T. 2 S., R. 1 W., Murray County	563 feet above base; 810 feet below top	7	**C. buttsi**
Owsc 102 (Paratype, USNM 128185)	1,100 feet S. of E¼ corner sec. 9, T. 2 S., R. 1 W., Murray County	238 feet below top	31	**C. unguis**
Owsc 103	1,100 feet S. of E¼ corner sec. 9, T. 2 S., R. 1 W., Murray County	229 feet below top	27	**C. unguis**
Owsc 104	1,150 feet S. of E¼ corner sec. 9, T. 2 S., R. 1 W., Murray County	196 feet below top	6	**C. unguis**
Owsc 105	200 feet N., 1,800 feet W. of E¼ corner sec. 9, T. 2 S., R. 1 W., Murray County	179 feet below top	10	**C. unguis**
Owsc 106	SW¼SW¼ sec 19, T. 2 S., R. 2 E. Carter County	270 feet below top	8	**C. unguis**
Owsc 107	1,700 feet E., 500 feet S. of NW. corner sec. 19 T. 2 S., R. 4 E., Murray County	169 feet above base	3	**C. ankylosa**
Owsc 108 (Holotype, USNM 128183)	1,400 feet E., 1,700 feet N. of SW. corner sec. 6, T. 3 S., R. 4 E., Johnston County	About 550 feet above base; about 900 feet below top	6	**C. buttsi**
Owsc 109	Center SE¼ sec. 24, T. 1 S., R. 2 W., Carter County	550 feet above base	6	**C. buttsi**
Owsc 110	1,000 feet W. of NE corner sec. 5, T. 2 S., R. 4 E., Murray County	800-805 feet below top	40	**C. buttsi**

Owsc 111	1,050 feet E., 750 feet S. of NW. corner sec. 19, T. 2 S., R. 4 E., Murray County	335 feet above base	2	C. ankylosa
Owsc 112 (Paratype, USNM 128184)	1,500 feet E., 1,000 feet N. of SW. corner sec. 10, T. 2 S., R. 1 E., Murray County	595 feet above base; about 960 feet below top	1	C. buttsi
Owsc 113 (Holotype **C. knighti**, USNM 128187)	Center NE¼ sec. 5, T. 2 S., R. 1 W., Murray County	610 feet above base	3	C. hami (= C. knighti)
Owsc 114 (Holotype, USNM 128182)	300 feet W., 950 feet N. of SE. corner sec. 14, T. 2 S., R. 2 E., Murray County	About 600 feet above base	1	C. hami
Owsc 115	2,400 feet W., 1,100 feet S. of NE. corner sec. 13, T. 2 S., R. 1 W., Murray County	About 370 feet above base	6	C. ankylosa
Owsc 116	1,350 feet W., 700 feet S. of NE. corner sec. 24, T. 1 S., R. 2 W., Carter County	Lower middle Owsc	1	C. ankylosa
Owsc 117	1,600 feet N., 1,300 feet E. of SW. corner sec. 16, T. 1 S., R. 5 E., Johnston County	About 350 feet below top	39	C. hami (opercula and shell fragments)
Owsc 118	400 feet S., 900 feet W. of NE. corner sec. 17, T. 1 S., R. 5 E., Johnston County	Upper(?) part	12	C. unguis
Owsc 119	1,000 feet S., 650 feet E. of NW. corner sec. 22, T. 1 S., R. 5 E., Johnston County	Upper(?) part	1	C. hami
Owsc 120	2,300 feet N., 1,300 feet E. of SW. corner sec. 3, T. 1 N., R. 6 E., Pontotoc County	Upper part	5	C. unguis
Owsc 121	1,900 feet S., 1,100 feet W. of NE. corner sec. 33, T. 2 N., R. 6 E., Pontotoc County	210 feet below top	2	C. sp.
Owsc 122	NE¼NE¼SW¼ sec. 21, T. 2 S., R. 6 E., Johnston County	500 feet below top	8	C. buttsi
Owsc 123	500 feet N., 2,300 feet E. of SW. corner sec. 25, T. 1 N., R. 4 E., Murray County	About 500 feet below top	4	C. hami
Owsc 124	1,000 feet N., 1,800 feet E. of SW. corner sec. 28, T. 1 N., R. 4 E., Murray County	About 350 feet below top	1	C. hami
Owsc 125	1,750 feet E., 300 feet S. of NW. corner sec. 30, T. 2 S., R. 4 E., Murray County	395 feet above base	5	C. ankylosa
Owsc 126	2,000 feet S., 1,500 feet E. of NW. corner sec. 19, T. 1 N., R. 5 E., Pontotoc County	450 feet below top	1	C. hami
Owsc 127	2,300 feet S., 500 feet E. of NW. corner, sec. 25, T. 1 S., R. 6 E., Johnston County	About 200 feet below top	2	C. hami

[1]Plotted position on Ham's log is 690 feet above base.
[2]Plotted position on Ham's log is about 600 feet above base.

References Cited

Ham, W. E., 1955, Field conference on geology of the Arbuckle Mountain region: Oklahoma Geological Survey Guide Book 3, 61 p.

Ham, W. E. [with contributions by **Stitt, J. H., Derby, J. R., Fay, R. O.,** and **Graffham, A. A.**], 1969, Regional geology of the Arbuckle Mountains, Oklahoma: Oklahoma Geological Survey Guide Book 17, 52 p.

Yochelson, E. L., and **Bridge, Josiah,** 1957 [1958], The Lower Ordovician gastropod **Ceratopea:** U.S. Geological Survey Professional Paper 294-H, p. 281-304, 4 pls.

Yochelson, E. L., and **Wise, O. A., Jr.,** 1972, A life association of shell and operculum in the Early Ordovician gastropod **Ceratopea unguis:** Journal of Paleontology, v. 46, p. 681-684.

USGS Assesses World Resources

The U.S. Geological Survey has announced publication of results of the first assessment of critical mineral and fuel commodities ever attempted on a worldwide scale. The ambitious project netted data on production, imports, exports, proved reserves, and estimated reserves of oil and gas, copper, nickel, cobalt, and manganese for 120 nations and 6 continents. In addition, historical trends and the impact of probable future developments were considered.

According to the report, Asia (including the USSR) and North America, currently the dominant oil-producing regions of the world, also have the largest reserves for the future. Proved oil reserves for the world total about 634 billion barrels (511 onshore and 101 offshore plus an additional 22 billion for which onshore-offshore distribution data are not available). The United States has 45.3 billion barrels of proved reserves (39.6 onshore and 5.7 offshore), while the Soviet Union has about 75 billion barrels (less than 73.6 onshore and greater than 1.4 offshore). Asia alone contains over 70 percent of the total reserves of all 120 countries considered.

Oil and gas production in the United States is rising dramatically —from about 2,900 million barrels of oil and 14,945 billion cubic feet of gas in 1960 to 4,091 million barrels of oil and 23,905 billion cubic feet of gas in 1971. However, the report indicates that oil and gas production is shifting from North America to Africa and Asia. Also interesting if not disturbing is the prediction that the center of the world supply and production of gas may shift from North America to an area of the USSR east of the Ural Mountains.

Prepared by a task force of USGS scientists under the direction of Dr. John P. Albers, associate chief geologist and senior author of the publication, *Summary Petroleum and Selected Mineral Statistics for 120 Countries, Including Offshore Areas* has been released as USGS Professional Paper 817. It can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, for $2.10 a copy.

Results of AIPG Questionnaire on Registration in Oklahoma

Following several months' discussion of the pros and cons of the recognition of the professional practice of geology and geophysics in Oklahoma by State registration, the Oklahoma Section of the American Institute of Professional Geologists decided to prepare and mail out a questionnaire so that a consensus on this question could be obtained from the largest possible number of geologists and geophysicists in Oklahoma.

The purpose of the questionnaire was twofold: (1) to guide the Oklahoma Section of AIPG in determining whether or not to advance a registration bill to the State Legislature and (2) whether or not the "Model Bill Providing for the Registration of Geologists and Geo physicists in Oklahoma"[1] was an appropriate vehicle for registration.

The questionnaire itself comprised three main sections requesting personal data, opinions on the proposed Model Bill, and opinions on statutory registration. Copies of the questionnaire were mailed out in August 1972 and were to have been returned by September 1, 1972.

John W. Ramsey, Jr., was appointed chairman of the committee to handle the distribution and tabulation of the questionnaire. His committee members were Louis R. Wilson, Ralph H. Espach, Jr., and Joe W. Ferguson (a member of SExG). The work of John and his committee is acknowledged and appreciated.

A total of 1,481 questionnaires were distributed in the following manner: 1,114 to members of The American Association of Petroleum Geologists residing in Oklahoma, 41 to members of the Ardmore Geological Society not on the AAPG list, 97 to members of the Geophysical Society of Oklahoma City, 121 to members of the Oklahoma City Geological Society not on the AAPG list, 76 to members of the Tulsa Geological Society not on the AAPG list, and 32 picked up by geologists using the Oklahoma City Geological Society library. (The membership of the Geophysical Society of Tulsa was inadvertently omitted from the mailing because of an oversight; this oversight is regretted.)

By September 1, 1972, the closing date, 439 questionnaires had been received, representing a return of 30 percent. Following is a detailed breakdown of the information obtained from the returned questionnaires.

A **Personal Data**

1. Years of professional experience: 0-5 years, 18 persons; 5-15 years, 76 persons; 15-25 years, 225 persons; 25-35 years, 69 persons; over 35 years, 48 persons; no answer, 3.
2. Employment status: major company, 113; independent company, 131; teaching, 12; consultant/independent, 178; government agency, 8; retired, 7; other, 14; no answer, 3.
3. Principal endeavor: research, 60; administration, 66; operations, 299; other, 57; no answer, 22.
4. Are you: a geologist, 363; a geophysicist, 25; both a geologist and geophysicist, 42; other, 11; no answer, 5.
5. Is your principal membership in: Tulsa Geological Society, 105; Geophysical Society of Tulsa, 21; Oklahoma City Geological Society, 252; Geophysical Society of Oklahoma City, 37; Ardmore Geological Society, 38; no answer, 36.
6. Are you a member of: AAPG, 364; SExG, 70; AIPG, 71; no answer, 47.
7. Do you practice professionally in states other than Oklahoma? Yes, 327; no, 95; no answer, 17.

B **Model Registration Bill**

1. Have you carefully read the "Model Bill Providing for the Registration of Geologists and Geophysicists in Oklahoma"? Yes, 329; no, 99; no answer, 11.
2. Did you attend any meeting where the Model Bill/registration was the principal topic of discussion? Yes, 182; no, 244; no answer, 13.

---

[1] This bill was drafted early in 1972 by a joint committee representing the State's geological and geophysical societies. The draft was published in the **Shale Shaker** (v. 22, no. 4), the official organ of the Oklahoma City Geological Society.

3. Which one of the following statements most nearly reflects your opinion? (a) I would like this bill introduced into the Legislature at the earliest appropriate moment, 68; (b) this bill should be shelved until statutory registration is forced upon us by outside interests, 136; (c) this bill is unsatisfactory and efforts toward registration should be discontinued, 189; no answer, 46.

C **Statutory Registration**

1. Which one of the following statements most nearly reflects your view? (a) I favor statutory registration, 53; (b) I favor statutory registration but do not feel strongly about it, 48; (c) I am neutral, 37; (d) I am opposed to statutory registration but do not feel strongly about it, 94; (e) I am strongly opposed to any form of statutory registration, 202; no answer, 5.
2. If a registration law is passed in Oklahoma in the next 5 years, will you: (a) have to apply for registration, 173; (b) not have to, but probably would, apply for registration, 155; (c) not have to, and will not, apply for registration, 77; no answer, 34.
3. If registration becomes law in any state adjoining Oklahoma, how would you feel about registration in Oklahoma? Would favor, 137; would oppose, 262; no answer, 40.
4. Do you believe that some form of registration will ultimately be necessary? Yes, 152; no, 262; no answer, 25.
5. As an alternative to statutory registration, would you prefer official state recognition of certification by existing national geological and geophysical organizations? Yes, 300; no, 108; no answer, 31.

In view of the information obtained from this questionnaire, the Oklahoma Section of AIPG has dropped all efforts to seek statutory registration as a means for recognizing the professional practice of geology and geophysics in Oklahoma until such time as the geocommunity requests that it be recalled.

—*Executive Committee, Oklahoma Section, AIPG*

OKLAHOMA ABSTRACTS

AAPG Southwest Section-SEG Midwest Societies Joint Meeting
Fort Worth, Texas, March 14-16, 1973

The following abstracts are reprinted from the February 1973 issue, v. 57, of the *Bulletin* of The American Association of Petroleum Geologists. Page numbers appear in brackets below each abstract. Per-

---

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.

mission of the authors and of A. A. Meyerhoff, managing editor of AAPG, is gratefully acknowledged.

Application of Reservoir-Pressure Data in Prospecting

P. A. DICKEY and L. MASROUA, Department of Earth Sciences, The University of Tulsa, Tulsa, Oklahoma

The search for stratigraphic traps is basically the search for barriers to the movement of fluids. Such barriers can be identified more surely by pressure information than by stratigraphic correlation. We think of normal reservoir pressure as "that necessary to sustain a column of water to the surface." However, when oil or gas is in lenticular sands, the initial reservoir pressures may be much less or much more than "normal." Examples of low pressures are found in the Cretaceous of New Mexico and Alberta, and the Morrow of western Oklahoma. Abnormally high pressures are found in many areas of the world, especially in Tertiary sediments, but also in the Pennsylvanian Morrow sandstones of central Oklahoma. In Blaine County there are about 10 separate Morrow reservoirs. All the wells in each reservoir have similar initial pressures and subsequent pressure-decline histories, which differ markedly from one reservoir to another. It should be possible from well performance, or even good drillstem-test data, to tell which reservoir a wildcat well has penetrated, or whether it has found an entirely new reservoir. Thus the regional extent of each reservoir can be ascertained very early during exploration. [420]

Stereo and Mosaic Aerial Photo Study of Part of the Central Ouachita Mountain System in Oklahoma and Arkansas[1]

F. A. MELTON, School of Geology and Geophysics, The University of Oklahoma, Norman, Oklahoma, and K. S. JOHNSON, Oklahoma Geological Survey, Norman, Oklahoma

A careful study of stereo aerial photographs of a central part of the Ouachita Mountains in Oklahoma and Arkansas, followed by a related study of photo-index sheets of a much larger area in the Ouachitas, yields the following tentative conclusions:

1. The earliest structural dislocations of field dimensions are a series of approximately parallel "early bedding faults" in the Stanley Shale, increasing in number downward in the section. A slight schistosity and (or) cleavage, also nearly parallel to bedding, may likewise increase downward. The prime source of this deformation was probably an underthrusting basement moving northward. There is a scarcity of proven overthrusts, as opposed to underthrusts, but there are a great

[1]Abstract expanded at authors' request.

many thrust faults with a normal age sequence of formations across the fault.

Other investigators have pictured the predominant faulting as overthrusting. Some overthrusts should form even with predominant underthrusting, and some are believed to exist. The most likely place for this is in the western part of Windingstair Mountain and in the Ti Valley fault zone. These are outside the area of this study.

2. The next major episode seems to be steep faulting, probably involving the basement and overlying sediments, producing semi-fault-block structures with tight broken anticlines; this was followed or accompanied by a collapse of the sediments into deep synclines. Most of the high synclinal and more complicated ranges have straight or gently curved bordering steep faults in the adjacent lowlands.

3. The next recognizable tectonic movements were probably the uplifts of three main anticlinoria. At this time the Ouachitas began to shed coarse as well as finer clastic sediments toward the west and probably in other directions. The Fallis, Garber, and Duncan-San Angelo sandstone stratigraphic wedges may have been deposited to the west in Oklahoma at this time.

4. The Mid-Continent regional uplift which included the Ouachitas must have produced a flood of coarse clastics adjacent to the mountains. These tectonic conglomerates have been removed by subsequent deep erosion, except for their distal equivalents—the three units mentioned in item 3 and the Whitehorse (Marlow and Rush Springs) sands—which are present in the Lower and Middle Permian of western Oklahoma and the western part of north-central Texas. This episode cannot be definitely separated from those of item 3 above.

5. The nearly vertical Big Cedar (Y City?) fault extends nearly 200 mi from near Big Cedar, Oklahoma, to Jacksonville, Arkansas, northeast of Little Rock. It probably was formed during a period of relaxation or tension in Jurassis or Cretaceous time, and may roughly parallel other faults in the Coastal Plain in southwest Arkansas. The Big Cedar fault touches 9 or 10 separate local structures along its length.

Plate Tectonics and New Proposed Intercontinental Reconstruction

C. L. ROWETT and J. L. WALPER, Department of Geology, Texas Christian University, Fort Worth, Texas

Published reconstructions of the pre-drift positions of North and South America have failed to take into account many geologic continuities present in the Paleozoic fold belts of southwestern United States, Mexico, Central America, and northwestern South America. The well-known Bullard "fit" terminates Mexico at about 23°N lat., but if southern Mexico and Central America are added, they overlap the Guianan shield of South America. Dietz and Holden attempted to solve this problem by postulating crustal blocks that filled the Gulf of Mexico and subsequently rotated southwestward to form part of Central America.

We propose a new reconstruction in which the Gulf of Mexico is completely closed by northern South America and where Mexico is adjacent to northern and northwestern South America. The evidence for this reconstruction is found in the similar geologic history of the Appalachian, Ouachita, Marathon, and Coahuila fold belts as well as throughout the eastern Andean Cordillera of Venezuela, Colombia, Ecuador, and Peru. We further propose that the Gulf of Mexico resulted from (1) the separation of North and South America by spreading and transform faulting, (2) the opening of a sphenochasm to produce the Mississippi embayment, and (3) great left-lateral displacements of the initially linear Paleozoic mobile belt along the Wichita, Texas, Coahuila, and other megashears. [422]

OKLAHOMA GEOLOGY NOTES

Volume 33 April 1973 Number 2

IN THIS ISSUE