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Cover Picture

Rhombohedral Rubble of Wesley Siliceous Shale

The cover photograph is from figure 6 of a publication issued in July by the Oklahoma Geological Survey, *Geology of the Eastern Part of the Lynn Mountain Syncline, Le Flore County, Oklahoma,* by Garrett Briggs, interim head of the Department of Geology, The University of Tennessee. Released as Circular 75, the publication describes the areal geology of a portion of the central Ouachita Mountains extending through southern Le Flore County from the Pushmataha County line on the west to the Arkansas State line on the east.

Illustrated on the cover is rubble derived from siliceous shale in the top part of the Wesley Formation, Jackfork Group, Lower Pennsylvanian, at an outcrop on the north flank of the Lynn Mountain syncline along U.S. Highway 259 in SE¼SE¼ sec. 32, T. 2 N., R. 25 E. The siliceous shale has been extensively fractured in a rhombic pattern, and these distinctive blocks are a result of undermining the siliceous layers by weathering and removal of less resistant shale. As Briggs explains: "The light-colored exteriors seen in this photograph testify to the proximity of the rubble to the outcrop. Removal of the clayey exterior after only short transport renders the blocks dark gray to black."

A principal part of Circular 75 is a geologic map, which includes, in addition to the area reported on by Briggs, an adjoining area to the south in northeastern McCurtain County that has been mapped by Donald L. Smith, associate professor in the Department of Geology, Idaho State University. The map is printed in 5 colors at a scale of 1:42,240, or about 1½ inches to the mile; the total area covered by both maps is about 340 square miles. The publication of this geologic mapping is especially significant because it blocks in a previously unmapped area adjoining published mapping of OGS Bulletins 88, 101, and 103.

The 39-page circular with geologic map is available from the Survey at a cost of $3.50 paperbound and $4.50 clothbound.

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.

The Elk City Blowout—A Chronology and Analysis

Robert O. Fay[1]

INTRODUCTION

The widely publicized "Elk City blowout" created a flurry of excitement in the news media during February and March of 1973. In addition to varying coverage by the local, state, and national press, and by television and radio, it was summarized in the April issue of *Oklahoma Geology Notes* (Fay, 1973). The account presented here is meant to be a more thorough, albeit less glamorous, treatment of the event than the others. Special thanks are due Kenneth S. Johnson, Oklahoma Geological Survey geologist, who provided the photographs that accompany this article.

Last February, or even as early as November 1972, a creek bed on land belonging to James Walter was blown out and lifted 5 to 20 feet or more. The crater at the blowout site centered along a tributary to Elk Creek, about 910 feet south and 860 feet west of the NE cor. sec. 22, T. 10 N., R. 21 W., Beckham County, Oklahoma (fig. 1). Mr. Walter, who lives about 1.5 miles east of the site, stated that no one had heard an explosion at any time, and while he thought that the creek bed might have been disrupted as early as last November, he also theorized that the explosion could have occurred during the night of February 16, 1973.

Mr. Walter reported the occurrence to Bill Goines, undersheriff of Beckham County, on February 23, 1973, and the sheriff examined the area. A Mr. Fred Gordon, science instructor at Merritt High School—about 5 miles west of Elk City—visited the area soon after the initial report to the sheriff. The author first viewed the blowout site February 24, after a request for assistance was received by the Oklahoma Geological Survey.

DESCRIPTION OF BLOWOUT SITE

The blowout site and associated phenomena (fig. 2) may be subdivided into 4 parts: (1) the central crater (figs. 3, 4), about 30 feet wide (east-west) by 50 feet long (north-south) by about 15 to 20 feet deep; (2) 3 pressure cracks radiating from the crater along the main creek and 2 tributaries, striking N. 5° E. (70 feet long), N. 75° W. (60 feet long), and S. 30° E. (160 feet long) (fig. 5), with 5 to 10 feet of upswelling of the creek beds along a zone 20 feet wide or more parallel to each crack; (3) a tension zone about 10 to 35 feet away from the edges of the central crater and pressure cracks, subparallel to joint patterns that strike northwest and northeast, with cracks 1 inch to 1 foot wide or more and 8 feet deep, showing movement toward the creeks (fig. 6); and (4) ejecta, consisting of 1-foot

[1]Geologist, Oklahoma Geological Survey.

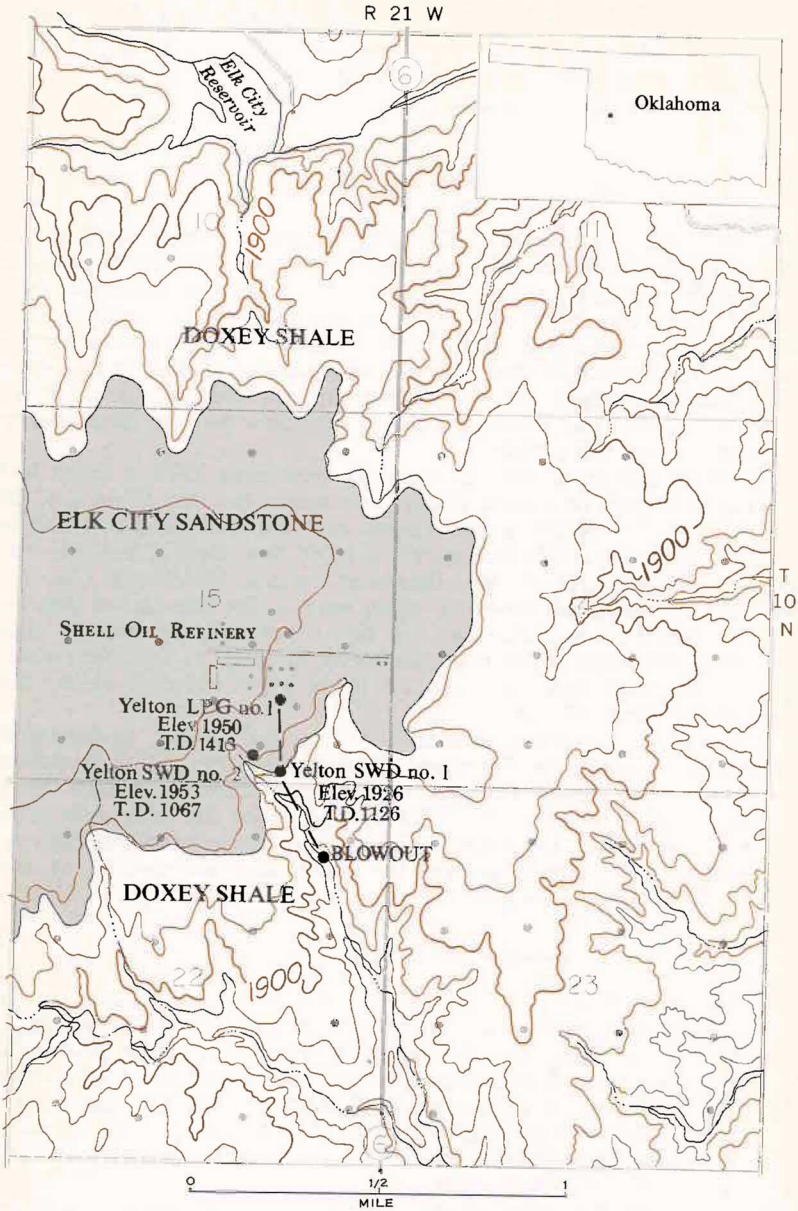

Figure 1. Geologic map of area surrounding Elk City blowout site in Beckham County, Oklahoma. Also shown are Shell Oil Company natural-gas-processing plant, Shell propane-storage (LPG) and salt-water-disposal (SWD) wells, wells of Elk City oil field, and line of cross section (fig. 10).

blocks of Doxey siltstone thrown as far as 75 feet from the center of the crater and weighing 50 to 75 pounds.

The rocks around the main crater are tilted 28° to 78° from the horizontal. The large blocks on the north side (fig. 3) are about 3 feet thick, 20 feet long, and 10 feet wide and strike N. 65° E. and dip 78° northwest; they are estimated to weigh 30 tons. The large blocks on the west side strike N. 50° W. and dip 33° southwest. Large

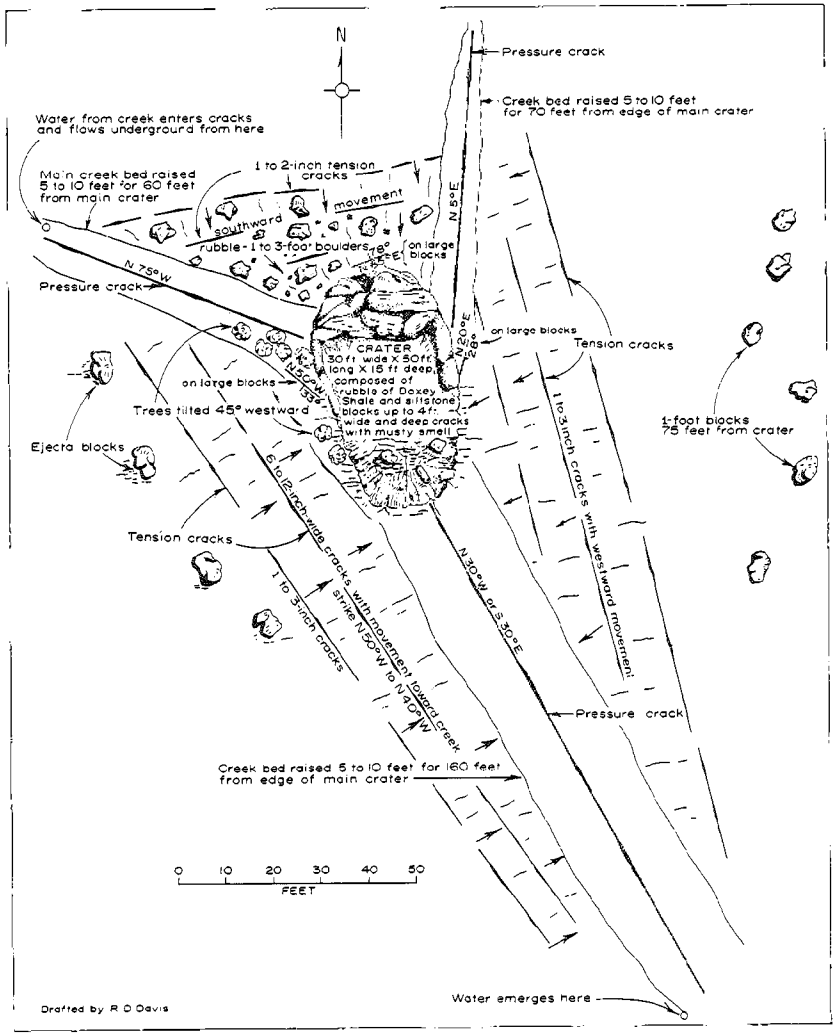

Figure 2. Diagram of blowout site. Center of site is 910 feet south and 860 feet west of NE cor. sec. 22, T. 10 N., R. 21 W.

trees (15 to 20 feet high, with trunks 1 foot in diameter) have been uprooted on the west side and tilted about 45° westward from the vertical (fig. 4). On the east side, a large block strikes N. 20° E. and dips 28° southeast. Near the center and also at the south end of the crater, large blocks 3 to 4 feet in diameter are scattered. On the southeast end of the crater, the surface soil and rock were overturned slightly past the vertical against a tree, toward the east. Mud was found on the highest limbs, and grass and some corn stalks with roots and mud attached were thrown out on the east side of the crater.

Along the pressure cracks, the ground is broken and rocks and mud are on edge (fig. 5). A musty smell was reported to have issued from the deep cracks in the main crater, and Mr. Gordon and his students, who visited the site just after the initial report, stated that they saw fumes issuing from numerous vents along the south crack. They reported that the fumes smelled like gas. These fumes persisted from Saturday, February 17, to Monday, February 19, 1973. It should be noted that although natural gas (methane) and related gases such as ethane and propane are odorless and invisible, fumes (water vapor condensing) could have developed in the presence of water. The musty smell could have come from decaying material in the deep cracks.

The creeks follow joint patterns in the bedrock, and the cracks followed these same patterns. The main creek flows southeastward, turning eastward at the blowout site. The old creek bed is dry along the blowout site, but the water is clear on either side of the site and supports plant and animal life. No salt water was found, except for a little salt crust on the 3-foot siltstone in the creek bed. On the west end of the west pressure crack, the creek flows underground, where it probably enters a large tension crack that strikes N. 40° W. The water bubbles out under a small head of pressure just below the south end of the south pressure crack and slightly up the west side of the creek bank. Mr. Goines thought that some of the tension cracks on the west side had widened and deepened and that some new cracks had developed between February 17 (when they were first noted) and February 24 (when the Oklahoma Geological Survey began its investigation).

GEOLOGIC INVESTIGATION

Geologic setting.—The logical first step in the Oklahoma Geological Survey's investigation was review of the geology of the area in which the blowout had occurred. The rocks at the surface and in the shallow subsurface consist of Upper Permian red beds that are almost flat lying (fig. 7). The highest stratigraphic unit is the Elk City Sandstone (10-35 feet thick or more, top eroded), which caps the area west and north of the blowout site.

The underlying Doxey Shale (165 feet thick) crops out at the blowout site and is mostly red-brown shale and siltstone. The section at the blowout site represents a zone about 70 feet below the top; here, a 3- to 4-foot well-indurated siltstone occurs along the creek bed.

Figure 3. View at central crater, looking north. Large vertical blocks of Doxey siltstone are estimated to weigh 30 tons. Note Shell Oil Company natural-gas-processing plant on skyline.

Figure 4. View at central crater, looking southeast. Trees on west side of crater are tilted almost 45° westward.

Figure 5. View along southeast crack, paralleling creek bed, looking northwest. Soil and grass have been pushed up almost 5 feet.

Figure 6. Tension crack formed by release of material downhill toward creek, looking southeast. Crack 1 foot wide and about 10 feet deep is about 20 feet west of creek and extends for about 200 feet along a N. 50° W. line, following a joint pattern.

Below the Doxey, in the subsurface, is the Cloud Chief Formation (430 feet thick), which is mostly orange-brown shale with some fine-grained siltstone and sandstone and some gypsum beds near the base. The formation crops out south and east of the mapped area, with the top about 100 feet below the blowout site. The remaining units below the Cloud Chief occur only in the subsurface in this region.

The underlying Whitehorse Group (430 feet), mostly orange-brown fine-grained sandstone, is subdivided into the Rush Springs Sandstone (310 feet thick), above, and the Marlow Formation (120 feet thick), below. The Marlow has several thin gypsums or dolomites in the upper 20 feet and 1 or 2 thin gypsums in the basal 32 feet.

Below the Marlow is the Dog Creek Formation (305 feet thick). The upper 90 feet is mainly red-brown blocky shale, and the Yelton salt constitutes the lower 215 feet of the formation.

Underlying the Dog Creek is the Blaine Formation (240 feet thick), which is mainly salt and anhydrite in several distinct beds, each separated by thin zones of red-brown shale. Several thousand feet of older Permian red beds occurs below the Blaine, consisting mainly of red-brown shale, with several thick salt and anhydrite beds.

A detailed surface geologic map was made of this area by Smith (1964, pl. 1), from which the present geologic map (fig. 1) was adapted. The shallow subsurface stratigraphy was summarized by Jordan (1959), Ham and Jordan (1961), and Jordan and Vosburg (1963).

Procedure.—This investigator scanned the blowout area with a metal detector; no metal or parts of a pipeline were detected. It was subsequently determined that no pipeline had been placed in this area.

The U.S. Bureau of Mines office in Bartlesville, Oklahoma, was contacted, and on March 1, 1973, Robert Arndt, liaison officer for Oklahoma, Oklahoma City, and F. E. Armstrong, project leader, and Herbert B. Carroll, Jr., research physicist, both from the Bartlesville Energy Research Center, visited the site. They surveyed the area with a Century hydrocarbon detector and found gaseous hydrocarbons in several places, with higher concentrations near the upright slabs on the north end of the crater. In a cavity just north of these slabs, they found concentrations of 1 to 2 percent, during which time a wind of 20 to 30 knots was blowing. They estimated that with only a slight wind the total hydrocarbons would probably have been higher. Tests were run for carbon monoxide, carbon dioxide, and oxides of nitrogen, with negative results. Gas samples were taken back to the laboratory and analyzed by gas chromatography, with the result that a typical sample contained approximately 1 percent total hydrocarbons, of which 4 percent was methane (CH_4), 21 percent ethane (C_2H_6), and 75 percent propane (C_3H_8). As naturally occurring hydrocarbon gas does not contain nearly this high a percentage of propane, it was concluded that the nearest source of relatively pure propane should be examined as the most likely point of origin for the gas that had caused the Elk City blowout.

It was concluded that the source of the propane was a well at Shell Oil Company's natural-gas-processing plant, about 2,300 feet north of the blowout site (figs. 8, 9), where liquefied petroleum gas

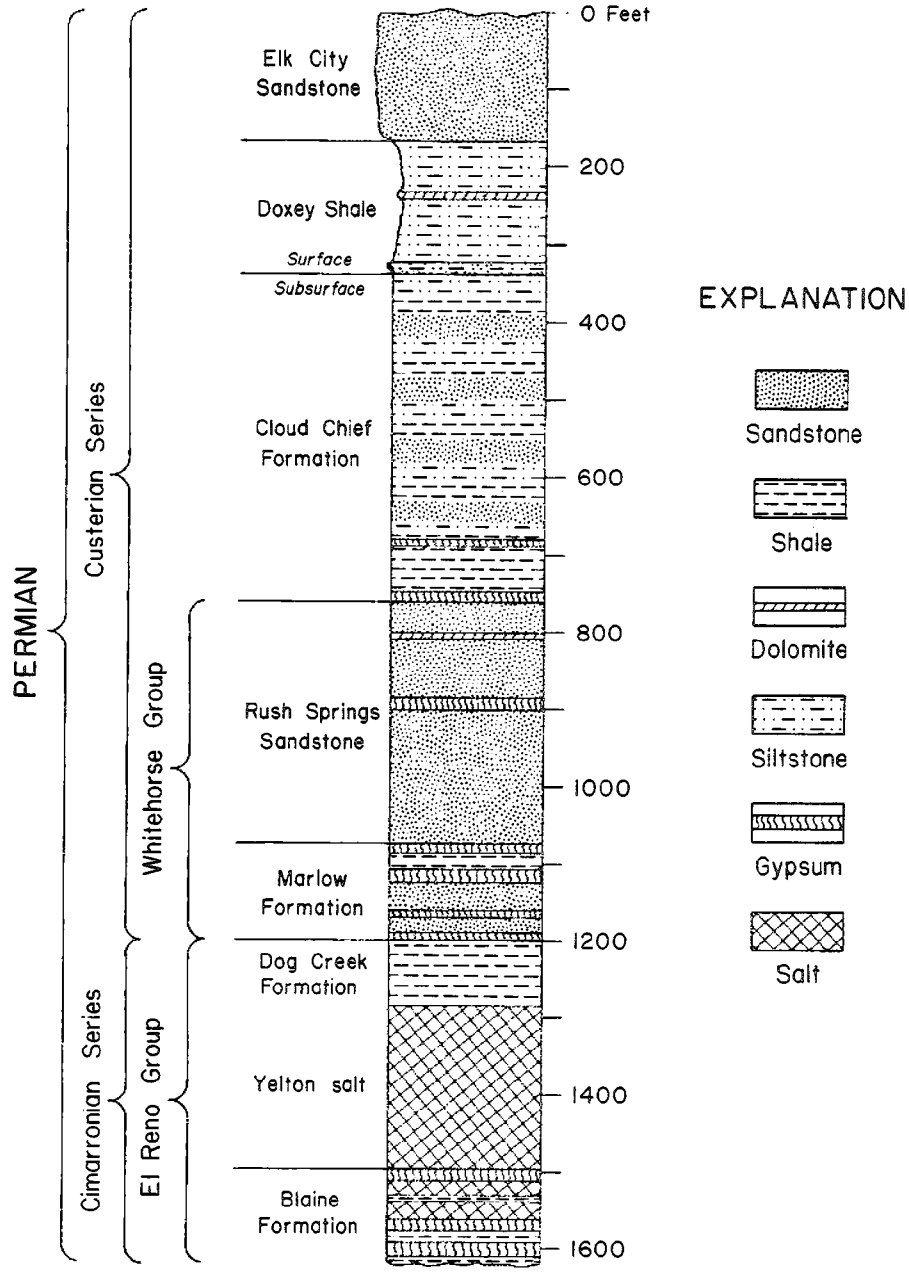

Figure 7. Surface and subsurface stratigraphic section for area around blowout site.

(LPG), mostly propane, was being pumped into a small underground storage reservoir which has been dissolved from salt beds in the upper part of the Blaine Formation. But it was essential that this investigation not cease with merely pinpointing the source of the gas leak.

In 1971, 136 underground LPG storage systems with a capacity of 169.9 million barrels were in service in the United States, according to the *Oil and Gas Journal* (1971). Of these, 35 systems were caverns mined in rock, about 90 were in salt, and 11 were in brine wells and depleted gas wells. Of the total, 78 are in Metropolitan Statistical Areas of 17 large cities: 39 in Houston, 9 in Detroit, 7 in Cincinnati, 3 in Los Angeles, 3 in Philadelphia, 2 each in New York, St. Louis, Chicago, Omaha, and Toledo, and 1 each in Peoria, Des Moines, Baltimore, Grand Rapids, Lincoln, Canton, and Tulsa. In Oklahoma in 1971, about 2,089,500 barrels of LPG products were stored underground.

The Shell facility at Elk City is typical of a number of underground storage systems. It is quite possible that leaking propane from other systems elsewhere has gone undetected. Thus, isolating the specific cause for the Elk City blowout and insuring that proper repairs were effected and preventive measures taken could be invaluable in forestalling other explosions.

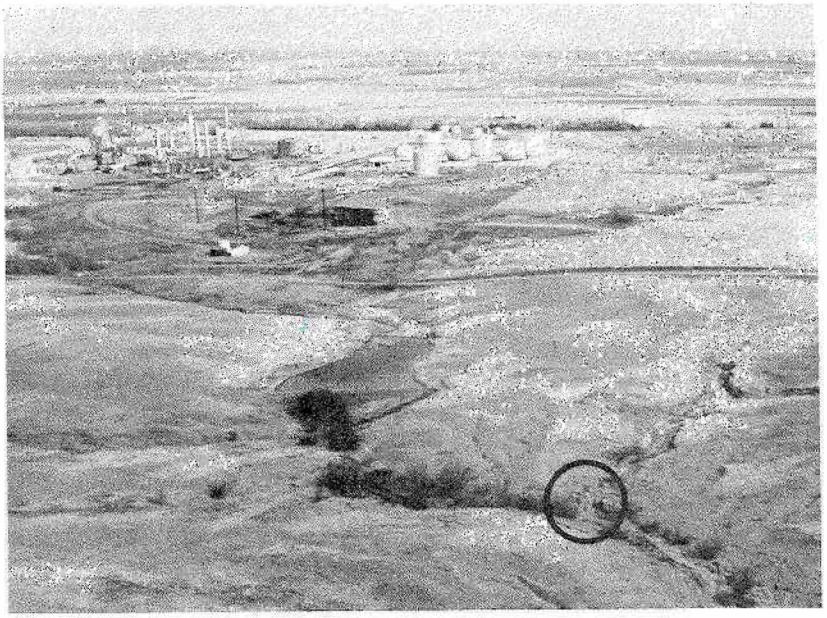

Figure 8. Oblique aerial view of blowout site (crater circled), looking northwest, with Shell Oil Company natural-gas-processing plant in background. White building north of section-line road extending across photograph just above center marks location of 1-SWD Yelton well, and lone tank south of the six tanks is salt-water-storage tank for 1-LPG Yelton well, directly to west.

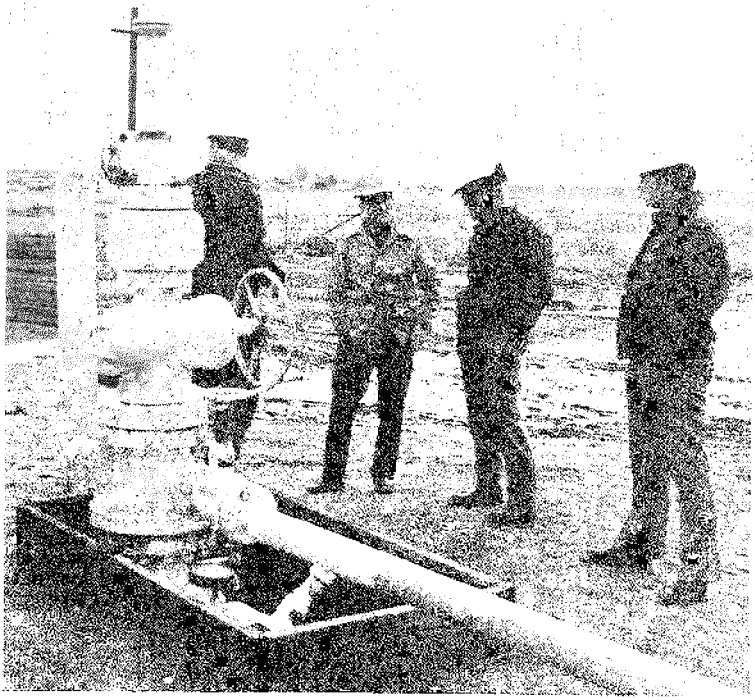

Figure 9. Christmas tree of 1-LPG Yelton well, looking southeast. Salt-water pipe on left enters well at top; salt-water flow is controlled by large wheel on right. Propane pipe on right connects from plant to 7-inch casing, with cutoff valve just to right of wellhead.

SHELL'S UNDERGROUND LPG STORAGE FACILITY

Shell Oil Company has maintained its Elk City underground storage facility since 1954 (Saye, 1956; Jordan, 1959). The storage well, the Shell 1-LPG Yelton, NE¼NE¼SW¼SE¼ sec. 15, T. 10 N., R. 21 W., was drilled to a total depth of 1,420 feet. The storage zone in the Blaine salt occurs from 1,360 to 1,411 feet.

About 1,000 feet south and southwest of the 1-LPG Yelton well are two salt-water-disposal (SWD) units, the Shell 1-SWD Yelton, SE¼SE¼SW¼SE¼ sec. 15, and the Shell 2-SWD Yelton, SW¼-SW¼SE¼ sec. 15, T. 10 N., R. 21 W. The 1-SWD Yelton was perforated opposite the lower Marlow Formation and upper 90 feet of the Dog Creek Shale at 956-1,126 feet. The 2-SWD Yelton was perforated in about the same zone, at 974-1,067 feet. These wells were spudded in August 1956, and they each receive about 2,000 barrels of salt water per day at pressures ranging from 450 to 625 pounds per square inch (psi).

The 1-LPG Yelton was spudded in the lower 10 feet or more of the Elk City Sandstone in August 1953 and was completed in January 1954. The pear-shaped cavity or "jug" is in salt of the upper Blaine Formation and is 45 feet high; the base is 63 feet in diameter, and the top, 43 feet (figs. 10, 11). The cavity was created by dissolution of the salt by circulation of fresh water through the salt beds and removal of the salt water. Surface casing (16-inch) was cemented to 117 feet. The main casing (10¾-inch) was cemented to 1,347 feet, with resin cement used on the lower 200 feet. The next string of casing (7-inch) hangs free to 1,361 feet, through which the propane moves. In the center is the 4½-inch salt-water casing, which hangs free to 1,411 feet and extends upward to a 50-foot storage tank at the surface. Salt water remains at the bottom of the jug at about 740 to 750 psi, and propane is at the top of the jug and in the 7- and 10¾-inch casings at about 425 psi pressure at the top. The initial capacity of the jug was 17,500 barrels, which is also the present capacity. (This figure was incorrectly reported as 16,000 barrels in Jordan, 1959.) Shell initially produced about 1,800 barrels of propane per day.

MECHANICS OF PROPANE MOVEMENT

The blowout site is the closest topographically low area to the 1-LPG Yelton. In other words, if the propane had moved out about 2,000 feet from the LPG well, this creek bed would have been the weakest and lowest point of static pressure in the area and would have been the first to blow out. If the propane had been very deep, it is unlikely that the blowout would have occurred this close to the LPG well. Therefore, the propane was probably moving along a permeable "thief" zone, less than 200 feet deep, in the Doxey Shale. One of the few thin, permeable siltstones in the relatively impermeable Doxey must have transmitted the propane laterally until it cracked its way to the surface by following natural joint patterns (fig. 10).

If 30 gallons per day of propane were leaking to a 1-inch-thick siltstone in the Doxey Shale over a 20-year period, and if the propane were traveling 2,000 feet—postulating about 10 percent effective porosity and 1 millidarcy permeability—about 220,000 gallons (or 30,000 cubic feet) of propane would have been lost to a volume of 100,000 cubic feet of rock if leakage were radial. If leakage were in one direction, say one-fourth of a circle, the total rock volume would be 25,000 cubic feet, which would be complete saturation of the thief zone from the LPG well to the blowout site. The 3-foot siltstone at the surface, and the overlying mud and trees, including a column of air above, would exert about 20 psi pressure downward. In addition, about 22.5 psi would be needed to lift this weight about 20 feet high. The crushing strength of a Permian red-bed siltstone is about 700 psi (Handin, 1966, p. 273); but in weathered rock this factor may be reduced tenfold to about 70 psi. Thus about 110 psi pressure is adequate to explain the Elk City blowout, and a pressure buildup of up to 400 psi or so could possibly result from long-term leakage into the thief zone.

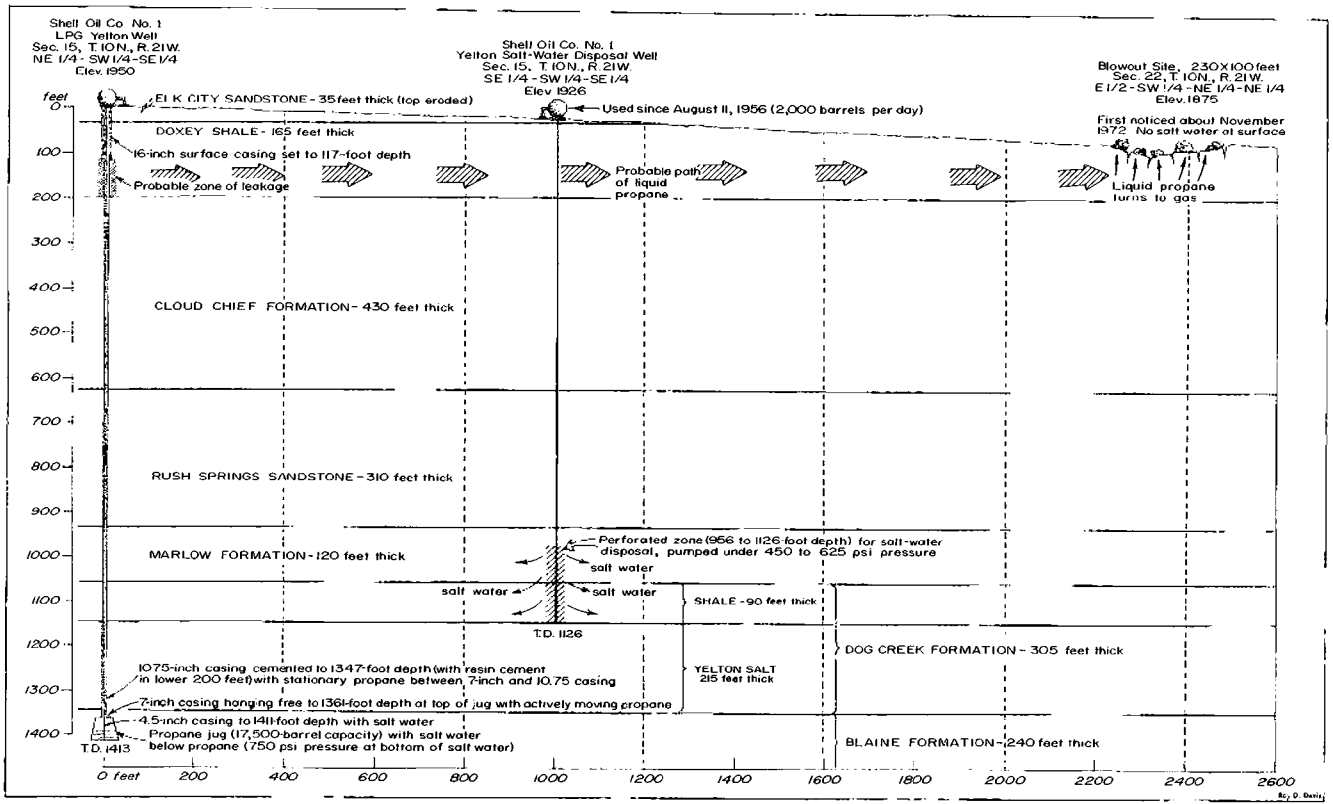

Figure 10. Cross section from Shell Oil Company natural-gas-processing plant (on north) extending south-southeast to blowout site (see fig. 1), showing propane-storage zone, salt-water-disposal zone, and probable zone of movement of liquid propane toward blowout site.

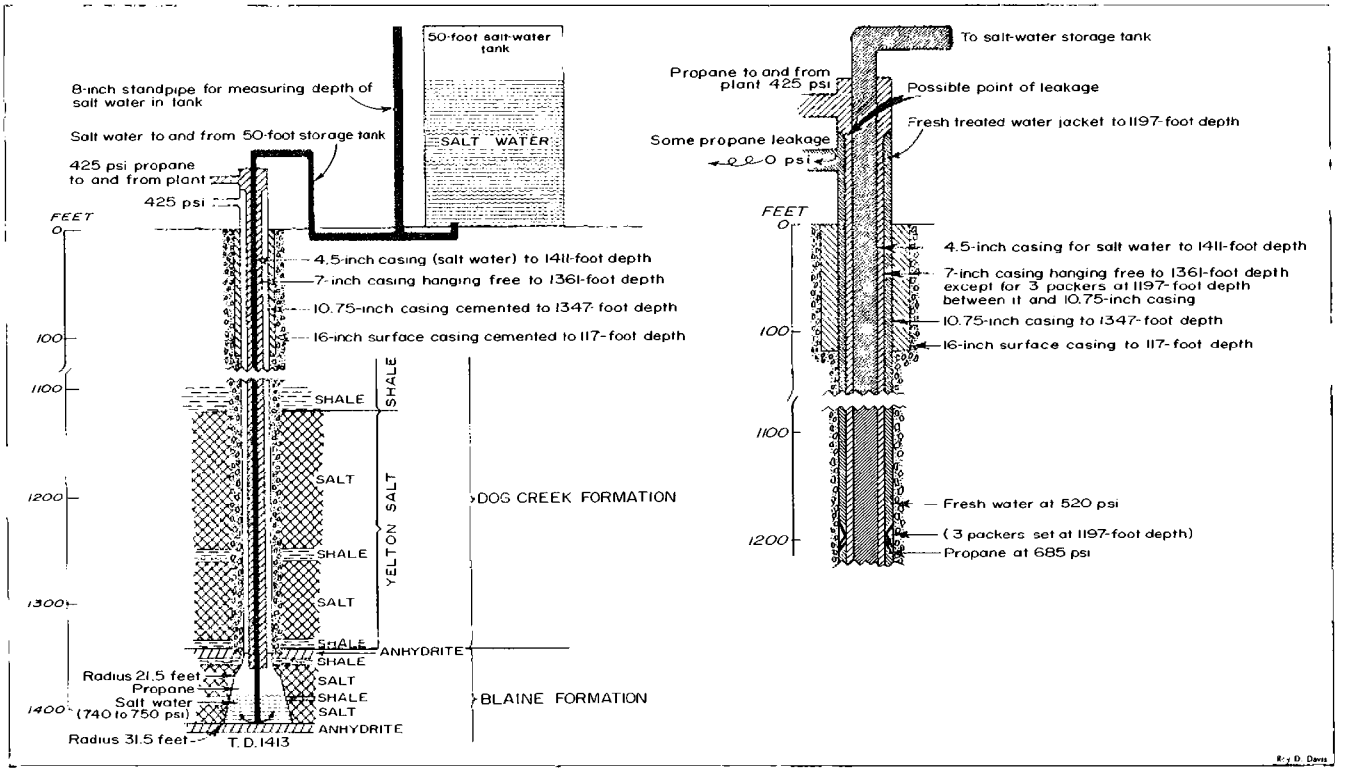

Figure 11. Cross sections of 1-LPG Yelton well. Section on right reflects status of well in April 1973.

CORRECTIVE ACTION TAKEN

Shell Oil Company officials were contacted on February 27, 1973. They also tested the site, finding total hydrocarbons in almost explosive quantities (at least 4 percent), and verified that the main constituent was 85 percent propane. William Bateman, manager of safety and environmental conservation for Shell, Midland, Texas, and D. L. (Larry) Forsander, foreman of the Elk City plant, had the area guarded for protection of the public, at the same time initiating action to determine the cause of the propane leak. Robert Norris, Shell geologist from Midland, visited the area on March 5-6.

Shell personnel isolated the propane-storage well and checked for an indication of a possible leak by watching in a surface standpipe the level of a column of salt water in direct pressure communication with the underground storage reservoir. About 7,000 barrels of propane was in the jug and casing at the time. A drop of 75 inches was observed in the standpipe over a 13-hour period, indicating a total loss of about 30 gallons of liquid per day, presumably propane. This small amount of leakage would normally go undetected, but it could have allowed sufficient buildup of propane over an extended period of time to account for the nearby blowout.

The next step was to locate the point of leakage. It was concluded that the jug was not leaking directly, or else the salt water from the disposal wells would also have leaked to the surface, because the salt water is under pressure in the basal Marlow and upper Dog Creek Formations about 200 feet above the top of the jug. No salt water, or very little, was detected at the surface, so the leak must have been at least above the top of the salt-water-disposal zones (975 feet or less) somewhere in the 10¾-inch casing. The 16-inch surface casing is cemented to 117 feet, and the blowout site is about 75 feet below the surface elevation of the 1-LPG Yelton, so the leak must have been at least 75 to 117 feet below the top of the 1-LPG Yelton, and probably below 117 feet.

Shell officials decided to empty the storage reservoir of propane so that adequate tests could be conducted to determine the probable leakage source. The propane was displaced from the reservoir with salt water by March 28. The 4½-inch-tubing and 7-inch-casing strings were pulled from the well and checked for flaws. A few threads in the 7-inch-casing string were found in need of repair, but otherwise these tubulars were in good condition. With these tubulars out of the well, a cement-bond survey was run to determine how well the cement sheath around the 10¾-inch-casing string was bonded to the casing. This survey showed that the lower 200 feet (from about 1,120 to 1,347 feet) was well bonded and that the upper 1,120 feet was poorly bonded. A special resin cement had been used in the lower part of the hole, and this probably explains the better bond of the lower 200 feet. At any rate, this good bond at the bottom precludes leakage of propane from the reservoir upward outside the 10¾-inch casing. It is possible, however, that propane leaking through the 10¾-inch-casing threads at some point above the resin cement would also penetrate the regular cement sheath even if it were well bonded. The tubulars were run

back into the well with a packer added between the 7-inch- and 10¾-inch-casing strings at 1,197 feet. Next, the annulus between these casing strings was filled with inhibited fresh water and tested for leaks. No leaks were found, nor did a pressure test on the reservoir indicate any leakage. Next, the storage well was returned to service by pumping propane at 425 psi down the annulus between the 4½-inch tubing and 7-inch casing (fig. 11). Thus the system has been back in operation since April 23, 1973. No tests were made for leakage from the 10¾-inch casing with propane under pressure, and, as previously stated, no leakage was detected when testing with water. (The fresh water exerts no pressure at the surface, and about 520 psi at the packer. The propane exerts about 425 psi at the surface within the 7-inch casing and about 685 psi beneath the packer.)

Soon after returning the well to service, a propane leak developed in the fresh-water-filled annulus between the 7-inch and 10¾-inch casings. The small amount of propane leakage is being continuously bled off at the surface in order to prevent the annulus from pressuring up while a solution to this leakage problem is being sought. By preventing the annulus from pressuring up, leakage of propane from the 10¾-inch casing into the thief zone is precluded. It is suspected that this leak is somewhere in the casing-hanger assembly, which is the point of greatest pressure differential.

CONCLUSION

A press release was distributed by the Oklahoma Geological Survey on March 9, 1973. Up to that time, many people had submitted independent theories, some of which were published in local newspapers. The ideas (all incorrect) ranged from meteorite impact, deep natural-gas blowout, earthquake or microearthquake, volcano, gravity-thrust slide, and collapsed cavern to those with religious implications, including plowing the ground on Sunday. (Osmond in 1950 had reported a somewhat similar disturbance in the Leuders Limestone of Permian age in Concho County, Texas, although he concluded that the buckled rocks were probably due to a compressional stress activated by gravity.) The Survey attempted to investigate all plausible explanations and make the results available to the public, but most of the suggestions could be easily dismissed by geologists. A noteworthy exception, however, was the idea of a fault extending from the surface down to a gas source. The bedrock is well exposed in badlands around the blowout site, but there is no displacement or sign of movement of rock except at the immediate site (fig. 12). Leon Reiter, assistant professor in the School of Geology and Geophysics at The University of Oklahoma, was unable to find evidence of this event on short-period seismology records from the OU Earth Sciences Observatory near Leonard in Tulsa County. Donald Hart, Jr., of the U.S. Geological Survey, Water Resources Division, Oklahoma City, checked the hydrograph charts from a water well at Clinton-Sherman Air Force Base, about 12 miles east of Elk City, for sharp fluctuations in water level that might have been caused by eathquake activity. Five such fluctua-

tions did occur: on October 31, 1972, on November 1, 1972, on December 9, 1972, on December 11, 1972, and on December 29, 1972. Other types of movement, however, such as dynamite blasting and sonic booms, could have affected the water level. As Dr. Reiter was unable to relate any of these dates to recorded seismic events, he concluded that the water movements had a local cause, probably sonic booms.

On March 12, 1973, Shell Oil Company officials had the blowout site restored, as near as was reasonably possible, to the original contour. A small dam was built on the west end, but this has since been breached by floodwater. The stream still flows under the blowout area on the west side, following one of the tension cracks underground and flowing out on the west side of the creek bank, below the south pressure cracks.

Although the exact time of the blowout could not be ascertained, the staff of the Oklahoma Geological Survey is satisfied that, with the help of cooperating State and federal agencies and the complete and

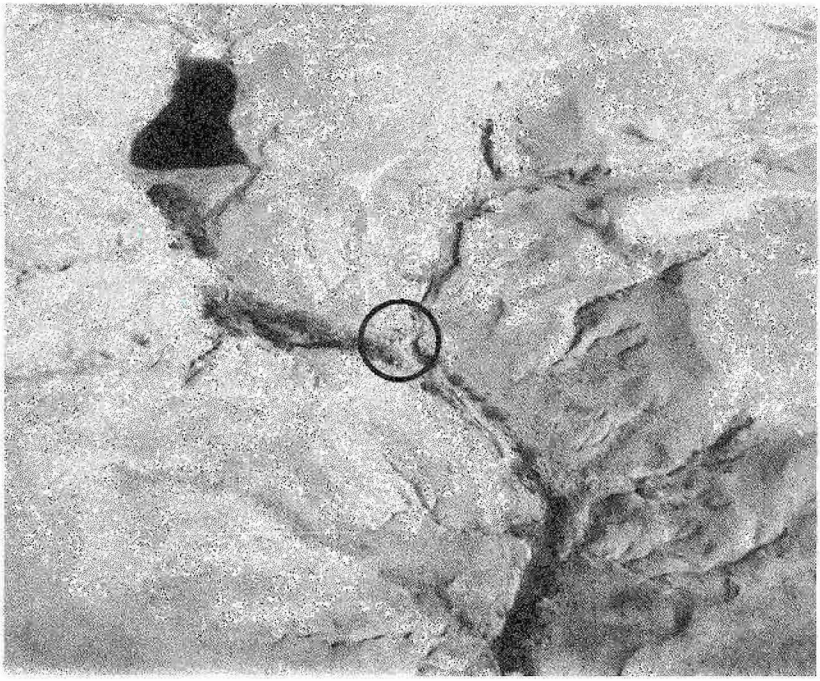

Figure 12. Oblique aerial view of blowout site (crater circled), looking north. Photograph taken from an altitude of 500 feet, using infrared film.

unhesitating action and assistance of Shell Oil Company, the cause of the Elk City blowout has been isolated. The blowout site has been restored to its normal appearance, and precautionary measures have been taken to prevent further leakage from the storage facility.

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New Dissertation Added to OU Geology Library

The following doctoral dissertation was recently added to The University of Oklahoma Geology and Geophysics Library:

Mineralogy and Geochemistry of Volcanic Ash and Bentonite in the Ogallalla Formation (Tertiary) of Western Oklahoma, by David M. Patrick.

New Maps Available from USGS, AAPG, *Oil and Gas Journal*

The U.S. Geological Survey has published a new, skeleton-type base map of the conterminous United States. The 6-color map is issued in 2 sections, each measuring 41 by 54 inches; the complete map measures 54 by 80 inches and is suitable for wall mounting. Sheets are separated at the 96th meridian. The scale is 1:2,500,000. Features shown include state and county boundaries, county seats, major metropolitan areas, major swamp and water features, continental-shelf areas, and deep-water ocean areas. Inserts show Alaska, Hawaii, and outlying U.S. territories. The map is available in two editions, plain or with a buff background distinguishing the United States from adjoining countries; it costs $1.00 a sheet, $2.00 a set. Orders should be addressed to the U.S. Geological Survey's Distribution Section, Federal Center, Building 41, Denver, Colorado 80225.

Additional information about the base map can be obtained from the Map Information Office, U.S. Geological Survey, GSA Building, 19th and F Streets, NW, Washington, D.C. 20244.

The American Association of Petroleum Geologists has issued a portfolio of 45 computer-contoured and labeled geothermal gradient maps for most areas of the United States. The scale is 1:1,000,000. Maps for Canadian regions will be ready this summer, and the completed geothermal map of North America—at a scale of 1:5,000,000—will be available in the spring of 1974. The gradient maps are $5.00 each, $200 a complete set.

AAPG is also offering a basic-data file of 35,000 data records of oil-well, water-well, and heat-flow information available on magnetic tape, punched cards, or computer printouts at a cost of $400.

To order the maps or data file or for additional information, contact The American Association of Petroleum Geologists, P.O. Box 979, Tulsa, Oklahoma 74101.

The *Oil and Gas Journal* recently published a six-color wall map of products pipelines in the United States and Canada. The map, suitable for framing, measures 40 by 57 inches. The price is $6.00 folded and $8.00 rolled in a mailing tube. It is available from the Book Department, P.O. Box 1260, Tulsa, Oklahoma 74101.

New Council Directed to Formulate State Energy Policy

The Oklahoma Energy Advisory Council was recently created to assist in the formulation of a State energy policy that would give equal priority to development and conservation of the State's energy and water resources and to maintenance and improvement of the State's natural environment. Established by Senate Bill 386, the council was set up as a 30-member body. By law, it is required to consist of 15 members appointed by the Governor, 7 appointed from the membership of the Oklahoma Senate by the President Pro Tempore, 7 appointed from the membership of the Oklahoma House of

Representatives by the Speaker, and the chairman of the Oklahoma Corporation Commission or his designee. Additional stipulations were that 2 of the Governor's appointees be professional geologists, 5 be representative of the exploration, development, and production segments of the energy industry, and 6 be representative of the energy-consuming segment of our society (of these 6, no more than 4 can be connected with the industrial production or industrial consumption of energy).

Robert A. Hefner III, gas explorationist for Glover, Hefner, Kennedy Oil Company in Oklahoma City, is chairman of the council; Alex P. Aven, consulting geologist with the Resource Analysis and Management Group in Oklahoma City, is serving as vice-chairman. Joining them on the 7-member executive committee are State Senator Herschal Crow of Altus, State Representative Gary Payne of Atoka, Jim Harlow of Oklahoma Gas and Electric Company in Oklahoma City, Duke Cooper of the Rural Electric Cooperative Association, Stillwater, and Margaret Larason of Fargo.

Charles J. Mankin, director of the Oklahoma Geological Survey, was asked to participate on the council, an appropriate request since the group was specifically charged by the Legislature with "acting as coordinator with the Oklahoma Geological Survey in the collection of data on Oklahoma's energy resources from state agencies."

Current energy policies are the result of deliberations and actions that include those of a number of State agencies, the Legislature, and the office of the Governor. The council intends to work closely with all such groups. In addition, any member of the State Legislature, elected or appointed public official, representative of industry, or any individual citizen has the statutory right to attend meetings of the Oklahoma Energy Advisory Council.

The group's effectiveness will be measured by its ability to devise a sound policy with respect to energy requirements, and contributions to its understanding of the situation will be welcome.

Mine Inspectors Meet at Fountainhead Lodge

The 63d annual convention of the Mine Inspectors Institute of America was held at Fountainhead State Lodge near Checotah, Oklahoma, on June 10-13. The institute, primarily composed of State mine inspectors, is open to others interested in coal-related matters such as mining and safety, mine safety equipment, ore and coal transportation, and mined-land reclamation, according to Ward Padgett, chief mine inspector of Oklahoma. Mr. Padgett was host to the institute as its president for 1972-73.

The annual convention traditionally attracts inspectors and their families from all over the country. This group totaled 244 registrants this year, and another 89 persons attended special sessions and banquets.

The participants were welcomed by the Hon. John N. Happy Camp, U.S. Congressman from Oklahoma, who then introduced Dean

A. McGee, chairman of the board of Kerr-McGee Corporation. Mr. McGee indicated in his address that coal liquefaction and coal gasification would have to become realities on a commercial scale soon to help avoid a major crisis in energy supply. He also called for sharp increases in exploration and mining of uranium so that fuel requirements of 165 nuclear-power plants now on order could be supplied by 1985.

Other talks were presented on experiences in combating fires in underground coal mines, diesel-emission measurement and control in underground mines, a new method of surface coal mining in steep terrain, and the surveillance and communication system at the U.S. Bureau of Mines' research coal mine at Bruceton, Pennsylvania.

The highlight of the final day's sessions was an address by Oklahoma's Governor, the Hon. David Hall, who reviewed briefly the State's coal-mining history and stated that Oklahoma intends to maintain its position as a national leader in energy production, in part by increasing its coal production to compensate for decreasing oil and gas reserves. He noted that gas production could be supplemented by coal gasification from three plants that could be constructed in eastern Oklahoma.

—*S. A. Friedman*

AIPG State Section Meets September 8 in Oklahoma City

The Oklahoma Section of the American Institute of Professional Geologists will hold its annual convention on Saturday, September 8, at the Skirvin Hotel in Oklahoma City. Section president Edward L. Johnson of the U.S. Geological Survey, Tulsa, will preside over the sessions.

The morning session will begin at 9:30 and will be devoted to the section's business affairs. Committees reporting will include environmental, membership, professional and scientific standards, and regulatory and legislative.

An event of special interest will be a luncheon talk by Denzil Garrison of Bartlesville, whose subject will be "Government and the Oil Industry." Mr. Garrison is well known as a former state senator, having served as minority floor leader and as vice-chairman of the oil and gas committee.

The afternoon session will include a review of national AIPG affairs plus any business remaining from the morning session. Tentatively planned is a discussion of AIPG's role in relations between industry and its geologist employees. A good-fellowship hour over liquid refreshment will round out the afternoon's activities.

Convention chairman Harold Kleen has issued a special invitation to nonmembers to attend the entire meeting. A registration fee of $6.00 will cover the cost of the luncheon as well as two drinks during the social hour. For further information, contact Mr. Kleen at the Kerr-McGee Center, Oklahoma City 73102, phone (405) 236-1313.

Oklahoma Paleoichthyology
Part III: Description of an Arthrodiran Plate

Jiri Zidek[1]

INTRODUCTION

Eastman (1917) illustrated two arthrodiran plates from the collections of the U.S. National Museum. These specimens were collected by G. H. Girty, who placed them stratigraphically in the Mississippian "Caney Shale" (=Delaware Creek Formation) of Oklahoma, but in view of what is known today about the geological occurrence of the Placodermi this assignation must be questioned. It is more likely that the specimens were collected from an Upper Devonian unit, possibly the Woodford Shale. Unfortunately, Girty's locality is given only as south-central or southeastern Oklahoma, so the precise stratigraphic position can only be surmised. Moreover, one of the specimens cannot be found. Because of their importance as the only placoderm remains known from Oklahoma, the specimens are considered worthy of discussion in spite of the lack of definite information on their occurrence.

I would like to thank Mr. Robert W. Purdy of the U.S. National Museum for his help during my visit and Dr. Robert H. Denison, curator emeritus for the Field Museum of Natural History, who kindly agreed to check the manuscript. Financial assistance received through the short-term visitors program of the Smithsonian Institution and through the Foundation of Geology and Geophysics of The University of Oklahoma is gratefully acknowledged.

DESCRIPTION AND DISCUSSION

Class Placodermi
Subclass Arthrodira
Superorder Euarthrodira
Order Coccosteomorphi
Coccosteomorphi Indet.
Fig. 1 a-d

Arthrodiran (**Coccosteus**-like) antero-ventro-lateral plates, Eastman, 1917, p. 255, pl. 10, figs. 5, 6. See also Zidek, 1972, p. 172-173.

Material: U.S. National Museum (USNM) Cat. No. 8107, counterparts in concretion, collected by G. H. Girty.

Zone: Upper Devonian, possibly Woodford Shale.

Locality: South-central or southeastern Oklahoma—Arbuckle Mountains or western-northwestern margin of Ouachita Mountains.

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[1]Assistant professor of geology and curator of vertebrate paleontology for the Stovall Museum, The University of Oklahoma, Norman. Parts I and II of this study were published in **Oklahoma Geology Notes** (v. 32, p. 171-187, and v. 33, p. 87-103, respectively).

Note: The arthrodiran plate illustrated by Eastman (1917, pl. 10, fig. 5) is the USNM 8107 specimen that is depicted in this paper as figure 1b. Its counterpart, not illustrated by Eastman, is here depicted in figure 1a. On the same plate Eastman illustrated as fig. 6 another arthrodiran plate from the "Caney" that I have been unable to locate in the USNM collection.

Description and discussion of USNM 8107 specimen.—Unfortunately, the concretion in which the specimen is preserved was broken in such a way that the plate split in its middle bone layer and is difficult to reconstruct from the counterparts. Perhaps for this reason Eastman illustrated only one of the separated parts (fig. 1b in this paper). His identification of the plate is indicated above.

An examination of the counterpart illustrated by Eastman shows a longitudinal low and broad crest dividing it into a lateral part and a larger mesial (ventral) part, or lateral and ventral laminae. The ventral lamina has a concave profile (fig. 1b, *a-a'*, *b-b'*), and although no true surface is visible anywhere on the fossil it is evident from the curvature that the plate is preserved with its visceral side up. Viewed externally, both the laminae thus would be convex upward and separated by a longitudinal shallow and widely open trough. The lateral and mesial sides are determined by the morphology of the plate: the lateral portion has a well-developed, anteriorly projecting postbranchial lamina (fig. 1c, *pb. la*), whereas the mesial side shows in restoration (fig. 1c) what can be interpreted only as an internal overlap area (fig. 1c, *PVL. cf*). The morphology indicates that the plate is not an anterior but a posterior ventrolateral plate (PVL) viewed from its visceral side.

The restoration shows, too, that the plate was actually broader than indicated by the counterpart illustrated by Eastman. With regard to the bone structure (fig. 1b), the mesial edge has been restored in a line parallel to the preserved margin (fig. 1c), giving the plate an obliquely triangular shape. As it is preserved with its visceral side up, it is the left PVL, and this makes the shape somewhat unusual. As a rule, in the arthrodires the left PVL overlaps the right one, resulting in the left plate's being broader and rather quadrangular—i.e., their lateral and mesial margins are roughly parallel to each other (cf. fig. 1f). In the specimen under discussion, we have the usual case of the left PVL overlapping the right one (*PVL. cf* in fig. 1c), but in spite of this, the plate appears to maintain the triangular form normally characteristic of right PVL's (cf. fig. 1e).

Another interesting feature of the specimen is a transverse ridge in its anterior third extending in a straight line across the ventral lamina (fig. 1a). Because of its straightness and excessive length, it is unlikely that this ridge marks the internal overlap area for the posterior median ventral plate (*PMV. cf*), which would imply an exceptionally broad PMV with a correspondingly deep external overlap. Also, this ridge could hardly be compared to the transverse ridge (*rdg. p* in fig. 1f) described by Miles (1964, p. 445-449), because the ridge in Miles' description is a more posteriorly situated loop-curved

bend on the visceral surface. I am unable to suggest any reasonable explanation of this feature.

The counterpart depicted in figure 1b is small, only 18 mm long and 10 mm wide. Although there is no way of ascertaining that the plate is from a fully grown individual, even if immature, it may still be regarded as belonging to a small arthrodire, because a plate even twice the size would be representative of a moderately small arthrodire.

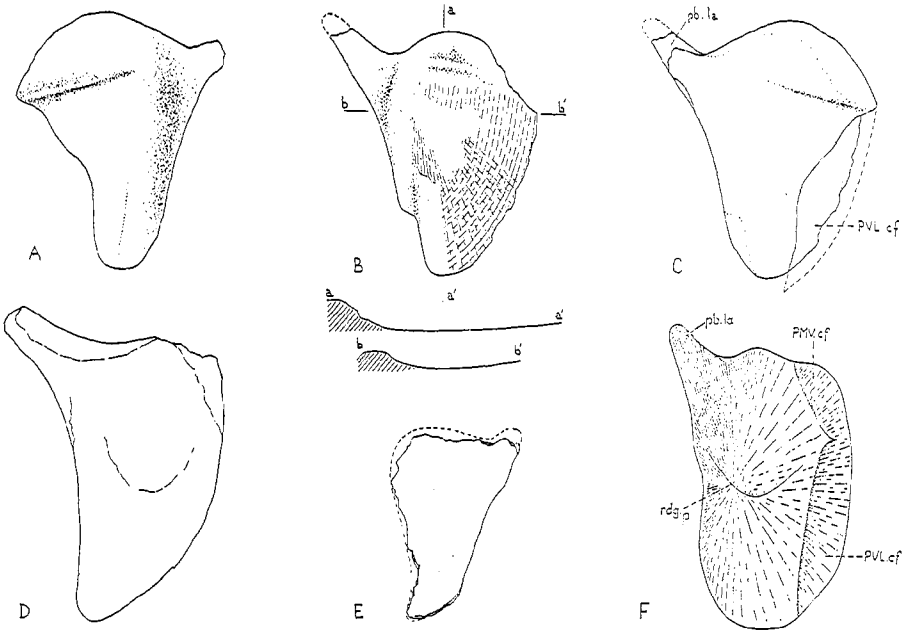

Figure 1. Coccosteomorph posterior ventrolateral plates (PVL).

a-d — Coccosteomorphi Indet. from Upper Devonian (possibly Woodford Shale) of Oklahoma; ×2.

a-c, left PVL (USNM 8107) shown split open (a, b) and restored (c); visceral view.

d, another PVL illustrated by Eastman (from Eastman, 1917, pl. 10, fig. 6).

e — Plourdosteus trautscholdi (Eastman) from Upper Devonian of Leningrad area, U.S.S.R.; right PVL in visceral view; ×¼ (from Obrutcheva, 1962, fig. 38d).

f — Eldenosteus arizonensis (Hussakof) from Upper Devonian of Arizona; restoration of visceral surface of left PVL; ×1 (from Miles, 1964, fig. 2D).

PVL. cf, PMV. cf, internal overlap areas for right posterior ventrolateral and posterior median ventral; pb. la, postbranchial lamina; rdg. p, transverse ridge; a-a', b-b', longitudinal and transverse profiles.

The well-developed, anteriorly projecting postbranchial lamina and the long, moderately broad ventral lamina are characteristic of the PVL plates of the Coccosteomorphi. In its overall shape the plate resembles a number of coccosteomorph genera, although in most of these (*Coccosteus, Dickosteus, Watsonosteus, Millerosteus*) the PVL's have posteriorly projecting spines. In contrast, the posterior margin is rounded in our specimen. Therefore, consideration of a generic relationship can here be given only to two genera, *Plourdosteus* and *Eldenosteus,* in which the PVL's are posteriorly rounded and in which the depth of the internal overlap area (*PVL. cf*) is comparable to that seen in the specimen under discussion (cf. fig. 1c, f). Unfortunately, however suggestive they may be, these similarities do not warrant systematic assignment of the specimen to either of the genera named. Such an assignment is precluded by (1) the discrepancies noted above (the triangular shape and the peculiar transverse ridge), (2) substantial difference in size (the PVL's of both *Plourdosteus* and *Eldenosteus* are at least twice the size of the plate in question), and (3) lack of information about surface features of diagnostic character. The specimen is sufficiently distinct that some taxonomists might regard it as a new genus. However, it is not well enough preserved for a diagnosis, and basing a new taxon on a single, poorly preserved plate can hardly be justified. In addition, plates of juvenile individuals are known to differ from those of adults in shape and proportions, and it is possible that some of the discrepancies noted above are evidences of immaturity. Therefore, unless comparative material becomes available, the plate should be identified only as Coccosteomorphi Indet.

The other arthrodiran plate illustrated by Eastman (1917, pl. 10, fig. 6).—This also is a posterior ventrolateral plate (PVL), but owing to the unavailability of the specimen and the lack of information about the site in which it was found, little else can be said concerning it.

I have attempted to draw it from Eastman's figure (cf. fig. 1d), even though the figure reveals nothing about the curvature of the plate and provides little detail. Without having the specimen at hand it is impossible to tell what side is exposed and therefore whether it is the left or right PVL. The face exposed may be either the visceral surface or, of equal possibility, the result of a split that occurred in a manner similar to that of the specimen just described. Two features are comparable to those illustrated in figure 1f (*PMV. cf, rdg. p*) and therefore indicative of the visceral surface. On the other hand, on the lateral edge there appears to be an indistinct ridge that could be interpreted as the "Ventrolateralkante" (cf. Miles, 1964, for description and further references), and this ridge is indicative of the outer surface. All these features appear only as indistinct broken lines based on conjecture and certainly are not conclusive. They are mentioned here solely for the purpose of a possible future study, in case the specimen should be located. Since the size and shape of this plate appear to be similar to the USNM 8107 specimen, the only conclusion possible at present is to identify it tentatively as Coccosteomorphi Indet.

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New Officers Announced by Oklahoma's Geological Societies

New officers and executive boards for the 1973-74 year have been announced by the following geological and geophysical societies in Oklahoma:

Ardmore Geological Society

President, **Joe Kalkman,** consulting geologist
Vice-President, **James M. Coffman,** consulting geologist
Secretary-Treasurer, **Gordon D. Clark,** independent oil operator
Past-President, **Harris S. Smith,** independent geologist
Executive Committee: **Robert W. Allen,** independent oil operator; **B. W. James,** Quinton Little

Geophysical Society of Oklahoma City

President, **Joseph W. Ferguson,** Data Computing Corporation
First Vice-President, **Harry R. Goebel,** Lone Star Producing Company
Second Vice-President, **Wayne C. Carrier,** Union Oil Company of California
Secretary, **Jeffrey M. Collar,** Cities Service Oil Company
Treasurer, **Richard E. Schneider,** Continental Oil Company
Past-President, **Bill Dulaney,** Mobil Oil Corporation

Geophysical Society of Tulsa

President, **B. G. Baugh,** Seismograph Service Corporation
First Vice-President, **E. L. Current,** Cities Service Oil Company
Second Vice-President, **James M. Bird,** Industrial Vehicles, Inc.
Secretary, **Arthur A. Milton,** Seismograph Service Corporation
Treasurer, **Keith W. Loucks,** Continental Oil Company
Editor, **Karl E. Baer,** Seismic Reference Service, Inc.
Editor-Elect, **P. Edward Byerly,** Continental Oil Company
Past-President, **Homer W. Lawrence,** Seismograph Service Corporation

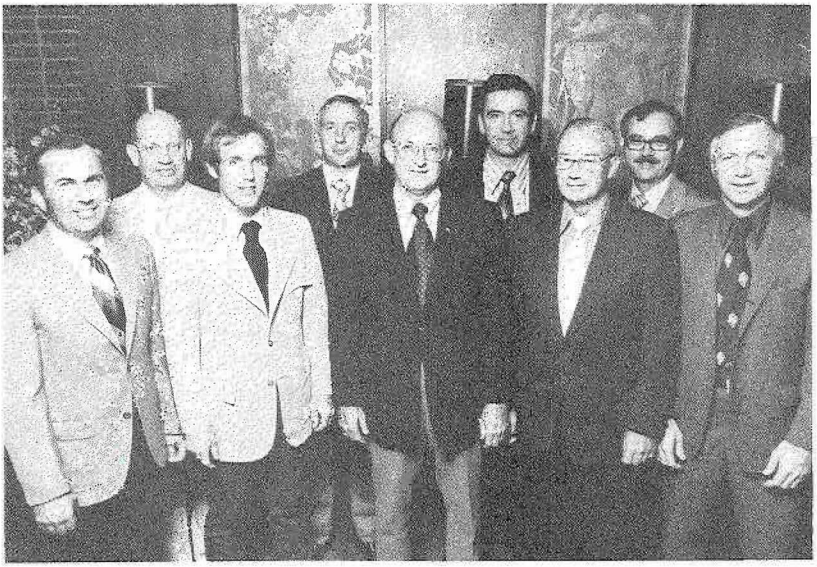
Oklahoma City Geological Society

President, **Louis M. Ford,** Walter Duncan, Inc.
First Vice-President, **James J. Gladden,** Gulf Oil Company
Second Vice-President, **William E. Jackson,** Eason Oil Company
Secretary, **Harold A. Brown,** Texas Oil and Gas Corporation
Treasurer, **Gerald D. Neff,** Montgomery Exploration Company
Shale Shaker Editor, **Thomas C. Cronin,** Midwest Oil Corporation

Library Director, **Lloyd E. Gatewood,** independent oil operator
Social Chairman, **Robert W. Richter,** Texas Pacific Oil, Inc.
Public Relations Chairman, **Sherrill D. Howery,** Union Oil Company of California
Past-President, **Gary A. McDaniel,** Clark Canadian Exploration Company

Tulsa Geological Society

President, **Joseph F. Mueller,** Metro Gas Reports
First Vice-President, **Floyd W. Beghtel,** Phillips Petroleum Company
Second Vice-President, **Ted E. Stanzel,** Skelly Oil Company
Secretary, **John S. Porter,** Cities Service Oil Company
Treasurer, **David L. Docater,** Amoco Production Company
Editor, **Fred V. Ballard,** Amerada Hess Corporation
Past-President, **T. Leo Broin,** Cities Service Oil Company
Councilmen:
John Woncik, consultant
Larry S. Grubbs, Texaco, Inc.
James R. Derby, Amoco Production Company



Oklahoma Geological Society executive committee for 1973-74. Front row, left to right: Gary A. McDaniel, past-president; Thomas C. Cronin, editor; Louis M. Ford, president; James J. Gladden, first vice-president; William E. Jackson, second vice-president. Back row, left to right: Lloyd E. Gatewood, library director; Sherrill D. Howery, public relations chairman; Harold A. Brown, secretary; Robert W. Richter, social chairman. Not pictured: Gerald D. Neff, treasurer.

Oklahoma Geologist Dan Busch Takes AAPG Helm

Daniel A. Busch assumed duties July 1, 1973, as president of The American Association of Petroleum Geologists. Dr. Busch operates a one-man petroleum consultancy that works out of a Tulsa office but extends all over the world. In addition, for the past 9 years he has served as a visiting professor of geology at The University of Oklahoma, teaching courses in petroleum geology and applied subsurface stratigraphy. An active participant in the AAPG continuing-education program, Dr. Busch is a rare fusion of the scholar and the technician—the product of a wealth of theoretical and applied knowledge in a man who has the ability to communicate his learning to others.

At a time when energy has become a household word, most often coupled with crisis and shortages, Dr. Busch believes that geologists must apply creative imagination to improve petroleum technology. He also believes that government should be held responsible to provide an environment conducive to utilization of the vast technical talent concentrated in the earth sciences; AAPG should, however, provide assistance in solving energy problems rather than engaging directly in political activities.

Aiding Dr. Busch with AAPG duties is an impressive slate of supporting officers: vice-president, August Goldstein, Jr., Lubell Oil Company, Tulsa; president-elect, Merrill W. Haas, Exxon Company, U.S.A., Houston; secretary, Bernold M. (Bruno) Hanson, consultant, Houston; editor, Frank E. Kottlowski, New Mexico State Bureau of Mines and Mineral Resources, Socorro; and chairman of the House of Delegates, Robert J. Gutru, consultant, Wichita.

We wish these new officers the luck and support they need tc make this the best year ever for AAPG.

Geology, GSA's New Monthly Publication

In September, The Geological Society of America will launch its new monthly publication, *Geology*. The periodical has been designed to emphasize current awareness by quick publication, thereby helping to fulfill today's need of rapid dissemination of research information. Only about 8 weeks will elapse from acceptance of a manuscript to publication.

Geology was also designed to bridge the gap between completely

informal publication, such as presentations at meetings, conversations, and preprints, and formal publication, represented by the GSA *Bulletin* and other standard serials.

GSA editor Bennie Troxel plans for the scope of *Geology* to be broad enough to include timely articles on all facets of geology and related fields, ranging "from the purely speculative to documentation of new ideas or revisions of old ideas." Other components visualized are symposium and conference reports, preliminary reports of large research programs, and perhaps annotated bibliographies. The format will also include a section entitled "Current Abstracts," containing abstracts of papers already accepted for publication in standard GSA series.

Prospective authors are encouraged to submit articles for the new publication. One requirement for acceptance is at least one outside review by a critical reader who is an authority in the author's field. Also, most manuscripts must be limited to 4 printed pages (about 16 manuscript pages), including abstract, illustrations, and references. A brochure containing complete information for contributors is available on request from GSA headquarters, 3300 Penrose Place, Boulder, Colorado 80301.

Geology will be sent at no extra cost to GSA members. Nonmember subscriptions in North America will cost $9.00 a year; single copies will cost 75 cents.

IOCC Endorses Fuel Conservation

The 1973 midyear meeting of the Interstate Oil Compact Commission (IOCC) was held June 10-13 in the Fairmont Mayo Hotel in Tulsa. Approximately 450 persons attended, with 26 of the 35 member and associate member states represented. Three states were represented by their governors—Oklahoma by David Hall, New Mexico by Bruce King (chairman of the commission), and Colorado by John A. Love. In attendance as official observers were Rush Moody, Jr., Federal Power Commission; Joe Mullin, U.S. Department of Justice; John F. Matthews, Jr., California; Harold A. Meyer, Wisconsin; and Douglas D. McLean, Ontario, Canada.

At the general session, Governor Hall welcomed participants to Oklahoma; each of the governors in attendance commented on the nation's energy crisis with emphasis upon actions currently being taken in their respective states; and representatives from Illinois and Pennsylvania issued statements on behalf of their governors relating to the energy-supply situation.

The serious energy shortages facing the nation prompted the IOCC to set in motion a self-study of its operations. During the business session, the commission voted unanimously to direct the chairman to appoint a subcommittee of the executive committee to review the operations and functions of the compact and to determine whether changes are needed in the charter and bylaws.

The commission's standing committees presented reports, prepared during time allotted the second and third days of the meeting, at the business and general sessions. Reports received included those from committees on energy resources, engineering, secondary recovery and pressure maintenance, research, environmental protection, legal considerations, public lands, regulatory practices, and resolutions.

One of the most significant actions of the meeting was adoption of a resolution urging the governors of the member states to take positive actions to encourage conservation of energy; relax environmental timetables to help overcome fuel shortages; encourage development of oil and gas in Alaska, in U.S. coastal waters, and elsewhere in the nation; encourage the development of advanced technology for oil recovery; and help cultivate attitudes of energy conservation in citizens and in all segments of the economy to reduce oil and gas consumption. The resolution also reminded the oil and gas industry of its responsibility to supply hydrocarbons to this nation at reasonable prices.

This is the first time that the IOCC has spoken out on conservation of energy by consumers, urging development of alternative fuels and calling attention to the fact that environmental concerns have helped create the current shortages of oil and gas.

Papers presented before the standing committees will be published in the *Committee Bulletin.* Proceedings of the meeting and committee reports will appear in the *Compact Bulletin.* These publications will be available upon request to the IOCC Headquarters Office, P.O. Box 53127, Oklahoma City, Oklahoma 73105.

—C. E. Bowlin
Interstate Oil Compact Commission

AAPG Mid-Continent Section Plans October Meeting in Tulsa

The Mid-Continent Section of The American Association of Petroleum Geologists will hold its next biennial meeting in Tulsa, October 3-5. The Tulsa Geological Society will serve as host, and sessions will be in Tulsa's modern assembly center, only two blocks from the downtown area.

The theme of the meeting will be "Petroleum Explorationist's Challenge—The Energy Crisis." Wilson Laird, director of the American Petroleum Institute's committee on exploration, will be the featured speaker. Calling upon a wealth of experience that includes 28 years as the North Dakota state geologist and a stint as director of the Office of Oil and Gas, Department of the Interior, Dr. Laird has worked for years to acquaint public officials with the hardships created by an energy scarcity coexisting with the illusion of energy abundance.

He has repeatedly decried what he calls environmental schizophrenia—"a healthy concern for the problems of preserving the environment, coupled with a complete absence of contact with reality

in dealing with them" (*Vital Speeches of the Day,* April 15, 1970, p. 399). While proclaiming that Americans can make some sacrifices to help clean up their environment, he recommends acknowledging that the clock can never be turned back to the peaceful, uncomplicated Currier-and-Ives regimen of the 19th century.

In addition to Wilson Laird, key speakers are W. R. Walton, Amoco Production Company, who will speak on "Significant Properties of Sandstones—Aids to Exploration and Exploitation," and K. W. Klement, The University of Texas at El Paso, whose topic is "Comparative Lithostratigraphy of Major Carbonate Reservoirs in the World." T. W. Amsden, geologist with the Oklahoma Geological Survey will present a paper on "Porosity and Permeability in Silurian Carbonate Rocks of the Hunton Group, Anadarko Basin, Oklahoma."

For advance registration forms, information concerning other papers scheduled for the technical sessions, or hotel accommodations, please contact Donald D. Ott, GeoData Corporation, 1420 Thompson Building, Tulsa, Oklahoma 74103. (Mid-Continent members should receive pre-registration forms and information automatically.)

Tulsa Hosts Forum on Growth with Environmental Quality

A National Forum on Growth with Environmental Quality, which will be held in Tulsa in September, is expected to draw a large attendance both regionally and nationally. Scheduled for September 23-26, the forum is co-sponsored by the National Science Foundation, the Midcontinent Environmental Center Association, and the Metropolitan Tulsa Chamber of Commerce. It will convene in the downtown Tulsa Assembly Center.

Russell E. Train, new head of the U.S. Environmental Protection Agency, will be the keynote speaker. Other speakers scheduled are Jules Bergman, ABC-News science editor, Sen. Henry M. Jackson of Washington, and Christian A. Herter, Jr., of the U.S. Department of State.

The program will include an energy session moderated by Dean A. McGee, board chairman of Kerr-McGee Corporation; a land-use session moderated by Thomas L. Kimball, executive vice-president of National Wildlife Federation; a people and quality-of-life session moderated by Sen. John V. Tunney of California; a general session moderated by Chet Huntley, board chairman of Big Sky of Montana, Inc., and former NBC-News commentator; and a technology session moderated by Philip L. Johnson of the National Science Foundation.

The forum will conclude with a wrap-up by Jenkin Lloyd Jones, editor and publisher of the *Tulsa Tribune.*

A registration fee of $75.00 will cover the entire cost of the forum, including 3 luncheons, 2 dinners, social-hour discussions, and the published proceedings. For further information, contact Bruce Carnett, Chamber of Commerce, Tulsa, Oklahoma 74119.

A Crinoid Crown Preserved in Lower Pennsylvanian Conglomerate near Fayetteville, Arkansas

Harrell L. Strimple[1]

A poorly preserved crinoid crown collected by James A. Quinn, chairman of the Department of Geology of the University of Arkansas, was kindly presented by him to the author. The crinoid was recovered from the House of Hess Conglomerate, Prairie Grove Member, Hale Formation (Morrowan, Lower Pennsylvanian), south of Fayetteville, Washington County, Arkansas; since the matrix in which it was found is a conglomerate, it is surprising that the specimen survived at all, regardless of whether its source was of primary or of secondary deposition. A few crinoid ossicles had been recovered previously from this conglomerate, but most of them are disarticulated crinoid segments or slightly abraded, fused infrabasal circlets of *Paragassizocrinus* sp. Moore and Plummer, 1938.

If the cup were intact, identification of the specimen would be relatively easy, but the species is certainly of the family Pirasocrinidae Moore and Laudon, 1943. The crown has three anal plates in the posterior interray, spinose axillary primibrachs *1*, multiple branching, uniserial arms, and a large platform surrounded by outwardly directed spines at the summit of the anal sac (fig. 1). Unfortunately, the only pirasocrinid from Morrowan rocks for which the crown is known is *Anchicrinus rugosus* (Strimple), 1971, from the Wapanucka Limestone of southern Oklahoma. That species has a few platform spines, and they are quite small and rounded at their base. The present specimen has numerous spines, but they are broad and more flattened in basal portions.

Angles of the lateral sides of the large tegminal spines have been computed and used to restore a circular platform surrounded by about 16 outwardly directed spines. Considering that 6 spines are preserved more or less in place, it is obvious that at least 12 spines would be required to complete the circlet. The number of platform spines narrows the field of potentially closely related genera to *Sciadiocrinus* Moore and Plummer, 1938, *Metaperimestocrinus* Strimple, 1961, *Eirmocrinus* Strimple and Watkins, 1969, *Schedexocrinus* Strimple, 1961, and *Polygonocrinus*, Strimple, 1961. *Sciadiocrinus, Schedexocrinus,* and *Polygonocrinus* have nonspinose axillary primibrachs *1* and therefore can be eliminated. *Metaperimestocrinus* has a tendency toward spinose axillary primibrachs *1*, and *Eirmocrinus* is characterized by stout, long spines. Although *Eirmocrinus* has not been observed previously in Morrowan or Atokan rocks, it is well known from the shale below the Kickapoo Limestone Member, Millsap Lake Formation, Strawn Group (Desmoinesian), near Dennis in Hood County, Texas. *E. grossus* Strimple and Watkins, 1969, the type species of the genus,

[1]Research associate and curator, Department of Geology, The University of Iowa, Iowa City.

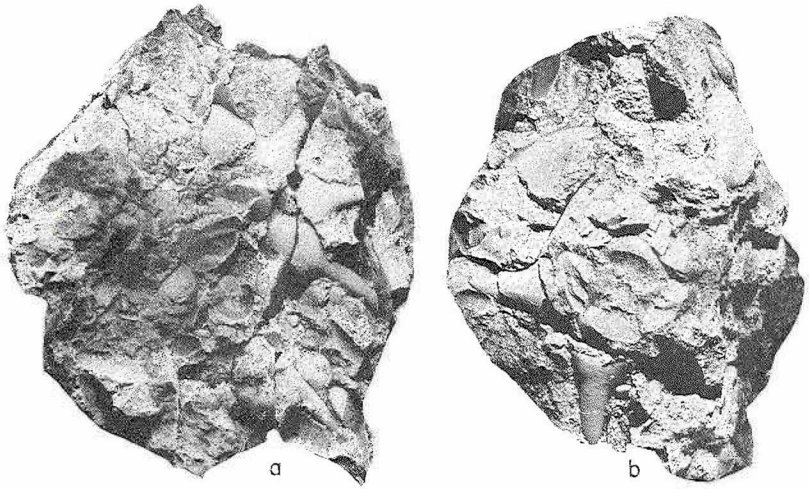


Figure 1. Eirmocrinus **sp. Imperfect crown (SUI 33379) preserved in House of Hess Conglomerate (Morrowan). Viewed from base (a), showing damaged cup and spinose primibrachs 1, and from summit (b), showing several spinose terminating spines of anal sac; ×1¼.**

has 13 large, outwardly directed spines surrounding the platformlike termination of the anal sac, and it has large, spinose primibrachs *1*. Because the specimen at hand has spinose primibrachs *1* and nonspinose upper axillary brachials, it is referred tentatively to *Eirmocrinus*.

Moore and Plummer (1938, text-fig. 22i) presented a restoration of the top of a sac composed of a central platform surrounded by 10 spinose plates ascribed to *Sciadiocrinus*? *crassacanthus* Moore and Plummer from the Brentwood interval, Bloyd Formation, in the Keough quarry north of Fort Gibson, Muskogee County, Oklahoma. The holotype of *S.*? *crassacanthus* is a distinctive tegmen spine which tapers gradually from its greatest width. It is erroneously illustrated (Moore and Plummer, 1938, text-fig. 24a) in top view as having one basal facet (square) and in bottom view (text-fig. 24c) as having two basal facets (pointed). The designated paratype (spine) (text-fig. 24a, b) narrows abruptly from its widest point, then tapers more gradually, attaining a considerable length, as in *Eirmocrinus*? sp. The material is not adequate for specific designations or comparisons.

Remarks.—The stratigraphic placement of the crinoid crown in the House of Hess Conglomerate of the Prairie Grove Member of the Hale Formation is validated by the recovery in the area of *Arkanites* above *Reticuloceras henbesti* (W. L. Manger, University of Arkansas, personal communication, March 22, 1973).

Material.—Hypotype, Department of Geology Repository, The University of Iowa, Iowa City, SUI 33379.

Occurrence.—House of Hess Conglomerate, Prairie Grove Member, Hale Formation (Morrowan, Lower Pennsylvanian), south of Fayetteville, Washington County, Arkansas; SW¼SW¼ sec. 9, T. 14 N., R. 30 W.

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John Clausen Receives Earth-Science Teaching Award

The National Association of Geology Teachers recently named John F. Clausen the Outstanding Earth Science Teacher in Oklahoma. A science teacher at Hefner Junior High School in Oklahoma City, Mr. Clausen was lauded as a "devoted teacher, having strong support from his students and colleagues."

To expand his knowledge of the earth sciences, Mr. Clausen participated in The University of Oklahoma's Summer Sequential Institute from 1967 until he received the degree Master of Natural Science in 1971. The institute and the MNS degree were designed by OU, with funding from the National Science Foundation, to relieve the shortage caused by the enormously increased demand in recent years for qualified teachers of earth science.

Mr. Clausen is a member of the Hefner Junior High Steering Committee, the OU Alumni Association, the Kansas State Alumni Association, the Association of Classroom Teachers, the National Education Association, the Oklahoma Education Association, and the National Association of Geology Teachers.

John D. Naff, Oklahoma State University professor of geology, served as chairman of the selection committee and reported that a large number of nominations were considered for the honor. Our compliments to the committee members on their fine work, and we join them in commending Mr. Clausen for his dedication to the earth-science teaching profession.

Water-Planning Program "Plays the Numbers"

The recently released U.S. Geological Survey Circular 601-H, *Role of Water in Urban Planning and Management*, by William J. Schneider, David A. Rickert, and Andrew M. Spieker, defines a new approach in assessing the relative importance of urban water problems. The system is based on a numerical matrix.

This matrix, as demonstrated in the new circular, is a checkerboard sheet which graphs hydrologic information against potential problems. The value of such a matrix, as explained by William J. Schneider, chief of the USGS Urban Water Program and senior author of the report, lies in the help it offers "scientists and urban planners to systematically sort out the most pressing problems and information needs."

A matrix of the Washington, D.C.-Baltimore, Maryland, area recovered surprising data showing that the most pressing problems had to do with population distribution and trends, i.e., with municipal water supply and pollution "loading" of surface water. Secondary values appeared for industrial-waste discharge, municipal waste disposal, and water and sediment quality.

In this as in other applications, the final decision on management rests with the planner; a matrix evaluation offers him facts with which to work, a valuable tool to aid in his determinations.

Copies of Circular 601-H may be obtained free on request from the Director, U.S. Geological Survey, Washington, D.C. 20244.

Grant for Water-Resource Data Base Awarded to OURI

The Oil Information Center (OIC) of The University of Oklahoma Research Institute (OURI) has contracted with the federal government to provide a data-retrieval base for the Water Resources Division (WRD) of the U.S. Geological Survey. The data base, to be operated through the General Information Processing System (GIPSY) at the Merrick Computing Center facilities at OU, will contain detailed information on surface water, ground water, and water quality. Jack L. Morrison, project director, indicates that operational information regarding each station providing information will also be included in the data base.

Source documents have been field-generated by WRD on specially designed forms which can be keypunched directly to the GIPSY format. A $50,000 grant to OIC will fund the 14-month project of keyboarding of source data and building of a computer-readable data base through the use of GIPSY programming modules. Additional computer programs will probably be necessary to tailor the data base to the specific needs of WRD.

The contract will implement OURI studies described previously in *Oklahoma Geology Notes* (v. 32, June 1972, p. 94) .

OKLAHOMA ABSTRACTS

AAPG-SEPM Annual Meetings, Anaheim, California
May 14-16, 1973

The following abstracts are reprinted from the April 1973 issue, v. 57, of the *Bulletin* of The American Association of Petroleum Geologists. Page numbers are given in brackets below each abstract. Permission of the authors and of A. A. Meyerhoff, managing editor of the *Bulletin,* is gratefully acknowledged.

Porosity and Permeability in Silurian Carbonate Rocks of Anadarko Basin, Oklahoma

THOMAS W. AMSDEN, Oklahoma Geological Survey, Norman, Oklahoma 73069

Ninety Hunton cores have been studied, from which 37 Silurian samples from 21 wells were tested for porosity and permeability. Each sample was examined in thin section and was analyzed chemically for $CaCO_3$, $MgCO_3$, and HCl insolubles. The specimens range from limestones and calcareous mudstones having less than 1% $MgCO_3$ to crystalline dolomites with more than 43% $MgCO_3$. Porosity ranges up to 21%, and permeability to 305 md. Rocks with appreciable porosity and permeability have a circumscribed range in texture and composition: specimens with more than 5% porosity are confined to crystalline dolomites with more than 35% $MgCO_3$ (65% dolomite), and those with more than 10% porosity to dolomites with more than 37% $MgCO_3$ (80% dolomite). Much of the pore space is in the form of fossil molds and vacuities in the matrix surrounding oolites. The fossil molds were formed by leaching, and the porous oolites probably result from a primary porosity increased by dissolution. Not all dolomites have high porosity, and several specimens with more than 35% $MgCO_3$ have less than 1% porosity; the latter condition appears to result from preservation of the fossils by calcspar and dolospar rather than as molds. Leaching of fossils and preservation by spar are confined to crystalline dolomite, thus indicating a genetic relation to dolomitization. A suggested sequence of events in the development of porosity is dolomitization and leaching, followed by some secondary cementation of pore space by spar.

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.

Present information indicates a geographic concentration of these porous Silurian dolomites in the north-central and western parts of the Anadarko basin (data on the deeper parts of this basin are lacking). [766-767]

Global Look at High Pressures

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Formation pressures higher than hydrostatic have been found in all parts of the world during oil and gas drilling operations. The present paper analyzes the worldwide distribution of these high pressures. Data used include wells from western Europe, Hungary, Poland, Rumania, Russia, the Middle East, the Indian subcontinent, Australia, New Guinea, New Zealand, Japan, the Arctic, the African West Coast, the Red Sea, South America, and the United States. A statistical analysis to define the main geologic characteristics of high-pressure reservoirs was carried out using data from wells penetrating more than 5,000 reservoirs in the Gulf of Mexico, Santa Barbara Channel, and the Anadarko, Permian, and Uinta basins. The probability of finding high pressures in a given depth range for each of these basins has been established.

The main mechanisms responsible for the creation of these high pressures are concluded to be (1) gravitational compaction, (2) the montmorillonite-illite transformation, (3) wax seals, and (4) tectonic compression. Although in certain instances one of the mechanisms predominates, in most places a combination of them is responsible for the high pressures. Modeling of the geologic processes that have created a basin allows us to recognize in advance the type of pressures to be found there. [775]

Late Paleozoic Clastic Wedges in Appalachian Province

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Late Paleozoic clastic wedges, arrayed from north to south along the western edge of the Appalachian tectonic welt, differ in age as well as spatial relations. The northern, Catskill, wedge is the oldest and apparently was derived from the north, whereas the succeeding Warrior-Arkoma wedge was apparently derived from a southern or Ouachita source. The youngest, Pocahontas and Dunkard, wedges are located between the older two and were derived from only a relatively small area in the central Appalachian Blue Ridge and Piedmont. Although the style of sedimentation differs among these large sedimentary prisms, all were governed by similar tectonic controls of differential subsidence and growth faulting. Significantly, the trend of tectonic complexes from which the sediments were derived is nearly at right angles to most of the present structures and suggests predrift tectonic connection. [778]

Sedimentary and Tectonic History of Ouachita Mountains

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The Ouachita Mountains of Oklahoma and Arkansas contain Paleozoic flysch-like geosynclinal rocks exposed by elongated east-west folds and thrust faults. Approximately 5,000 ft of Cambrian to Devonian flysch consists predominantly of dark slates and cherts, comprising a classical "starved trough" succession. Minor incursions of mature sands, apparently from the North American craton, invaded the trough at three different intervals. The succeeding Carboniferous, almost 40,000 ft thick, consists of proximal and distal turbidite sandstones, black shales, and minor interlayered wildflysch and volcanic ash. Sedimentary structures indicate southwestward, westward, and northwestward sand dispersal. Sandstone compositions suggest a cratonic, quartz-rich provenance as well as a feldspathic, lithic extracontinental source.

The tectonic setting may well have been due to oceanic crust spreading northwestward, plunging under continental crust, and creating an island-arc-trench-subduction zone whose present location is overlapped by post-Paleozoic rocks. Northwest of the trench, a complex of slope, rise, and abyssal sediments formed upon the depressed outer margin of continental crust. East of the Ouachitas, continent-continent collision caused suturing of Africa and North America, which created source materials that were subsequently emplaced as a westward-building subsea cone during the Carboniferous. In the Ouachita area, continued subduction finally created a series of uplifted tectonic lands resulting in northward sliding of the sedimentary succession as continentward-directed folds and thrust sheets. Subsequent stress-field orientation changed so that the area then became dormant. [796]

Oklahoma State University

Grain Orientation, Paleocurrents, and Reservoir Trends

HOWARD RICHARD BURMAN, JR., Oklahoma State University, M.S. thesis, 1973

Grain orientation has proved to be an accurate paleocurrent indicator. With bulk methods, such as those performed with the conductivity anisotropy instrument, COBRA, measurements can be made rapidly and accurately for a vast number of sand grains.

Grain orientation has been examined in various sand-depositing environments. In the case of strandline (barrier-bar) and certain shallow marine environments, grain orientation is found to be approximately normal to sandstone-body trend. In this study, these environ-

ments are represented by the Recent Galveston Island barrier sand, the Cretaceous Eagle Sandstone, the Ordovician Harding Sandstone, the Ordovician Burgen Sandstone, and the Cretaceous Trinidad Sandstone. Imbrication in all these units except the Harding shows a shoreward dip and thereby indicate deposition is dominantly by backwash. The Harding is believed to be the product of a stable shelf environment, with imbrication resulting from shoreward-directed currents.

Deltaic environments are represented by the Pennsylvania Vamoosa Formation, in which grain orientation shows favorable results compared to megascopic paleocurrents. The Vamoosa is divided into four subdivisions, and the average grain orientation, from older to younger units, shows a rather progressive westerly change in direction. This relationship suggests change in source areas with time.

The Cimarron River study was undertaken to prove the adaptability of the COBRA for field measurements utilizing an *in situ* probe. Grain orientation measurements correlated well with the paleocurrent measurements. All indicators show a direction parallel with the trend of the sand body.

In this study, new techniques and improvements have been made in impregnation methods and COBRA measurements, both laboratory and *in situ*. These improvements result in better consolidated cores and more rapid and reliable sample measurement.

Geology of Western Payne County, Oklahoma

ARTHUR JOHN GARDEN, Oklahoma State University, M.S. thesis, 1973

The study area in western Payne County, Oklahoma, is in the Central Redbed Plains and is almost entirely within the Cimarron River drainage basin. Only the extreme northern part lies in the Arkansas River drainage basin. Maximum elevation is 1175 ft in the west, and minimum elevation is 825 ft in the southeast; local relief commonly is about 100 ft. Major soil associations include the Kirkland-Zaneis, Vernon-Lucien, Dougherty-Teller-Vanoss, and Yahola-Port.

The surface rocks are Early Permian (Leonardian) in age; all units become progressively younger westward. The stratigraphic section is composed of units assigned to the Wellington Formation. The section is characterized by red beds in a repetitious sequence of shale, lenticular sandstone, and nodular dolomite. The sandstones are fine- to very fine-grained, feldspar-rich subarkose to quartz-rich subarkose, with an overall paleocurrent trend of N35°W. The sandstones exist as single genetic units, up to 25 ft thick, multistoried complexes, as much as 80 ft thick, and widespread multilateral units. The sandstones characteristically have undulatory erosional bases, although some have gradational bases. The amount of sandstone increases southward at the expense of mudrock and nodular dolomite. In general, sand deposition during arid climatic conditions was in a tide-dominated deltaic environment. The area lies southeast and south of

prominent mudrock with thin well-defined carbonate beds representative of tidal-flat conditions.

The area is characterized by gentle westerly homoclinal dip, generally 40 to 60 ft/mi. Local structural noses, averaging 1 sq mi in areal extent, are present in the subsurface as larger complexes, which increase in size and intensity with depth. Two sets of vertical joints, with mean trends of N55°E and N45°W, are similar to those of central Payne County.

Petroleum is the major mineral resource, with cumulative production of some 45 million bbl and 183 million cu ft of gas primarily from Pennsylvanian and Ordovician sandstones. Other resources include sandstone for local road subbase material; nodular dolomite for local county road material; sand for fill, asphalt, masonry purposes, and concrete; and clay for brick. Potable ground water is best developed in irregularly distributed sandstones and in terrace and floodplain sands of the Cimarron River. The distribution of the fresh ground water reflects local sandstone development, topography, and saline influent from Cimarron River.

The University of Oklahoma

Subsurface Stratigraphic Analysis, "Cherokee" Group (Pennsylvanian), Northeast Cleveland County, Oklahoma

M. A. ALBANO, The University of Oklahoma, M.S. thesis, 1973

The area of investigation includes Townships 8-10 North, Ranges 1 East to 2 West in central Oklahoma. The objectives of this study are to determine (1) the degree to which irregularities on the pre-Pennsylvanian unconformity surface influenced the depositional pattern of "Cherokee" sediments; (2) the depositional history and environment(s) of sand units deposited during the time interval investigated; (3) the appropriate stratigraphic position and nomenclature of these units; and (4) the significance of both structure and stratigraphy as trapping mechanisms for commercial accumulations of hydrocarbons in Pennsylvanian sandstones.

A modified dendritic drainage pattern with low relief formed on the pre-Pennsylvanian erosional surface.

A drainage divide extending approximately diagonally across the investigated area, separated the drainage into the Arkoma basin to the south-southeast and into the Anadarko basin toward the southwest. Compensatory thickening on the downthrown side of growth faults modified this dendritic pattern.

The "Cherokee" Group represents an alternating sequence of transgressive and regressive lithologic units of shallow-water marine and deltaic origin deposited upon this pre-Pennsylvanian erosion surface. It consists of a series of thin limestone marker beds that are separated by sequences of shale or lenticular sand zones. They are in descending order, Prue zone, Verdigris Limestone, Skinner zone, Pink

lime, Red Fork zone, Inola Limestone, and Bartlesville zone.

Red Fork and Prue sands were deposited in prograding deltaic channels along a costal plain of low relief.

"Cherokee" sands produce from combination stratigraphic and structural traps.

USGS Announces New Conservation Districts

As a further step in the decentralization of administration of the U.S. Geological Survey (see *Oklahoma Geology Notes,* v. 32, p. 135, 187), Russell G. Wayland, chief of the USGS Conservation Division, has announced the reorganization of his division.

For the past 50 years the Conservation Division has functioned along branch lines with each branch—Oil and Gas Operations, Mining Operations, Mineral Classification, and Waterpower Classification—responsible for its own operations nationwide. New structuring is regional, on the basis of four major locations, bringing more decision-making authority to the field.

New regional centers and their managers are: Western Region, Menlo Park, California, Willard C. Gere; Central Region, Denver, Colorado, George H. Horn; Eastern Region, Washington, D.C., Reid T. Stone; and Gulf of Mexico, Metairie, Louisiana, Robert F. Evans. Oklahoma is a part of the Central Region.

The Conservation Division has jurisdiction over the use and extraction of mineral deposits and water power on public land holdings. The restructuring is expected to enable the division to respond better to industry and public needs and to environmental issues as they develop.

Oil Shale Task Group Report Released

The National Petroleum Council (NPC) has recently released a report, *Oil Shale Availability,* which analyzes changes in government and industry policies and in economic conditions necessary for the practicable recovery of fuel from oil shale.

The report discusses reserves (54 billion barrels in the Piceance and Uinta basins); mining methods (underground room and pillar mining); projected production rates of syncrude by 1985 (750,000 barrels per day, maximum; 100,000 barrels per day, minimum); price levels necessary to make production economically attractive; and government policies and legislation needed to stimulate shale-oil commercialization.

Oil Shale Availability, prepared by the Oil Shale Task Group of NPC, is one of a series of task-group reports prepared in connection with NPC's studies issued as *U.S. Energy Outlook* (see *Oklahoma Geology Notes,* v. 33, Feb. 1973, p. 13-14). It is available for $8.00, prepayment requested, from the National Petroleum Council, 1625 K Street, NW, Washington, D.C. 20006.

State Geologists Elect Officers

The Association of American State Geologists met May 27-31 at Stone Mountain, Georgia, for the group's 65th annual meeting. Charles J. Mankin, director of the Oklahoma Geological Survey and of the OU School of Geology and Geophysics, was elected vice-president for the current year.

Other officers named at the meeting were: president, Kenneth N. Weaver, Maryland Geological Survey; president-elect, James L. Calver, Virginia Division of Mineral Resources; secretary-treasurer, Daniel N. Miller, Jr., Geological Survey of Wyoming; historian, Charles G. Doll, Vermont Geological Survey; editor, Edwin A. Noble, North Dakota Geological Survey; and statistician, Robert R. Jordan, Delaware Geological Survey.

Raymond E. Corcoran, Oregon state geologist, will serve as host for the association's next meeting, scheduled for June 9-13, 1974, in Bend, Oregon.

Kansas Geological Survey to Sponsor Energy Symposium

A Symposium on Elements of a National Energy Policy will be held September 28-29 in Lawrence, Kansas, under the sponsorship of the State Geological Survey of Kansas. The meeting will mark the formal dedication of Raymond C. Moore Hall, the Survey's new facility, named to honor a man whose name is famous in the annals of the science of geology in the State of Kansas and far beyond. (See *Oklahoma Geology Notes*, v. 33, April 1973, p. 65-66.)

The purpose of the symposium is not merely to discuss the recognized energy crisis but to pull together people involved in input of information on the crisis and to evolve solutions to be referred to the Nation's Capital.

Key speakers will include Robert D. Ray, governor of Iowa and chairman of the Midwest Energy Task Force; Robert B. Docking, governor of Kansas; James Pearson and Robert Dole, U.S. senators; Vincent E. McKelvey, director of the U.S. Geological Survey; Merrill Haas, president-elect of The American Association of Petroleum Geologists and vice-president for exploration for Exxon Company, U.S.A.; Beatrice Willard of the President's Council on Environmental Quality; and Wilson M. Laird, director of the American Petroleum Institute. It is hoped that other invited dignitaries from the U.S. Department of the Interior and from the White House will also be able to participate.

Meetings are scheduled for several buildings on the campus of The University of Kansas, including the new Raymond C. Moore Hall, and will be in the form of panel discussions in the morning, a luncheon

presentation, and afternoon presentations by the various speakers.

For further information about the symposium, contact Roderick A. Hardy, State Geological Survey of Kansas, 1930 Avenue A, Campus West, The University of Kansas, Lawrence 66044.

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