cross-section board. The board is basically a large white surface upon which various types of well logs are suspended and correlations shown with string and tacks. The final result is a photographic reproduction. Details of the process are described.

14. Oil Production from Pre-Cambrian Basement Rocks in Central Kansas, by Robert F. Walters, geologist, Heathman Drilling Company, Inc. Wichita, Kansas.

Pre-Cambrian basement rocks are the reservoir from which several scattered wells in central Kansas produce oil. More than a million barrels of oil have been produced from pre-Cambrian quartzite in the Orth field, Rice County, from fifteen wells. Similar quartzite is the reservoir from which oil is produced in four wells in the Kraft-Prusa field, one well in the Eveleigh field, and one well in the Trapp field, all in Barton County. Fresh pink biotite granite is the reservoir rock producing oil in three wells in the Hall-Gurney field and in one well in the Gorham field, both in Russell County. A few other wells, not investigated by the writer, are reported to be producing from pre-Cambrian rocks.

All wells known to be producing from pre-Cambrian rocks are located on the summits of buried pre-Cambrian hills. Porosity consists of a reticulated fracture system. The pre-Cambrian reservoir rocks are unconformably overlapped by Pennsylvanian limestones now draped above the hills in gentle anticlinal folds which trap oil in multiple thin porous zones in the Topeka (Virgil) and Lansing-Kansas City (Missouri) limestones. The Pennsylvanian rocks are considered as the probable source from which oil migrated locally into the cracks in the pre-Cambrian rocks. Truncated Cambro-Ordovician Arbuckle dolomites, themselves an oil reservoir, are present on the flanks of each hill and are a less probable source from which the oil in the pre-Cambrian reservoirs was derived.

Production records for individual wells are difficult to obtain, but available data indicate that recoveries from several quartzite wells in the Orth field exceed 75,000 barrels per well. Two wells, now abandoned, drilled by Slick, Pryor, and Lockhart on the Habinger lease in Sec. 27, T. 18 S., R. 10 W. produced 173,217 barrels of oil or 86,608 barrels per well from a depth of 3,200 feet. Wells on three other leases in the Orth field are estimated to have produced 100,000; 130,000; and 150,000 barrels per well from pre-Cambrian quartzite and are still producing. The Sunray's Culbertson No. 1 in Sec. 26, T. 18 S., R. 10 W. produced 168,000 barrels of oil (gravity 43°) into its own individual tank battery from the pre-Cambrian quartzite encountered at a depth of 3,211 feet from its completion in February, 1941, to July, 1948, and is still producing (January 1, 1950). Data on oil recoveries from wells producing from biotite granites are not available.

It is the writer's opinion that in a great many wells the pre-Cambrian rocks have been inadequately tested for porosity and fluid content. It is suggested that the pre-Cambrian basement rocks, where encountered structurally (or topographically) high in future drilling in central Kansas, are worthy of careful consideration as a potential oil reservoir.

15. Paleogeology of Panhandle of Texas, by Robert Roth, Humble Oil and Refining Company, Wichita Falls, Texas.

The sedimentary sequence and facies changes in the subsurface of the Panhandle of Texas are shown by three cross sections. The stratigraphic column is divided into thirteen geologic subdivisions. A paleogeologic map presents the areal distribution of each geologic subdivision. The effects of orogenic and epeirogenic movements are discussed.

16. Geology of Fort Worth Basin, by J. B. Moorhead, Continental Oil Company, Wichita Falls, Texas.

The Fort Worth basin is a regional syncline of north-central Texas, approximately 150 miles in length, varying from 0 to 70 miles in width, and striking northwest-southeast. Bounded on the west by the positive Bend arch, on the north and northeast by sharp granite scarps of the Red River-Muenster buried ridges, the trough is limited at the south and southeast by Ouachita folding. Paleozoic sediments of Cambrian, Ordovician, Mississippian, and Pennsylvanian are preserved basinward, greatest thicknesses being noted in the Ellenburger (Beekmantown) and Strawn (Des Moines) groups. Major unconformities in the geologic section occur at the top of the Trenton (Viola), top of the Chester (Mississippian), and at the Pennsylvanian-Cretaceous overlap contact.

Oil fields in the basin are relatively small in areal extent but are economically profitable. Production to date has been largely governed by structural conditions, but local porosity variations are likewise influential. It is conservatively predicted that new basin oil to be found will be greater in quantity than either the amount produced to date or known reserves in place.

17. Review of Geology of Western Anadarko Basin: Texas and Oklahoma Panhandles, by Graydon L. Meholin, Sinclair Oil and Gas Company, Amarillo, Texas.

Very little has been written about that part of the Anadarko basin west of the Texas-Oklahoma line other than to mention that "it appears to extend some 125 miles westward into the Texas Panhandle." The main reason for this was, of course, the lack of deep well control. During the past 2

years eleven deep (Mississippian or Ellenburger) wildcat tests have been drilled in the Texas Panhandle part of the Anadarko basin. These have served to give some insight into what the structure and deposition in this part of the basin is going to be: a few questions have been answered and a great many more have been posed which only additional drilling can answer.

18. EASTERN COLORADO OIL AND GAS PROSPECTS, by Harry W. Oborne, Colorado Springs, Colorado.

Prospective regions of eastern Colorado are divided naturally into two main classes: the basins which have in the past, because of depths, been thought of as limited to Cretaceous possibilities; and those areas in which the Paleozoic formations present the principal, or only, chances of production. With the advent of deeper drilling techniques the phantom barrier to prospects below the Cretaceous in the basin areas tends to disappear. This barrier is also modified by the fact that excessive drilling depths, formerly predicated for the deeper parts of the basins, can be scaled down in line with sections measured along the Rocky Mountain front, and from a few scattered well logs in the east.

The areas of Cretaceous prospects are the three basins in the western part of the region. Oil and gas have long been produced from all three of these basins and the recent discovery in southwestern Nebraska has centered much attention on that and other parts of the Denver basin. Additional prospects exist within the Cretaceous, and beneath the Cretaceous, especially in large parts of the Denver basin.

The areas which have heretofore been considered the particular loci of Paleozoic prospects are the Sierra Grande uplift and the so-called Las Animas arch, plus the territory north and northeast toward the northeast corner of the state. The Apishapa uplift, connecting the Sierra Grande uplift with the Wet Mountains, and separating the Denver and Raton basins, has been included in this area of Paleozoic prospects. Parts of these areas still hold excellent prospects, especially on the flanks of the uplifts, and in areas east and north.

In the literature Sierra Grande uplift and Las Animas arch have been used as synonymous terms. The Sierra Grande uplift is a very old feature in New Mexico and southern Colorado, and the so-called Las Animas arch is a much younger feature due mainly to the subsidence of the Denver basin contemporaneous with Cretaceous sedimentation, and probably modified by later Laramide orogeny. The northwestward continuation of the Anadarko basin, in the older rocks, may be traced directly across the present surface expression of the Las Animas arch.

The geologic history and paleogeography are briefly traced to show what the writer believes to be excellent prospects in the Paleozoic formations in the deeper parts of the basins, especially the Denver basin, at what are not drillable depths.

19. RESULTS OF HYDRAFRAC TREATMENTS, by W. D. Owsley, Halliburton Oil Well Cementing Company, Duncan, Oklahoma.

The Hydrafrac process, originally developed by the research department of Stanolind Oil and Gas Company, has now been in use throughout the industry for 10 months. The results during the research period and those in the succeeding months of commercial operation have been of great benefit in increasing the production of oil and gas. The Hydrafrac process generates new and increased effective permeability in the well. This is accomplished by hydraulic fracturing of the particular zone being treated. The fracture formed is held open by graded sand carried into it with the fracturing medium. This sand acts as a propping agent to hold open the fracture thus produced. While the Hydrafrac process is applicable to many types of formations it is, nevertheless, highly important that the well conditions be properly evaluated before a decision is made to use the process. Such factors as thickness of the zone, state of depletion, permeability and the general condition of the well with regard to isolation of the zone, must be taken into account in the planning of a job. Where applied in a properly planned manner, either as a completion method on new wells or for rejuvenation of existing wells, the Hydrafrac treatments have resulted in a high degree of success. It is believed that this method will give greater ultimate recovery, as well as a higher rate of recovery. A complete résumé of the Hydrafrac process treatments is given in the paper with regard to various areas, formations, and production history of the wells thus treated.

20. GEOLOGIC RESPONSIBILITY IN SEISMIC EXPLORATION, by B. W. Beebe, Anderson-Prichard Oil Corporation, Oklahoma City, Oklahoma.

The seismograph, after more than 20 years of successful operation, remains the most important mechanical instrument available to assist in locating new petroleum reserves. However, it is evident that the "honeymoon" has been over for some time, that the seismograph in the hands of the geophysicist alone is not the most efficient method of operation. The seismograph as an instrument has proved its usefulness and is not on trial, but in far too many instances its employment and the interpretation of observations have either failed or left much to be desired. The primary responsibility in any geophysical exploration program with the object of locating commercial deposits of petroleum is and must be jointly that of the geologist and geophysicist. Geologists as a group have failed to recognize and assume their full share of the responsibility insofar as geophysical prospecting is con-