23. SIGNIFICANCE AND USE OF LAP-OUT MAPS IN PROSPECTING FOR OIL AND GAS, by Lon B. Turk, consulting geologist, Oklahoma City, Oklahoma.

The term "lap-out" is used to define sediments, transgressively deposited, whose bottom-sides lap onto an unconformity surface, and whose terminal edges lap-out against the top-side of an unconformity; the same sediments, in turn, are overlapped by other sediments, which successively repeat this relationship to the unconformity at a stratigraphically younger position. In other words, the sediments bear the same relationship to an unconformity as the shingles placed on a roof; the first ones are toward the bottom. A positive area, so buried by transgressive sediments, will show formations that continue over and blanket the crest of the buried area, just like the last shingles on a roof are at the top or crestal part.

A lap-out map is a plan view of the distribution pattern, made by the intersection of transgressive formations lapping out on the TOP-SIDE of an unconformity surface. Petroleum geologists are routinely familiar with paleogeologic maps, showing areal distribution of sediments during periods of truncation. Such periods, commonly examined, are pre-Cretaceous, pre-Pennsylvanian, pre-Mississippian, and many others. In these instances, a plan view is presented of the pattern created by formations exposed after truncation; therefore, the pattern represents intersection of these truncated sediments at the BOTTOM-SIDE of the resultant unconformity. Anticlines on such areal maps are interpreted by the pattern of successively older sediments being inside the pattern of younger sediments. And conversely, synclines are interpreted by older sediments being outside the pattern of younger sediments.

Since lap-out maps deal with the pattern of sediments intersecting the TOP-SIDE of an unconformity, the pattern of younger sediments follows inside the pattern of older sediments. Therefore, to the untrained eye, such a pattern might seem to be depicting a syncline on the usual areal map, but, in reality, on lap-out maps, dealing with the TOP-SIDE of an unconformity, such a pattern indicates burial of a high positive area by transgressive onlap or overlap.

Lap-out maps have a multitude of uses in the search for oil, and likewise, in the study of geologic history of positive areas buried by transgressive seas. First to be considered are the aspects of application of these maps in the search for oil. Levorsen's geologic thinking in "Studies in Paleogeology,"[1] and "Discovery Thinking,"[2] and *Stratigraphic Type Oil Fields*[3] has sparked the industry to a new conception of the areas to be explored for oil and gas reservoirs—new areas that do not require anticlinal or crestal geology. His "wedge belts of porosity and layers of geology" is predominantly a thinking, evolving out of facies changes or TRUNCATION by unconformities, causing wedge belts of porosity, or reservoirs, wedge-edged by truncation.

Since lap-out maps reflect the pattern by which former positive areas of regional proportions have been buried transgressively, these maps define location belts of wedge edges that have three favorable aspects for oil accumulation and exploration areas:

1. They are traps that were formed early in the history of the reservoir rock.
2. They are a petroleum province where trapping conditions are still favorable. dependent on the geologic history of the positive area, involving effect of rejuvenation folding or regional tilting.
3. Most important, therefore, lap-out maps envisage areas where there may be pools of major proportions!

Another application of lap-out maps is the usefulness in studying geologic history of such positive areas. Inclination or attitude of such positive areas at the time of burial can be determined by the relationship between the lap-out pattern and the pre-unconformity areal pattern. Any rejuvenation during burial of such positive areas can be measured relatively by the lap-out patterns. Exact age of burial of any such positive area can be determined.

24. EOLA, OKLAHOMA, TYPICAL ARBUCKLE MOUNTAIN STRUCTURE, by R. M. Swesnik, Anderson-Prichard Oil Corporation, and Thom H. Green, Sunray Oil Corporation, Oklahoma City, Oklahoma.

The Eola field is in T. 1 N., R. 2 W., southern Garvin County, Oklahoma just north of the exposed Arbuckle Mountains. It is on the subsurface extension of these mountains and is exceptional in the structural complexities revealed by the drill. Ten wells have been drilled, of which six have been producers. These tests indicate the major structural feature of the area to be a west-northwest striking fault, with the magnitude of the stratigraphic displacement measurable in miles. Highly folded and faulted pre-Deese strata north of the fault form an overturned syncline whose axial plane

[1] *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 17, No. 9 (September, 1933), pp. 1107–1132.

[2] *Ibid.*, Vol. 27, No. 7 (July, 1943), pp. 887–928.

[3] Amer. Assoc. Petrol. Geol. (1941).

dips southward. Oil and gas accumulation is controlled by local closure along secondary faults on the north and normal flank of the described syncline.

The attitude of identifiable formations and sequence geometry as observed in the bore-holes dictate that the major faulting be interpreted as thrusting. Thus, for the first time it is demonstrable from subsurface data that Dott's premise of major thrusting in the Arbuckle Mountains is tenable. In interpreting the data the writers have used minor thrust and reverse faults to account for stratigraphic discontinuities in the bore-hole in an attempt to explain the structure as homogenous in fault type, thus avoiding the indiscriminate use of mixed fault types. In an area so complex it is understood that there is no unique solution; however, the interpretation presented is logical and in no instance are the data violated.

The interpretation of these data indicate two major periods of diastrophism: post-Springer pre-Deese and post-Hoxbar pre-Pontotoc. Evidence concerning the relative importance and intensities of these orogenies is discussed. Cross sections are presented as an aid to deciphering the geological structure and history.

Production is from the basal Bromide sand of Ordovician age at depths of 10,000–11,000 feet. Five wells have produced approximately 640,000 barrels from January, 1947, to September 30, 1949, the discovery well contributing 375,000 barrels of this amount.

25. GEOLOGY OF ELK CITY FIELD, by R. J. Beams, consulting geologist, Oklahoma City, Oklahoma.

The Elk City field is in T. 10 N., R. 20–21 W., Washita and Beckham counties, Oklahoma, on the north front of the Wichita Mountains near the axis of the Anadarko basin.

The field was discovered by the Shell Oil Company's J. G. Walters well No. 1 in the NE. ¼, SW. ¼ of Sec. 14, T. 10 N., R. 21 W., which was completed in November, 1947, from a reservoir at the depth of 9,260–9,360 feet with an initial daily production of 470 barrels, 65.4° A.P.I. gravity condensate, 25 barrels fresh water, and 5,650 MCF of gas. Crude oil was discovered and first produced by the field's second well, the Shell-Long No. 1, NE. ¼, SW. ¼ of Sec. 15, T. 10 N., R. 21 W., which was completed in February, 1949, from a reservoir at a depth of 9,040–9,080 feet, with initial production of 2,345 barrels, 49.1° A.P.I. gravity crude oil, 70 barrels of fresh water, and 3,661 MCF of gas.

Subsequently, development has proved several reservoirs in the Missouri series of the Pennsylvanian to be productive of condensate and oil at a depth range from 8,800 to 10,200 feet. The field has a productive extent at present of 7 miles in length and 2 miles in width as determined by about 30 wells producing condensate and crude oil. The probable productive limits have not been indicated along the axis of the field but two dry holes on the north and south flanks, respectively, restrict the probable productive width to less than 3 miles.

In the Missouri series of the Pennsylvanian system, this field is structurally an elongate anticline with about 400 feet of closure trending west-northwestward with several culminations along the axis. The initial folding of this structure is unknown due to inadequate knowledge of the deeper strata, but drilling to date has proved that the structure was present during post-Missouri pre-Virgil time. This is shown by angularity at the base of the Virgil series. Further folding probably occurred in Upper Pennsylvanian, Permian, and post-Permian time.

The surface beds are Permian in age and extend to a depth of about 6,500 feet. The Pennsylvanian system is composed of more than 7,500 feet of strata extending from 6,500 to below 14,000 feet. The deepest well drilled is the Continental's Proctor No. 1, in the center, NW. ¼ of Sec. 28, T. 10 N., R. 20 W., which penetrated the Pennsylvanian to the depth of 14,572 feet.

Although oil and gas showings have been encountered both above and below the Missouri series, the field is presently being exploited from the granite wash and conglomerate reservoirs from 8,800 to 10,200 feet. These reservoir strata are interbedded with shale and marine limestone, but the series is predominantly of a coarse clastic type which ranges lithologically from heterogeneous granite wash to pure quartz sandstone and to limestone conglomerate. Most conceivable combinations of clastic material are present to some degree.

One of the more reliable structure markers is a limestone at the top of the Kansas City group located about 500 feet below the top of the Missouri series at a depth of about 8,700 feet. This limestone formation is readily identified from electric logs and is commonly used as a datum for structural interpretation since it immediately overlies the first productive reservoir of the field.

Some of the characteristics of the producing reservoirs have been established but more extensive development is necessary to define the total number of reservoirs and their productive extent. All data however show that this is a major field and of importance to the future development of the vast Anadarko basin. Oil and gas recoveries in this field justify the deep drilling necessary and the further exploration for similar accumulations.