PETROLEUM AND SURFACE VEGETATION

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Ever since man first began to use metals and other mineral substances, he has continually been looking for surface indications and clues that would enable him to locate these minerals beneath the surface. The prospector on the desert searches for "float rock." In Germany the searcher for metal seeks the *"eisener hut,"* and in France the *"chapeau de fer,"* both terms meaning "iron hat," or zone of oxidation at the surface. These men know that beneath this "hat" a vein of metal may be present.

These searches for indications of mineral under ground often take curious turns. We are all familiar with the time worn process of water witching which includes the use of witch hazel or peach tree twigs. The doodle bug man is still abroad in the land, and the gullible is still giving up his hard earned cash to the omnipresent fakir.

One of the oldest, and at the same time most common, of the so-called indications for oil or other mineral, is the presence on the surface of some particular kind of plant. Just what can be the possible relation between deep-seated oil or other mineral and vegetable growth on the surface does not appear, but the fact remains that very many people honestly believe that certain plants, or perhaps certain plant association, indicate the presence of mineral.

No one who has been in the field doubts that there is often definite relation between geology and vegetation. In tramping over the hills, one of the first and most outstanding phenomena that attracts the attention is the relation of vegetation to formations. We all know, for example, that under certain climatic conditions, shale carries grass, and sand carries trees. In some clifmates, limestone will be grass-covered, and in other climates limestone will support forests.

Perhaps no better example of this fact need be mentioned than the one known to all of us, the Arbuckle Mountains. Who of us has not stood on a hill near the periphery of these mountains, and by means of vegetal covering traced out the upturned edges of the various Paleozoic formations? We all know the Arbuckle, Viola, and Hunton formations form grass covered knobs and ridges, while the Woodford, Sylvan, and Simpson usually support growths of timber.

I well remember a few years ago hunting anticlines in Eastland County, Texas. The rocks, Pennsylvanian in age (Cisco) consist of alternating ledges of shale and sandstone with an occasional ledge of limestone, all dipping west. The stratigraphy is very like that in northern Oklahoma or in southern Kansas. The competent rocks, the limestones and sandstones, form scarps and ridges. The trees are chiefly postoak and liveoak. The liveoak retains its green leaves during the winter while the leaves of the postoak fall. We happened to be working in February. We soon learned that liveoak grew only on limestone, and so by looking

for patches of green were thus able to determine whether or not the ledge capping a hill a mile away was sandstone or limestone.

There is a tradition among geologists that a certain noted reconnaissance man in his work on the plains in Wyoming and western Nebraska some years ago learned that certain of the Tertiary formations were tree-covered while others were prairie. It is claimed that this man, by means of a field glass, was able to map in these formations many miles away. Those who have since tried to follow some of his mappings are willing to agree that the work must have been done with field glasses.

So we might multiply instances. These are ecological problems and must eventually be dealt with by the plant ecologist. They need not concern us further at this time.

An outstanding example of the fallacy that certain plants indicate the presence of minerals is the plant *Amorpha fracticosa,* which goes by the common name "lead plant" or "mineral weed." This plant, which is a legume, is wide spread throughout the Mississippi Valley. It grows chiefly in prairie soil, becoming a foot to eighteen inches in height, with a spike of small purple flowers. It blooms in June, and the seed pods persist until frost.

This plant grows quite abundantly in the lead and zinc region of southwestern Missouri, southeastern Kansas, and northeastern Oklahoma, and in that region there is a persistent belief that lead will occur underground wherever the "lead plant" or "mineral weed" grows on the surface. Many aweary hour has been spent by hopeful miners in digging shafts in impossible places, but like other superstitions, it dies hard. Over and over again, times without number, during the past thirty years, has some old prospector pointed out to me this plant growing somewhere on the surface in Kansas, Oklahoma, or Missouri, assuring me that if one would dig deep enough he would find there lead ore.

And there may be a basis for the belief. Professor H. C. George, who has had wide experience prospecting in the Wisconsin lead region, tells me that in that district veins outcropping on the surface may often be traced across the country by the more abundant growth of this plant, known to the miner as "mineral weed." The theory is that at the places where the veins cut the surface the soil contains an abundance of iron, which seems to add to the growth of *Amorpha.*

And so one might go on multiplying instances. But I wish at this time to discuss particularly the matter of plant association with petroleum.

Not many weeks ago we had the privilege of entertaining the American Association of State Geologists in a field conference in southern Oklahoma. Among others present was E. F. Bean, State Geologist of Wisconsin. Riding along one day in the oil fields of western Carter County, he pointed to a hill in the Hewitt field covered with jackoak timber and turning to me said, "Gould, I believe this must be the hill that got me into trouble."

"How," I asked, "Could this hill in Oklahoma get a Wisconsin geologist into trouble."

"It's this way" Mr. Bean explained, "one of your promoters from Oklahoma recently came to Wisconsin, secured some leases, organized a

company, and then applied to our commission for the privilege of selling stock in Wisconsin in order to secure money to drill an oil well. The commission asked me to sit in on the hearing and to pass on the geological prospects for finding oil in that particular region. I happened to know that at the place where he wanted to drill there were a few hundred feet of sandstone covering granite rocks, and that the chances for oil were practically nil. I so informed the commission. The promoter became very indignant and pointed out that the surface of the ground, the character of the soil and the jack oaks which grew on the surface, were exactly like those in the oil fields in southern Oklahoma that had produced millions of barrels of oil. However, the commission chose to believe me rather than the promoter, and the request to sell stock in Wisconsin was denied."

A few years ago an article appeared in Literary Digest, quoted from some rather obscure source which I have now forgotten, to the effect that oil and gas were never found in a country of pine trees. Just what influence the growth of pine on the surface had on the occurrence of oil thousands of feet down was not made clear in the quotation. This article in a reputable magazine attracted wide attention, and for some time my mail was cluttered up with requests from all sorts of people who wanted to know if the statement were true and, if so, why.

Of course we know that there is no possible connection between pine trees on the surface and oil or gas accumulation. While it iss true that many, perhaps most, oil fields do happen to occur in those regions where pine does not grow, it is also true that some oil fields are found in pine forests. I happen now to think of the Orange field in southeast Texas which is out on the flat Coastal Plain, in a swampy country covered with pine timber. Many of the oil fields in Louisiana and some in east Texas are among pine forests, notably the group usually known as the Caddo fields on the Sabine uplift in northwest Louisiana. The gas field near Poteau, Oklahoma, lies between Cavinol and Sugar Loaf mountains, on both of which pine grows. An abundance of coniferous trees, including cedar, pinon, and probably large species of pine occur in the Salt Creek and Teapot Dome oil fields of Wyoming.

However, we have at our door an example showing that after all there is a sort of relation between vegetable covering and oil production. I refer to the Oklahoma City field which is now being developed. If one will take the trouble to drive back and forth through this field over the various roads running north and south and east and west, he will notice that there is in the center of the field an area originally covered by jackoak timber. The general shape of the area covered by jackoak is roughly elliptical with its major axis north and south, and this area coincides quite closely with the supposed outline of the oil field. This fact has been noted not only by geologists and oil men, but by the general public, and there is even now growing up a tradition which will doubtless increase with years that the geologists originally located the Oklahoma City oil field on account of the jackoak timber. This tradition, which should be full grown in another decade, will doubtless serve to help keep alive the superstition regarding the relation of oil to vegetation.

And queer as it may seem the idea has some foundation in fact, but like many other statements is true only in part. Let me attempt to explain. The surface geology of this part of Oklahoma is usually quite simple. The rocks are all of Permian age, known popularly as red beds, consisting of alternating beds of red sandstone and red shale. The two formations which occur on the surface on or near the Oklahoma City oil field are known to the geologist as the Garber sandstone and the Hennessey shale, the Hennessey lying upon the Garber. As exposed on the surface, these formations occur in long, narrow bands, extending north and south across Oklahoma from the Kansas line to the vicinity of the Arbuckle Mountains. The Garber consists largely of beds of sandstone with some layers of red shale. The upper formation, the Hennessey, is largely shale with little sand.

Now it is very well known by all observers, whether geologists or ecologists, who are familiar with conditions on the Great Plains, that areas containing on the surface either beds of sandstone or loose sand are most frequently covered with oak and hickory timber. The most abundant species is the jackoak or blackjack, *Quercus marylandica.* The next most abundant is postoak or *Quercus stellata.*

The area occupied by these oak forests is popularly known as the blackjack country. The approximate line of contact between the Garber to the east and the Hennessey to the west may in most cases be easily traced on the surface by the presence or absence of the oak trees. This line which is popularly known to the people of the country as the tree line, extends a little west of north crossing McClain, Cleveland, Oklahoma, Logan, and Garfield counties.

Three of the larger oil fields of Oklahoma happen to be located near this line of contact, notably the Garber field in eastern Garfield County, the fields in western Logan County known as the Marshall, Lovel, or Crescent fields, and the new Oklahoma City field. These facts, however, are thought to be only a coincidence and have no real geological significance.

The reason for the island of oak forest in the Oklahoma City field is very obvious. The regional dip of the rocks is to the west or southwest, toward the Anadarko Basin, averaging only a few feet to the mile. At the oil field there is a reversal of this dip to the east, or slightly north of east. At the time of the writing of this paper, it seems quite probable that this reversal of dip is occasioned by a subsurface fault which is not apparent in the surface beds. At any rate, there is a surface dip of between 100 and 150 to the northwest. In a region of low relief with the rocks lying almost level, this east dip is enough to swing the outcrop of the Hennessey shale quite a distance to the east, and at the same time to bring up, near the axis of the dome, some outcrops of the underlying Garber sandstone. On this Garber island, oak timber grows abundantly, while in the area occupied by the Hennessey to the east of the dome covered with Garber there is found only prairie with a few trees.

So that the reason for the presence of the island of oak timber in the area occupied by the Oklahoma City oil field is obvious. It is simply a peculiar combination of structural geology and accompanying plant

growth. Let us hope that there will not spring up in Oklahoma an epidemic of drilling useless holes wherever the promoter, whether he be unscrupulous or simply ignorant, happens to find a narea of jackoak timber surrounded by prairie.