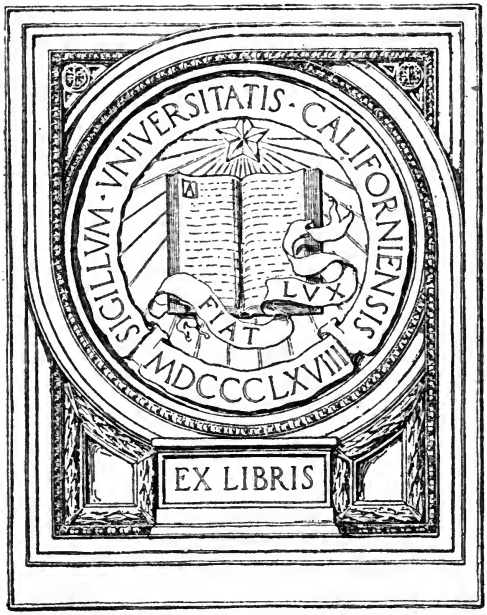
Isogeotherm Hypothesis

of MINERAL OCCURRENCE and ORIGIN

The ORIGIN of PETROLEUM

Coal, and Other Carbonaceous Products. By Wm. Plotts



Isogeotherm Hypothesis

of Mineral Occurrence *and* Origin

Origin *of* Petroleum

Coal, *and* Other Carbonaceous Products.

Showing how these products occur in orderly, definite, limited horizons, independently *of* the plane *of* stratification.

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Whittier, California.

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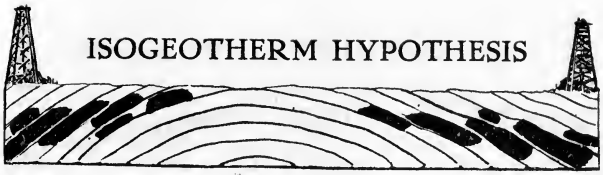
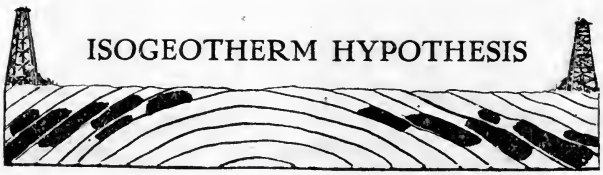


OCCURRENCE *of* COAL, PETROLEUM, &c

¶ Petroleum and coal occur in strata of various ages, the general series of which may be of the greatest variety of texture and hardness, and the general appearance of which may vary greatly in different fields, but in every region where they occur there is a something in common that is more or less discernable to the observer, but which is very difficult to describe. I am not now referring to the oil stains or coal blossom that are generally easily distinguishable where erosion has cut into or through the oil or coal horizons, but to the series of strata in general, extending thousands of feet above and below those products.

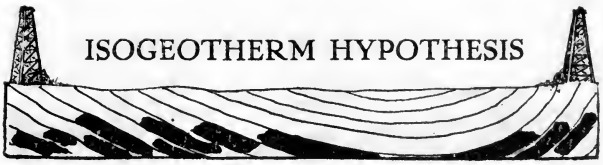
¶ Many observers, in trying to define this similarity, call it the age of the strata, it apparently being much younger and more crumbly than strata in the same series many thousands of feet under it, but this is not the true solution, as different oil and coal bearing strata vary greatly in age, as determined by the fossils occurring in them; those of Pennsylvania, for instance, being probably several times as old as those of California. The true solution is: each horizon of like products has been subjected to a like approxi-



mate pressure from the mass of material above it, and to an exactly like maximum of heat at the time of its greatest subsidence; and that this heat was the point of distillation of these products (probably several hundred degrees), seems quite plain, and that the source of this heat was the presence of enough material above the carbonaceous horizons to create it through the orderly increase of heat downward in the earth's crust, must become apparent as soon as the facts in connection are generally known.

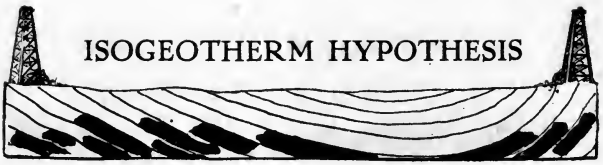
¶ The classification of strata, according to the amount of pressure and heat they were subjected to, is of the greatest importance from a mineral standpoint, when we consider that most of the earth's present land surface has plainly had miles of material eroded from above it. This feature must not be lost sight of if we expect to form rational theories of the present condition of any part of this grand old earth's sub-surface.

¶ The original superficial deposits above the petroleum must have been so vast, that where only half of them remain, the petroleum must be hopelessly beyond our reach. That this is so, is proven in many ways, the most simple of which



is the very slow augmentation of, or increase of firmness in the strata as you trace them stratagraphically downward. It also seems plain that thousands of feet of the upper portion of the original deposits could have been little else than loose, incoherent masses, owing to the lack of sufficient pressure and heat to knit them into substantial strata, sufficiently firm to resist the wave erosion, as they emerged above the surface of the ocean.

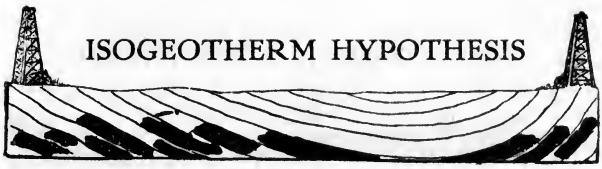
¶ In the following pages I intend to show that petroleum, in the continuance of its aggregate occurrence, forms a definite, limited horizon independently of the plane of stratification; and I hope that the reader will not lose sight of the grand and enormous scale on which the series of deposits were originally laid down, the slow rate of increase of heat in nearly all strata, and not to expect to observe a "made to order", or continuously regular horizon, because nature has been the constructor, and she does not work along geometrical lines; and I hope to convince you that it occurs in a former isogeotherm (plane of equal heat in the earth), and that coal, and many other more or less closely related products, occur in like



manner, also limestones of like type, and that many, perhaps most of our mineral, and non-mineral earth products have a closer relationship to each other, than has been supposed. Most, if not all, of the metallic minerals seem to occur in horizons independently of the stratification, that represent former isogeotherms; but they do not necessarily occur in their zones of former fusion or volatilization; for instance, certain carbonate iron ores of a certain type occur numerously in, and seem to be confined to, the coal horizons. They may be said to be of purely chemical origin, but it seems that they required a certain degree of heat in order to enable their constituents to combine.

¶ In pointing out the origin of petroleum, and other carbonaceous products, I am not going to bring to my aid any theoretical conditions of an exceptional or miraculous nature, or conditions that might result from some catastrophe; but am merely pointing out what must occur under normal conditions, such as we know of today.

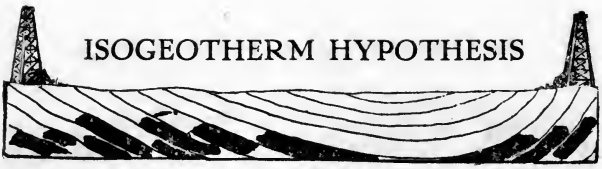
¶ To give a better understanding of the subject, I will now give in brief a summary of my conception of how petroleum and kindred products



were concentrated in strata, and the probable source of the carbonaceous matter from which they were formed.

¶ All authorities of any note now concede that most parts of the dry earth show evidences of former subsidence and emergence during inconceivably long ages of time, and may, and some certainly have, repeated the process over and over again, and that some of these subsidences, and subsequent elevations, have amounted to several miles vertically. Of course this may seem fantastic to many, but I am only appealing to those who have given the matter some thought and inquiry. The best evidence that we can get is, that this buckling of the earth's strata is going on now as actively as ever, and has been going on for a time that is practically infinite.

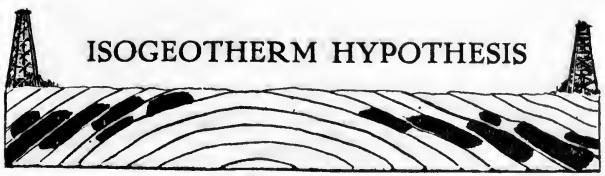
¶ We see different kinds of debris and sediment carried continually into oceans, building up the strata on the bottom. In this sediment is a proportion of vegetable matter, composed mainly of finely ground up leaves, etc. The remains of the lowest animal life might also in some cases, be sufficiently preserved to contribute, but the vegetable remains would seem to be ample.



¶ Of course, the percentage of such remains in any strata might be small, but the aggregate in miles vertical of strata would be enormous, and from such deposits perhaps miles thick, we might expect to come the principal part of the carbonaceous matter that forms our petroleum, coal, our massive limestones, and allied minerals.

¶ Now, we know that downward in the earth's crust, the heat increases. To the thoughtless this increase of heat might seem too slow to be applicable to our purposes, but we recollect that nature's operations are conducted on a grand and tremendous scale.

¶ Of course, where a succession of regular strata is being built on an ocean floor, there is a gradual subsidence of the region, which might continue many million years, and after the subsiding strata became sufficiently hot, on account of the constantly added material above it, the heat would drive the distilled matter from the leaves, wood, etc., upward. Or rather, the resulting volatilized matter, instead of subsiding with the strata, would maintain its relative distance from the surface, or at least from the bottom of the ocean, as the constantly reinforced mass subsided, "skim-

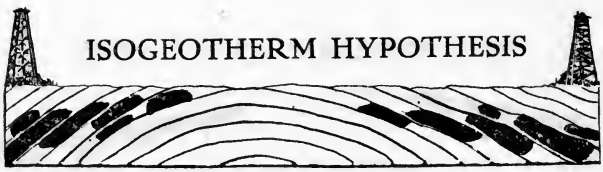


med" of its carbonaceous matter, which accumulated in quantity according to the amount of subsidence, and the richness in said matter.

¶ To those who have had experience in confining gases under great pressures, there is no difficulty in conceiving the possibility of compounds of carbon penetrating and permeating any strata when at several hundred degrees temperature and tons pressure per square inch, and at the time of maximum subsidence of the region, which would only occur after ages, the varying carbon compounds would be left blended with the strata, confined to a definite, vertically limited, horizon, which would occur independently of the plane of stratification, and during the long ages of emergence and erosion, they would become further concentrated, and more or less firmly fixed by chemical affinity in the different forms in which they are now found.

HOW PETROLEUM OCCURS in STRATA

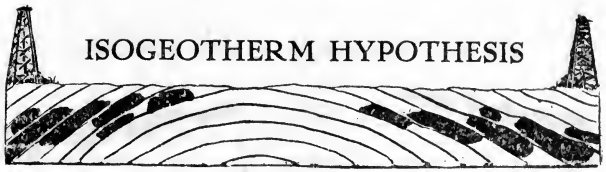
¶ Petroleum occurs in any kind of porous strata that happened to be in its horizon of general occurrence. This horizon is always limited vertically, and in its continuance thruout large areas



always occurs independently of the plane of stratification. Of course I do not mean that the horizon is evenly or continuously productive in petroleum; but that the successive or overlapping deposits all occur in this limited horizon; often with very extensive unproductive gaps between the productive portions. The common practice of speaking of successive horizons, one or more above others, is incorrect and misleading, as there cannot strictly be more than one oil horizon in the same locality.

¶ We almost invariably find oil in such environments as show that it could not possibly have arrived there in its present liquid condition. Any oil prospector that has investigated much can testify to this. It is common to find pitted limestones of the hardest kind with the pits full of oil, on the surface, where it has weathered for ages, where the oil horizon has been eroded away.

¶ It is common to find oil in sandstone, and pebble rock sometimes of adamantine hardness, altho much of the oil in the newer formations, like that of California, Texas, and Mexico, occurs in sandstone so soft, that the expanding gas that

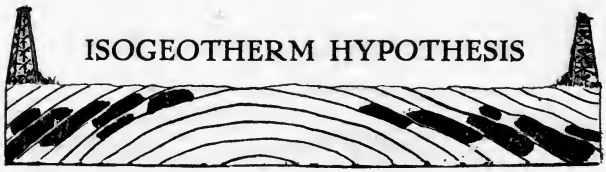


occurs in connection with all oil, pulverizes the sand strata, so that sometimes large quantities issue with the oil from the wells, but most generally the stata is too firm to cave.

¶ Those sandy strata were, of course, laid down under water, and the fact that they are barren of water generally, proves that before the oil took possession, they had of course, subsided to a great depth, too great for water to occur as such, the heat or other chemical action having disassociated the component elements.

¶ Water of varying degrees of impurity sometimes occur in the oil strata under the oil, but it seems plain that where such is the case the presence of the water is the result of erosion, or faulting, long after the advent of the oil, and perhaps after the surface had been cut to within comparative nearness to the oil.

¶ Where water has obtained access to deposits of oil the latter has generally slowly percolated to the surface, or sub-surface, in sufficient quantity to betray the petrolific character of the locality and region. If the oil is of dense kind, containing much asphalt or other basic material,

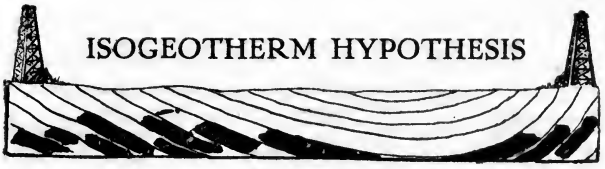


the residuum from such seepages sometimes occurs in large quantities.

¶ Of course the oil and gas, and other fluid substances are under pressure in accordance with their depth, the discussion as to the cause of the pressure is without point. It would be a miracle if they were not under pressure until the pressure is removed by artificial means.

¶ The actual pressure in a virgin oil "sand" or deposit is always in accordance with its depth below the surface, and is probably always below the pressure exerted by a column of water from the surface to the deposit, because as the region emerges and the surface is worn away, the deposit becomes cooler, causing the gases to condense and the pressure to decrease accordingly. Of course it often happens that the gas pressure in a well-hole will overcome the hole-full of water, or even thin mud, causing a "blow out", but this is owing to gas in considerable volume having free access to the hole, when the ascending gas, by lightening the column of water, would slowly overcome it.

¶ If there are numerous oil showings on the surface where the strata is horizontal, or only

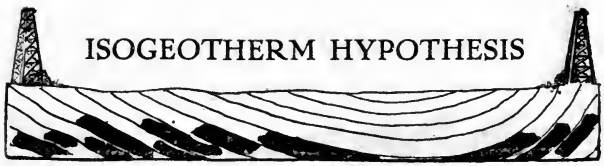


moderately tilted, the valuable oil deposits, if any, are usually of only moderate depth and it is useless to drill to a great depth; and in similar strata if oil is found at a great depth there is never any showing on the surface.

¶ Many times operators have drilled exploration wells a couple of thousand feet below the productive zone in search of another profitable deposit, but such attempts have always been failures. However, in localities of exceptional disturbance the oil horizon is likely to be more erratic and irregular than elsewhere.

¶ We sometimes read geological reports of oil and gas, where the writers suggested that those products had moved freely through the strata and had arrived from afar along with the "circulating waters." Such writers' observation must be very superficial and their logic faulty, for those products are firmly incorporated with the strata of which they are practically a part; were it not so they would have been lost ages ago. The continuance of porosity of an oil stratum is usually quite limited or the grain is very fine.

¶ It sometimes happens that a well is opened where the oil is under full pressure, in old ter-

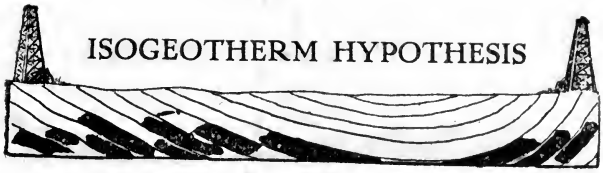


ritory where adjacent wells had been exhausted and abandoned for many years, and many other circumstances show us how thoroly the oil is confined to the strata where it had to remain ever since it was forced there in a volatilized form.

¶ There is a wide-spread notion that oil is a concomitant of certain strata and that if it is found at all it must occur in those strata, and that it is most likely to occur indefinitely in continuation of the plane of stratification from where it is known to occur.

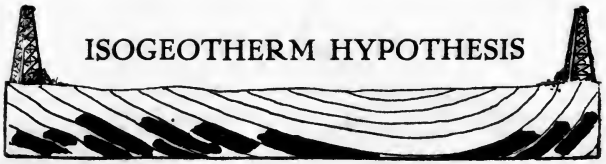
¶ This belief has been a very costly error, for the aggregated deposits of oil in their continuance, despite the irregularity of their occurrence, form a definite horizon which is limited in vertical scope and which is rarely in exact conformity with the bedding over any considerable scope of country, and whenever an oil-containing stratum extends outside of the orderly zone of oil occurrence (unless the porosity should be continuous beyond any known example), it is bound to be barren of oil and thereafter remain so, unless it should re-enter the oil horizon, which would be improbable.

¶ Where the oil occurs extensively and per-



sistently in certain strata to which it has been narrowly confined over a considerable area, geologists have repeatedly and foolishly predicted that it would not occur in adjoining regions or localities because they were stratigraphically much higher and much younger; and when oil was found there in violation of their warning, the geologists would explain that the original lower stratum was the place of origin of the oil but that it had "migrated upward", and urged deeper drilling in order to tap the basic sands. It is perhaps needless to add that where such advice was acted on it was unproductive of any good results. Contentions of this kind never had any basis of fact.

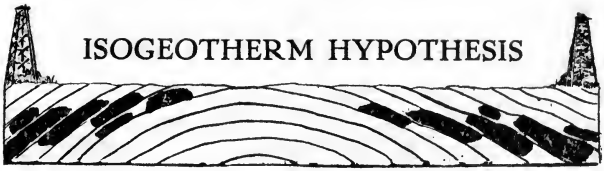
¶ If we could drill a well 30,000 feet deep do you suppose that we might find some oil at, say 1000 feet, and then go 5000 feet further and find another batch, and perhaps a few thousand feet below that find a bed of coal, etc.? Not at all. If oil was found at all the bulk of it would be found to occur in a vertical scope of a few hundred feet with possibly traces extending as much as 2000 feet above, and a less distance below, and below that no more would be found unless you



could continue the hole to the Hellespont or China. If coal occurred it would be found above the oil, as it occurs everywhere that those two products are found in the same locality.

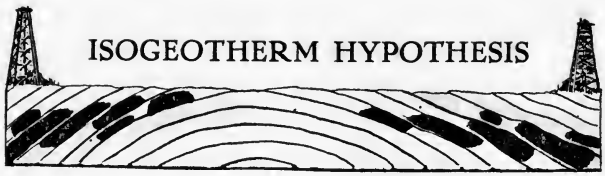
¶ Critics who fail to see an orderly, definite horizon that occurs independently of the bedding in the apparently irregular, hap-hazard grouping of the different oil "fields" when viewing the matter in this regard, seem to be expecting a "made to order" horizon where the fields would occur without wide gaps and in a perfect plane; but nature does not work along geometrical lines or in any manner that could be described as regular, so I have described the horizons of mineral occurrence as "orderly" in the sense of their occurrence vertically, because I well know how very irregularly those products occur in their zones or horizons.

¶ Each group of like products occurs in a common horizon, but any chemist knows what a great difference there is in composition of the different kinds of mineral oils, or of the different kinds of coal. Different kinds of oil being therefore of unlike kind might be expected to range in different positions in the grand horizon of pet-



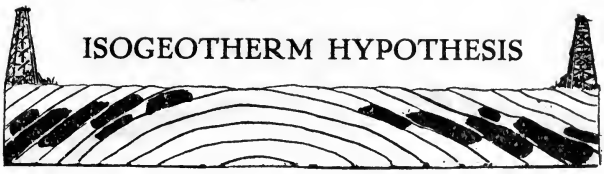
roleum occurrence, and it is common to find several beds of oil-containing strata overlaying each other, and occupying a vertical scope of possibly a thousand feet, altho it is more commonly confined to three or four hundred feet. In California, the several oil deposits may, including traces, extend vertically as much as three thousand feet, but such is rare. Much observation of the phenomena of petroleum occurrence has led me to think that cases of migration of petroleum out of its original zone of deposition are rare, except where erosion has permitted water to obtain access to oil, when the latter would slowly escape to the surface in the form of a seepage, which generally would require thousands of years to exhaust a deposit.

¶ Petroleum found in different fields is never identical in composition. It ranges all the way from the tarry product of Trinidad, Mexico, and California, to the light product of the Appalachian region, Colombia, Java, etc., which is nearly as thin and clear as water. In some fields like Whittier, California, although the oils may conform to a certain type, there are hardly two wells that produce identical oil. Not only is the



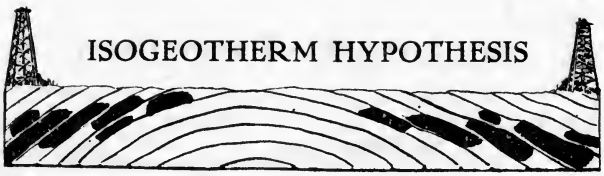
gravity varied, but the character of the oil otherwise is different. In the latter field the oil horizon cuts diagonally across the trend of the steeply upturned strata; and there are perhaps one hundred different producing stratums; and as many of the wells obtain oil from several strata, and as each stratum contains different oil from its neighbor, the resultant blend is rarely exactly alike in any two wells. There is no such a thing as drawing a definite line between asphaltic oils and oils of paraffine base, as practically all oils contain both asphalt and paraffine, in traces, at least. Even in products resembling either coal or petroleum, it is difficult to draw the line between the two, for coal and kindred products blend into those resembling petroleum.

¶ Petroleums of different character are often blended with shale of so fine a grain that the oil can hardly be detected except by smell. Such oils can only be obtained by distilling the shale, which is done profitably in some countries. The writer has seen such shales that looked, to his unpracticed eye, exactly like some cannel coals, which will also yield oils by distillation. Limestones in the horizons of petroleum, often smell



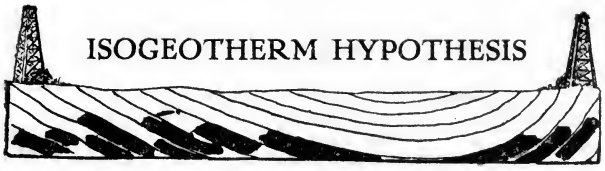
strongly of oil. In western Texas, and the larger part of eastern New Mexico, over an immense region, notably at Las Vegas, the harder shale, when freshly dug smells strongly of oil. "Stinking rock" is of this nature, as nearly all oil prospectors know.

¶ If petroleum occurs in strata of one age more than another, it is probably one of those things which might be considered as accidental; and ability to determine and classify strata by their age according to the fossils they contain is not of the slightest value to the prospector. Indeed geology has never had the slightest knowledge of any value to the oil man, notwithstanding many promotion oil companies loudly proclaim that their properties are recommended by some "expert geologist" who gives a long dissertation of his "knowledge" to the suckers; and of his ignorance to the rest of us. There are many expert oil men who make a business of passing judgment on properties for others, and some of them prefer to be called geologists to which we can not object, but the odium that has been connected with the term of late would seem to be enough to dissuade any from attaching it to their names.



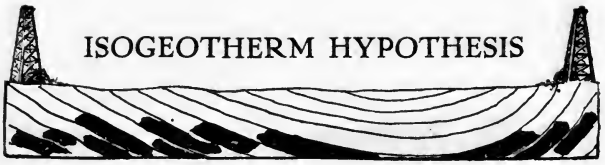
¶ The character of the oil, also, does not seem to be affected by the age of the strata in which it is found; for, altho the great bulk of the high grade oils have been found in very ancient formations, and nearly all the large production of heavy oils is produced from formations of recent age, the reverse is true of the very light oils of Java, India, and Colombia, S. A.; and of the rather inferior black oil of western Ohio and eastern Indiana.

¶ The similarity in appearance of the strata that is so noticeable in all regions where petroleum and other carbonaceous products are found, could only be caused by the degree of heat and pressure to which those strata in which these products are found were subjected at the time of their maximum subsidence. However, petroleum and coal bearing strata of great age, which were presumably subjected to pressure of the superincumbent strata for long ages, are firmer than are those of recent age, as might be expected. For instance, the shales of Pennsylvania, among which petroleum and coal are found, are much harder than the shales of California where the same products occur, but the same general appearance and color-



ing, and other indescribable conditions prevail in both regions, although one is vastly older than the other.

¶ The definite, vertically limited oil-containing horizons of California, although not continuously productive, occur sometimes in considerable non-conformity with the plane of stratification, and sometimes obliquely cross the demarkations, where one series of deposits rest unconformably upon another. The same is true in the Appalachian and middle west region, where the immediate surface for a thousand to two thousand feet, over the whole country, is an almost unbroken petroleum and coal horizon, although those products occur in separate deposits, or groups of deposits in that horizon, often widely separated from each other. That the successive deposits, do collectively, in their continuance, represent on a grand scale a definite limited horizon, which really occurs on lines of a former isogeotherm, must become apparent on sufficient consideration, altho why the deposits do not occur more continuously in that horizon has never been satisfactorily accounted for.

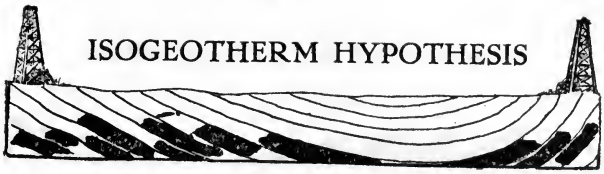


HOW COAL OCCURS IN STRATA.

¶ Coal also occurs in a horizon which in its continuation, is independent of the stratification. It commonly occurs in the same locality with petroleum, and is always above the petroleum, usually 1000 to 1500 feet. Sometimes it is as much as 2000 feet above, and in rare instances, it is but a few hundred feet above, and slight quantities of oil have been known to seep upward into coal mines that had recently been opened.

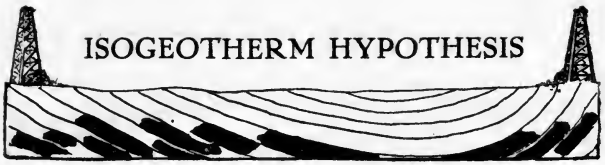
¶ The petroleum and coal horizons always parallel each other, regardless of the non-conformity of their horizons to the plane of stratification, showing that the relationship between them is intimate, as could not be otherwise; for in the various carbonaceous products resembling either petroleum or coal, it is difficult to draw the line, as there is a gradual blending of one into the other.

¶ If we consider the limited areas of coal regions, and the still more limited area of the known oil-containing territory of the world, we must admit that if these two products occurred together in six or eight different regions, it would seem more than a coincidence. But when we consider that nearly all the petroleum of the



world occurs in close proximity to coal, we may justly consider the fact of their relationship to be firmly established, and I will say more about this phase of coal and oil occurrence.

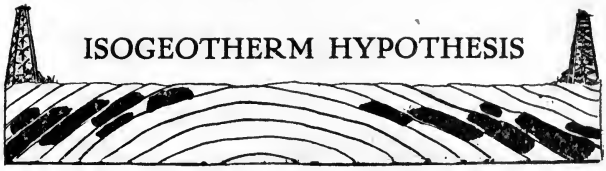
¶ People past middle age who have been interested in geological maps have noticed that the "carboniferous" areas have enormously increased the last two or three decades, which time is remarkably coincident with the discovery and development of coal all over the world. This stretching of the carboniferous over what was formerly classed as permian, and devonian, reminds me of the professional "oil smellers." Those good old uncles, who formerly used a forked peach branch to "trace" the oil belt, now commonly have a much more elaborate and entirely inexplicable machine to prognosticate with and supply a long felt want of unsophisticated land owners. The point is this: the "uncles" display wonderful acumen in tracing the oil-containing belt or deposit, in so far as it has already been proven by the pioneer operator with his drilled wells; but there is no well attested case of their having been themselves successful as pioneers.



¶ The extension of the carboniferous has evidently been for the purpose of bolstering up the popular (and precarious) notion that there was once an age or period of extraordinary development of vegetation; which belief was in its turn necessary to bolster the popular theory that coal represented accumulated vegetation in situ, a theory which has no basis in fact, as I intend to show, but which has acquired a widespread acceptation owing to a mass of apparent evidence which has appealed strongly to the superficial investigator, and owing to the persistence and industry with which this apparent evidence has been collected and advertised.

¶ The more our knowledge of this old earth accumulates the less need we have for promulgating theories of special or exceptional conditions, and the writer who tells us of wonderful catastrophies in the dim past, no longer is honored above those who can only see evidence of an orderly course of nature, similar to what we can observe in our own short time.

¶ Coal, like petroleum, occurs in strata of all ages except the very youngest where there has not been sufficient time for the enormous sub-

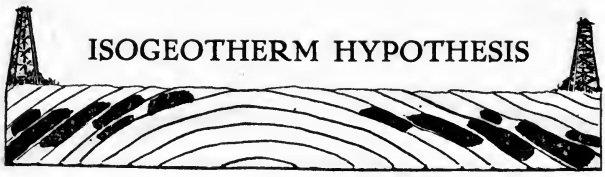


sidences, and subsequent elevations, with the attending erosion which is necessary to bring those products within our reach.

¶ It is popularly believed that hard, or anthracite coal became differentiated from other coal by having subsided to a great depth after the carbon became fixed, and where the heat operated on it.

¶ That the heat operated on it the same as on other coal, and no more, is what seems to be proven by anthracite that occurs above a petroleum horizon in the coast country of Colombia, near Barrenquilla, South America. The coal occurs sparsely at several places, apparently 600 or 800 feet above the oil horizon, which latter is well marked. The writer did not observe any, or hear of any deposit that was worth working, but it is there just the same. The strata is recent, probably tertiary.

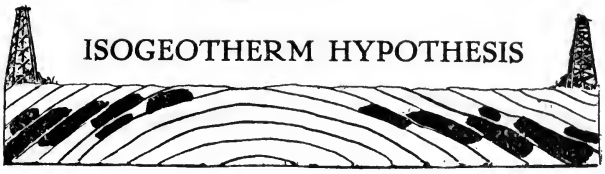
¶ The fact that sometimes coal is hard, at other times soft, or coking, or non-coking, or a worthless lignite, or merely a manifestation of coal, seems to make little difference in regard to its occurrence in orderly horizons and its relationship to other minerals, and the deep secrets of na-



ture's processes are beyond our ability to fathom at present, except where we get the key to them in the plainest manner.

¶ There has been much microscopic investigation of coal, with a view of studying its origin, but it is safe to say that the results have been entirely unsatisfactory, as they had a tendency to show that each different stratum was formed of different matter. This is exactly what might be expected, for coal is merely ordinary strata that has been changed, and which contains more or less clearly marked impressions of the coaser debris that the original sediments contained, the finer lines of the leaves or other debris being sometimes brought out by the black particles of coal on a background of lighter colored shale, in a wonderful manner.

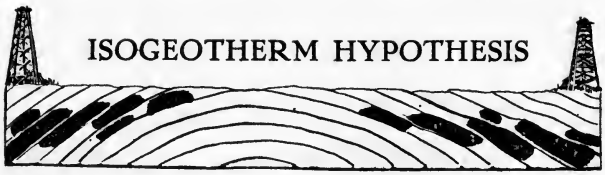
¶ The best examples of this seen by the writer (who has worked in coal mines,) occurred in the shale, with only fine particles of coal matter to produce the markings, and as other strata, even limestone, contain impressions of vegetation, apparently as frequently as coal, why are not those strata coal, if such evidences of original vegetation prove the accumulated vegetation theory?



¶In some lignitic coals that might be designated as immature, where there may not have been sufficient time or other essential conditions to completely form the carbonaceous gases into "fixed" carbon, pieces of carbonized wood have been found, being of such a nature as to correspond with the rest of the coal seam. It is noted, however, that when wood remains are found above or below the coal, they are almost invariably petrified, silica having taken the place of the original chemical constituents.

¶Geologists have industriously gathered and placed on exhibition many exhibits which apparently evidence the correctness of the compressed vegetation theory, and a museum of mineralogy is hardly considered complete without one of them. Almost every geologist of note has gone into print endorsing the idea, which they will hardly abandon, until the oil men find it universally profitable as well as instructive to search for oil in horizons of former isogeotherm.

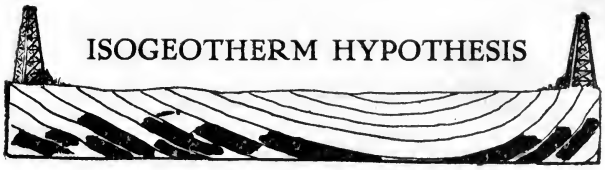
¶In the Royal Geological Museum on Germyn Street, London, there is an exceptionally complete series of exhibits, tending to show that coal is compressed vegetation, and if one-half of the



labor and ingenuity had been bestowed upon showing that coal is merely changed strata, in which the chemical constituents had been replaced by carbonaceous matter, and that the aggregate occurrence of coal in its continuance, in any region, represented a former isogeotherm, the theory would have been well proven.

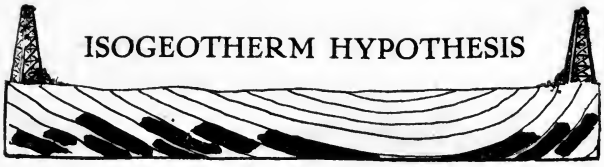
¶ There is one exhibit in particular, in the London museum, which is worth much study. It is intended to show that an intrusion of gabbro had changed the nature of the adjacent coal, but to a keen observer it only shows that the intrusion had occurred before the coal was there. The coal, which still adhered to the piece of gabbro, does not seem to have been changed by subsequent heat, its exceptional appearance (it is an odd looking semi-anthracite and is probably changed gabbro) having evidently created the impression that it had been changed by heat. Had the exhibit consisted of a large portion of the coal bed, with some of the intrusive rock attached, it would have been of much more value.

¶ The great bulk of coal strata was formerly a soft, massive shale, or hard clay, of much uniformity of texture, which seems to have been



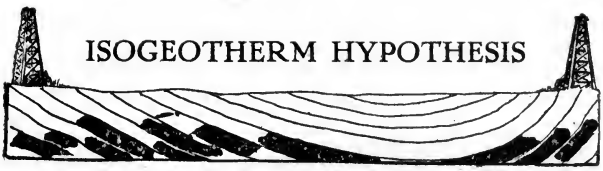
best adapted to arrest and receive the carbonaceous matter, but in exceptional cases apparently any kind of strata turned into coal. Even coarse pebble, the waterworn roundness being well preserved, has formed coal.

¶ A popular geological writer, who of course was an adherent of the compressed vegetation theory, having such a case brought under his observation, says: "In a period of elevation, the superincumbent strata must have been eroded away, and the coal bed cut into by a rivulet, which formed a bed of waterworn coal pebbles in the coal bed itself: after which the region subsided, and was covered by sediment as before." This is a sample of the immature reasoning that has established a theory which is actually taught in our schools. First, the coal was formed, necessitating a covering of thousands of feet and perhaps millions of years to compact the bed of vegetation into good coal: then erosion, which is so slow, that where our present coal beds have been cut into by erosion, it requires a practised eye to determine that there ever was a coal bed there, and the "blossom" has to be traced by drifting, often for a hundred yards



from the surface, before any coal good enough for use can be obtained, the outcrop having been destroyed, or deteriorated, by access of air. It is well known that the best commercial coal deteriorates in value, by being stored in the open air, and for this reason arrangements are being made to store it under water. But entirely oblivious of the perishability of coal, this "authority" had the coal actually worn into pebbles by slow erosion, and then covered up by the settlings of erosion, without affecting the quality.

¶ The popular hypothesis of coal origin as promulgated by the geologists of the last few decades is quite definite, and I think that I will not be charged with unfairness when I state that it supposes each bed or vein of coal to represent an accumulation of vegetation on the ground on which it grew: after which, the region subsided, and was covered with sediment which became the soil in which another accumulation of vegetation grew, when the region again emerged, etc. Those theorists neglected to make provision for preserving a sufficiency of vegetation from decay pending its submergence under the ocean, and when we consider the perishable



nature of coal itself, to say nothing of vegetation, the idea seems absurd.

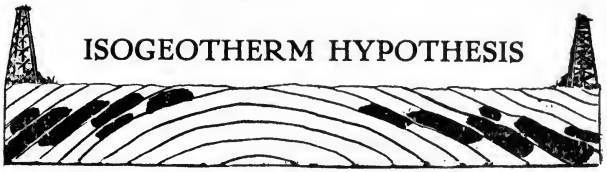
¶ The immense amount of carbon contained in a large coal vein, and the small amount contained in a yearly growth of vegetation, must have rather queered the gentlemen, for they agreed that it took an enormously long time, which they reckoned into the hundreds of thousands of years, during which time the mass, which must often have been hundreds of feet in thickness, was in some inexplicable manner preserved from decay.

¶ Now, the accumulation of such an immense amount of carbon by growth is an utter impossibility, owing to the limitation of fertility of the soil. Any good farmer can tell you that without the application of matter containing certain salts, the best soils would become unproductive, if heavy crops were taken off continuously. Before the vegetation would sufficiently decay for the salts to become again available, the carbon matter would all have escaped into the atmosphere. Then again, the large number of subsidences and elevations that, in some caaes, would have to occur successively,

during the building up of a very small amount of strata, is hardly consistent with our understanding of such phenomena.

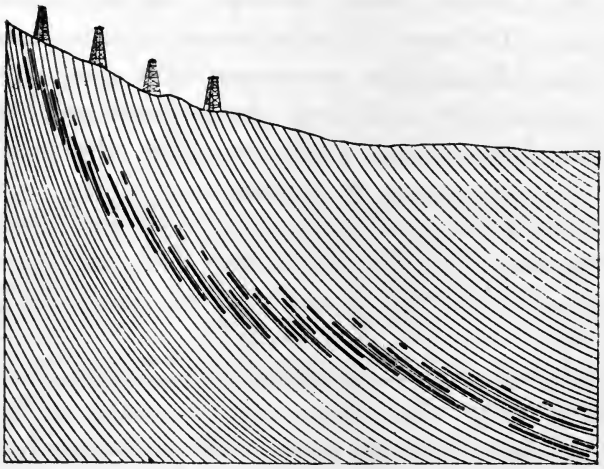
¶ The belief in the accumulated vegetation theory, seems to be based mainly on the fact that fossil impressions of vegetation are found to occur in coal, but they also occur intermittently in the whole series of deposits in which the coal occurs, as frequently as they do in the coal. In some coal, no fossil vegetation whatever can be detected, in other coal it is common. The same is true of the shales. Many geological writers have stated that coal measures (which term, if it means anything, means the coal containing horizon) were many thousands of feet in thickness, but we must consider their methods of determining the thickness, which was by aggregating the thickness of all the strata in which coal occurred at any point. Had the result been determined by drilling a deep well at any point that they might have selected in the coal regions, they undoubtedly would have found that the whole horizon of coal occurrence would have been confined to a few hundred, or at most, a thousand feet.

¶ But the feature of the geologists' theory of



coal origin, that is most opposed to reason, however, is, the emergence of those thin sheets of clay strata between some of the minor coal seams, which strata are sometimes only a few inches in thickness, and extend over large areas, and which, before they had hundreds of feet of covering were nothing but slimy pulp like occurs now on the bottom of the deep ocean, the only place where clayey shales are formed. The absolutely uniform texture of those shales would prohibit their formation in a lagoon, or in any other place whatever, except on the bottom of a very deep ocean, at a great distance from shore, and it is too much to suppose that in their emergence they would survive the wave erosion, of which I will speak further on. Some geologists think that coal-beds represent accumulations of driftwood, but this theory, also, presents insurmountable difficulties, as it would require the postulation of conditions enormously different from any we know of. But it is not necessary to further dwell on the absurdities of the compressed vegetation theory, altho a book might be filled with them. ¶ Coal sometimes, especially in much disturbed mountain regions, occurs in immense masses, in

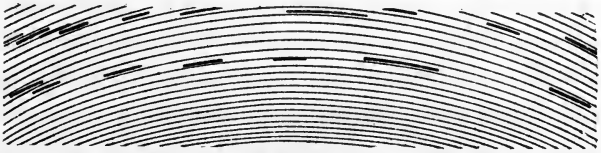
very limited areas. The name, "horse balls" applied to one series of them, will give the reader some idea of their form, which however is generally irregular. In most of such occurrences of coal, it is plain that there is little or no conformity of the coal, to the plane of stratification.



Stratagraphy of the west-end Whittier oil field looking east--further S. E. the dip is not so great. Light lines represent the bedding; short heavy lines represent oil deposits, which, in their aggregate continuance, form the oil horizon, which represents a former isogeotherm.

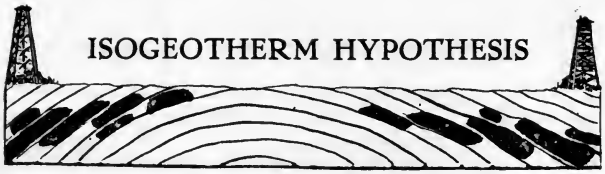
¶ But there is hardly a coal-bed, or vein anywhere, that does not display in some portion of

its extent, some unconformity to the bedding, and I wish to call the reader's attention particularly to this point. It must be apparent to the careful student that if this is true, it alone, must establish the origin of coal in the manner herein set forth. If you enter a coal mine in the Pittsburg, Pa., district, and travel towards the south, you will notice by observing carefully, that the coal encroaches gradually on the strata above, and correspondingly vacates the strata below, until in the course of half a mile or so, the whole vein



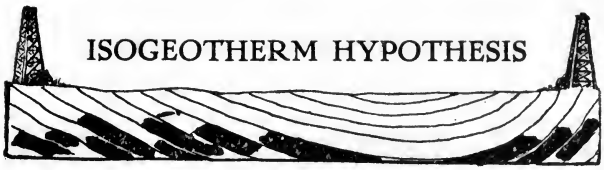
Diagram, showing the prospector how the successive occurrences of petroleum and coal are likely to appear on both sides of the same anti-cline.

will be in different strata from where you first observed it. In other coal fields, where this non-conformity to the stratification is much greater, and the separate veins or beds of much less extent, the field is a succession of veins occurring in a series of benches or steps, generally overlapping each other, each vein conforming



fairly well to the stratification, but the whole field throughout its continuance being sometimes as much as 20 degrees out of parallel with the stratification. It is in such cases as this that careless investigators have stated that the coal occured throughout a horizon of thousands of feet, when in reality the actual horizon of coal occurrence did not exceed a few hundred feet.

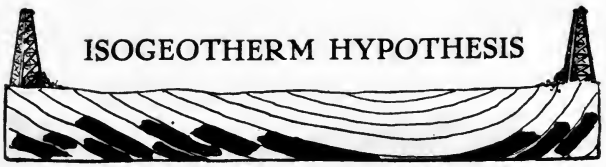
¶ Now, the only logical deduction that can be made in regard to this occurrence of coal (and other mineral) in an orderly limited horizon, independently of the stratification, is, that it was formed subsequently to the formation of the strata with which it is blended, and at the time of maximum subsidence of the region, the coal field as a whole, was spread out approximately horizontal, parallel with the surface, but the stratification was not. (Strata of any considerable age is never exactly horizontal.) Chemical investigation of a series of strata in which coal occurs, shows us that there is a great excess of free silicates in the strata adjoining the coal. The same is often true of iron ore. The shiny, greasy appearance of the cleavage is a manifestation of this change in chemical structure. Most of the valuable fire-clays, ka-



olins and soap-stones of commerce, accompany coal and iron ore in their occurrence, showing us the chemical changes that occurred, when the silicates, etc., were forced to vacate the strata, as the latter was taken possession of by the carbonaceous matter in its concentration.

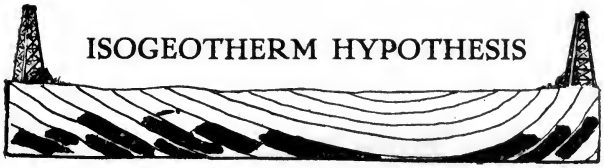
¶ If you take a good encyclopedia, and look over the mineral reports of various countries, like for instance, the Spanish American countries, where adverse governmental conditions have heretofore prevented exploitation, you may be surprised at the large number of regions that are reported to contain "coal and petroleum," or "coal and traces of petroleum." If you investigate further, you will almost invariably find that both these products occur in the same region, most commonly in the same locality, and a personal investigation will disclose that those products occur in the same general horizon, with the coal above the petroleum, and this, notwithstanding that the strata in which those minerals occur, are of the greatest variety of geologic age.

¶ In some petroleum regions, there are only slight traces, or manifestations of coal, so far discovered; and in some coal regions, perhaps the



oil is not in sufficient quantity to be profitable, but this should not detract from the significance of the apparent relationship.

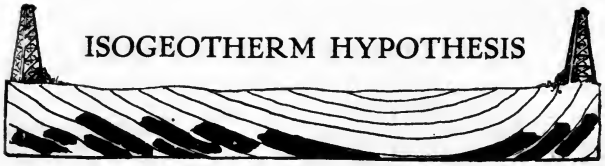
¶ In Great Britain, petroleum occurs in small quantities under the coal at some points, but it is of little value, being mostly of the oil shale variety, which has to be mined before it can be distilled. It is here that the coal bearing deposits, being confined within narrow geological limits, first gave the name "carboniferous" to the strata. The most important of the North American coal deposits were then exploited, and it so happened that they were in strata of similar age, as nearly as could be determined; and it was then that the belief was formed, that there could be no coal of any considerable value, outside of that series of rocks, and it began to be noticed that there seemed to be a relationship between the coal and petroleum. However, there was no getting around the fact that the Appalachian, and Middle West important coal deposits occurred throughout a stratagraphic scope of many thousands of feet, with the oil paralleling the coal at some hundreds of feet below. The coal of Warren and McKean counties, in



northern Pennsylvania, occurs in a plane of stratification, which, if continued south, would underly the various oil containing strata in southwest Pennsylvania. No coal, however, was ever found under oil, despite the fact that many deep (but futile) wells were drilled in middle and southwestern Pennsylvania in search of the oil, which, it was thought, ought to occur in continuation of the plane of stratification of the northern oil deposits.

¶ In connection with this parallelism of the coal and oil horizons, it is well to remember that in many oil fields, the oil occurs too near the surface to admit of a coal horizon above it, the strata where the coal belonged having been eroded away ages ago.

¶ No doubt the same coal horizon is represented by the coal of Pennsylvania, Ohio, Michigan, Indiana, Alabama, Kentucky, Virginia, West Virginia, Tennessee, Illinois, Missouri, Iowa, Kansas, Oklahoma, Texas, and perhaps other states. Oil occurs under the coal in all these states with the possible exception of Michigan. The strata in which these products occur, in this great area, can not by any stretch of the imagin-

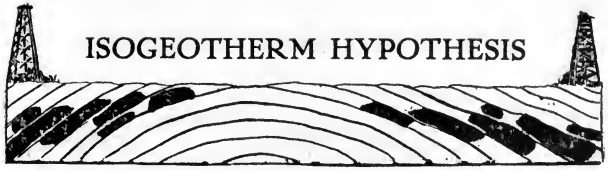


ation be considered syncronous, or continuous, and altho the coal and oil occur in patches only, with often wide areas that are barren, there can be no doubt that they represent on a grand scale, a former isogeotherm throughout this immense region.

¶ Petroleum also occurs under coal, in Wyoming and Utah: and at several places in California, coal of an inferior kind occurs, if not directly above the oil, at least in continuation of the general horizon of carbonaceous products.

¶ I wish particularly to call attention to the occurrence of coal in parallelism with petroleum throughout regions having surface strata of various ages, and the continuance, or at least corelation of the coal or petroleum horizons in strata of one age, to strata of a different age in adjoining locality or region. Also to the fact that the horizons of those products, altho each may consist of several deposits overlying each other, both maintain their identity, and maintain an orderly distance apart over a considerable region.

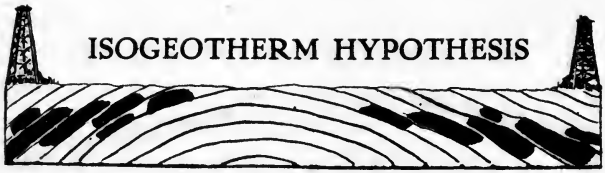
¶ Where the oil containing horizon has a considerable scope, the coal horizon also, has a con-



siderable scope, and the two maintain a great distance apart; as in southwest Pennsylvania, and northern West Virginia, where the two horizons are about 2,000 feet apart from center to center. In Illinois, where there is only a few hundred feet between them, the coal and petroleum are each confined to one or two deposits close together.

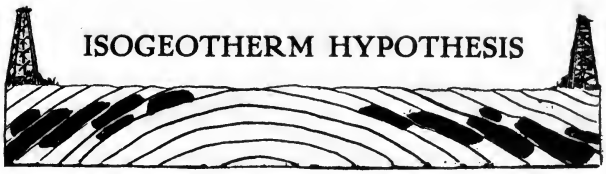
¶ Many textbooks and geological reports and bulletins, altho edited by persons who "never looked at it that way," are useful in showing that oil and coal occurrences in their aggregate continuance, represent former isogeotherms.

¶ Most, if not all the metallic minerals, seem to occur in horizons, independently of the plane of stratification, like petroleum and coal. That is, each deposit of exactly like variety, (if there be any two such in nature) has required like conditions of covering, heat, and other like conditions of environment. Carbonate iron ores: hematite, limonite, magnetite, etc., in infinite variety, occupy a definite position in relation to each other and to coal, lying above the coal at varying distances according to type, while another, and vastly different kind of iron occurs well down in the metamorphic rocks, where the heat



was evidently sufficiently great to deposit it in a volatile condition analogous to our treatment of iron in the arts. The before mentioned iron ores which are plainly deposits of former gravel and sandrock, the substance of which has turned more or less into iron, may be said to be of "chemical" origin, but the fact that they occur in a definite limited horizon, independently of the plane of stratification, shows that their occurrences represent, in their continuance, a former isogeotherm. The carbonate iron ores are popularly supposed to be precipitates from iron-charged water that percolated into the strata that afterwards became iron, but consideration of the fact that coal and iron carbonates so frequently occur together, must show that there is a relationship between them.

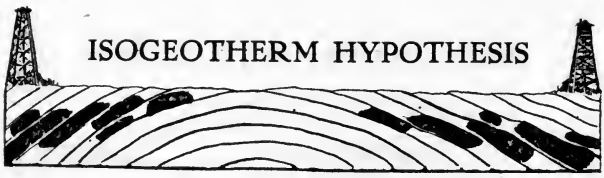
¶ Limestones of like type also occur in limited horizons: and, while a massive limestone deposit may closely adhere to the plane of stratification for a hundred miles, if it has extended out of conformity with the former isogeotherm, it will have changed its type; and as like as not another deposit, 500 or 1000 feet above or below the first, will have developed into the original type



of the first deposit, defining the course of the former isogeotherm. It is more common, however for a massive limestone to occur out of conformity with the bedding, when people who do not suspect its true nature often use it as a base for the determination of the position of other strata, with much confusion of understanding.

¶ The text-books tell us that limestone is mainly or largely composed of the remains of marine creatures that lived--and died--in great numbers at the time the said limestone was forming at the bottom of the ocean. But much contemplation and observation of limestone, (which is a very indefinite term,) shows us that it does not contain evidences of marine forms in greater number, or more frequently than other sedimentary strata.

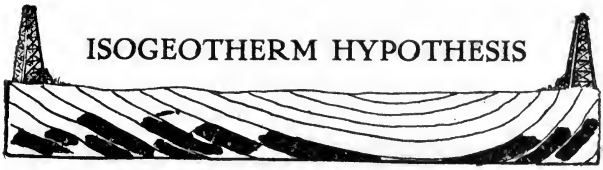
¶ It is common to see massive limestone, very pure and hard, without a trace of marine forms throughout its extent, while a few hundred feet under it will be found shales, sands and conglomerates, containing numerous shells of marine creatures, composed not of lime, but of silica. The Niagara limestone at Niagara Falls is typical of the kind that occurs so frequently in, or just above the petroleum horizons. To the



southwest for hundreds of miles, the "Niagara" maintains its type because it conforms to the lines of a former isogeotherm, but to the south, it soon loses its identity, because it dips below the oil horizon. The mile-deep well near Pittsburgh did "not reach" it, to the astonishment of the geologists.

¶ Where carbonate of lime is abundant in the horizons of coal and petroleum, it has changed shales into hard dolomites or other hard limestones; sand has been turned into sandstones; pebbles have been turned into conglomerates; etc. Four or five thousand feet higher in the series it occurs in a more or less chalky form, often in the form of concretions, which occurrence would absolutely forbid their formation by accumulation of limy marine shells. Many other forms of limestone occur so irregularly as to utterly preclude their formation in this way. If lime can leave, or be driven out of fossil shells through chemical action, can it not be driven indefinite distances through strata, to redeposit in strata containing no trace of marine forms?

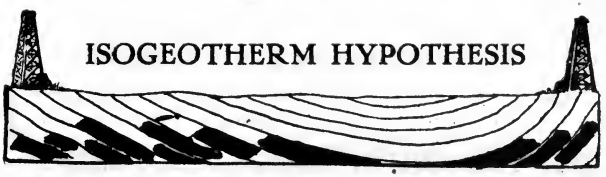
¶ Did petroleum, coal, limestones of similar type, and other products, occur evenly and con-



tinuously in their proper horizons, then, the fact of their occurrence on lines of former isogeotherms would be self-evident, but that perplexing old alchemist, the earth, has grouped them in such an irregular way, owing to causes that are not yet understood, that it requires quite an application to the subject to properly view them in this regard. Sometimes the carbonaceous matter in a series of deposits has apparently all, or nearly all, entered into combinations to form a limestone of massive form. At other places it has gone almost exclusively into an immense coal vein, or into a number of coal veins or beds, occurring one above another, sometimes several hundred feet apart, and varying in their character of composition, which probably accounts for their position vertically in the zone or horizon. At other places, nothing but petroleum is in evidence, (this, however, is rare.) Elsewhere, salt alone, or iron carbonates are found. Where all, or several of these products occur, they always occur in their regular order, the petroleum occurs below the coal, the salt between the two, or possibly sometimes below the oil. The iron

ore, if a typical hematite, closely adheres to the zone of the coal, but if a limonite, it may occur 2000 or 3000 feet above it. Limestones of like type always are confined to a certain position in relation to the other products, but being of various degrees of pureness and composition, they of course have a range vertically of many thousands of feet, as might be expected.

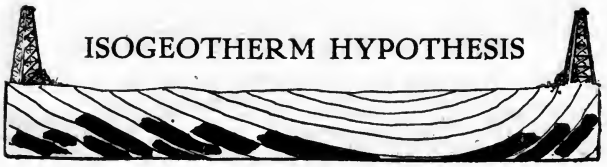
¶ Many other non-metallic minerals of like type occur in definite limited horizons, independently of the plane of stratification. Mineral nitrates occur in this way. Their occurrence in quantity is, however, limited to regions where there is very little or no rainfall, as, if there was enough water to reach down in the earth, it would quickly dissolve the valuable salts. Common salt, soda, etc., are found outcropping only in desert countries for the same reasons, but are now largely obtained by shafting or boring through impervious superincumbent strata, below the point where the water has penetrated, because, of course, there was no water in those zones or isogeotherms, until they emerged and were eroded, the original sea water with which they were charged, when they were formed,



having been dissipated as such, before they had reached their maximum subsidence.

¶ The most common form of salt occurs in petroleum and coal horizons, sometimes in such enormous quantities, and in such purity, that the popular conception of its origin in desert basins must be wrong. Water found at great depths is almost invariably charged with some kind or other of salts which make it unfit for use. Close to the surface however, especially above the level of the deeper valleys, the circulation of the water in countries having a fair amount of rainfall, has removed the salts. All this evidences the truth of the theory, that the strata had subsided to where the heat or other factors of great depth and pressure, had operated to eliminate the uniformly brackish sea water that saturated the sands when the strata was formed. Sulphur and other substances that blend with coal, petroleum and many other products, could only have done so in a condition of volatilization.

¶ Soils also, might advantageously be classified along lines of former isogeotherms.



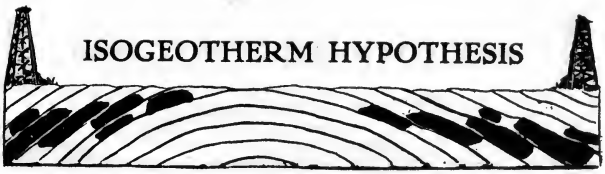
VERTICAL EXTENT OF MINERAL HORIZONS

¶ All deep well drillers know by practical experience, that the heat increases downward, but in some regions it increases much more rapidly than in others. Unless a flow of water is encountered, it is difficult to get the exact temperature of a hole at any point, because the cool water that is constantly admitted to the hole, has a tendency to cool the rock, which, being a non-conductor of heat, is slow and uncertain about recovering its normal temperature.

¶ Where the heat increases rapidly, it is thought to be owing to the strata being of a less complete non-conductive nature, than where it increases slowly.

¶ No doubt this variation in the increase of heat applies to great depths as well as to the insignificant depth of a few thousands of feet to which we can penetrate with our present facilities.

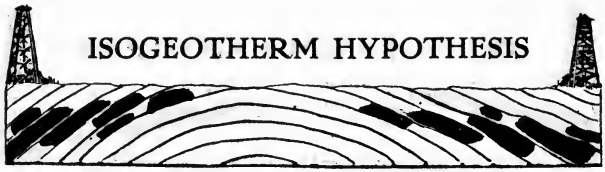
¶ If, at the time of maximum subsidence of a region, the heat increased rapidly in the isogeotherm of deposition of volatilized carbonaceous matter, then we should expect to find the result-



ing products confined to a few hundred feet vertically in each case, altho there would be other factors, such as the presence of other substances with which each product would have a tendency to blend.

¶ If the heat increased slowly, we should expect the coal for instance, to occur in a considerable vertical scope, a thousand feet in some extreme cases, like for instance, southern Pennsylvania, or northern West Virginia, where the oil likewise occurs a couple of thousand feet below the coal, and like the coal, has a considerable scope.

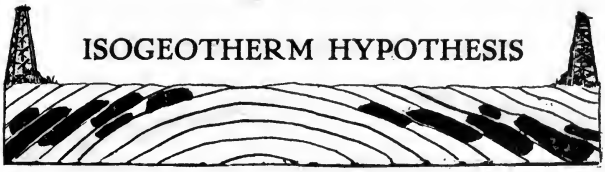
¶ We must not forget about the enormous denudation that has occurred almost everywhere, at least wherever there is a semblance of hills or uneveness of any kind. The present surface lines in an oil or coal horizon, or region, should be regarded largely as an accidental circumstance. We frequently see a thousand feet thickness of strata outcropping in plain view, the upper portion of which is apparently as firmly knit by the former pressure as the bottom layers are. This shows that the weight of the one thousand feet of strata was such a small part of the whole



pressure to which the strata had originally been subjected, that it made no appreciable difference to our eyes. If however, we have an opportunity of observing a few thousand feet additional of outcrop above the other thousand, we will probably be able to note a difference, owing to an increase in firmness as we trace the strata downward.

¶ Near the Hill street tunnel, on First street, Los Angeles, Cal., there is beautifully exposed, strata tilted almost vertically, resting upon which, unconformably, of course, is a horizontal strata, which is not much less firm than the lower one. Both series are among the most recent deposits, and constitute an object lesson of the immensity of past time.

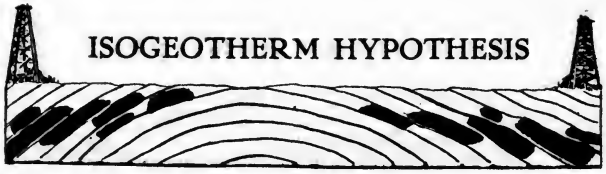
¶ We must remember that where we can trace a single series of 30,000 feet or so of strata, we must look for the petroleum and coal horizons near the top of the visible series, because the comparatively few thousands of feet of material that had been above them would be more crumbly and less compact, and hence not likely to survive the denudation that had exposed the immense series of strata. Likewise when we ob-



serve a flat, or gently rolling landscape, composed of crumbly material, where the bedding can only be detected in the most favorable locations, we may be sure that the valuable minerals, if any, are far below, excepting, of course, in a possible separate series of deposits within reach of the surface.

¶ While petroleum is confined to a definite vertically limited horizon which, like coal, occurs independently of the stratification, it does not occur so regularly in that horizon, being collected more in spots, or irregular belts, and rarely spreads continuously over a considerable stretch of country. The fact that petroleum only occurs in porous strata, often very limited and irregular in occurrence, also, probably has much to do with its irregular occurrence.

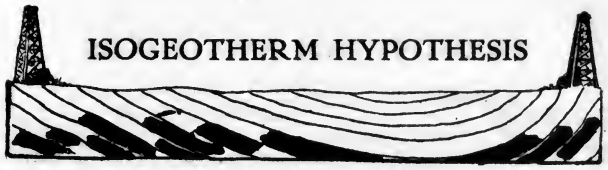
¶ All who have read geological textbooks and official bulletins, may have noticed that the writers or editors sometimes described certain conditions, admitting that they were perplexing and inexplicable, but which are not so at all, when considered in connection with the isogeotherm hypothesis. Several geological writers have stated that it was "a curious fact" that in



the Appalachian region, or at least certain portions of it, the petroleum, or coal, in their successive occurrences in a certain direction, occurred successively higher, and in younger strata, or the reverse, over several hundred miles in one direction. It has been admitted that cross-bedding, and other phenomena, in strata that only admitted of certain definite conditions in their formation, occurred in both coal and limestone. Of course, there is nothing wonderful in this, when we regard both of these products as merely promiscuous ordinary strata that has been changed in its chemical contents only, but the old geological conception of their origin requires the performance of miracles in their behalf.

STRATIGRAPHY OF THE WHITTIER OIL FIELD

¶ The stratigraphy in connection with the oil occurrences in the old Whittier oil field, although possessing certain general features in common with all other oil producing districts, contains those fundamental features in such an exaggerated aspect, that the determining of the law of the oil occurrence has seemed inexplicable and

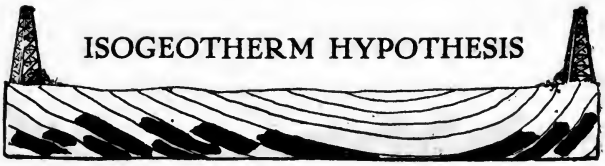


past finding out, and while perhaps no other oil field has been so much studied and described, it will perhaps interest many to get still another description, and general deductions from my observations, because, perchance, they "never looked at it that way."

¶ The trend of the exposed strata in this field, is found by much investigation, to average a true east and west, but as the developed portion, which is well defined by numerous failures (at least on its northeast side,) extends in a nearly northwest and southeast direction, and is very restricted in width, at least in its northwest end, owing to the steep dip of the oil horizon, it is obvious that oil occurrence along the line of strike of the strata is not very extended, and seldom reaches as much as half a mile.

¶ This is the feature that was so puzzling to the early operators, and many investors still have an aching void in the region of their pocketbooks, owing to failure to locate producing wells a short distance along the line of strike of the strata from good producers.

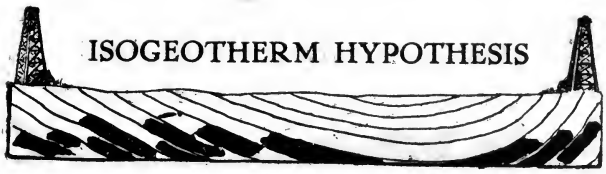
¶ It might be supposed that whatever was the cause of this general unconformity of the course



of the oil belt to the trend or strike of the strata, the continuance of porosity in many of the oil strata, in obliquely crossing the narrow field, would cause great irregularities in the flanks of the general oil belt. But this is not the case, the limits of the field being fairly regular, as represented by developments, oil seepages, and other surface indications; one exception, however, being a considerable seepage midway of the field, and near the line of the southwestern edge of developments, the rest of the seepages being, of course, on the other, or shallow side.

¶ There has not been a single failure in the defined field, except such wells as were pinched out, or plugged with lost tools, or by failure to shut off the water, while close outside the defined limits, there have been sunk numerous failures, and not a single productive well. All those failures on the southwestern or deep side, however, may be considered as being of insufficient depth, while the northeastern side, representing the outcrop of the oil horizon--as the writer pointed out several years ago--is defined permanently, and nothing of any consequence can be expected there.

¶ This clean-cut limit of the oil field may be

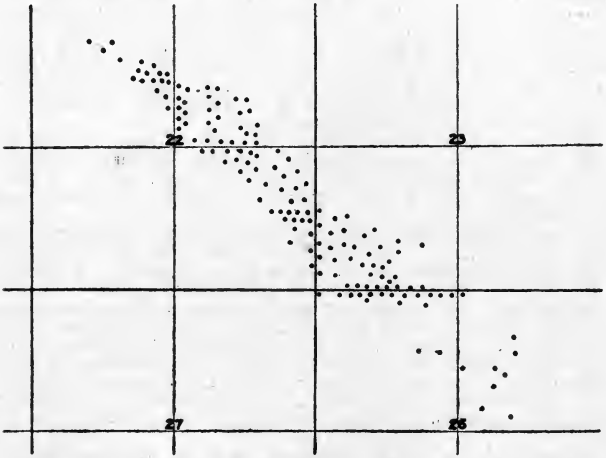


accounted for on the supposition that the separate oil strata have little persistence or continuance of porosity, so that the oil has always remained well in its defined limits of original deposition, and indeed this seems to be the case, as seldom can any single stratum be identified with any certainty in adjoining wells.

¶ The old time driller in the Whittier field does not speak of "the oil sand" because he knows that there is no such thing as a definite oil sand there, but there are dozens, perhaps hundreds of them, so many that it is impossible to more than give their mode of occurrence. Perhaps the oil in some of these separate strata is intercommunicable, although they seem to be separated by well defined strata of impervious shale.

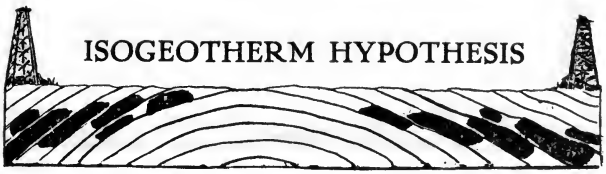
¶ The strata in this field dip all the way from 45 degrees in the southeastern end, to vertically in the northwestern end. This is determined by observing the dip of the exposed strata at the surface, by comparing in neighboring wells the depth at which is encountered certain persistent strata that may reasonably be supposed to be continuous from well to well, and by recovering

numerous pieces of under-reamings, containing portions of the face of the hole, in which the bedding is plainly marked.



The northwest end of the Whittier-Puente oil field. Dots represent wells that are, or have been producers. Outside of the area represented by the dots no profitable wells have been found. In this area, practically no failures have been obtained. Most of the wells are many years old. Development has been going on for about 15 years. Observe that the direction of the development, (which parallels the outcrop of the oil horizon) is N.W. and S. E., although the steep-dipping, outcropping strata, trend east and west; showing a non-conformity of the oil horizon to the plane of stratification of nearly 45 degrees.

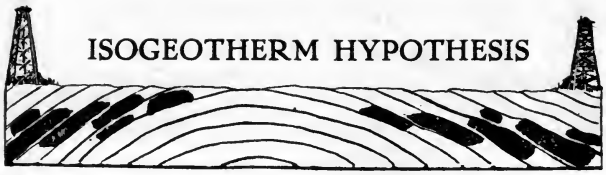
¶ The general trend of the hills or anti-cline conforms closely to the trend of the oil field, so that the trend of the strata cuts obliquely across



both. It has often been held by persons who have not themselves investigated, that this is impossible; that the strike of the strata must necessarily conform to the axis of the anti-cline, but this need not follow, as in this case there might have been, and probably was, over the whole region originally, a universal dip of the strata to the south southeast before the anti-cline began to form.

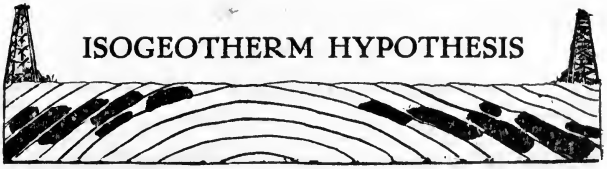
¶ This feature of unconformity of the outcrop of the oil horizon to the horizontal trend of the strata is not at all exceptional, but nowhere else, perhaps, does it occur in such exaggerated form. If, however, we view in perspective, a profile of the oil horizon of this field as it extends into the earth in the direction of the dip of the strata, we find that the same phenomenon of unconformity to the plane of bedding occurs, the oil horizon, as in most other fields, dipping roughly about half as much as the strata does, but as the strata in this field dips very steeply, and in most other fields but slightly, the unconformity here is very noticeable, while in other fields it has not been sufficiently noticed to cause comment.

¶ Here we have under consideration an oil



field where the strata stands at such a pitch that it is considerably nearer vertical than horizontal throughout the field; the field extending, not with the strata, but obliquely across it; a narrow belt of oil producing territory with shallow wells and oil outcroppings on one side, denoting the outcropping of the oil horizon, with gradually deepening wells towards the other side where the field is defined by the limitation of depth, the cost and time of drilling the deep wells being heretofore prohibitive.

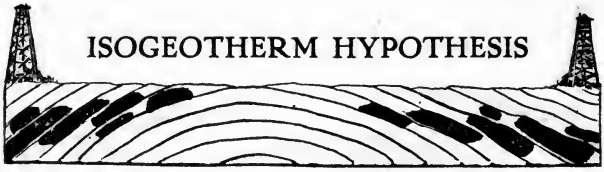
¶ It must be admitted that this is a very difficult matter to describe comprehensively to those who have heretofore not given it much attention, and people generally have somehow got the notion that oil is a concomitant of certain individual strata, and must necessarily occur in connection with those strata and nowhere else, and it must be confessed that it does appear so in an oil country like, for instance, western Pennsylvania, where, sometimes over an extent of twenty or thirty miles the oil is confined to one or two well defined strata, which can be unmistakably identified for that distance; however, if the observer will view in perspective 100 or 200 miles



of that country, he must note that the oil-containing horizon as a whole does not conform to the plane of stratification.

¶ Now what does this orderly, I will not say regular, non-conformity of the oil horizon to the plane of stratification signify? Just this, it gives us the key to the origin of the oil, to its distillation from below by the heat in the earth, and its final deposition in its original isogeotherm, or plane of equal heat, which would rarely or never be in exact conformity with the plane of stratification, and as the region slowly emerged from the hot depths, and the miles of strata above became worn away, the strata continued its tilting, usually on the same order it began, until the oil horizon itself became contorted and dipping, though usually not so greatly as the strata.

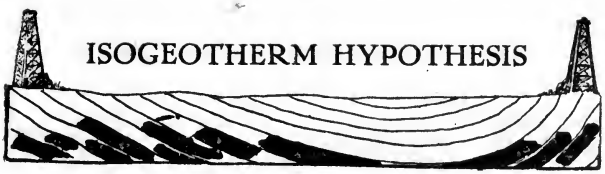
¶ The oil at Whittier all occurs in the regular Puente series of formation, composed of shales, sands, and conglomerates. Beginning generally at the base of the hills, and extending south, is a much later formation, resting unconformably upon the Puente. At the Leffingwell ranch this newer deposit extends into the hills in a body of several hundred acres, with the bottom of the



canyons cutting through in places into the Puente series, which is noticeably different, even to a novice. At several other places there are detached patches of the later formation, which have so far escaped complete denudation.

¶ This matter of more than one series of deposits, however, is of little interest or value to the oil man, for the lines of demarkation mapped out by geologists, separating the supposed serial deposits with their fanciful names, (generally borrowed from far away Britain), is no barrier whatever to the orderly course of the petroleum, and coal and perhaps other horizons, which, scorning such insignificant obstacles, keep right on into and through many named deposits. Even truly separate series resting unconformably upon each other, providing they had reached sufficient subsidence, exert no influence whatever upon the orderly course of those horizons.

¶ The continuation of the Whittier field, or rather the outcrop, is in an E. S. E. direction, along the Puente hills, and, while the whole oil horizon does not outcrop--portions continuing over the summit where the hills are lowest--it outcrops sufficiently completely, to form a line of

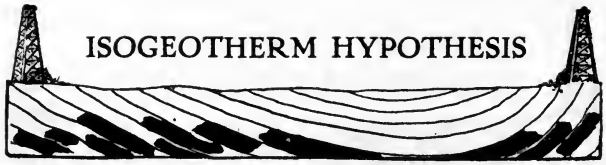


seepages to beyond Olinda, about fifteen miles.

¶ This outcropping represents the edge of an immense oil field which has heretofore been considered too deep to successfully operate to any great extent, except near the outcrop, which is somewhat irregular, owing to its non-conformity with the steeply dipping outcropping strata. These strata as at Whittier, trend east and west the whole distance, while the line of seepages along with the groups of wells at Whittier, run S. E.; a few miles S. E. of that point, bend more easterly, and continue about E. S. E. to Olinda, being considerably out of conformity with the bedding the whole distance.

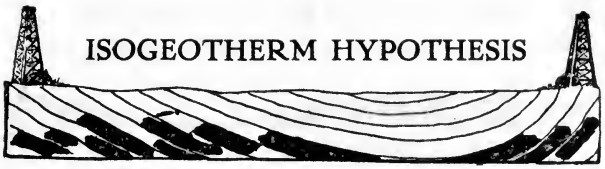
¶ Recent development, in closing up the gaps between the groups of producing wells, has a tendency to show that what was apparently a succession of overlapping oil strata a thousand or so feet apart, with barren strata between, is really a practically continuous outcrop of the whole oil horizon, altho somewhat irregular, owing no doubt to the irregularity of porous strata, in which only, the oil can occur, and which is absent at points along this grand outcrop.

¶ At other oil fields in California there are

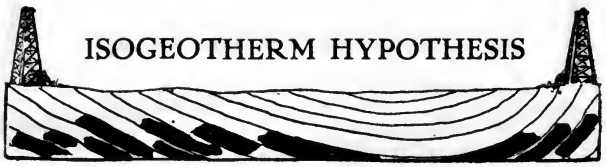


somewhat like conditions, the oil horizon rising abruptly from a great depth, and outcropping in steeply dipping strata, the porosity of the oil sands not being very continuous or persistent, so that altho some of the minor oil deposits have been destroyed by surface water having entered them, the near-by deposits are uninjured.

¶ A remarkable feature of this Whittier-Puente oil field is the great diversity in the character of the oil: especially in the gravity, which ranges from a tarry substance too heavy to pump, up to 36 gravity (Baume.) It used to be thought that the basic oil was very light, and that the heavier oils had become so through the loss of their volatile constituents, but since the field is better developed, it appears that the lightest oils are the lowest in the oil horizon, and as a rule the heaviest are highest in that horizon. It seemed difficult at first to formulate such a rule, because, where the oil horizon cut diagonally across the edge of the steeply upturned strata, the differing oils seemed to be sandwiched in the oil horizon in a bewildering manner, but it is now plain that those deposits that are confined to the N. E. side, or underside of the oil



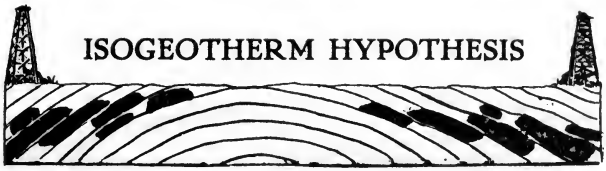
horizon, are always much lighter and more valuable than the more persistent deposits that cut clear across the oil horizon, and the very tarry oil is confined to the top of the oil containing horizon. In fact, in nearly every well in California, traces, or small showings of tar are encountered, usually many hundreds of feet above the main bodies of oil, and operators generally have learned to pay no attention to such showings, as they are usually of no great extent. The very light oil deposits also, are generally of limited extent, and the wells rarely hold up as well as those of medium gravity. It must not be assumed, however, that because a strata yields a very heavy oil, that deeper drilling will necessarily develop a deposit of light oil immediately under, although the chances are such as to be well worth the cost of making an extra thousand feet of hole, where there is a considerable area to be proven. In other California oil fields it is also recognized that light oils are most likely to be found lower than the heavier oils, but the practise of classifying each level at which oil is found, as a separate oil "horizon," has confused the matter.



¶ People who object to the subsidence, or isogeotherm hypothesis of petroleum origin, refer to the enormous amount of deposit it would necessitate above the petroleum zones in order to secure the necessary heat to properly distill the product found therein, and ask for proof that there were two or three miles or so of deposit above it.

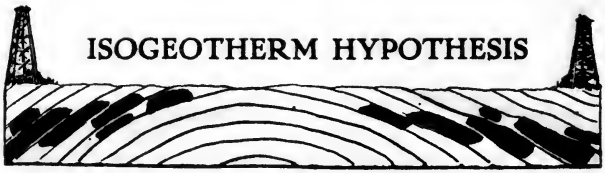
¶ At several places in California, notably in the Coyote Hills district, it is more than 4,000 feet to the oil, and the only reason it is not found deeper at other places is obviously because that is close to the practical limit that can be reached without an outlay of cost which would be prohibitive. Indeed it is only the last few years that it has been considered practicable to go more than half that distance in California, and wells of 4000 feet, cost on an average, at least thirty thousand dollars.

¶ The strata, where it is cut into, 4500 feet above the oil, has the same general appearance and texture, as it has in the oil horizon, or below it. The inference is, that if there had not been several times that much superincumbent deposit at the time of maximum subsidence, the



difference in texture in that 4500 feet of strata would be noticeable. Then the temperature at 4000 feet depth, is in the Coyote field, about 170° F. which would amount to about one degree increase for 40 feet. The deposit is tertiary and the universal denudation must have been very great, as in such a friable formation, the rate of elevation would hardly much exceed that of denudation.

¶ But what is especially worthy of our attention is the enormous amount of denudation that would occur in such a formation, before it emerged above the surface of the ocean. Indeed it never would have so emerged, containing the oil horizon intact, had it not been protected by immense masses of coarse flinty sand, the siftings from the thousands of feet of denuded superincumbent strata; and the like masses of similar sand that everywhere protect the emerging beaches, give eloquent testimony to this universal denudation by the waves. Nature in her destructive operations, takes no account of economic values, and it seems that recently formed oil strata like those of California, that have not had sufficient age to harden them, are as often as



not, entirely cut to pieces by the wave erosion in their emergence. Examples of such oil horizon erosion can be witnessed at Point Firmin, and Summerland; and the shore of the Pacific for hundreds of miles is littered with splashes of asphaltum and parafine, that come from the eroded bottom.

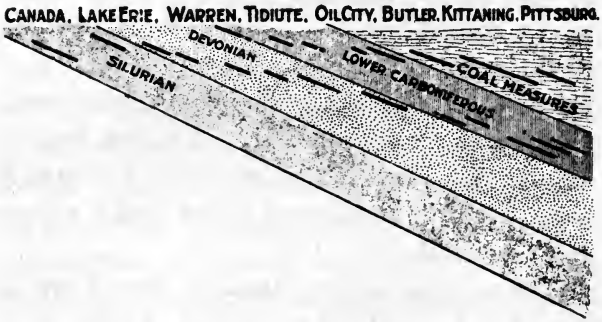
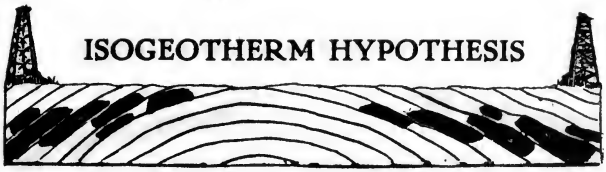


Diagram showing the successive occurrences of petroleum and coal across western Pennsylvania. The upper series of short lines represent the coal, and the lower ones the petroleum horizons.

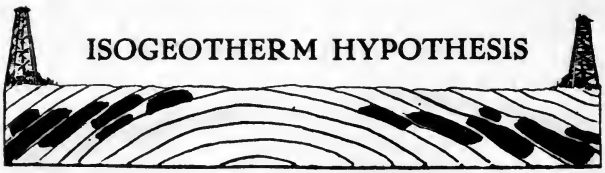
¶ Millions of dollars have been needlessly wasted in drilling futile exploration wells in the last 60 years, in insistent attempts to find oil in strata that were supposed to correlate with strata that are oil bearing in a distant locality, but which are entirely out of the oil containing horizon.



Those errors are made mostly where the oil fields are being developed in the direction of dip of the strata, where the oil horizon generally passes gradually from a lower, to a higher stratigraphical plane. For instance, where the oil is obtained at, say 1000 feet depth, and it is known that at 3000 feet depth, would be encountered strata, that correlated with oil containing strata in a distant locality. Parties frequently sink wells to the lower level, when that great depth would be entirely out of the possible oil containing horizon for that locality. This has been going on ever since the writer was a boy, and he never heard of an instance where such a venture was successful.

¶ After going a few hundred feet below the known oil containing zone, the chance of encountering oil is less with every foot drilled, regardless of how prolific the strata are elsewhere.

¶ The great irregularity of the occurrence of petroleum in it's horizons, and it's tendency to occur in extremely prolific deposits on or near the summits of anti-clines, may be accounted for in this wise. As the heated strata subsided, and was being "skimmed" of its volatilized, carbon-



aceous and other matter, the volatilized matter that was to form the petroleum, would encounter certain strata which would offer more resistence to its progress upward than other strata, and it would develop a tendency to follow lines of least resistence up under the shelving strata, thus gathering it constantly towards the apex of the anti-clines, or towards a region of less vertical resistence.

¶ There are cases, on the edge of large sedimentary areas, where quantities of oil have been found abutting on, and over granitic masses. In Placeritas Canyon, near Newhall, California, oil has been found in small quantities where the wells were started in granite. Possibly the granite had been elevated, and tilted over atop of the steeply dipping sedimentary strata which is near at hand.

¶ The volatilized matter that formed coal, seemed to have more affinity for finegrained impervious strata, where it generally finally lodged, and which would offer little resistance to its upward movement, consequently, coal is found to occur much more evenly, and continuously in it's individual deposits or beds.