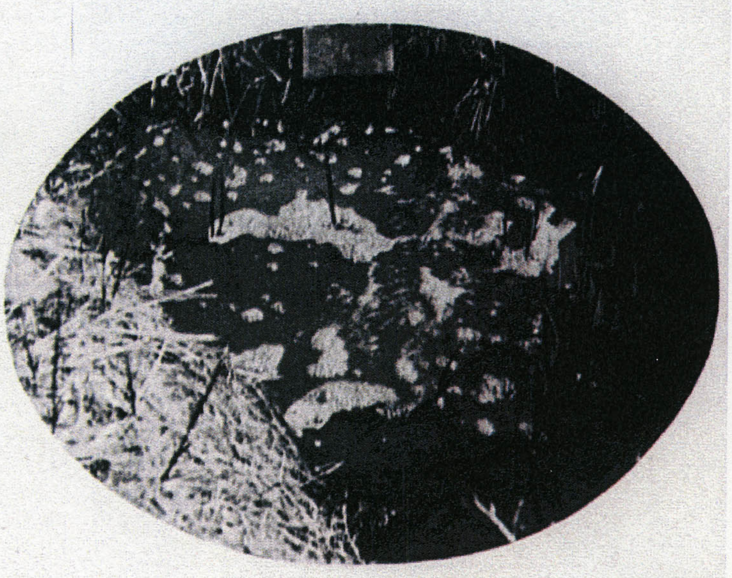


● Gas seepage in Sheep Creek was early evidence of the presence of oil in The Valley.

A COMPLICATED STRUCTURE

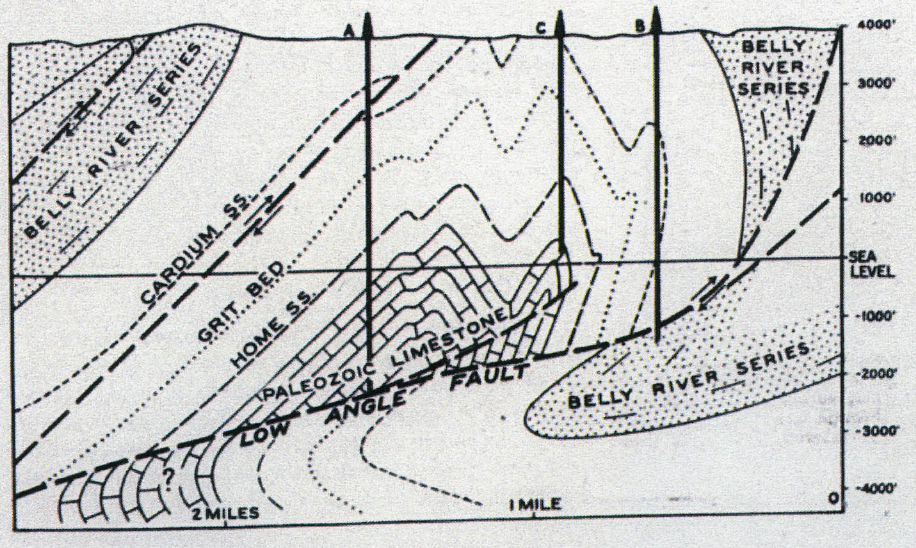
● With the Aid of the Drill, Geologists have Learned Something, but not All, of the Complicated Jig-Saw Puzzle of Mother Nature which We Call Turner Valley.

● "Of course, the structure is very complicated!"

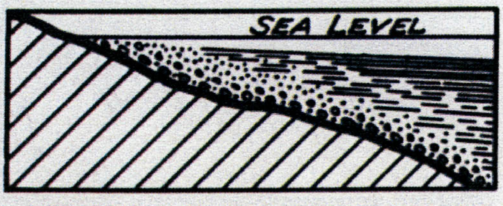
That is not merely a phrase, it has come to be a slogan as applied by all and sundry to Canada's bright particular star in the Petroleum firmament, the Turner Valley.

It may be a couple of geologists discoursing learnedly on overthrusts, low-angle faults, drag-folds, dips and strikes. It may be a driller describing luridly the idiosyncrasies of the various strata and their reactions to the drill. It may be a promoter seeking an alibi for the non-success of his venture or a reason for demanding further financing. It may be a group of wise-acres watching the incomprehensible antics of the oil-stocks in a broker's office. Eventually they all come to the same conclusion—"Of course, the structure is very complicated."

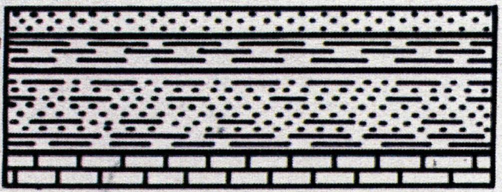
Speaking generally, sedimentary rocks were derived from the detritus of older formations which was carried by the streams and rivers from the existing land-surface and deposited on the ocean-floors or on delta or lake beds. Originally it was arranged in layers lying more or less horizontally and it solidified, through long



● If we could slice open Turney Valley, this is what geologists believe they would find. The gamble every driller takes in sinking a new well is evident from the topsy-turvy arrangement of the oil-bearing rocks.

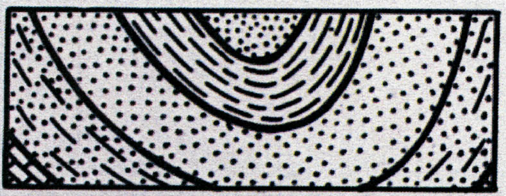


1. DEPOSITION OF SEDIMENTS ALONG SEA-SHORE. Sedimentary rocks are usually deposited along sea shores and are derived from the materials eroded from the land. The coarser materials are deposited nearest the shore.

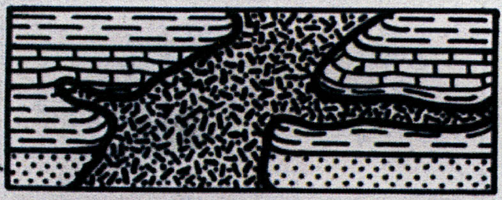


2. HORIZONTAL STRATA. Most sediments have been laid down on a flat or only gently inclined sea bottom and in many regions they still retain their original position.

3. ANTICLINAL STRUCTURE. In some cases the beds are found to be bent into an arch-like form called an anticline.



4. SYNCLINAL STRUCTURE. In other cases the beds are bent into a trough-like form called a syncline.



5. IGNEOUS INTRUSION. Sometimes masses of molten rock from deep down in the earth have ascended into the overlying sedimentary rocks perhaps melting their way through and absorbing more or less the materials encountered, and have then solidified.

ages, into stratified beds of one character or another depending on whence it came and the chemical changes incident to its long process of evolution.

Sometimes Nature built up a tremendous series of such rocks without a chronological break, at other times the advance or retreat of the waters would result in a land surface being exposed for a period and then again being inundated to have a formation much younger geologically laid upon a surface which had undergone the ravages of time. In the first instance, the rocks rest "conformably" upon each other, in the latter case there is a hiatus, some beds are missing and a younger series rests upon an older "unconformably".

As an illustration of what effect this might have on the search for oil, let us imagine two adjoining areas where the surface rocks are Cretaceous in age. In one area a well might be drilled through the Cretaceous series and oil found in the underlying Jurassic, but in the other area the drill, after penetrating the Cretaceous, might go directly into rocks of Devonian age, the oil-bearing Jurassic beds being entirely absent.

This is merely an illustration and, as they say in the "talkies", all names and incidents in this picture are purely fictitious.

Nature, however, was not content merely to cover the earth with layers of sediment like a neatly made bed with its sheets, blankets and quilts. She started to muss things up a bit.

The interior of the earth was a molten magma, continually in the throes and liable to erupt whenever a weakness in the imprisoning strata presented itself. The surface was continually being adjusted so that, at one place, the rocks might be stretched to breaking point and in another elbowed into a space much too small for comfort. The neatly horizontal beds lost all semblence of their former uniformity. They were heaved up into arches or "anticlines"; they sagged into troughs or "synclines"; they were tilted at crazy angles by the irresistible pressure of rocks looking for a place in the sun; great masses of underlying strata were pushed, as by an invisible hand, over their younger compatriots; belching volcanoes poured their lava streams both on the surface and along lines of weakness underground and, as a last phase of the beauty treatment, great sheets of ice moved majestically hither and yon, scouring and grinding the softer strata except where it was protected by a buttress of unyielding rock, and mercifully leaving behind the material for the good earth, that man might sow and reap.

During this hectic period the upheaval of a mountain range, such as the Rockies, had much the same effect as dropping a pebble into a pool. It caused geological ripples which were intense near the point of origin and moderated as they spread outward. The outer range of Alberta's foothills represents one of the more moderate of these manifestations which finally disappear, as far as the eye is concerned, in the broad expanse of the prairies.

Anticlines have long been the oil-seekers' Mecca, as it was early realized that oil had a tendency to migrate upwards in pervious beds and become trapped in such a structure. Doubtless the visual evidences of anticlinal formation in Sheep Creek, together with the seepages of gas and oil which were present, helped to influence Mr. Dingman in the location of his historic Calgary Petroleum Products No. 1 well, but science, as well as production, has made tremendous strides in the Turner Valley since 1914 and the veriest tyro would hesitate to show his limitations by referring to the Valley as an "anticline"; he would probably call it a very complicated structure.

How complex it is has gradually been unfolded as drilling has progressed, but the end is not yet and even the doctors disagree in their diagnosis. With the aid of the drill they have learned something, but not all, of this jig-saw puzzle of Mother Nature and each well, as it goes down, adds something here, refutes some preconceived notion there, or opens up new fields of speculation elsewhere as to the riddle of the sands.

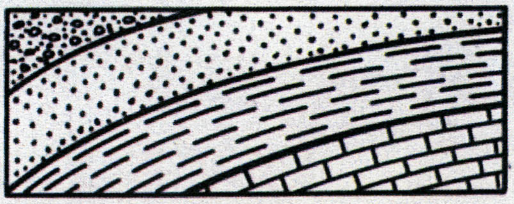
For the benefit of the readers of the Review we reproduce a cross-section of Turner Valley geology as interpreted by our Company's geologists in 1934. They, however, are not responsible for any conclusions we may draw from it and would no doubt reserve the right to change their views as more wells are completed and more definite information obtained.

In descending order the formations encountered in a Turner Valley well section would comprise Belly River, sandstones; Benton, sandstones and shales; Blairmore (Dakota), sandstones; Kootenay, sandstones with coal seams; Fernie, shales; Palezoic Limestone, commonly called the Madison lime. We must qualify this by saying that very few wells have started drilling in the Belly River formation as it occupies the extreme flanks of the structure; most of the wells are located on the Benton outcrop or where the Blairmore makes its few appearances at the surface.

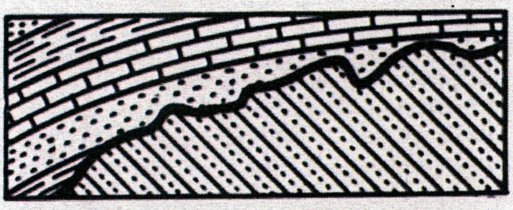
The main producing horizons are the MacDougall-Segur sands, the Home Sands, the Dalhousie sands, and the Porous Zone in the limestone. The first mentioned belongs to the Blairmore. The Home and the Dalhousie are Kootenay, whilst the Porous Zone is, of course, Palezoic.

In well-drilling it is rather important to know how one is getting along; is it still two or three thousand feet to production or, like prosperity, is it just around the corner? For this purpose the geologist and the driller look for "Horizon markers", key-beds of distinctive character which persist throughout the area and act as guide posts on the downward trail. In Turner Valley drilling, the first of those horizon markers is the "Cardium sandstone" which marks the division of the

(Continued on Page 38)

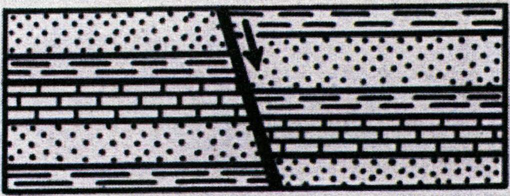


6. CONFORMABLE BEDS. When sediments are formed continuously, each bed resting regularly and uniformly upon the one below, the strata are said to be conformable.



7. UNCONFORMITY. When a series of beds has been deposited on the eroded surface of an older series the two are said to be separated by an unconformity.

8. FOLDING. When compressional forces are existent the rocks become folded into a series of arches and troughs.



9. FAULTING (NORMAL). Under sufficient stress the earth's crust breaks and the blocks thus formed slip into a new position of rest. The planes along which such adjustments take place are called faults.

10. FAULTING (THRUST) Faults may also be caused by a push which results in a forward and upward movement of the rocks instead of the normal downward slip and the term thrust is applied to them. This type is most frequent and important in mountain regions.

A COMPLICATED STRUCTURE

(Continued from Page 29)

Benton into an upper and lower series; the "Grit Bed" tells the driller he has entered the Blairmore, whilst the coal-seams of the Kootenay are easily recognizable. Most important of all is "the top of the lime" and when that is reached the optomistic driller starts dickering for field storage tanks.

It all seems very simple but a glance at our illustration on page 27 will show that complications may arise. At "A", for instance, a well would encounter the Cardium at comparatively shallow depth, then pass through a fault to encounter the Cardium for a second time and redrill the same beds. A more glaring example of grief might be found on the eastern flank of the structure where the rocks are standing almost on edge. Drilling at "B", the well might go down and down but never get any "forarder". The Cardium would be penetrated at 1,500 and again at 4,000 feet and eventually the drill would reach Belly River formations, higher stratigraphically than where the well started; in fact the well, in its ultimate stage, would have gone up instead of down. "C", on the illustration, would roughly indicate the location of the famous Royalite No. 4, which reached the limestone at a lesser depth than the great majority of wells drilled in the valley.

Speaking as man to man, we might make bold to say that the Turner Valley geology is a result of the tremendous disturbances which accompanied the birth of the Rockies. In this upheaval, a great mass of rock was thrust eastward and superimposed on beds younger, in part, than itself which had already felt the influence of earth movement. The heart of this transported mass was the one-time proud peak of a limestone ridge buried deep under ground and thus unceremoniously yanked from its profound seclusion to do its bit for the struggling oil-fraternity of Alberta.

In more technical language, and on the authority of the geologist, "the limestone mass under Turner Valley is merely a core cut off on the west flank as well as on the east by the low-angle fault underlying this structure. (See pages 28-29.) This means two pulsations of movement, namely a folding into an anticline, then a decapitation of the anticline by a low-angle fault with the limestone torn away entirely on the west side from the parent mass of which it was formerly a part. This explanation is contrary to the belief that the Turner Valley fold is a drag-fold developed on the top of a low-angle thrust fault, and that the faulting is responsible, in a large part, if not entirely, for the folding."

Now, of course, you know why the structure is very complicated!