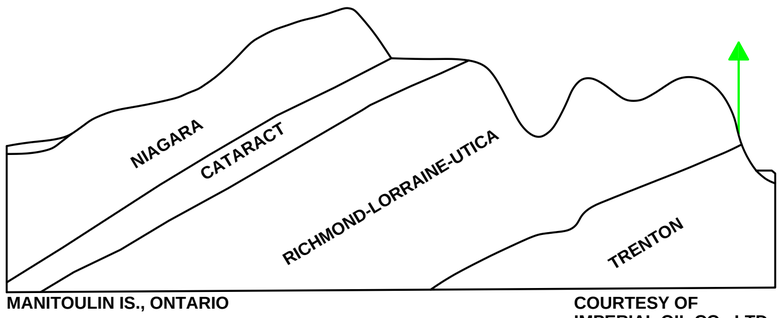
MACROSEEP ASSOCIATION WITH PRODUCTION

SEEP ON HOMOCLINE WHERE OIL-BEARING BEDS COME TO SURFACE



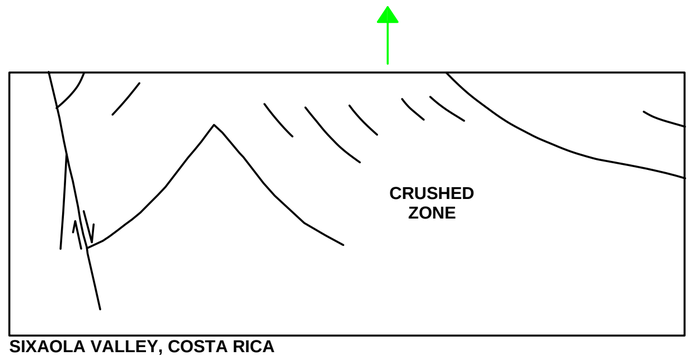
MANITOULIN IS., ONTARIO

COURTESY OF IMPERIAL OIL CO., LTD.

FIGURE 1

(Seep type 1) - This is the simplest type of oil seep which occurs where oil-bearing homoclinal beds come to the surface. These seeps are generally small in volume, but persistent in activity.

SEEP CAUSED BY CRUSHING

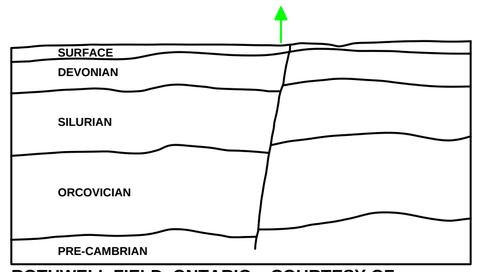


SIXAOLA VALLEY, COSTA RICA

FIGURE 2

(Seep type 2) - This section illustrates a seep in dark shales which, under normal conditions, have no free oil. Upon crushing, these shales liberate small amounts of high-grade free oil, enough of which is released to cause small seeps. It is the opinion of the writer, as well as other geologists, that some limestone pools are formed in this manner, that is, petroliferous limestones when shattered by folding or faulting release indigenous oil which accumulates in the fractures.

SEEP ON A NORMAL FAULT INTERRUPTING VERY FLAT BEDS



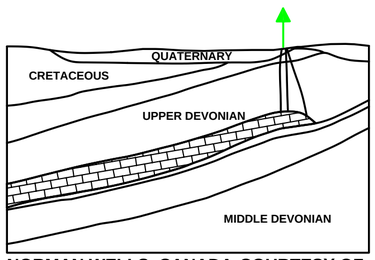
ROTHWELL FIELD, ONTARIO

COURTESY OF IMPERIAL OIL CO., LTD.

FIGURE 3

(Seep type 3) - Seeps occurring along normally faulted homoclinal beds are not uncommon. Such seeps can be an interruption of the homoclinal type illustrated in Figure 1, or the leakage of structural accumulation, closure of which is along the fault.
A great quantity of oil has been discovered along such normal faults. They are commonly responsible for direct closure on one side of the pool, or may be responsible for the deposition of sand beds and lenses. Many Gulf Coast and Eastern Venezuelan fields occur in conjunction with normal faulting, and seeps along such faults are of more than usual interest.

SEEP OVER A LEAKING REEF RESERVOIR



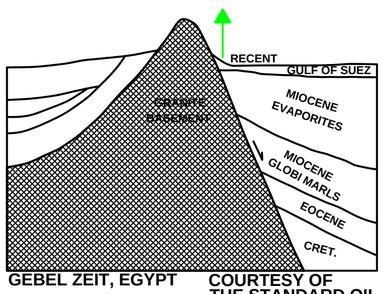
NORMAN WELLS, CANADA

COURTESY OF IMPERIAL OIL CO., LTD.

FIGURE 4

(Seep type 3) - The Norman Wells field is a leaking reef limestone. Oil comes up along the fault zones on the edge of the reef. This faulting is caused by draping over the reef itself, and is a classical example of dissipation from a stratigraphic trap through tension faults without folding.

NORMAL FAULT SEEP



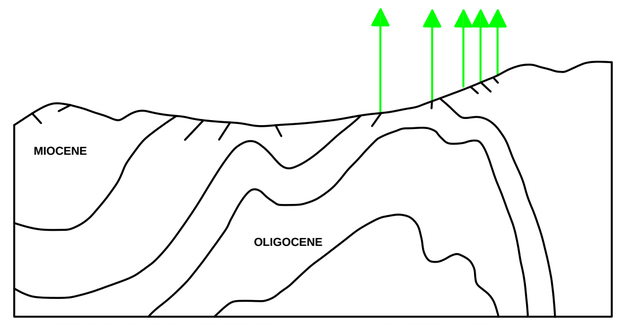
GEBEL ZEIT, EGYPT

COURTESY OF THE STANDARD OIL CO. OF EGYPT S. A.

FIGURE 5

(Seep type 3) - A seep of this type, that is, normal faulting with sediments on one side and igneous rocks on the other, is rather common and easy to explain. It is conceivable that a seepage would occur without the fault. The fault, however, probably aided the migration of oil upward. This type of seep along the margin of the basin should assure almost any geologist that oil was generated in sedimentary beds basinward. Such a seep can also mean that an accumulation of some kind is being dissipated.

SEEPS ON ERODED ANTICLINE WITH OIL SANDS EXPOSED



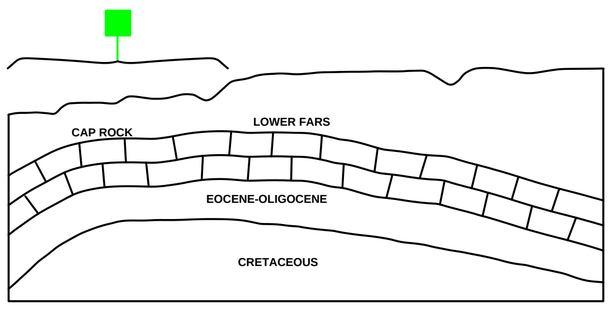
HOMBRE PINTADO, VENEZUELA

COURTESY OF CREOLE PETROLEUM CORP.

FIGURE 6

(Seep type 3) - The most logical of all oil seeps are those on anticlinal structures where erosion has cut into the oil reservoir. The cutting of a reservoir at a few points does not necessarily mean that the oil came out with a rush, as is the case when the drill taps a reservoir. The fact that a reservoir is being eroded, and is about to be bared, does not mean that oil and gas do not start seeping until the producing bed is cut. Long before, seepage starts through small fractures, and with the disappearance of the gas and the light products the remaining heavy ends and bitumen commonly reseal the eroded reservoir itself.

SEEP ZONE IN UNBROKEN STRUCTURE WHERE OIL AND GAS COME UP THROUGH SMALL FRACTURES IN CAP ROCK



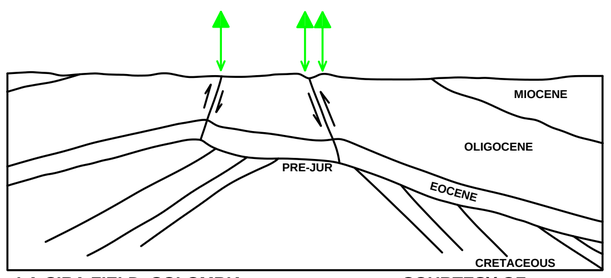
MASJID-I-SULAIMAN FIELD, IRAN

COURTESY OF ANGLO IRANIAN OIL CO., LTD.

FIGURE 7

(Seep type 3) - This example of a complete anticlinal fold in Iran is interesting from several angles; first, there are seeps on this structure without major faulting; second, a good cap rock is present; and third, the seeps occur just at the crestal turnover.
Most Anglo-Iranian geologists are convinced that the seepage oil comes from the Asmari limestone reservoir. Although there is no apparent major faulting indicated, enough minor fracturing in the cap rock and overlying beds is present to allow passage of the oil upward. These are young Tertiary anticlines, and structural adjustment is still not complete.

OIL COMING UP THROUGH MINOR FAULTS ON A PRODUCING STRUCTURE



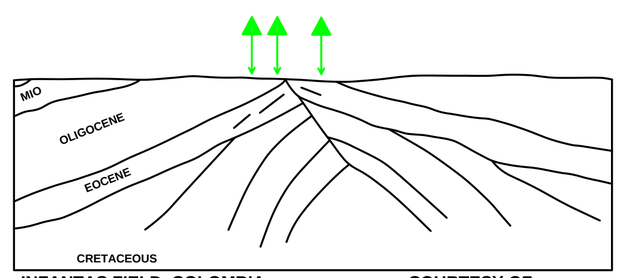
LA CIRA FIELD, COLOMBIA

COURTESY OF INTERNATIONAL PETROLEUM CO., LTD.

FIGURE 8

(Seep type 3) - La Cira is a wide domal fold with considerable faulting on its crest. Production starts at 1,000 feet or less. On the top of the structure are numerous oil seeps. As none of the producing formations is exposed the seepage oil had to migrate from the producing zone upward along the faults.

SURFACE SEEPS ALONG THRUST FAULT



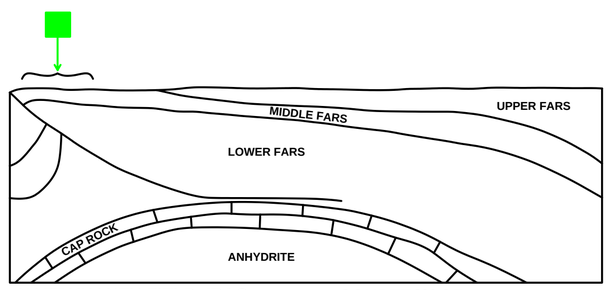
INFANTAS FIELD, COLOMBIA

COURTESY OF INTERNATIONAL PETROLEUM CO., LTD.

FIGURE 9

(Seep type 3) - This section illustrates the simplest of thrust-fault seeps. On the right side of the fault the producing beds are brought to the surface and have lost their oil. The producing field lies on the left side of the fault, and although the reservoir is ruptured it has not lost all of its oil. When Infantas was first drilled gas was escaping with the oil, making a hissing sound. This field, along with connecting La Cira at the north, has produced 400 million barrels of oil since 1918. Repressuring and water injection were started several years ago, and today the seeps, that had almost disappeared as the field was developed, are once more in evidence, and the hissing of escaping gas has started again. These seeps are very prolific, and the asphalt residue left on the ground indicates that many millions of barrels of oil were lost before man touched the reservoir with the drill.

SEEP ALONG LOW ANGLE THRUSTS SOME DISTANCE AWAY FROM THE UNDERLYING FOLD



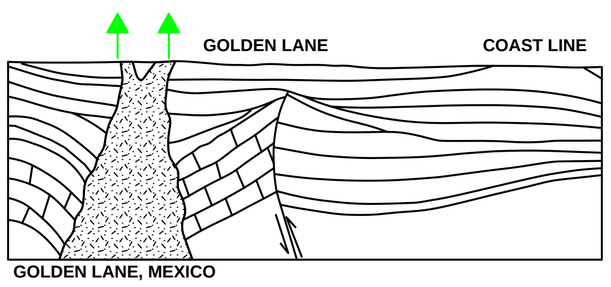
NAFT KHANEH FIELD, IRAQ

COURTESY OF ANGLO IRANIAN OIL CO., LTD.

FIGURE 10

(Seep type 3) - Most of the discovered oil fields in Iraq and Iran have associated with them oil and/or gas seeps. These seeps are not necessarily over the subsurface structure. The Lower Fars formation overlying the cap rock is a salt anhydrite section, and during the last folding, which is of the compression type, this salt and anhydrite mass flowed and in many places was thrust over the more competent cap rock. The surface indication of structure, therefore, does not everywhere match the subsurface, and it generally requires a number of wells definitely to pin down the producing structure. In the Naft Khaneh field the oil and gas escaped through fractures in the cap rock, found the thrust fault, and the migrated along the fault to the surface.

SEEPS CAUSED BY IGNEOUS INTRUSION



GOLDEN LANE, MEXICO

FIGURE 18

(Seep type 5) - Many of the seeps in Mexico are associated with stock-like, igneous intrusions. These intrusions penetrate the entire sedimentary section, and at the contact of the igneous with the sedimentary rocks, seeps are common. It is the opinion of many geologists that these seeps are not connected with large subsurface accumulations.

LINK, W.K., 1952
Significance of Oil and Gas Seeps in World Oil Exploration
AAPG Bulletin, V.36, pp. 1505-1541

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