

"In answering the first question, we find the views of Hunt and Newberry distinctly opposed to each other. Hunt counts limestone as the principal source of petroleum, and denies that it has been produced by distillation from bituminous shales; while Newberry finds in these shales the main source of both oil and gas, and vigorously opposes the view that limestones are ever an important source of either. It is not necessary to follow the discussion in relation to these points further. It is enough to say that in the light of present knowledge each statement is sustained as to its particular affirmations, and, in its conclusion, as to general denials. Petroleum is undoubtedly indigenous to and derived from certain limestones, as Hunt has so strongly asserted. On the other hand, Newberry's doctrine that the great supplies of the Pennsylvania field are derived from Devonian shales is becoming more firmly established and widely accepted every year, though it seems likely that he has laid too much stress on bituminous shales. In other words, the theories are not incompatible with each other. Different fields have different sources. We can accept without inconsistency the adventitious origin of the oil in Pennsylvania sandstones and its indigenous origin in the shales of California, or in the limestones of Canada, Kentucky, or Ohio.

"The double origin of petroleum from both limestones and shales—and it is not necessary to exclude sandstones from the list of possible sources—deserves to be universally accepted. In confirmation of this double origin, it is coming to be recognised that the gas and oil derived from these two sources—limestones and shales—generally differ from each other in noticeable respects. The oil and gas derived from limestones contain larger proportions of sulphur and nitrogen than are found in the oil and gas of the shales. Nitrogen renders the oil unstable, and sulphur compounds impart to them a rank and persistent odour from which they can be freed only with great difficulty. In the case of the oil-bearing shales of California the petroleum is evidently derived from the animal remains with which the formation was originally filled. In composition this oil agrees with the limestone oils already described. It contains more than four times as much nitrogen as the Mecca oil of North-eastern Ohio, and its percentage of sulphur is very high." Peckham, referring to these California oils, states—

"The exceedingly unstable character of these petroleum, considered in connection with the amount of nitrogen that they contain, and the vast accumulation of animal remains in the strata from which they issue, together with the fact that the fresh oils soon become filled with the larvæ of insects to such an extent that pools of petroleum become pools of maggots, all lend support to the theory that the oils are of animal origin."

"It now appears as if oil and gas derived from animal remains can be distinguished from those of the bituminous shales by the characters above described; certain it is that the limestone oils differ in physical characteristics from the Pennsylvania oils, for example, in a marked degree. They are dark in colour; they are heavy oils, their specific gravity ranging from 34° to 36° Beaume, though sometimes falling to 40° or even 42°; they have a rank odour arising from the sulphurous compounds which they contain.

"In the preceding statements the organic matter of the bituminous shales has not been positively referred to a vegetable source. Such a source is highly probable, but it cannot be said to be fully demonstrated until the origin of the so-called 'sporangites' of the shales is finally determined. There are a few geologists who are inclined to refer these forms to hydroid zoöphytes—animal—rather than with Dawson to marine rhizocarps—vegetable. Whatever their origin, they give rise to petroleum and oil of a definite character, which is in marked contrast to that of the limestone oils.

"The propositions in regard to the origin of petroleum that seem best supported may be summarised thus: (1.) Petroleum is derived from organic matter. (2.) It is much more largely derived from vegetable than from animal substances. (3.) Petroleum of the Pennsylvania type is derived from the organic matter of bituminous shales, and is of vegetable origin. (4.) Petroleum of the Canada and Lima type is derived from limestones, and is of animal origin. (5.) Petroleum has been produced at normal rock temperature—in the Ohio fields—and is not the product of distinctive distillation of bituminous shales. (6.) The stock of petroleum in the rocks is now practically complete."

In regard to the petroleum found in the vicinity of New Plymouth, it is difficult to state whether it is of animal or vegetable origin by its mere appearance, but its colour, specific gravity, and thickness seem to point to its being of animal origin, although there are semi-bituminous shales in the district. About forty-five miles to the northwards the coal-measures at Mokau crop out, and a similar formation extends for a considerable distance southward. On going up the Mokau River, about eight miles from its mouth, there is a hard sandstone dyke, running about 10° to the east of north, and 10° to the west of south. This dyke seems to cut clean through the other formation. It can be seen near the mouth of the Awakino River to the northward, and at the Mohakatina River to the southwards. On the easterly side of this dyke limestone and different seams of brown-coal are found, having veins of semi-bituminous coal intersected through it. On the west side of the dyke referred to, the formation is of a calcareous marl, having the beds all dipping southerly. There is very little indication of bituminous shales being found on the west side of the dyke, unless at a great depth; but if this same formation follows on the coast-line to New Plymouth unbroken, it is probable that the bituminous shales has something to do with the origin of the petroleum. It may be that on the west side of the sandstone dyke the carbonaceous matter in the rocks was subjected to a different chemical process than on the eastern side, and resulted in petroleum and gas being produced and stored in a reservoir at a considerable depth. At the same time, the sample of oil obtained from the bore at the breakwater does not coincide with the light oils found in the bituminous shales in Pennsylvania, being more like the dark, heavy oils found in Lima and Canada. It may be termed a good lubricating-oil, but not so well adapted for illuminating purposes.

There are three products of petroleum in the first distillation, namely: illuminating oil, naphtha, and residuum. Each of these products are redistilled—the naphtha into gasoline, benzine, and various lighter oils; the residuum is broken up by a process of redistillation, freezing, and