

found. In oil geology in particular, which is one of the youngest branches of economic geology, the geologist cannot guarantee payable production; but from a study of surface conditions he can estimate whether boring is justified, and what parts of the field are more favourable. If the best sites in a field are tested and found barren, then the field may be abandoned; but if, as in the Gisborne-East Cape district, a few wells located at hazard have not produced payable oil there remains a practically untested field.

From October, 1921, to June, 1922, the writers were in the field, and surveyed 540 square miles, which, with the addition of the 470 square miles examined in the previous season and the 1,102 square miles reported on in Bulletin No. 21, makes an area of 2,212 square miles examined in detail in the Gisborne-East Cape district. A relatively small area of possibly petroliferous country between East Cape and Cape Runaway has still to be explored.

PHYSIOGRAPHY.

The western part of the Waiapu Subdivision contains the crest and the eastern slopes of the Raukumara Range, which in places is more than 4,000 ft. high. East of the range hilly country from 2,000 ft. to 1,000 ft. high extends to the east coast. The even crests and flat tops of the ridges in the eastern half of the district indicate erosion from an extensive plateau. Above the general level the rugged peaks of Hikurangi (5,606 ft.), Aorangi (4,091 ft.), Wharekia, and Taitai (2,012 ft.) stand up sharp and steep.

GENERAL GEOLOGY.

The district consists of Mesozoic and Tertiary sedimentaries which contain many shallow-water beds and vary considerably laterally. The rocks can be divided into five series: Tawhiti Series, Te Arai Series, Taitai Series, Tapuwaeroa Series, and Raukumara Series.

The lowest rocks seen, the Raukumara Series, are dark, evenly banded greywacke, argillaceous sandstone, and arenaceous mudstone, folded into close meridional folds in the south-west, but in other places with open folds trending east and west. They form the Raukumara Range and the western part of the subdivision. The beds generally contain broken pieces of *Inoceramus*, in some places concentrated into bands of shell rock 1 ft. thick; occasionally large shells up to 3 ft. long were observed. As no underlying rocks were seen, the total thickness of these beds cannot be estimated, but in some places they are 8,000 ft. thick. Towards the top they vary. One conspicuous bed in the upper part is a thick massive or poorly bedded blue mudstone which contains occasional red bands. The beds pass upward into greenish- and light-coloured mudstones and argillaceous sandstones. The rocks of this series are moderately indurated and contain indefinite plant-remains; but they only exceptionally show traces of oil, and are regarded as lying below the main oil-beds.

In some places these rocks grade into the overlying series, but in others conglomerate bands containing pieces of the Raukumara beds form the base of the Tapuwaeroa Series. The rocks of this series are dark fissile shales, of which the more arenaceous bands are twisted and contorted, and the more argillaceous bands crushed and polished. With these occur bands of dark carbonaceous shale and coarser sandstone bands smelling of oil. In the Waiorongomai Valley and east of it the Raukumara beds are overlain by a series of grits, greenish and light shales, carbonaceous shales, and fine conglomerates, the equivalents of the dark fissile shales to the west and south. The Tapuwaeroa beds vary in thickness from 800 ft. to 1,800 ft., and cover large areas east of Ihungia Stream, and in the valleys of the Aorangiwai, Tapuwaeroa, and Waiorongomai rivers. Fossils collected from these beds indicate that they are Upper Jurassic in age.

In the Tapuwaeroa Valley coarse conglomerates with igneous boulders and hard dark sandstone, 2,000 ft. thick, lie unconformably above the dark fissile shales. These rocks, here called the "Taitai Series," form the summits of Hikurangi, Aorangi, Wharekia, and Taitai. The sandstone occurs again at the foot of Whakoau, in Hauturu Creek, in Ihungia Creek, at Puketiti, and close to Te Puia. Above it lie, in ascending order, dark mudstones, greenish and light shales, fine conglomerates and grits, light-blue mudstone, greensandstone, and chalky limestone. These beds are thought to be of Cretaceous age.

Tertiary strata, in places more than 10,000 ft. thick, unconformably overlie the Cretaceous rocks. They consist of a lower argillaceous series and an upper arenaceous series.

OIL-INDICATIONS.

The Taitai and Tapuwaeroa beds generally, but the Upper Jurassic and Tertiary only exceptionally, show evidences of oil. In addition to the indications mentioned in last year's annual report, the following are worth noting:—

(a.) *Seepages of Oil*.—An oil-seepage has been known at Rotokautuku for more than half a century, and led the Southern Cross Petroleum Company to bore there in 1881–83. At the present time gas and salt water are rising from the old shaft, and each gas-bubble brings to the surface a film of oil.

(b.) *Asphalt Deposits*.—In sandstone at the top of the Tapuwaeroa beds thin irregular cracks, $\frac{1}{16}$ in. thick and several inches long, are filled with a dark pitch.

(c.) *Evolution of Gas*.—Many small gas-vents occur scattered throughout the subdivision. Samples from twenty of these have been analysed, and all are "wet," the ethane they contain ranging up to 22 per cent. A "wet" gas contains appreciable quantities of hydrocarbons higher in the series than methane, while a "dry" gas consists almost entirely of methane. Wet gas is everywhere considered a favourable indication of oil. "It is obvious that the heavier and wetter a gas the more favourable the evidence of the presence of oil in the neighbourhood. Though there may be steady and brisk flows of gas or gas-wells at a locality, it does not necessarily prove that oil