country now occupied by the andesitic ranges of Waitakerei. The Parnell grit may well have had its origin there, and have been brought down by rivers and currents operating at a time when the physical features of the district were altogether different. But the whole question, either of locating precisely these old vents or of estimating with certainty their probable number, is one which offers but a feeble chance of ever being satisfactorily solved.

Note.—The Waitemata series can be traced further north than Whangaparaoa, good sections showing along the cliffs at Waiwera and round the Mahurangi Harbour, where the volcanic grits again appear. North of this the sedimentary rocks change considerably in character, the numerous layers which distinguish the sandstones on the Auckland isthmus giving place to thicker bands of a more highly indurated sedimentary rock darker in colour and closer in texture. The grits at Waiwera and Mahurangi are very similar both in appearance and texture to those already described, and, like these, contain numerous angular and subangular fragments of augite-andesite, some of which reach upwards of 1 ft. in diameter. Their mode of occurrence, however, does not throw any additional light on the questions raised in this paper.

ART. XL.—*Notes on some Andesites from Thames Goldfield.*

By Professor JAMES PARK, F.G.S., Director, Otago University School of Mines.

[*Read before the Otago Institute, 12th November, 1901.*]

HORNBLENDE-ANDESITE.

FROM the Mata Stream southward, the deeply eroded surface of the crumbling Palæozoic slaty shales, which form the basement rocks of the Hauraki Peninsula, are covered with a great pile of andesite lavas, tuffs, and breccias. From the Mata northward the coast-line is occupied by the slaty shales for a distance of eight or nine miles without interruption. Between the Mata and Waikawau Streams the slaty shales are intruded by seven massive dykes of igneous rock which are well exposed in the deep road-cuttings winding around the indentations of the rocky shore-line. The general trend of the dykes is east and west, but, so far as I could discover, they do not appear to reach the valley of the Waikawau, which runs parallel with the coast-line for some

two miles, at a distance varying from half a mile to a little over a mile; nor do they crop out on the ridge separating the Waikawau Valley from the sea. These circumstances would tend to show that the portions of the dyke-like masses now exposed in the sea-cliffs and road-cuttings are the original summits of igneous intrusions uncovered by comparatively recent marine erosion. The contact-line between the slaty shales and dykes is clearly exposed in a number of places, but in all cases the degree of alteration of the clastic rock is singularly little. In the immediate vicinity of each dyke the slaty rocks are generally bent and shattered and the joints much slickensided, as if the intrusions of the igneous mass had exerted sufficient pressure to cause local thrust accompanied by shearing and displacement, more especially along the planes of bedding. At the actual line of contact the shales are merely hardened, or sometimes brecciated for a depth of an inch or two. On many surfaces no alteration is perceptible.

In my memoir on the "Geology and Veins of the Hauraki Goldfields"* I described these rocks as hypersthene-augite-andesite, from the petrological description and name supplied by the late Professor Ulrich.† A subsequent visit to the locality convinced me that an error had arisen, probably through a misplacement or exchange of a label, and in January of this year I made a further examination of these dykes, at the same time collecting examples of each for more detailed investigation. As a result of microscopic examination in thin sections I find that these intrusive masses are composed of hornblende-andesite. There is no evidence obtainable in the field to fix the date of their eruption even approximately; but, judging from the fact that they occur as dykes penetrating the basement rock, and that no hornblende-andesite, so far as ascertained at present, is known to occur associated with the gold-bearing andesitic volcanic rocks which everywhere overlie the slaty shales, it is perhaps only reasonable to infer that they are at least older than the gold-bearing andesites. All the dykes are much decomposed, making it difficult to obtain good examples for microscopic study.

Dyke No. 1.—This forms the first rocky bluff, some 30 chains south of the mouth of Waikawau River. It shows an apparent width of about 240 yards. It is a dark-grey compact rock; feels somewhat rough to the touch. Hand samples show conspicuous crystals of feldspar and hornblende, the former up to 0·5 cm. and the latter 1 cm. long. In polarised light the base is clear and crowded with feldspar

* Trans. N.Z. Inst. Mining Engineers, 1897, vol. i., p. 81.
† *l.c.*, p. 26.

microlites and thinly dusted with magnetite, which also occurs in occasional large irregular aggregates. The feldspars are plagioclase, translucent, often much clouded with glass inclusions; not often well developed; larger phenocrysts zoned with inclusions and not much twinned; extinction angles large, indicating a basic variety, probably labradorite. Some large plates show no twinning, but exhibit a zoned structure due apparently to a succession of isomorphous layers of growth. A little sanidine is present. The hornblende is generally altered; often shows black resorption border; interior changed to serpentinous matter showing bright polarisation colours; strongly pleochroic, changing from pale yellowish-brown to greenish-brown. Calcite abundant. With dilute hydrochloric acid brisk effervescence takes place around feldspars and hornblendes.

Dyke No. 2.—This occurs about a quarter of a mile further south. It runs east and west, and shows a width of about 300 ft. It is a compact dark greenish-grey rock. Shows crystals of feldspar and hornblende plainly to unaided eye, but not conspicuously. Under the microscope the ground-mass, or base, is very abundant, clear, and finely dusted with magnetite. The feldspars are zoned with glass inclusions; in other parts clear and fresh. The inclusions are arranged round the periphery of the crystals, following the crystallographic planes, and also as irregular aggregates along cracks. A little sanidine is present. The hornblendes are mostly altered to serpentinous matter, but do not show resorption borders. Prismatic forms common. Pleochroism: a = light-brown; β and γ = dark bluish-green.

Dyke No. 3.—This occurs about eight chains further south. Its greatest extension appears to be parallel with the coast. It throws out many ramifying branches through the slaty shales; extends along the beach for nearly 350 yards. This is a dark greenish-grey rock, closely resembling No. 2 in hand samples. Ground-mass clear; not abundant; crowded with feldspar and other mineral microlites. Feldspars mostly clear, well-twinned, showing brilliant polarisation colours; inclusions numerous. A few large idiomorphic plates present in each section. A little sanidine present. Hornblendes are all much altered; outlined with black borders; centre clear or crowded with decomposition products. Calcite and a little secondary quartz present. A section cut from a sample of this dyke, obtained near southern point of *contact* with slaty rocks, contains nothing very marked to distinguish it from the section described above, except the condition of the hornblendes, which is less altered, being often quite fresh.

Dyke No. 4.—This occurs about 45 yards further south. It extends along the beach for some 170 yards. A dark

greenish-grey rock crowded with crystals of feldspar and hornblende just discernible to the unaided eye, and imparting a rough impression to the touch. Base clear; not abundant, but, like No. 3 dyke, crowded with microlites and crystals of feldspar and hornblende. Feldspars fresh, but often clouded with inclusions; zonally arranged. Not much twinned. Hornblendes generally altered. Calcite and secondary quartz present. Iron not abundant, except as fine dust in base and around hornblendes.

Dyke No. 5.—This begins about 400 yards further south. It trends east and west, and shows a width of about 125 ft. This rock is much altered. Colour on surface pale bluish-grey speckled with chlorite, imparting porphyritic appearance. Ground-mass clear. In polarised light presents a finely granular appearance, due to presence of grey microlites of fairly uniform size

Feldspar phenocrysts not numerous; mostly fresh, and not much twinned. Slides contain isolated crowded aggregates of small plagioclase crystals, not much twinned, but fresh, and showing bright polarisation colours. The hornblendes are mostly altered to chlorite or replaced by magnetite. All are bordered with magnetite.

Dyke No. 6.—This occurs 330 yards south of No. 5. It has an exposure about 400 yards long. A very dense blackish-green rock, with conspicuous crystals of feldspar. When wet almost dense black. Ground-mass abundant, dark bluish-grey, in places almost black, from presence of clouds of iron-dust. Feldspars plagioclase, not abundant; occur only as large idiomorphic plates, not much twinned; fairly fresh and clear. The hornblendes are completely altered to serpentinous matter. Their original crystalline forms are sharply outlined by narrow, but very even, distinct black borders of magnetite. Parts of interior often occupied by clear matter. A little calcite and hæmatite are present.

Dyke No. 7.—This begins about 300 yards further south, and thence extends to Mata Stream It is a greenish-grey rock, much decomposed near the surface; feels rough to touch; shows crystals of feldspar and hornblende, imparting a granular appearance to rock. Base clear, but not abundant; crowded with microlites and plates of feldspar and hornblende. Feldspars fresh, but not very clear, from presence of inclusions; mostly well-twinned plagioclase. Extinction angles indicate basic variety. A little sanidine present.

Hornblende occurs both fresh and changed to chlorite and serpentinous matter; some plates show black resorption borders. Apatite present; iron fairly abundant.

In a paper read before the Australasian Association for the Advancement of Science Captain Hutton, F.R.S., describes a

similar hornblende-andesite from a dyke on the shore a little north of the mouth of Tapu Creek, which evidently refers to the dyke at the mouth of the Mata Stream.*

AUGITE-ANDESITE.

A very dense compact blackish-green, almost black, rock cropping out on coast between McCormick's farm and Puru Flat, about four miles and a half north of Thames. Base abundant; grey-coloured, with microlites of uniform size. Feldspars fresh, plagioclase, not much twinned. Augite fairly abundant; fresh, with brilliant polarisation colours; often twinned; one plate shows marked hour-glass structure.

HYPERSTHENE-ANDESITE.

This is a compact dark greenish-grey rock cut 125 ft. north of Queen of Beauty shaft at the Thames, in the north crosscut from No. 11 level, 748 ft. deep. Ground-mass very clear, dusted with magnetite. Feldspars plagioclose; fresh, but clouded with inclusions; not much twinned. Hypersthene often outlined or replaced with black dust; generally affected with decomposition. No augite detected.

This rock forms the Exchange bar, one of the best-known bars or undecomposed cores of andesite which traverse the Thames Goldfield, running parallel with and separating the main lode systems of the field. At the 748 ft. level it was found to be 60 ft. wide; in the Exchange shallow level, due north-west, about 90 ft. thick; and in the 452 ft. level of the May Queen Mine, at a point about 450 ft. north of the Queen of Beauty shaft, 300 ft. thick. Like many of these hard blue bars, it shows a marked tendency to thin out in depth.

HYPERSTHENE-AUGITE-ANDESITE.

A compact dark greenish-grey rock, cut last January a few feet from the foot-wall of the Golden Age lode in the Moanataiari Mine, at the 100 ft. level, Point Russell section. Ground-mass clear, but not abundant. Feldspars plagioclase; fresh, often clouded with microlites and glass inclusions; not much twinned; mostly basic. Hypersthene more abundant than augite; contains enclosures of glass; often altered to serpentinous products, and much dusted with magnetite.

AUGITE-ANDESITE, TAIRUA.

This is a dense fine-grained rock with a vitreous or glassy lustre and conchoidal fracture. It occurs as isolated fragments and large masses weighing many hundredweights on the hills around and south of Tairua Broken Hills Mine,

* Hutton, Proc. Aust. Assoc. Ad. Sc., 1888, p. 7.

being evidently derived from the Tairua andesitic tuffs. The masses generally present a corroded and often ropy appearance, with a pitted surface. Under the microscope it is seen to consist of a very pale-yellow glassy ground-mass, with scattered feldspars and augite, the former occurring as narrow laths and phenocrysts, apparently representing two crops of generation. The feldspar laths are arranged with their principal axes parallel to the fluxion plane. Some binary twins do not exhibit straight extinction, and cannot be sanidine. The majority of the feldspar microliths and plates appear to be plagioclase. Augite is fairly abundant, often well formed and generally twinned. Occurs both as plates and narrow laths, which lie with their long axes parallel with the fluxion plane. Polarisation colours very brilliant. One phenocryst, showing multiple twinning, encloses two crystals of feldspar. Magnetite not very abundant.

ANDESITIC GLASS, OMAHU HILL.

This is a black semi-vitreous rock speckled with white feldspars. Lustre vitreous; feels rough. It occurs as irregular masses in the grey tuffs on the Omahu Bridle-track, about a quarter of a mile on the Thames Valley side of Odlam's gold-mining claim. Under the microscope it is seen to consist of a grey glass exhibiting wavy fluxion lines, and surrounding a few large and badly developed phenocrysts of plagioclase. Some patches of the base are partially devitrified and crowded with microliths of feldspar and augite. Augite is fairly abundant. A little magnetite is dusted throughout the base.

ART. XLI.—*On the Secular Movements of the New Zealand Coast-line.*

By Professor JAMES PARK, F.G.S., Director, Otago University School of Mines.

[*Read before the Otago Institute, 12th November, 1901.*]

THE solid ground is popularly considered the symbol of stability, but exact observations in the older-peopled countries of Europe have shown that, on the contrary, the crust of the earth is in a state of constant oscillation. The upheaval or depression of the land from this secular movement is so slow and gradual as to produce no appreciable difference in the physical aspect of the ground affected from year to year, and it is only after the lapse of generations, and