(*b.*) Material of Dunes.

The material out of which dunes are built consists for the most part of small particles of the more resistent constituents of the rocks of the land surface. Quartz-grains usually form 90 per cent. of the whole. This is due to two main causes.

(1.) Quartz is a very widely distributed mineral in rocks of the earth's crust. It forms the greater part of all sandstones, and is an important constituent of many other rocks.

(2.) It is a mineral not susceptible to the action of weathering agents; it resists the action of all acids occurring naturally, and it is extremely hard. Owing to this cause its importance is always increasing as a constituent in the waste of the land; other minerals suffer decomposition, or are worn away, but quartz survives, and so its percentage becomes greater as the products of erosion are subjected to further disintegration and weathering.

Other minerals play an important though subordinate part in the formation of dunes—viz., feldspar, iron oxides, hornblende, augite, and limestone, and with these occur occasionally the rarer minerals, zircon, rutile, and tourmaline. Their power of resisting decomposing agents explains their presence also. But account must be taken of the character of the rock which has furnished the material of dunes when speaking of the mineralogical character of the individual grains.

A sandstone or quartz rock produces sand consisting almost wholly of quartz grains. As the main mountain ranges of the North Island and of the eastern part of the South Island are composed principally of sandstones, greywackes, and slates, the sands on the eastern shores of the South Island and of the south of the North Island contain a high percentage of quartz. Slates weather into very fine particles, and usually form mud.

Granites, gneisses, and schists produce a sand with predominating quartz grains, unless the parent rock is of basic type. Feldspar and mica are of subordinate importance, for the reason that, although they may be predominant in the solid rock, they are less able to resist attrition and decomposing agents. Mica is a very important constituent of river-sand, but it becomes rapidly shredded out into thin films, and is finally carried away when exposed to wind-action in a dune. Sands of this type occur on the beach at St. Clair, derived in all probability from the Central Otago schists by the action of the Clutha and Taieri Rivers, and carried north by the strong shore-current running up the coast.

The sands from volcanic rocks depend in composition on that of the parent rock. Pumiceous and scoriaceous varieties are extremely common in the North Island, and the titaniferous iron-sands of its west coast are largely derived from the breaking-down of the volcanic rocks of Mount Egmont and of the Central Plateau. Little or none of this sand is found further east in Cook Strait than the mouth of the Rangitikei River. That on the shore between there and Porirua owes its origin to the disintegration of the quartziferous rocks of the Ruahine and Tararua Mountains, and magnetite is absent. One point should be noted here. The black sand of the Taranaki coast contains a good deal of hornblende and augite grains, both dark in colour, but of no value as a source of iron. These minerals have also been weathered out of the volcanic rocks, and at first sight are indistinguishable from the magnetic ironsand, but they detract very much from its value as an ore, and will have to be separated before it is treated metallurgically.

Similar magnetic sands occur in smaller quantities on other stretches of coast. Small patches of fairly pure titaniferous magnetite are to be found on some of the beaches of Banks Peninsula, derived from its basic volcanic rocks; and also on the west coast of the South Island, weathered out of the metamorphic rocks and basic volcanics of Westland.

In Bulletin No. 6 of the Geological Survey (page 119) it is stated, "The beach sands of Westland consist mainly of quartz. Magnetite is a noticeable constituent, whilst garnet and zircon are fairly common, the former being especially abundant on the beach near Ross. More or less fine gold is always associated with the magnetite." This mineral forms an important constituent of these sands because of its hardness, its resistance to chemical decomposition, and its tendency, owing to its weight, to accumulate in masses by the ordinary process of water-concentration.

A cursory examination of specimens of New Zealand dune sands shows that they are largely composed of quartz, with subordinate magnetite, hornblende and augite, and feldspar, in that order of importance; but subsequent examination may lead to a modification of this statement. Limestone formed from shell-fragments is very common in some places, and at times forms the main bulk of the sand. Its presence is a distinct advantage, as it forms a valuable cementing agent, and thus tends to fix the position of dunes.

(*c.*) Form of the Sand-grains.

The sand-grains of dunes exhibit certain peculiarities of form which distinguish them from ordinary river and sea sands. The latter are angular or subangular in shape, as they have not been subjected to the abrasion which dune-grains have to endure. Although stones and gravel are invariably rounded by the continual friction as they are rolled along by river or sea, the smaller particles are more or less protected by an enveloping film of water, which, as they become smaller, prevents that close contact necessary for rapid abrasion. However, the corners and edges of the grains get worn off in process of time. But when sand accumulates as dunes, and there is no protecting envelope of water round each grain, abrasion is very rapid, and thoroughly rounded grains result from the backward and forward drift in varying winds, or even by the constant onward drift in a prevailing wind. Desert sands are always rounded for this reason. Nevertheless, it is frequently very difficult, if not impossible, to decide on the origin of sand grains, judging from their contour alone. Long unconsolidated sands carried for long distances in river or sea, also those derived from old sandstones by the removal of the cementing material, will also exhibit this peculiarity. In fact, some of these old consolidated sandstones