

minerals, such as occur in desert sands; orthoclase, plagioclase, and muscovite mica being the most conspicuous.

These peculiarities might well lead us to doubt whether the carbonaceous substance is truly coal, for it recalls the structure of a vesicular lava flow and suggests that at one time the material existed in the fluid state and might be an inspissated product of a mineral oil.

Its specific gravity, however, determined by a diffusion column from the purer parts, proved to be that of a household coal; it gave off water and tarry matter when heated in a closed tube, burnt with a white flame, and yielded very little dissolved material when heated with chloroform, ether, and other solvents. Whatever its origin, it does not now differ to any marked degree from ordinary coal.

The second specimen is not laminated and is more highly vesicular than the first, its substance, as seen in section, being reduced to a network, enclosing comparatively large open spaces which are not elongated in any direction. In the network itself many minute vesicles are present, but mineral fragments are rare.

The origin of this coal is obscure; it may have been formed by the growth of vegetable matter in quiet water, into which mineral grains were at the same time carried by the winds. Marsh gas evolved by the decaying vegetable matter would account for the vesicles, and that in one of the specimens these are flattened out in the planes of lamination might be due to its having been formed nearer the bottom than the top of the deposit and thus under the pressure of overlying layers.

22. Lo-t'o-ch'üan, Pei-shan (01). From a rocky kopje, one mile NW. of Lo-t'o-ch'üan. *Granophyre.*

A much-jointed reddish flinty rock with a dark brown patina. It consists of quartz and orthoclase in micrographic growths, including negative spherulites. Ferro-magnesian elements are absent, but a fine dust of iron oxide is scattered through the rock and confers upon it its red colour. Iron oxide also occurs in long lines as though deposited along cracks, and in some cases it helps to define the outlines of the constituents of a radiate micrographic growth.

23. Lo-t'o-ch'üan (02). From a rocky kopje, eighteen miles NW. of Lo-t'o-ch'üan. *Biotite Granite.*

White granite speckled with black mica.

It consists of large hypidiomorphic crystals of perthitic orthoclase which sometimes include smaller crystals of oligoclase or corroded fragments of muscovite. A little microcline is also present. Quartz is present, sometimes in mosaics; it invades the orthoclase and shows a tendency to micrographic growths. Biotite occurs as a fragmentary residue, sometimes passing into chlorite with associated epidote; it is strongly pleochroic—X, pale yellowish brown; Y and Z, deep brown to black—and includes crystals of apatite as well as zircon, with pleochroic haloes. There is a little muscovite in corroded crystals.

24. Lo-t'o-ch'üan (03). From a detritus hillock near Lo-t'o-ch'üan. *Fine-grained Grit.*

A dark grey grit; sp. gr. 2.7.

This rock is remarkably fine grained and contains a great deal of secondary calcite, which rendered its analysis under the microscope remarkably difficult. This was removed with hydrochloric acid. Quartz, in splinters and angular grains, is abundantly present; there is some felspar with albite twinning which extinguishes at 16° ; and a good deal of muscovite in small flakes and ragged contorted laminae. Some opaque white granules, probably leucoxene, are scattered here and there.

24 a. (04 and 05).

Quartz.

25. Lo-t'o-ch'üan (01). Rocky kopje, six miles NW. of Lo-t'o-ch'üan. *Quartz Mica Schist.*

A highly schistose fragment of a rock composed mainly of quartz, plagioclase felspar, and biotite.

The quartz is very clear, without vapour cavities, or with very few, shows marked undulose extinction, and forms with the plagioclase a mosaic of various degrees of fineness. The plagioclase is twinned on the albite plan and may thus be distinguished from the quartz, which it otherwise closely resembles. Its refractive index is so nearly that of quartz that one cannot determine the difference.

The biotite is fresh and extremely uniform in all its characters, clear, slightly brownish yellow in colour, with marked pleochroism: X, colourless; Y and Z, brownish yellow. It is remarkable for the abundant presence of pleochroic haloes, some surrounding zircon, others a mineral not identified. One of these haloes, well defined and circular, surrounding the pyramidal end of a crystal of zircon gave .0355 mm. as the value of the radius of the halo, after deducting for the radius of the zircon.

Some small grains of magnetite are scattered through the rock.

26. Lo-t'o-ch'üan (02). Rocky kopje, eighteen miles NW. of Lo-t'o-ch'üan. *Adamellite.*

The chief constituents are large hypidiomorphic crystals of orthoclase and plagioclase, both for the greater part extremely sericitized. The plagioclase is closely twinned on the albitic plan with a maximum extinction of 15° , but as its index of refraction cannot be determined it is impossible to say certainly whether it is albite or oligoclase. Quartz occurs in coarse mosaics and is interstitial. Hornblende and biotite are fairly abundant. The hornblende is green and pleochroic, with X, faint straw yellow; Y, dark green, and Z also green. The maximum extinction angle is 14° .

The biotite rarely retains a trace of its original brown colour and is green by alteration, with pleochroism: X, straw yellow or colourless; Y and Z, dark green. It contains a good deal of apatite, often in fairly large crystals, and some zircons which are surrounded by a pleochroic halo.

There is a good deal of secondary epidote and chlorite. Iron ores were not observed.

27. Lo-t'o-ch'üan (03). Detritus hillock near.

Limestone.

A fragment of fine-grained grey limestone, consisting of