earth reside in the earth itself, and that "the earth is not merely an inert mass cooling in space." [1]

Our conception of the geologic potentialities of matter has been marvellously widened by the recent discoveries. How these discoveries may affect our views of the interaction of matters as explaining geological changes remains to be decided when the new methods are established on a firm basis, of which there seems to be an early prospect.

NOTICES OF MEMOIRS, ETC.

Abstracts of Papers read before Section C (Geology), British Association: South Africa, 1905.

I.—On the Marginal Phenomena of Granite Domes. By Professor Grenville A. J. Cole.

IN examining the gneisses of the counties of Donegal and Tyrone, which have been in part regarded as sheared Archæan masses, the author was led to conclude that the main structures are due to igneous flow, and that the most marked gneissic structure occurs where previously foliated sedimentary and igneous material has been incorporated with an invading granite. The patches of foliated gneiss in the granites of Donegal are thus remnants of considerable masses of older rock that have been absorbed; and the phenomenon of banded gneiss arises characteristically as a marginal feature of granite domes. Foliation is found in surrounding masses parallel to that in the granite, and at the same time parallel to the surface of junction, for the simple reason that the granite has picked off, leaf by leaf, the layers of foliated rock against which it rose. The author thus ranges himself with those who ascribe the most profound metamorphism to igneous rather than to dynamic action, and ventures to suggest that similar conclusions may be drawn from the rocks of the Malmesbury series in the west of Cape Colony, where a commingling of rocks appears to have taken place during a period of subterranean flow.

II.—Magmatic Segregation of Sulphide Ores. By Dr. A. P. Coleman.

THE formation of ore bodies by magmatic segregation in eruptive rocks has long been admitted as regards magnetite and titaniferous iron ores, but the formation of sulphide ore bodies in this way has been disputed by many geologists. The pyrrhotite ores of nickel in Norway were first recognised by Professor Vogt as having this origin; and his theory has been applied to the Sudbury nickel ores by various geologists, and opposed by others. The recent complete mapping of the eruptive sheet, with which the Sudbury ore bodies are all connected, proves that they are really

[1] "Evolution of Earth Structure," p. 28.

segregated from the eruptive rock and form an integral part of it, with every gradation between ore and rock. It is believed that gravitation played a large part in the segregation, since the ore bodies are regularly found at the lowest points in the lower edge of the norite-micropegmatite sheet with which they are connected.

III.—On the Geology of South Victoria Land. By H. T. Ferrar, M.A.

I. The knowledge we had of South Victoria Land previous to the departure of the "Discovery" was mainly acquired by the expedition under Sir James Clarke Ross in H.M.S. "Erebus" and H.M.S. "Terror," in the years 1839–1843. His discoveries may be briefly summed up thus :—

(*a*) A great range of mountains, which rise occasionally to heights of 15,000 feet, and extend in a north and south direction for at least 500 miles.

(*b*) The presence of volcanic and plutonic rocks in this area.

(*c*) An open shallow sea south of the Antarctic circle.

(*d*) An active volcano, Mount Erebus, over 12,000 feet high, emitting flame and smoke in great profusion.

(*e*) A wall of ice, the Great Ice Barrier, on an average 150 feet high and about 470 miles long.

In 1899 the "Southern Cross" expedition brought home from Cape Adare specimens of granites, basalts, and quartz slates, but unfortunately the latter proved to be unfossiliferous.

II. This section deals with the *volcanic islands* off the coast, commencing with the Balleny Group, in latitude 66° S., and passes on to the rocks of the mainland in latitude 77° S. The rocks from the islands are chiefly basalts and tuffs, though intrusions of trachyte are fairly common. Edward VII Land and the volcanoes on the mainland are included in this section, as the latter, at any rate, belong to the recent volcanic eruptions of the area. All the volcanoes are undenuded cones, and are usually situated in isolated positions, and contrast strongly in outline with the rugged scenery of the main mountain range.

III. *The Continental Range.* The great range of mountains discovered by Sir James Ross has been proved to be at least 800 miles long, and to have some remarkable features common to the whole length. This great mountain range is divided into smaller ranges, to which distinguishing names have been given; but only one, the Royal Society Range, has been examined in detail by the expedition. The rocks that compose the range are conveniently separated into four distinct groups—namely, gneisses, granites, sandstones, and dolerites. The sandstone, to which I propose to give the name Beacon Sandstone Formation, provides a convenient stratigraphical datum-line, with reference to which the other phenomena may be considered.

(i) *The Gneissic Rocks* occur at sea-level and below a sequence of rocks which is at least 12,000 feet thick, and may be safely regarded

as forming the ancient platform on which the central part of South Victoria Land is built. The foot-hills of the Royal Society Range and the lower portions of the Cathedral Rocks are composed of this class of rock.

(ii) *The Granites* have been encountered at the north end of the Royal Society Range, where they rest upon gneisses, and dykes of granite pierce the gneissic series. At Granite Harbour this type of rock is found as a huge boss, and is probably covered by a sheet of dolerite. Where the Ferrar Glacier forks, a junction of dolerite and granite proves that there are two distinct developments of granite, one older and one younger than a certain sheet of dolerite.

(iii) *The Beacon Sandstone Formation* is met with at a height of 4,000 feet above sea-level, and about 40 miles from the sea. It appears to be nearly 3,000 feet thick, and near the top indeterminable fossil plants were found. The bedding is practically horizontal, and the rock is remarkably uniform in texture. The surface upon which it rests has not yet been discovered.

(iv) *The Dolerite Sheets* produce the plateau features characteristic of that rock, and cap the sandstone over a very large area. Dykes, sills, and pipes of the dolerite occur in the sandstone, and prove the former to be intrusive. The original dolerite plateaux have been dissected by water action, apparently prior to the faulting which has dislocated the Beacon Sandstone.

IV. *The Ice.* Sea-ice, produced by the freezing of the sea during the Winter, is on an average 8½ feet thick, but during the Summer the sea-water melts the lower surface of the ice. Shore-ice, a fringe of glacier ice attached to the land, shows the conservative action of ice in this latitude. Inland ice, local ice-caps, piedmonts, and other types of glaciers may be recognised in South Victoria Land. The term 'floating piedmont' has been suggested as descriptive of the Great Ice Barrier, or Ice Sheet, of Ross, and there are at least three examples in our area.

The moraines high on the slopes of Mount Erebus, and other moraines stranded at various spots, are considered in their relation to the past and present distribution of the ice, and the conclusion arrived at is that the glaciation is approaching a minimum.

IV.—Evidences of Glacial Conditions in Permo-Carboniferous Times in the Transvaal. By Edward T. Mellor, B.Sc.

[Communicated by permission of the Director of the Geological Survey of the Transvaal.]

THE present paper gives a brief account of recent work in connection with the rocks at the base of the Karroo System in the Transvaal, including some additions to the evidence of extensive glacial action in early Karroo times. The description given of the character and mode of occurrence of the glacial conglomerate is based mainly upon observations made in the course of mapping a district lying between the Elands and Wilge Rivers, east of Pretoria. The Karroo System does not here attain so

complete a development as in the more eastern and southern portions of South Africa. The whole thickness of the formation rarely exceeds 400–500 feet, and it is not possible as yet to recognise the many divisions which it presents in those parts of South Africa where it attains a much greater thickness. Outliers along the margin of the main area occupied by the Karroo System afford good opportunities for the study of the glacial conglomerate which forms its base. They are occasionally entirely composed of this conglomerate owing to the complete denudation of the overlying sandstones and grits.

The upper and well stratified portion of the formation lies everywhere horizontally, and its base maintains a very constant elevation of about 4,900 to 5,000 feet. The glacial beds of the lower portion of the formation rarely show distinct stratification, and outliers consisting of these alone closely resemble, both in appearance and mode of distribution, patches of glacial drift of comparatively recent origin. There is abundant evidence that they were laid down upon an old land surface possessing considerable variety of surface feature, and some of the thickest deposits of glacial conglomerate occur in valleys or below escarpments which were in existence before its deposition.

Owing to the abundant sandy drift arising both from the conglomerate itself and from the grits and sandstones which usually overlie it, the solid conglomerate is rarely exposed at the surface. Where seen, it is of a light yellow or cream colour, and usually consists of a sandy-looking matrix containing abundant boulders and pebbles distributed without definite arrangement through the mass. The pebbles and boulders vary in size from 2 to 3 inches up to as much as 10 feet in diameter. The materials of which the boulders are composed vary much in character. There is always a great preponderance of local rocks, with an admixture of others which can be shown to be derived from comparatively distant sources, which are to the north of the present position of the boulders. In the district here specially referred to, the majority of the boulders consist of hard red quartzites and conglomerates derived from the Waterberg Formation, which underlies the glacial conglomerate over a large part of the area. Almost equally numerous are boulders of the Red Granite, which occurs extensively further to the north.

The boulders are always highly polished and usually facetted. When composed of fine-grained rocks, such as felsites and shales, they frequently show striations on the facets. The matrix of the glacial conglomerate consists of sharply angular fragments of quartz and of rocks similar to those of which the boulders are composed, varying in size from mere grains upwards. It differs to some extent from the matrix of the typical Dwyka conglomerate of the more southern portions of South Africa in presenting an appearance much less suggestive of an igneous origin. By weathering, the matrix of the conglomerate usually gives rise to sandy products; in some localities, however, it produces a yellowish clay, in which the boulders remain embedded. In specimens from a depth, the matrix

is occasionally greenish in colour. Locally there occur in the conglomerate lenticular patches of fine-grained, massive, white or cream-coloured sandstones, and white, finely laminated shales and mudstones.

The progressive denudation of the glacial conglomerate exposes at its margin the glaciated surfaces of the underlying rocks, which frequently show very clear striation. The best examples yet met with are those occurring to the north of the Douglas Colliery near Balmoral. In a number of examples distributed over an area of 300 square miles the striæ exhibit great constancy of direction, and point to the existence of an extensive ice-sheet with a movement from N.N.W. to S.S.E.

It is very probable that the glacial conglomerate extends very much further north than the localities at present known. During the past year outliers of the conglomerate were found ninety miles north of the latitude of Johannesburg.

V. — The Plutonic Rocks and their Relations with the Crystalline Schists and other Formations. By F. P. Mennell.

IT has been pointed out by Teall that the final solution of the problems arising in connection with the origin of igneous magmas is possibly to be looked for where the plutonic rocks are seen in their relations with the crystalline schists. The writer dealt with observations made in such an area and the inferences to be drawn therefrom. He concluded that the average igneous rock has practically the composition of the average granite, and that plutonic rocks are immensely more important than the other classes, even when the term plutonic is used in a much more restricted sense than by many authors. The causes of variation were discussed, and segregation, except as a phenomenon of limited importance, was dismissed as an untenable theory. The origin of the magmas must be considered in order to account for subsequent variation. 'Refusion' seems the only possible mode of formation. Granite appears to result from the effective mixing of the heterogeneous materials melted down, other igneous rocks being the result of the cooling of different parts before mixture is complete, basic material having also the best chance of reaching the surface as lava, owing to its superior liquidity. There is circulation of material between the igneous and sedimentary rocks, the material analysed in the latter being subjected to synthesis in the making of the former.

VI.—Baviaan's Kloof: A Contribution to the Theory of Mountain Folds. By Ernest H. L. Schwarz, A.R.C.S.

BAVIAAN'S KLOOF is a narrow valley lying between mountains belonging to the Triassic period. The geological history may be summarised thus :—

(*a*) First base-level. Deposition of Enon Conglomerate, derived

from the disintegration of the newly-formed mountains, on a plain eroded between the two mountain chains.

(*b*) Period of cross-folding. The area traversed by two sets of folds in directions W.N.W.–E.N.E. and S.W.–N.E.; these let down portions of the surface in deep pits, bounded by circular faults and sharp folds.

(*c*) Second base-level. The Enon Conglomerate removed, except that in the fold-basins, and the surface of the valley again reduced to a double level of erosion.

(*d*) Rising of the land. Deep erosion of the river channels; immense gorges cut in the floor of the plain and most of the loose contents of the Enon Conglomerate in the fold-basins removed.

Cross-folding is the interpretation of the two sets of mountain folds, and the sinking of areas in the meshes between is contrary to what would happen if the folds were produced by direct tangential thrust. The direct thrust theory also has to explain how a force could act at a distance when the material through which it is transmitted is so heavy in proportion to its strength and has such immense friction to overcome.

The resemblance of these Baviaan's Kloof fold-basins to pits found between two sets of crossing ripple-marks has suggested that certain mountain folds are produced by earth-shaking waves which become retarded when approaching an immovable buffer, such as masses of granite anchored to the deep substructure of the earth's crust. This theory is further illustrated experimentally by what happens in a lead sink where hot and cold water is let in at one end from a tap; the disturbance produced by this gradually causes ridges to form at the further end of the sink, though the lead is too pliant to allow a direct thrust thus to act at a distance.

'Shearing' and 'fold arc' structure may also be explained on the wave theory, whereas 'block up-lift' structure is rather a problem in isostasy.

REVIEWS.

I. — An Introduction to Geology. By J. E. Marr, Sc.D., F.R.S. 8vo; pp. viii, 229, with 33 illustrations. (Cambridge: at the University Press, 1905. Price 3*s*.)

THAT geology flourishes as a recreative science is manifest to all who read their Quarterly Journal, Geological Magazine, or Proceedings of the Geologists' Association; while the good work that is being done and may be done by amateurs as well as professionals, especially in the study of fossils, formed the text last year of Dr. Smith Woodward's interesting address to the Geologists' Association. Most excellent work is being achieved by those who concentrate their attention on certain formations, or fossils, or districts; and it is necessary that the supply of such workers be maintained.