tourmaline, to the various types of normal fissure-veins, where it is associated with sulphides of iron, copper, and antimony, and to a lesser extent with lead. Throughout the sulphide zones it constantly accompanies gold. This association of tungsten with gold is one of the most significant facts in the occurrence of tungsten-ores. Mention should here be made of the occurrence of strings of gold in alluvial wolframite in the Ballinvalley stream, co. Wicklow, Ireland,[1] but it is possible that the gold has here been deposited on the wolfram by secondary action in the auriferous alluvium.

It follows that tungsten, which is found in such a continuous series of vein-types, must give important evidence as to the ultimate source of the metals with which it is associated, and since tungsten is universally a product of the acid and superacid phases of magma-differentiation in the first place, it seems probable that it is to these magmatic phases that we must look for the ultimate point of departure of many gold- and sulphide-ores, just as in the case of tin-ores. While this line of evidence as to the source of gold-ores—especially when taken in conjunction with the authentic occurrences of primary free gold in granitic rocks—supports in part the hypothesis of Mr. J. E. Spurr,[2] it is clear that the genesis of gold-ores and sulphides is much too complex to be thus dealt with. While magmatic differentiation has probably been the fundamental factor at work, there are many gold-ores which have probably originated during an intermediate or basic phase of differentiation.

Apart from the view of derivation of ores by progressive magmatic differentiation, which is strongly supported by the evidence here discussed, there remains the problem of the origin of the vein-solutions. The view advocated by Mr. Spurr, that the quartz gangue of normal fissure-veins represents the extreme product of siliceous magmatic differentiation, seems to be of very limited application. The views as to the origin of vein-forming solutions are still somewhat conflicting, but it is doubtful if any theory of vein-formation can be comprehensive which demands the exclusive agency of 'juvenile waters', and which fails to recognize the work of underground solutions of meteoric origin in the middle and higher zones of ore-deposition.

The work in connexion with this paper was carried out at the Imperial College of Science and Technology, London, and the writer is indebted to Professor W. W. Watts for advice and criticism.

NOTICES OF MEMOIRS.

On the Evidences of a Former Land-bridge between Northern Europe and North America.[3] By R. F. Scharff, Ph.D., M.R.I.A.

THE author enunciated the theory some years ago that North-Western Europe and North-Eastern America had been connected with one another by land within comparatively recent geological times, and

[1] Bull. Imp. Inst., 1909, vii, No. 2, p. 171.
[2] Ec. Geol., ii, No. 8, p. 781.
[3] From the Proceedings of the Royal Irish Academy, 1909, vol. xxviii, Section B.

that the reindeer had probably utilized this land-connexion in gaining access to Europe from its supposed American centre of dispersion. Further studies have led to the conviction that a second and more southerly land-connexion, joining Scotland, Iceland, and Greenland with America, must have existed in later Tertiary times. This does not materially alter the general principle of his original views; and he still adheres to the belief in a North Atlantic land-bridge between Europe and America during the lifetime of the reindeer.

In 1897 Mr. W. S. Green gave us the results of his expedition to the Rockall Bank. Surrounded by deep water on all sides, this bank is of an average depth of 100 fathoms, and lies far out in the Atlantic to the west of Scotland. Dredging on the bank yielded only such shallow-water species of molluscs and other marine invertebrates as could not have lived there under the present conditions. Moreover, as all the specimens were dead, it was concluded that the bank had only subsided to its present depth within comparatively recent times.[1] In 1900 the Danish 'Ingolf' expedition to Iceland likewise reported having met littoral molluscs near the island at considerable depths where these animals could not possibly have lived. That such cases as these are due to accidental dispersal by floating icebergs containing shells in the ice-foot or by floating seaweeds, had been suggested; but the view that the occurrence of shore forms of animal life in deep water implies a depression of the land seems to meet with more general favour, especially as no icebergs are known to stray to the Rockall Bank at present.

More recently Professor Hull lays stress on the occurrence of channels in submerged platforms bordering the British Isles, and urges that they represent the drowned river-valleys and cañons of an ancient land-surface. By means of the Admiralty charts he succeeded in tracing the course of the River Shannon for a hundred miles beyond its present mouth, right to the edge of the continental platform, while he followed the continuation of the River Erne for a distance of 80 miles from the Irish coast.[2]

In America similar researches have been conducted, chiefly by Dr. Spencer,[3] but while Professor Hull advocates an elevation of the land during the early part of the Glacial period of 7000 to 8000 feet, Dr. Spencer suggests an uplift of 12,000 to 15,000 feet. A more cautious attitude on these oceanographic problems was adopted by Mr. Hudleston. He conceded that some sort of a bridge across the Atlantic may have existed during portions of the Tertiary era; but he did not believe in an uplift beyond 2000 or 3000 feet.[4]

The subject of continental shelves has lately received renewed attention from Dr. Nansen, and is discussed by him at great length. At several places, he argues, there is weighty evidence for the supposition that the drowned river-valleys have been sculptured after the

[1] W. S. Green, "Notes on Rockall Island": Trans. Roy. Irish Acad., 1897, xxxi.
[2] E. Hull, "Submerged Terraces and River Valleys": Trans. Vict. Inst., 1897, xxx.
[3] J. W. Spencer, "Submarine Valleys": Bull. Geol. Soc. America, 1903, xiv, p. 224.
[4] W. H. Hudleston, "Eastern Margin of North Atlantic Basin": GEOL. MAG., 1899, p. 148.

formation of the continental shelves. The latter consequently have been dry land after their formation.[1]

The remarkable circumstance that the submarine fjord-valleys on the European and on the American side, and likewise the submarine ridges connecting the two continents, are situated at about the same depth makes it probable that the whole area had once been raised simultaneously, and had thus become connected by land. Dana long ago urged that the refrigeration of the climate at the close of the Tertiary era was connected with a period of high-latitude elevation,[2] and I cannot refrain from expressing my opinion, that the Glacial period was primarily due to the diversion of oceanic currents produced by changes in the distribution of land and water. With every respect for the views of those who hold different opinions, it seems to me that the peculiar phenomena connected with the Ice Age in Western Europe, and especially the apparent survival of southern species of plants and animals in Ireland through the Glacial period, are best explained by such a theory as that just stated.

It is especially the teachings of Edward Forbes and A. R. Wallace that led to the recognition of the significance of the present geographical distribution of animals and plants as an indicator of the changes which have taken place in the arrangement of land and water. They believed that many terrestrial animals and plants require a continuous land-surface for their dispersal. Yet the diversity and comparative richness of the fauna and flora of some of the oceanic islands, and the depth of water intervening between them and the mainland, had to be accounted for in some other manner. Neither Wallace nor Darwin was inclined to admit extensive geographical changes within the period of existing species. The distribution of plants and animals by 'accidental', or what Darwin called 'occasional', means of dispersal seemed to furnish them with a clue to the worldwide dissemination of certain species.

Darwin's experiments have found many imitators; and valuable observations tending to show that at any rate some of the more minute animals and plants are liable to be conveyed by occasional means of dispersal, have been made.

It would be idle to deny that the seeds of certain plants are carried to great distances by wind; that many others are undoubtedly transported by ocean currents; that some seeds are even scattered here and there by birds. My contention is, and I concur in this opinion with many eminent botanists, that only a small percentage of plants are disseminated and actually established in that manner. Most of them require for their dispersal a solid and continuous expanse of soil.

Sir Joseph Hooker evidently believed that the flora of Greenland had travelled across from Europe by a land-bridge in Pre-Glacial times. He considered the existing plants of the country as certainly older than the Glacial period; for he argued that the severity of the climate destroyed many species, while the remainder took refuge and survived in the southern parts of Greenland.[3] Professor James Geikie

[1] F. Nansen, *Norwegian North Polar Expedition*, 1904, iv, p. 192.

[2] J. D. Dana, *Manual of Geology*, 3rd ed., p. 540.

[3] J. D. Hooker, "Distribution of Arctic Plants": Trans. Linn. Soc., 1860, xxiii, pp. 252–5.

maintains that a land-connexion between Greenland, Iceland, the Faröes, and Scotland, must have existed, because the plants could only have migrated from Europe over a land surface,[1] but to him the idea of a survival of plants during the Ice Age in Greenland is inconceivable. He therefore argues that the land-bridge could only have existed in Post-Glacial times. Hence the Glacial period and its supposed adverse influence upon the flora of Northern Europe has now become the mainspring of most speculations as to the former presence or absence of a northern land-bridge.

The question of the supposed survival of plants through the Ice Age in Greenland largely depends on the problem whether or no the glaciers of that country had a vastly greater extension formerly than they have at present, and covered the whole of the land now free from ice. That the latter has never been entirely invaded by ice has been clearly demonstrated by the leader of the German Greenland Expedition, Dr. E. von Drygalski. The greater extension of ice in former times no doubt can be proved, he remarks; yet glaciers certainly never reached the cliffs and rock-pinnacles which abound on all parts of the coast-lands of Greenland.[2] No reason, therefore, can be adduced why the flora of Greenland should not have survived the Ice Age in that country, particularly as we have some grounds for the supposition that the land in the Arctic regions then stood higher than it does now.

It would be wrong to suppose that plant migration to the Faröes and Iceland has proceeded altogether from Europe. A stream has likewise advanced from the opposite direction. Thus in the Faröes we find at least seven plants unrepresented in the British Islands. These came from Greenland and Arctic America.

A small group of plants is of particular interest to Irish botanists, as being almost exclusively confined to the West of Ireland and North America. According to Messrs. Colgan & Scully,[3] the plants in Ireland which belong to this group include *Spiranthes Romanzoviana*, *Eriocaulon septangulare*, and *Naias flexilis*. All of these plants are indigenous and discontinuously distributed. An interval of more than 200 miles separates the northern and southern stations in Ireland of the rare orchid *S. Romanzoviana*. The water plants *E. septangulare* and *N. flexilis* inhabit not only some of the western Irish lakes, they occur also in Scotland.

Messrs. Colgan & Scully do not explain the presence in Ireland of these plants as being due to any such accidental transport. They believe them to have reached Europe by means of an ancient northern land-connexion. Mr. Praeger likewise comes to a similar conclusion with regard to the origin of the American plant group in Ireland. He does not favour the theory of accidental dispersal. A land surface, long since destroyed, of Pre-Glacial age, appeals to him as a more likely explanation of the presence of the American plants.[4]

The number of plants common to Europe and North America is really far greater than we imagine, though very few, as we have seen,

[1] James Geikie, *Prehistoric Europe*, 1881, p. 520.
[2] E. von Drygalski, *Grönland Expedition*, 1897, vol. i, p. 335.
[3] N. Colgan & R. W. Scully, *Cybele Hibernica*, 1898, 2nd ed., p. 71.
[4] R. Ll. Praeger, *Irish Topographical Botany*, 1901, p. 23.

are quite confined to these continents. Of those which also occur in Asia there are many, like the Orchid *Listera cordata*, which grows only in a few localities in the extreme east, that are apparently absent from the greater part of the continent. It is probable that all these have found their way from America to Europe by a direct passage. Moreover, we know from Professor Drummond's researches that of seventy species of fossil plants observed by him in the Pleistocene clays of Toronto in Canada, twenty occur at the present day both in that country and in Europe.[1] This seems to indicate that during the Pleistocene period, the great mass of the flora common to America and Europe had already found its way from the one continent to the other.

The zoological testimony in support of this view is of a more pronounced character. The interest aroused in Ireland by the discovery of the American plants has led to research in other directions. Thus, in 1895, three species of freshwater sponges were detected in various lakes at some distance from the sea on the west coast. Only one of these sponges, viz. *Tubella pennsylvanica*, has since been observed in another European locality, in Loch Baa in Scotland, but all of them are identical with American species.[2] Dr. Hanitsch identified them as *Ephydatia crateriformis*, *Heteromeyenia Ryderi*, and *Tubella pennsylvanica*.

In my more recent work on European Animals, I have incidentally dwelt on the past range of the Great Auk (*Alca impennis*) as indicating the presence of a former more continuous coastline between the British Islands, Iceland, Greenland, and Newfoundland, in all of which countries this bird was known to have been abundant.[3] Yet, after all, the best evidence in favour of a North Atlantic land-bridge is furnished by the invertebrates. Our special attention is drawn by Mr. Born to the importance of the 'Running Beetles' of the genus *Carabus*. From the fact of their being wingless and usually found under stones or clods of earth, they are not liable to be transported accidentally by any of the means usually supposed to aid animals in their dispersal. Mr. Born claims that at least two European species of *Carabus*, viz. *C. catenulatus* and *C. nemoralis*, have crossed the Atlantic by means of an ancient land-bridge. A third form—*Carabus groenlandicus Chamissonis*—seems to have originated in America, and to have travelled from there to Greenland and Lapland.[4]

Of another group of insects—the Collembola—Professor Carpenter remarks: "It is of interest to find that the presence of not a few species of these wingless insects in America, in Greenland, in the islands to the north of Europe and Asia, and on the Euro-Asiatic continent, lends support to our belief in a Pliocene or Pleistocene

[1] A. T. Drummond, "Plants common to Europe and America": *Nature*, 1904, lxx, p. 55.

[2] R. Hanitsch, "Freshwater Sponges of Ireland": *Irish Nat.*, 1895, iv, p. 126. Annandale, "Freshwater Sponges in Scotland": Journ. Linn. Soc. (Zool.), 1908, xxx.

[3] R. F. Scharff, *European Animals*, 1907, pp. 37–9.

[4] Paul Born, "Carabologische Studien": *Entomol. Wochenblatt*, 1908, xxv, pp. 8, 9.

land-connexion to the north of the Atlantic Ocean—a belief already upheld by so much evidence, both geological and zoological." [1]

Quite a number of naturalists believe that any resemblance between the European and the American fauna must have arisen, not from any direct intercourse between Europe and America, but by a migration across Asia and a Bering Strait land-connexion. The supposition of an ancient northern Pacific land-bridge presents fewer difficulties to them than the Atlantic one, and is preferred for that reason. Dr. Horváth, for example, who states that no less than 128 species of Hemiptera are common to the two continents, argues that they all must have crossed Asia in reaching the one from the other.[2] But he and those who agree with him were apparently unaware that certain freshwater species common to Europe and America are almost totally absent from Asia or Western America.

Let us take, for example, our common Perch (*Perca fluviatilis*), a variety of which also inhabits North America. It is absent not only from a large part of Asia, but also from Western North America. Certainly this looks like a case of direct migration from America to Europe.

Another example that I have had occasion to quote in my work on *European Animals* (p. 35) is the freshwater Pearl-Mussel (*Meleagrina margaritifera*). On our continent it inhabits the British Islands except Eastern England, the mountain streams of Scandinavia, and the hill-region of Central Europe except the Alps. Far to the east it reappears in a different form in the River Amur in Eastern Siberia, in the island of Sakhalin, and in Kamchatka. Another variety is met with across the Bering Strait in Alaska and in Western North America generally. The type form occurs in the Quebec province of Canada, in the Lower Saskatchewan River, and in New England. The typical freshwater Pearl-Mussel is only met with in Eastern North America and in Central and North-Western Europe. America is undoubtedly its original home. From it the mussel spread to Europe in an eastward direction, and not by way of Asia. As the fry of these mussels attach themselves to the gills of fishes, they are liable to wide dispersal within at least one river system; but fishes in this case could scarcely have aided them in reaching Europe. A land-connexion between the two continents explains their distribution certainly better than any other theory.

The most striking piece of evidence we possess in favour of a Pre-Glacial land-connexion between North-Western Europe and North-Eastern North America is the presence in the latter country of the snail *Helix hortensis*.

A western species in Europe, *Helix hortensis*, is remarkable for its extensive northern range. It occurs in Scandinavia, all over the British Islands, in the Shetlands and Faröes, and even in Iceland. It is altogether absent from Asia. Its occurrence in Southern

[1] G. H. Carpenter, "Collembola from Franz Joseph Land": Proc. R. Dublin Soc., 1900, ix, p. 276.

[2] G. Horváth, "Faunes hémiptérologiques": Ann. Hist. Nat. Mus. Hungarici, 1908, iv, pp. 4–7.

Greenland had generally been attributed to a recent human introduction; but it has been taken in several different localities, and we must, I think, look upon it as an indigenous species. During the year 1864 Professor E. S. Morse discovered the shell of this snail among ancient 'kitchen-middens' on some of the islands off the coast of Maine. This fact led him to consider that the snail had wandered along some ancient coastline from the Old World across the North Atlantic. Dr. Binney, and more recently Professor Cockerell, concurred with Professor Morse's opinion, while the Rev. Mr. Winkley even suggested that *Helix hortensis* arrived in North America before the advent of the Glacial period. With the latter theory Mr. Johnson, another conchologist, expressed his agreement; and it is to his paper that I am indebted for the above-mentioned information.[1]

All doubts as to the claim of *Helix hortensis* being an indigenous American species are now set at rest through the discovery by Dr. Dall of the shell of this snail in undoubtedly Pleistocene deposits in the State of Maine.[2] Moreover, the species is now known to inhabit a much greater area than was formerly supposed; for it has been collected in Labrador, Newfoundland, Prince Edward Island, and many other small islands where it could not possibly have been brought by man. It may, therefore, be considered as definitely established that *Helix hortensis* reached America in Pleistocene or Pliocene times without human intervention.

The discovery of *Helix hortensis* in Greenland is an important factor in favour of the land-connexion theory. That this species should have survived the Glacial period in that country need not surprise us; for several other species of land and freshwater molluscs certainly must have done so. *Planorbis arctica*, *Limnæa Vahli*, *L. Wormskioldi*, *Succinea grœnlandica*, *Vitrina angelicæ*, *Pupa Hoppii*, and *Conulus Fabricii* are almost all confined to Greenland, and no doubt originated there in Pre-Glacial times.

Of all the theories which have been advanced in explanation of the occurrence of identical species on both sides of the Atlantic Ocean, only the following three have met with wide approval:—

1. Migration from Europe across Asia and a Bering Strait land-bridge to America or vice versa.
2. Occasional transport by birds across the Atlantic Ocean.
3. Migration across a direct Atlantic land-connexion.

If we consider the zoological evidence alone, namely, the absence of *Helix hortensis* from Asia and Western America, the distribution of the Perches and the freshwater Pearl-Mussel, and that of the freshwater Sponges, the first of the three hypotheses is scarcely applicable to these instances of distribution, and does not, therefore, explain the presence of identical species on both sides of the Atlantic in a satisfactory manner.

As regards the supposed conveyance by birds of seeds and invertebrates across the same ocean, the second theory must be

[1] C. W. Johnson, "Distribution of *Helix hortensis*": *Nautilus*, 1906, xx, p. 73.
[2] W. H. Dall, "Land and Freshwater Mollusks": Harriman Alaska Exped., 1905, xiii, p. 20.

applicable to a transport in two directions, both from America to Europe as well as vice versa.

The fact that both in America and Europe the indigenous species of plants and animals identical to the two continents are largely confined to the coast region may appear at first sight in favour of the theory of introduction by birds. Almost all the American plants, and all the American freshwater sponges at any rate, occur in the vicinity of the coast. It has been argued, therefore, that, after their long flight across the ocean, birds would naturally alight on the earliest opportunity; and that it was for this reason that the plants and animals common to the two continents were so largely confined to the coastal districts. But from what has been mentioned we have no reason to infer that American birds do habitually alight on the west coast of Ireland on first reaching Europe. It seems highly probable that they cross by way of Greenland. We should, therefore, expect all species of the invertebrates and plants common to the two continents to be found in Greenland as well. This is not so. Only comparatively few of them are met with in Greenland. The theory that the resemblance in the fauna and flora of Eastern North America and Western Europe is due to the action of birds is, I think, not supported by sufficient evidence.

The third theory, that the identical species on either side of the Atlantic Ocean are the result of a direct land-connexion between Scotland, Iceland, Greenland, and Labrador, appears to me to be well founded on geological, bathymetrical, and biological evidence. No decisive testimony, however, has as yet been brought forward to show during what geological period this land-bridge was formed and how long it lasted. The assumption that such geographical conditions prevailed during early Tertiary times is very widespread. That this state continued during the Miocene period is likewise maintained by many; though Professor Dawkins and a few others do not admit the existence of the northern land-bridge in Pliocene or more recent times.[1] Sir Archibald Geikie's researches point to the production of the great basalt plateaux of North-Western Europe in early Tertiary times. These plateaux formed a continuous tract of land, as far as the Faröes at any rate. He proves that in many places, such as Iceland, the Faröes, and the West of Scotland, enormous subsidence subsequently took place.[2]

Once we admit that animals and plants were able to survive the Glacial period in northern latitudes, a land-connexion such as suggested in Pliocene times would readily account for the presence of all the animals and plants common to Europe and America. By many of those best able to judge, an admission to that effect has been made. Pliocene deposits are scanty in the British Islands; yet they yield valuable suggestions as to the geographical conditions of the North Atlantic. An examination of the fossil invertebrates contained in the St. Erth Beds in Cornwall, which are of Pliocene age, showed that the fauna possessed a remarkably southern facies, and that there was

[1] W. Boyd Dawkins, *Early Man in Britain*, 1880, p. 43.

[2] A. Geikie, "Basalt Plateaux of North-Western Europe": Q.J.G.S., 1896, lii, p. 405.

a total absence of boreal or Arctic species. This fact led Professor Kendall and Mr. Bell to the conclusion that at the period during which these deposits were laid down—that is to say, during the latter part of the Pliocene period—no channel or direct communication existed between the North Sea and the Atlantic Ocean, the Straits of Dover being closed in the south, while in the north the Tertiary volcanic chain formed a barrier across from the North of Scotland to Greenland by way of the Shetland Islands, Faröes, and Iceland.[1]

Mr. Reid's contention that the St. Erth Beds are older than Messrs. Kendall & Bell estimated—that they are, in fact, of early Pliocene age—is founded chiefly on the circumstance that the percentage of extinct species is about the same as that of the Coralline Crag. The consideration of the supposed climatic conditions does not seem to me of any particular value; and, as he remarks, the exact age of the clays is still doubtful.[2] Even if the St. Erth Beds belong to the lower Pliocene, there are no grounds for the supposition that the northern barrier, alluded to by Messrs. Kendall & Bell, had ceased to exist in later Pliocene times.

The change in the Pliocene fauna of the east coast of England, as we pass from the older to the newer beds, no doubt implies, as Mr. Harmer pointed out, an opening up of the area to the influence of the northern seas.[3] But we do not possess the slightest evidence for the assumption that the Atlantic Ocean was similarly affected. Many of the facts, indeed, lead to the conclusion that the land on the Atlantic coasts of the British Islands stood highest in late Pliocene and early Pleistocene times, and that it was then that *Helix hortensis* and many other European species must have made their way to America.

Glacial conditions prevailed at this time on all the high mountain ranges surrounding the warm Atlantic Ocean, and yet the coast region must have supported an abundance of animal and plant life. The presence of a land-bridge between Scotland and North America by way of Greenland, and another between England and France, would have excluded the Gulf Stream from the Arctic regions. Professor Blytt's argument that under such conditions all the coast region, including Iceland and Southern Greenland, would have had a higher temperature than at present, while the lands beyond were probably colder, seems irrefutable.[4] Yet Professor James Geikie believes that even the latter countries would then have had a more genial climate.[5]

In my opinion it was during this epoch, in Pre-Glacial times, that the interchange between the fauna and flora of North-Western Europe and North-Eastern America was effected across the northern land-bridges.

Only one other point needs to be commented upon. I have shown

[1] P. F. Kendall & A. Bell, "The Pliocene Beds of St. Erth": Q.J.G.S., 1886, xlii, pp. 206, 207.

[2] C. Reid, *Pliocene Deposits of Britain*, 1890, p. 61.

[3] F. W. Harmer, "Pliocene Deposits of Holland": Q.J.G.S., 1896, lii, p. 754.

[4] Abel Blytt, "Theorie d. wechselnden Klimate": Engler's *Botanische Jahrb.*, 1881, ii, p. 49.

[5] James Geikie, *Prehistoric Europe*, 1881, p. 520.

that most of the American species occupy the Atlantic coast region in the British Islands. Almost all the southern or Lusitanian species are found in precisely the same area in England, Ireland, and Scotland. This seems to me partly due to the fact that the temperature was considerably higher there during the Glacial period than in the more inland localities. Even now the plants are under more favourable climatic conditions on the west coast than further inland, and less exposed there to competition with the stronger eastern rivals. Moreover, almost the whole of Ireland and a large portion of England are thickly swathed in a mantle of Glacial clay. We can only suppose that the forces which controlled the deposition of this clay were less effective on the west coast, which may have extended far to the west of its present boundary, and have thus given rise to the preservation of many species of animals and plants which were destroyed elsewhere.

REVIEWS.

I.—Geological Survey of Great Britain.

1. The Geology of the Seaboard of Mid Argyll, including the Islands of Luing, Scarba, the Garvellachs, and the Lesser Isles, together with the northern part of Jura and a small portion of Mull. By Dr. B. N. Peach, F.R.S., H. Kynaston, and H. B. Muff [Maufe]; with contributions from S. B. Wilkinson, J. S. Grant Wilson, J. B. Hill, A. Harker, F.R.S., E. B. Bailey, and petrological notes by Dr. J. S. Flett. 8vo; pp. vii, 121, with 7 text-illustrations and 8 plates. Glasgow, 1909. Price 2*s.* 3*d.*

We cannot refrain from a feeling of sympathy with librarians, who give cross-references in their catalogues, at the lengthy title and array of authors and contributors imprinted in this memoir. The field-work, however, has been carried out by many hands in a very diversified region, comprising a number of islands and parts of islands, together with the western seaboard of Argyllshire, from Easdale and Kilmelfort on the north, to the plateau beyond the Crinan Canal on the south.

Nearly the whole of the area described is made up of various metamorphic rocks, including the Craignish and Ardrishaig Phyllites, the Easdale Slate and Limestone Group, and the Quartzite Group, together with epidiorites. No less than fifty-two pages are given to the description of these rocks, and of the folding, metamorphism, the crush-conglomerates, and thrust-planes; while the subject is illustrated by remarkable photographs of pseudo-conglomerate and strain-slip cleavage, of folds, boulder-beds, and phacoids of epidiorite.

Rocks of Lower Old Red Sandstone age occur on the mainland north of Loch Melfort, and in the islands of Seil and Lunga; and they consist mostly of andesitic lava-flows, with here and there some shales, grits, and conglomerates, as well as tuffs and agglomerates. There occur also masses of diorite and granite, together with dykes and sills of other intrusive rocks, and these, with the effects of contact metamorphism, are duly described.