Chapter 38 Various mineral industries and resources

Silica-rocks

Quartzites from both the horizons in the Mona Complex are used in processes where a pure or nearly pure quartz is, required.

Porcelain-quartz — The Gwna quartzites have been quarried at Graig Wen, Gynfor; Pen-y-parc, Beaumaris; and Bethel, Bodorgan, for the silica required in the making of porcelain, as they are unusually pure and clean. The two first localities are not now used, but that of Bethel, which is near a railway, has been actively worked for several years, and the high boss cut entirely away, so that further work will have to be below the level of the road. The rock is not ground on the spot, but sent away in blocks to the potteries of Staffordshire.

Silica-brick — The Graig Wen rock has been used for making silica-brick, and also in its native state for flooring furnaces, but was not being utilised in either condition in 1910. Silica-brick is now being made on a considerable scale from the Holyhead quartzite, and a factory established in one of the old Breakwater quarries, from which the produce is taken along a short railway to vessels at the Breakwater. The brick is used for lining Siemens-Martin iron furnaces. The same material, ground, but not made into bricks, is used for lining Bessemer furnaces. The purest parts of the quartzite are found to be the best. But *very* pure quartzite is said not to be so good, so that the small proportion of felspar and white mica in the Holyhead quartzite is an advantage. The products are used also for copper-smelting furnaces.<ref>A detailed account of the technology of these industries will be found in Vol. vi (pp. 116–17) of the 'Special Reports on the Mineral Resources of Great Britain' which are being issued by the Geological Survey.</ref>

For the siliceous rocks of Parys Mountain see pp. 828–9.

Limestone for burning

Not the Carboniferous Limestone only, but also some of those of the Mona Complex, have been burnt for lime in times past; and there are a considerable number of old kilns. Not one of these is known to be still in use. Most of the lime now used in Anglesey is brought thither, 40 miles or more, by railway, a deplorable case of neglect of local resources. Probably the inability of the local kilns to resist the competition has been due to selection of unsuitable material. Most of the limestones of the Mona Complex are magnesian, and often full of silicates as well; while some clean-looking beds even in the Carboniferous contain a good many grains of quartz. But in such a country as Anglesey there is no need to select any but good clean types of rock, as will be evident from the analyses given on p. 605. The particular exposures from which the analysed rocks came are upon the sea-shore, in inconvenient places; the bed from which the cleanest was taken, moreover, being only a yard or two thick, and very limited in extent. But abundance of excellent clean rock, especially of the massive light grey type, may be found inland; and there is no reason whatever why lime should not be burnt again in the Island for local use<ref>A modern kiln has been built at Red Wharf Station since this was written.</ref>. Indeed, the purer of the calcite-limestones of the Mona Complex would be almost as good as the Carboniferous. But before selecting any bed, samples of it from all over the space intended to supply the kiln should be powdered, the carbonates removed by solution in hydrochloric acid, and the insoluble residues weighed, and then examined by a petrologist, to ascertain both their nature and proportion. The hydrochloric acid solution should also be examined chemically for magnesium and for iron.

Brickworks

Bricks have been but little used in Anglesey, and few signs of old pits are to be seen. They are now being made at Cemaes, Llwydiarth-fawr, and Porth Wen; and were, a few years ago, at Traeth Dulas.

The last named appear to have been made partly from the alluvium, partly from the red boulder-clay. The works at Cemaes use a boulder-clay, after elimination of the larger stones. Those of Llwydiarth-fawrarein a stiff blue boulder-clay,

most of whose stones are of black Ordovician shale. The harder stones are picked out, and the clay and shale ground-up together and burnt. This is for the common brick. There are parts of the clay that are nearly stoneless, and these are used for making tiles and pipes. It will be noted that the shale-boulders, when ground-up, unite satisfactorily with the clay, in virtue of being themselves old clay-stone, somewhat hardened. The upper boulder-clay of the east, being poor in stones, would be the best for this purpose, but then there is good building stone (pp. 852–3) in most of the eastern districts.

The material used at Porth Wen Bay is not a distinct accumulation of any kind, but is the decomposed rock alluded to on pp. 311, 472, 702, still *in situ* and retaining all its structures. The decay has affected both the pebbly grits of the Ordovician and the Gwna schists of the Mona Complex. Both series have been worked, but when visited in 1910 only the Gwna phyllites were being used. The decay is excessive. Even their little quartzites have yielded along the joints, their felspathic grits are filled with kaolin (not crystalline kaolinite), and the argillaceous phyllite, which is here the principal material, has crumbled to a mere clay, which when freshly dug out smells of sulphides, as if pyritous. Being really an old mudstone, it has returned, as a result of the decomposition, to something like its original state of clay, and as such, is baked for the bricks<ref>A detailed account of the technology of this industry will be found in the Report cited on p. 849.</ref>. Mr. W. B. Hartley, manager of the United Silica Company (who have now taken over these works), has kindly furnished the following partial analysis of a 'blue clay' obtained from near the foot of the cliffs a little way to the south of the train-incline, and therefore evidently from the Gwna Beds:

SiO_2	75.73
Al_2O_3	17.84
Na_2O	2.56

It shrinks 4 per cent. at 1330° C, softens at 1450° C, and melts at 1590° C.

This analysis should be compared with those on p. 70 (though iron and combined water have not been estimated in this case), from which it will be seen that SiO_2 is unexpectedly high for a variety containing 17.84 per cent. of Al_2O_3. The decomposition appears to have robbed the rock of about half of its alkalies:

About 20 years ago bricks were made at Porth Swtan, Llanrhyddlad, and from the descriptions now given on the spot, the material here also was not the boulder-clay but the Gwna schists, which are decomposed to a still greater depth than at yorth Wen. They contain, however, much grit, which may have been the reason why the work was abandoned.

The marls of the Red Measures would make excellent bricks, but whether they rise to a sufficient height above sea-level to be convenient of access is uncertain.

Building stone

The Mona Complex — As this formation occupies nearly two-thirds of the Island surface, most of its more durable members have been, and must continue to be, widely used for local building purposes, but care and thought, both in selection and in treatment, are necessary in order to obtain really good results from them. The irregular surfaced and splintery edges of the corrugated schists render them quite undressable, and their interspaces have to be liberally filled in with cement. Walls of this kind are usually faced with rough-cast', which is often not as successful in excluding damp as it is commonly supposed to be, and adds greatly to the monotonous and dismal aspect of the tall, narrow-doored, and eaveless houses that have defaced many charming sites in the last 20 years. Far better material, however, could often be obtained from the Complex by going a short distance for its more massive or more evenly-foliated members, such as the Skerries Grits, the Church Bay Tuffs, the Coeden beds, or the thicker grits of the Llwyn, Soldier's Point, or Amlwch Beds. Some of such have, in fact, been used in this way for several of the railway stations on the main line. These would lie evenly, need comparatively little cement, and would probably be drier (certainly more comely) ' without rough-cast than with it. Excellent houses are built of similar materials in Scotland without any rough-cast, and that in extremely rainy climates. Those characters of the schists, however, that are bad for house-building, make them. particularly suitable for the numerous 'dry-stone' walls that separate the fields, as their surfaces tend to interlock and bind in a rough way; and there is a local art of setting them on edge, filling in with turf, and planting hawthorn on the top, that makes a very solid

fence indeed.

For massive works on a great scale which are of the nature of engineering rather than building in the ordinary sense, the more evenly-splitting rocks of the Mona Complex are quite suitable, and have been used with success. The great Breakwater at Holyhead, more than a mile and a half long, 60 feet wide, and 40 feet above Ordnance Datum, completed in 1873, was 26 years in building. It stands upon a submarine mole of massive quartzite rubble, and the visible structure is made of heavy blocks of the quartzite, with their foliation set vertically, the upper parts being faced with Carboniferous Limestone from Red Wharf. The same quartzite is now (June, 1912) being used for its repair<ref>For an account of the ravages of the sea upon the Breakwater, see p. 809.</ref>. The sea-walls of Salt Island are also made of it. Such quantities of the quartzite were taken for these works that the 'Breakwater Quarries' are a conspicuous feature for many miles around.

The Ordovician rocks — The finer sandstones of this system, in the districts least affected by cleavage (p. 549), particularly those of the Llanerchymedd country, are quite suitable. Some of them, it is true, are rather hard, but they are tolerably free to break across the bedding, and local masons, when accustomed to their characters, would soon acquire skill in shaping them. Cases are already known where, for sites upon the Mona Complex, when not too far from an Ordovician boundary, rural builders have, wisely, resorted to these rocks rather than use an intractable schist which occurred at the site itself.

The Carboniferous rocks — By far the best ordinary building-stone in the Island is, as might be expected, in the Carboniferous system. The Limestone itself has been extensively used all over the Carboniferous areas, especially its massive grey varieties. It has also been quarried on a larger scale for exportation. The quarries of Traeth Bychan have been almost abandoned, but large quantities of limestone are now being shipped from Penmon, and the Edwen oolite is also, on a smaller scale, exported. The Mersey Dock and Harbour Board have lately quarried extensively (to the detriment of the beautifully weathered natural section shown in (Plate 26) B, the photograph for which was fortunately taken long before the quarrying began) at Careg-onen, for their works at Liverpool. The heavy blocks for the two Menai Bridges came from Castell-mawr (Plate 40) and other quarries on Red Wharf Bay; and the great mediaeval castles of Beaumaris and Carnarvon were built in great part of the rock of Penmon.

The sandstones of the Carboniferous have not been used in proportion to their merit. When not too pebbly they can easily be dressed and shaped, they are durable without being refractory, and would probably give the best results of any building-stones in the Island. They are of course more porous than the limestones, but it has been pointed out by Buckley ['Building Stones of Wisconsin', pp. 20, 68, 372] that the absorption of water by a stone is by no means in proportion to the size of its pores, and that water, once in, is much more difficult to expel from a compact than from an open-textured rock. The sandstones would need no rough-cast, might even be rendered damper by it; and they weather to a warm and pleasant colour.

Slate

This was quarried many years ago in the black Ordovician shales at Llaneilian, where the cleavage is more strong and even than usual, but the quarries have long been abandoned. The truth is that the cleavage in the Ordovician and Silurian shales of Anglesey is not intense enough to produce a slate that can compete with those of Carnarvonshire, even were they at a much greater distance than they are. But for rough sheds and other farm outbuildings a local slate might be used with advantage, and ought to be employed in districts remote from railways.

Sites for houses

The geological conditions will hardly be the same in any two cases; but the nature of the rocks, the nature and depth of the glacial deposits, and the sub-soil drainage, are perhaps the most important. Sub-soil may be quite different from surface drainage, may be in a different or even an opposite direction. On the Carboniferous rocks it is usually very free, on Ordovician shales it will generally be sluggish, and on the Mona Complex may be expected to be somewhere between these extremes. On the two former it may be looked for in the direction of bedding-dip; on the Mona Complex for the most part in that of the dip of foliation, but often in that of the pitch of the minor folding. Boulder-clay will render it very

sluggish. Where, therefore, as may be the case on many sites, there are only a few feet of that deposit, freer sub-soil drainage, as well as firmer foundations, may very likely be obtained by clearing it altogether, and founding direct upon the underlying rock. Care should be taken to ascertain whether the sub-glacial surface is very irregular, for if so, the depth of the boulder-clay, and with it the nature of the foundations and of the sub-soil drainage, may vary very much in the space of a few yards. A vital question for isolated houses is that of local water-supply, for which Chapter 39 should be consulted. In such a country as Anglesey, many sites must be close to formation-boundaries, where the difference of a few yards will give totally different conditions. A curious case, that came under the present writer's notice, will illustrate how much trouble and expense may be avoided by attention to this point. The approach-drive to a new house had just been made, and the owner was complaining of the excessive obduracy of the rock, which he had been obliged to blast for every yard of the way. Reference to the six-inch map revealed that he had taken his drive just along the outcrop of a dolerite dyke, with whose direction and width, it coincided precisely! Along a parallel course, four or five yards to the north-east, for which there was plenty of room, the work would have been inexpensive and easy.

Road-stones

Macadam

Almost all the nicks of the Island are used, locally at any rate, as road metal. Many of them are very poor in quality, but no doubt, for country cross-roads along which there is but little traffic, it is wise to employ a local rock that is easy of access. Nevertheless, in Anglesey, whose geology varies so rapidly that no formation holds the field exclusively for any great distance, better material might often be found quite near at hand. It is hoped that the following remarks upon the rock-types, combined with a use of the geological map, may enable this to be done<ref>Those interested in the matter should also consult the article upon road-stones in the 'Summary of Progress of the Geological Survey' for 1905, pp. 79–88 (with three plates).</ref>. Where there are so many types any classification as to quality must be rough and general, but the possible roadstones of the Island may be arranged in four main classes, Group 1 being, for general purposes, of the lowest order, and Group 4 the best. It must be borne in mind that mere hardness is not the only desirable quality in a road-stone.

1.	2.	3.	4.
Boulders	Carboniferous sandstones and limestones	Glaucophane-schist	Palaeozoic Dolerites
Gravel		Hornblende-schist	Picrites
Shale		Schistose Grits	Gabbro
		Gneiss	Dioritic Gneiss
		Schistose Hornfels	Felsites
		Mica-schist	Quartzites
		Chlorite-schist	Granites
		Holyhead Quartzite	Parys Rocks
		Later Dolerites	Bodafon Quartzite
			Ordovician Grits

***Group* 1** — The smaller boulders gathered from the fields are used a good deal for the roughest roads. They are subangular to begin with, and will not bind, while their composition is so various that it is impossible to discuss their quality. The same considerations apply to the glacial gravels, the stones in which are still more rounded. The Ordovician shales are far too soft for public roads, but can be used for private ones where the traffic is both rare and light. The glacial gravel of Ty'n-y-caeau, which is full of shale (pp. 43f, 757) has been used a good deal for carriage drives, where it has the advantage of working quickly to a smooth surface.

***Group* 2** — The Carboniferous Sandstones tend to crumble when broken small. The Carboniferous Limestone must, doubtless, be used for the lighter roads in the heart of the limestone districts, but no limestone can be a good road-metal; its dominant mineral, calcite, being far too soft. The compact varieties will be found to be the least troublesome. It will probably be worth while, for the main roads through the limestone areas, to bring members of Groups 3 and 4 from

places near their margins.

***Group* 3** — The later dolerite dykes would be good roadstones, but the cores only of their spheroids remain undecoin posed, and these are very refractory bodies to break up. The rest of the rocks placed in this group are schistose members of the Mona Complex. Most of them are durable enough, and the schistose grits and hornfels very hard, but they are very variable, seams of softer matter constantly coining in. All, moreover, have different and indeed opposite characters according to the direction of fracture, owing to the parallel arrangement of their minerals. Their foliation-planes, upon which fragments tend to lie, are smooth and slippery, but to compensate in part for this defect, the ends and edges of the fragments are very splintery, tending to interlock and hold together, especially if settling gradually, and not crushed in at once by a steam roller. Best of these rocks, probably, are the glaucophane and other hornblende schists. Being almost free from the micas, their foliation-planes are not so smooth, and they are very tough, especially the glaucophane-schist, with which five or six miles of the Holyhead main road have been metalled. The gneisses are the least schistose, some being almost granitoid. The Holyhead quartzite, being very hard, is almost on the borders of Group 4, but its foliation, though slight, is enough to give the fragments a platy form.

***Group* 4** — The harder sandstones of the Ordovician, in which there has been a little secondary change, will probably prove to be tolerably durable, and are uniform in fracture. Such are the Berw grits, the grit of Foel Hill, Llanerchymedd, and most of the less pebbly parts of the great sheet of basal conglomerate that ranges from Llyn Maelog to Presaddfed. The Coedana granites have. been made much use of, locally, with fair results, but only the fine varieties, like that of Pen-sieri, can compare with Scottish granites, and they are not extensive. As a whole they are perhaps rather too coarse for a good road-stone; but their real drawback is their peculiar susceptibility to the late mylonising movements of the Mona Complex which have set up numerous planes of crushing and sliding, along which they break with a smooth surface. The Gwna quartzites would be good road-stones, but their purer portions are too valuable (p. 849). Foliated. though they are, the dioritic gneisses are placed here because their toughness may compensate for their foliated structure, which is, after all, not strong enough to make them really schistose'. At Four-mile Bridge one of the gabbros is being used. These rocks are extremely tough, and seldom very coarse. Some of those upon Holy Isle might also be used with advantage, if the finer, and especially the undeformed varieties were carefully selected. The hornblende-picrites are extremely tough, but are also coarse, and therefore difficult to reduce to the necessary size. The silicified rocks of Parys Mountain are probably the hardest in the Island: they are extremely fine in grain, and must have a high power of resistance to attrition, though their disseminated pyrite might cause them to succumb, after a long time, to atmospheric agencies by oxidation. But mere hardness, as remarked above, is not the one and only desirable quality of a road-stone. Being smooth upon the fracture, they do not work in well; and when the lumps begin to stand out from the washing of the rain, their merciless hardness gives rise to an almost painful surface. In a less degree, the fine Bodafon quartzite has the same sort of character, owing to the thermo-metamorphism of the Coedana granite. The various felsitic dykes would make some of the best road-stones in Anglesey. Rocks of the kind have a high power of resistance to attrition, without being quite so intractable as the Parys Mountain rocks, and they are free from pyrite. Those of the central area are easy of access, and could be made use of with advantage upon the Holyhead main road. Those of the north might be even better, but are somewhat remote from the frequented roads, and their associated dolerites may be more suitable for the light rural traffic of that district.

Characters of the Palaeozoic dolerite dykes — When all points are considered, the most generally serviceable road-stones of the Island are probably the dolerites of the Paleozoic dykes (Chapters 16 and 17). Those of the Palaeozoic sills are rather coarser, and usually not quite so fresh, and are, moreover, rather rare except in the remoter districts of the north. The dykes are widely distributed, and are numerous, very numerous in certain districts. Their good qualities have, indeed, been_ long ago perceived, and, under the name_ of iron-stones ' (from their toughness apparently, rather than from their ferro-magnesian silicates), they have been worked for road-metal in many places. One of their deep, long, narrow quarries is a curious feature of the view from the Suspension Bridge. Though not so hard as the felsites, they have a much rougher surface upon fracture, and will therefore bind more firmly.

It must be borne in mind that there is much difference, not only between different dykes, but between different parts of the same dyke. For a discussion of these variations, both general and local, Chapters 16 and 17 must be consulted; but it may be briefly pointed out here that the wider a dyke is the coarser it is, and that every dyke becomes finer from the centre to the sides. Having been affected by shearing stresses, they have acquired a schistose or fissile structure in

places, and these places must be avoided. Wide zones of schistosity are, however, uncommon, and the narrow schistose seams (which can generally be found if looked for) have acted in the way of relief to strain, and enabled the intervening portions to remain undeformed; being thus an advantage rather than otherwise. It is, indeed, to these very stresses that the best qualities of the rock are due, for they have induced mineral changes that have added to its toughness. The original ophitic, that is interlocking, relations of the felspar and augite have not often been destroyed, so that the rocks retain. the strength which such a structure naturally gives. Further, although the original felspar, labradorite, is rather liable to be attacked by the weather, it is often cased in thin shells of oligoclase, a more stable variety, while both of them are almost always partially, and sometimes wholly, replaced by albite, perhaps the least unstable of all the felspars. But the felspars have been to a considerable extent replaced internally by minute flakes of white mica; the augites by fibrous pale green hornblende, both of which are far less brittle, more elastic, than the minerals which they replace. Chlorite, a source of weakness, is always present; but so it is in some of the most famous road-stones. Moreover, in the present cases, much of the. fibrous hornblende has developed within the chlorite, substituting for a feeble mineral one of the toughest that could be desired. Rocks that have undergone these changes have been found to withstand attrition tests remarkably well, those that also contain a little quartz being_ the most durable of all, according to the experiments. Quartz is frequently present in these rocks, some of which, accordingly, may be expected to rank with the very best road stones; while the quartzless varieties cannot be far behind them.

Hitherto these dykes have been worked only in conspicuous and accessible road-side exposures, a good many of which are now exhausted (horizontally, that is, for it is not convenient to carry the work below the level of the roadways). Numerous other exposures, however, can be found along the courses of the dykes as laid down on the map<ref>On the six-inch maps, the actual exposures are indicated.</ref>. There is no reason why these excellent local road-stones should he neglected in favour of material brought by railway from a distance.

Railway-ballast

Its own special conditions may sometimes make it easier for a railway to bring ballast from a distance, than to obtain it on the spot. Attention may nevertheless be drawn to some local sources that are immediately adjacent to the railways. Hardness, in this case, being no special advantage, the most advantageous character being a rough and hackly fracture that will bind well and . give stability to the track, several rocks are admissible that would be excluded from road-metal. On the other hand, foliated members of the Mona Complex, however hard, would be slippery and undesirable. Along the main line, the Millstone Grit could be obtained at Bodorgan, the Coedana granite and Ordovician grits about Rhos-neigr, and unfoliated gabbros near Treflesg. On the Amlwch Branch, Ordovician grits are almost touched by the railway at Berw-uchaf, a considerable tract of the Coedana granite is traversed by it near Tryfil, and Ordovician grits are again close at hand as it passes Mynydd-mwyn-mawr. We may express a most earnest hope, however, that the great boulders of hornblende-picrite near that spot ((Plate 45) and pp. 709, 738), which are natural monuments of supreme interest, would be left untouched. On the Red Wharf Branch, limestone can be obtained in unlimited quantity about Llanbedr-goch and Red Wharf stations, while sandstones (which would give excellent hackly fracture for binding) occur only half a mile away, near Castell.

Asphalt

Since the great increase of motor-traffic, the roads have been asphalted where they- pass through several of the towns and larger villages. Small gritty rubble for roughening the asphalt-surface is therefore needed. Foliated rocks will not effect this if all the fragments lie upon their foliation-planes, but will do so if they are mixed in pell-mell, so that more than half are held up with the edges vertical when the asphalt hardens. But unfoliated or feebly foliated rocks will of course be better, and such can be obtained with convenience for the principal towns and villages as follows: Aberffraw, feebly foliated spilite; Amlwch, spilite, felsite of dykes, or the thicker grit-bands in Amlwch Beds; Beaumaris, dolerite of dykes; Bodedern and Bodffordd, feebly foliated spilite; Bryn-gwran, Ordovician grit; Bryn-siencyn, Carboniferous limestone or dolerite of dykes; Caer-geiliog, dolerite of dykes, or feebly foliated spilite; Cemaes, Gwna limestone or grit; Gaerwen and Holland Arms, dyke-dolerite or dioritic gneiss; Gwalchmai, Coedana granite; Holyhead, dyke-dolerite, or the thicker grits of the Llwyn beds; Llanddeusant, feebly foliated spilite -or Church Bay tuff; Llanerchymedd, Ordovician grit; Llanfachraeth, feebly foliated spilite, or the thicker grits in the New Harbour Beds; Llanfair-p.-g., the dyke-dolerite of

Bryn-gof, or the zoisite-albite-amphibolite; Llanfechell, the Skerries grits, or the dolerite and felsite dykes; Llangefni, the Gwna quartzite of the Old Windmill, or the adjacent Pencraig sandstone of the Carboniferous; Llangoed, the Ordovician sandstone of Bryn-celyn, or the Carboniferous limestone; Menai Bridge, dyke-dolerite; Newborough, spilite on Bodorgan road near edge of alluvium; Pentraeth and Benllech, Carboniferous limestone and sandstone, or deformed spilites; Rhosncigr, Ordovician grits; Valley and Four Mile Bridge, gabbro.

Paving-flags, curbs, and setts.

Paving-flags — The Mona Complex abounds in flaggy rocks, but their smooth foliation-planes make them slippery. The sandstones of the Carboniferous are rarely flaggy. The best natural flags in the Island are the more thin-bedded,sandstones of the Ordovician, some of which, to the south-west of Llanerchy-medd, could be used locally with advantage. But the traffic in most of the little towns is really so quiet, even now, that a side-walk is hardly needed. Local bricks, or well-gritted asphalt, would suffice in most cases.

Setts are hardly needed in the Island itself, and although there are a good many rocks of which they could be made for export, it is unlikely that any of these could compete with the setts-quarries of Carnarvonshire.

Curb-stones for the quiet local traffic might be made of almost any flaggy rock, cut across the bedding or foliation, and set vertically. There is one rock, however, whose possibilities for export may be worth considering. The curb-stones in our large towns are usually of granites or some kindred plutonic rocks. Under the incessant pedestrian traffic they polish, as many have found to their cost, slippery curbs and crossings having even resulted in loss of life under the rapid motor traffic of the present time. Now, a foliated rock, when cut at right angles to the foliation, polishes far less easily. But then, if set with the foliation-planes vertical, such rocks usually also split easily. The foliated parts of the Holyhead quartzite, however, set in a vertical attitude, have proved, in the Breakwater, to be extremely strong, the granoblastic texture being so firmly knit. It could be cut with ease parallel to the foliation. Might not slabs of it set vertically as curb-stones be almost as durable as a granite, and yet afford, on their cross-cut, an unpolished and reliable foot-hold?

Minor industries and resources

Sand

Sand for building purposes has been taken from the sea-shore, but the salts (unless very carefully washed out) deliquesce and give rise to serious internal damp in buildings. The sands from the Glacial gravels are free from this, and their stones can be sifted out with ease by screens at the gravel-pits, leaving the gravel available for other purposes. Salt-free sand could also, probably, be obtained from the inland margins of the great dune-tracts which occur along the western sea-board. The dolerites of the Later Dykes, where excessively decomposed, have occasionally been dug and used as a sand'.

Peat

Considerable growths of this are found in the alluvia, both freshwater and estuarine. Some details of the larger ones are given on pp. 769–71, but for the smaller ones, reference must be made to the six-inch maps. Some 16 products, ranging from brown paper to paraffins, have lately been prepared from peats<ref>H. M. Cadell, *Proc. Edin. Geol. Soc.,* October 10, 1918.</ref>. But severe loss has been incurred by bad methods of expelling the water (which amounts to 80 or 90 per cent.), and by selection of unsuitable varieties of peat. Mr. Cadell aptly remarks that 'an evil spirit like the Will-o'-the-wisp seemed to haunt the bogs, and lure on the adventurer till he was finally swallowed-up'! The Anglesey mosses might with advantage be cut for burning more than they are, especially where remote from a railway; and the ash, which is phosphatic (p. 771), should be used for a manure. Wattled huts and other works of pre-historic man are sometimes found in peat-mosses. Any such discovery should be communicated at once to the Secretary of the Anglesey Archaeological Society, so that the remains may be taken out with scientific skill, and duly preserved.

Marl

A Chara-marl has been found (p. 771) in Cors Bodeilio. A small marsh not far off is called 'Cors-y-farl' on the six-inch maps, which seems to imply that marl was once cut therein, and it is stated by Rowlands<ref>'Idea Agriculturæ', p. 23, cited by Lady Boston in 'Anglesey Industries', p. 11.</ref> that an excellent 'white tophaceous marl' was found in various places about Llanddyfnan. Very likely it might be obtained from other alluvia; particularly those upon the Carboniferous Limestone. A singular deposit, which is described as a clean white paste resembling lard, has lately, I am informed by Mr. O. J. Lloyd, been found at Red Wharf, about 180 yards north-north-west of the Hotel. An analysis by Mr. L. C. Scott, of Llangefni County School, showed it to be nearly pure CaCO3, with no more than traces of Al_2O_3. The position is not in a closed alluvial basin, but merely in a gap of the hills, and the true nature of the deposit has not yet been ascertained.

Millstones and rollers

The Carboniferous sandstones have been much used for making millstones, especially at the large quarries of Ynys, Llyn Cadarn. The industry has declined, owing to the decrease in the number of mills at work. Should the windmills come into use again (as they will, when better methods of storing electrical energy are devised), the millstones will be made locally as before. Heavy farm-rollers made of the massive grey limestones of the Carboniferous are still in general use, but the production of them seems to be falling off. Suitable beds for making them occur quite near to the stations on the Red Wharf branch railway, so that there is no need whatever to allow them to be displaced by iron ones imported from long distances away.

Ochre and umber

The ochre produced at Parys Mountain has been described on pp. 842–3. 'Umber' seems also to have been made from the decayed parts of the more ferruginous of the Gwna limestones. The Later Dykes, too, decompose to an ochreous earth. Possibly the loam found' as a solution-residue in fissures of the Carboniferous Limestone might furnish a similar colour.

Asbestos

This has been obtained in small quantity from the serpentines of Llanfechell and Mynachdy. Lhuyd, in 1684, describes a sort of paper made of it; and it is said that an incombustible pocket-handkerchier was woven from it and sent as a present to King George the Third. Little specimens can still be obtained at Mynachdy, and these have the optical characters of chrysotile; but thin veins in the other serpentines have proved to be tremolite, as has that which, was obtained at Bodrwyn.

Rocks suitable for decoration

The only rocks which appear to be made use of in this way at present are some of the mottled and coralline limestones of the Carboniferous, which can be had in large slabs, and are suitable for mantelpieces, washhand-stands, and other pieces of furniture. They take a low polish, and are variegated and interesting.

Nearly all the rest of the, rocks that could be used for decoration are older than the final catamorphic (*i.e.* destructive) movements of the Mona Complex (p. 201), and are therefore apt to be traversed by numerous planes of sliding, which impose limits upon the size of the blocks that can be taken out. Those of the most intrinsic beauty are the ophicalcites, the marbles of the Pentnynydd Zone, and the limestones and jaspers of the Gwna Beds.

The ophicalcite of Rhoscolyn is a really beautiful rock, a green and white marble, composed of serpentinous fragments and folia bound together by a matrix of fine snow-white sparkling calcite. Slabs of sufficient size for structures of modest ambitions could be obtained with ease. It was quarried many years ago, and was used again in 1897 for the Stanley monument in the old church of Holyhead. The allied rocks of the north (see Chapters 4, 10), though less brilliant, have reddish tints, and there are some of intermediate types in the Rhoscolyn district itself. Another rock of great beauty is the Bodwrog marble. Parts of it are snow-white, with glistening flakes of mica, while other parts have green and purplish tints. The ashy limestones of the Gwna group, full of red fragments, would be striking rocks if cut and polished; and in the rhodocrosite-limestones (p. 83) the matrix has itself a delicate rose colour. The jaspers would polish to a fine strong

scarlet. It is true that they occur in masses that are seldom as much as a foot in diameter, and that they are very hard. But richly inlaid work in stone can only be applied to structures of moderate size, in which little insets of bright colour afford very effective contrasts, and for this purpose they would be well adapted. None of these rocks, however, should be employed for any but internal decoration. Their present neglect, moreover, need not be matter of regret, for the supply is but limited, and the use now being made of. many splendid rocks in our large towns is anything but encouraging.

The ophicalcites, the Bodwrog marble, the Gwna limestones and the jaspers are the only ones at all likely to be used outside the limits of the Island. But if — or rather, be it said, when — a living (not merely imitative) architecture once more develops in Europe, it will be pretty sure to give rise to provincial varieties differing according to the needs and resources of different districts. Schools of this kind would be quite well able to make effective use of local rocks such as the serpentines, or even of. somewhat intractable materials like the hornblende-picrites, or the granites, diorites and epidotic rocks of the Mona Complex. Nor would they fail to do likewise with much less pretentious materials. We speak of 'decorative' stones, but in the eyes of a true craftsman, every stone with which he can build at all is a decorative stone. If men can evoke no beauty from a sandstone, it is worse than useless to put marble in their hands, for they will make ugliness even of that. The living local schools for which we hope, however, will understand the admirable aphorism that sound method is not 'constructed decoration' but decorated construction', and will understand how to employ, according to the geology of the several parts of the Island, the quiet browns and greys of the Carboniferous and Ordovician rocks, or the subtle greens of the Mona Complex. Natural growths of Anglesey itself, their works will partake of the charm of its marvellous variety.

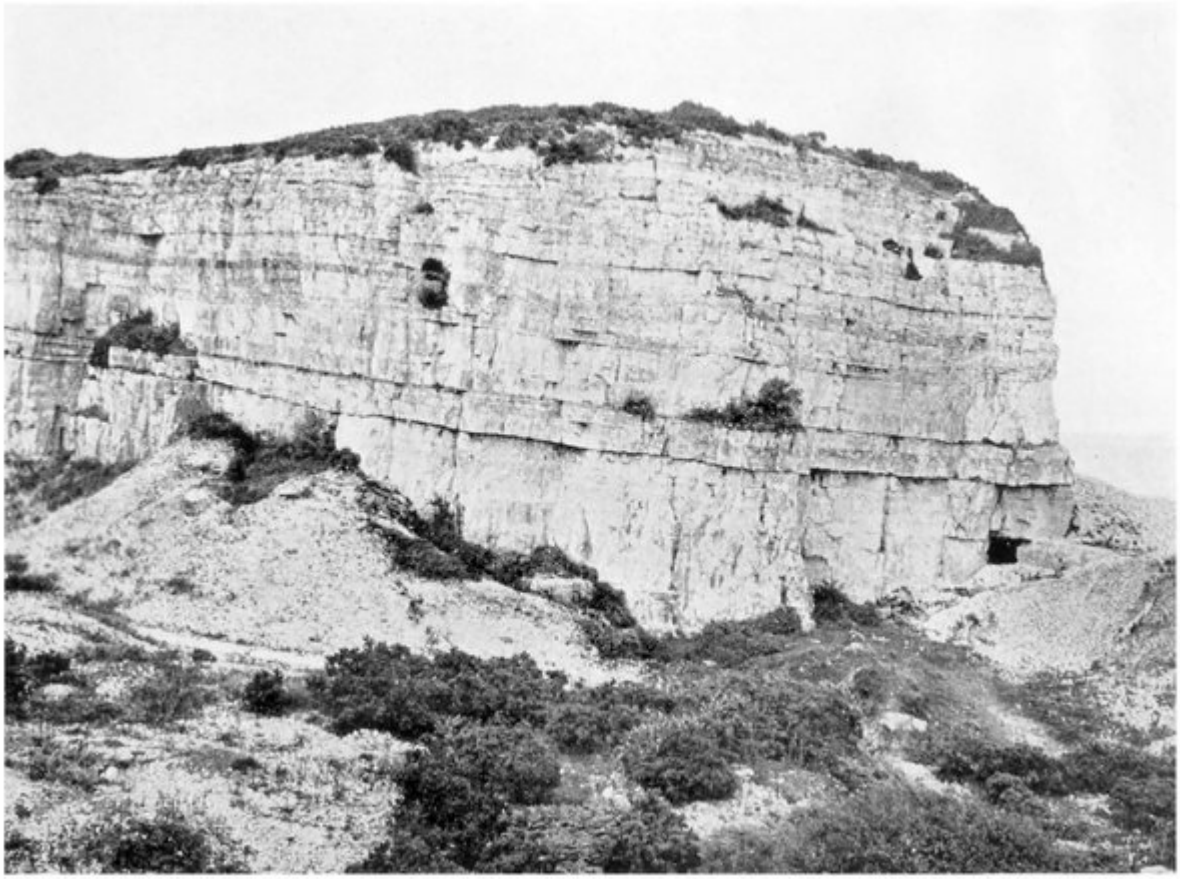
Churchyard and cemetery monuments — These have of late become very numerous, and are multiplying faster than ever. It does not seem to be generally known that the practice of erecting out-of-door sepulchral monuments is essentially a modern one. In mediaeval Britain, monuments were built over the tombs of persons of note, but they were inside the churches. In our churchyards, ancient though they are, inscriptions even of the eighteenth centuryareby no means common, those of the seventeenth are extremely rare,: and I do not remember to have seen a single one of the sixteenth or earlier centuries. Where the forefathers of the hamlet were content with the 'violet of their native land', their posterity demand half-a-ton of stone<ref>Precisely the same change, we are told by Cicero (De Leg. II. 25–7) took place in the course of the social development of ancient Europe.</ref>, often brought, moreover, from four or five hundred, or even a thousand miles away. Now Carrara marble, it may be freely admitted, is, in itself, a very beautiful substance; and in suitable positions, such as in the neighbourhood of the marble-inlaid churches of Italy, it might be pleasing enough. But nothing can well be more painfully discordant than to see a grey church of the north, venerable with the storm-scars of some six or seven centuries, thronged-round by a score of machine-cut, staring-white crosses that sting sharply on the eye from half a mile away. Polished granite or smooth-cut Carnarvonshire slate, though inconspicuous at a distance, are little better close at hand, for their mechanical and prim precision is no less out of keeping.

Yet, all the while, the right materials have been close at hand, or at the most, but a mile or two away. For the Island contains abundance of rocks which, however unpretentious, are at once tractable and delicate of tint. Best of all are the sandstones of the Carboniferous (where tolerably free from white pebbles), and next to them the softer parts of the Ordovician grits. The massive grey beds in the Carboniferous Limestone would also be good, and so would the simpler grey limestones of the Mona Complex. Even when freshly cut, these would not be staring, and a few years of the weather and the lichens would tone them into harmony with their quiet surroundings. Moreover, for the reasons given on p. 811, they should be cut by local masons. Is it feared lest such work might be somewhat rude? Then: so is that on the ancient church itself, wrought by the local mason of centuries ago. By the side of the little churches of Anglesey, too, the monuments should be on as small a scale as contemporary sentiment will tolerate<ref>The practice of cremation (see p. 875) would at once arrest the crowding of these little churchyards.</ref>. Perhaps the sentiment of the future will reduce it, once more, to vanishing-point.

The Skerries. From near Carmel Head.

Careg-onen Cliffs.
Mona Complex, Careg-onen Beds, Ordovician Shales, and Carboniferous Limestone.
Height seen = about 330 feet.

(Plate 26) The Skerries. From near Carmel Head. 26a Careg-onen Cliffs. Mona Complex, Careg-onen Beds, Ordovician Shales, and Carboniferous Limestone [Note.—The crags in the foreground are composed of the Careg-onen Beds, ex where to 1¾ to 2 and one eigth inches from right hand edge of view) the sharp anticline of G Green-schist (Figure 194), (Figure 195) rises from under them.].



(Plate 40) Outlier of bedded cherts resting upon Carboniferous Limestone. Castell-mawr, Red Wharf Bay.

(Plate 45) Transported boulder of hornblende-picrite. Near the railway, Mynydd-mwyn-mawr, Llanerchymedd.