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Configuration of the Clyde sea- area

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grandson of Aaron. That it may have been copied from it, is probable, but this in particular is generally ascribed to the thirteenth century. Their old Pentateuch is spoken of by the early Christian Fathers. There are many reasons for supposing that the present scroll is a direct descendant of that brought to them by the Israelite priest. The characters used by the Samaritans closely resemble those on the Moabite Stone and the Assyrian Lion weights. Altogether, the Samaritan customs and records are the most interesting to a biblical scholar that the world possesses at the present day.

I have had the good fortune to be present at the Passover, and to see it celebrated ; and, without any hesitation, I would say it is the most remarkable sight now to be seen on earth—it is the one existing connecting link with the far-away past.

CONFIGURATION OF THE CLYDE SEA-AREA.

Read at Meeting of British Association, 1886.

BY HUGH ROBERT MILL, D.Sc., F.R.S.E., F.C.S.,

Chemist and Physicist to the Scottish Marine Station.

IN a previous paper¹ I was obliged to preface the discussion of temperature and salinity in the deep-water basins of the west coast by a short account of their physical features. The present paper deals more fully with the bathymetrical conditions of the Clyde sea-area, and may be viewed as an extension of the descriptive part of Mr. Cadell's discussion of the configuration of the Dumbartonshire Highlands.²

TOPOGRAPHY.

The general appearance of the Firth of Clyde and its associated lochs is familiar to every one, and the variety and beauty of the scenery it presents are appreciated by all. There is probably no other region in Great Britain so much traversed by visitors bent on business and pleasure, and there is no other which is such a perfect museum of physical geography. On examining a map of this district we see a wide channel running nearly due north between the peninsula of Cantyre and the mainland. The island of Arran lies nearly in the middle of it, and at the upper end it is bounded by the deeply indented peninsula of Cowal. The western corner of the wide channel runs straight up as Loch Fyne, at first to the N.N.W., then curving towards N.E. The eastern corner is prolonged in a N.N.E. direction into Loch Long, and is joined abruptly by the estuary of the Clyde, which runs W. by N. from Bowling. Thus from a purely topographical point of view the water system known generally as

¹ *Scottish Geographical Magazine*, vol. ii. June 1886, p. 347.

² *Ibid.* p. 337.

the Firth of Clyde appears to be only accidentally connected with the river of that name, and is evidently not a true extension of it, as the Firth of Forth is of the stream which gives it origin. In this relation it is specially noteworthy that all the fresh-water lakes, valleys, and channels of the district, as well as those of the west of Cantyre and the depressions between the islands, have a general north and south trend, with the play of a point or two to east or west; while the Clyde river-bed alone runs from west to east. The land traversed by the Clyde from Glasgow to Greenock is flat, contrasting with the elevated character of that to the west and north. Before discussing the bathymetrical conditions I shall describe the commonly accepted geographical divisions.

The *Firth of Clyde* may be said to commence at a line drawn from the Mull of Cantyre through Ailsa Craig to Girvan in Ayrshire, and measured along this line its width is 30 miles. Its eastern boundary swerves to the east, forming a wide sandy bight which includes the bays of Ayr and Irvine. A few miles further north a flat headland appears, extending for a mile from Fairlie Head, and succeeded by a straight coast-line. Here the character of the land changes, the low, gently-sloping shore rising into a series of hills on the boundary between Ayrshire and Renfrew; the highest, Misty Law, attains 1669 feet. At Cloch Point the coast-line turns abruptly towards the east, and, broken only by Gourock Bay and the harbours of Greenock and Port Glasgow, stretches up along the river. The only streams of importance are the Girvan, Doon, Ayr, and Irvine. The western boundary of the Firth of Clyde is at first the southern portion of Cantyre, then the west coast of Arran with its two bays of Lamlash and Brodick, the former converted into a perfect natural harbour by Holy Island. Arran is 21 miles long; the ground rises towards the interior all round and attains its greatest height, 2863 feet, in Goatfell, near the north of the island. From Arran the boundary of the Firth of Clyde is continued across the Sound of Bute by Garroch Head, Kilchattan Bay, and the eastern shore of Bute to Bogany Point. The Cumbraes lie right in the channel, reducing it at the narrowest place to $1\frac{1}{2}$ miles on each side of Little Cumbrae. The boundary crosses to Argyllshire at Toward Point, where the firth is nearly 4 miles wide. The western or northern shore rises into a series of picturesque heights, and on the whole follows the outline of the eastern or southern coast; so that, allowing for the entrances to the Holy Loch, Loch Long, and the Gareloch, the width of the firth varies between 2 and 3 miles until off Port Glasgow, after which it rapidly diminishes.

Kilbrennan Sound, the channel between Arran and Cantyre, is $3\frac{1}{2}$ miles wide at its upper entrance, runs at first S.W., then curves to a southward course, contracting to 3 miles at Carradale, and finally widening out towards the south of Arran, where it merges into the Firth of Clyde.

Bute Sound is a short wide piece of water between the north-east shore of Arran and the south-west of Bute.

Inchmarnoch Water, named from the little island of Inchmarnoch to

the west of Bute, is the meeting-place of the Kyles, Loch Fyne, and the Sounds of Kilbrennan and Bute.

The Kyles of Bute form a narrow tortuous channel, separating the north end of Bute Island from the mainland. A group of small islets at the northerly bend lies across the mouth of Loch Ridun, into the head of which the river Ruel falls.

Loch Fyne bears the same relation to Kilbrennan Sound and the Firth of Clyde that Loch Ridun does to the West and East Kyles. It is the largest of the sea-lochs, being 41 miles in length from Ardlamont Point to the head, and varying in width from 5 miles at Ardlamont Point to $\frac{1}{4}$ at Cuill. Loch Gilp terminates the northern extension of Loch Fyne, which then turns to the north-east. Loch Gair, a mere bay, and Loch Shira, similar in all but size to Loch Gilp, branch off to the north. The largest streams run parallel to Loch Fyne on both sides, and, with the exception of the Aray, the Shira, and the Fyne near its head, only mountain burns flow into this fiord. Loch Fyne is roughly parallel to the upper part of the Firth of Clyde, and all the lochs branching off the latter run towards it.

Loch Strivan, 9 miles long and from 1 to $\frac{1}{2}$ wide, runs N. by W. from opposite Rothesay Bay. A tongue-shaped piece of land—Strone Point—separates it from the Kyles.

The Holy Loch, a bay $2\frac{1}{2}$ miles long, runs N.W., parallel to the Kyles. It is connected by the river Eachaig, 3 miles in length, with Loch Eck, a fresh-water lake running parallel to Loch Strivan and Loch Goil.

Loch Long, separated from the Holy Loch by a tongue-shaped Strone Point, runs N. by W. for 5 miles with a width of $1\frac{1}{2}$ miles to Ardentinnny, then, contracting to from $\frac{2}{3}$ to $\frac{1}{2}$ a mile, continues in a N.N.E. direction $12\frac{1}{2}$ miles farther, where it terminates at Arrochar, 2 miles from Tarbet on Loch Lomond.

Loch Goil.—Four miles above Ardentinnny, the mountain wall on the west side of Loch Long, is broken by the entrance of Loch Goil, which stretches northwards for 7 miles in a gentle double curve.

The *Gareloch* runs for $6\frac{1}{2}$ miles from Helensburgh, N.N.W. and reaches to within a mile of the mouth of Loch Goil.

With the exception of the Gareloch and Holy Loch, all these long narrow inlets are surrounded by lofty mountains, rising to nearly 2000 feet close to the water's edge.

These, the divisions commonly met with on maps, are not by any means truly descriptive of the conformation of the sea-area, which is much simpler than the great number of names employed would lead one to suppose.

CONFIGURATION.

I shall now describe the region with special reference to the accompanying chart, for the construction of which I am indebted to Mr. J. G. Bartholomew. It represents differences of level on the uniform

plan of deeper colours for greater depths. The scales for land and water are different. On land, heights above 2000 feet are represented in light brown, and the spaces between the contour lines of 2000, 1000, 500 feet, and sea-level are printed in deepening shades. The sea-bottom is contoured at 10, 30, 50, and 80 fathoms, and the intervening spaces tinted in progressively darker shades of blue. Loch Lomond is treated as if it were part of the sea, but the other fresh-water lakes are coloured light blue irrespective of their depths. The sea-water under 10 fathoms deep, represented by the palest shade of blue, may be imagined as a thin film of water spilt over the dark brown of low-lying land.

Taking into account the features emphasised by this chart, we may define and divide the district as follows. To divest the mind of any misleading idea as to the region under consideration being a river entrance such as the Firth of Forth, I use the words "Clyde Sea-Area" as a convenient term for the whole connected water-system inside the peninsula of Cantyre, and, if it were not for an accidental 30 feet of land, would extend it to include Loch Lomond and Loch Eck as well.

The *Clyde Sea-Area* may be taken as bounded on the south by a line drawn from the Mull of Cantyre to Corsewell Point in Wigtownshire, almost coinciding with the contour of 50 fathoms. The whole area of water at high tide within this line, including all the channels, bays, and sea-lochs, is 1300 square miles. It is divided according to depth in the following manner:—

Depths exceeding 80 fathoms,	occur over	10 square miles.
„ between 50 and 80 fathoms,	„	100 „
„ „ 30 „ 50 „	„	450 „
„ „ 0 „ 30 „	„	740 „

Clyde Barrier Plateau.—From the southern boundary line indicated above, the water shoals gradually, until at a line joining Sanda Island and Bennan Head in Ayrshire, it is about 25 fathoms deep. The average depth over a plateau of 270 square miles, which terminates near a line joining Davaar Island, off Campbeltown, to Turnberry Point in Ayr, is about 27 fathoms. This Clyde Barrier Plateau forms a wide ridge between the deep water on each side, and in the middle of it, 10 miles from Girvan, the rocky islet of Ailsa Craig, two-thirds of a mile in diameter, rises to a height of 1097 feet above the water, or 1250 feet above the sea-bottom. The 25-fathom contour line bounds a double triangle of shallow water, the apices meeting near Ailsa, and the bases running along the coasts of Cantyre and Ayrshire. Thus there is deeper water to the north and south of Ailsa than to the east and west, and the rock rises close to the narrowest part of the ridge. Two basins and five loch-troughs are clearly marked out inside the plateau, and their outline may be followed on the chart by the 30-fathom contour line.

Arran Basin.—The largest basin, shaped like the letter λ, comprises the channel on both sides of Arran, and extends up Lower Loch Fyne, nearly as far as Otter Ferry. Although this depression has been named

the Arran Basin, it also partly surrounds the Little Cumbrae, runs up the channel past the south of Bute to near Bogany Point, and up the west Kyles to near Blair Ferry. The depth in this basin exceeds 30 fathoms over 340 square miles, of which 100 exceed 50, and 10 exceed 80 fathoms in depth. The trough of deepest water (more than 80 fathoms) extends as a submarine gully, about half a mile wide, for 20 miles in a north-westerly direction through the Sound of Bute, Inchmarnoch Water, and Lower Loch Fyne. It attains its greatest depth (107 fathoms) at a point 1 mile west of Skate Island, near Tarbert. A detached portion of this trough lies in the same straight line, a few miles beyond each end. The contours approach the shore most closely, *i.e.* the slope is steepest, around the north of Arran.

Bute Plateau.—A plateau, with an average depth of about 20 fathoms, passes from the Great Cumbrae across to Toward Point, and through Rothesay Bay, dividing the southern from the northern basins.

Dunoon Basin.—A narrow tract of water, with an average depth of 40 fathoms, runs N. by E. from the north end of Great Cumbrae, close along the Renfrew shore, and continues up lower Loch Long to the Dog Rock, opposite the entrance of Loch Goil, at "Argyll's Bowling-green," a length of 21 miles. Its greatest depth, 56 fathoms, occurs off Dunoon.

Estuary.—The 5-fathom contour line extends no farther east than Greenock; and the Estuary of the Clyde—a name applied to the water extending from a line drawn between Greenock and Helensburgh to Bowling—is extremely shallow, the channel being only kept open for navigation by constant dredging.

The *Gareloch*, above Row Point, where the depth is under 5 fathoms, has an area of about 5 square miles, and an average depth of 20 fathoms in the centre. It is surrounded by low-lying land, the elevation between it and Loch Long being less than 500 feet; on the north-eastern side the land is higher, but the hills are distant. No streams of importance flow into the Gareloch.

Upper Loch Long and *Loch Goil* are of equal area, 4 square miles. Each consists of a deep trough cut off by a narrow ridge from the Dunoon Basin, and descending in Loch Long to a depth of 25 fathoms, in Loch Goil to 47. The sides are precipitous in many places, and present an almost unbroken mass of mountain. The 1000-feet contour comes within half a mile of the water's edge, and hills of over 2000 feet run along both sides of each loch.

Loch Strivan, 5 square miles in area, appears to differ from the other loch basins, in as much as it is a depression on the Bute Plateau, not the barred-off end of a submarine gully. It is surrounded by land rapidly rising to over 1000 feet, and, as in other cases, innumerable torrents score the mountain sides and hurry the rainfall into the water.

Upper Loch Fyne, 25 miles long from the narrow channel at the great Otter Spit to the head at Clachan, has an area of 20 square miles; and a depth, along the centre, gradually increasing from 30 fathoms at Gortans to 40 at Furnace and 80 at Strachur, then shoaling to 70 near Inveraray, 30

at Dunderave, and 15 at Cuill. The land along Loch Fyne, especially on the north-western shore, has a comparatively gentle slope, and the hills are not very high. The upper 6 miles are, however, surrounded by hills both high and steep; and this portion is particularly subject to the influence of fresh water, as, in addition to the innumerable torrents that spring into being after every shower, it receives several rivers.

The Kyles of Bute, Loch Ridun, and the Holy Loch have not been taken into special consideration, as they seem to be simply extensions of the Bute Plateau and Dunoon Basin.

The ragged peninsula of Cowal, between Loch Lomond and Loch Fyne, has, including Bute its natural pendant, an area of 460 square miles. Of this, 170 square miles, chiefly at the south-western end, have a height under 500 feet; elevations of from 500 to 1000 feet cover 150 square miles; heights from 1000 to 2000 cover 125, and in the north-east there are 15 square miles of the earth's surface covered by mountain summits of over 2000 feet. These 15 square miles of great elevation are associated with the 8 square miles of Loch Long and Loch Goil, and 10 square miles of Upper Loch Fyne; but some of the drainage of the eastern slopes finds its way to Loch Lomond. The deep lochs winding amongst these mountains are profoundly affected by their surroundings, both as regards the temperature and the salinity of the water. This piece of country is intersected by a number of remarkable valleys, either running from sea to sea like that of Loch Eck, or simply pushing their way into the interior like Glendaruel.

The relation between height of land and depth of sea appears from the chart to be very intimate. In the deep loch basins at the Mull of Cantyre, and round the north of Arran, high and precipitous land is associated with exceptionally deep water and a steep gradient. Along the Ayrshire coast, very low land and a gradually sloping shore are associated with shallow and slowly deepening water; while farther north, where the land rises, deep water comes close inshore. The exceptions to this generally accepted rule are no less remarkable than the concurrences. Between the low-lying headlands of the south of Bute and Little Cumbrae there is water of great depth (more than 70 fathoms), and the plateau of comparatively shallow water between the Mull of Cantyre, the south of Arran, Ailsa Craig, and South Ayrshire, is not apparently connected with any special flatness of the shores. This plateau is a very interesting feature, and suggests many hypotheses to account for its origin. Regarded from one point of view, it is only a repetition, on a much larger scale, of the bars marking off loch-troughs that characterise this whole sea-area, and might thus appear to have been formed subsequently to the main features. On the other hand, the plateau of 25 fathoms may be supposed to have formerly extended over the whole area, the various basins being scooped out in it. The origin of physical features is not, however, the subject of this paper, and it has merely been alluded to in order to direct special attention to the existence of the plateau.

Observations on the specific gravity and temperature of the water of the Clyde sea-area at all times of the year confirm by their results the divisions just described, viz. :—The Channel, the Barrier Plateau, the great Arran Basin, the Dunoon Basin, the troughs of Upper Loch Fyne, Loch Strivan, Loch Goil, Upper Loch Long, Gareloch, the Bute Plateau, and the Estuary. If the term “Firth,” as physically defined,¹ is to be applied to any part of the sea-area, it must be to that between Port-Glasgow and Toward.

FÂ-HIEN'S TRAVELS IN INDIA.²

BY J. W. McCRINDLE, M.A., M.R.A.S.

BETWEEN the fourth and eleventh centuries of our era, India was frequently visited by Chinese Buddhists, who came on pilgrimage to view the consecrated scenes amid which their great teacher had spent the years of his earthly existence. They were for the most part devout monks, whose object in travelling so far abroad was not merely to render their tribute of worship at the holiest shrines of their faith, but also to obtain copies of their sacred books, and to learn the Sanskrit language, in which these had been written and authoritatively expounded. On this account their sojourn in India was in some instances extended over a good many years. The names of two of these scholarly pilgrims, Fâ-hien and Hiouen-Thsang, are now quite familiarly known throughout the republic of letters, a distinction due to the fact that they wrote accounts of their Indian travels, which, within the last fifty years, have been translated into several European languages, and have been found extremely useful to students of Buddhism, and to Indian archaeologists.

Fâ-hien, who preceded Hiouen-Thsang by a couple of centuries, came from Ch'ang-gan,³ now Si-gnan, a town of Shen-se, one of the northern provinces of China. He started on his long and perilous journey in the year 399 A.D., and did not return home till some fourteen years afterwards. The greater part of the intervening years he spent in India, visiting its monasteries and shrines, learning Sanskrit, and seeking to procure canonical works on the doctrine and discipline of his faith. The work of which he was especially in quest was one which contained the rules of discipline observed at the first great council of Buddhism, which had been held while Buddha was still in the world.⁴ His search was not

¹ Mill and Morrison, Tidal Variations in Estuary of Forth, *Proc. R.S.E.* xiii. 1886, June 7.

² *A Record of Buddhistic Kingdoms* : Being an Account by the Chinese Monk, Fâ-hien, of his Travels in India and Ceylon (A.D. 399-414), in search of the Buddhist Books of Discipline. By James Legge, M.A., LL.D. Oxford : Clarendon Press, 1886.

³ This is the Kenjan-fu of Marco Polo, and perhaps the Thinae of Claudius Ptolemy. It was probably, says Colonel Yule, the most celebrated city in Chinese history, and the capital of several of the most potent dynasties.

⁴ This work was called the *Vinaya Pitaka*.

BATHY-OROGRAPHICAL CHART OF THE CLYDE SEA-AREA
By J. G. BARTHOLOMEW.

NOTE.

The colouring of the map is designed to show with special effect the area and depths of the Firth of Clyde and its inlets, or what Dr MILL calls the "Clyde Sea-Area." For this purpose the land and sea have been treated separately, and coloured in strong contrast to each other. The system of colouring is, however, uniform, and in both cases the lowest or deepest areas are distinguished by the darkest tints, and graduated up to the lighter tints of the higher or shallower portions.

REFERENCE TO COLOURING