spot for the shore observer—of course removed from all possibility of attraction by iron in the immediate vicinity; such basin to be kept exclusively for this purpose, and known as "The Ship-swinging," or "The Compass-adjusting" Dock.

With the view of deducing a practical result from what has been advanced in the foregoing remarks, the author would most strongly urge the necessity of some official inspection of iron vessels with reference to their compass-fittings. A code of rules and instructions might be laid down for this purpose; this would be essential in the cases of *new* ships; *old* ships should be examined at stated times, and certificates of compass adjustment be recognized by the appointed officer solely from those who can furnish evidence of having been properly instructed by competent persons, so that such an important work should not be allowed to be taken up and carried on by any amateur as his fancy may dictate.

It may be a question how far a Government inspection would be cordially received by shipowners or public companies; it might by some be regarded as an undue interference; the Government also might be indisposed to incur the cost of an extra office, with all its details; it might be more properly thought a matter for the consideration of Lloyd's. It is a question assuredly in which underwriters are largely and personally interested, and they already hold arbitrary powers as concerns the construction of the hull of a ship. The simple question of the compass as a means of safety is comparatively disregarded.

The above suggestions are offered with great deference, and the author would rather leave the subject in the hands of those more conversant with legislation than himself; but he cannot refrain from repeating that the results of his own practical experience (which has been of no small amount) convince him that an official supervision of the compass-fittings of iron ships has become, from various causes, absolutely requisite.

III. "On the Tidal Currents on the West Coast of Scotland." By Archibald Smith, M.A., F.R.S. Received March 1, 1866.

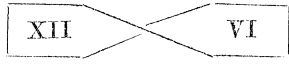
The tidal currents on that part of the west coast of Scotland which is comprised between the Mull of Cantyre and the Island of Mull run in general with great velocity. Their velocity, direction, and the time of their change, or of slack water, are therefore matters of great importance to navigators. On the other hand, the rise and fall of the tide is so small, and the depth of water in the channels and the harbours so considerable, that the times of high and low water are of comparatively small importance.

While the laws of the currents are thus of more importance than the laws of the rise and fall of the tide, they are also much more simple. The times of high and low water are very different at different parts of the

coast, while the times of slack water are nearly the same throughout the whole region in question. In a great part of this region the current, which sets for six hours in one direction, has no distinct title to be considered either a flood tide or an ebb tide. The consequence is, that to describe the laws of the currents by reference to the time of high and low water, introduces great and unnecessary complexity. The application to the currents of the method first applied by Admiral Beechey to the tidal stream of the English Channel and German Ocean (Phil. Trans. 1851, p. 703) introduces at once order and simplicity, and makes that intelligible which before was only a confused maze.

In the following paper an attempt is made, from the materials to be found in the charts of the Admiralty Survey of the west coast of Scotland, now nearly completed, to obtain a first approximation to a tidal chart of the west coast of Scotland. For this purpose I have, with the kind assistance of Commander Evans, F.R.S., the first Naval Assistant to the Hydrographer of the Navy, deduced from the charts all the information to be there found as to the direction and times of change of the tidal streams, as well as the times of high and low water. The latter are indicated in the usual way by Roman numerals, which, to avoid confusion, are always within the land. The times of change and direction of the currents are described by a particular symbol which I have found convenient for the purpose, and which I will now describe.

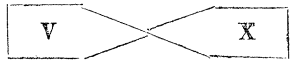
In the seas which we are considering, the stream at any point generally flows for six hours in one direction and for six hours in the opposite direction. This may be conveniently indicated by the following symbol:—



which indicates a stream flowing from XII. o'clock to VI. towards the east, and from VI. to XII. towards the west.

In this notation, for simplicity, the interval of the tide is considered as 12 hours instead, as it really is, about $12^h\ 25^m$. The hours are expressed in Greenwich mean time.

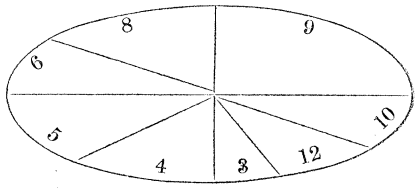
The same symbol is adapted to the case of a stream flowing longer in one direction than in the other. Thus in the Sound of Sanda the stream at full and change may be indicated by



indicating that it flows seven hours towards the west and five hours to the east.

The velocity of the stream may be expressed by the length of the figure, or sometimes more conveniently by separate lines, the terminations of which are well marked as |———|, the length of the lines indicating either the velocity at the middle of the stream, or, if it is found more convenient, the whole distance which a particle of water moves in one tide.

I may observe that an analogous symbol may be used to express the more complicated tides which occur where different streams meet. Thus near the Eddystone the stream may be expressed by a symbol of this kind :—



the bearing and distance of the centre of the diagram from any numeral indicating the direction and rate of stream at that hour.

The time of high and low water in the region which we are considering may be thus described. Near the two extremities, viz. the Giant's Causeway and the Island of Eysdill, the time of high water at full and change is nearly V$\frac{1}{2}$ Greenwich time, being very nearly that due to the Great Atlantic tidal wave propagated from S.W. to N.E., and the same is very nearly the hour of high water on the chain of islands of which Isla, Jura and Scarba are the chief. But along the coast of the mainland of Ireland and Scotland the case is very different. Between these two countries is the great opening into the Liverpool basin, in which it is high water about XI. The change in the time of high water takes place by the following gradations :—At Giant's Causeway it is high water about VI., at Ballycastle VII., Torpoint X., Mull of Cantyre XI., Gigha II., Loch Killispoint IV., Eysdill and Scarba V, Jura and Islay V$\frac{1}{2}$. But while the hour of high water varies, the stream through nearly the whole of the region runs from X. to IV. in one direction and from IV. to X. in the other.

Between the Mull of Cantyre and the N.E. coast of Ireland, the X. to IV. stream runs to the north.

The most westerly part turns to the west, and runs through the Sound of Rathlin along the north coast of Ireland; the central part flows to the N.W. past the Rhynns of Islay; the easterly part, which has flowed partly through the Sound of Sanda, turns sharply round the Mull of Cantyre, and flows to the northward, pouring with great velocity through the narrow openings in the chain of islands, viz., the Sound of Islay between Islay and Jura, the Gulf of Corry Vreckan between Jura and Scarba, the little Corry Vreckan between Scarba and Lunga, the Slate Isles and the Cuan Sound; of these the little Corry Vreckan is quite impassable; and Corry Vreckan and the Cuan Sound are seldom attempted except near slack water.

These channels open into the basin which lies between Jura and Iona—a comparatively tideless sea, owing apparently to the circumstance of the ocean tide from the outside of Isla rising to nearly the same height as that

which pours through the openings, so that the tidal stream would be little altered by building a dam from Islay to the Ross of Mull.

The question may now be asked, Is the great X. to IV. stream which has just been described a flood or an ebb tide? So far as regards the Mull of Cantyre, Fairhead, and all that lies to the south or east, it is a true ebb tide. So far as regards Jura, Scarba, and the coast to the north and east, it is a true flood tide; but as regards a great part of the region in question, it cannot be called either a flood or an ebb tide, and much confusion is occasioned in the Charts by attempting so to distinguish it.

At the south end of Gigha in the Admiralty charts an arrow is laid down, indicating that the flood tide runs to the northward; and a few miles south of this, another arrow is laid down, indicating that the flood tide runs to the southward. From these arrows we might expect to find at this place a meeting of the tide and a sudden change in the direction of the flood stream. But the stream which is indicated by these arrows is nothing more than the great X. to IV. northerly current which we have described. The spot which is treated as a meeting of the tides, is merely that at which it is high water at I. North of this, for more than three hours of the X. to IV. stream, the tide is rising, and it is indicated as a flood tide. South for more than three hours the tide is falling, and it is indicated as an ebb tide.

On the south and west coast of Isla the confusion is greater. In some of the charts, the incoming stream is marked as the flood, in others, and perhaps with better reason, the outgoing tide. It is in truth neither the one nor the other.

The extreme complication which arises from describing the time of change of the stream by reference to the time of high and low water will now appear; thus we should have to say that in the Sound of Sanda, the ebb stream begins two hours before high water; at the Mull of Cantyre, one hour before high water; a little north of this again two hours before high water. At the south of Gigha we might say indifferently, that the flood tide runs to the south and begins three hours before low water, or that it runs to the north and begins three hours after low water; in the Sounds of Islay and the Gulf of Corry Vreckan that it begins an hour before low water; and in describing the streams along the north coast of Ireland, we have even greater complication.

The direction of the tidal streams on the rest of the west coast of Scotland is easily described. The X. to IV. stream, through the course which I have described, becomes an XI. to V. stream at the outside of Isla, and through the Sound of Iona. The stream which sets to the northward up the Sound of Jura fills the Linnhe Loch, and causes high water at the south end of the Sound of Mull at half-past V., whilst the high water caused by the ocean tide at the north end of the Sound of Mull is an hour later; the consequence, as may easily be seen, is that nearly the whole flood tide through the Sound of Mull runs to the northward, and the nearly whole ebb tide runs to the southward.

The tides round the island of Skye are comparatively simple. The V. to XI. tide from the outside of Mull is gradually retarded to a VI. to XII. stream at the outside of Skye, and then as it rounds the north end of Skye, it is met by the tidal stream which has rounded the north end of the island of Lewis, and bends round into the inner Sound of Skye, where it becomes a VII. to I. tide; the course of both streams being nearly the same as if there were an embankment from Loch Shell in the island of Lewis to Ru Rea on the coast of Ross-shire. At the same time, another branch of the tide which has rounded the point of Ardnamurchan flows through the Sound of Skye as a XII. to VI. tide, and being an hour earlier than the tide which has rounded the north end of Skye, it pours with great velocity through Kyle Rea, but only to fill Loch Alsh and Loch Duich; the retardation which it meets with in so doing, making the rise inside of the narrows at Kyle Akin so nearly contemporaneous with the rise outside, that there is little stream through that narrow opening; the flood stream, as I am informed, sometimes flowing in one direction and sometimes in the other, according to the prevailing winds.

There are many more minute details in these streams which have features of great interest. I have not, however, ventured in the present imperfect state of the data which we possess to enter upon these. I venture, however, to express a hope that before the survey is completed, the data may be obtained for showing, and that the charts may show the direction and rate of the stream at every place and at any time.

March 15, 1866.

Lieut.-General SABINE, President, in the Chair.

The following communication was read:—

"On a possible Geological Cause of Changes in the Position of the Axis of the Earth's Crust." By JOHN EVANS, F.R.S., Sec. G.S. Received February 28, 1866.

At a time when the causes which have led to climatal changes in various parts of the globe are the subject of so much discussion, but little apology is needed for calling the attention of this Society to what possibly may have been one of these causes, though it has apparently hitherto escaped observation.

That great changes of climate have taken place, at all events in the northern hemisphere of the globe, is one of the best established facts of geology, and that corresponding changes have not been noticed to the same extent in the southern hemisphere may possibly be considered as due, rather to a more limited amount of geological observation, than to an absence of the phenomena indicative of such alterations in climatal conditions having occurred.