structural changes induced by mechanical movements in ancient crystalline rocks have nothing in common with that mysterious process which has been supposed by the metamorphic school to generate similar crystalline rocks from non-crystalline sediments. As regards the changes wrought by the same agency in detrital masses, it may be repeated that "the resemblances between primitive crystalline rocks and what we know to be detrital rocks, compressed, recemented, and often exhibiting interstitial minerals of secondary origin, are too slight and superficial to deceive the critical student, and disappear under microscopical investigation."

The doctrine of a regional and progressive metamorphism as the origin of the crystalline rocks, which was very widely received a generation since, both in Europe and America, has within the last fourteen years become greatly discredited. In the Alps, where it was first seriously applied, as well as in Great Britain, it is now generally abandoned. Callaway wrote not long since, that "every case of supposed metamorphic Cambrian and Silurian has been invalidated by recent researches;" and Bonney, now president of the Geological society of London, declared, in 1883, that the hitherto accredited "instances of metamorphism in Wales, and especially in Anglesea, in Cornwall, in Leicestershire, and in Worcestershire, have utterly broken down on careful study," as had already been the case in the Alps, and, it may be added, in North America. The official geologists in Great Britain, representing the traditions of the old school, have, however, hitherto held to the Scottish Highlands as their last stronghold, which they are now forced to abandon, — a substantial victory for rational geology.

T. STERRY HUNT.

Montreal, Jan. 10.

THE BASIN OF THE CARIBBEAN.

THE U. S. hydrographic office having sent to the New-Orleans exposition, as part of its exhibit, a model of the Caribbean Sea, it will be interesting at this time to discuss the deep-sea soundings taken by officers of the navy in the coast-survey steamer Blake, and in the fish-commission steamer Albatross, from 1878 to 1884, by means of which this model was constructed.

Particular attention was called to this great basin in the coast-survey reports for 1880 and 1881, and also in a paper read by the writer before the American Geographical Society in the winter of 1882.

It was not possible, however, to give the contour of the bed of this sea until the completion of the work of the Albatross last winter. The data then obtained permitted the construction of the accompanying chart, which is a faithful representation of the model before mentioned, and by means of which it will be easy to draw attention to some of its most important features.

During the cruise of the Challenger, it was demonstrated that in a submarine lake the temperature is constant to the greatest depth, and the same as that of the ocean at the depth of the rim of the lake at its lowest or deepest point.

The investigations of the temperature of the Gulf of Mexico by Commander Sigsbee, from 1874 to 1878, had shown that below a depth of 800 fathoms the temperature is constant at 39½°, which is the normal temperature of the ocean at that depth in the region of the Equatorial Current. It was evident, therefore, that the Caribbean Sea, from which the Gulf of Mexico receives its waters, must be enclosed by a rim which at its deepest part was 800 fathoms below the surface.

The purpose of the investigations of the Blake, during the time that I had the honor to command, was to verify the deduction thus made, and to determine the position and height of this rim, which limits the low temperature of the waters of the Gulf of Mexico.

All the passages between the islands from Trinidad to Cuba were carefully sounded, and the existence and position of the rim definitely established. At the same time temperatures were taken both outside and inside the basin, and at the points of minimum depth. With one exception, however, the only place where the rim was sufficiently low to admit water of the required temperature (39½°) was in the windward passage. In all other places the depths on the rim were much less than 800 fathoms.

The exception noted was a narrow gully of 1,100 fathoms, with a bottom temperature of 38°, leading into a basin of 2,400 fathoms between Santa Cruz and St. Thomas; this great depth also having a bottom temperature of 38°. As the temperature at 1,500 fathoms just south of Mona Passage was 39½°, there could be no doubt of the existence of a rim from Santa Cruz to Puerto Rico. The Albatross, therefore, was directed to examine this locality, and, as was expected, found the ridge with 900 fathoms on it at the greatest depth, and a least

temperature of 39½°. This established the continuity of the rim, and consequently the truth of the deduction made from the examination of the temperatures of the waters of the Gulf of Mexico.

That part of the Caribbean Sea west of the Island of Jamaica, and the Pedro and Rosalind banks, were thoroughly sounded in the winter of 1880–81; and the Cayman Islands and the Misteriosa Bank were found to be part of a submarine extension of the range running along the south-east side of Cuba.

Immediately south of these partially submerged peaks was an immense deep valley, extending from between Cuba and Jamaica as

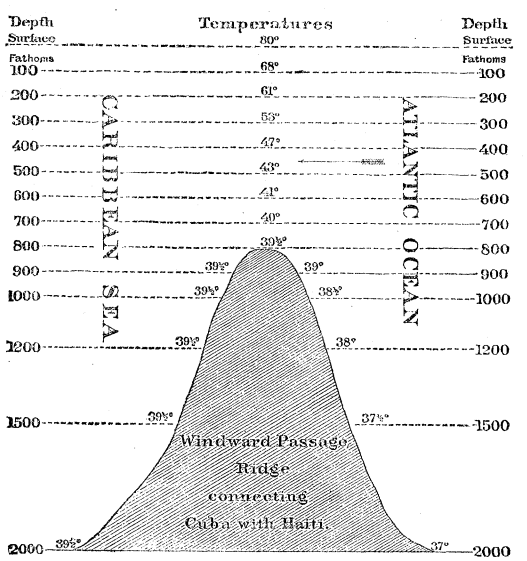

DIAGRAM OF RIDGE CONNECTING CUBA WITH HAYTI.

far as the Gulf of Honduras. This valley is narrow at its eastern end, but widens between the western end of Jamaica and Cape Cruz, where the soundings were 3,000 fathoms within fifteen miles of Cuba, and 2,800 fathoms within twenty-five miles of Jamaica. This valley is 700 miles long, with an average breadth of 80 miles. The greatest depth was 3,428 fathoms, just south of the Island of Grand Cayman. Between Misteriosa Bank and Chinchorro Bank, the soundings were regular at 2,500 fathoms. North of Misteriosa and Grand Cayman, to the Isle of Pines and Cape San Antonio, the soundings were generally 2,500 fathoms. So much for the western Caribbean.

The lines of deep-sea soundings taken by Lieut.-Commander Tanner in the Albatross last winter, were first from the east end of Puerto Rico to Bird Island, thence nearly south to Trinidad, and then north-west towards the Mona Passage. These lines, in connection with that which I ran with the Blake from the island of Dominica to Bird Island, and back to Monserrat, clearly developed a submarine elevation reaching north and south nearly parallel to the main chain of islands from Granada to St. Christopher; the depth on this ridge being considerably less than 1,000 fathoms, with 1,500 and 2,000 fathoms on each side.

From the Mona Passage a line was run to Los Roques, thence to the mainland, and then to Curaçoa. The soundings south of this chain of islands gave a greatest depth of 1,030 fathoms. A line was run from Curaçoa to Beata Island, at the extreme south point of Santo Domingo. A line was also run from Morant Cays, off the east end of Jamaica, to the mouth of the Magdalena River, and then across the Rosalind Banks.

These several lines show an immense basin of nearly the same depth, extending from Santo Domingo and Puerto Rico to the shores of the Spanish Main, and over an area of more than 200,000 square miles, without any apparent inequality of surface. A line drawn from the west end of Santo Domingo to Cartagena shows a depth of 2,200 fathoms. The floor of the basin then rises gradually to the banks connecting the island of Jamaica with the Mosquito Bank.

The basin is a few hundred fathoms deeper in its eastern part, but rises abruptly to the submarine elevation previously mentioned. A very remarkable depression will be observed in the Atlantic, north of Puerto Rico. Lieut.-Commander Brownson here obtained a depth of 4,561 fathoms. Additional soundings will be taken, when a vessel is available, for more details over the ridge of which Bird Island forms a part; but the general basin is probably correctly portrayed.

The soundings connecting the islands and various banks, and to determine the depths of the western Caribbean, have already been made in detail. This work, so eminently within the province of the navy, and performed with so much success by naval officers, should be continued, and I hope to obtain many new soundings this summer.

The model also shows the elevations of adjacent shores and islands. The horizontal scale is 33 miles to the inch; vertical, 6,000 feet or 1,000 fathoms to the inch. The latter, though so much distorted, was necessary to give the smaller elevations and depressions.

Even with this scale, the highest mountain

on the Isthmus of Panama was only one half-inch, and the elevation of the railroad less than one-twentieth of an inch. Again: the mountain of Santa Marta, near Cartagena, was 17,000 feet, or nearly three inches in height; but the whole gave relative heights which could have been shown in no other way.

J. R. BARTLETT.

U. S. hydrographic office, Jan. 15.

THE BALLOON IN METEOROLOGY.

ON the afternoon of Jan. 19 the first balloon ascent ever made in this country solely in the interest of meteorology took place at Philadelphia. As the beginning of a series to be carried out strictly for scientific purposes, it was an event of no small importance. Gen. Hazen, chief signal-officer, U.S.A., recognizing the importance and value of a more complete knowledge of the upper atmosphere, entered into a contract some time ago with the well-known aeronaut, Mr. S. A. King, for a number of 'trips to the clouds,' an ascent to be made at any time on eight hours' notice.

Although the first balloon excursion for strictly scientific purposes made in America, this was by no means the first on record. Naturally, very soon after the invention of the balloon, attempts were made to utilize it in meteorological investigations. Doubtless, the first ascents having this end in view were made by Mr. Robinson, from St. Petersburg, at the command of the emperor of Russia, in 1803 and 1804; but it does not appear that any important results came from them. On Aug. 31, 1804, Gay-Lussac and Biot made an ascent, reaching a height of thirteen thousand feet; and meteorological observations were commenced after an elevation of seven thousand feet had been passed. On Sept. 15 of the same year, Gay-Lussac reached a height of twenty-three thousand feet, making a series of most important observations, and bringing air down from that height, which, on being analyzed, was found to have the same constitution as that at the surface.

Not much seems to have been done from that time until 1843, when the British association for the advancement of science appointed a committee and voted a sum of money for the purpose of experimenting with captive balloons. Although the work was continued under several committees, it was not very successful, owing, doubtless, to a lack of skill in the management of captive balloons. In 1850 Messrs. Bixio and Barral made ascents in France for the purpose of meteorological study, in which it was planned to ascend to heights as great as forty thousand feet. They did not succeed, however, in reaching greater elevations than had been attained before, but obtained results verifying in the main those of Gay-Lussac. On one of these excursions an elevation of twenty-three thousand feet was reached; and, in addition to the meteorological work, interesting observations were made on polarization and other optical phenomena.

A series of very important ascents was made by Mr. Welsh of the Kew observatory in August, October, and November of 1852, in which heights varying from twelve thousand feet to twenty-three thousand feet were reached.

A few years later the interest of the British association in the subject was renewed, and culminated in the celebrated series of ascents made by Mr. Glaisher, the first being on July 17, 1862. In these ascents the most complete arrangements were made for the study of the physics of the higher atmosphere, and they were remarkably successful.

Since that time, scientific ballooning has been carried on with great success in France by Camille Flammarion, W. De Fonville, and Gaston Tissandier. A complete and extremely interesting history of their work (up to the date of its issue), together with that of Glaisher, is to be found in a volume entitled 'Travels in the air,' by James Glaisher.

The U. S. signal-service has had this subject under consideration for several years. Professor Abbe began in 1871 to collect meteorological records made in balloons. In 1872 the records of fifty ascents had been tabulated, studied, and valuable results obtained. In 1876 one thousand small balloons were sent with the Polaris expedition, to be used in determining the height of the clouds; but, owing to an unfortunate accident, they could not be utilized. At various times the chief signal-officer has sent observers on balloon excursions which were made for purposes other than scientific.

The considerable certainty with which the movement of a storm can now be predicted renders it possible and desirable to make systematic use of the balloon in the study of unusual atmospheric conditions, and the series of ascents just begun is planned with that end in view. Among other things, it is desired to determine the difference in the temperature gradient in well-defined 'high' and well-defined 'low' pressures. For this purpose it is necessary to foretell the arrival of a particular atmospheric condition at Philadelphia, from