hidden a lot of war materials in the cellars of the observatory. After a thorough inspection an electric battery was found in the cellars. However, the absence of instruments of destruction did not allay the suspicions, especially as the story was told at the time the French soldiers were approaching Antanánarivo.

In August, the Madagascan Government sent M. Ramarosaona to make a complete search over the observatory. He found in the north tower six cases with the following inscription on them: "Produits chimiques et photographiques, Brewer Frères, Paris," and at once concluded that this was the ammunition, deciding that the two copper-mounted telescopes were the cannons, and he announced his discovery to the Prime Minister with much pride. The Prime Minister, however, knew that the instruments were really telescopes and not cannons, and expressed the wish to look through one. On seeing how clearly distant objects could be observed, he at once concluded that the instruments were used for watching the manœuvres of the French soldiers. All suspicious instruments and boxes were then taken to the palace; inspectors were frequently sent to the observatory to try and find the hidden war material, but to no effect.

Finally, in September an order was issued from the Queen that the inhabitants of the neighbouring villages were to take the instruments and furniture of the observatory to the college at Ambohipo, and to destroy the observatory, in order that the French, who were advancing on the town, should not find a single shelter. With all possible speed the two men in charge dismounted as many instruments as possible, and packed them ready for transport. The inhabitants, however, were already in the buildings breaking down windows and doors, so that many instruments were broken, and others disappeared. The meteorological observations were continued up to the last moment, and much credit is due to the two assistants, who were indefatigable in their efforts to save as much as possible.

Soon after the destruction of the observatory, of which only a few feet of the walls were left, the French arrived, and an engagement followed between them and the Madagascans; and the position of the latter became so bad that they had to escape to Antanánarivo, leaving behind them their cannons and ammunition, which were afterwards used by the French to bombard the palace.

The next day an inspection was made of the instruments at the college, but most of them were found to have been damaged in transport; so much so, that it was either a case of sending them to France to be mended, or of replacing them by new ones. Most of the other instruments that were taken were returned, and in some cases money was sent to compensate for damages.

The observatory had been at work for a little over six years, and during that time very important observations in meteorology, astronomy, magnetics and geodesy had been made. A subscription is now open for a new observatory and for the College of France at Antanánarivo, and in all probability the new observatory will be dedicated to the memory of the soldiers killed in Madagascar.

TIDES IN THE GULF AND RIVER ST. LAWRENCE.

WE have received a copy of a paper[1] read before the Royal Society of Canada, giving a general description of the results of the tidal observations which are being carried out in the St. Lawrence under the direction of the Canadian Government. In NATURE of April 22, 1897, an account was given as to the origin of this survey and the manner in which the operations were being conducted by Mr. Bell Dawson, the officer in charge of the work, under the direction of the Marine Department of the Dominion. One of the principal objects of the survey is to obtain, by means of self-recording tide-gauges, data for computing trustworthy tide-tables for the use of the navigation.

Tide-tables for two of the stations—Halifax and Quebec—have been issued for the last two years, and for St. John for the present year. Owing to the great variation of the rise and time of the tides at different parts of the Gulf, the pamphlet affords an extremely interesting study of tidal conditions. The regularity with which the tide proceeds to Quebec after it has once entered the mouth of the river is in great contrast with its character while in the Gulf.

The variation in the period of time which the tidal undulation occupies in crossing the open Gulf is twice as great as the variation in the period between Anticosti and Quebec, where the distance is double. The main set of the tide is along the deep-water channel of 100 fathoms, which continues up the river to the mouth of the Saguenay, 130 miles below Quebec. Along the 240 miles from St. Paul Island in Cabot Strait to Anticosti the tide is propagated at the rate of 43 miles an hour; whereas over the 450 miles from Anticosti to Quebec the rate is 82 miles an hour. The variation in the range of the tide at different parts of the Gulf and river is even more varied. At some of the stations and in the Atlantic the range is from 4 to 5 feet. At Magdalen Island, in the middle of the Gulf, and also in parts of Northumberland Strait, the rise is almost imperceptible; while at Quebec and St. John the range is 26 and 32 feet. The wind is also found to have a material effect on the range and time of the tides, which are delayed or advanced from 1½ to 2 hours in some parts of the Gulf, according to its direction and force. The pamphlet is accompanied by a map of the Gulf and several tidal diagrams.

[1] "Character and Progress of the Tides in the Gulf and River St. Lawrence, as ascertained by Simultaneous Observations with Self-registering Tide-Gauges." By W. Bell Dawson, M.A., Assoc. M. Inst. C.E. (Ottawa: J. Durie and Son. London: Bernard Quaritch, 1897.)

THE DUKE OF DEVONSHIRE ON UNIVERSITY EXTENSION.

A CONFERENCE on University Extension was held in Cambridge last week, and on Thursday, the second day of the proceedings, the Duke of Devonshire presided, and delivered an address, portions of which, taken from the *Times* report, we reproduce :—

LOCAL EXTENSION COLLEGES.

The most important outcome of University extension during the last few years has been the light which it has thrown on the possibility of coordinating, where the circumstances are favourable, various forms of adult education. A few weeks ago his Royal Highness the Prince of Wales opened the new buildings of the University Extension College at Reading, and the presence of a large and distinguished body of representatives of the University of Oxford showed the deep interest taken by the sister University in this new institution, which is the direct result of the University extension movement aided and supported by municipal contributions, local generosity, and the subsidies of the neighbouring County Councils. Special local circumstances and the encouragement given by the Board of Agriculture have given a particular character to the organisation of the Reading College; but the essential fact in its rapid and striking growth has been the part played by the representatives of the University in organising and stimulating local effort and in educing out of various elements a new type of educational institution which associates municipal and local activity with University traditions and prestige. The successful growth of the Exeter University Extension College, which stands in a close relation to the University of Cambridge, and largely owes its increasing educational importance to that connection, is another proof the value of the services which the Universities are rendering to this branch of national education. The differences in the organisation of the Reading and Exeter Colleges show how wisely the methods of University extension work have been allowed to adapt themselves to the various conditions of distinct localities. The operations of the University syndicates have been happily marked by a judicious sense of the need for elasticity and freedom in educational organisation, coupled with an earnest care for high aims and for a high standing of teaching. A good beginning has also been made, in close connection with the University of Cambridge, at Colchester, where the new University Extension College will, it may be hoped, render excellent educational service to the municipality and surrounding neighbourhood.

A VINDICATION OF THE EXTENSION MOVEMENT.

Apart from providing guidance and stimulus in studies for those who would otherwise be deprived of them, the University Extension colleges and courses have proved of great advantage to many who desire to keep up their intellectual interests and to refresh their knowledge. Teachers in the various grades of schools, public and private, are among those who have had

reason to be grateful for the efforts made by the Universities to extend these educational opportunities. And stimulus given to the teachers reacts most beneficially upon the schools and pupils under their care. In educational as in all work it is necessary to have patience in awaiting results. The best results of an improved system of primary or secondary education are not those which are the first to show themselves. And in course of time it is probable that the number of persons desiring to avail themselves of opportunities for continuing their education within easy reach of their own homes and in the leisure hours of life will steadily increase. In the circumstances of our own country, where momentous issues of Imperial policy constantly turn upon the popular vote, it is of high importance that we should encourage by all the means in our power the growth of educational organisations which are providing dispassionate instruction in the duties of modern citizenship and diffusing that kind of knowledge which is necessary to the formation of a discriminating judgment. We do not believe that it is possible to indoctrinate busy people with a systematic knowledge of a dozen or fifteen subjects, to understand any one of which would require a preparatory knowledge of many years. But it is possible to aid intelligent students in every rank of life to gain the elements, the gist, of liberal culture, and to obtain that insight into the vast complexity of human affairs which is the salutary safeguard of intellectual modesty and the best protection against hurried and partial judgments. It is in training and providing the teachers for this great and difficult work of adult popular education that the Universities are rendering one of their highest services to the country. By equipping and sending out these intellectual missionaries; men of high purpose and of high culture, they are really guiding a national movement. Let us not imagine that great educational enterprises realise themselves mechanically—that the merely fortuitous combinations of County Councils or other public authorities will suffice to secure all that is wanted in the training of citizens for citizenship. Material aid of this kind is indispensable. It is a mark of local interest, it secures the further development of that local interest. But by itself it is insufficient. What is really indispensable is leadership. The man, or group of men, must be forthcoming who, in each centre of population, will take the lead and guide the various forces which are at our disposal into wisely-chosen channels of systematic effort. And it is one of the highest duties of the Universities to train and to send forth such men, to give them moral support in their difficult labours, and to attach to their enterprise the weight of academic prestige.

SOME CONDITIONS AFFECTING GEYSER ERUPTION.[1]

The Influence of Hydrostatic Pressure.

BOTH field observation and experiment have contributed to our present knowledge of the physical causes of geyser eruption. The natural history of geyser regions has been summarised by Weed (*School of Mines Quarterly*, New York, 1890, vol. xi. No. 4, p. 289), and the experimental work by Andreæ (*Neues Jahrbuch für Min. Geol. und Pal.*, 1893, Bd. ii. p. 1). Weed concludes that geysers occur only in acid volcanic rocks, and along natural drainage lines where meteoric waters accumulate for discharge. The source of heat is conceived to be escaping hot vapours from slowly cooling lavas, the only known geysers occurring in regions of recent volcanic activity. New geysers originate by the opening of new waterways along fissure planes in the rock, and such new orifices of overflow are continually forming to compensate the diminution in activity of older vents. The cause of the intermittent spouting which distinguishes the typical geyser was originally stated by Bunsen (Tyndall: "Heat as a Mode of Motion"; Appleton, 1888, p. 168); the boiling-point of water rises with increased pressure, hence decreases from the lower end of a water-filled tube upward. If water of a lower stratum, nearly, but not quite, at the boiling point, be lifted by the entrance of steam from below to a level of less pressure and lower boiling point, "the heat which it possesses is in excess of that necessary to make it boil. This excess of heat is instantly applied to the generation of steam: the column is lifted higher, and the water below is further relieved. More steam is generated, and from the middle downwards the mass suddenly bursts into ebullition. The water above, mixed with steam-clouds, is projected into the atmosphere. . . . " (Tyndall, *l.c.*, pp. 169-170).

The accuracy of Bunsen's theory was early confirmed by experiment; and the only mechanism necessary to produce geyser eruption is a tube filled with water, open above and heated below. Many further experiments have been made, however, with a view to explaining the variations observed in the period and interval of geyser eruptions, the relative amount of steam and water, and the effect of artificial stmulants in hastening eruption. Andreæ's experiments were directed toward the imitation of Peale's ("U.S. Geological Survey of the Territories, 1884," vol. xii. part 2) types, a classification based on the form of the basins and the relation of the periods of steam and water in the eruption. It is noteworthy that in most of these experiments, the apparatus recommended has an open basin above, which retains the water thrown out and permits it to *flow back* into the geyser tube.

In Peale's classification no mention is made of the nature of the geyser-spring during the interval of quiescence; in some cases there is continuous overflow or discharge, in others there is no overflow except during eruption. As it may be shown that this fact of the presence or absence of hydrostatic pressure at the geyser vent has an important bearing on the conditions of eruption, the writer would suggest a classification based on this very simple distinction; it is a singular fact that in the published descriptions of geysers this point has been frequently overlooked. If geyser waters represent meteoric drainage, they are affected by the laws of hydrostatic equilibrium. In such case a tube continuously overflowing is in a distinctly different class from one which throws off its waters to join the superficial drainage to the sea only during the period of its occasional or intermittent discharge. The first case is represented by such a geyser spring as "Excelsior," in the Yellowstone Park, a violently boiling cauldron in the hill slope, continually discharging vast volumes of water into the pond below, which in turn drains into the Firehole River; the Great Geyser of Iceland, and the Rotomahana Geyser (destroyed by the Tarawera eruption in 1886) of New Zealand are other types of the continually overflowing class. "Old Faithful" is the type of the second class; its waters may be seen in violent ebullition a few feet below the orifice of the vent, but overflow takes place only during eruption.

Any apparatus designed to imitate accurately either of these must be provided with a supply reservoir having subterranean connection with the geyser tube, by which water may siphon in to replace that discharged. Obviously this replacement takes place in nature: if the water, as asserted, is meteoric, and governed by the same laws that determine the loci of springs, the natural method of such replacement is by the action of gravity. In the case of Excelsior, this subterranean compensation is continuous; the effective head of water at the orifice of exit is fairly constant: in the case of Old Faithful the water-column is in equilibrium, and replacement occurs only after each eruption, when this equilibruim has been disturbed by the ejection of the column.

Experimental Demonstration.

A simple device to illustrate this process was described by G. Wiedemann (*Wiedemann's Annalen*, xv., 1882, p. 173) and mentioned by Andreæ (*l.c.*, p. 4). Wiedemann made no geological comparisons, the apparatus having been constructed for class-room illustration in physics; and most of the geological experimenters have used back-flow apparatus, without supply reservoirs. The essential parts of Wiedemann's apparatus are a water-column heated below, and a supply-tube entering this column and connecting it with a reservoir of cooler, superficial waters. When the excess of steam generated has thrown out the main column, cooler water filters in through the supply tube, and fills the geyser tube to the level of the reservoir. For effective and regularly repeated geyser eruptions, the reservoir level must be maintained a little below the height of the mouth of the geyser tube.

The accompanying figure illustrates Wiedemann's apparatus, as it has been used by the writer. The dimensions are as follows: capacity of each flask, one quart; length of main geyser tube 4 feet, diameter (outside) 5/16 inches; diameter of basin 2 feet; the bottom flares funnel-wise from the centre slightly, and is provided with a ¼-inch outlet tube *t*. The lower flask rests on a sheet of wire-netting over the flame of a

[1] By T. A. Jaggar, jun. (Abridged from the *American Journal of Science*, May.)