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EARTHQUAKES IN AUSTRALASIA.

BY GEORGE HOGBEN, M.A., SECRETARY SEISMOLOGICAL COMMITTEE, A.A.A.S., TIMARU, N. Z.

SEISMOLOGY is a branch of science that until quite recently received very little attention in Australasia. This could hardly be said to be due to the lack of phenomena; though, with one or two exceptions, the earthquakes that have taken place, even in New Zealand, — the seat of the worst disturbances, — have been very mild in character. The stimulus the subject has received lately was given by the Australasian Association for the Advancement of Science, an association which has done so much in other departments to encourage systematic scientific work. As one of the research committees, the A. A. A. S. appointed a committee to report upon seismological phenomena in Australasia; and I think I cannot make a better beginning of what I have to say on the subject than by setting forth in brief the work this committee is attempting to do.

In the first place it has set itself to compile a list of all recorded earthquakes (within the area of its investigations) up to the present time, including in that list all the important details as far as they are given in the existing records.

In the next place we have attempted to provide for the future recording of earthquake shocks in all the colonies according to a uniform system. These records include, among other details, the exact time of the beginning of each shock, the time being checked by the standard telegraph time of each colony through the medium of the Public Telegraph Departments.

Inasmuch, also, as it is, to a large extent, as part of a world-system of observations that our observations in Australasia may become useful, we propose to do for the islands of the Pacific, as far as circumstances will admit, what is being done for the Australasian colonies. There, of course, exact time-observations are generally out of the question; but with the aid, already largely promised, of missionaries, consuls, and other residents, much more, we trust, will be done than at first appears possible.

To secure uniformity in recording the intensity of earthquakes, the Committee have adopted as a common standard the Rossi-Forel scale of intensity. Though rough and variable to a slight extent, it has the advantage of being a recognized standard and is suited to the nature of the evidence at our command.

The materials obtained are used, where sufficient data are to be had, in the determination of the origins of the shocks. In many cases the epicentrum and velocity of propagation can be found; and in a few instances the facts are sufficient in number and accuracy for a more or less probable determination of the depth of the centrum or actual source of disturbance. With the advantage of easy reference to a standard time in most parts of the Australasian colonies, and with increased experience and skill on the part of the observers, it is hoped that accurate observations may become more and more common; in fact, in New Zealand, where the present system has been in use for three and a half years, we find that this is the case. It is true that we have very few seismographs; but the great value of time observations based upon a universal standard time has been fully shown by Major Dutton in his report upon the great Charleston earthquake of August 31, 1886, and his conclusions in that respect are fully borne out in our experience.

The want of special instruments cuts us off from any direct means of determining the amplitude and intensity of the shocks; but the field of research already indicated will give us enough to do for some time to come.

If it be asked what we expect to accomplish by our investigations, I reply that any general theories relating to earthquake phenomena must be based upon observations in all parts of the world, and we aim at making our work of sufficient value to count as a part — only a small part, perhaps — of the materials required for solution of many of the interesting questions arising out of, or connected with, seismology. For example, the nature of the interior of the globe, whether solid or liquid, or solid but potentially liquid, — a problem discussed in such an interesting manner by Osmond Fisher in "The Physics of the Earth's Crust," — would receive considerable light from the determination of the depth of earthquake-origins. If no earthquakes, let us suppose, could be shown to come from a greater depth than twenty-five miles, we should have a strong presumption that at about that depth there was a great change in the condition of the interior; and with a very large number of instances we might have something like a proof of such a break in continuity. The physicists have been at war over this point for some time, and without undue conceit we may say that a definite solution is at least as likely to come from seismology as from any other branch of physics.

In another paper I hope to give a short account of the results already obtained from our observations in this part of the globe. I trust, however, that the editor will allow me to say here that I shall be very glad to communicate with or receive hints from any one engaged in seismological work in America (North or South), especially with reference to earthquakes occurring on or near the coast of the Pacific.

THE PREFIX AQ- IN KITONAQA.

BY ALBERT S. GATSCHET, VINITA, INDIAN TERRITORY.

UP to the present only two scientists are known to have studied seriously the Kootenay or Kitonāqa language, which is spoken by about one thousand Indians in northwestern Montana and in the adjacent parts of British America. These two investigators are Dr. Franz Boas and Dr. A. F. Chamberlain; both have collected a large amount of lexical material and a considerable body of ethnological texts. Chamberlain's report on the tribe and language forms one fascicle of the publications of the British Association for the Advancement of Science, which contains the Transactions of the Edinburgh Meeting of 1892, and is entitled, "Eighth Report on the Northwestern Tribes of Canada," with preface by Horatio Hale (octavo, pp. 71).

The prefix āq- plays a great part in this northern language, for the large majority of the substantives, many particles, and other terms begin with it. The q- is pronounced like the Spanish j and the German ch in *lachen*. It appears from Chamberlain's long list of the substantives begining in āq-, that this prefix should really be spelt āqk-, for -k is always following the first two sounds.

These two sounds easily combine with each other in many of the Indian languages. In Peoria and Cheyenne the k- alternates with qk-, and in Tonica of Louisiana every k- may be spelt qk- as well, for this is simply an "expansion" of the simple sound k-. Chamberlain ventures no derivation or explanation of this prefix, and Boas is also doubtful concerning its origin.

There is a linguistic family in Oregon, the Kalapuya, the dialects of which show exactly the same peculiarity concerning the substantive nouns. In the Atfálati dialect, once spoken near Gaston and Wappatoo Lake, west of Portland, almost all substantives begin with a-, as apúmmeig, *woman*. Among the few exceptions, I now remember only mäntäl, *dog*. All adjectives of Atfálati begin in wa-, u-a-, ua- in their form for the singular, and this coincides exactly with the radix of their numeral for *one*. Although what we call *articles* do not frequently appear in American languages, the proclivity of these to agglutinate with their nouns is a well-known fact though more so when the article is suffixed than when prefixed to the noun, *cf.*, the Dakota, Otomi, Basque, and Scandinavian. In the Chonook jargon the French article *le*, *la* was by the Indians fused into one word with the noun following: Lipipan, *le ruban;* liblō, *le bleu*, or purple; lilu, *le loup*. Thus I argue that the Atfálati numeral for *one* became an indefinite article *a* and was coalescing with the noun following it into an inseparable unit.

The same thing occurred in the case of the Kitonāqa prefix āq-, āqk-. We find it, though pronounced somewhat differently, as o'kē, ō'kwē, *one*, the first numeral, *cf*, aiwōm tla ō'kwē, *ten and one*, viz., "eleven;" in what Chamberlain calls the independent form of the substantive and adjective, which through this addition differs from the form as used in composition; tlū, *snow*, āqktlū (independent form). The same radical also occurs in āqktō, *bear one year old;* aqksākes kō'kwes, *one leg;* ā'qkī, *and, again, more* (perhaps "one more" originally).

I therefore consider this prefix as an obsolete indefinite article, which has gradually fused into one solid body with the noun following; we are at leisure to consider it now as a definite or an indefinite article in its original state. It was once *an article* and is now fossilized, like the a- of the Kalapuyan dialects, into the body of the word.

MAMMOTH CAVE IN MARCH.

BY H. C. HOVEY, D.D, BRIDGEPORT, CONN.

I HAVE long been curious to see the great cavern amid wintry surroundings. The capricious season is not without charms to one who can appreciate nature's changing moods. As our train pulled out from Louisville we saw that the tumultuous yellow flood had wholly obliterated the falls of the Ohio, as well as the costly canal around them, and had inundated the broad flats by the great bend below to a breadth of twenty miles. The storms of rain and snow swept over the Kentucky hills that guard the line of the Louisville and Nashville Railroad, but could not wholly hide the rugged grandeur of their naked crags and pointed peaks; while the torrents, rolling southward between bright-red ocherous banks, were far more interesting than their dry courses could be in sultry August. There are said to be five hundred caves in Edmondson County, and several of these are lauded by their owners as rivals to Mammoth Cave. This petty jealousy cropped out in the remarks made to us on our arrival at the Glasgow Junction, where we had to change cars, to the effect that Green River had broken into Mammoth Cave so as to make its avenues impassible; that visitors were not admitted at this season; that the hotel was literally dropping to pieces and had been closed; and, in short, that we had better turn our steps in some other cavernous direction. This local jealousy has occasionally even taken the malignant form of wanton injury to the estate and ugly threats of violence to the manager. Whenever a grander cavern than Mammoth shall actually be discovered (which may sometime be the case), let its claims be allowed; but thus far it stands as the noblest specimen of its kind. As such it has an interest for all patriotic Americans. True, our interest is weakened slightly when we find ourselves taxed fifteen cents per mile on the Mammoth Cave Railroad — a tariff never relaxed by the Nashville company even for excursion parties of hundreds of passengers; and it is further impaired on finding the ancient hotel, if not literally dropping to pieces, yet far from luxurious, or even thoroughly comfortable. It is a great architectural curiosity as having been evolved from a log-cabin germ planted in 1812, but it fails to meet the demands of the modern travelling public. While admiring the good taste that keeps the surrounding forest intact in its native wildness, we should appreciate better walks by which the woodland charms might be made more accessible. We would also respectfully remark that these are days when electric lights are quite generally used, in preference to lard-oil lamps, and nowhere would they be more serviceable than in illuminating the grand subterranean realm of Mammoth Cave, as has long been done at Luray. It is our conviction that the owners of this splendid estate could make no more remunerative investment than by the timely adoption of these friendly suggestions.

And yet justice should be done to the improvements already made by the enterprising manager, Mr. H. C. Ganter, about the hotel and grounds, and especially within the cavern itself. One of the first localities we explored on this visit was Audubon Avenue, the first right-hand branch from the main cave, which when we last saw it was heavily encumbered throughout with great fragments of limestone that made the going very tedious. These have all been removed at great expense, some of them being dumped into a deep ravine, and others piled up in formidable, yet shapely, walls. One object of all this is to prepare the way for the practical cultivation of mushrooms on a scale equal to that at Frèpillon and Méry, in France. Over $5,000 have already been spent in this work under the direction of skilled gardeners, and ultimate success is looked for. Another striking change accomplished recently is the opening for the public of what is to be known henceforth as Ganter Avenue, and which has hitherto been passable only for the guides and hardly for them. It is a wonderful fissure, or rather series of fissures, extending through solid limestone for 8,500 feet, as actually measured by us. The passage, until recently widened, used to be for a great distance only about eight inches wide. But by patient drilling and blasting it has been enlarged so that persons of ordinary size have no serious difficulty in going through. Indeed, it has already been threaded by perhaps a thousand visitors. It twists and winds in the most curious manner, more than two hundred turns having been actually noted, and it is well worth seeing for its own sake. But the main advantage derived from it is that when River Hall is flooded, as it is liable to be during more than half the year, tourists can thus gain the crystalline regions beyond and reach the extreme end of the "long route;" and should they ever be caught there by a sudden rise of the waters, they have this safe way of exit always available. At the time of my visit Echo River, Lake Lethe, the Styx, and the Dead Sea were all united into one vast body of water, extending from Bacon Chamber to Cascade Hall, its depth from surface to bottom being at least 100 feet; and the water was backing up into Gorin's Dome, the Bottomless Pit, and all other pits in the cavern; but not a drop in Ganter Avenue, through which we safely passed to the regions beyond and returned dry shod. The temperature, both of the water and air, is uniformly 54° F. all the year round; the exceptions being in localities where a strong draft lowers the mercury a degree or two, or where the warm air from the lamps, fireworks, etc., gathers in close domes, whence it cannot immediately escape. On the whole, I do not hesitate to recommend Mammoth Cave as a delightful winter resort. The climate is salubrious always, and the sole difference in the cave itself from its summer condition is in the subterranean waters; and even here, if suitable boats were provided, guests might enjoy a charming sail, and they would find the passage-way over Lake Lethe endowed with the same marvellous echoing peculiarities that have made Echo River so famous. By the way, I have never heard mention made of the quite different but equally wonderful acoustic properties of the Chief City. This is an immense hall, 450 feet long by 175 feet wide (as measured by us) in which many Indian relics are found. Stationing ourselves at its opposite sides, as far apart from each other as we could get, we had no difficulty in conversing in ordinary tones or even in the very softest whispers, every faintest sound being faithfully carried across the hall.

It is not my object now to describe the familiar wonders of the great cavern, always the same, winter and summer, and that