

NOTE ON SEICHES OBSERVED AT HAKONE LAKE.

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Towards the end of June of last year, I stayed for two days at the village of Hakone. The weather had been very unsettled and, at the time of my visit, it was both raining and blowing considerably.

On the second day, looking out from the window of the hotel, I noticed that the water was flowing and ebbing with remarkable regularity in a little creek that was so shaped at the mouth that the small waves produced by the wind could not enter it to disturb the smoothness of the surface.

I took the time of this sort of tidal motion, and found that it was 55 seconds for a complete cycle. After noticing what I have just described, I walked along the shore of the lake for several miles, as indicated by doubling the shore line on the accompanying map of the district. At two or three places where there were fairly long creeks, protected from the waves, I observed exactly the same phenomenon that I had seen at Hakone, and the time was the same. The actual rise and fall was so small that it was not measurable without special apparatus. I think that it was certainly under an inch, yet the ebbing and flowing mentioned was very noticeable, small floating objects moving regularly many feet landwards and then lakewards.

At one place, where there was a creek longer than any of the others that I had seen, I observed what appeared to me to be indications that there was a second motion of much longer period than that just described. There was the regular flowing

and ebbing of the unmistakable seich, with a 55 second period, and then there appeared to be a disturbance, the flowing taking longer than the ebbing, till, for one or two cycles there was only flowing, with an interval of complete rest between two waves. After a time, the motion became regular again, but again became irregular, the ebbing this time taking a longer time than the flowing.

The motion of the long period seich—if such it was—was much more irregular than that of the short. So irregular was it, in fact, that it seemed impossible to determine its time with any degree of exactness. Indeed, for long intervals it would not be observable at all. Probably it still existed, but was so far subordinate to the short period seiches that it was not noticeable. Doubtless it would show itself very clearly were a self-recording instrument used. Meantime, I can only say that it seemed to be of a period some ten to fifteen times as long as the short period seich.

In the curve that I have drawn and now show, I indicate what I think would probably, roughly, be the result from a self-recording instrument.

I have not been able to get particulars as to the depth of Hakone lake, but it is known to be very deep. Thus, although the elevation is more than 2,000 ft. above sea level, and the frost must be severe for several of the winter months, there is never any ice formed. The people of the district talk of the water as unfathomable.

The accompanying map shows the form of the lake. It will be seen that it is somewhat irregular.

It would seem that the short period seich was due to the breadth of the lake, opposite to where the observations were made. This is about, on the average, 1,200 metres. Taking the formula of Dr. F. A. Forel, communicated to the Society by Mr. C. D. West some time ago, namely: $h = \frac{l^2}{g \times t^2}$ where h = the depth of the water in metres, l = the length of the

wave in meters, t = the time, in seconds, of a demi-seich, and g , the co-efficient of gravity, in metres, = 9.8088, we get a depth of 194 metres, or say 100 fathoms. This is, indeed, a great depth, but does not seem an impossible one.

The long period seiches are probably due to the length of the lake, and their comparative irregularity is perhaps, as suggested by Mr. West, caused by part of the wave being reflected from the contraction in the width of the lake that there is near the end remote from the vilage of Hakone.

This short note must not be taken as much more than indicating that there are seiches on Hakone Lake, which may be worth investigating more exactly than I was able to investigate them during one rainy day, when I was suffering from influenza.



