

OBJECT OF THE CATALOGUES.

The principal object of the following catalogues, as we have indicated, is to furnish investigators with a certain quantity of material relating to the occurrence of earthquakes, different to that which has hitherto been at their disposal, on account of the want of which it has been impossible to make many desirable enquiries.

Many catalogues exist, like those of Perrey, Mallet, Kluge, de Ballore, and Fuchs, in which the actual number of records are equal to or greater than the number of earthquakes noted in the following pages, and which are equally good as foundations for a particular class of investigations. The incompleteness of these catalogues however, is seen in the fact that they give for the whole world a frequency less than the present list gives for a small portion of it like Japan. If, for example, we take Dr. C. W. C. Fuchs' Statistik der Erdbeben 1865 to 1885, giving a list of some 8,000 disturbances, out of these Japan is credited with from 3 to 30 shocks per year, while a truer estimate would have been from 500 to 1,000. Again, it is often difficult to distinguish between shocks which have shaken

a few square miles and those which have disturbed an Empire. Large shocks and small shocks, primary shocks and after shocks, are with difficulty separable, and no data have been available enabling an investigator to separate disturbances arising from the yeilding of strata in one area from those due to fracturing which might take place in a neighbouring region. Even when the lists of a particular observatory have been examined by themselves, inasmuch as its records are those of shocks of local origin combined with those of shakings which originated at distances of several hundreds of miles, all that we can expect to find is a relationship between earthquake occurrence and influences of a wide-spread character. Such investigations have been made for the records of observatories, countries, and the world, with the result that a more or less pronounced annual and semi-annual periodicity and traces of what is apparently a lunar influence, have been discovered.

No doubt many and very just objections may be made as to the accuracy of much of the material in the present list, but because it enables us to give approximate *weights* to the different shocks, to distinguish between primary and secondary disturbances, and to divide the country to which it refers into distinct seismic or natural districts, it is to hoped that it will open the way for investigations along new lines.

Although the catalogues suggest several investigations hitherto impossible, inasmuch as it so often happens that one enquiry becomes the parent of another, it is impossible to indicate all the paths which may be followed. A suggestion given by the list, which

shews that shocks originating in Japan have travelled to Europe, is that a ring of 12 or 24 stations situated round our globe would in a very short time give us valuable information, not simply about its crust, but possibly also about its interior.

One set of investigations which may possibly lead to interesting results, will be those relating to the frequency and periodicity of earthquake shocks which may be considered as having equal values, or receive values relative to the area they have disturbed. Each of these analyses may be made for Japan as a whole, or for special seismic districts; in the former case the object being to determine whether the occurrence of earthquakes is dependent upon influences which simultaneously affect Japan as a whole, while in the latter case to determine how far their frequency may be related to phenomena of a more local character.

As an example of an influence which affects Japan as a whole, the difference in the summer and winter barometrical gradients crossing the country may be taken, while tidal loads along the coast would be expected to produce effects in different districts at different times.

Not only is it open for us to determine effects due to external influences, but these, so far as possible must be distinguished from effects resulting from internal conditions. The great frequency in district 7 was entirely due to the shocks succeeding a terrible disturbance which took place on October 28th, 1891, and if these after shocks, which at first occurred at the rate of 1,700 per month, and which apparently result from the settlement of disjointed strata, are included in any general

list, it is clear that they might accentuate or destroy any law respecting a long period frequency. What is true for district 7 is also true for district 11. By themselves they yield information about the rate at which an enormous quantity of broken up strata settles to a state of equilibrium, and because the district around the epicentrum is for some time after the primary disturbance in an extreme state of seismic sensibility, it is quite possible that there may be fluctuations in the rate at which quiescence is approached, due to external influences. Other orogenic problems which suggest themselves, are the possible relationships between the seismic activity of the various districts, the times taken for different areas under the influence of secular movement to attain varying degrees of seismic sensibility, and the connection between earthquake occurrence and the geotectonic character of the country. If the object of an analysis is to discover a relationship between earthquake frequency and exogenous phenomena which recur at long intervals, it would seem advisable to omit long lists of after shocks, and only to take into consideration disturbances which occur in districts where seismic activity is in a normal state. On the contrary, should we seek a relationship between the occurrence of earthquakes and phenomena which recur at intervals of not more than a few days, as for example barometrical fluctuations or the rising and falling of the tide, this precaution is hardly necessary.

For the latter investigation, the most desirable lists to use would be those referring to shocks originating beneath the ocean or along the sea board, and as an assistance to this I give the following table, showing the

times of high water at full and new moon on the coasts of the fifteen seismic districts shewn in the small map.

Place.	District.	High Water Full and Change.	
		h.	m.
Nemuro	1	4.	9
Tsugaru Strait	2	5.	0
Hachinohé	3	4.4	0
Yamada.....	4	4.15	
Kinka-san	5	4.30	
Inuboye-saki	6	5.45	
Yedo Bay	6	5.45	
Mia-ura	7	6.00	
Kii Channel	8	6.00	
Bungo Channel.....	9	6.00	
Kagoshima Bay	10	6.50	
Shimabara Gulf.....	11	9.22	
Idzumo Coast	12	1.20	
Echizen Coast	13	2.00	
Toyama Bay	14	3.06	
Off Niigata	15	2.55	

Nothing has been said about the possible relationship between earthquakes and volcanic eruptions, first, because we have no reason to believe that, with the exception of a few feeble shocks which may precede or accompany an eruption, there is any marked direct connection between these two phenomena, and secondly, because the present catalogue does not extend over a sufficiently long period of years to lend itself to such an investigation. Although one or two new investigations have been here suggested, the principal work will be a repetition of old analyses, taking advantage of the fact that we are now able to deal with natural districts, to give earthquakes, where required, relative *weights*, and to distinguish between after shocks, the occurrence of which is but little influenced by epigenic actions of long periodicity and those of a district where seismic strain is in a normal condition.

As to whether seismology will be advanced by carrying out these and other enquiries which may present themselves, is a question which can not yet be answered. It may be or it may not be, but the catalogue which could not have been compiled without the generous assistance of the Royal Society of London and the kindness of the director and officers of the Imperial Meteorological Department of Japan, by allowing access to their unequalled store of valuable facts, will, it is hoped, settle the question as to whether it is desirable to continue in its present form the largest and probably the most perfect seismic survey which has hitherto been attempted.

I am glad to say that some of the features presented by the catalogues are now being analysed by Dr. C. G. Knott, of Edinburgh.