Note on the Distribution of the Intensity of an Earthquake.

BY

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The intensity of earthquake decreases, in general, with the increasing epicentral distance, though in some cases the relation seems to be quite contrary as in the cases of the earthquakes whose epicentres are supposed to have been in the Japan sea, while they were felt only on the Pacific coast of Japan. This general decrement of the intensity with the epicentral distance is true at the first sight, but further investigation shows us that the isoseismic lines are always irregular closed curves. Such a distortion of the isoseismals is partly due to some geological conditions of the ground, as has ever been supposed.

I have intended to smooth out the irregularities of isoseismals which are due to localities, and examined the records of a number of earthquakes. In Japan the intensity of felt earthquakes is to be estimated in a scale of six degrees. The scale is as follows:

6. Violent;—wooden Japanese houses fall down and landslips and other geodynamical phenomena may be observed.
5. Strong;—walls crack and (stone lanterns), gravestones and others overturn, chimneys are shattered.
4. Strong (rather weak); Houses shaken violently and fluids overflow.
3. Weak;—Clocks stop, doors rattle and etc.
2. Weak (rather faint); generally felt.
1. faint; only felt by specially careful men.
o. faint (unfelt); Unfelt but is strong enough to start the automatic starter of Gray-Milnes seismograph.

When the intensities of an earthquake estimated in the above scale at various localities are plotted against the epicentral distances, we may obtain a system of points, which gives the relation between the epicentral distance and the intensity of earthquake. A curve, which representing the mean course of the points system has been drawn, and the departures of the points from the mean curve have been entered in a map. The point above the mean curve shows the intensity at the locality is comparatively strong, and the point under the mean curve represents the place where the shock is comparatively weak. For simplicity I will call the former seismic active and the latter inactive. In Figure I the active regions for a few earthquakes are shown. Of course local effect is eliminated by subtracting the mean departure of intensity for every station. It is a very remarkable fact that pairs of active regions lie, in general, in a symmetrical position about the epicentre.

We have two examples, which have four active regions, but these active regions are not at the same epicentral distance (Fig I a and b).

In majority of cases the active regions are two in pair, because the situation of land and sea is not favourable to give all active regions about the epicentre.

If the islands of Japan are under the isostatic condition of the earth's crust, we may naturally expect that the velocity of propagation on the island is more or less smaller then that under the seas surrounding Japan. As the wave path in the heterogeneous medium turns to where the velocity of propagation is smaller, the rays of the seismic waves emitted from a point are more or less concentrated to the central ridges of Japan.
Second type of distribution of the active regions are that of volcanic earthquakes. In this case there are no decidedly active regions, which is probably the characteristic of the volcanic earthquakes (Fig I c and d). Fig I e and f are of special types with active regions at a very large epicentral distance.

Prof. Shida of Kyōto Imperial University reduced the mode of oscillation at origin from the first shock of earthquake. According to his opinion the most of earthquakes observed in Japan were caused by some horizontal shearing motion at origin. As a natural consequence, according to his opinion, the intensity of earthquake must be greatest for the rays emitted in the horizontal direction from origin, hence the active regions must be found at a certain epicentral distance. Fig II. shows the frequency of occurrence of the active regions at different epicentral distances. From the figure, we will find that the most frequent epicentral distance is about 200 km, for which the depth of origin will be about 30 km. This depth is the least limiting value of the earthquakes examined.

Conclusion: The seismic intensity very rapidly decreases as the epicentral distance increases. This intensity decrement varies with the direction from epicentre, probably in some direction the intensity
is larger than in others. As the natural consequence of this inequality of intensity decrement, in certain localities the intensity is comparatively large. If these comparatively strongly shaken localities be at such an epicentral distance that Shida's model requires, the depth of origin can be calculated from the epicentral distance. This consideration gives about 30 km as the mean depth of origins.

There are also local effect on the intensity, which is very interesting subject for further investigation.

The earthquakes occurred in the Japan Sea had special distribution of intensity as already mentioned. A probable explanation of the distribution of intensity for the case is given by this anomalous distribution of intensity.