

# On Earthquake Zones in Central Japan.

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**I. Introductory.** The four principal Japanese islands, namely, Hokkaido, Honshu (Main Island), Shikoku, and Kyushu, are arranged in a curvilinear form\*, which may be divided into two

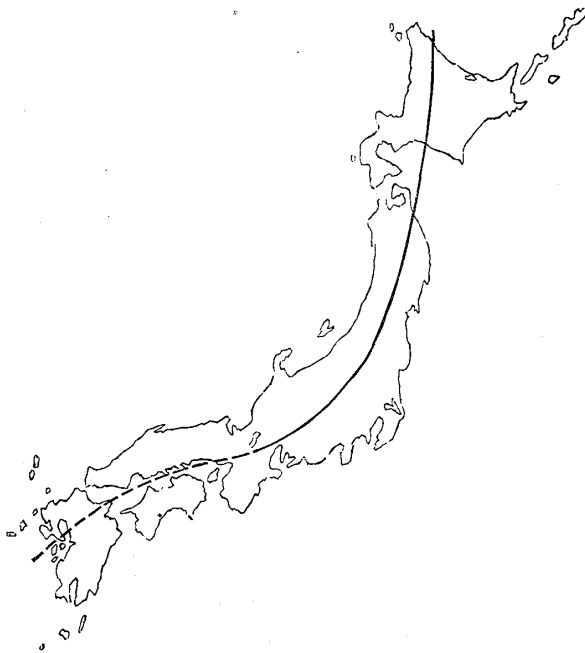


Fig. 1.

The curve shows the arcual form of the northern half of Japan, while the dotted line shows that of the south-western half.

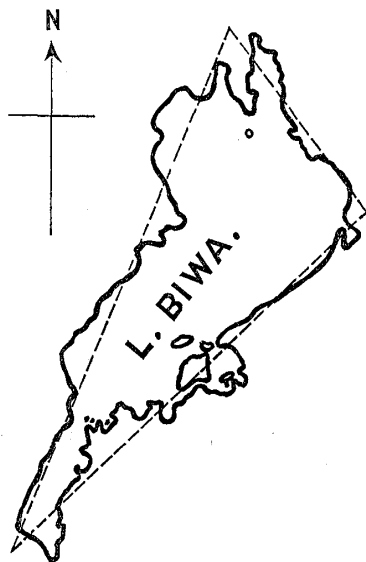
portions, namely, the northern and south-western halves, whose curvatures are turned in opposite directions; their convex sides facing towards SE and NW respectively. Omi, Iga, and the neighbouring provinces may be regarded as forming the junction between the two component arcs; and it is a noteworthy fact that we have just there great complicat-

ions of topographical features, resulting in the formation of the Bays of Tsuruga and Ise, and the lake of Biwa. The latter, greatest of the sort in Japan, forms together with the Bay of Osaka a depression zone, whose direction is inclined at an angle of

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\* See the *Bulletin*, No. 2.

Fig. 2.  
Showing the  
approximate  
form of the  
Lake Biwa.



$45^{\circ}$  to the central line or arc of the Japanese islands. As shown by the dotted line in Fig. 2, the Lake of Biwa is roughly triangular in form, and it is the object of the present note to see, if any, the relation among the earthquake zones in Central Japan with reference to the lake.

## 2. Zones of Destructive Earthquakes in Central Japan.

Great destructive earthquakes in Central Japan, whose origins can be more or less accurately ascertained, are the 5 following:—

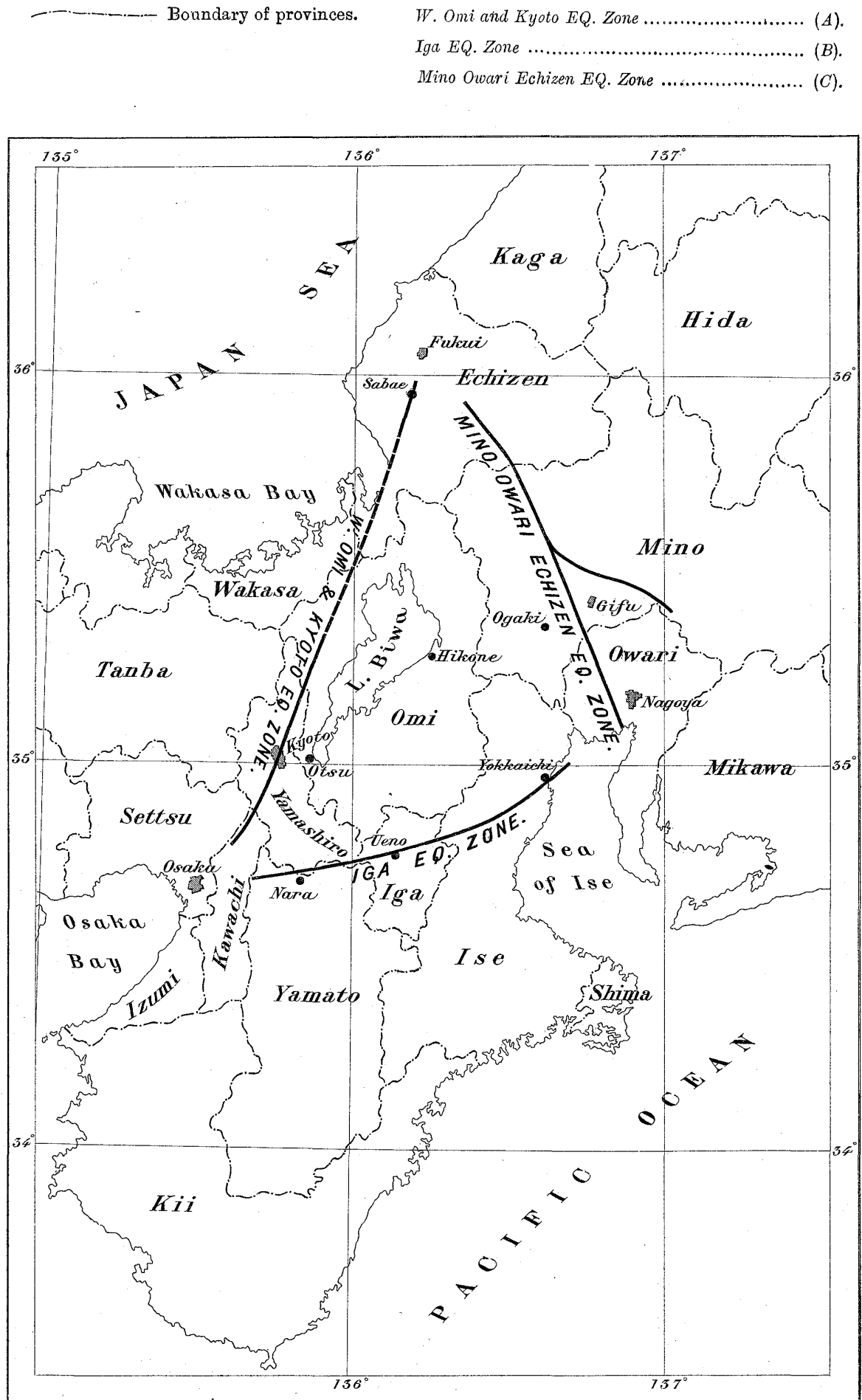
- (i) Eqke of the 1st year of Keichō : Sept. 4, 1596.\*
- (ii) „ „ 2nd „ Kwanbun : June 16, 1662.
- (iii) „ „ 1st „ Tempō : Aug. 19, 1830.
- (iv) „ „ 1st „ Ansei : July 9, 1854.
- (v) Mino-Owari Eqke : Oct. 28, 1891.

The Keichō earthquake (No. i), which was very violent and became famous from the destruction of the great Fushimi Castle erected by Taikō (Toyotomi Hideyoshi), had its origin in the district extending from the southern part of Kyōto to the towns of Fushimi and Yodo. On the other hand, the Kwanbun earthquake (No. ii), which was very violent and extensive in area, originated about 40 km to the NNE of the first earthquake, namely, to the west of Mount Hira, at the boundary of the northern part of

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\* Prior to this date there were several destructive earthquake in Kyoto and the vicinity, the earliest great shock having occurred in 827. It is, however, impossible to locate exactly their origins.

Fig. 3. Earthquake Zones in Central Japan.



the province of Yamashiro and the western part of the province of Ōmi. The Tempō earthquake (No. iii), which was smaller than the Keichō and Kwanbun shocks, originated between the centres of the two latter, being strongest in the northern part of Kyōto and the adjacent region to the north. Thus, it will be observed that the three earthquakes above mentioned all originated along a line which extends from the western part of Ōmi to the vicinity of Ōsaka, in the direction of N20°E and S20°W. This earthquake zone, which may be called **A-Zone**, (Fig. 3), passes on the north through the city of Fukui (province of Echizen); it being specially interesting that the severe earthquake of March 22, 1900, which was felt strongly in the vicinity of the town of Sabaé (Echizen), originated just on the northern prolongation of the zone under consideration. It will be seen that the occurrence of the different earthquakes along **A** was in accordance with the principle explained in the next Article.

The Ansei earthquake\* (No. iv) was a very extensive shock and was most violent about the city of Uéno (province of Iga), the epifocus, **B-Zone** (Fig. 3), being a zone about 100 km in length, which extends in a mean direction of S70°W—N70°E from the vicinity of the city of Nara (province of Yamato) to that of the city of Yokkaichi (province of Ise). The western end of this zone also points to the city of Ōsaka, on the head of the Ōsaka Bay.

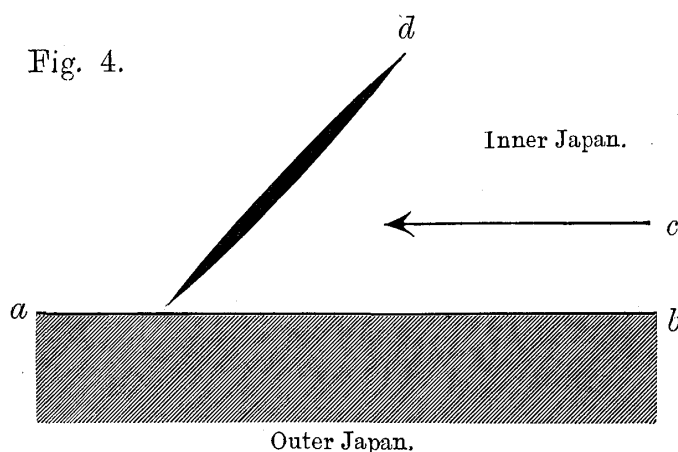
Finally, the great Mino-Owari earthquake was caused by tectonic disturbances which produced faults extending from the central part of the province of Echizen to the south-eastern part of the

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\* This is different from the two great earthquakes, also in the 1st year of Ansei, which originated off the south-western coast of Japan, respectively on the 23rd and 24th, Dec. 1854.

province of Mino, the vertical and horizontal convulsions of the ground being most markedly manifested in the famous Néo-Valley of the latter province. There was very probably an underground line of disturbance which formed a direct southern prolongation of the Néo-Valley fault, reaching down to the head of the Bay of Ise. On the whole, the direction of the epifocus, **C**-Zone, (Fig. 3), of the Mino-Owari earthquake was N 20° W —S 20° E.

The three earthquake zones, **A**, **B**, and **C**, form approximately a right-angled triangle, whose hypotenuse is **A**, and whose right angle is formed by **B** and **C**, these two latter sides being inclined to the former at an angle of 45° or 50°. The great destructive earthquakes in the central part of Japan seem always to originate at some parts of the sides of this seismic triangle, which is roughly similar to, and similarly situated as, the triangle formed by the Lake Biwa. It thus appears probable that the latter was formed as the result of the existence of some forces in the earth's crust in this part of Japan. The zones **B** and **C** may be regarded as being respectively *parallel* and *normal* to the general arc or central line of the Japanese islands.



The formation of the zone **A** may be explained by the application of the theory of the *secondary*, or *shear*, cracks accompanying the fault produced in the epifocal zone of a destructive

earthquake.\* Thus let  $ab$  (Fig. 4) represent the boundary between the convex, or outer, side and the concave, or inner side, of the Japan arc. If now the latter side be sheared relatively to the former as shown by the arrow  $c$ , then there ought to be produced some oblique cracks, as  $d$ , which is inclined to the boundary line,  $ab$ , at an angle of  $45^\circ$ .  $d$  corresponds to the seismic zone **A** or the depression formed by the Biwa Lake and the Osaka Bay. That some such action of the terrestrial forces as above imagined took place seems probable, since the geological formations on the exterior or convex side of the Japan arc are regular in arrangement, while those on the inner or concave side are very irregular and complicated.

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\* See the *Bulletin*, No. 1.

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