

# STUDIES IN THE DISTRIBUTION OF GRAVITY ANOMALIES IN NORTH-EAST HONSHU AND THE CENTRAL PART OF THE NIPPON TRENCH, JAPAN.

by

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Under the title *Studies in the Distribution of Gravity Anomalies in North-East Honshu and the Central Part of the Nippon Trench, Japan*, in the Japanese Journal of Astronomy and Geophysics, Transactions, Vol. XVII, N° 3, Tokyo, 1940, pages 475 to 551, the National Research Council of Japan publishes an important article concerning gravimetric measures, their anomalies and their comparison with certain geological or seismological phenomena in the interesting continental and maritime region close to the Nippon Trench.

We reproduce below part of the Introduction of these studies, and also the comparison made by the author between the phenomena occurring in this region and that which occur in the region of the Java Trench in the Netherland East Indies.

The report of Naoiti KUMAGAI is followed by a very complete documentary bibliography.

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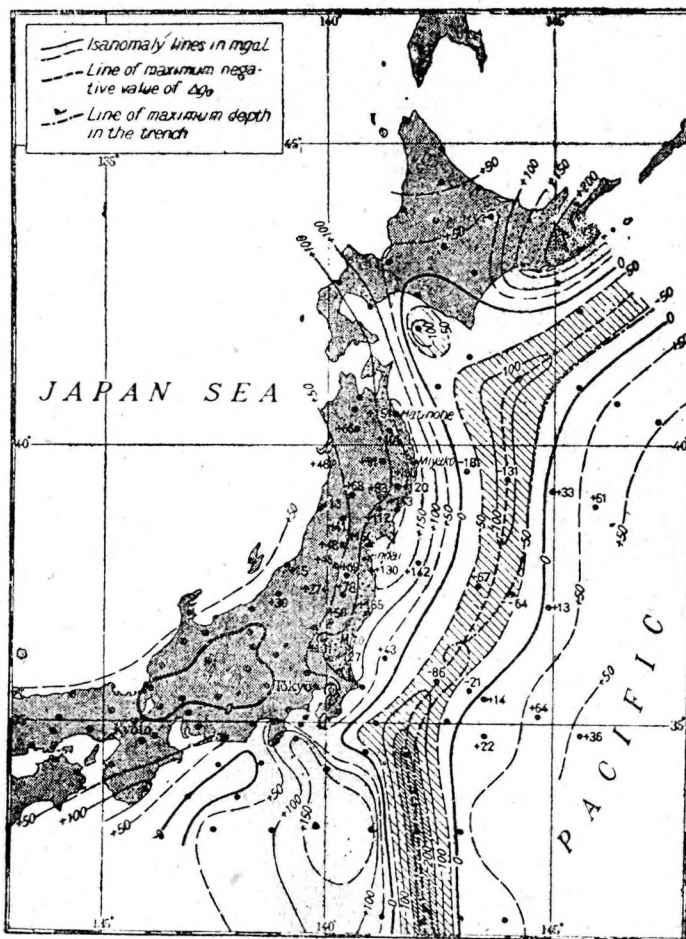
## INTRODUCTION.

It has been noticed for a long time that the anomalies of gravity in North-East Honshu, Japan, determined with the free-air or Bouguer's method of reduction, rapidly increase toward the Pacific coast, where they reach unusually great values, particularly near the coast. In 1927, HEISKANEN published a short article on the results of isostatic reductions of 80 Japanese gravity stations by Hayford's method with a depth of compensation of 113.7 km. Although, of the stations in North-East Honshu, about one-third were omitted from his reductions, the isostatic anomalies obtained by him indicate that they increase also toward the Pacific coast, showing large values near the coast. In 1929, the same (Hayford's) method was used for the whole of the 122 stations in Japan by members of the Astronomical Observatory of the Kyoto Imperial University under the superintendence of the late Dr. S. SHINJO. Graphical representations of the isostatic anomalies thus obtained and other gravity data were prepared in three sheets of maps by Prof. M. MATUYAMA and the present writer, and these maps were then presented by the Japanese Geodetic Commission to the Japanese Section of the International Exhibition in Commemoration of the Centenary of the Independence of Belgium, held at Liège in 1930. The isostatic anomalies thus obtained in North-East Honshu also increase towards the Pacific coast, showing large positive anomalies near the coast.

At the annual meeting of the Physico-Mathematical Society of Japan, held at Kyoto in 1931, the writer read a paper on the structure of the crust under North-East Honshu as considered from Bouguer anomalies. Owing however, to lack of gravity data on the contiguous surface of the Pacific, the writer's effort to reach more rigid conclusions were scarcely possible.

With the object of making gravity surveys on the sea and the isolated islands in the Pacific, near Japan, the Japanese Geodetic Commission ordered a set of Meinesz's pendulum apparatus from the Nederlandsche Seintoestellen Fabriek, Holland. This was placed at our disposal in July, 1932. The first sea gravity survey by the Commission was made in October 1934, in the central part of the Nippon Trench and south of Hokkaido, on board H.I.J.M.

Submarine *Ro-57*, commanded by Lieutenant-Commander A. HUDII, Captain T. AKIYOSI, of the Hydrographic Department of the Imperial Japanese Navy, who participated in the survey, undertook the important task of determining the positions and the velocities of the boat, Prof. M. MATUYAMA being the superintendent of the survey, the present writer had charge of the pendulum observations, assisted by Messrs. M. HURUTANI and S. TANABE.



After completion of the above gravity survey, the present writer, assisted by Mr. M. HURUTANI, carried out determinations of the constants of the pendulums and apparatus, by means of which the reductions of the above marine pendulum observations were completed (\*), the results of which have already been published.

The intensities of gravity thus obtained over the continental slope of North-East Honsyu and the Nippon Trench now supply us with valuable data, with the aid of which it will be possible to enquire into the state of the earth's crust of the North-East Honsyu in greater detail and with better data than at the time of the writer's previous work just mentioned, as also the state of the crust below the sea bottom on the Pacific side.

The present study may be summarized as follows :

The relief of land and sea bottom and also the distribution of the free-air anomalies on sea and Bouguer anomalies on land are treated two-dimensionally, the curvature of the

(\*) The details of determinations of the constants and those of reductions of the pendulum observation will shortly be published.

earth's surface being neglected. Based upon Pratt's hypothesis of isostasy, isostatic reductions are made for various depths of compensation and the most probable depth obtained. The isostatic gravity anomalies obtained for the most probable depth are very large, that is, the isostatic equilibrium is greatly disturbed; below the total areas of land and sea, the departure from a complete compensation, with its signs disregarded, is on the average in the neighbourhood of 100% of the computed anomaly. These isostatic gravity anomalies are closely related to certain geological facts, from which viewpoint these anomalies are interpreted as the resultant effects of the deficient density of the sedimentary formations and the excessive densities of the batholith and the unseen batholith both underlying the above sedimentary formations. From the distribution of the anomalies, the vertical thicknesses of the formations and the depth of the bottom of the batholith below sea level are obtained. What is remarkable is that the strips of positive and negative isostatic gravity anomalies, that are contiguous with one another, coincide with the zones in which earthquakes are very frequent, whence it would appear that the cause of these earthquakes is closely related to isostatic adjustment. It is also noticed that isostatic anomaly field of gravity dealt with in this paper is markedly similar on various points with that found by Prof. F.A. VENING MEINESZ for the area comprising Java-Sumatra and the Java Trench.

The isostatic reduction by Airy's hypothesis of isostasy, which is now under progress, will be published in the near future.

#### COMPARISON OF NORTH-EAST HONSYU AND THE NIPPON TRENCH WITH JAVA-SUMATRA AND THE JAVA TRENCH.

The isostatic anomaly field of gravity found by F.A. VENING MEINESZ in the area covering Java-Sumatra and the Java Trench, has been studied from the geological side by J.H.F. UMBGROVE, and from the morphological side by Ph. H. KUENEN. Of the various facts pointed out by these authors, some are strikingly analogous with what has already been noticed for North-East Honsyu and the Nippon Trench. These will now be summarised.

(1) The distributions of the isostatic gravity anomaly are parallel to the longitudinal arrangement of topography both of land and the sea bottom.

(2) The strip of large negative isostatic gravity anomaly is bordered on its two sides by the fields of positive anomaly; this negative strip, which does not coincide with the Java Trench and its northwestern continuation, runs over the zone that lies between the ocean-ward coast of Java-Sumatra and the line of maximum depth of the trench.

(3) The alignment of the recent volcanoes of Java-Sumatra is parallel to the isanomaly lines.

(4) The negative strip occurs in a zone that swarms with epicenters of strong earthquakes.

It might be added to (4) that in the case of North-East Honsyu and the Nippon Trench, the negative strip occurs also in a zone that swarms with epicenters of conspicuous earthquakes. But it is characteristic of our case that the zone of the epicenters extends into the land and covers nearly the whole of the positive strip that is in contact with the negative strip.

(5) As to the negative strip in the case of Java-Sumatra, there is a row of islands and submarine ridges where are found the only areas in which an intensive miocene folding is known. In the negative strip in our case, there is neither island nor submarine ridge, but the average profile of the sea bottom under the negative strip has an upward bulge. The upward bulge might be seen to be analogous to the above mentioned submarine ridge. The rock constituting the sea bottom in our case is, as already inferred, Cenozoic.

It is worth noticing that North-East Honsyu is unlike Java-Sumatra on the following points :

(a) A number of the recent volcanoes in Java-Sumatra occur within the field of positive isostatic gravity anomaly on land, while in North-East Honsyu, except for the Nasu volcanic chain which runs nearly along the boundary between the negative field and the positive strip, the volcanic chains occur in the field of negative anomaly on land.

(b) No field of negative isostatic gravity anomaly occurs in the area of Neogene folding in Java-Sumatra, whereas in the Miduho folded zone, which is Miocene and Pliocene strata folded during late Pliocene, there is a field of negative anomaly.

(c) Although both Honsyu, which is the main part of the Nippon Islands, and Java-Sumatra are members of the groups of islands that make up the south-eastern margin of the Asiatic continent, the northern area of Java-Sumatra is continental, as indicated by the existence of a shallow sea of depth less than 200 meters and large land masses, such as Borneo and Malacca, while, in our case, the Japan Sea is a deep of depth more than 2000 meters, embracing no island, except for those islets that fringe the northern coast of Honsyu and lie off the southeastern coast of Tyosen (Korea).

