

IZU-OGASAWARA (BONIN) ARC AND TRENCH INVESTIGATIONS JUNE AND OCTOBER-NOVEMBER 1974 GH 74-3 AND -6 CRUISES

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INTRODUCTION

The Geological Survey of Japan is engaged in a five year programme of marine geological investigations on the continental shelves and slopes around Japan beginning from 1974 up to 1978. The investigations will provide fundamental information about the geology of the continental margin for social and economic needs. The final results of the investigations will be expressed in geological and sedimentological maps on the scale of 1:200,000 and geological reconnaissance maps on the scale of 1:1,000,000.

For the investigations, the geological research vessel "Hakurei-maru" is chartered from the Metal Mining Agency.

In 1974 (financial year), the G.S.J. has carried out geological investigations in four areas of continental margin over a period of 100 days, as follows:—

No. of cruise	duration	month	areas and objects
GH 74-1	5 days	April	Sagami-nada Sea. For tests of survey machinery.
GH 74-2	20 days	May	Sagami-nada Sea. For mapping the geology of the sea bed.
GH 74-3	20 days	June	Around the Izu-Ogasawara Arc and Trench. For reconnaissance geological research.
GH 74-4	20 days	July	South of the Kii-suido channel. For mapping the sea bed and investigation of superficial sediments.
GH 74-6	5 days	Oct.— Nov.	Izu-Ogasawara area. For supplementary research.
GH 75-1	30 days	Jan.— Feb.	Around Ryukyu Islands. For reconnaissance research.

This report is concerned with the outline of the work and the preliminary results of geological investigations in GH 74-3 and -6 cruises which were carried out in the area around the Izu-Ogasawara Arc and Trench from June 10 to 29 and October 27 to November 1.

GENERAL REMARKS OF THE AREA SURVEYED

The area surveyed extends between 34°50'N-24°55'N and 137°00'E to 144°15'E as shown in Fig. 1.

The area covers the Izu-Ogasawara (Bonin) Islands and Trench, the eastern margin of the Shikoku Basin and the deep sea floor of the northwest Pacific.

The area occupies a geologically important situation in terms of understanding the

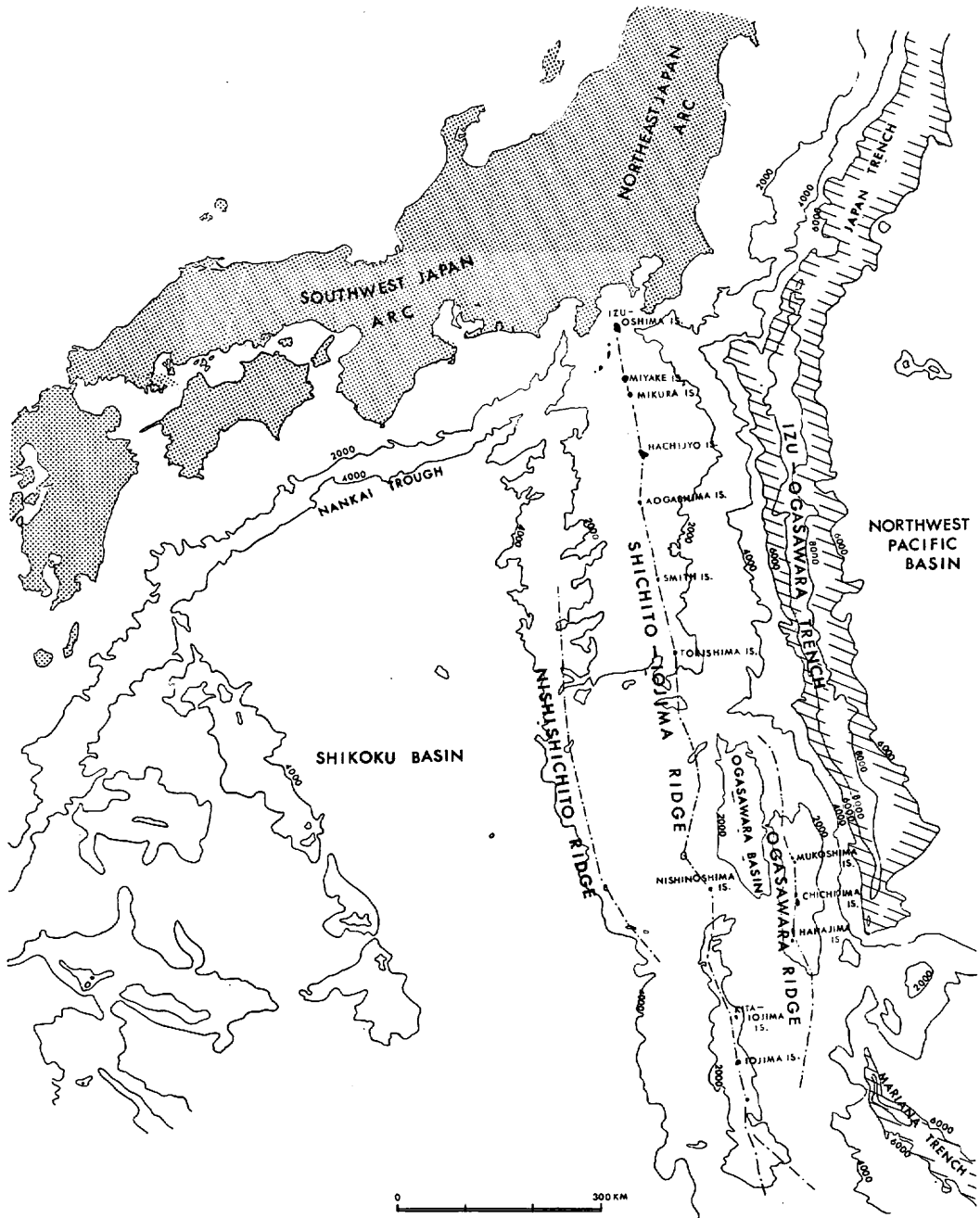


Fig. 1 Distribution of ridges and basins in the area surveyed around Izu-Ogasawara (Bonin) Arc and Trench.

origin of the Japan Arc and the relations between ocean and continental crusts; i.e., the Izu-Ogasawara Arc is considered to be the southern extension of the Northeast Japan Arc, while the trench marks the boundary between the Pacific and the Philippine Sea Plates.

For several years the geological significance of the arc-trench system has been stressed by geologists and geophysicists concerned with plate tectonic movement.

Geological and geophysical characters of the area surveyed

1. Izu-Ogasawara (Bonin) Arc

The island arc lies between the Northeast Japan and Mariana arcs with an extension of 1,350 km. The width of the arc at depths of less than 4,000 m is about 400 km.

The arc is a typical island arc accompanied by a trench, active volcanism and deep earthquakes. The arc also has a double structure of inner and outer belts, similar to other typical island arcs in the Pacific.

The Izu-Ogasawara Arc consists of three ridges striking parallel to each other; namely, the Ogasawara Ridge to the east, the Shichito-Iojima Ridge in the central part and the Nishi-Shichito Ridge to the west. The Ogasawara Ridge, which extends 100 km in a N-S direction, is adjacent to the trench to the east and is separated from the Shichito-Iojima Ridge by a trough to the west. The Ridge is represented above sea level by the Chichijima, Hahajima and Mukoshima Islands. The islands consist mainly of pyroxene and quartz andesites intercalated with limestone containing *Nummulites* of Eocene age. No Quaternary volcanics are present. These rocks are weakly altered and have been deformed during the Bonin-Palau Tectonic Movement (FUJITA, Y. 1975).

The Shichito-Iojima Ridge comprises the main part of the Izu-Ogasawara Arc. The northern part of the ridge connects with the Fossa-Magna Zone, while the southern part continues to the Mariana Ridge.

The Shichito-Iojima Ridge consists of a chain of active volcanoes, namely, these are Izu-Oshima, Miyakejima, Mikurajima, Hachijojima, Aogashima, Myojinsho, Smithjima, Torishima, Nishinoshima, Kita-Iojima, Iojima and Minami-Iojima Islands from north to south. These volcanic islands are composed of Quaternary tholeiitic rocks. The islands from Izu-Oshima to Torishima consist mostly of olivine and pyroxene basalts and the other islands are composed of olivine and pyroxene andesites. The ridge of the active volcanoes is defined as the volcanic front of the Izu-Ogasawara Arc.

The Nishi-Shichito Ridge is situated on the western side of the Shichito-Iojima Ridge and separated from the latter by a rather indistinctive basin. Since the ridge has no island expression, geological knowledge of the ridge is poor. It is probable that the ridge is composed mainly of volcanic rocks as such rocks have been previously dredged from the ridge.

There are some small ridges trending in a NE-SW direction at the northern extension of the Nishi-Shichito Ridge. Parts of the small ridges appear above sea level as the islands of Niijima, Toshima, Udonejima and Kozujima, composed of high alumina basalts of Quaternary age. It is a problem whether these volcanic islands belong to the Nishi-Shichito or the Shichito-Iojima Ridges.

2. Izu-Ogasawara Trench

The Izu-Ogasawara Trench is situated between the Japan and the Mariana Trenches. The trench runs parallel to the Izu-Ogasawara Arc and is approximately 850 km, 80–90 km and 9,700 m in length, breadth and a maximum depth respectively. The slopes of the trench are steep; at about 15–20°. The eastern slope of the trench merges into the abyssal plain of the northwestern Pacific at a depth of 5,000–6,000 m and the western slope continues to the gentle slope of the Izu-Ogasawara Arc at about 5,000 m.

There are submarine valleys, deep benches and grabens on the slopes. The bottom of the trench is flat and very narrow. The Izu-Ogasawara Trench does not extend southward into the Mariana Trench as there is a rise or plateau between both the trenches. The plateau, the Ogasawara plateau, consists of seamounts and guyots at the depths of 1,000–2,500 m, runs in an E-W direction across the trenches and is about 30 km wide. Although the plateau has been considered to be relic of western part of the Darwin Rise (MOGI, S. 1972), the nature of the plateau is unknown in detail. Therefore, further geological investigation of the plateau is needed in order to understand the origin of the trench system and the plate movements of the Pacific.

3. Geophysical characteristics of the area

Gravity anomalies: Along the Izu-Ogasawara Arc high free-air anomalies of 100 mgal have been measured, while low anomalies of –100 mgal are distributed over the trench. The parallel nature of the low and high anomalies along the trench and arc is common to the other arc-trench units of the Pacific.

Heat-flow: A high heat-flow area is limited to the Shichito-Iojima Ridge, which is a volcanic front, and a highest value of the area attains 2.5–3.0 HFU near Nishinoshima Island. From the ridge the value of heat-flow decreases to 1.5–1.0 HFU in the trench.

Earthquakes: According to the distribution of the epicenters of earthquakes around Japan by KATSUMATA and SYKES (1969), shallow earthquakes occur at focal depths of 70 km along the Izu-Ogasawara Trench. Deep earthquakes at focal depths of 300–400 km increase toward the island arc from the trench and deep earthquakes with a focal depth of more than 410 km occur to the west of the arc. The mechanism of earthquakes is such that the axes of maximum compression coincide at right angles to the extension of the arc-trench. Such distribution of earthquakes is interpreted as evidence for the underthrust of the Pacific plate beneath the Philippine Sea plate. According to the opinion of NAGUMO (1970), uplift of the Izu-Ogasawara Arc resulted from the underthrusting of the Pacific plate, while SUZUKI (1970) considered that the uplift of the arc resulted from vertical movement aided by high angled faults.

As briefly mentioned above, the area surveyed includes a typical island arc-trench unit which has significance in solving problems related to the plate tectonics theory in the Pacific Basin.