Technical Report

海洋情報部研究報告 第 51 号 平成 26 年 3 月 24 日
REPORT OF HYDROGRAPHIC AND OCEANOGRAPHIC RESEARCHES No.51 March, 2014

Newly discovered submarine volcano near the Tokara Islands†

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Abstract

A submarine volcano was newly discovered near the Tokara Islands in the Okinawa Trough through a survey using a multibeam echo sounder. The volcano is located at 25 km north to the Takara Shima Island and the water depth is about 300 to 500 m. The volcano has a small caldera with a diameter of 1.6 km, consisting of two central cones and nine craters.

1 Introduction

Hydrographic and Oceanographic Department, Japan Coast Guard (JHOD) is acquiring detailed bathymetric data as fundamental information in Japan's territorial water and Exclusive Economic Zones (EEZs) for ensuring marine interests and integrated management of the ocean. The bathymetric mapping in the Nansei-Shoto region, south of Kyushu, Japan is now in progress (Fig. 1-1).

In 2013, JHOD conducted a bathymetric survey around the Tokara Islands, which are located south of Kagoshima. The Tokara Islands are in the volcanic front formed by the subduction of the Philippine Sea plate below the Eurasian plate. Some active volcanoes including Kutino Shima Island, Nakano Shima Island and Suwanose Shima Island exist in the volcanic front, and discolored water has frequently been observed in Akuseki Shima Island, Yokoate Shima Island and so on. In the back-arc region behind the volcanic front, there are lots of bathymetric highs such as Gogo-Sone ("Sone" means shoal in Japanese), Tawara Sone, Shirahama-Sone, and Naka-no-Sone. Although the presence of volcanic rocks was known (Yokose et al., 2010; Yokose, 2010) from these highs, volcanic activities were not reported.

This report describes the newly discovered submarine volcano with a caldera, central cones, and craters in the northern part of Takara Shima Island by the bathymetric survey using multibeam echo sounder (MBES).

2 Survey Details

2.1 Survey Area

The survey area is located about 25 km north off Takara Shima Island (Fig. 1-2). The water depth ranges from 200 to 700 m.

2.2 Date and Survey Vessel

The survey was conducted from April to May in 2013. The platform used for the survey was the

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JHOD's Survey Vessel *Shoyo*. The vessel specifications are 3,000-tonnages, 98 m in length, 15.2 m in beam, and 5 m in draft.

2.3 Data Acquisition

A hull-mounted Kongsberg EM 122 MBES system was used for the bathymetric data acquisition. The EM 122 is a sonar for deep water mapping. The operating depth is between 10–11,000 m using a frequency of 12 kHz. It transmits 288 beams with 2 degrees beam width and forms 432 depth soundings in maximum per swath. The details of the EM 122 system installed on S/V *Shoyo* are listed in Table 1.

Table 1. Details of EM 122 data acquisition system.
表 1. EM 122 データ収録システムの詳細.

	Equipment	Manufacturer	Model
Echo Sounding	Transducer (Tx)	Kongsberg Maritime	EM 122
	Receiver (Rx)	Kongsberg Maritime	EM 122
	Work station	Kongsberg Maritime	HWS 14
	Acquisition software	Kongsberg Maritime	SIS 3.9.2
Position/ Attitude	GPS antenna	AeroAntenna Technology	–
	Differential GPS	Hemisphere	MBX-3S
	IMU	Kongsberg Seatex	MRU 5
	Processing unit	Kongsberg Seatex	Seapath 300
Sound Speed	Surface sound speed	AML Oceanographic	Smart SV&T
	Sound speed profile	The Tsurumi Seiki Co., LTD.	XCTD-1

2.4 Data Processing

During the data acquisition, sensor offsets, angular biases in pitch, roll, yaw and timing offset, and attitude corrections in heave, pitch, roll, and heading were applied to the MBES data in real time. Surface sound speed and sound speed profile are also input in real time for beam forming and ray tracing. During the post processing, only static draft correction was made. Tide corrections were not applied to the MBES data. This is because the survey area was far away from the coast, therefore the difference of the water level between the gauge in near island and survey area may be large. In this case, it is difficult to make accurate tide correction. The survey area is deep enough from 200 to 700 m depth, so the effect of tide correction (1–2 m) is relatively small and does not affect large scale topographic determination.

After all of these corrections were made, noises were removed manually and grid data were created from the soundings. Any filters were not used for data cleaning. Grid cell size is 15 m and CUBE algorithm was used for gridding in CARIS HIPS and SIPS version 8.0.2.

3 Results

Bathymetric map created from the 15 m grid data is shown in Fig. 2. The geomorphological interpretation is depicted in Fig. 3. The bird's-eye view images from north, east, south and west are shown in Fig. 4. The volcano has circular shape and a caldera is in the center and the diameter is about 1.6 km. The relative elevation is nearly 170 m. Two central cones exist inside the caldera. The shallowest point of the cones is 282 m in depth and the deepest point of the craters is 453 m in depth. Nine volcanic craters with the diameter of 200 to 400 m are also found inside and outside the caldera. Some craters are located outside the caldera.

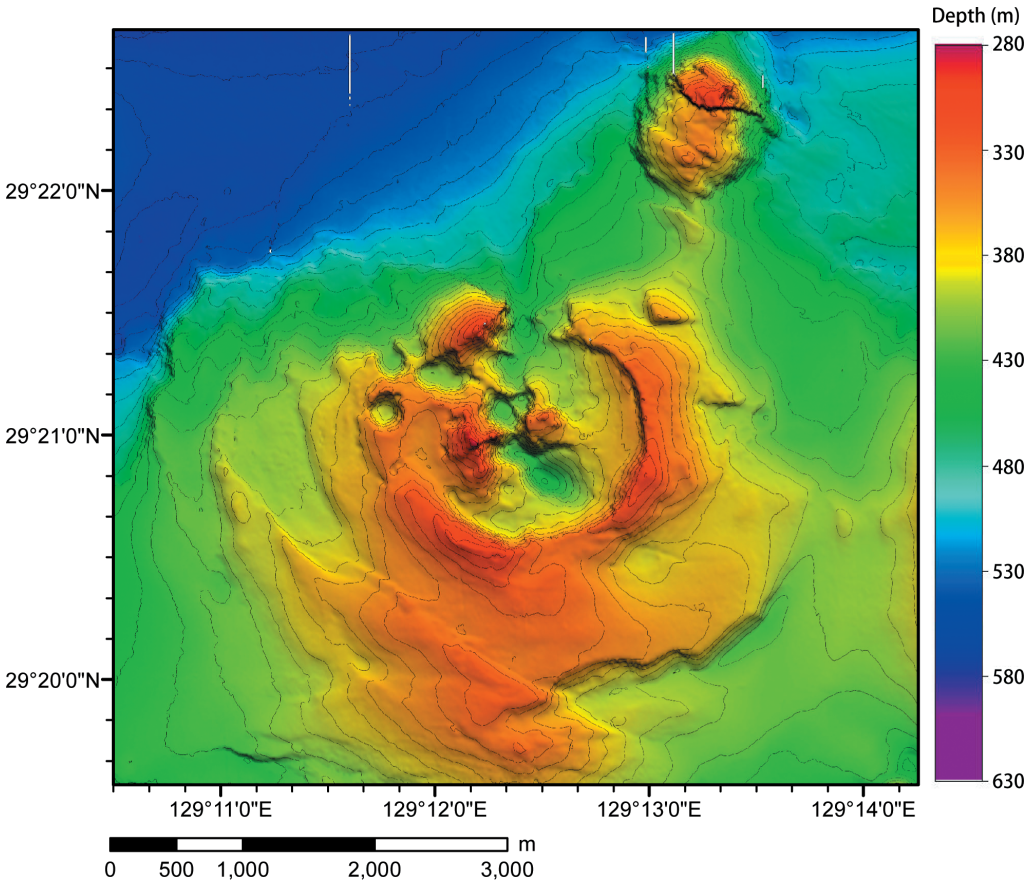

Fig. 2. Bathymetric map of the newly discovered volcano (contour interval is 10 m).
図 2. 新たに発見された火山の地形（等深線の間隔は 10 m）.

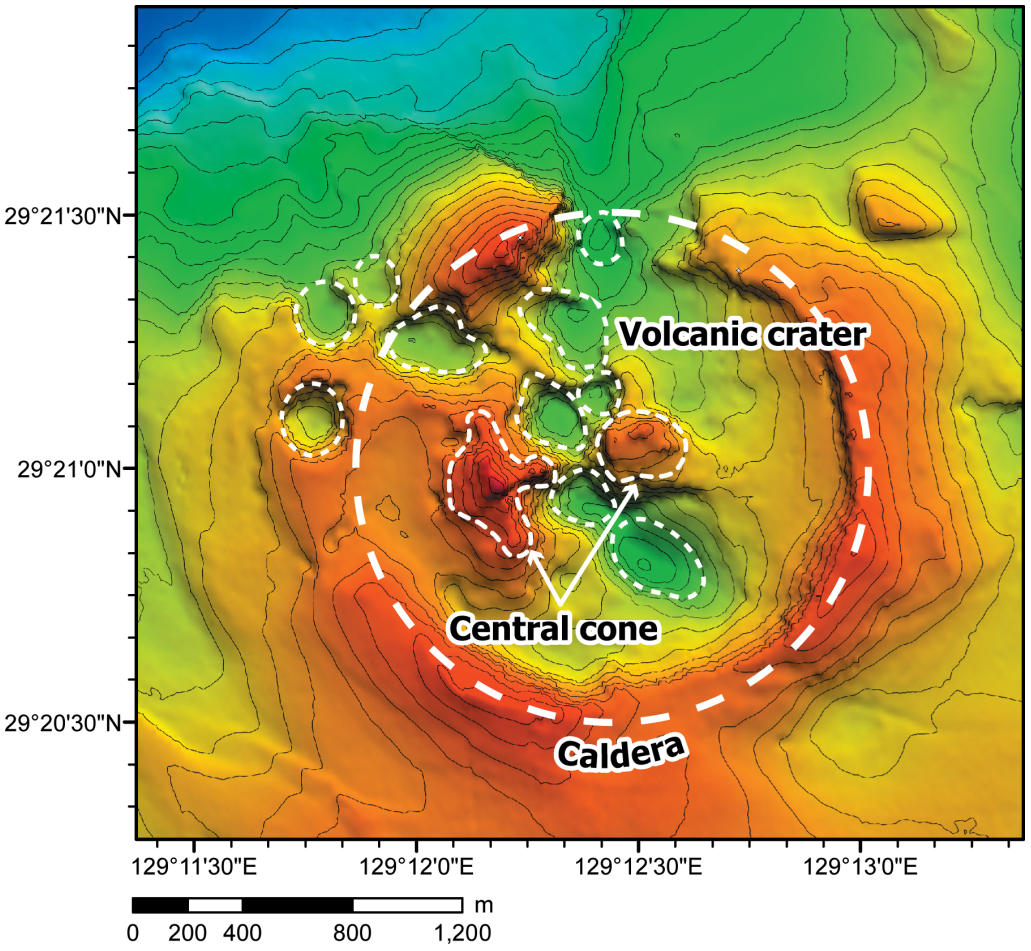

Fig. 3. Geomorphological interpretation of the volcano.
図 3. 火山地形の地形学的解釈.

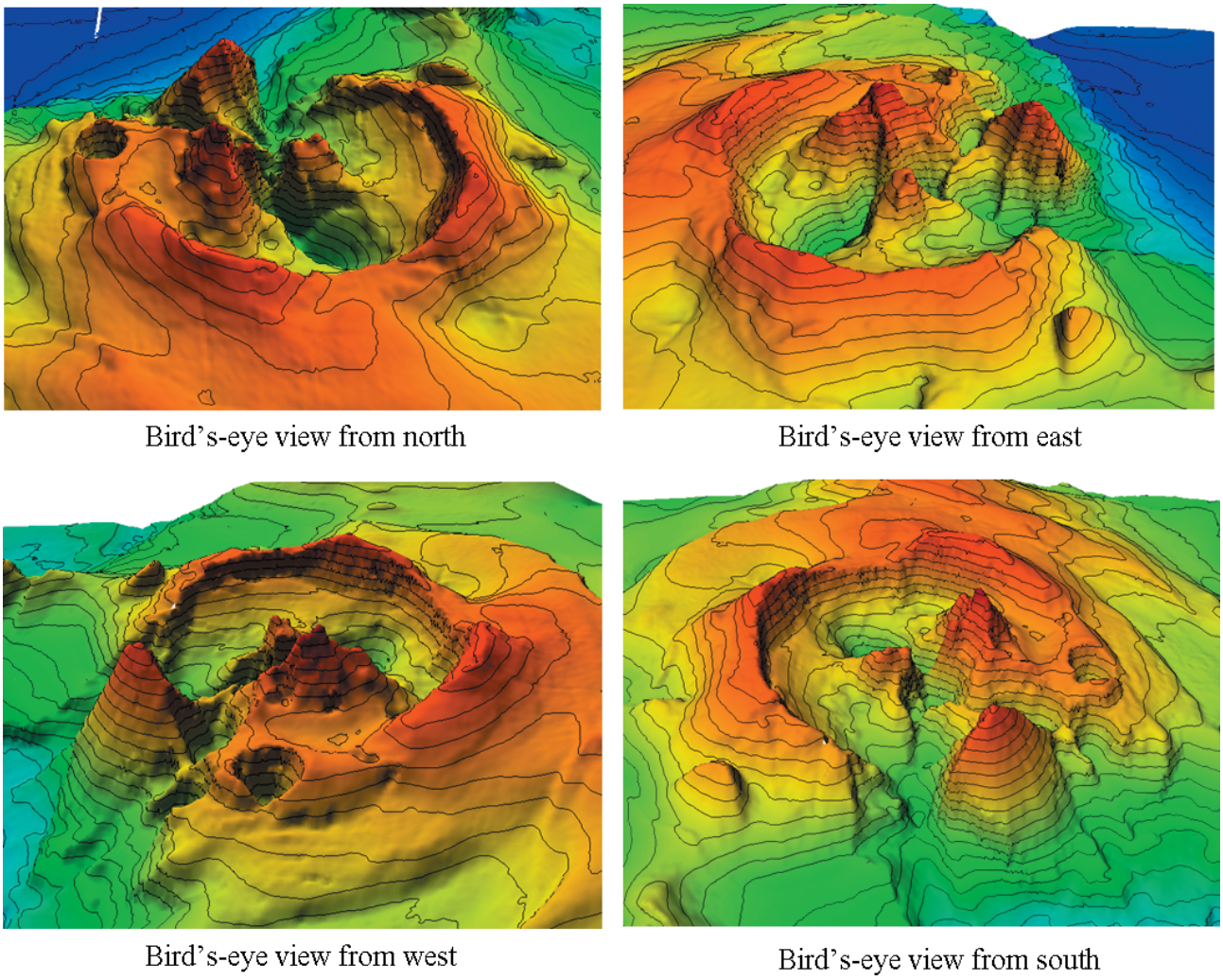

Fig. 4. Bird's-eye view images of the volcano (Vertical exaggeration is 5 times. Color scale is same as Fig. 2).
図 4. 火山地形の鳥瞰図（鉛直方向に 5 倍に誇張．図 2 と同じカラースケールを使用）.

Acknowledgement

We would like to thank Captain Hamaoka and all of the crew of the S/V *Shoyo* for data acquisition. We also would like to thank the officers in Continental Shelf Survey Office for the cruise planning and data collection.

References

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Yokose, H. (2010) The possibility of giant eruptions on the Tokara Islands, southern Kyushu, Japan : verification of the suspected submarine calderas, Report to the Ministry of Education, Science, Sports and Culture for 2009 Grant-in-Aid for Scientific Research (no. 19450165) (in Japanese).

トカラ群島で新たに発見された海底火山地形

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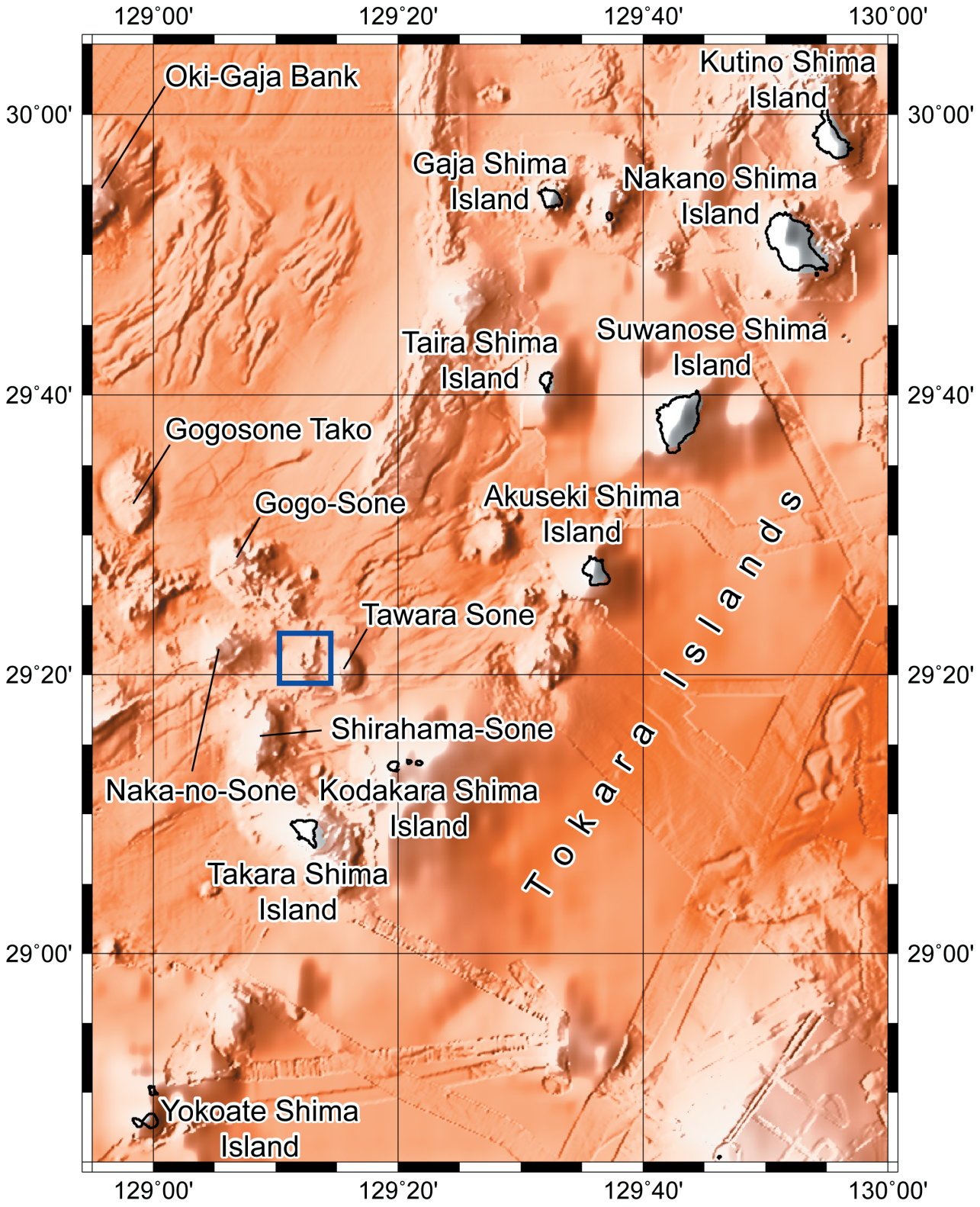

Fig. 1–2. Location map of the survey area (blue square).
図 1–2. 調査海域の位置（青四角）.

要　旨

マルチビーム音響測深機を用いた海底地形調査により，トカラ群島の海底に新たな火山地形が発見された．この火山地形は宝島の北約 25 km，水深 300－500 m に位置する．火山地形の直径は 1.6 km であり，2 個の中央火口丘と 9 個程度の火口を有している．

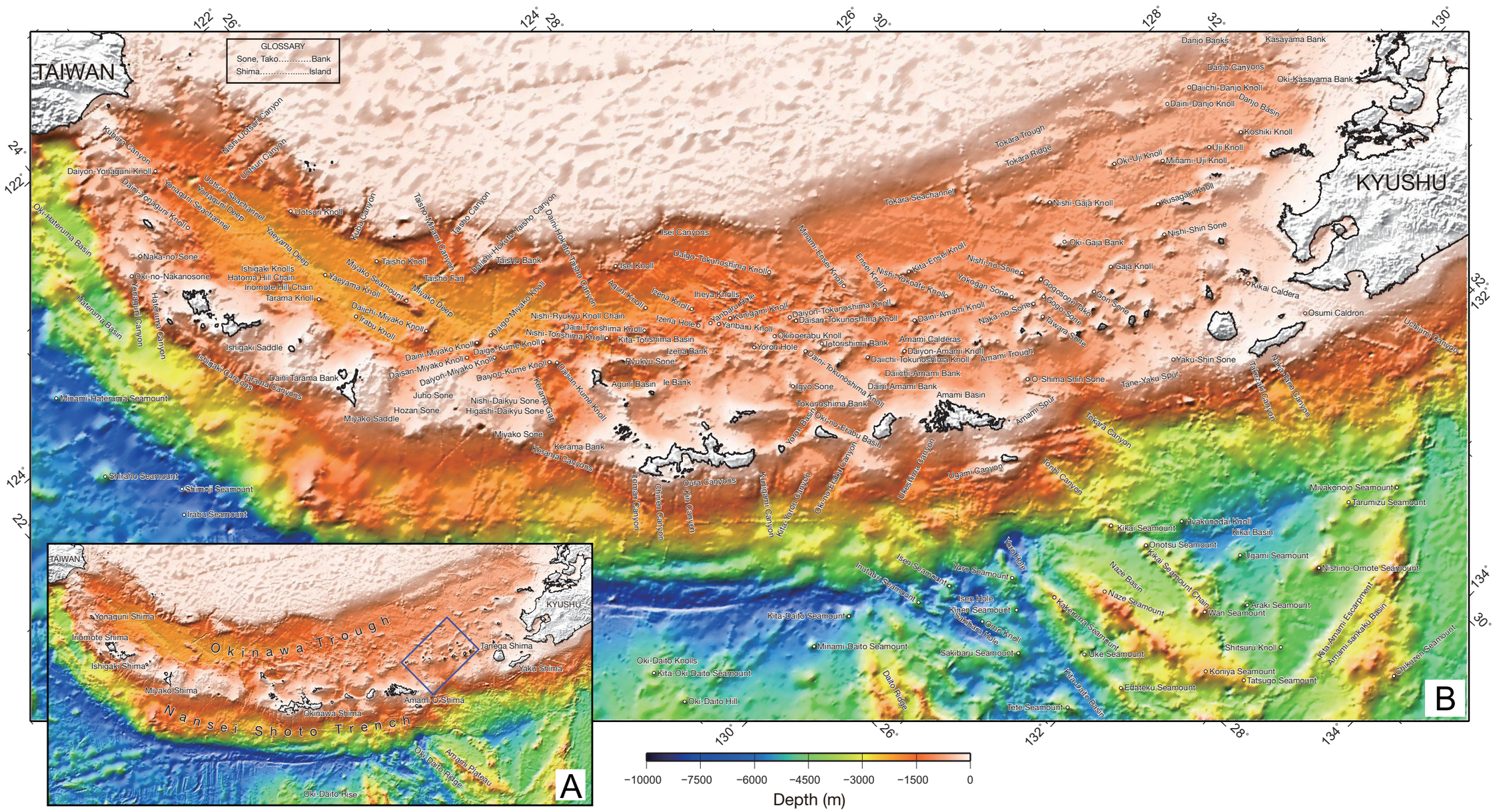

Fig. 1–1. Bathymetric map of the Nansei–Shoto region. Panel A shows the names of main islands and undersea features in this region. The area enclosed by a blue square is shown in Fig. 1–2. Panel B shows the names of individual undersea features.

図 1–1. 南西諸島海域の海底地形図．本海域の主な島嶼名と海底地形名を A に示した．また，Fig. 1–2 の範囲を A の青四角で示した．個々の海底地形名は B に示した．