

*Report on DELP 1984 Cruises in the Middle  
Okinawa Trough  
Part I: General Outline*

JAPANESE DELP RESEARCH GROUP ON BACK-ARC BASINS

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**Abstract**

In the summer of 1984, as a part of the Japanese Lithosphere Research Program (DELP), two research cruises were made in the middle Okinawa Trough area, which was suspected to be in a very early stage of back-arc basin formation. The cruises comprised the DELP-84 WAKASHIO cruise and the KT 84-14 cruise of TANSEI-MARU, University of Tokyo. Major results obtained are described in Parts II-V.

This report describes the results, some of which are still preliminary, of the research cruises (DELP-84 WAKASHIO and KT 84-14) in the middle Okinawa Trough area, conducted as a part of the 1984 Japanese DELP (Dynamics and Evolution of the Lithosphere Project\*). Ships used for the two cruises were the WAKASHIO-MARU chartered from Nippon Salvage Co. and the TANSEI-MARU of the Ocean Research Institute, University of Tokyo, respectively. Scientists from six Japanese universities and Texas A and M University participated in the program. The scientific objectives, surveyed area, cruise periods, items of observation, data filing and names of participants of the two cruises are listed below. A portion of KT 84-14 cruise devoted to the study of the Kikai area is not included in this report. Some other cruises closely related to the DELP cruises are mentioned.

**1. Scientific objective**

Evolution and structure of very young or nascent back-arc basins.

The evolutionary stage of the Okinawa Trough is relatively advanced in its southwestern part in which the existence of an oceanic crust is suggested by some investigators, whereas in its northeastern part active rifting has barely begun (*e. g.* HERMAN *et al.*, 1978; LEE *et al.*, 1980; LETOUZEY and KIMURA, 1985; KIMURA, 1985). The middle Okinawa Trough

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\* International Lithosphere Project (ILP) is called DELP in Japan.

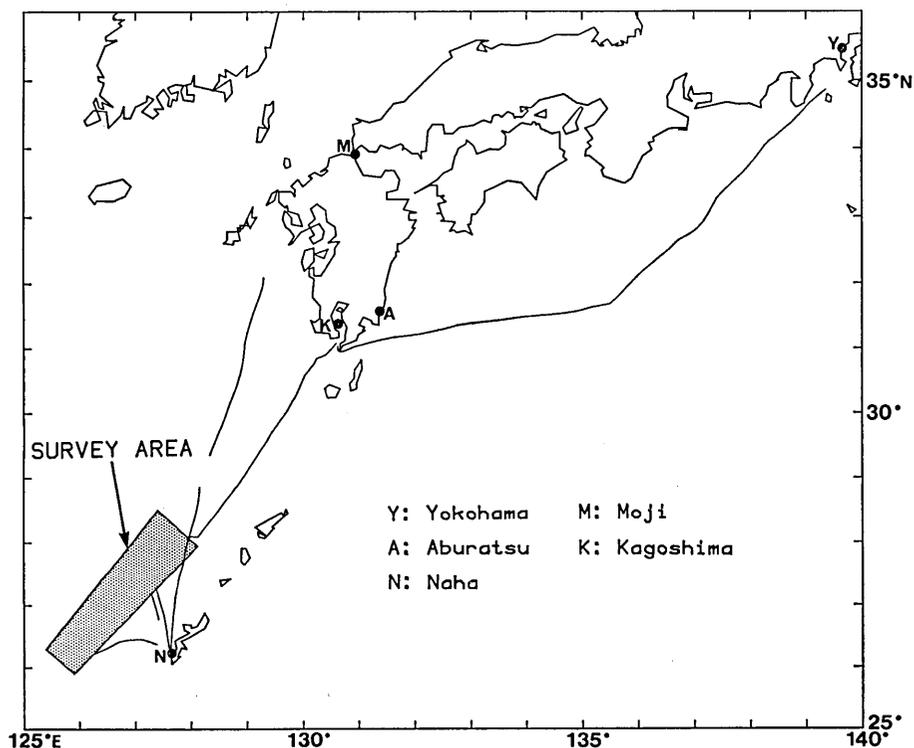


Fig. I-1. Track lines of the DELP-84 WAKASHIO cruise.

area was considered to be a site of the initial active rifting. Therefore, the middle Okinawa Trough area was chosen for the present study to meet the above stated scientific objective.

## 2. Area surveyed and related cruises

Underway geophysical measurements were made along a track from Yokohama—Kagoshima Bay—to the middle Okinawa Trough area (Fig. I-1), and a detailed survey was made in the middle Okinawa Trough area (Fig. I-2).

## 3. Cruise periods

Cruise; DELP-84 WAKASHIO (Wakashio-Maru)

1984 Aug. 15 Dept. from Yokohama

Aug. 17 Arriv. at Kagoshima Bay; to wait for a typhoon to pass.

Aug. 22 Dept. from Kagoshima Bay.

Aug. 24 Arriv. at the survey area.



Sept. 2 Moored at Naha, Okinawa: to disemperk some scientific members

Sept. 5 Arriv. at Naha

Sept. 6 Dept. from Naha

Sept. 9 Arriv. at Moji, Fukuoka (mother port of the vessel),

Cruise; KT84-14 (Tansei-Maru)

1984 Oct. 17 Dept. from Naha

Oct. 22 Arriv. at Naha

Oct. 30 Arriv. at Aburatsu, Miyazaki

#### 4. Items of observation

1. 12 KHz precision depth recording
2. Single channel seismic profiling
3. Multi-channel seismic profiling (KT 84-14)
4. Ocean bottom seismometer observation
  - 4-1. Structure
  - 4-2. Seismicity
  - 4-3. Test operation of new digital OBS
5. Geomagnetic suvey (3-component and total force measurement)
6. Heat flow
7. Dredge haul
8. Piston coring (KT 84-14)
9. Bottom photography (KT 84-14)

#### 5. Data filing

The following digital data are available on MT based data file (2400 ft, 1600 BPI, EBC-coded)

1. Track positioning (limited area)
2. Depth record (Kagoshima—Naha—Naha of WAKASHIO-84 cruise)
3. Shot instance of large volume airgun
4. Shot instance of explosions
5. Geomagnetic elements (Hz, Hx, Hy, F)

#### 6. Participants (DELP related)

DELP-84 WAKASHIO;

\* S. Uyeda, S. Nagumo, J. Kasahara, S. Koresawa, H. Tokuyama, M. Watanabe, M. Yamano, E. Kikawa; University of Tokyo

\* H. Kinoshita, H. Hatori, H. Chiba, T. Iidaka, M. Suyemasu, M. Takato, N. Matsuda, R. Morijiri; Chiba University

- \* N. Isezaki, T. Ouchi, Y. Kitahara, H. Katao; Kobe University
- \* H. Ujiie, M. Kimura, S. Yamamoto, E. Masaki, J. Oshida; University of the Ryukyus
- \* Thomas W. Hilde; Texas A and M University, USA
- \* Crew Members of WAKASHIO-MARU; Nippon Salvage Co. Ltd., Japan  
KT84-14;
- \* K. Kobayashi, H. Tokuyama, M. Watanabe, J. Kasahara, S. Koresawa, M. Yonekura, H. Kayane; University of Tokyo
- \* H. Ujiie, S. Yamamoto, T. Ono, Y. Tanaka, R. Tabuki; University of the Ryukyus
- \* N. Isezaki, T. Ouchi, Y. Kitahara; Kobe University
- \* H. Kinoshita, H. Chiba; Chiba University
- \* K. Konishi, J. Kosaka; Kanazawa University
- \* N. Hori; Hiroshima University

#### 7. Other related cruises in the Okinawa Trough region in 1984

- (1\*) Japan Maritime Safety Agency 1984 Seabeam mapping (SBM) by R/V TAKUYO.
- (2\*) 1984 R/V JEAN CHARCOT, France, POP-1 cruise: SBM, gravity (GR), magnetics (MG), and heat flow (HF).
- (3\*) 1984 R/V SONNE, FRG, Sonne 34 cruise of Japan-Germany Cooperation Program: SBM, HF, GR, MG, and OBS.
- (4\*) SHINKAI 2000, Japan: Submersible missions in the middle Okinawa Trough.

Participants from DELP Group in the above (2\*), (3\*) and (4\*) Cruises.

- (2\*) M. Kimura (Univ. Ryukyus) and T. W. C. Hilde (Texas A and M Univ.)

- (3\*) Leg. 1

H. Shimamura, T. Iwasaki (Hokkaido Univ.), T. Kanazawa, N. Hirata, S. Ueno (Univ. Tokyo), K. Suyehiro, T. Honda (Chiba Univ.)  
T. Urabe (Kyushu Univ.)

- Leg. 2

S. Uyeda, J. Segawa, T. Furuta, T. Matsumoto, M. Yamano, Y. Furukawa, H. Toh (Univ. Tokyo), T. Oogami (Kagoshima Univ.), J. Takenaka (Chiba Univ.)

- (4\*) S. Uyeda (Univ. Tokyo), and M. Kimura (Univ. Ryukyus)

#### 8. Main results

- 1) Multi-channel reflection records across the Central Rift Zone, near the Natsushima-84 Deep in which extremely high heat flow was

observed, indicate reflections that are probably from the top of a magma chamber.

- 2) Refraction seismic study using 10 OBS's and four tons of explosives indicated that the crust of the middle Okinawa Trough has a five km thick 6.0 km/sec layer above a highly attenuating 6.8 km/sec layer. Moho was not detected even at epicentral distances greater than 130 km. The crust was considered to be continental but low in  $Q$  in its lower part and the uppermost mantle to be anomalously low in both wave velocity and  $Q$ .
- 3) Observations of natural earthquakes, carried out for about one month by 10 OBS's, detected highly active micro-seismicity in the area. Some OBS's recorded phases suspect of reflections from magma sheets as well as waves similar to volcanic tremors.
- 4) Shipboard three component geomagnetic field measurements, conducted throughout the DELP-84 WAKASHIO cruise, detected magnetic anomalies, with amplitudes exceeding 300 nT, associated with the topographic highs near the Iheya Deep that are lineated in the  $N60^{\circ}E-N85^{\circ}E$  direction.
- 5) Heat flow values were obtained at 17 sites in the area by means of an Ewing-type multiple-penetration device. The most remarkable finding was the extremely high heat flow ( $\approx 1600$  mW/m<sup>2</sup>) in the Natsushima-84 Deep in the Natsushima-84 Deep. Non-linear gradients were also measured, indicating high hydrothermal activity.
- 6) In this area, at least five segments of central rifts are aligned en echelon and in the central axis of these rifts are small ridges. The Iheya Deep is the most pronounced of the rifts. Pieces of olivine augite basalt and olivine-bearing augite basalt were dredged from the ridge in the Iheya Deep. These rocks are island arc type high alumina basalts with K-Ar age younger than  $0.42 \pm 0.19$  Ma. Some rhyolite, dacite and andesite of the Quaternary age were also dredged in the vicinity, indicating bimodal volcanism. No positive evidence was found for the existence of transform faults connecting the en echelon rifts.

Summarizing all the information, it may be concluded that the middle Okinawa Trough area is indeed in the pre-spreading rifting stage of the continental margin crust.

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Salvage Co.) for their devoted cooperation in ship operation throughout the DELP-84 WAKASHIO cruise. They thank Messrs. K. Ohmori and A. Murakami who handled the explosives aboard the ship safely. Thanks are also due to President S. Takeuchi, Mr. S. Yamamoto and other staff of the Nippon Salvage Company and the staff of the Administration Department of the Earthquake Research Institute, University of Tokyo who contributed much in the realization of the cruise. This work was supported partially by Grant-in-Aid for Scientific Research No. 5912708, Ministry of Education, Science and Culture, Japan.

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## DELP 1984 年度中部沖繩トラフ研究航海報告

### I. 全体計画

#### DELP 背弧海盆研究班

わが国のリソスフェア探査開発計画 (DELP) の一環として、その課題の一つである「背弧海盆の形成」研究のために、1984年に中部沖繩トラフ海域において、総合的な研究航海を行った。中部沖繩海域がえらばれたのは、背弧海盆形成の極く初期あるいはその前段階にあると考えられるからである。航海は、日本サルベージ社若潮丸を借船した1984年8月15日～9月9日のDELP-84 WAKASHIO 航海と東京大学海洋研究所淡青丸による同年10月17日～30年のKT84-14航海であった。主要な観測は前者において実施され、後者においては海底地震計の回収と、多成分反射法による地震探査が行われた。主な科学的成果はPART II～Vに記載されている。なお、この海域においては、1984年、海上保安庁水路部観測船拓洋によるシービーム他、フランス観測船 Jean Charcot 号によるシービーム他、西ドイツ観測船 Sonne 号による日独協力研究航海、科学技術庁海洋科学技術センター深海潜水船“しんかい 2000”による潜水研究も行われた。

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