# BASALT PEBBLES COLLECTED FROM THE SEA BOTTOM OF EAST CHINA SEA

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# BASALT PEBBLES COLLECTED FROM THE SEA BOTTOM OF EAST CHINA SEA

By

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**Abstract**

Petrology of basalt pebbles collected from the sea bottom of East China Sea at 28.5°N latitude and 125.5°E longitude was given, and the geological meaning was discussed. The basalt pebbles comprise a large amount of olivine phenocrysts or microphenocrysts, and range in composition from alkalic to calc–alkalic. It is suggested that the basalt pebbles can be probably correlated with some alkaline basaltic rocks of Pliocene to Recent age in Northwest Kyushu, Japan, and that alkaline basaltic rocks occur zonally in the continental side of the north of Ryukyu Arc, as well as of the Honshu Arc.

## Introduction

Submarine geological studies of the East China Sea and the surrounding areas were carried out by WAGEMAN *et al.* (1970), and tectonic geological studies of the same regions also by OTUKA (1939), KONISHI (1965), WAGEMAN *et al.* (1970), KAGAMI *et al.* (1971), KONISHI and SUDO (1972) and KIZAKI (1978). However, no record that basaltic rocks had been collected from the East China Sea has been reported. A large amount of pebbles composed of mainly basaltic rocks were collected from the sea bottom of East China Sea. In this paper, petrology of the collected basalt pebbles will be given, and the geological meaning will be discussed. Recently, Deer fossil collected from the same sea bottom has been studied by OTSUKA *et al.* (1977).

## Locality of Basalt Pebbles

Basalt pebbles were dredged up from the sea bottom of East China Sea at 28.5°N latitude and 125.5°E longitude by the Kagoshima–maru of Department of Fisheries, Kagoshima University, in March, 1971. The locality lies about 340 kilometers in distance away to west–northwest from Amami–o–shima Island. The depth of sea bottom at the locality is −122 meters below the sea level. The locality is situated submarine–

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topographically in the continental margin of China Mainland, the westward of Okinawa Trough, and geo-tectonically in the Taiwan-Sinzi Folded Zone (OTUKA, 1939) or in the Goto Belt (KAGAMI *et al.*, 1971), as shown in Fig. 1.

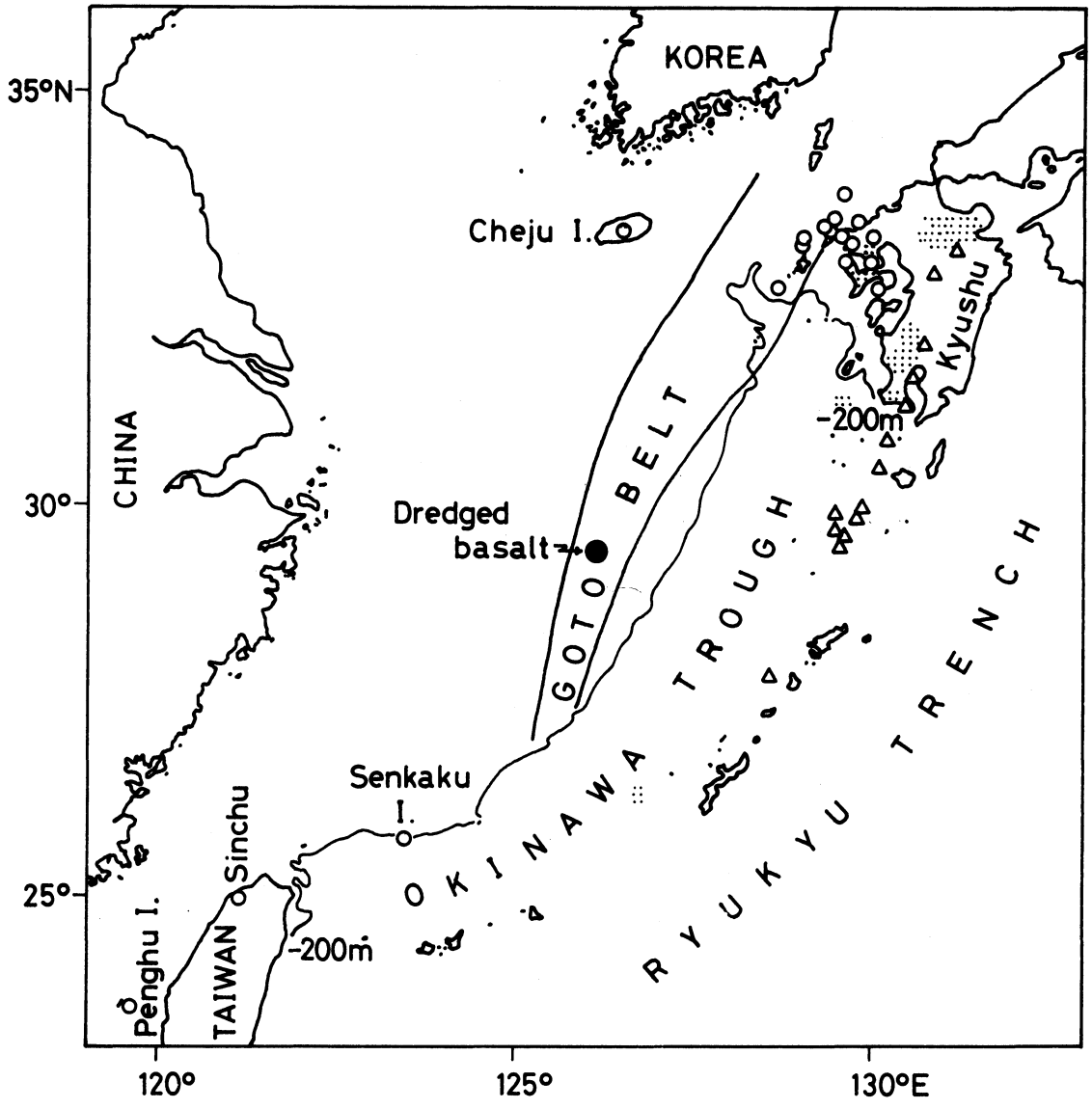


Fig. 1. Map showing locality of basalt pebbles.
Open triangle : High-alumina and calc-alkaline volcanoes.
Open circle : Alkaline basaltic rocks.
Dotted area : "Green Tuff" region.

## Petrology of Basalt Pebbles

Collected basalt pebbles are subangular in shape and have 50 centimeters in maximum diameter. Three representative specimens of basalt pebbles, Nos. 1, 2 and 5, were

petrographically and chemically studied.

## 1. Petrography

The specimen No. 1 is a black–colored and massive olivine basalt composed of magnesian olivine ($Fo_{71}$) with 0.7 mm. in maximum length as a microphenocryst. Its groundmass shows basaltic in texture and docrystalline in crystalinity, and consists of basic plagioclase, olivine, clinopyroxene, Fe–Ti oxide and altered interstitial glass.

The specimen No. 2 is a black–colored and porous alkaline olivine basalt composed of magnesian olivne ($Fo_{70}$) with 1.2 mm. in maximum length as a phenocryst. Its groundmass shows basaltic in texture and hyalocrystalline in crystalinity, and contains basic plagioclase, olivine, clinopyroxene, orthopyroxene, Fe–Ti oxide and altered interstitial glass.

The specimen No. 5 is a black–colored and porous alkaline olivine basalt composed of basic plagioclase ($An_{65}$) with 0.7 mm. in maximum length and magnesian olivine ($Fo_{76}$) with 0.9 mm. in maximum length as microphenocrysts. Its groundmass shows largely cryptocrystalline in granularity, and is composed of basic plagioclase, alkali feldspar, olivine, clinopyroxene, Fe–Ti oxide and altered interstitial glass.

## 2. Composition

Chemical analyses and CIPW norms of collected basalt pebbles are listed in Table 1. The analyses were carried out on the basis of combination of the X–ray spectrographic

Table 1. Chemical analyses and CIPW norms of basalt pebbles

| Chemical Analyses | | | |
|---|---|---|---|
| No. | 1 | 2 | 5 |
| $SiO_2$ | 50.11 wt% | 51.95 wt% | 48.73 wt% |
| $TiO_2$ | 2.32 | 2.42 | 2.62 |
| $Al_2O_3$ | 14.12 | 15.23 | 13.34 |
| $Fe_2O_3$ | 3.50 | 2.19 | 1.89 |
| FeO | 8.05 | 8.62 | 9.43 |
| MnO | 0.09 | 0.10 | 0.10 |
| MgO | 7.66 | 5.92 | 9.51 |
| CaO | 8.43 | 7.10 | 8.53 |
| $Na_2O$ | 3.01 | 3.84 | 2.85 |
| $K_2O$ | 0.62 | 1.78 | 0.94 |
| $H_2O+$ | 1,34 | 1.06 | 1.49 |
| $H_2O-$ | 0.42 | 0.16 | 0.26 |
| $P_2O_5$ | 0.19 | 0.34 | 0.23 |
| Total | 99.86 wt% | 99.81 wt% | 99.92 wt% |

| CIPW Norms | | | |
|---|---|---|---|
| No. | 1 | 2 | 5 |
| Q | 1.29 wt% | - wt% | - wt% |
| Or | 3.66 | 10.52 | 5.56 |
| Ab | 25.47 | 32.49 | 24.12 |
| An | 23.19 | 19.06 | 20.83 |
| Hy (En | 14.35 | 5.28 | 8.15 |
| Hy Fs) | 6.19 | 3.66 | 4.00 |
| Di Wo | 7.26 | 5.82 | 8.34 |
| Di (En | 4.73 | 3.29 | 5.25 |
| Di Fs) | 2.04 | 2.28 | 2.58 |
| Ol (Fo | - | 4.33 | 7.21 |
| Ol Fa) | - | 3.30 | 3.90 |
| Mt | 5.07 | 3.18 | 2.74 |
| Il | 4.41 | 4.60 | 4.98 |
| Ap | 0.44 wt% | 0.79 wt% | 0.53 wt% |

and the atomic absorption methods.

Content of $SiO_2$ of the analyzed rocks is less than 52 wt.%, and shows that they are basaltic in composition. The analyzed rocks are also characterized by higher $TiO_2$ content and lower $Al_2O_3$ one. The chemical analyses of specimens Nos. 1 and 5 are similar to one another. It can be seen in Table 1, however, that contents of MgO and CaO of the specimen No. 2 are lower, whereas those of $SiO_2$, $Al_2O_3$, $Na_2O$ and $K_2O$ are higher, as compared to the other two Nos. 1 and 5.

In CIPW norms, 7.6 wt.% and 11.1 wt.% normative olivines were calculated in the specimens Nos. 2 and 5, respectively, and it is indicated that these two rocks are alkalic in composition. On the other hand, normative olivine was not calculated but a very small amount of normative quartz in the specimen No. 1, and it is indicated that the rock is calc–alkalic in composition. Such compositional characteristics of the analyzed rocks are also shown in the relation between $SiO_2$ content and $(Na_2O+K_2O)$ one (Fig. 2), although the specimen No. 1 is plotted in the field of high–alumina basalts.

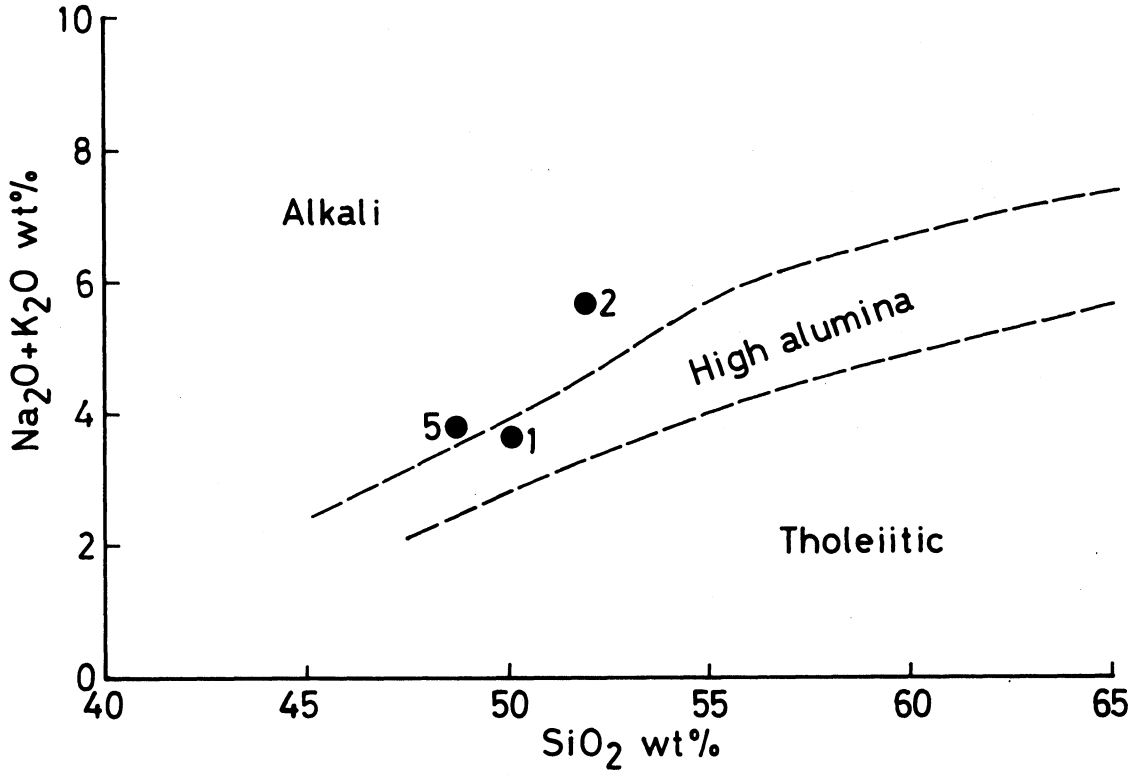


Fig. 2. Plots of analyzed basalt pebbles on the $SiO_2$–$(Na_2O+K_2O)$ diagram.

## Discussion

A number of localities of alkaline basaltic rocks have been known in the surrounding areas of East China Sea. The alkaline basaltic rocks occur in Northwest Kyushu (AOKI,

1958 ; TAKAHASHI and KURASAWA, 1960 ; MATSUMOTO, 1961a, b ; KURASAWA and MATSUI, 1964 ; KURASAWA and TAKAHASHI, 1962, 1965 ; KURASAWA, 1967) and Senkaku Islands (MATSUMOTO and NOHARA, 1974) in Japan, Cheju Island (HARAGUCHI, 1931 ; TANEDA *et al.*, 1970) in Korea, and Hsinchu (ICHIMURA, 1943 ; YEN, 1948) and Penghu Islands (YEN, 1965) in Taiwan (Fig. 1). Mode of occurrence and composition of basalt pebbles collected from the East China Sea are apparently different from those of alkaline basalts in the Senkaku Islands. The basalt pebbles Nos. 1 and 5 are compositionally different from alkaline basaltic rocks of Pliocene to Recent age in Northwest Kyushu, but the basalt pebble No. 2 is compositionally similar to some alkaline basaltic rocks in Northwest Kyushu. Judging from the fact that the locality where the basalt pebbles were collected is situated in the Taiwan–Sinzi Folded Zone (OTUKA, 1939) or in the Goto Belt (KAGAMI *et al.*, 1971), it is suggested that they can be probably correlated with alkaline basaltic rocks in Northwest Kyushu, although comparison of the basalt pebbles with alkaline basalts in Korea and Taiwan was not tried in the process of this study.

It is well known that the north of Ryukyu Arc belongs to the type 1 of double arc on the basis of MIYASHIRO's (1974) classification. Quaternary high–alumina and calc–alkaline volcanic rocks occur in the Ryukyu Arc, and are accompanied by so–called "Green Tuff" of Neogene age (MIYAHISA and MATSUMOTO, 1969 ; YAMAMOTO *et al.*, 1980). The finding of basalt pebbles from the East China Sea suggests that alkaline basaltic rocks occur in the continental side of north of Ryukyu Arc, and that across the north of Ryukyu Arc from the east to west, the Quaternary high–alumina and calc–alkaline volcanic rocks, the "Green Tuff" and the alkaline basaltic rocks are zonally distributed, as seen in Fig. 1. It is therefore suggested that the zonal distribution in the north of Ryukyu Arc is similar to that of Honshu Arc.

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