

## Uraninite and Thorite Ages of Around 400 Granitoids in the Japanese Islands

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**Abstract.** Systematic dating of around 400 granitoids in the Japanese Islands have been made on the basis of total  $\text{UO}_2$ ,  $\text{ThO}_2$  and  $\text{PbO}$  contents of uraninite and anhydrous thorite using an electron microprobe analyzer (EPMA) at the National Museum of Nature and Science, Tokyo. The ages range from ca. 5 Ma to 300 Ma. From the granitoid ages, the Japanese Islands were divided into many terranes. In northern Japan, granitoids with ages of approximately 110–120 Ma occur in the Kitakami Mountains, southwest Hokkaido and eastern Abukuma Mountains, and granitoids with ages of approximately 100–110 Ma occur at the western Abukuma Mountains and its northern extension. The granitoids that are around 90–100 Ma old occur sporadically in the Japanese Islands: mainly in the Asahi Mountains, the Nikko area, northern Shikoku and northern Kyushu. In central and northern Japan, the younger Cretaceous granitoids, partly Paleogene, with an age of around 65 Ma occur along the western part of the Asahi Mountains and Tsukuba–Nikkou area. In western Japan, granitoids that are 60–70 Ma old occur linearly along the coastal zone of the Sea of Japan. However, other granitoids with similar ages do not always show a linear or zone arrangement, but are concentrated in relatively restricted regions. These divisions by granitoid ages using uraninite and thorite are essentially similar to those determined by K–Ar ages, but the former ages are much more concentrated in each area than the latter ones.

**Key words:** uraninite, thorite, age, EPMA, granitoid

### Introduction

Yokoyama *et al.* (2010) reconfirmed the age method for uraninite and thorite in granitoids based on the  $\text{UO}_2$ ,  $\text{ThO}_2$  and  $\text{PbO}$  contents that were obtained via an electron microprobe analyzer (EPMA). Holmes (1911) first established a method for dating minerals through normal wet chemical analyses on the basis of the assumption that inherited Pb was negligible at the time of mineral crystallization. Holmes (1931) later dealt exhaustively with the application of radioactivity to the measurement of geologic time. The method was used by many researchers and was

referred to as the chemical age. After the isotope methods had been established for many minerals, the Holmes's method was not applied for uraninite and thorite until 1990. Bowles (1990) developed accurate age calculations for uraninite through EPMA analyses. Uraninite, thorite, and huttonite contain high concentrations of radiogenic Pb even in Paleogene and Neogene rocks. In most of the dating studies, the EPMA ages for these minerals were consistent with those obtained by isotopic methods (Yokoyama *et al.*, 2010).

Iimori (1941) analyzed uraninite in a granitoid from Iisaka, Fukushima Prefecture, using the wet

chemical method and calculated using the simple Holmes's equation. The age was 103 Ma, similar to the age obtained by the K–Ar method. Since 1965, the K–Ar method has been widely used for age analyses of granitoids in Japan (e.g. Kawano & Ueda, 1964 & 1966). Based mostly on the K–Ar method of the Kawano group, radiometric age data of granitoids in the Japanese Islands were summarized by Nozawa (1975). From the K–Ar method, it is well known that Cretaceous granitoids are the most ubiquitous in the islands, whereas Neogene granitoids occur mostly in Southwest Japan along the Pacific Ocean. Permian to Triassic granitoids occur only in the Hida Terrane, and ages of far older granitic rocks, Cambrian to Silurian, occur as small plutonic bodies.

The EPMA age method, *i.e.* U–Th–total Pb or chemical method, has attracted attention for its quickness, high spatial resolution and relatively high precision similar to isotopic methods. In this paper, we studied mainly uraninite and thorite ages of granitoids in the Japanese Islands and try to clarify age variation in each province. The age method was described in detail by Yokoyama *et al.* (2010). They demonstrated the validity of the EPMA method, which yields age results comparable to those obtained by isotopic methods such as Sensitive High Resolution Ion Microprobe (SHRIMP) and the K–Ar method. There are many methods used to obtain the ages of granitoids. Among them, SHRIMP and Laser Ablation Inductively Coupled Plasma (LA–ICP–MS) are the most reliable and useful for this study because of the common presence of zircon. However, LA–ICP–MS and SHRIMP methods have, so far, only been applied to restricted samples or terranes. The present age method has a disadvantage that uraninite and thorite are not always present in the granitoids. It is, however, important to summarize the ages of the granitoids in the Japanese Islands by the same method as was performed for the K–Ar age method. In this study, the granitoid age is obtained by the same machine in the National Museum of Nature and Science and by the same analytical conditions

and standards as reported by Yokoyama *et al.* (2010). Most granitoids older than the Cretaceous rarely contain uraninite and thorite. In such rocks, monazite ages are obtained by the EPMA method. Monazite ages comparing the results obtained by the same EPMA machine and isotopic ages have been reported by Santosh *et al.* (2006).

Paleomagnetic measurements showed that Southwest Japan was rotated clockwise, whereas Northeast Japan was rotated anticlockwise at the time of the opening of the Sea of Japan at around 20 Ma (e.g. Otofuji & Matsuda, 1983 & 1984). However, the boundary between the Southwest and Northeast terranes has not yet been clarified. In the Japanese Islands, Cretaceous granitoids are most common. The study of the spatial distribution of the granitoids will contribute to the reconstruction of the terranes in the islands and Prymorye, Far East Russia, before the opening of the Sea of Japan. Even if only a little, the present study will find a solution to the problem of the tectonic boundary between the Southwest and Northeast Japan.

## Samples

Cretaceous and Cenozoic granitoids are widely distributed in the Japanese Islands (Fig. 1), whereas Jurassic to Permian granitoids occur only in the Hida terrane. Far older granitoids occur sporadically in the islands. Most of the granitoid samples used for this study are registered samples at the National Museum of Nature and Science. Some are preserved in storages at few universities. In total, around one thousand granitoids were crushed to check for radiogenic minerals such as uraninite, thorite and monazite. In the granitoids, uraninite (UO<sub>2</sub>) and thorite (ThSiO<sub>4</sub>) are usually rare minerals. Uraninite, if present, occurs mostly as a euhedral grain in the heavy fraction, rarely surrounded by pyrite. Although thorite was found in most of the granitoids in the Japanese Islands, it is commonly altered into hydrous thorite, especially in older granitoids. Anhydrous thorite is well preserved in

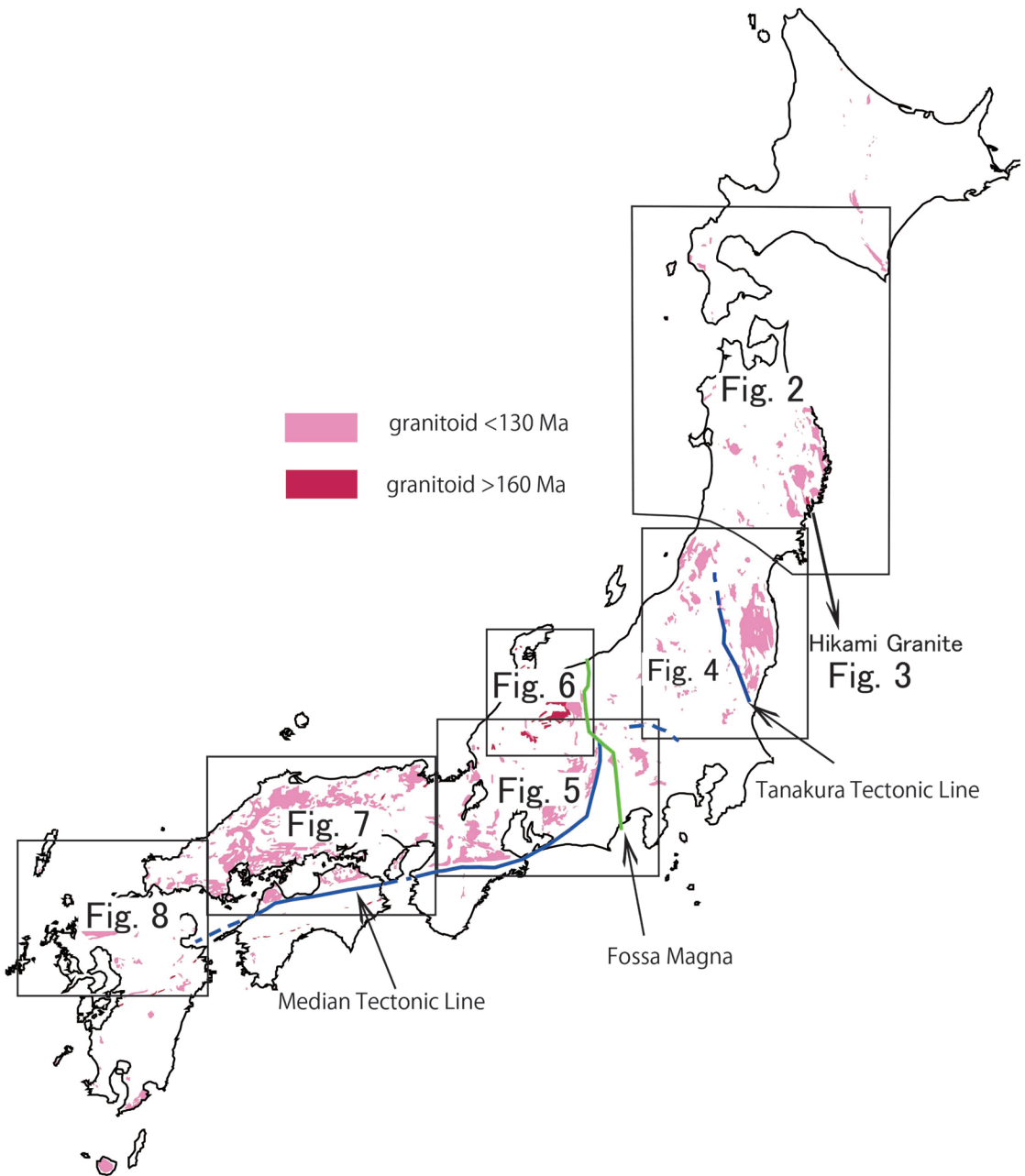


Fig. 1. Distribution of granitoids in the Japanese Islands and index map for the following figures.

the Neogene granitoids, but it is preserved partly in hydrated thorite grains in Cretaceous or older granitoids. Finally, we obtained ages from about 400 granitoid samples.

### Age results

Ages of granitoids in the Japanese Islands are summarized according to the six provinces as shown in Fig. 1: southern Hokkaido–Tohoku, Asahi–Abukuma, Chubu–Kansai, Hida, Chugoku–northern Shikoku and northern Kyushu. All the

Table 1. Locality and age data of the analyzed granitoids in the Japanese Islands. The samples with registered number are stocked at the National Museum of Nature and Science.

| sample No                    | rock           | reg. No | locality                                                    | Uraninite       | Thorite         | Monazite         |
|------------------------------|----------------|---------|-------------------------------------------------------------|-----------------|-----------------|------------------|
| Age data in Figs. 2, 3 and 4 |                |         |                                                             |                 |                 |                  |
| DN-01                        | granite        | 134109  | Kenichi-onsen, Yakumo-cho, Futami-gun,<br>Hokkaido          | 121.1 $\pm$ 1.7 |                 |                  |
| DN-02                        | granodiorite   | 134110  | Kumaishitomarikawa, Yakumo-cho, Futami-gun,<br>Hokkaido     | 119.6 $\pm$ 1.2 |                 |                  |
| DN-07                        | granite        | 134115  | Pirika, Imakane-cho, Seta-gun, Hokkaido                     | 122.2 $\pm$ 1.5 |                 |                  |
| OK-6                         | granodiorite   | 135359  | Kamoishi Coast, Okushiri-cho, Okushiri-gun,<br>Hokkaido     | 103.1 $\pm$ 0.6 |                 |                  |
| AO-6                         | granite        | 134279  | Ohmagoe-rindo, Fukaura-machi, Nishitugaru-gun,<br>Aomori    | 104.6 $\pm$ 0.7 |                 |                  |
| AO-7                         | granite        | 134280  | Ohmagoe-rindo, Fukaura-machi, Nishitugaru-gun,<br>Aomori    | 106.1 $\pm$ 1.6 |                 |                  |
| AO-8                         | granite        | 134281  | Ohmagoe, Fukaura-machi, Nishitugaru-gun,<br>Aomori          | 106.8 $\pm$ 1.7 |                 |                  |
| AO-9                         | granite        | 134282  | Ohmagoe, Fukaura-machi, Nishitugaru-gun,<br>Aomori          | 108.8 $\pm$ 0.9 |                 |                  |
| AO-10                        | aplite         | 134283  | Ohmagoe, Fukaura-machi, Nishitugaru-gun,<br>Aomori          | 107.7 $\pm$ 1.1 |                 |                  |
| AO-11                        | granite        | 134284  | Ohmagoe, Fukaura-machi, Nishitugaru-gun,<br>Aomori          | 92–107          |                 |                  |
| AO-14                        | granodiorite   | 134287  | Ajigasawa-machi, Fukaura-machi, Nishitugaru-<br>gun, Aomori | 107.0 $\pm$ 1.0 |                 |                  |
| KTK-13                       | granite        |         | Hashikami-cho, Sannohe-gun, Aomori                          |                 | 118.2 $\pm$ 1.7 |                  |
| AK-2                         | granite        | 135408  | Nibetsushinrin Museum, Akita-shi, Akita                     |                 | 5.0 $\pm$ 2.2   |                  |
| AK-3                         | granite        | 135409  | Sannai River, Kawabesannai, Akita-shi, Akita                | 101.9 $\pm$ 1.5 |                 |                  |
| AK-5                         | granite        | 135411  | Idemaisawa, Kawabesannai, Akita-shi, Akita                  | 101.6 $\pm$ 0.9 |                 |                  |
| AK-8                         | Qz diorite     | 135414  | Kobuchigasawa, Akinomiya, Yuzawa-shi, Akita                 | 103.0 $\pm$ 1.3 |                 |                  |
| AK-9                         | Qz diorite     | 135415  | Kosawa, Akinomiya, Yuzawa-shi, Akita                        |                 | 23.4 $\pm$ 2.0  |                  |
| TH-06                        | granitic rock  | 134472  | Obonai, Tazawako, Senboku-shi, Akita                        |                 |                 | 111.1 $\pm$ 7.3  |
| TH-01                        | granitic rock  | 134464  | Hondera, Genbi-cho, Ichinoseki-shi, Iwate                   | 111.8 $\pm$ 1.2 |                 | 112.2 $\pm$ 6.0  |
| TH-02                        | granitic rock  | 134465  | Yuda Dam, Nishiwaga-machi, Waga-gun, Iwate                  |                 | 109.1 $\pm$ 2.1 |                  |
| TH-04                        | granitic rock  | 134467  | Toyosawa Dam, Hanamaki-shi, Iwate                           | 115.3 $\pm$ 1.4 | 112.5 $\pm$ 2.0 |                  |
| TH-07                        | granitic rock  | 134470  | Sawauchi, Nishiwaga-machi, Waga-gun, Iwate                  | 109.0 $\pm$ 1.8 |                 |                  |
| TH-08                        | granitic rock  | 134471  | Sawauchi, Nishiwaga-machi, Waga-gun, Iwate                  | 108.4 $\pm$ 1.5 |                 |                  |
| AK-11                        | granite        | 135417  | Koishizawa, Izawa-ku, Oshu-shi, Iwate                       | 111.6 $\pm$ 1.2 | 114.4 $\pm$ 2.4 |                  |
| AK-12                        | granite        | 135418  | Hosoturusawa, Izawa-ku, Oshu-shi, Iwate                     |                 | 110.6 $\pm$ 2.2 |                  |
| AK-13                        | granitoid      | 135419  | Kazayodosawaguchi, Izawa-ku, Oshu-shi, Iwate                | 111.2 $\pm$ 2.4 |                 |                  |
| 8605                         | granodiorite   | 8605    | Fujikirisawa, Tsukimoshi-cho, Thono-shi, Iwate              | 118.4 $\pm$ 2.4 | 118.9 $\pm$ 4.4 |                  |
| 8612                         | granodiorite   | 8612    | Sarugaishikawa, Tsukimoshi-cho, Thono-shi, Iwate            | 119.5 $\pm$ 2.3 | 118.0 $\pm$ 1.4 |                  |
| 8608                         | granodiorite   | 8608    | Shimoarisu, Sumita-cho, Kesen-gun, Iwate                    |                 | 125.0 $\pm$ 4.0 |                  |
| 8609                         | granodiorite   | 8609    | Sarugaishikawa, Tsukimoshi-cho, Thono-shi, Iwate            |                 | 116.4 $\pm$ 4.9 |                  |
| 6515                         | granodiorite   | 6515    | Koidenakataki, Tsukimoshi-cho, Thono-shi, Iwate             |                 | 116.8 $\pm$ 2.0 |                  |
| 7294                         | adamellite     | 7294    | Himegamidake, Tamayama-ku, Morioka-shi, Iwate               |                 | 126.3 $\pm$ 4.7 |                  |
| SK-1                         | adamellite     | 127853  | Higashidake-toge, Hiraizumi-machi, Nishiiwai-<br>gun, Iwate |                 | 121.9 $\pm$ 4.5 |                  |
| SK-2                         | adamellite     | 127854  | Nakajima, Ichinoseki-shi, Iwate                             |                 | 116.6 $\pm$ 4.3 |                  |
| SK-5                         | granite        | 127857  | Orikabe, Murone-machi, Ichinoseki-shi, Iwate                |                 | 118.7 $\pm$ 4.0 |                  |
| SK-19                        | granite        | 127871  | Kamitubo, Takekoma-cho, Rikuzentakada-shi,<br>Iwate         |                 | 119.6 $\pm$ 4.4 |                  |
| SK-32                        | granite        | 127884  | Maide, Yokota-cho, Rikuzentakada-shi, Iwate                 |                 | 117.1 $\pm$ 1.4 |                  |
| SK-14                        | granite        | 127866  | Mt.Hikami, Rikuzentakada-shi, Iwate                         |                 |                 | 454.8 $\pm$ 13.5 |
| SK-16                        | granite        | 127868  | Mt.Hikami, Rikuzentakada-shi, Iwate                         |                 |                 | 455.7 $\pm$ 6.3  |
| SK-18                        | granite        | 127870  | Seisou-Center, Takekoma-cho, Rikuzentakada-shi,<br>Iwate    |                 |                 | 447.6 $\pm$ 11.7 |
| SK-25                        | granite        | 127877  | Mt.Raishin, Rikuzentakada-shi, Iwate                        |                 |                 | 125.1 $\pm$ 16.8 |
| SK-29                        | biotite gneiss | 127881  | Kamitubo, Takekoma-cho, Rikuzentakada-shi,<br>Iwate         |                 |                 | 449.4 $\pm$ 14.6 |
| SK-30                        | biotite gneiss | 127882  | Kamitubo, Takekoma-cho, Rikuzentakada-shi,<br>Iwate         |                 |                 | 451.9 $\pm$ 16.4 |
| YT-5                         | granite        | 133770  | Tamayamakogenr Takekoma-cho, Rikuzentakada-<br>shi, Iwate   |                 |                 | 445.8 $\pm$ 11.7 |
| SK-52                        | granite        | 127904  | Rainai, Kamigo-cho, Thono-shi, Iwate                        | 117.2 $\pm$ 1.9 | 114.4 $\pm$ 5.3 |                  |
| SK-53                        | granite        | 127905  | Nagaoka, Ayaori-cho, Thono-shi, Iwate                       | 115.1 $\pm$ 1.9 | 117.0 $\pm$ 6.6 |                  |
| SK-57                        | granodiorite   | 128618  | Tahara-toge, Daito-cho, Ichinoseki-shi, Iwate               | 118.5 $\pm$ 2.3 | 118.0 $\pm$ 2.3 |                  |
| SK-59                        | granodiorite   | 128620  | Ogayu, Morioka-shi, Iwate                                   |                 | 119.0 $\pm$ 2.5 |                  |
| SK-61                        | granodiorite   | 128622  | Takazudou, Towa-cho, Hanamaki-shi, Iwate                    |                 | 117.0 $\pm$ 2.7 |                  |
| SK-62                        | granodiorite   | 128623  | Yanagawa, Esashi-ku, Ohshu-shi, Iwate                       |                 | 118.0 $\pm$ 3.7 |                  |
| SK-64                        | granodiorite   | 128625  | Ide, Esashi-ku, Ohshu-shi, Iwate                            |                 | 118.0 $\pm$ 4.0 |                  |

Table 1. (continued)

| sample No                 | rock         | reg. No | locality                                                 | Uraninite                          | Thorite     | Monazite |
|---------------------------|--------------|---------|----------------------------------------------------------|------------------------------------|-------------|----------|
| KTK-1                     | granite      |         | Fujisawa-cho, Ichinoseki-shi, Iwate                      |                                    | 116.3 ± 2.3 |          |
| KTK-5                     | granite      |         | Toni-cho, Kamaishi-shi, Iwate                            |                                    | 117.2 ± 3.7 |          |
| KTK-6                     | granite      |         | Hakizaki-cho, Kamaishi-shi, Iwate                        |                                    | 116.5 ± 2.6 |          |
| KTK-7                     | granite      |         | Tashiro, Miyako-shi, Iwate                               | 123.2 ± 0.9                        | 118.4 ± 2.9 |          |
| KTK-9                     | granite      |         | Iwaizumi-cho, Shimohei-gun, Iwate                        |                                    | 117.4 ± 2.4 |          |
| KTK-10                    | granite      |         | Fudai-mura, Shimohei-gun, Iwate                          |                                    | 118.9 ± 2.2 |          |
| KTK-12                    | granite      |         | Hirono-cho, Kunohe-gun, Iwate                            |                                    | 120.1 ± 2.5 |          |
| KTK-14                    | granite      |         | Hanamaki-shi, Iwate                                      |                                    | 114.8 ± 3.2 |          |
| KTK-15                    | granite      |         | Tsukimoshi-cho, Thono-shi, Iwate                         |                                    | 113.2 ± 2.5 |          |
| KK-4                      | granodiorite | 127605  | Ayukawa-hama, Kinkazan, Ishinomaki-shi, Miyagi           |                                    | 116.4 ± 3.7 |          |
| KK-16                     | granodiorite | 127617  | Ayukawa-hama, Kinkazan, Ishinomaki-shi, Miyagi           |                                    | 118.6 ± 5.2 |          |
| Age data in Figs. 5 and 6 |              |         |                                                          |                                    |             |          |
| 031107-4                  | granitoid    |         | Jinzu-kyou, Ooe-cho, Nishimurayama-gun, Yamagata         | 101.5 ± 0.9                        |             |          |
| 041122-2                  | granitoid    |         | Ooisawa, Nishikawa-machi, Nishimurayama-gun, Yamagata    | 93.4 ± 1.4                         |             |          |
| 041122-3                  | granitoid    |         | Ooisawa, Nishikawa-machi, Nishimurayama-gun, Yamagata    |                                    | 92.5 ± 1.6  |          |
| 050609-12                 | granitoid    |         | Ooisawa, Nishikawa-machi, Nishimurayama-gun, Yamagata    | 95.7 ± 1.6                         |             |          |
| 050906-3                  | granitoid    |         | Ooisawa, Nishikawa-machi, Nishimurayama-gun, Yamagata    | 95.5 ± 1.5                         |             |          |
| 051128-6                  | granitoid    |         | Yanagawa, Ooe-machi, Nishimurayama-gun, Yamagata         | 102.4 ± 1.6                        |             |          |
| 051128-3                  | granitoid    |         | Yanagawa, Ooe-machi, Nishimurayama-gun, Yamagata         | 107.9 ± 2.8                        |             |          |
| 051130-5                  | granitoid    |         | Sirakura, Asahi-machi, Yamagata                          | 97.7 ± 2.2 core,<br>92.4 ± 1.3 rim |             |          |
| 051130-6                  | granitoid    |         | Sirakura, Asahi-machi, Yamagata                          | 91.1 ± 1.4                         |             |          |
| 051130-7                  | granitoid    |         | Yanagawa, Ooe-machi, Nishimurayama-gun, Yamagata         | 91.7 ± 1.1                         |             |          |
| 051130-9                  | granitoid    |         | Zao-dam, Kamihosawa, Yamagata-shi, Yamagata              | 93.3 ± 1.3                         |             |          |
| 060426-2                  | granitoid    |         | Oura-hashi, Tsuruoka-shi, Yamagata                       | 67.9 ± 1.0                         | 65.6 ± 1.9  |          |
| 061115-1                  | granite      |         | Ooisawa, Nishikawa-machi, Nishimurayama-gun, Yamagata    | 95.8 ± 1.2                         | 91.3 ± 2.6  |          |
| 061115-5b                 | granite      |         | Ooisawa, Nishikawa-machi, Nishimurayama-gun, Yamagata    | 67.3 ± 1.7                         | 66.3 ± 2.2  |          |
| 061021-19                 | granitoid    |         | Asahi-kosen, Asahi-machi, Nishimurayama-gun, Yamagata    | 91.0 ± 1.6                         |             |          |
| 061105-1                  | granitoid    |         | Oohagemoriyama, Asahi-machi, Nishimurayama-gun, Yamagata | 92.5 ± 2.1                         |             |          |
| 061108-13                 | granitoid    |         | Asahi-machi, Nishimurayama-gun, Yamagata                 | 97.2 ± 1.0                         | 97.6 ± 2.5  |          |
| 070627-29                 | granitoid    |         | Nishikawa-machi, Nishimurayama-gun, Yamagata             |                                    | 66.9 ± 3.6  |          |
| 070719-2                  | granitoid    |         | Oguni-machi, Nishiokitama-gun, Yamagata                  | 80.7 ± 1.6                         |             |          |
| 070726-4                  | granitoid    |         | Iide-machi, Nishiokitama-gun, Yamagata                   | 80.2 ± 1.7 core,<br>68.0 ± 0.7 rim | 65.6 ± 4.3  |          |
| 070726-11                 | granitoid    |         | Teraizumi, Nagai-shi, Yamagata                           |                                    | 63.0 ± 3.0  |          |
| 061201-4                  | granitoid    |         | Nakaisazawa, Nagai-shi, Yamagata                         | 97.9 ± 1.3                         |             |          |
| 061201-5                  | granitoid    |         | Urushiyama, Nanyou-shi, Yamagata                         | 98.2 ± 1.3                         |             |          |
| 061115-8                  | granitoid    |         | Nishikawa-machi, Nishimurayama-gun, Yamagata             | 91.0 ± 1.7                         |             |          |
| 06120-1c                  | granitoid    |         | Shirataka-machi, Nishiokitama-gun, Yamagata              | 103.8 ± 1.4                        |             |          |
| ER6-4                     | granitoid    |         | Yamaguchi, Tendo-shi, Yamagata                           | 101.8 ± 1.3                        |             |          |
| 111206-3                  | granitoid    |         | Kamihigashiyama, Yamagata-shi, Yamagata                  | 95.1 ± 1.4                         |             |          |
| 111207-6                  | granitoid    |         | Daimon, Kamino-yama-shi, Yamagata                        | 101.6 ± 1.3                        |             |          |
| 091022-1                  | granitoid    |         | Tachiyazawa, Shonai-machi, Higashitagawa-gun, Yamagata   | 97.2 ± 1.0                         |             |          |
| 111012-3                  | granitoid    |         | Nagaiohashi, Hinode-machi, Nagai-shi, Yamagata           | 97.2 ± 0.6                         |             |          |
| Nihon-2                   | granite      | 130674  | Oodai, Murayama-shi, Nigata                              | 65.6 ± 1.3                         |             |          |
| Nihon-3                   | granite      | 130675  | Omata, Murakami-shi, Nigata                              | 65.0 ± 1.2                         |             |          |
| Nihon-15                  | granite      | 130686  | Ganjiki, Murayama-shi, Nigata                            | 65.5 ± 0.6                         |             |          |
| Kita-1                    | diorite      | 129956  | Nyotaisan, Nakagawa-machi, Nasu-gun, Tochigi             |                                    | 105.1 ± 3.7 |          |
| Ashi-6                    | adamellite   | 127850  | Chyugushi, Nikko-shi, Tochigi                            | 63.5 ± 2.5                         | 63.6 ± 3.0  |          |
| Ashi-4                    | granite      | 127848  | Ashio-machi, Nikko-shi, Tochigi                          | 63.7 ± 2.0                         | 65.2 ± 3.7  |          |
| Ashi-7                    | granite      | 127851  | Sasamekura, Nikko-shi, Tochigi                           | 65.1 ± 2.2                         | 65.7 ± 3.2  |          |
| Ashi-5                    | granite      | 127849  | Chyugushi, Nikko-shi, Tochigi                            | 97.9 ± 1.8                         |             |          |
| Ashi-3                    | aplite       | 127847  | Hara, Ashio-machi, Nikko-shi, Tochigi                    | 99.2 ± 1.7                         |             |          |
| Ashi-2                    | granite      | 127846  | Kusaki lake, Azuma-cho, Midori-shi, Gunma                | 99.2 ± 2.5                         |             |          |
| ABK-7                     | granitoid    |         | Yokokawa-machi, Koriyama-shi, Fukushima                  | 103.4 ± 1.0                        |             |          |

Table 1. (continued)

| sample No                 | rock         | reg. No | locality                                                    | Uraninite    | Thorite                          | Monazite    |
|---------------------------|--------------|---------|-------------------------------------------------------------|--------------|----------------------------------|-------------|
| ABK-8                     | granitoid    |         | Tamura-machi, Koriyama-shi, Fukushima                       | 124.1 ± 1.2  | 120.9 ± 2.6                      |             |
| ABK-10                    | granitoid    |         | Ono-machi, Tamura-gun, Fukushima                            |              | 113.3 ± 2.4                      |             |
| ABK-11                    | granitoid    |         | Hirata-mura, Ishikawa-gun, Fukushima                        | 106.5 ± 1.0  |                                  |             |
| ABK-12                    | granitoid    |         | Ishikawa-machi, Ishikawa-gun, Fukushima                     | 110.3 ± 1.5  |                                  |             |
| ABK-15                    | granitoid    |         | Samekawa-mura, Higashishirakawa-gun, Fukushima              | 114.4 ± 1.2  |                                  |             |
| ABK-16                    | granitoid    |         | Tabito-machi, Iwaki-shi, Fukushima                          | 106.5 ± 3.0  |                                  |             |
| ABK-17                    | granitoid    |         | Furudono-machi, Ishikawa-gun, Fukushima                     | 110.3 ± 1.0  |                                  |             |
| ABK-24                    | granitoid    |         | Katsurao-mura, Futaba-gun, Fukushima                        | 110.4 ± 1.5  |                                  |             |
| ABK-25                    | granitoid    |         | Tokiwa-machi, Tamura-shi, Fukushima                         | 104.2 ± 1.0  | 102.5 ± 1.7                      |             |
| YK24                      | granodiorite | 127564  | Mt. Takakura, Yaguki, Yotsukura-machi, Iwaki-shi, Fukushima | 117.9 ± 3.5  |                                  |             |
| Yk27                      | granodiorite | 127568  | Shiosawa, Ogawa-machi, Iwaki-shi, Fukushima                 | 115.8 ± 1.5  |                                  |             |
| K44                       | metaporphry  | 127480  | Mt. Haguro, Soma-shi, Fukushima                             | 116.0 ± 0.05 |                                  |             |
| I-A                       | granite      | 128636  | Oda, Tsukuba-shi, Ibaraki                                   | 65.1 ± 1.3   |                                  | 80.0 ± 7.4  |
| I-B                       | granite      | 128637  | Shiio, Makabe-cho, Sakuragawa-shi, Ibaraki                  | 65.8 ± 1.5   |                                  |             |
| I-C                       | granodiorite | 128638  | Sakurabo, Makabe-cho, Sakuragawa-shi, Ibaraki               | 65.0 ± 1.2   |                                  | 74.7 ± 12.5 |
| I-E                       | granite      | 128639  | Inada, Kasama-shi, Ibaraki                                  |              | 69.5 ± 2.7                       |             |
| I-4                       | granodiorite | 128643  | Iwafune, Shirosato-machi, Higashiibaraki-gun, Ibaraki       |              |                                  | 68.6 ± 1.5  |
| I-11                      | granodiorite | 128650  | Shimokimita, Takahagi-shi, Ibaraki                          |              | 105.0 ± 0.8                      |             |
| I-12                      | granodiorite | 128651  | Ishioka, Nakago-cho, Kitaibaraki-shi, Ibaraki               | 105.2 ± 0.8  |                                  |             |
| I-14                      | granodiorite | 128653  | Takahara, Juoo-cho, Hitachi-shi, Ibaraki                    | 106.1 ± 2.1  | 102 (1grain)                     |             |
| Z-4                       | granite      | 128658  | Inada, Kasama-shi, Ibaraki                                  | 66.5 ± 1.1   | 68.2 ± 1.4                       |             |
| Z-6                       | granodiorite | 128660  | Iwase, Sakuragawa-shi, Ibaraki                              |              | 67.2 ± 3.8                       |             |
| Z-7                       | granite      | 128661  | Kurusu, Kasama-shi, Ibaraki                                 |              | 69.3 ± 4.5                       |             |
| Z-9                       | granite      | 128663  | Ohirominami, Kasama-shi, Ibaraki                            |              | 67.7 ± 1.0                       |             |
| Z-13                      | granite      | 128667  | Hojo, Tsukuba-shi, Ibaraki                                  | 64.6 ± 2.3   |                                  |             |
| Z-14                      | granite      | 128668  | Usui, Tsukuba-shi, Ibaraki                                  | 68.5 ± 2.1   | 80.5 ± 2.2core,<br>67.8 ± 4.5rim |             |
| ABK-18                    | granite      |         | Oda, Tsukuba-shi, Ibaraki                                   | 65.2 ± 0.9   |                                  |             |
| ABK-20                    | granite      |         | Makabe-cho, Sakurakawa-shi, Ibaraki                         | 79.7 ± 1.4   | 81.0 ± 1.9                       |             |
| Age data in Figs. 7 and 8 |              |         |                                                             |              |                                  |             |
| S-1                       | granodiorite | 128628  | Mt. Eimeiji, Chino-shi, Nagano                              |              | 11.5 ± 0.8                       |             |
| 91030804                  | granitoid    |         | Kashimata, Takagi-mura, Shimoina-gun, Nagano                | 72.6 ± 0.9   |                                  |             |
| 98031201                  | granitoid    |         | Ogawa, Agematsu-machi, Kiso-gun, Nagano                     |              | 71.6 ± 2.1                       |             |
| YG-118                    | granitoid    |         | Momiji lake, Minowa-machi, Kamiina-gun, Nagano              |              | 72.3 ± 2.7                       |             |
| YG-120B                   | granitoid    |         | Kuwabara fall, Kamiina-gun, Nagano                          | 72.2 ± 1.2   |                                  |             |
| YG-121B                   | granitoid    |         | Koshibu lake, Minowa-machi, Kamiina-gun, Nagano             | 71.6 ± 1.0   |                                  |             |
| S-2                       | granite      | 128629  | Hakusyu-cho, Hokuto-shi, Yamanashi                          |              | 14.1 ± 1.2                       |             |
| 5763                      | granite      | 5763    | Taguchi, Shidara-cho, Kitashidara-gun, Aichi                | 101.0 ± 2.3  |                                  |             |
| E-1                       | granite      | 128626  | Kerokubo, Kasagi-cho, Ena-shi, Gifu                         |              | 69.4 ± 1.5                       |             |
| TG-2                      | granite      | 134087  | Tateishi, Tsuruga-shi, Fukui                                |              | 68.6 ± 2.7                       |             |
| TG-3                      | granite      | 133088  | Irohama, Tsuruga-shi, Fukui                                 |              | 68.3 ± 2.4                       |             |
| TG-4                      | granite      | 132089  | Kutsu, Tsuruga-shi, Fukui                                   |              | 67.9 ± 2.3                       |             |
| TG-5                      | granite      | 131090  | Takekawa, Mihama-cho, Mikata-gun, Fukui                     |              | 69.3 ± 1.9                       |             |
| TG-6                      | granite      | 130091  | Kurokawagawa quarry, Tsuruga-shi, Fukui                     |              | 67.8 ± 2.5                       |             |
| TS-3                      | porphyry     | 134453  | Hachimangu, Masuya, Echizen-shi, Fukui                      | 66 (1grain)  | 65.5 ± 1.5                       |             |
| 98031401                  | granitoid    |         | Tanokami, Otsu-shi, Shiga                                   | 77.3 ± 1.0   |                                  |             |
| 98031402                  | granitoid    |         | Tanokami, Otsu-shi, Shiga                                   | 77.7 ± 1.1   |                                  |             |
| 98031403                  | granitoid    |         | Tanokami, Otsu-shi, Shiga                                   |              | 79.7 ± 2.1                       |             |
| 98031405                  | granitoid    |         | Mt. Hiei, Otsu-shi, Shiga                                   | 101.1 ± 1.0  | 101.9 ± 1.8                      |             |
| 98031501                  | granitoid    |         | Hira, Otsu-shi, Shiga                                       |              | 77.0 ± 2.1                       |             |
| OG-3                      | granitoid    |         | Ogi, Otsu-shi, Shiga                                        |              | 102.4 ± 3.8                      |             |
| RZ-2                      | granitoid    |         | Ryozen, Otsu-shi, Shiga                                     |              | 74.1 ± 2.0                       |             |
| SZ-1                      | granitoid    |         | Mandokoro-cho, Higashiomi-shi, Shiga                        |              | 73.0 ± 2.0                       |             |
| SZ-2                      | granitoid    |         | Tuchiyama-cho, Koga-shi, Shiga                              |              | 73.4 ± 2.5                       |             |
| OM-5                      | granitoid    |         | Ide-cho, Tsuzuki-gun, Kyoto                                 |              | 104.2 ± 2.3                      |             |
| HA-4                      | granitoid    |         | Hanasebetsusho-cho, Sakyoku-ku, Kyoto                       |              | 105.6 ± 1.9                      |             |
| IN-08                     | granite      | 135895  | Mie, Omiya-cho, Kyotango-shi, Kyoto                         |              | 65.7 ± 4.7                       |             |
| IDM-1                     | granitoid    |         | Ide-cho, Tsuzuki-gun, Kyoto                                 |              | 90.1 ± 2.0                       |             |
| KO-1                      | granitoid    |         | Somada, Wazuka-cho, Sora-gun, Kyoto                         | 98.0 ± 1.0   | 94.4 ± 3.3                       |             |
| GY-4                      | granitoid    |         | Mt. Gyoja, Kameoka-shi, Kyoto                               | 98.8 ± 1.2   |                                  |             |
| Ik-5                      | granodiorite |         | Taishi-cho, Minamikawachi-gun, Osaka                        |              | 80.9 ± 1.6                       |             |
| KTN                       | granitoid    |         | Kisabe, Katano-shi, Osaka                                   |              | 84.2 ± 1.5                       |             |

Table 1. (continued)

| sample No                  | rock         | reg. No | locality                                                 | Uraninite                           | Thorite                         | Monazite     |
|----------------------------|--------------|---------|----------------------------------------------------------|-------------------------------------|---------------------------------|--------------|
| 98031502                   | granitoid    |         | Ibaraki-shi, Osaka                                       |                                     | 80.9 ± 1.9                      |              |
| 98031503                   | granitoid    |         | Ibaraki-shi, Osaka                                       |                                     | 82.2 ± 1.8                      |              |
| 98031504                   | granitoid    |         | Ibaraki-shi, Osaka                                       |                                     | 81.5 ± 2.7                      |              |
| Ik-1                       | granite      | 129930  | Kitasanjyoguchi-station, Heguri-cho, Ikoma-shi, Nara     | 86.7 ± 0.9                          |                                 |              |
| Ik-2                       | granite      | 129931  | Ichihara tunnel, Heguri-cho, Ikoma-shi, Nara             | 86.0 ± 0.6                          |                                 |              |
| Ik-3                       | granite      | 129932  | Kitasanjyoguchi-station, Heguri-cho, Ikoma-shi, Nara     | 86.6 ± 0.5                          |                                 |              |
| IK-9                       | granite      | 129938  | Hondo, Sango-cho, Ikoma-gun, Nara                        | 81.2 ± 2.2                          |                                 |              |
| Ik-11                      | qz diorite   | 129940  | Kyuanji, Heguri-cho, Ikoma-shi, Nara                     |                                     | 86.0 ± 1.4                      |              |
| SK-02                      | granitoid    |         | Nakatani, Sakurai-shi, Nara                              | 89.0 ± 1.7                          |                                 |              |
| SK-03                      | granitoid    |         | Kasa, Sakurai-shi, Nara                                  | 89.3 ± 1.4                          |                                 |              |
| SK-04                      | granitoid    |         | Kasa, Sakurai-shi, Nara                                  | 74.7 ± 1.3                          |                                 |              |
| S-3                        | granite      | 128630  | Kamiobina-cho, Kofu-shi, Yamanashi                       |                                     | 15.8 ± 1.7                      |              |
| S-4                        | granite      | 128631  | Yoshizawa, Kai-shi, Yamanashi                            |                                     | 16.9 ± 2.1                      |              |
| S-5                        | granodiorite | 128632  | Yanagidaira, Makioka-cho, Yamanashi-shi, Yamanashi       |                                     | 4.1 ± 0.8                       |              |
| S-6                        | granodiorite | 128633  | Kanazakura shrine, Makioka-cho, Yamanashi-shi, Yamanashi |                                     | 4.8 ± 1.2                       |              |
| S-8                        | granodiorite | 128635  | Narusawa, Makioka-cho, Yamanashi-shi, Yamanashi          |                                     | 12.8 ± 1.2                      |              |
| S-9                        | granodiorite | 134085  | Kaiyamoto statim, Yamato-cho, Kosyu-shi, Yamanashi       |                                     | 12.1 ± 1.5                      |              |
| Age data in Figs. 9 and 10 |              |         |                                                          |                                     |                                 |              |
| 98031301                   | granite      |         | Niho power station, Yatsuo-machi, Toyama-shi, Toyama     | 195.5 ± 3.2                         |                                 |              |
| 98052212                   | granite      |         | Iori, Kamiichi-machi, Nakanikawa-gun, Toyama             | 66.8 ± 2.0                          | 67.1 ± 3.1                      |              |
| 98052217                   | granite      |         | Iori, Kamiichi-machi, Nakanikawa-gun, Toyama             | 198.7 ± 2.5                         |                                 |              |
| 98112501                   | granite      |         | Minamimata vally, Sanga, Uozu-shi, Toyama                | 232.4 ± 4.4                         |                                 |              |
| 98112504                   | granite      |         | Minamimata, Sanga, Uozu-shi, Toyama                      | 236.3 ± 5.5                         |                                 |              |
| 99040905                   | granite      |         | Mt. Shiridaka, Kamiichi-machi, Nakashinkawa-gun, Toyama  | 241.0 ± 3.6                         |                                 |              |
| 99042210                   | granite      |         | Kufusu river, Kiritani, Yatsuo-machi, Toyama-shi, Toyama | 189.9 ± 3.2                         |                                 |              |
| 99082802                   | aplite       |         | Shona river, Tateyama-machi, Nakashinkawa-gun, Toyama    | 198.1 ± 3.0                         |                                 | 195.4 ± 6.5  |
| 99100705                   | granite      |         | Otozawa, Unazuki-machi, Kurobe-shi, Toyama               | 255.8 ± 2.9                         |                                 |              |
| 99100707                   | granite      |         | Unazuki-machi, Kurobe-shi, Toyama                        | core: 241.1 ± 4.2, sec: 191.8 ± 5.9 |                                 |              |
| 5760                       | granite      | 5760    | Aimoto, Unazuki-machi, Kurobe-shi, Toyama                | 95.9 ± 2.4                          |                                 |              |
| 98112201                   | granite      |         | Isurugiyama, Nakanoto-machi, Kashima-gun, Ishikawa       | 183.5 ± 3.7                         |                                 |              |
| 99042801                   | granite      |         | Mt. Hotatu, Hakui-shi, Ishikawa                          |                                     |                                 | 188.5 ± 7.1  |
| 99042805                   | granite      |         | Mt. Hotatu, Hakui-shi, Ishikawa                          | 234.3 ± 2.8                         |                                 |              |
| 99091807                   | granite      |         | Notokongo, Shika-machi, Hakui-gun, Ishikawa              |                                     | 189.2 ± 7.0                     |              |
| 99111304                   | granite      |         | Metuke vally, Aratani, Hakusan-shi, Ishikawa             | 188.9 ± 3.1                         |                                 |              |
| 99111305                   | granite      |         | Metuke vally, Aratani, Hakusan-shi, Ishikawa             | 161.1 ± 4.5                         |                                 | 215.2 ± 13.6 |
| 99111306                   | granite      |         | Metuke vally, Aratani, Hakusan-shi, Ishikawa             |                                     |                                 | 196.5 ± 9.8  |
| 98092905                   | granite      |         | Horatani, Miyagawa-cho, Hida-shi, Gifu                   |                                     |                                 | 198.3 ± 4.1  |
| 98092906                   | granite      |         | Horatani, Miyagawa-cho, Hida-shi, Gifu                   |                                     |                                 | 196.5 ± 3.8  |
| 98092907                   | granite      | 129249  | Horatani, Miyagawa-cho, Hida-shi, Gifu                   |                                     | 245.2 ± 5.0core, 196.7 ± 7.4rim |              |
| 98092908                   | granite      |         | Horatani, Miyagawa-cho, Hida-shi, Gifu                   | 206.8 ± 2.4                         |                                 |              |
| 98092910                   | granite      | 129248  | Utsubo, Miyagawa-cho, Hida-shi, Gifu                     | 204.4 ± 4.3                         |                                 |              |
| 98092911                   | granite      |         | Utsubo, Miyagawa-cho, Hida-shi, Gifu                     | 208.5 ± 2.5                         |                                 |              |
| 98092913                   | granite      |         | Utsubo, Miyagawa-cho, Hida-shi, Gifu                     | 189.6 ± 3.6                         |                                 |              |
| 98100304                   | granite      | 129250  | Azukizawa, Miyagawa-cho, Hida-shi, Gifu                  | 189.6 ± 4.0                         |                                 |              |
| 98100308                   | granite      |         | Hongo, Kamitakara-cho, Takayama-shi, Gifu                | 201.7 ± 2.8                         |                                 |              |
| 98100309                   | granite      |         | Shimosatani, Kamitakara-cho, Takayama-shi, Gifu          | 198.8 ± 3.5                         |                                 |              |
| 98100310                   | granite      |         | Shimosatani, Kamitakara-cho, Takayama-shi, Gifu          | 191.5 ± 2.9                         |                                 |              |
| 98100311                   | granite      |         | Kuzuyama, Kamitakara-cho, Takayama-shi, Gifu             | 194.2 ± 3.3                         |                                 |              |
| 99042103                   | granite      | 129252  | Morimo, Kamioka-cho, Hida-shi, Gifu                      | 198.9 ± 2.6                         |                                 |              |
| 99042106                   | granite      |         | Sugoroku river, Kamitakara-cho, Takayama-shi, Gifu       |                                     |                                 | 205.4 ± 7.8  |
| 99042107                   | granite      |         | Kasatani, Kamitakara-cho, Takayama-shi, Gifu             | 205.2 ± 3.6                         |                                 |              |
| 99042108                   | granite      |         | Kamitakara-cho, Takayama-shi, Gifu                       |                                     |                                 | 267.8 ± 10.1 |
| 99082901                   | granite      |         | Kagasawa, Utubo, Miyakawa-cho, Hida-shi, Gifu            | 190.2 ± 4.0                         |                                 | 193.4 ± 4.9  |
| 99093003                   | granite      |         | Osaka-toge, Furukawa-maci, Hida-shi, Gifu                |                                     |                                 | 215.2 ± 13.6 |
| 99093004                   | granite      |         | Furukawa-cho, Hida-shi, Gifu                             |                                     |                                 | 196.1 ± 11.9 |

Table 1. (continued)

| sample No                   | rock       | reg. No | locality                                        | Uraninite                          | Thorite    | Monazite |
|-----------------------------|------------|---------|-------------------------------------------------|------------------------------------|------------|----------|
| HD31                        | granite    |         | Asoya, Kamioka-cho, Hida-shi, Gifu              | 201.6 ± 3.1                        |            |          |
| KM133                       | granite    |         | Mannami river, Miyagawa-cho, Hida-shi, Gifu     | 233.4 ± 3.4core,<br>191.4 ± 1.8rim |            |          |
| Age data in Figs. 11 and 12 |            |         |                                                 |                                    |            |          |
| D2000408                    | granitoid  |         | Aioi, Aioi-shi, Hyogo                           |                                    | 86.8 ± 2.4 |          |
| GY-05                       | granitoid  |         | Okuyane, Tanto-cho, Toyooka-shi, Hyogo          |                                    | 66.2 ± 2.6 |          |
| GY-06                       | granitoid  |         | Tanto-cho, Toyooka-shi, Hyogo                   |                                    | 67.4 ± 2.3 |          |
| TSHY-60                     | granitoid  |         | Nada-ku, Kobe-shi, Hyogo                        |                                    | 81.6 ± 2.5 |          |
| 9803170313                  | granitoid  |         | Kita-ku, Kobe-shi, Hyogo                        |                                    | 79.3 ± 2.0 |          |
| 98031702                    | granitoid  |         | Mt.Rokko, Higashinada-ku, Kobe-shi, Hyogo       |                                    | 81.6 ± 1.1 |          |
| MIKAGE                      | qz-diorite |         | Mt.Rokko, Higashinada-ku, Kobe-shi, Hyogo       |                                    | 82.2 ± 1.0 |          |
| TSHYG-42                    | granitoid  |         | Mt.Rokko, Higashinada-ku, Kobe-shi, Hyogo       |                                    | 81.6 ± 2.5 |          |
| Akou                        | granitoid  |         | Tenwa, Akou-shi, Hyogo                          |                                    | 88.2 ± 1.7 |          |
| Tatsuno-1                   | granitoid  |         | Shinmiya-cho, Tatsuno-shi, Hyogo                |                                    | 87.6 ± 2.0 |          |
| TSTAU-1                     | granitoid  |         | Shiosaki, Miya, Ienaga-cho, Himeji-shi, Hyogo   |                                    | 85.4 ± 2.0 |          |
| TSTAU-7                     | granitoid  |         | Hishinohana, Ienaga-cho, Himeji-shi, Hyogo      |                                    | 85.8 ± 1.8 |          |
| NGM-2                       | granitoid  |         | Nojima-Hirabayashi, Awaji-shi, Hyogo            | 82.9 ± 1.6                         | 86.1 ± 1.7 |          |
| AW-58c                      | granitoid  |         | Oomachi, Awaji-shi, Hyogo                       |                                    | 87.0 ± 3.0 |          |
| SZUKI-1                     | granitoid  |         | Shio, Awaji-shi, Hyogo                          | 84.0 ± 0.7                         |            |          |
| YG-41                       | granitoid  |         | Iwaya, Shinmura, Awaji-shi, Hyogo               | 84.8 ± 1.8                         | 87.3 ± 2.5 |          |
| YG-43                       | granitoid  |         | Iwaya, Shinmura, Awaji-shi, Hyogo               |                                    | 81.2 ± 2.1 |          |
| YG-58                       | granitoid  |         | Takenokuchi, Sumoto-shi, Hyogo                  | 85.4 ± 1.2                         | 85.8 ± 2.1 |          |
| YG-59                       | granitoid  |         | Shio, Awaji-shi, Hyogo                          | 84.3 ± 1.4                         |            |          |
| YG-81                       | granite    |         | Shio, Awaji-shi, Hyogo                          | 88.1 ± 0.5                         |            |          |
| YG-87                       | granitoid  |         | Iwaya, Shinmura, Awaji-shi, Hyogo               | 81.2 ± 1.1                         | 81.7 ± 1.2 |          |
| YG-88                       | granitoid  |         | Nojima Hikinoura, Awaji-shi, Hyogo              | 81.9 ± 0.9                         |            |          |
| YG-89                       | granitoid  |         | Higashiyama, Shinmura, Awaji-shi, Hyogo         | 82.8 ± 2.1                         | 87.8 ± 3.3 |          |
| GY-02                       | granitoid  |         | Shimonomiya, Toyooka-shi, Hyogo                 |                                    | 66.4 ± 1.5 |          |
| GY-03                       | granitoid  |         | Hokkeiji, Toyooka-shi, Hyogo                    |                                    | 74.8 ± 2.5 |          |
| GY-05                       | granitoid  |         | Okuyane, Tanto-cho, Toyooka-shi, Hyogo          |                                    | 66.2 ± 2.6 |          |
| GY-06                       | granitoid  |         | Okuyane, Tanto-cho, Toyooka-shi, Hyogo          |                                    | 67.4 ± 2.3 |          |
| Mannari                     | granite    |         | Mannai, Kita-ku, Okayama                        |                                    | 87.8 ± 1.9 |          |
| GY-12                       | granitoid  |         | Kamisaibara, Kagami-cho, Tomata-gun, Okayama    | 72.6 ± 2.6                         |            |          |
| GY30-2                      | granitoid  |         | Ushiroyama, Mimasaka-shi, Okayama               |                                    | 65.9 ± 3.0 |          |
| GY-65                       | granitoid  |         | Hiruzen-Nishikayabe, Maniwa-shi, Okayama        | 64.3 ± 1.3                         |            |          |
| GY-86                       | granitoid  |         | Fujimori, Maniwa-shi, Okayama                   | 68.0 ± 1.2                         |            |          |
| YG-07                       | granitoid  |         | Kashino, Ushimado-cho, Setouchi-shi, Okayama    |                                    | 83.9 ± 2.3 |          |
| YG-08                       | granitoid  |         | Yomogisaki, Ushimado-cho, Setouchi-shi, Okayama |                                    | 86.6 ± 2.6 |          |
| YG-09                       | granitoid  |         | Oka, Ushimado-cho, Setouchi-shi, Okayama        |                                    | 88.7 ± 1.8 |          |
| YG10-1                      | granitoid  |         | Kashino, Ushimado-cho, Setouchi-shi, Okayama    |                                    | 85.8 ± 1.2 |          |
| YG-12                       | granitoid  |         | Tamahara, Tamano-shi, Okayama                   | 87.5 ± 1.1                         | 85.1 ± 2.1 |          |
| YG-17                       | granitoid  |         | Miyaura, Minami-ku, Okayama-shi, Okayama        | 87.2 ± 1.6                         | 87.8 ± 2.4 |          |
| YG-18                       | granitoid  |         | Mt.Hachijyoiva, Minami-ku, Okayama-shi, Okayama | 84.8 ± 0.9                         |            |          |
| YG-19                       | granitoid  |         | Hase lake, Kamiyamasaka, Tamano-shi, Okayama    |                                    | 87.0 ± 1.7 |          |
| YG-20                       | granitoid  |         | Kamo-cho, Tsuyama-shi, Okayama                  | 73.4 ± 1.1                         |            |          |
| YG-105                      | granite    |         | Kamisaibara, Kagami-cho, Tomata-gun, Okayama    | 63.8 ± 1.5                         |            |          |
| YG-106                      | granite    |         | Kamisaibara, Kagami-cho, Tomata-gun, Okayama    | 64.5 ± 1.5                         |            |          |
| YG-130                      | granitoid  |         | Okutsu, Kagamino-cho, Tomata-gun, Okayama       | 71.6 ± 0.9                         | 71.6 ± 0.8 |          |
| YG-132                      | granitoid  |         | Okutsu, Kagamino-cho, Tomata-gun, Okayama       | 72.4 ± 1.0                         | 71.9 ± 2.1 |          |
| YG-135                      | granitoid  |         | Okutsu, Kagamino-cho, Tomata-gun, Okayama       | 72.2 ± 1.2                         | 72.4 ± 2.1 |          |
| YG-137                      | granitoid  |         | Okutsu, Kagamino-cho, Tomata-gun, Okayama       |                                    | 72.7 ± 2.0 |          |
| YG-138                      | granitoid  |         | Okutsu, Kagamino-cho, Tomata-gun, Okayama       |                                    | 75.3 ± 3.7 |          |
| YG-139                      | granitoid  |         | Kamisaibara, Kagami-cho, Tomata-gun, Okayama    | 72.5 ± 1.0                         |            |          |
| 84101601                    | granitoid  |         | Kaita-cho, Aki-gun, Hiroshima                   |                                    | 89.5 ± 1.9 |          |
| 84101804                    | granitoid  |         | Jhoge-cho, Fuchu-shi, Hiroshima                 |                                    | 94.7 ± 2.3 |          |
| 84102702                    | granitoid  |         | Fukutomi-cho, Higashihiroshima-shi, Hiroshima   |                                    | 94.8 ± 1.8 |          |
| 84102901                    | granitoid  |         | Higashihiroshima-shi, Hiroshima                 | 92.9 ± 1.1                         |            |          |
| GY-21-3                     | granite    |         | Iwamoto, Iwami-cho, Iwami-gun, Tottori          | 32.4 ± 0.8                         |            |          |
| GY-53                       | granitoid  |         | Yamaguchi, Mochigase-cho, Toori-shi, Tottori    | 86.3 ± 2.3                         |            |          |
| GY-56-1                     | granite    |         | Tanigawa, Hoki-cho, Saihaku-gun, Tottori        | 89.9 ± 2.8                         | 88.0 ± 2.0 |          |
| GY-58                       | granite    |         | Asakane, Aimi-cho, Saihaku-gun, Tottori         | 65.4 ± 1.1                         |            |          |
| GY-59                       | granite    |         | Ikeno, Aimi-cho, Saihaku-gun, Tottori           | 65.0 ± 1.0                         |            |          |
| GY-61                       | granite    |         | Neubara, Hoki-cho, Saihaku-gun, Tottori         | 66.1 ± 0.7                         |            |          |
| GY-62                       | granite    |         | Kakibara, Kofu-cho, Hino-gun, Tottori           | 68.2 ± 0.8                         | 71.2 ± 2.0 |          |
| GY-63                       | granite    |         | Furuyashiki, Kofu-cho, Hino-gun, Tottori        |                                    | 65.0 ± 1.8 |          |

Table 1. (continued)

| sample No                   | rock           | reg. No | locality                                                | Uraninite                 | Thorite     | Monazite     |
|-----------------------------|----------------|---------|---------------------------------------------------------|---------------------------|-------------|--------------|
| GY-64                       | granite        |         | Sukesawa, Kofu-cho, Hino-gun, Tottori                   |                           | 66.6 ± 3.2  |              |
| GY-85                       | granite        |         | Yamaguchi, Sekikane-cho, Kurayoshi-shi, Tottori         | 64.1 ± 1.3                |             |              |
| YG93-1                      | granite        |         | Kuro pass, Okumoto, Chizu-cho, Yazu-gun, Tottori        |                           | 90.2 ± 1.4  |              |
| YG93-2                      | granite        |         | Kuro pass, Okumoto, Chizu-cho, Yazu-gun, Tottori        |                           | 87.7 ± 2.6  |              |
| YG-95                       | granite        |         | Hazi, Chizu-cho, Yazu-gun, Tottori                      | 83.3 ± 1.3                |             |              |
| YG-96                       | granite        |         | Kuchiunami, Chizu-cho, Yazu-gun, Tottori                | 83.0 ± 1.3                |             |              |
| YG-98                       | granite        |         | Kuchiunami, Chizu-cho, Yazu-gun, Tottori                | 83.0 ± 1.5                |             |              |
| YG-104                      | granite        |         | Oshikakei, Misasa-cho, Tohaku-gun, Tottori              | 64.6 ± 0.9                |             |              |
| YG-141                      | granite        |         | Kijiyama, Misasa-cho, Tohaku-gun, Tottori               |                           | 42.1 ± 2.3  |              |
| YG-142                      | granite        |         | Kijiyama, Misasa-cho, Tohaku-gun, Tottori               |                           | 43.7 ± 2.0  |              |
| YG-143                      | granite        |         | Misasa-cho, Tohaku-gun, Tottori                         | 65.6 ± 0.8                |             |              |
| YG-144                      | granite        |         | Simonishidani, Misasa-cho, Tohaku-gun, Tottori          | 66.5 ± 1.0                |             |              |
| YG-145                      | granite        |         | Shimohata, Misasa-cho, Tohaku-gun, Tottori              | 70.2 ± 0.7                |             |              |
| YG-146                      | granite        |         | Fukumoto, Misasa-cho, Tohaku-gun, Tottori               | 66.9 ± 1.1                |             |              |
| 92072301                    | granite        |         | Hirao-cho, Kumage-gun, Yamaguchi                        | 94.2 ± 1.1                |             |              |
| 92072403                    | granite        |         | Totu, Iwakuni-shi, Yamaguchi                            | 92.9 ± 1.1                |             |              |
| 95101802                    | granite        |         | Suoshima-cho, Ooshima-gun, Yamaguchi                    | 94.5 ± 1.8                |             |              |
| Do-2                        | granite        | 130691  | Fuse, Okinoshima-cho, Oki-gun, Shimane                  | 18.7 ± 2.0                |             |              |
| YG-21                       | granitoid      |         | Kinosho, Shodoshima-cho, Shozu-gun, Kagawa              | 86.5 ± 1.2                | 85.6 ± 2.4  |              |
| YG-22-1                     | granitoid      |         | Yoshino, Shodoshima-cho, Shozu-gun, Kagawa              | 84.9 ± 2.9                |             |              |
| YG-22-2                     | granitoid      |         | Yoshino, Shodoshima-cho, Shozu-gun, Kagawa              | 87.7 ± 1.3                |             |              |
| YG-23                       | granitoid      |         | Kamano, Shodoshima-cho, Shozu-gun, Kagawa               | 93.0 ± 1.6,<br>88.6 ± 1.6 |             |              |
| YG-24                       | granitoid      |         | Futaomote, Shodoshima-cho, Shozu-gun, Kagawa            | 92.0 ± 1.7                |             |              |
| YG-26-2                     | granitoid      |         | Un-misaki, Furuo, Shodoshima-cho, Shozu-gun,<br>Kagawa  | 90.1 ± 2.1                | 92.2 ± 1.8  |              |
| YG-27                       | granitoid      |         | Sakate, Shodoshima-cho, Shozu-gun, Kagawa               | 92.2 ± 2.4                |             |              |
| YG-28                       | granitoid      |         | Tachibana, Shodoshima-cho, Shozu-gun, Kagawa            | 94.2 ± 1.1                |             |              |
| YG-29                       | granitoid      |         | Tachibana, Shodoshima-cho, Shozu-gun, Kagawa            | 104.4 ± 2.2               |             |              |
| YG-30                       | granitoid      |         | Tachibana, Shodoshima-cho, Shozu-gun, Kagawa            | 105.6 ± 1.7               |             |              |
| YG-31                       | granitoid      |         | Tachibana, Shodoshima-cho, Shozu-gun, Kagawa            |                           | 92.5 ± 2.5  |              |
| YG-33-2                     | granitoid      |         | Fukuda, Shodoshima-cho, Shozu-gun, Kagawa               |                           | 84.3 ± 1.6  |              |
| YG-53                       | granitoid      |         | Sue, Sanuki-shi, Kagawa                                 | 92.4 ± 1.5                |             |              |
| YG-54                       | granitoid      |         | Shido, Sanuki-shi, Kagawa                               | 90.8 ± 1.2                | 90.2 ± 1.5  |              |
| YG-55                       | granitoid      |         | Shirotori, Higashikagawa-shi, Kagawa                    | 90.1 ± 1.0                |             |              |
| YG-56                       | granitoid      |         | Nyunoyama, Higashikagawa-shi, Kagawa                    | 89.1 ± 0.9                |             |              |
| 87S34B                      | granitoid      |         | Matsuyama-shi, Ehime                                    | 100.5 ± 2.4               |             |              |
| 87S36A                      | granitoid      |         | Matsuyama-shi, Ehime                                    | 99.0 ± 2.0                |             |              |
| 87S36B                      | granitoid      |         | Matsuyama-shi, Ehime                                    | 96.8 ± 2.0                |             |              |
| YG-61                       | granitoid      |         | Takabe, Imabari-shi, Ehime                              | 95.6 ± 2.4                |             |              |
| YG62-1                      | granitoid      |         | Namikata, Namikata-cho, Imabari-shi, Ehime              | 92.9 ± 1.9                | 91.1 ± 2.2  |              |
| YG-65                       | granitoid      |         | Moriue, Namikata-cho, Imabari, Ehime                    | 95.3 ± 1.0                |             |              |
| YG-68                       | granitoid      |         | Kugawa, Matsuyama-shi, Ehime                            | 97.0 ± 1.3                | 96.2 ± 4.4  |              |
| 6415                        | aplite         | 6415    | Ashizurimisaki, Tosashimizu-shi, Kochi                  |                           | 13.7 ± 1.9  |              |
| KK-11                       | sheard granite | 130794  | Heimiyaganaro, Niyodogawa-cho, Agawa-gun,<br>Kochi      |                           |             | 465.8 ± 15.8 |
| Ko-16                       | gneiss         | 130709  | Umanohara, Sagawa-cho, Takaoka-gun, Kochi               |                           |             | 456.5 ± 17.1 |
| Age data in Figs. 13 and 14 |                |         |                                                         |                           |             |              |
| YG-04                       | granite        | 135813  | Onihara, Hekishimo, Nagata-shi, Yamaguchi               |                           | 87.3 ± 4.6  |              |
| Kyu-1                       | granitoid      | 133730  | Isozaki, Nijofukui, Itoshima-shi, Fukuoka               |                           | 101.5 ± 3.0 | 99.4 ± 6.8   |
| Kyu-5                       | granitoid      | 133734  | Mikasa, Dazaifu-shi, Fukuoka                            |                           |             | 87.8 ± 4.4   |
| Kyu-7                       | granitoid      | 133736  | Kakishita, Kawara-machi, Tagawa-gun, Fukuoka            | 103.0 ± 1.8               |             |              |
| 09-3-01                     | pegmatite      | 134200  | Imajuku-Nagataru, Nishi-ku, Fukuoka-shi, Fukuoka        | 93.9 ± 1.1                |             | 105.8 ± 5.3  |
| 09-3-02                     | pegmatite      | 134201  | Hakoshima, Nijohamakubo, Itoshima-shi, Fukuoka          | 105.5 ± 1.2               |             |              |
| 09-3-03                     | granite        | 134202  | Nijomatusue, Itoshima-shi, Fukuoka                      |                           | 95.2 ± 1.2  | 100.5 ± 7.6  |
| 09-3-04                     | aplite         | 134204  | Nijyofukui, Itoshima-shi, Fukuoka                       | 98.5 ± 1.0                | 105.5 ± 1.8 |              |
| 09-3-06                     | granite        | 134205  | Haisaki, Nijofukui, Itoshima-shi, Fukuoka               | 107.2 ± 1.1               | 106.0 ± 2.7 |              |
| 09-3-07                     | pegmatite      | 134206  | Haisaki, Nijofukui, Itoshima-shi, Fukuoka               | 107.7 ± 2.8               |             |              |
| 09-3-08                     | granite        | 134207  | Kushisaki, Nijoshikaka, Itoshima-shi, Fukuoka           |                           |             | 98.0 ± 6.7   |
| 09-3-09                     | pegmatite      | 134208  | Kushisaki, Nijoshikaka, Itoshima-shi, Fukuoka           |                           |             | 106.8 ± 8.9  |
| 09-3-16                     | granite        | 134215  | Kankake pass, Tanushimaru-machi, Kurume-shi,<br>Fukuoka |                           |             | 87.2 ± 15.0  |
| 09-8-01                     | granite        | 134217  | Tsufune, Itoshima, Nishi-ku, Fukuoka-shi,<br>Fukuoka    | 95.0 ± 1.4                |             |              |
| 09-8-02                     | granite        | 134218  | Tsugami, Itoshima, Nishi-ku, Fukuoka-shi,<br>Fukuoka    |                           | 106.3 ± 2.4 |              |
| 09-8-05                     | qz diorite     | 134221  | Masaki, Kawasaki-machi, Tagawa-gun, Fukuoka             | 97.9 ± 1.4                | 97.6 ± 2.4  |              |

Table 1. (continued)

| sample No                   | rock         | reg. No | locality                                                 | Uraninite   | Thorite      | Monazite      |
|-----------------------------|--------------|---------|----------------------------------------------------------|-------------|--------------|---------------|
| 09-8-06                     | qz diorite   | 134222  | Naiju-kyo, Naiju, Iisuka-shi, Fukuoka                    | 94.9 ± 1.2  |              | 97.2 ± 5.6    |
| 09-8-07                     | granite      | 134223  | Mt. Sangun, Yusubaru, Chikushino-shi, Fukuoka            |             |              | 94.0 ± 4.8    |
| 09-10-04                    | granite      | 134227  | Kitashima, Itoshima, Nishi-ku, Fukuoka-shi,<br>Fukuoka   |             | 111.9 ± 1.7  |               |
| 09-10-05                    | granite      | 134228  | Tsugami, Itoshima, Nishi-ku, Fukuoka-shi,<br>Fukuoka     | 112.9 ± 1.9 | 107.9 ± 3.0  |               |
| 09-10-07                    | granite      | 134230  | Karadomari, Itoshima, Nishi-ku, Fukuoka-shi,<br>Fukuoka  | 112.6 ± 0.9 |              |               |
| 09-10-08                    | aplite       | 134231  | Kafuri, Itoshio-shi, Fukuoka                             | 107.5 ± 1.6 |              | 110.7 ± 6.3   |
| 09-10-09                    | granodiorite | 134232  | Kafuri, Itoshio-shi, Fukuoka                             |             | 105.86 ± 1.5 |               |
| 09-10-10                    | aplite       | 134233  | Nijohamakubo, Itoshima-shi, Fukuoka                      |             |              | 111.6 ± 9.7   |
| 09-10-11                    | granite      | 134234  | Nijohamakubo, Itoshima-shi, Fukuoka                      | 106.9 ± 1.4 | 105.6 ± 2.8  |               |
| 09-10-12                    | granite      | 134235  | Nijomatusue, Itoshio-shi, Fukuoka                        |             |              | 107.0 ± 6.0   |
| 09-10-13                    | aplite       | 134236  | Nijofukui, Itoshio-shi, Fukuoka                          |             |              | 108.2 ± 7.9   |
| 09-10-14                    | granodiorite | 134237  | Nijyofukui, Itoshima-shi, Fukuoka                        |             | 104.4 ± 2.9  |               |
| 09-10-16                    | aplite       | 134238  | Maeda, Nijofukui, Itoshima-shi, Fukuoka                  | 103.5 ± 1.0 | 104.6 ± 5.2  |               |
| 09-10-17                    | pegmatite    | 134241  | Haisaki, Nijofukui, Itoshima-shi, Fukuoka                |             |              | 100.1 ± 4.7   |
| 09-10-19                    | granite      | 134242  | Ishikama, Sagara-ku, Fukuoka-shi, Fukuoka                |             |              | 95.7 ± 13.3   |
| 09-10-26                    | granite      | 134249  | Kamihoman, Hondoji, Chikushio-shi, Fukuoka               |             |              | 98.2 ± 9.7    |
| 09-10-27                    | granite      | 134250  | Hondoji, Chikushio-shi, Fukuoka                          |             |              | 92.7 ± 6.5    |
| 09-10-28                    | granite      | 134251  | Anraku temple, Hondoji, Chikushio-shi, Fukuoka           |             |              | 103.2 ± 10.1  |
| 09-10-29                    | granite      | 134252  | Kitaya dam, Kitaya, Dazaifu-shi, Fukuoka                 |             |              | 92.3 ± 10.3   |
| 09-10-30                    | granite      | 134253  | Byobu, Shioji, Usami-machi, Kasuya-gun,<br>Fukuoka       | 95.1 ± 2.8  |              | 90.8 ± 0.11.7 |
| 09-11-01                    | granite      | 134254  | Mt. Ganjaku, Soeda-machi, Tagawa-gun, Fukuoka            | 100.5 ± 1.7 |              |               |
| 09-11-02                    | pegmatite    | 134255  | Aburagi dam, Soeda-machi, Tagawa-gun,<br>Fukuoka         |             |              | 102.2 ± 7.6   |
| 09-11-03                    | granite      | 134256  | Tsuno, Soeda-machi, Tagawa-gun, Fukuoka                  | 102.1 ± 0.7 |              |               |
| 09-11-04                    | granite      | 134257  | Jinya dam, Soeda-machi, Tagawa-gun, Fukuoka              |             |              | 10.16 ± 12.0  |
| 09-11-05                    | granite      | 134258  | Jinya dam, Soeda-machi, Tagawa-gun, Fukuoka              | 99.6 ± 0.8  |              |               |
| 09-11-06                    | granite      | 134259  | Jinya dam, Soeda-machi, Tagawa-gun, Fukuoka              | 102.1 ± 1.8 |              | 97.6 ± 6.0    |
| 09-11-07                    | granite      | 134260  | Chugenji, Soeda-machi, Tagawa-gun, Fukuoka               | 98.1 ± 1.3  | 98.8 ± 1.2   |               |
| 09-11-08                    | granodiorite | 134261  | Toya-natural park, Kawsaki-machi, Tagawa-gun,<br>Fukuoka | 99.4 ± 2.2  |              |               |
| 09-11-09                    | granodiorite | 134262  | Amagi, Kawasaki-machi, Tagawa-gun, Fukuoka               |             | 99.2 ± 1.7   |               |
| 09-11-10                    | granite      | 134263  | Amagi, Kawasaki-machi, Tagawa-gun, Fukuoka               | 99.0 ± 1.2  |              |               |
| 09-11-11                    | granite      | 134264  | Amagi, Kawasaki-machi, Tagawa-gun, Fukuoka               | 98.5 ± 1.2  |              |               |
| 09-11-12                    | granite      | 134265  | Tateishi-toge, Aka-mura, Tagawa-gun, Fukuoka             | 99.8 ± 1.3  |              | 101.1 ± 9.0   |
| 09-11-13                    | granite      | 134266  | Yusubaru station, Aka-mura, Tagawa-gun,<br>Fukuoka       |             | 99.1 ± 2.0   | 100.2 ± 7.8   |
| 09-11-15                    | granite      | 134268  | Mt. Toshiro, Aka-mura, Tagawa-gun, Fukuoka               | 100.3 ± 0.9 | 97.1 ± 0.6   |               |
| 09-11-16                    | granodiorite | 134269  | Uchida, Aka-mura, Tagawa-gun, Fukuoka                    |             | 99.2 ± 2.8   |               |
| 09-11-17                    | granite      | 134270  | Uchida, Aka-mura, Tagawa-gun, Fukuoka                    | 100.3 ± 1.3 |              |               |
| 09-12-01                    | granite      | 134271  | Inokuni, Kawsaki-machi, Tagawa-gun, Fukuoka              | 102.1 ± 1.3 |              | 95.4 ± 6.8    |
| 09-12-02                    | granite      | 134272  | Amagi, Kawasaki-machi, Tagawa-gun, Fukuoka               |             |              | 93.4 ± 6.3    |
| Kyu-3                       | granitoid    | 133732  | Mitsuse, Mitsuse-mura, Saga-shi, Saga                    |             |              | 98.3 ± 7.7    |
| 09-3-11                     | granite      | 134210  | Mt. Kurosaki, Ura, Karatsu-shi, Saga                     |             |              | 86 ± 17       |
| 09-10-21                    | granite      | 134244  | Mitsuse, Mitsuse-mura, Saga-shi, Saga                    |             |              | 109.7 ± 7.2   |
| 09-10-22                    | pegmatite    | 134245  | Mitsuse, Mitsuse-mura, Saga-shi, Saga                    |             |              | 94.4 ± 8.9    |
| QK-1                        | granitoid    |         | Hinokage-cho, Nishiusuki-gun, Miyazaki                   | 14.7 ± 0.6  |              |               |
| QK-5                        | granitoid    |         | Kitakata-cho, Nishiusuki-gun, Miyazaki                   |             | 15.6 ± 1.7   |               |
| QK-6                        | granitoid    |         | Kitakata-cho, Nishiusuki-gun, Miyazaki                   |             | 15.6 ± 1.5   |               |
| QK-7                        | granitoid    |         | Kitakata-cho, Nishiusuki-gun, Miyazaki                   |             | 15.5 ± 1.9   |               |
| QK-8                        | granitoid    |         | Hinokage-cho, Nishiusuki-gun, Miyazaki                   |             | 15.7 ± 1.6   |               |
| QK-9                        | granitoid    |         | Hinokage-cho, Nishiusuki-gun, Miyazaki                   |             | 15.0 ± 1.6   |               |
| 1574                        | granitoid    | 1574    | Kiurakozan, Ume, Saiki-shi, Oita                         |             | 14.4 ± 3.0   |               |
| 6396                        | granite      | 6396    | Kitamura, Yamagashi-shi, Kumamoto                        | 113.4 ± 1.2 |              | 116 ± 6       |
| TSM-17                      | granite      | 135872  | Uchiyama, Izuhara-machi, Tsushima-shi,<br>Nagasaki       | 15.5 ± 0.5  | 15.5 ± 1.4   |               |
| Age data out of the figures |              |         |                                                          |             |              |               |
| 6644                        | granite      | 6644    | Kosugidani, Yakushima-cho, Kumage-gun,<br>Kagoshima      | 14.9 ± 0.3  |              |               |
| 3624                        | granite      | 3624    | Kinko-cho, Kimotsuki-gun, Kagoshima                      |             | 16.3 ± 1.5   |               |
| H-7                         | granite      | 128038  | Idenohana, Ashikita-machi, Ashikita-gun,<br>Kumamoto     |             |              | 426.3 ± 14.8  |

data in the granitoids were summarized as an average and standard deviation. The standard deviation is usually 1 sigma calculated from a Gaussian distribution in probability theory. The age data and localities of about 400 granitoids are summarized in Table 1. Age data and their histograms in each province are plotted in Figs. 2 to 16.

Uraninite and thorite ages obtained from the Japanese Islands range from ca. 5 to 300 Ma. In some granitoids, monazite age determined by EPMA analyses and zircon age determined by LA-ICP-MS are used. Their analytical methods were presented by Santosh *et al.* (2006) and Tsutsumi *et al.* (2010), respectively. In the present study, the standard deviations of uraninites are found to be around 4 Ma at around 200 Ma, 1 Ma at around 70 Ma, and less than 1 Ma at around 5 Ma, which is comparable to those obtained by isotopic methods. The standard deviation for thorite is roughly double that for uraninite. In some samples, bimodal age distributions were obtained due to a later stage thermal event as found by Yokoyama *et al.* (2010).

#### **Southern Hokkaido and Tohoku Province:**

Granitoids in Southern Hokkaido and Tohoku Province are mostly Lower Cretaceous in age (Figs. 2 & 3). Neogene granitoids and Ordovician granitoids rarely occur. The Cretaceous and Neogene ages were obtained using uraninite and thorite whereas ages of the Ordovician granitoids in the Hikami Area (Fig. 4) were obtained by monazite analyses. The age of one diorite dyke rock at the Shimokita Peninsula, Aomori prefecture, was obtained by LA-ICP-MS because of the absence of both uraninite and anhydrous thorite. Except for Neogene and Ordovician granitoids, the Lower Cretaceous granitoids are divided into two terranes based on age: the Kitakami Mountains area and the western Tohoku area. The former granitoids exceed 110 Ma and the latter is less than 110 Ma. The boundary between them extends in a N–S direction along the middle of the Ou Mountains. The age range of the western part of Tohoku is from 101 Ma to 109 Ma. Creta-

ceous granitoids younger than 101 Ma were not found in the area. As far as age is concerned, granitoids with ages > 110 Ma extend to southern Hokkaido except for Okushiri Island. In southern Hokkaido, the boundary between the two types is present between Esashi and the Okushiri Island. The oldest Cretaceous granitoid was found in the Himegami body in the Kitakami Mountains and is 126 Ma. The age histogram by uraninite is different from that by thorite as shown in Fig. 3. This is due to the strong alteration of thorite in the granitoids from the western part of Tohoku.

Many K–Ar ages were obtained from Southern Hokkaido and from Tohoku Province. In the Kitakami Mountains, K–Ar ages of granitoids range from 89 to 128 Ma (Kawano & Ueda, 1965a). Although their oldest age is similar to present results, about 30% of the ages are less than 110 Ma, which corresponds to the western part of the Tohoku group of granitoids. K–Ar ages in the western part of Tohoku are also variable ranging from ca. 80 Ma to 110 Ma, which is different from present results that are concentrated well in a narrow range: 101 Ma to 109 Ma. The variable range is because the Cretaceous granitoids suffered from a late stage thermal event or alteration that caused younger results due to Ar loss. The division of the area by uraninite and thorite ages will be important when we discuss the extension of the terrane or comparison of the granitoids in Primorye, Far East Russia, because the Japanese Islands were a part of the Eurasia continent and were in contact with Primorye before the opening of the Sea of Japan during the early Neogene.

Granitoid ages at Hikami Mountain were obtained only by studying the monazite (Fig. 4), even though thorite was commonly present. The thorite was completely altered into a hydrous state making it unsuitable for age dating. The monazite age is  $451 \pm 4$  Ma, which is almost consistent with the SHRIMP age of  $442.5 \pm 3.5$  Ma determined by Watanabe *et al.* (1995). Cambrian granitoids were found as a small block from the Isawa and Nagasaka areas, Iwate Prefecture (Isozaki *et al.*, 2015), in the terrane with an age

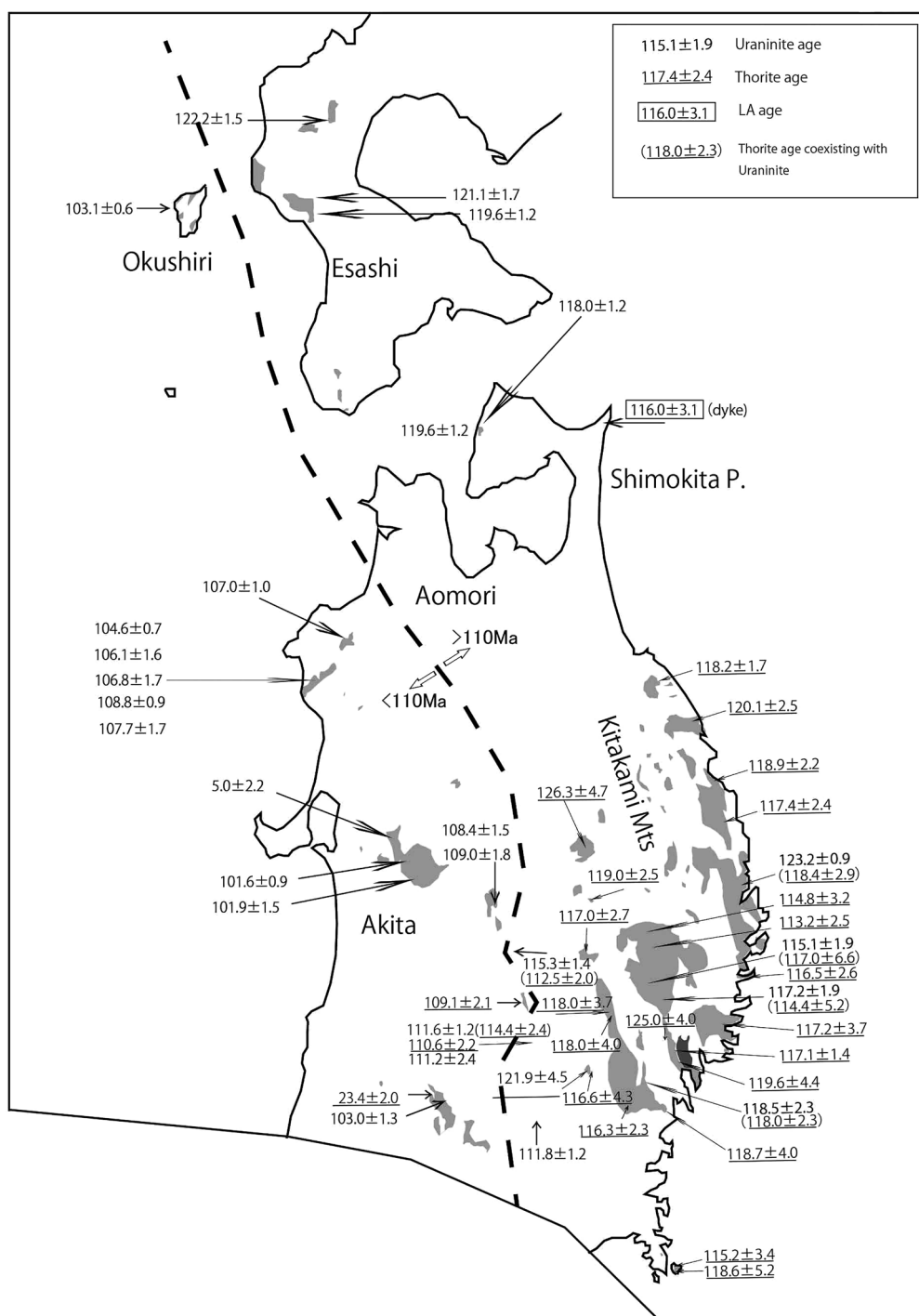


Fig. 2. Sample localities of the studied granitoids in the southern Hokkaido and Tohoku Province. Numbers are age data of granitoids. Most of the ages are obtained by EPMA analyses of uraninite and thorite. Zircon age in one sample is obtained by LA-ICP-MS method.

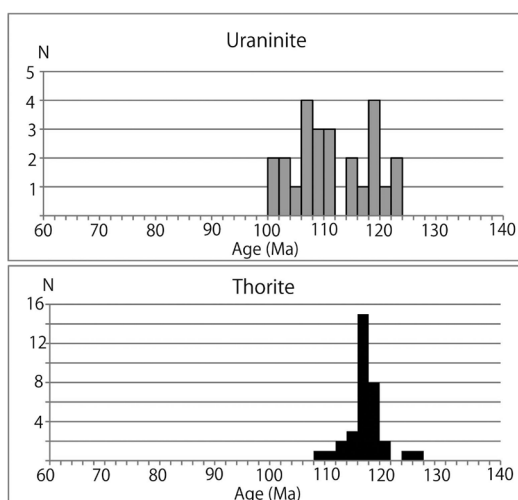


Fig. 3. Histograms of the uraninite and thorite ages from the granitoids in southern Hokkaido and Tohoku Province.

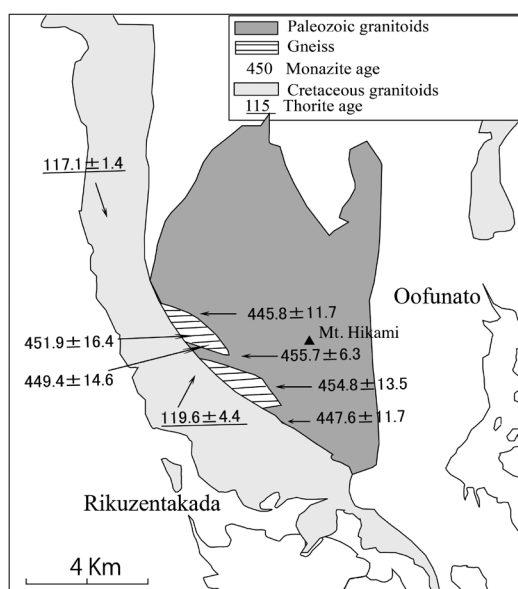


Fig. 4. Monazite ages of the Hikami granitoids and associated metamorphic rocks. Average age of the rocks are 451 Ma with a standard deviation of 4 Ma as one sigma.

>110 Ma as well as the Hikami Granitoids. Although the geological relations of the old granitoids are unknown, such old granitoids occur sporadically in the Japanese Islands such as in the Maizuru, Hitachi areas and Kurosegawa Belt

(e.g. Tsutsumi *et al.*, 2012; Tagiri *et al.*, 2010; Isozaki *et al.*, 2015). Isozaki *et al.* (2015) discussed such Early Paleozoic granitoids as remnants of the arc plutonic belt from the Early Paleozoic Japan that developed near the continental margin.

Neogene granitoid occurs sporadically in Hokkaido and in Tohoku Province. Only two Neogene granitoids were analyzed. Their uraninite ages are 23 and 5 Ma. They are probably related with the opening of the Sea of Japan and later stage igneous events, respectively, but regional study is necessary to discuss their origin.

**Asahi Mountains, Abukuma Mountains and Tsukuba–Nikko area:** Fig. 5 shows the ages of granitoids in the Asahi Mountains, the Abukuma Mountains and the Tsukuba–Nikko area. A histogram of the Cretaceous age is shown in Fig. 6. In this area, the Tanakura Tectonic Line (Fig. 1) runs along the western margin of the Abukuma Mountains. The tectonic line divides the Japanese Islands into two blocks. It was confirmed that the two blocks moved in different ways at the time of the opening of the Japan Sea (e.g. Otofujii & Matsuda, 1983 & 1984). Even though the line is important, its northern extension has not been clarified. In this area, we can divide the area into several terranes based on uraninite and thorite age. In the Asahi Mountains, the western part is composed of granitoids younger than 70 Ma, between 65 and 68 Ma, whereas granitoids in the eastern part are between 90 Ma and 98 Ma with one exception at 103 Ma. Two granitoids with an age around 80 Ma occur near the younger granitoid terrane mentioned above.

Granitoids in the Abukuma Mountains are roughly classified into two groups based only on the uraninite and thorite ages: 100–107 Ma and 110–124 Ma, with one exception at 301 Ma from the Soma area (Tsutsumi *et al.*, 2012). The latter older granitoid was further analysed and the age was confirmed by the LA-ICP-MS method (Tsutsumi *et al.*, 2012). If this division is available, the western part of the Abukuma Mountains is consistent with those from the western part of

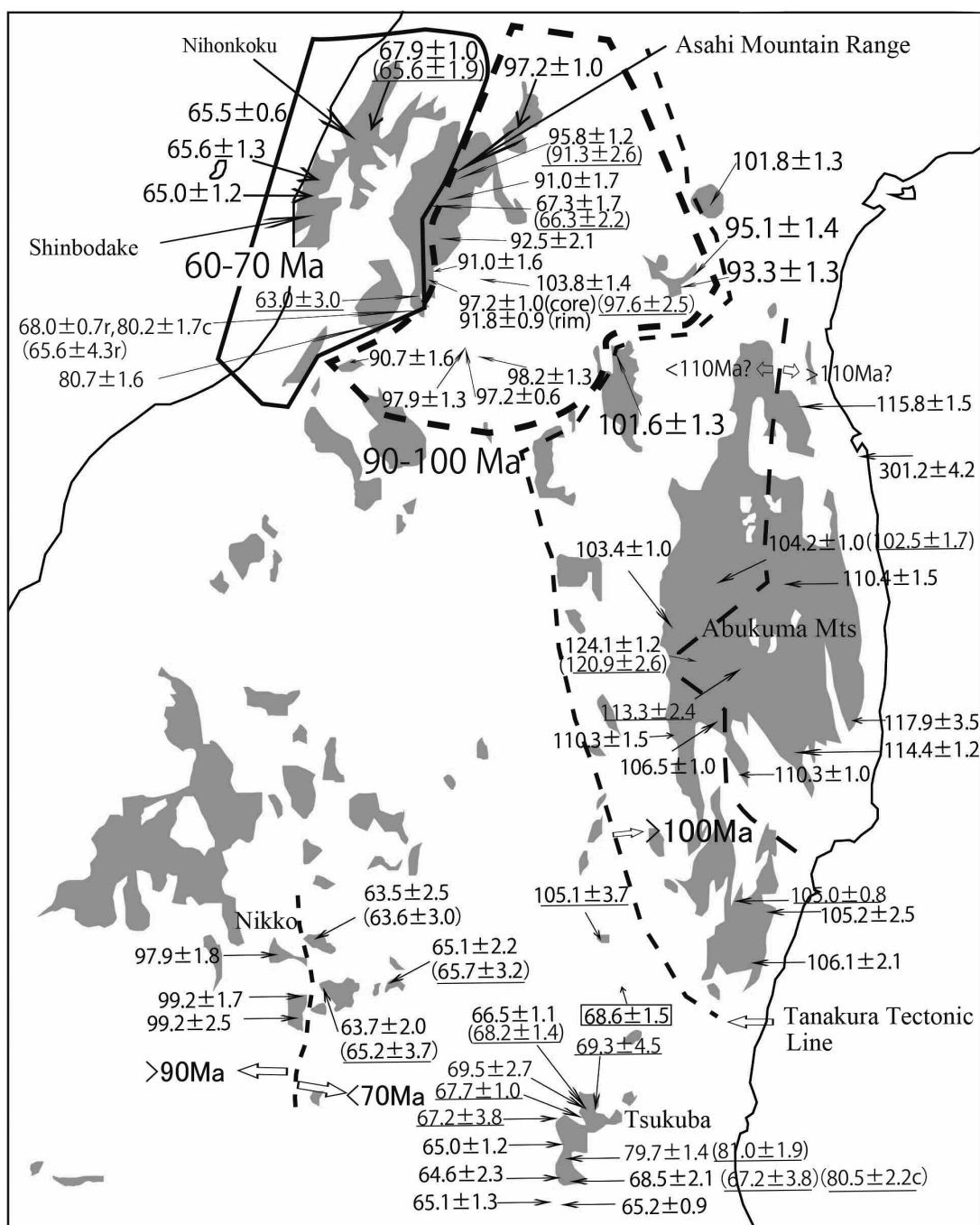


Fig. 5. Age data of granitoids in the Asahi Mountains, Abukuma Mountains and Nikko-Tsukuba area. Explanation of the age data is shown in Fig. 2.

Tohoku in Fig. 2, whereas the eastern part of the Abukuma Mountains corresponds to the Kitakami Mountains and its northern extension.

In addition to the K-Ar ages for the granitoids determined by Kawano & Ueda (1965b), there are many studies about the granitoid ages in the

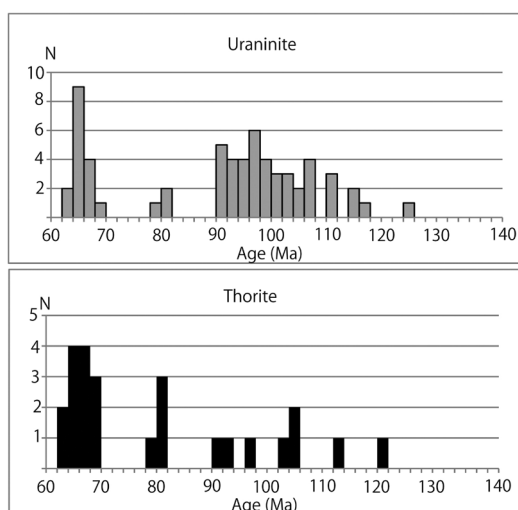


Fig. 6. Histograms of the uraninite and thorite ages from the granitoids in the Asahi Mountains, Abukuma Mountains, and Nikko–Tsukuba area.

Abukuma Mountains determined via zircon analyses by recent LA-ICM-MA and SHRIMP methods (Tagiri *et al.*, 2010; Kon & Tagiri, 2012; Kon *et al.*, 2015; Ishihara & Orihashi, 2015). Tagiri *et al.* (2010) reported a Cambrian metagranitoid from the Hitachi metamorphic terrane at the southern end of the Abukuma Mountains with an age of around 500 Ma. Many other papers presented Cretaceous granitoid ages from the central part of the Abukuma Mountains (Kon & Tagiri, 2012; Kon *et al.*, 2015; Ishihara & Orihashi, 2015). The Cretaceous age ranges from 97 Ma to 121 Ma similar to our results of 100–124 Ma. However, they reported a younger age from the eastern part of the mountains where the uraninite and thorite ages are 110–124 Ma. Kon *et al.* (2015) concluded that the spatial distribution of hornblende-biotite granitoids had no correlation with their intrusive ages. In contrast, the leucocratic granitoids with an age of around 110 Ma were located at the eastern part of the Abukuma Mountains, whereas those with an age around 100 Ma were at the western part. Our results may be comparable with the leucocratic granitoids.

In the Tsukuba area (Fig. 5), at the southern end of the Yamizo Mountains, granitoids have ages ranging from 65 Ma to 70 Ma with the

exception of two samples that had ages of 80 Ma. Granitoids in the Yamizo Mountains were studied using the K–Ar method by Shibata *et al.* (1973). The K–Ar ages are similar to uraninite and thorite ages, i.e. mostly less than 70 Ma. Two samples in this study were found to have an age of 80 Ma, which was found to be a relict age. The combination with 65–70 Ma and 80 Ma may be correlated with granitoids from the western part of the Asahi Mountains. One granitoid that had an age of 105 Ma occurs at the eastern part of the Yamizo Mountains, close to the Tanakura Tectonic Line. Although the age shows correlation with those in the Abukuma Mountains, it is clearly different because the Yamizo Mountains belonged to western Japan at the time of the opening of the Sea of Japan, whereas the Abukuma Mountains were in eastern Japan.

In the western part of the Nikko area, granitoids have an age of 99 Ma, whereas in the eastern part the ages are around 64 Ma. These age data show that the western part of the Nikko corresponds to the Asahi Mountain, whereas eastern Nikko, including the Tsukuba area, corresponds to the western part of the Asahi Mountains. It is well accepted that metamorphic rocks in the Tsukuba area belong to the Ryoike belt and its extension is the Nihonkoku area of northern Niigata Prefecture; western part of the Asahi Mountains (Fig. 5). Hence, it will be reasonable to conclude that the Tsukuba and Nihonkoku will be formed as the same igneous province. Granitoids that are 80 Ma in both areas will be treated same.

Many granitoids in this area have not been analyzed yet, especially in the region between Nikko and the Asahi Mountains (Fig. 5). Analyses of such granitoids will be important to study the spatial distribution between the Nikko and Asahi Mountains granitoids.

**Chubu and Kansai provinces:** Fig. 7 shows the ages of granitoids in the Chubu and Kansai provinces. Histogram of the Cretaceous age is shown in Fig. 8. In this area, the granitoid age ranges from 4 Ma to 106 Ma. The youngest granitoids occur along the Fossa Magna region, Yamanashi

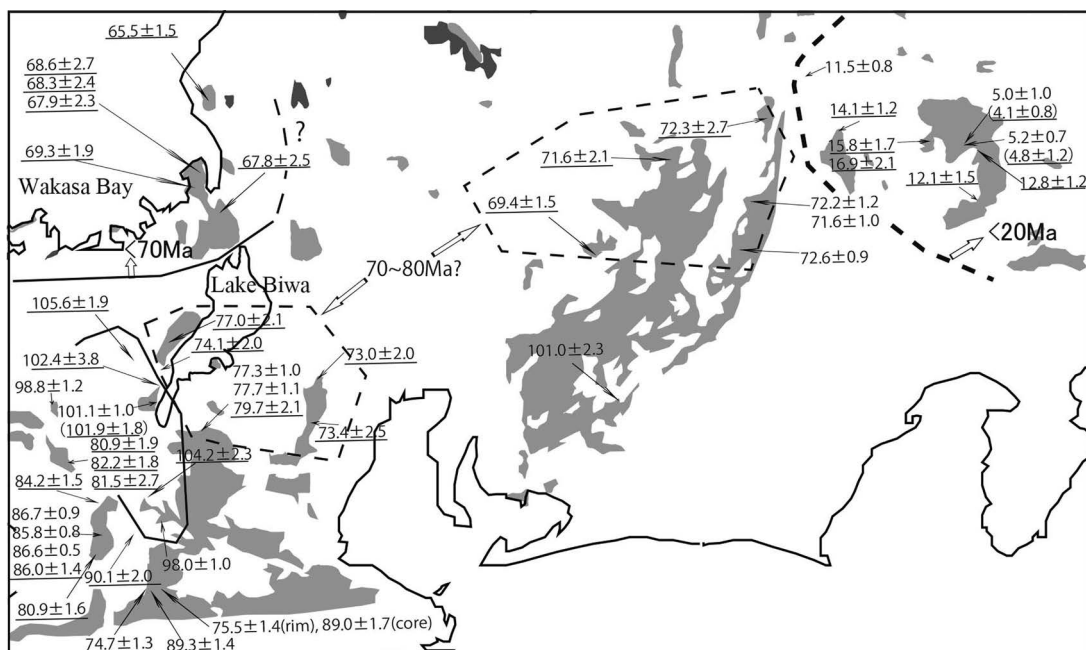


Fig. 7. Age data of granitoids in Chubu and Kansai provinces. Explanation of the age data is shown in Fig. 2.

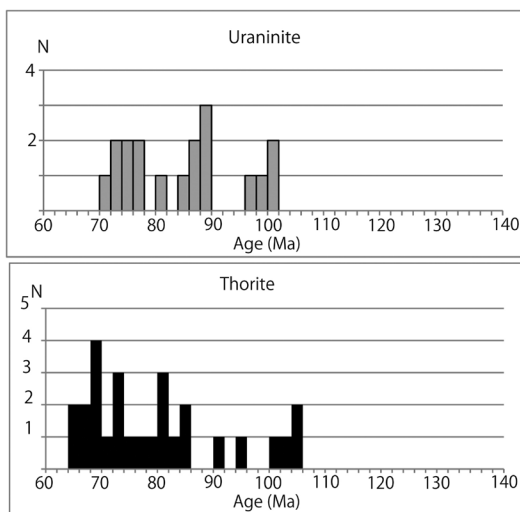


Fig. 8. Histograms of the uraninite and thorite ages from the granitoids in the Chubu and Kansai provinces.

Prefecture. Their ages range from 4.1 Ma to 16.9 Ma, which is comparable to the K–Ar data of 4.5–13.0 Ma by Shibata *et al.* (1984) and Uchiumi *et al.* (1990). Cretaceous granitoids are variable in age, but they are divided roughly into

four groups:  $>70\text{Ma}$ ,  $70\sim 80\text{Ma}$ ,  $80\sim 90\text{Ma}$  and  $98\sim 106\text{Ma}$ . The granitoids with ages younger than 70 Ma occur around the Wakasa Bay. Granitoids that are  $70\sim 80\text{Ma}$  occur at the Ina district, around Lake Biwa and at the Suzuka Mountains. Granitoids that are  $80\sim 90\text{Ma}$  are found around the Ikoma Mountains where SHRIMP analyses by Watanabe *et al.* (2000) presented similar ages. Granitoids with ages of  $98\sim 106\text{Ma}$  occur south-east of Lake Biwa. Suzuki & Adachi (1998) obtained granitoid ages in the Ryoke metamorphic belt analyzing monazite by EPMA. Their ages range from 67 Ma to 95 Ma, which is mostly much older than the K–Ar age. They thought that the difference was due to the cooling rate due to the difference of closure temperature of monazite and mica. As presented by Suzuki and Adachi, there is younger granitoid terrane in the Ryoke belt than in the present data. Although more age data were necessary in the other areas to confirm the regional differences, we tentatively divide the granitoids only by means of the present age data.

In the western part of the Chubu and Kansai areas shown in Fig. 7, it is expected that the

granitoid age will be getting younger northwards. In the inner zone of southwest Japan, granitoids are generally divided into three zones: the Ryoke belt, the Sanyo belt and the Sanin belt from south to north as discussed later. Generally speaking, age of granitoids becomes younger from south to north. However, granitoids with ages over 98 Ma occur surrounded by young granitoid regions such as 73 Ma to 80 Ma and 80–87 Ma. Such relatively old granitoids, 102–107 Ma, were reported from the same area by Imaoka *et al.* (2014). The complex spatial distribution of the granitoids shows that igneous activity is not consistent with the geological belts such as the Ryoke metamorphic belt and Mino Jurassic Belt. Apparently the older granitoids, 98–106 Ma, occur locally and were surrounded by younger granitoids that are 70–80 Ma and 80–90 Ma.

**Hida terrane:** There were many studies about the age of granitoids in the Hida terrane. Ota & Itaya (1989) summarized age data of K–Ar, Rb–Sr, U–Pb and other methods in the terrane. Fig. 9 shows uraninite, thorite and monazite ages of granitoids in the Hida terrane. The histogram of

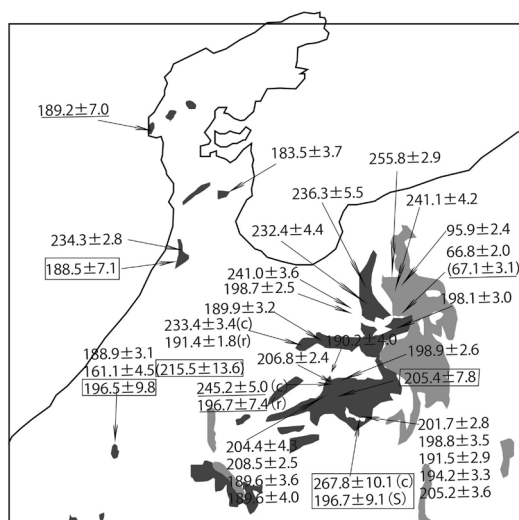


Fig. 9. Age data of granitoids in the Hida area. Explanation of the age data is shown in Fig. 2. The number in the box shows ages obtained from monazite by EPMA analyses.

the age data is shown in Fig. 10. In this analysis, we found that the granitoids are older than 180 Ma except for a local intrusion of Cretaceous granitoids with an age of around 60–70 Ma and 100 Ma. Uraninite and thorite ages in four granitoids from the Hida terrane were reconfirmed by SHRIMP analyses (Yokoyama *et al.*, 2010). In the Hida terrane, two granitoid types were recognized based on the geological relations. They are the Funatsu and Simonomoto types. Ota & Itaya (1989) concluded that Funatsu type is 170–180 Ma in age, whereas the Simonomoto type is around 190 Ma. Our study could not confirm a granitoid younger than 180 Ma except for a granitoid that is 160 Ma, which is much younger than the other age data. Because the granitoid with a uraninite age of 160 Ma has monazite ages of  $215 \pm 15$  Ma, the uraninite age will be due to resetting by a later stage thermal event different from the main metamorphic or igneous events in the Hida terrane.

Histogram in Fig. 10 shows a roughly bimodal distribution: 180–210 Ma and 230–260 Ma. The

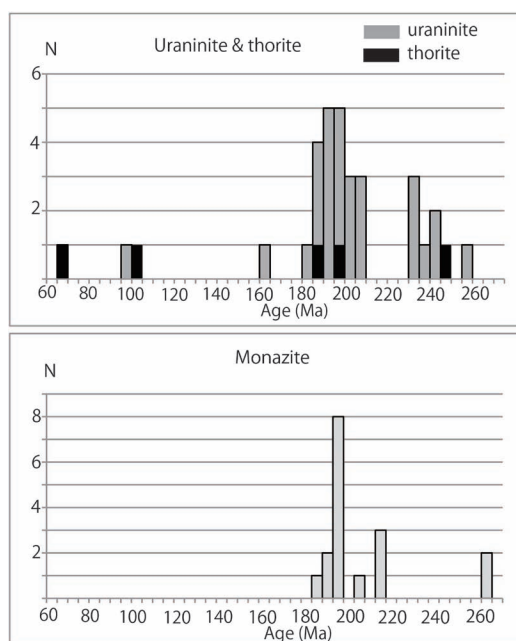


Fig. 10. Histograms of the uraninite, thorite and monazite ages from the granitoids in the Hida area.

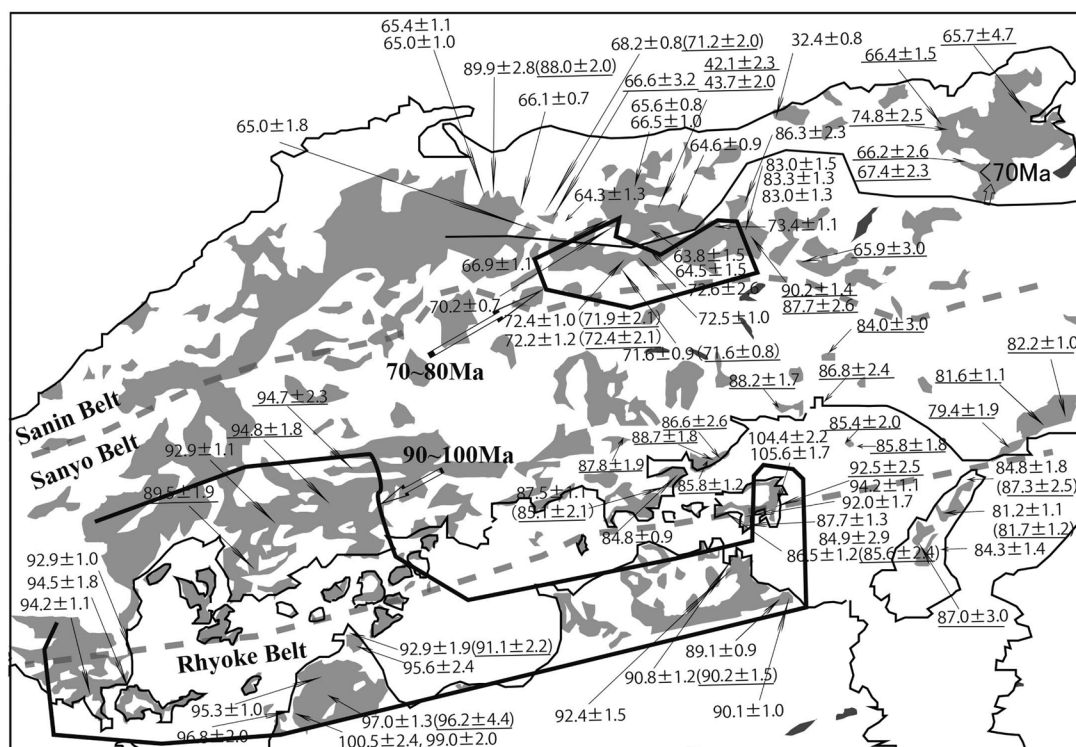


Fig. 11. Age data of granitoids in the Chugoku and northern Shikoku provinces. Explanation of the age data is shown in Fig. 2.

two age groups are confirmed often by the core and rim relationships in the uraninite and thorite grains (Fig. 9 and Yokoyama *et al.*, 2010). There is no areal distinction between the two groups in the map. It is difficult from the uraninite and thorite ages to conclude whether early stage igneous activity occurred in all the areas or only at the local level. These data will be important for future age studies or for determining the tectonic setting of the Hida terrane.

#### Chugoku and northern Shikoku provinces:

Fig. 11 shows the granitoid ages in the Chugoku and northern Shikoku provinces. A histogram of the granitoid ages is shown in Fig. 12. The inner zone of Southwest Japan is geologically divided into three belts: Ryoke, Sanyo and Sanin from the south to north. Even though there are many age data in the Ryoke and Sanyo belts, a reliable correlation with age has not been obtained. On the other hand, in the Sanin belt, Imaoka *et al.*

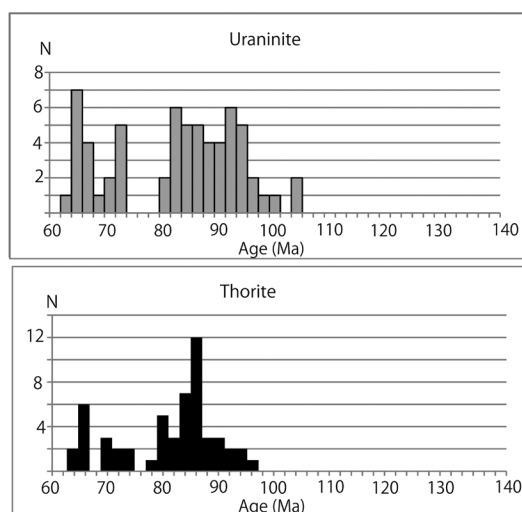


Fig. 12. Histograms of the uraninite and thorite ages from the granitoids in the Chugoku and northern Shikoku provinces.

(2011) obtained detailed ages of the Eocene–Oligocene granitoids by the K–Ar method and roughly found their linear arrangement as well as the granitoids that are 60–70 Ma. In the present analyses, granitoids younger than 70 Ma develop along the coast of the Sea of Japan. Except for a few granitoids that have ages of 30–45 Ma and 73–83 Ma in the Sanin Belt, the area almost overlaps with those of the Eocene–Oligocene granitoids by Imaoka *et al.* (2011). As far as the granitoid that is 60–70 Ma is concerned, the belt will continue to the 60–70 Ma granitoid region around Wakasa Bay in Fig. 7. Imaoka *et al.* (2011) concluded that the lineation of the granitoids that are 30–45 Ma was related to the plate subduction at the time of formation of the Shimanto Belt running parallel to the Pacific Ocean. The granitoids that are 30–45 Ma occur only in the rather restricted area of the Sanin Belt, which is different from the elongation of the Shimanto Belt that continues from Okinawa to the Boso Peninsula, Kanto Province. Distribution of such granitoids is too local to deduce a close correlation with the Shimanto Belt.

In contrast to the Sanin Belt, it is hard to find a linear arrangement on the basis of the granitoid age in the Ryoke and Sanyo belts. Murakami (1987) summarized K–Ar ages of the granitoids in the belts: 75–95 Ma in the Ryoke Belt and 70–115 Ma in the Sanyo Belt. There is no spatial distribution about the age in both the belts as shown in Fig. 11. The Ryoke Belt has uraninite and thorite ages from 90 to 105 Ma except for granitoids from Awaji Island. The oldest age observed is 106 Ma from the northeastern part of Shodo Island. Only granitoids with an age of around 80–85 Ma continue eastwards: Ikoma Mountains in Fig. 9. In the Sanyo Belt, most of the age data are from 70 to 95 Ma and there are three areas that collect together based on granitoid age. The oldest area is at the western part of Hiroshima and most of the granitoids are older than 90 Ma. The youngest are with 70–73 Ma, and they occur in a narrow area of the Sanin Mountain, close to the Sanin Belt. In the other area, granitoid ages are mostly 80–90 Ma, similar

to the Awaji Island of the Ryoke Belt. Linear arrangement of the granitoids simply by uraninite and thorite age is not recognized in both the Ryoke and Sanyo belts, but it seems that granitoids with similar ages have concentrated in restricted areas.

**Northern Kyushu Province:** Fig. 13 shows ages of granitoids in northern Kyushu. A histogram of the granitoids is shown in Fig. 14. Most of Cretaceous granitoids in northern Kyushu have a narrow age range determined by uraninite and thorite from 95 Ma to 108 Ma. A few granitoids have ages around 113 Ma. Karakida (1992) summarized K–Ar ages of granitoids in northern Kyushu. The range of the K–Ar age was from 75 to 115 Ma. As found in the other terranes, the oldest age obtained by the K–Ar age in each terrane is similar to that of the uraninite or thorite age, which is probably because a fresh granitoid gives a reasonable age for K–Ar dating. As far as the age is concerned, this terrane will be one igneous province similar to the western part of the Ryoke belt (Fig. 11) and the Abukuma Mountains. The granitoids younger than 20 Ma concentrate in the Okueyama Mountains. Such young granitoids occur at the Osumi Peninsula and in Yakushima Island (Table 1), Kagoshima Prefecture, as well as granitoids in the Shimanto belt, namely along the Pacific coast. In addition to the young granitoids from the Fossa Magna region (Fig. 7), they were formed after or during the opening of the Sea of Japan.

**Other granitoid ages:** Most of the age data are plotted in Figs. 2–13. Some granitoids analyzed in this study are not included in the figures. They are younger than 20 Ma and occur at the southern parts of Kyushu, Shikoku and the Kii Peninsula. Furthermore, some old granitoids occurring in the Maizuru and Kurosegawa belts are not presented in the figures. Their ages were obtained by monazite or LA-ICP-MS. The granitoids from the Maizuru belt were reported by Tsutsumi *et al.* (2014). The other age data are shown in Table 1.

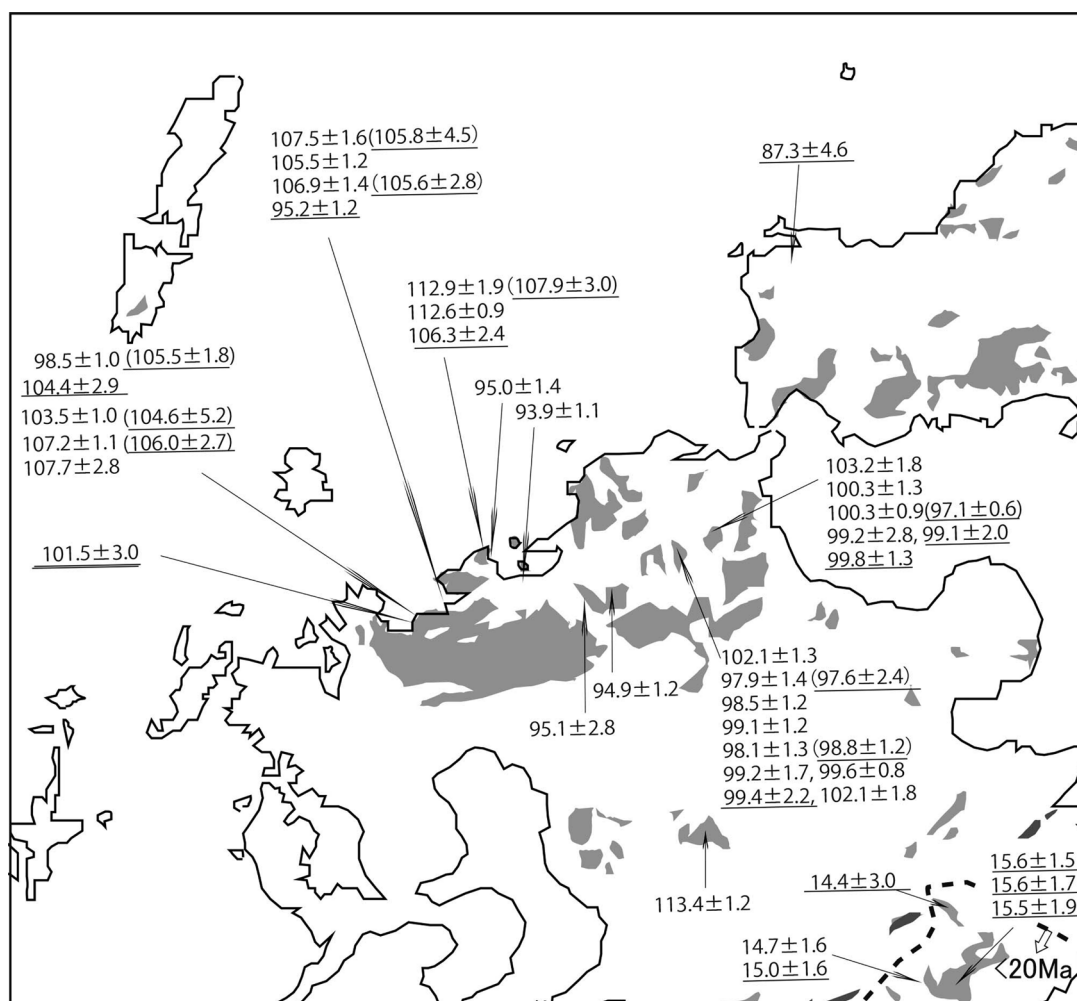


Fig. 13. Age data of granitoids in the northern Kyushu Province. Explanation of the age data is shown in Fig. 2.

## Discussions

Ages of about 400 granitoids in the Japanese Islands were obtained through EPMA analyses of uraninite and thorite. Although the age data are not enough to discuss a spatial distribution of granitoids in the islands, the present study is important because the ages of the granitoids are obtained by the same method and machine throughout this study. Age data obtained by LA-ICP-MS or SHRIMP will be available. But so far it is difficult to compare their age data with present data because of differences in method, standard, machine and other experimental differ-

ences. In the near future, it will be best to use a common mineral in granitoids such as zircon when we summarize more detailed distributions in the islands by a more reliable method such as LA-ICP-MS or SHRIMP. Among the obtained data, it is concluded that the uraninite and thorite ages are much more concentrated in each province than by ages obtained by the K–Ar method. The K–Ar method involves a few problems. One is the Ar loss during later stage thermal events and alteration. The others are an age difference among minerals used for the age analyses and low closure temperature. Uraninite and thorite ages also have a closure temperature problem as

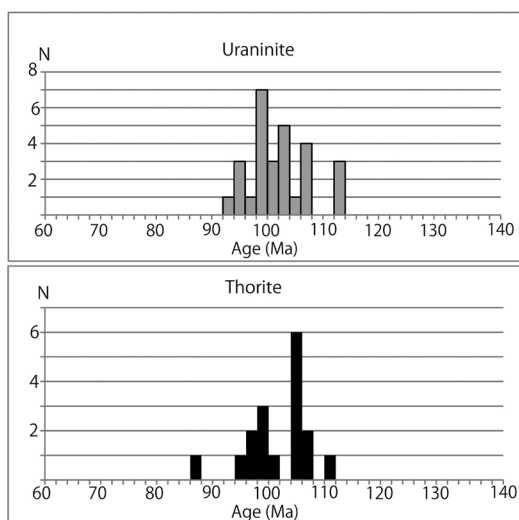


Fig. 14. Histograms of the uraninite and thorite ages from the granitoids in the northern Kyushu Province.

shown by Yokoyama *et al.* (2010). Uraninite and thorite are lower in closure temperature than zircon and monazite, but higher than micaceous minerals. For the other problem, uraninite and anhydrous thorite are usually rare and are not always present in the granitoids. In spite of these problems, the ages obtained by EPMA analyses of uraninite and thorite are available because of equivalent results to the SHRIMP age or K–Ar age for Neogene granitoids (Yokoyama *et al.*, 2010). Therefore, we try to discuss the spatial distribution of the granitoids only through uraninite and thorite ages.

Devonian and Cambrian granitoids occur only sporadically in the islands and were summarized by Isozaki *et al.* (2015). The other younger granitoids in the Japanese Islands are roughly summarized by the present study mainly using the uraninite and thorite ages and are divided into several terranes. Spatial distribution by granitoid ages in the islands is summarized in Fig. 15. It will be probable that the age boundaries are eventually more ambiguous and the zones with similar ages may overlap more or less with each other. The oldest terrane is the well-known Hida terrane that has an age older than 180 Ma. The

terrane will be further divided into two events: 180–220 Ma and 230–260 Ma (Fig. 10). As presented in the histograms (Figs. 10 and 16), it will be noteworthy that the granitoids with ages from 126 Ma to 180 Ma are absent in the Japanese Islands. Cretaceous granitoids that also partly include Paleogene in age are widely distributed throughout the islands. Their ages range from 60 Ma to 126 Ma that appears almost continuous in the summarized data (Fig. 16), indicating almost continuous igneous activity including volcanism in the islands. The Kitakami granitoids with 110–126 Ma show a zone from southern Hokkaido to the eastern Abukuma Mountains. Ages older than 110 Ma are only and locally found in northern Kyushu, though there may be no continuous relation with the Kitakami granitoids. Granitoids with ages of 100–110 Ma roughly form a zone from the Okushiri Island, Hokkaido, to the western Abukuma Mountains through the Akita area. Similar granitoids that are 100–110 Ma occur sporadically along the Median Tectonic Line and in a restricted area at the southwest part of Lake Biwa. Similar granitoids are well concentrated in northern Kyushu. Granitoids that are 90–100 Ma are found in several areas: the Asahi Mountains, Nikko and sporadically across southwest Japan along the Median Tectonic Line. So far, clear zonation has not been recognized among them.

Granitoids that are 80–90 Ma occur mostly in the Chugoku to Kinki provinces and may be grouped as the same igneous province. Granitoids that are 70–80 Ma occur in two areas: Shinshu on the northern side of the Median Tectonic Line, and the central part of the Sanin Province. Granitoids that are 60–70 Ma in age are well concentrated along the coast of the Sea of Japan and in the Tsukuba–Nikko area.

Igneous activity including volcanism in the Japanese Islands and along the continental margin of Asia has been treated as a result of subduction of the oceanic plate as an analogue of the present plate tectonics (e.g. Imaoka *et al.*, 2015; Kon *et al.*, 2015). Spatial distribution of granitoids with similar ages, especially Cretaceous

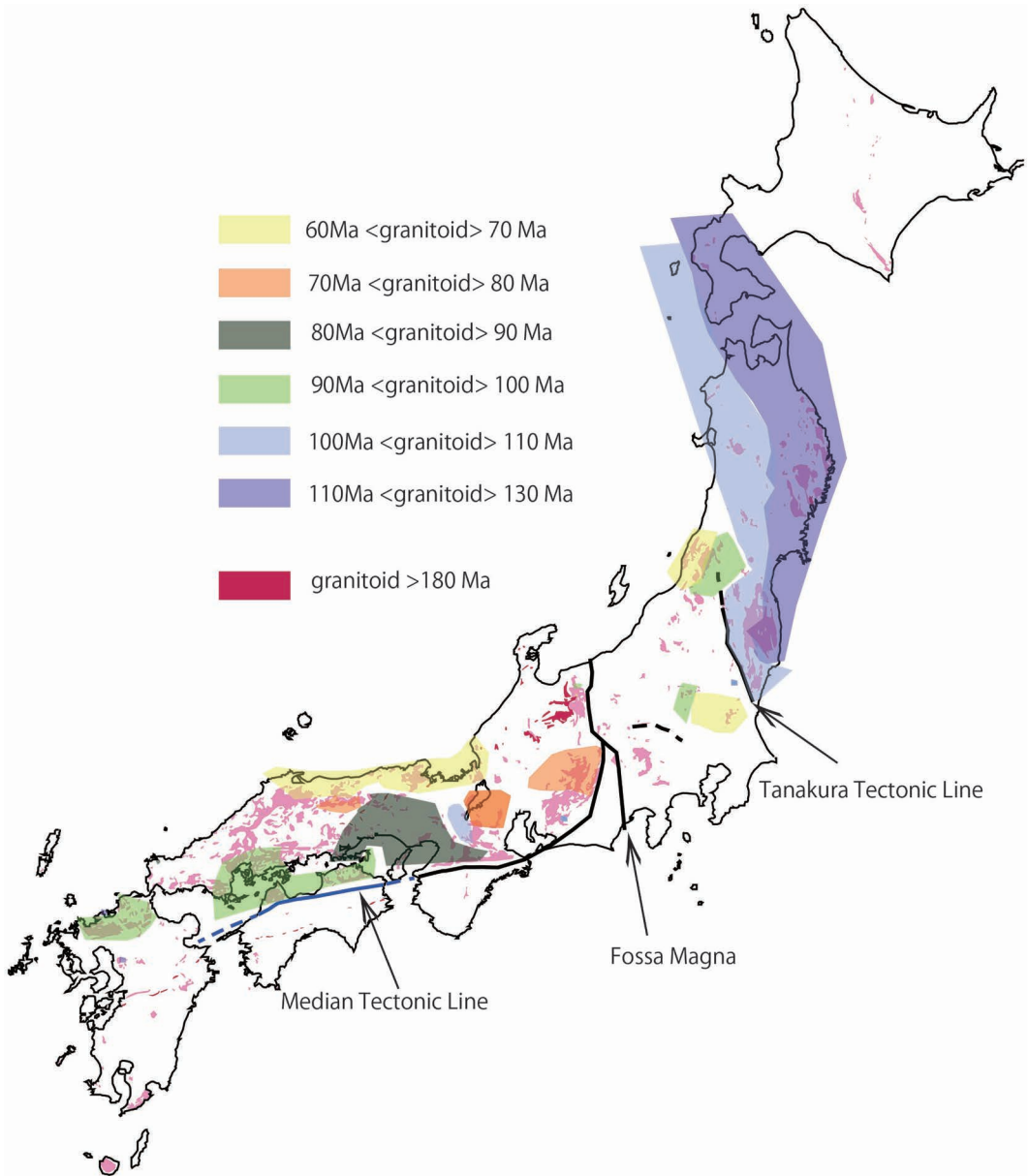


Fig. 15. Spatial distribution of granitoids summarized by uraninite and thorite ages in the Japanese Islands.

ones, does not always show a linear arrangement and is not related with the geological province. Hence, the correlation with subduction has not been solved yet. The youngest granitoids occur along the Pacific coast of western Japan and along the Fossa Magna zone and are related to the events that occurred after the opening of the

Sea of Japan. Unfortunately, we could not develop a clear model for the youngest granitoids. This study of the spatial distribution of granitoids in the Japanese Islands is still on the way and will be refined or reconfirmed by LA-ICP-MS, SHRIMP and/or new age techniques. The present data will be available as a prelimi-

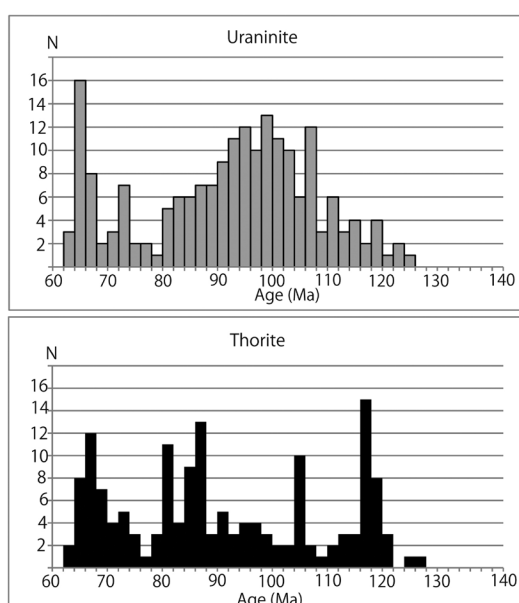


Fig. 16. Histograms of the uraninite and thorite ages from the granitoids in the Japanese Islands.

nary study for the compilation of the granitoids in the Japanese Islands in the near future.

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## 日本列島の花崗岩質岩400資料の閃ウラン鉱と ツールによる年代測定

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日本列島の花崗岩質岩400資料が閃ウラン鉱とツールのEPMA分析により年代測定された。年代は、5百万年から3億年の範囲で、狭い年代の範囲で地域ごとに纏められた。日本の北部では、海溝沿いに年代が並ぶ地域があるが、西南日本では、一部を除き、帯状配列は見られず、点状に分布する年代地域があることが判明した。これらの年代データは、日本海対岸の花崗岩質岩の年代との比較で古地理の復元に利用されるものである。