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Timing of mylonitization in the Nihonkoku Mylonite Zone of north Central Japan: Implications for Cretaceous to Paleogene sinistral ductile deformation in the Japanese Islands

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ABSTRACT

The Nihonkoku Mylonite Zone is one of the Cretaceous to Paleogene sinistral ductile shear zones in the Japanese Islands, which branches off from the Tanagura Tectonic Line (TTL). The Nihonkoku Mylonites are composed mainly of hornblende–biotite granodiorite mylonite, biotite granodiorite mylonite, and biotite granite mylonite, derived from Late Cretaceous to Paleogene granitic rocks in the Ashio Belt. SHRIMP U–Pb analyses of zircon from the Nihonkoku Mylonites yield ages of 63–67 Ma. K–Ar ages obtained for biotite of the Nihonkoku Mylonites are 46–52 Ma. The SHRIMP U–Pb ages of zircon indicate the ages of consolidation of the granitic magmas, whereas the K–Ar ages indicate the ages of cooling of granitic plutons. Mylonitization occurred under conditions of the upper greenschist to amphibolite facies, deduced from recrystallization of biotite and generation of myrmekite around porphyroclasts of alkali feldspar. Based on these results, the magmas of the parent rocks of the Nihonkoku Mylonites were intruded and consolidated at around 65 Ma, and mylonitization occurred at around 55–60 Ma, timing of which is correlative to the low-temperature deformation that occurred after 60–70 Ma along the TTL, subsequent to the main mylonitization.

1. Introduction

In the Japanese Islands, Cretaceous sinistral shear zones are widely distributed along the Median Tectonic Line (MTL; e.g., Takagi, 1986; Takagi et al., 1989; Shimada et al., 1998), the Tanagura Tectonic Line (TTL; Koshiya, 1986), the Hatagawa Tectonic Line (Sasada, 1988; Takagi et al., 2000; Shigematsu and Yamagishi, 2002) and in the Kitakami Mountains (Sasaki and Otoh, 2000; Sasaki, 2001) (Fig. 1). Studies on the geological and temporal relations among these shear zone are important in terms of understanding the tectonic framework of the eastern margin of the Asian Continent, as the Japanese Islands are regarded to have been situated on the eastern margin of the Asian Continent before the opening of the Sea of Japan during the Miocene (Otofuji and Matsuda, 1984; Maruyama et al., 1989).

The Nihonkoku Mylonite Zone, situated around Mt. Nihonkoku (555 m) on the Sea of Japan side of Central Japan (Takahashi, 1998a) (Fig. 1), NNW of the Tanagura Shear Zone (Omori et al., 1953), is regarded as a possible northern extension of the TTL (Shimazu, 1964a,b), which represents the boundary between the Ashio Belt (a Jurassic accretionary complex within Southwest Japan) and the Abukuma Belt (a Cretaceous high-T/P regional metamorphic belt within Northeast Japan).

The Nihonkoku Mylonites were originally termed the "Nihonkoku Gneisses" (Sugiyama and Chihara, 1951), the origin of which was explained in terms of protoclastic deformation of near-solidus granitic magma (Chihara, 1963). Subsequent structural analyses of the Nihonkoku Gneisses reported mylonitization (Otsuka, 1976; Shoji, 1976; Uda and Yuhara, 1992; Takahashi, 1998a); consequently, Takahashi (1998a) proposed that the name of these foliated rocks be changed from "Nihonkoku Gneisses" to "Nihonkoku Mylonites".

The Nihonkoku Mylonites were derived mainly from Late Cretaceous granitic rocks in the Ashio Belt—a Jurassic accretionary complex in the Inner Zone of Southwest Japan (Takahashi, 1998a). Geological, petrographical, and geochemical data indicate that the Iwafune Granite, widely distributed on the southwest side of the Nihonkoku Mylonite Zone (Agency of Resources and Energy, 1982), is one of the rocks from which the Nihonkoku Mylonites were derived (Takahashi, 1998a, 1998b).

In this paper, we investigate the timing of mylonitization within the Nihonkoku Mylonite Zone based on the results of SHRIMP U–Pb age dating of zircon and K–Ar age dating of biotite and

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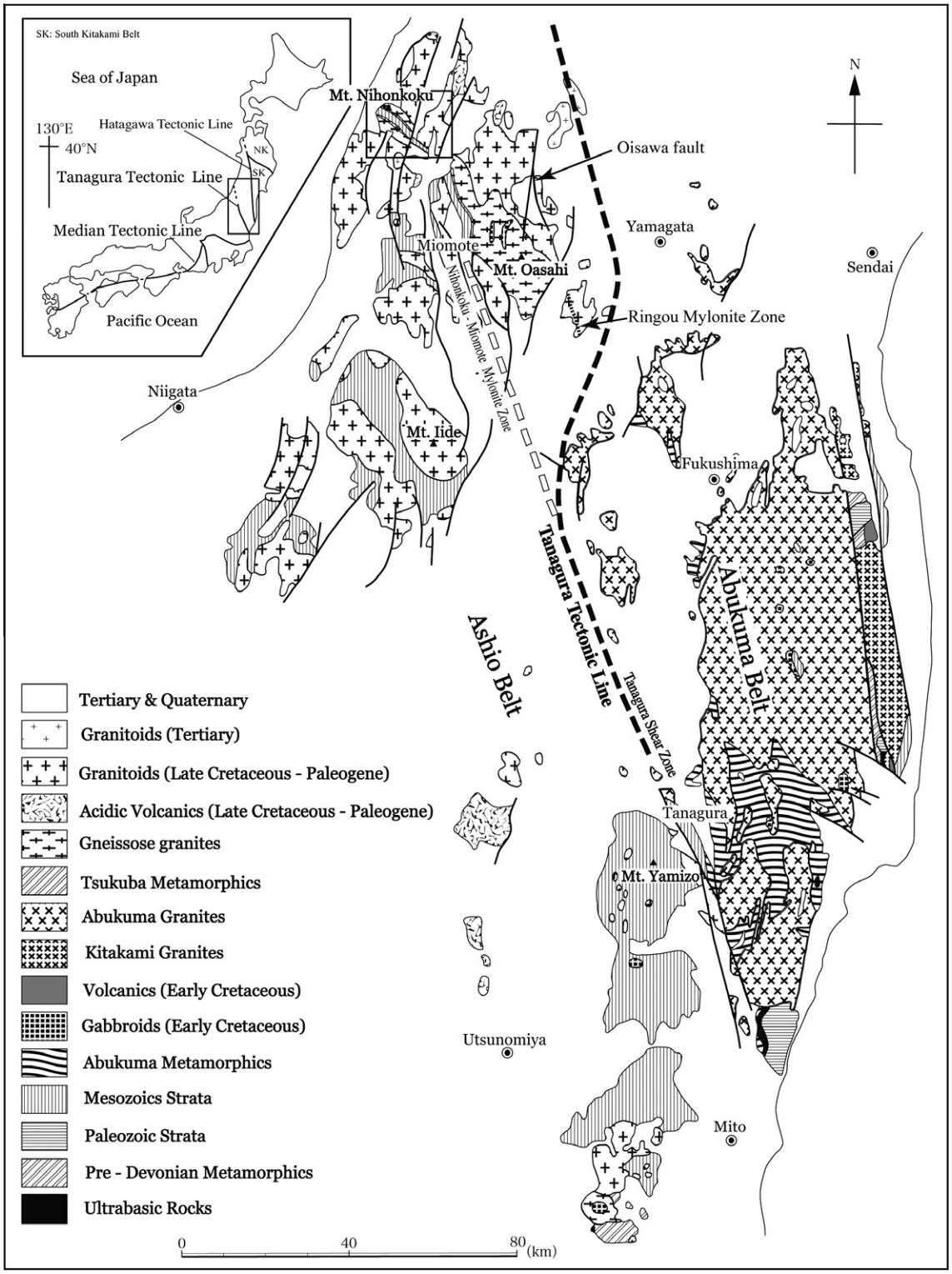

Fig. 1. Regional geological map of the pre-Neogene basement rocks around the Tanagura Tectonic Line (modified from Takahashi (1999)). NK: North Kitakami Belt, SK: South Kitakami Belt.

hornblende in the Nihonkoku Mylonites. We also consider the tectonic framework of Cretaceous sinistral ductile shear zones around the TTL and MTL in the Japanese Islands.

2. Geological outline of the Nihonkoku Mylonite Zone

The Nihonkoku Mylonite Zone strikes NW–SE, extending southeastward to the upper reaches of the Miomote River to form the "Nihonkoku–Miomote Mylonite Zone" (Fig. 1; Takahashi, 1999). The Nihonkoku Mylonites are composed of hornblende–biotite granodiorite mylonite, biotite granodiorite mylonite, and biotite granite mylonite.

The biotite granodiorite mylonite grades into gneissose biotite granodiorite and massive biotite granodiorite. Also, the biotite granite mylonite grades into gneissose biotite granite, and massive biotite granite (Iwafune Granite), thereby indicating that the