# The cooling/denudation rate of Mts. Rokko, southwest Japan based on fission-track thermochronology

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The Rokko mountains are distributed along the western margin of the Kinki-Triangle (Huzita, 1962). The mountain range, approximately 931 m high at the peak, 10 km wide and 30 km long, gently slopes to the northwest, with its peak lying on the eastern portion. These mountains are bounded to the south by the Rokko-Awajishima fault zone and to the north by the Arima-Takatsuki fault zone. The mountains of Rokko are the result of fault block movements along these thrust fault zones (Kaizuka and Chinzei ed., 1995). Some geomorphic surfaces are observed in the southeastern part of these mountains probably caused by the faults belonging to the Rokko-Awajishima fault zone, namely, Rokko surface, Hanabara surface, Kitayama surface and Uegahara surface in order of decreasing of altitude (Huzita and Kasama, 1982). Though Cretaceous (i.e., about 70 Ma; e.g., Matsuura et al., 1995) granitic rocks dominate the geology of the area, some deposits of the Osaka Group are also observed in the southeast (e.g., Huzita and Kasama, 1982; 1983).

Previous reports on the tectonic history of the Rokko mountains show that these have been uplifted by more than 500 m in the last 1 million years. This is evidenced by the presence of marine clay Ma 1 (i.e., deposited about 1 million years ago) in the Osaka Group deposits below the Hanabara surface (i.e., about 500-m-high) (e.g., Huzita, 1983). However, the tectonic history of a large part of this mountain group has not yet been constrained due to the scarcity of deposits on the Rokko surface, the highest surface. Thus, tectonic history prior to 1 Ma becomes more complex.

This study aims to limit the cooling and/or denudation history of the main part of the Rokko Mountains by using Fission-Track (FT) thermochronometry. FT thermochronometry is a method to estimate the timing of past heat events, which is based on the phenomenon that the FT age becomes younger than actual because of shortening and extinction of FT's by heat. In conditions where rocks are formed at greater depths (e.g., granitic rocks become exposed due to denudation), this method can be applied to limit the denudation history of the area, as rocks experience cooling according to the geothermal gradient. Advantages of the FT thermochronometry method include: 1) tectonic rates can be revealed by only using rock samples, and 2) it can be applied to many kinds of rocks regardless of the type or degree of weathering.

Samples used in this study are roughly separated into three groups: 1) outcrop samples from the Rokko granite, 2) outcrop samples from the Nunobiki granodiorite, and 3) Rokko granite samples picked from a boring core (courtesy of Ryuji Yamada, NIED). From these samples, eight apatite FT ages and twelve zircon FT ages are obtained, which are about 70-40 Ma.

Based on the obtained ages and results, the followings are proposed: 1) the total amount of denudation in the study area after formation of the Rokko granite is limited to about 1-3 km, 2) the denudation rate was about 0.05-0.06 mm/yr during the 50-40 Ma period, and 3) the average denudation rate was of 0.01 mm/yr order after the 50-40 Ma period and no huge and/or long tectonic events have occurred to affect the apatite FT ages. Thus, tectonic movements prior to the activities in the Rokko mountains (i.e., after about 1 Ma) were interpreted to be relatively calm.