AFT thermochronology of Cretaceous granites from the northern part of the NE Japan Arc: estimating thermal/denudation histories based on thermal inverse modeling

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Northeast (NE) Japan Arc is located at the subduction zone on the Pacific plate, which is known as a typical island arc because of having the inland linear topographic alignments and the island arc units. The tectonic history of the NE Japan Arc has been investigated by geologic and geomorphic researches so far. In particular, the evolution of the NE Japan arc after the opening of the Sea of Japan since ca. 15 Ma was well-understood (e.g., Sato, 1992, Jour. Geophys. Res.; Nakajima, 2013, INTECH; Yoshida et al., 2013, Geol. Soc. Lond. Spec. Pub.). Recently, the multidisciplinary project entitled “Crustal Dynamics” has successfully discovered a lot of geoscientific implications based on geodesy, geomorphology, and geology (Iio et al., 2018, EPS). As one of the disciplines in this project, thermochronology aimed at reconstructing vertical movements of the shallow crust over long-term timescales (>10^6 yr) in the unit of an island arc, and has contributed to revealing thermal/denudation histories coeval with the intense E-W compressive stress field since the Quaternary.

Thermochronology is a discipline which generally uses radiometric ages obtained from radiometric dating methods, and closure temperatures specific to the combinations of applied dating methods and these targeting minerals (namely, thermochronometers). Thus, thermal histories of rock bodies can be revealed, and moreover, denudation histories of them can also be estimated under the assumption of geothermal structure. Low-temperature thermochronology is useful for understanding upper crustal mountain building processes, which includes (U-Th)/He and fission-track (He and FT, respectively) methods for apatite and zircon. However, thermochronometric approaches directly measure cooling processes of rock bodies. Therefore, it is noteworthy that uplift histories require some assumptions, such as appropriate geothermal gradients and dynamic equilibrium between denudation and uplift (see the principle and application of thermochronology in Sueoka et al., 2016, Geosci. Fron.; Sueoka and Tagami, 2019, Jour. Geogr.).

Research findings by thermochronology of the NE Japan Arc are introduced here. We collected the Cretaceous-Paleogene granitic samples across the southern part of the NE Japan Arc, which is called as the S-traverse, and applied apatite and zircon He (namely, AHe and ZHe) methods (Sueoka et al., 2017, EPS), and apatite FT (AFT) methods (Fukuda et al., 2019, JAES:X) into island arc provinces, i.e., the Abukuma mountains, the Ou Backbone Range (OBR), and the Iide and Asahi mountains. These studies uncovered the contrasts of thermal and denudation histories between each tectonic unit. In the latest research, we have applied He methods into the northern part of the NE Japan Arc, namely, the Kitakami mountains, the OBR, and the Shirakami and Taihe mountains as the N-traverse (Fukuda et al., in press, EPS). This study attempted to reveal the overall trend of thermal and denudation histories along the NE Japan Arc. Consequently, estimated the similar contrasts of them along the S-traverse, which quantitatively provided that the landform development of arc-along direction is probably controlled by the E-W compressive stress field. In this presentation, we report the results of AFT dating and thermal

inverse modeling along the N-traverse in order to improve the thermal/denudation histories obtained by He thermochronometers.

We obtained AFT ages ranging from 138.0–2.0 Ma, which were consistent with the age contrasts between island arc provinces based on the He methods. In addition, thermal inverse modeling using by HeFTy (Ketcham, 2005, RiMG) provided high-accuracy thermal/denudation histories. On the fore-arc side, slow cooling patterns were estimated since the Cretaceous-Paleogene, while in the OBR and on the back-arc side, rapid cooling patterns were inferred since few Ma as last cooling episodes. Such last cooling episodes perhaps reflected the intense compressive stress field after the Quaternary, which indicated comparable to Fukuda et al. (2019, JAES:X). These observations implied that the S- and N-traverses have probably similar trends of thermal and denudation histories based on AFT methods as well as He thermochronometers. For enhancing the spatial-temporal resolutions of data, some future works will involve applying the application of lower-temp. thermochronometers (e.g., ESR or OSL methods), and extending our study area by increasing the number of sampling localities. Now, we have been conducting ongoing researches around the Kitakami, Abukuma mountains, and the OBR. Further investigations are desirable.

Keywords: Thermochronology, Northeast Japan Arc, Fission-track method, Island arc, Mountain building process

