Low-temperature thermochronology of Cretaceous granitoids from the northern Northeast Japan Arc: Towards reconstructing arc-parallel thermal/denudation histories

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Northeast (NE) Japan Arc is categorized as an arc-trench system, where volcanism and earthquakes frequently occur. The tectonic history of the NE Japan Arc has been well-investigated based on geomorphic and geologic approaches. Furthermore, the recent multidisciplinary project (Crustal Dynamics) successfully achieved and accumulated geoscientific results by means of GPS, active faults, numerical modeling, friction experiments, etc (see also Iio et al. 2018, EPS). For estimating vertical deformation over long-term timescales (>10^6 yr.), our research group has investigated the thermal/denudation histories on every geomorphic province of the NE Japan Arc by using low-temperature thermochronology.

Thermochronology can reconstruct the time-temperature relationship of rock/mineral samples, based on radiometric ages and closure temperatures specific to the combination of radiometric dating methods and target minerals. Low-temperature thermochronology is useful for understanding upper crustal mountain building processes and has been applied to estimate the tectonic history of major orogens (e.g. European Alps: Wagner et al. 1977, Mem. Inst. Geol. Mineral., Univ. Padova; Himalayas: Blythe et al. 2007, Tectonics). However, the thermochronology approach directly measures cooling processes, rather than denudation/uplift histories. Therefore, it is noteworthy that denudation/uplift histories require some assumptions, such as appropriate geothermal gradients and dynamic equilibrium between denudation and uplift. Long-term uplift rates on >1 Myr time-scales, require estimates from such protocols, which are assumed to be equivalent to the vertical inelastic deformation of the crust (Ikeda et al. 2012, JGS).

Between 2014-2019 we collected over 100 granitic rock samples from the NE Japan Arc. Low-temperature thermochronology has been applied to many of these samples, including the apatite/zircon (U-Th)/He (namely, AHe and ZHe) (Sueoka et al. 2017, EPS) and apatite fission-track(AFT) methods (Fukuda et al. 2019, JAES:X), particularly from Cretaceous-Paleogene granites located in the southern NE Japan Arc. This research elucidated the contrast of thermal/denudation histories among the island arc provinces, i.e., Abukuma mountains, Ou Backbone Range(OBR), and Iide and Asahi mountains. In this presentation, we report results based on AHe/ZHe and AFT thermochronometry from Cretaceous granites in the northern NE Japan Arc, aimed at reconstructing arc-parallel and across-arc thermal/denudation histories.

We obtained AHe ages ranging between 88.6-0.9 Ma, AFT ages from 138.0-2.0 Ma, and ZHe ages from 83.9-7.4 Ma. The ages show contrasting thermal/denudation histories between the fore-arc side, OBR, and back-arc side, which are similar to the southern NE Japan Arc. This observation implies that arc-parallel mountains have approximately the same trend along NE Japan Arc. On the other hand, some differences were observed between the northern and southern NE Japan Arc as follows; (1) significantly

older AFT ages were obtained for Kitakami mountains (130-75 Ma) compared to the Abukuma mountains (80-40 Ma), (2) much younger AFT ages at ~2 Ma were found on the back-arc side, Taihe mountains, and (3) considering the expected relationship between expected closure temperatures, some reversal of coexisting AFT ages compared to AHe/ZHe ages (e.g., FST04, FST05) were observed.

Future work will involve thermal inverse modeling using AFT thermochronometry for estimating more rigorous constraints on thermal histories. This will also involve increasing the number of sampling localities in an attempt to extend our study area.

Keywords: Thermochronology, Northeast Japan Arc, Fission-track method, (U-Th)/He method, Island Arc

