Findings on ~36 Ma adakitic magmatism in the Nakanogawa Group, Southern Hidaka Belt, Hokkaido, Japan

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A small trondhjemitic body (300 ×400 m) intruded into the mudstone-sandstone alternation of the Hiroo Complex, Nakanogawa Group, Hidaka Belt, in southern Hokkaido, Japan. The Nakanogawa Group adjacent to the trondhjemitic body is weakly metamorphosed due to the thermal effect of the intrusion. The trondhjemites are fine-grained (<0.8 mm) and composed mainly of plagioclase and small amounts of quartz with rare muscovite. The whole-rock geochemistry displays dacitic compositions, and low-Y contents relative to the high Sr/Y ratio that is plotted in the adakite and Archean high-alumina TTG fields shown by Defant and Drummond (1990). The trondhjemites are characterized by gentle light-rare earth element-rich chondrite-normalized rare earth element patterns ($La/Yn_{[N]}$= 4.7–7.7). The U–Pb zircon dating of the sample yielded a weighted mean $^{206}Pb/^{238}U$ age of ~36 Ma. The time-corrected Sr-Nd-Pb isotopic ratios suggest significant involvement with depleted mantle source material for the origin (e.g., $^{206}Pb/^{204}Pb_{(t)}$= 18.30, $^{207}Pb/^{204}Pb_{(t)}$= 15.52–15.53, $^{208}Pb/^{204}Pb_{(t)}$= 38.13–38.17).

In the Hidaka belt, three magmatic pulses, 46–45 Ma, 40–37 Ma, and 20–19 Ma, have been reported thus far (Kemp et al., 2007; Jahn et al., 2014; Takahashi et al., 2018). The first pulse presumably corresponds to the magmatic response of the Izanagi–Pacific ridge subduction; the third pulse likely corresponds to magmatism related to the opening of the Kuril (or Japan) basin. The ~37 Ma magmatism in the Hidaka belt includes mafic rocks with a mid-ocean ridge type composition (Kojima et al., 2015). As the timing of the Izanagi–Pacific ridge subduction is presumed to be ~48 Ma (Yamasaki and Nanayama, 2020), the cause of the significant time gap between the 46–45 Ma and 40–37 Ma magmatism remains uncertain. On the other hand, magmatic events in the late Eocene to Miocene post–46 phase continuously exist along the northeast Asian margin (e.g., Wu et al., 2019), whereas the clear gap between the two magmatic events has been observed in the Hidaka belt. According to the plate tectonic reconstruction by Müller et al. (2016), there have been extremely large ridge-offsets (extending ~1,600 km) in the areas subducted around Hokkaido. The distribution of 46–45 Ma and 40–37 Ma magmatism in the Hokkaido (Hidaka belt) is limited to the northern and southern areas, respectively. Thus, the border between the two magmatism can be interpreted as corresponding to the fracture zone with the large offset of the Izanagi-Pacific ridge segments. If we assume the Izanagi–Pacific ridge subduction at ~7 cm/yr (Wu et al., 2019), the 5-million-year-time gap of the two magmatic pulses requires ~350 km offset of the ridge axis. The >300 km offset of the spreading axis is present even in the modern East Pacific Rise, and thus, the offset of the first-order segment could be the cause of the 45–40 Ma magmatic gap in the Hidaka belt. As the adakitic magmatism strongly suggests the existence of a slab-window caused by ridge subduction, the magmatism most likely originated from the prolonged magmatic response to the Izanagi–Pacific ridge subduction in the southern Hidaka belt.

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in press.

Keywords: Hidaka belt, Izanagi-Pacific ridge, ridge subduction, Adakite, Zircon U-Pb age, Sr-Nd-Pb isotopes

