Provenance of the Yezo forearc basin in Northeast Japan from detrital zircon U–Pb age spectra

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Introduction

In Hokkaido, the Cretaceous to Paleogene Yezo Group narrowly extends in the north direction, and the Upper Cretaceous Futaba and Nakaminato groups sporadically occur in the Pacific side of Northeast Japan[1)]. They are thought to have been deposited in the forearc basin along the East Asian active continental margin, called the "Yezo forearc basin" [1)]. The modal composition of sandstones[2),3)] of the Yezo Group, and the detrital zircon age spectra[4)] suggested that its provenance is the East Asian continental margin. However, we have not been able to identify the specific provenance of each formation of the Yezo Group and its equivalents. In this presentation, we discuss the provenance of the Yezo forearc basin from the detrital zircon age spectra of sandstone samples and the database of the age and distribution of igneous rocks in East Asia.

Geological Setting

The Yezo Group consists mainly of black mudstone and sandstone. It is subdivided into the Shuparogawa (Srs), Hikagenosawa (Hgs), Mikasa (Mks), Haborogawa (Hbs), and Hakobuchi formations (Hks1, Hks2), in ascending order[5)]. The Futaba Group, consisting mainly of sandstone and mudstone, unconformably covers the granites of the Abukuma Belt. The group comprises the Ashizawa (Aos), Kasamatsu, and Tamayama formations (Tys), in ascending order[6)]. The Nakaminato Group consists mainly of turbidite and is subdivided into the Hiraiso and Isoai formations (Is8), in ascending order[7)]. The codes for the nine sandstone samples analyzed in this study are in the parentheses.

Analytical Method

We separated detrital zircons from each sandstone sample, measured their U/Pb isotopic ratios with LA-ICPMS, and calculated the U–Pb ages. YC is the weighted mean of the youngest zircon $^{206}Pb/^{238}U$ age and the other ages with the error bar ($\pm 2\sigma$) overlapping with the youngest age.

Result

Figure 1 summarizes the result of our measurements of the Yezo, Futaba, and Nakaminato groups.

Discussion

Samples Srs, Hgs, and Mks have zircons crystallized during the magmatic hiatus in Korea[8)] (158–138 Ma), 230–210 Ma, and 2400–1800 Ma zircons. The database indicates that igneous rocks of these ages are widely exposed in South China[9)]. In addition, paleomagnetic studies[10)] suggested that the Hikagenosawa and Takinosawa formations of the Yezo Group was deposited at 10°N and moved to the north during the Cretaceous. Thus, the provenance of the Yezo Group was probably South China during the Aptian to Cenomanian.

The detrital zircons from sample Aos are mostly 120–100 Ma in age and likely originated from the 120–100 Ma granites in the Abukuma Belt[11)]. 96–83 Ma zircons occupy more than 70% of the detrital zircons from sample Tys and likely originated from the ca. 90–80 Ma igneous rock bodies in the Inner

Zone of Southwest Japan[12].
About 95% of the detrital zircons from sample Hbs are 100–80 Ma. Thus, coeval, 100–80 Ma igneous rocks of an active igneous belt must have occupied the hinterland of sample Hbs.
From the Hakobuchi Formation of the Yezo Group, sample Hks1 has 250–203 Ma, 310 Ma, and 490 Ma detrital zircons, and about 18% of the detrital zircons from sample Hks2 are Paleozoic (excluding Permian) ones (Fig. 1). Sample Is8 has 210 Ma and 1800 Ma zircons. 500–400 Ma and 300 Ma igneous rock bodies widely crop out in Far East Russia[13]. The provenance of the Yezo and Nakaminato groups in the latest Cretaceous was probably Far East Russia. These lines of evidence strongly suggest that the provenance of the Yezo forearc basin continuously changed from south to north.

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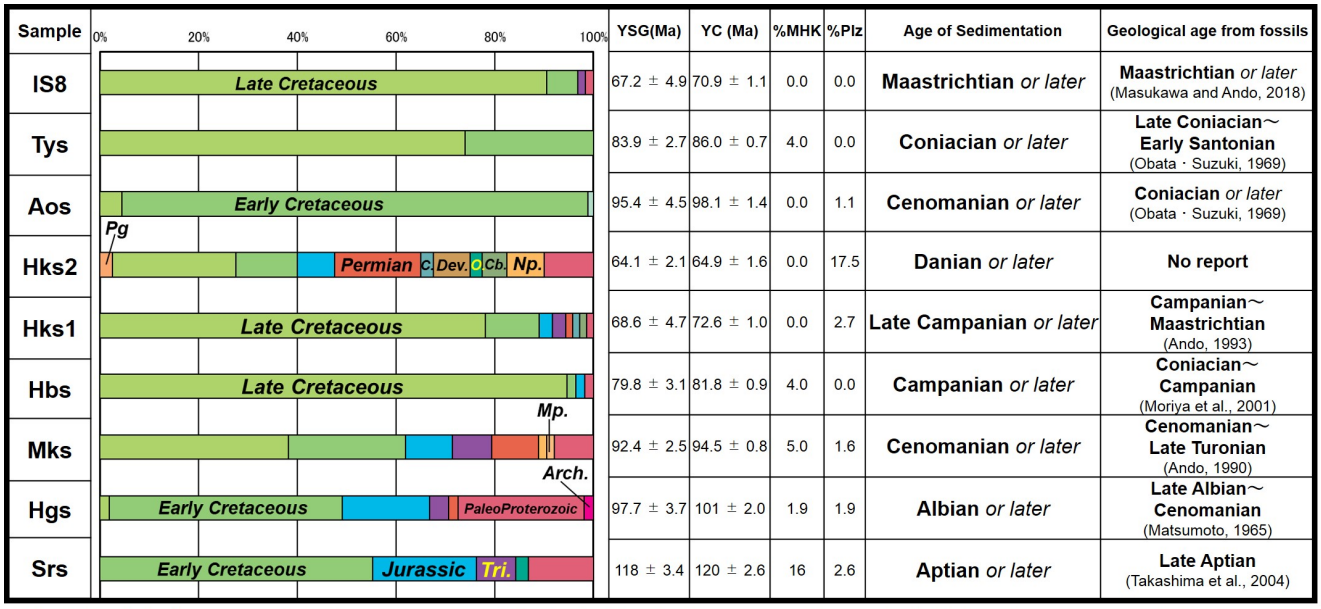

Sample	YSG(Ma)	YC (Ma)	%MHK	%Plz	Age of Sedimentation	Geological age from fossils
IS8	67.2 ± 4.9	70.9 ± 1.1	0.0	0.0	**Maastrichtian** *or later*	**Maastrichtian** *or later* (Masukawa and Ando, 2018)
Tys	83.9 ± 2.7	86.0 ± 0.7	4.0	0.0	**Coniacian** *or later*	**Late Coniacian～ Early Santonian** (Obata・Suzuki, 1969)
Aos	95.4 ± 4.5	98.1 ± 1.4	0.0	1.1	**Cenomanian** *or later*	**Coniacian** *or later* (Obata・Suzuki, 1969)
Hks2	64.1 ± 2.1	64.9 ± 1.6	0.0	17.5	**Danian** *or later*	**No report**
Hks1	68.6 ± 4.7	72.6 ± 1.0	0.0	2.7	**Late Campanian** *or later*	**Campanian～ Maastrichtian** (Ando, 1993)
Hbs	79.8 ± 3.1	81.8 ± 0.9	4.0	0.0	**Campanian** *or later*	**Coniacian～ Campanian** (Moriya et al., 2001)
Mks	92.4 ± 2.5	94.5 ± 0.8	5.0	1.6	**Cenomanian** *or later*	**Cenomanian～ Late Turonian** (Ando, 1990)
Hgs	97.7 ± 3.7	101 ± 2.0	1.9	1.9	**Albian** *or later*	**Late Albian～ Cenomanian** (Matsumoto, 1965)
Srs	118 ± 3.4	120 ± 2.6	16	2.6	**Aptian** *or later*	**Late Aptian** (Takashima et al., 2004)

Fig. 1 Detrital zircon-age of the Yezo Group (Srs～Hks2), the Futaba Group (Aos, Tys), and, the Nakaminato Group (Is8). YSG and YC denote the age of the youngest zircon and the youngest cluster (the weighted mean of the youngest zircon $^{206}Pb/^{238}U$ age and the other ages with the error bar ($\pm 2\sigma$) overlapping with the youngest age), respectively, of each sandstone sample. %MHK and %Plz are the percentages of zircons during the magmatic hiatus in Korea, and the Paleozoic zircons excluding the Permian ones, respectively.

