Geochemical records in delivery and accumulation of heavy minerals in sediments of Lake Biwa

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In the summer of 1995, seven piston cores (10-15 m long) were taken at three sites in the northern basin of Lake Biwa. Bulk INAA analysis was performed to 114 samples from BIW95-1 core, 457 samples from BIW95-4 core and 101 samples from BIW95-2 core. Conversion to the Suigetsu (SG) varve age is according to the measurements of the depth or the AMS14C age followed the procedure of Kitagawa and Van Der Plicht (1998).

Hf/Sc ratio has been fairly constant throughout at the BIW95-1 core. While, the variation of both Th/Sc and Ce/Sc ratios shows a steep rise during the last several centuries. Several spikes are found in both Th/Sc and Ce/Sc ratio variations and most of them are synchronized each other. The steep rise of Th/Sc ratio during the last several centuries and six spikes of Th/Sc are considered to be induced by higher accumulation rate of Th-rich heavy minerals from acidic rock areas around the lake. We considered that the steep rise of Th/Sc and Ce/Sc ratios during the last several centuries is caused by the destruction of forests around Lake Biwa by human activity. Since the Ce and Th enriched component have same chemical composition, it is suggested that the spiked sample on horizons was deposit at ancient heavy rains which had induced higher accumulation rate heavy minerals (monazite and/or allanite) from Tanakami-Shigaraki granite. In BIW95-1core also, eleven spikes are found in both Th/Sc and Ce/Sc ratio variations and most of them are synchronized each other. The sample whose Th/Sc and Ce/Sc ratios are high is different with the samples having Hf/Sc ratio peak. The comparison between the Greenland ice-core record (Stuiver et al., 1995) and the spikes of Th/Sc and Ce/Sc ratios in the chemical composition of BIW95-4 and BIW95-1 shows correspondence between rapid warming and the spike of the ratios would be expected.

In BIW95-1core, Hf/Sc ratio has been fairly constant until 16,000 SG varve yrBP, but it has been significant variation from 16,000 SG varve yrBP to 4,000 SG varve yrBP. The remarkable difference between two terms indicates a change at 16,000 SG varve yrBP. The vertical distribution patterns of Ti/Al, Th/Sc, and Hf/Sc ratios in the samples of BIW95-2 shows an outstanding boundary of chemical composition at ca. 16,700 SG varve yrBP. During the late 16,700 SG varve yrBP, core samples have lower Ti/Al ratio, higher Th/Sc and Hf/Sc ratios comparing with the one until 16,700 SG varve yrBP. The change of the chemical composition suggests the shift of the contribution of granitic materials. Granitic material has lower Ti/Al ratio and higher Th/Sc and Hf/Sc ratios rather than the one of general sedimentary rocks. BIW95-2 was collected near the mouth of the Ado River whose watershed area distribute along the sedimentary rocks and Hira granite areas. 16,700 SG varve yrBP is approximately consistent with the beginning the period of peaks of Hf/Sc ratios in BIW95-4 core. From the geographical relation between two cores, we can say that the peaks of Hf/Sc ratio in BIW95-4 were induced from the abrupt increase of the contribution of Hira granitic materials. The relation of chemical composition between two BIW95-2 and BIW95-4 cores confirms that increase of Hf/Sc ratio in BIW95-4 was induced by the enriched component in BIW95-2. It is interesting that Hf/Sc spikes appear at almost equal time intervals in BW95-4 core during 4,000 - 16,000 SG varve yrBP. We can say the Hf/Sc spikes appeared just after ancient earthquake on the west shore of coring sites. Many active faults are densely distributed in and around the lake, and destructive earthquakes were frequently generated from these faults in Japanese history. Activity of sublacustrine fault along Hira Mountains has brought the tectonic movement (Yokoyama et al., 1992). The upheaval of Hira granite block has promoted the delivery of the zircon grains from the western shore to the core sites at the center of Lake Biwa.