

**Mineral Analysis of river sand around Mt. Tsukuba for provenance estimation of
Atamadai type pottery (2500-1500 BC) from Hinoki site (Tochigi Japan)**

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Atamadai type pottery, a kind of Jomon pottery, had been distributed in eastern Kanto region of Japan in the Middle Jomon Period (2500–1500 BC). This pottery is thought to have been made from mixture of clay as a raw material and granite fragments as a temper[1]. We focused on X-ray diffractometry (XRD) to analyze minerals instead of mean chemical composition for identification of the minerals' origin, *i.e.*, the raw material and/or the temper, and to archaeologically characterize the raw material and the temper, respectively, using *d*-spacing shift of solid solution minerals. In previous study[2], finger print minerals for the provenance characterization were estimated to plagioclase and hornblende for the raw material and/or the temper and biotite for the temper. In this study, 37 river sand samples around Mt. Tsukuba were analyzed by powder XRD to estimate the temper in Atamadai type potteries from Hinoki site (Tochigi, Japan) by comparison with minerals in the potteries.

The following Jomon potteries from Hinoki site were selected in this study: 59 Atamadai type potteries and 18 other Jomon potteries. The samples (about 1 g) which were obtained from each pottery shard using a router, were finely ground with an almina mortar and pestle. Thirty-seven river sand samples (about 5 g) around Mt. Tsukuba were pulverized by the same method. This mountain is located on the south side of the site, and might be one of collection points for the pottery's materials. The powdered samples were analyzed by XRD using a Rigaku SmartLab diffractometer.

The XRD patterns showed as follows. All samples contained quartz and plagioclase which are major mineral component. Additionally, all Atamadai types had biotite; in contrast, other Jomon potteries had no biotite even though the potteries originate in the same findspot and prehistorical period as Atamadai types. This clearly reveals that rock fragments or sand containing the biotite mixed into raw material as a temper. On the other hand, 34 river sand samples contained the biotite according to the XRD pattern. Therefore, it seems possible that these samples were used as the temper for manufacture of Atamadai type potteries. The accurate measurement for *d*-spacing shift of the biotite may allow to estimate archaeological provenance for the temper.

[1] Y. Shimizu: *Res. Bull. Chiba Archaeol. Res. Cent.*, **8**, 80 (1984) (in Japanese).

[2] S. Ichikawa, M. Morikawa, T. Kurisaki, T. Yamaguchi: *Adv. X-ray Anal.*, **61**, Accepted (2018).