Recovery rates and external morphologies of zircon grains from mechanical and electrical pulverization of rock samples: examples from TEMORA2 and AS3

Mami Takehara[1], Kenji Horie[1,2] , Tomokazu Hokada[1,2] and Shoichi Kiyokawa[3]
[1]*National Institute of Polar Research, 10-3, Midori-cho, Tachikawa-shi, Tokyo 190-8518, Japan*
[2]*Department of Polar Sciences, The Graduate University for Advanced Studies (SOKENDAI), Japan*
[3]*Departmant of Earth and Planetary Sciences, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka, 819-0395 Japan*

Mineral separation is an essential process in sample preparation before SHRIMP U-Pb analysis. Selfrag Lab. is pulverization system using pulse power of high voltage discharge. This device can provide good opportunities to separate materials into individual constituents with retaining original morphology and mineral surface. There is possibilities that fine-grained mineral grains, such as zircon inclusions in garnets, can be collected without contamination and damage to zircon inclusions. In this study, enhancement of recovery rate of minerals is important for U-Pb dating if quantitative comparisons are to be attempted between polychronolomic zircon poppulations.

Focused on pulverization process in the mineral separation process for U-Pb zircon geochronology, we compared the recovery rates of zircon between conventional fragmentation with stamp mill and high-voltage selective fragmentation with Selfrag Lab. machine. Two rock samples which has been commonly used as standard of U-Pb zircon dating (TEMORA2; Black et al., 2004 and AS3; Paces and Miller, 1993) were used for comparison. TEMORA2 is a gabbroic diorite collected from the Lanchlan Fold Belt of southern Australia and AS3 is a gabbroic anorthosite from the Duluth Complex, Minnesota, U.S.A. Nearly equal weights of rocks are crushed by each crushing method. After pulverization, the conventional method (rinsing with water, heavy liquid separation, and magnetic separation with ferrite and Nd magnet) is applied. Weights of the products of each step were measured and recovery rates of the products of each step are also calcurated. Recovery rate is defined as the ratio of weight of product from each separation process divided by weight of rock sample before all separation processes in this study. Recovery rate of heavy and non-magnetic mineral including zircons were calculated and compared between two pulverizing processes.

Weights of TEMORA2 and AS3 rock fragments and recovery rates are shown in Table 1 (the values in the brackets are recovery rates; Takehara et al., 2018a). In the case of TEMORA2, recovery rate of heavy and non-magnetic minerals including zircons by Selfrag are slightly higher than stamp mill pulverization (stamp mill: 0.02680 g, 0.007%, Selfrag: 0.03067 g, 0.009%). However, the difference is so small that it is difficult to judge whether this is caused by difference of pulverization method or heterogeneity of component in TEMORA2 rock fragments. On the other hand, in the case of AS3, recovery rate of heavy and non-magnetic minerals including zircons by Selfrag are obvious difference from stamp mill pulverization (stamp mill: 0.070 g, 0.0166%, Selfrag: 0.147 g, 0.0348%), compared with the difference of TEMORA2. AS3 and the zircons collected from it show evidence of hydrothermal alteration (Takehara et al., 2018b). Zircon is resistant to mechanical weathering but this difference of recovery rate between electrical and mechanical pulverization suggest pulverizing methods affect the recovery rate not when robust minerals like zircon are collected but when relatively fragile minerals including hydrothermally altered zircon are collected.

Table 1. Weights and recovery rates of TEMORA2 zircon obtained using stamp mill and Selfrag Lab.

	rock sample	pulverization	elutriation (rinsing with water)	heavy liquid separation	non-magnetic fraction
TEMORA2					
Selfrag	378.5 g	307.9 g (81.3%)	--[a]	9.3 g (2.5%)	0.0361 g (0.00953%)
Stamp mill	383.0 g	290.0 g (75.7%)	98.9 g (25.8%)	6.6 g (1.7%)	0.0268 g (0.00700%)
AS3					
Selfrag	422.1 g	421.4 g (99.8%)	--[a]	9.6 g (2.3%)	0.147 g (0.0348%)
Stamp mill	421.7 g	309.1 g (73.3%)	94.6 g (22.4%)	5.7 g (1.4%)	0.070 g (0.0166%)

[a]In the separation process after SELFRAG, rock samples were not elutriated by using a tall beaker and the weights of products were not measured.

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