
Introduction: Shergottites show basaltic, olivine (+orthopyroxene)-phric or lherzolitic textures. Up to now seven specimens including Yamato (Y-) 793605 are classified as lherzolitic shergottites [1]. Except Allan Hills (ALH) 77005 and Northwest Africa (NWA) 1950 [2], sample seizes of lherzolitic shergottites are small, weighing less than 20 g. The lherzolitic shergottites show somewhat higher shock pressure (40-55 GPa) than basaltic shergottites (25-45 GPa) [3]. Y-793605 is far more brecciated than other lherzolitic shergottites. Ejection age of Y-793605 (4.70 ± 0.50 Ma) is similar to that of LEW88516 (3.94 ± 0.40 Ma) but do not overlap an ejection age of 3.06 ± 0.20 Ma for ALH77005. However, uncertainty in production rates of cosmogenic nucleides prevents precise determination of ejection ages. Thus, it is expected that three lherzolitic shergottites have the same ejection age [4].

As a part of the Yamato-79 shergottite consortium [5], we had undertaken U-Th-Pb and Rb-Sr isotopic studies [6,7]. The U-Pb and Rb-Sr ages are concordant with the Rb-Sr and U-Th-Pb chemical separations. Total procedural analyses were completed using the eluents from the previous experiment (leached with 1M HCl for 15 min) that phosphates could be a main sink of U, Th, REE and Sr, thus govern the bulk REE patterns [15-17]. We can estimate REE dissolution during acid treatments from the unleached whole-rock and the whole-rock residue samples. About 88% of total Nd and 82% of total Sm were dissolved during a three-step acid leaching. This is consistent with an earlier experiment (leached with 1M HCl for 15 min) that phosphates carry 80-90% of total LREE in ALH77005 [18]. Some of the trace elements in Y-793605 may have been mobilized to grain surface due to brecciation, making them more susceptible to leaching by weak reagents.

Sm and Nd abundances of whole-rock and olivine residues (WR,R and OL,R) are almost identical (Fig. 1). Abundances of Sr, Sm and Nd in the olivine residue (Sr = 0.17 x CI, Nd = 0.18 x CI, Sm = 0.57 x CI) are too high to account for igneous fractionation, suggesting a contribution from the glass inclusion enriched in incompatible elements [14]. Pyroxene residue (PX2,R) possesses the lowest Sm and Nd abundances among the measured samples. We could not obtain plagioclase (maskelynite) data point. All samples analyzed showed Cl-normalized Sm/Nd ratios larger than unity. Nevertheless, we obtained a variation of 147Sm/144Nd ratios from 0.34 to 0.63.

Figure 2 shows a Sm-Nd isochron diagram for Y-793605. Three acid-residue (WR,R, OL,R and PX2,R) and three acid leachate (WR,L1, WR,L2 and PX2,L1) samples define a linear array corresponding to a Sm-Nd age of 156 ± 14 Ma (MSWD = 3.2) for (147Sm) = 0.00654 Ga^-1 with an initial ε143Nd value of +7.5 ± 0.2 using the Isoplot regression program [19]. Assuming that the lherzolitic shergottite sources formed from a reservoir of chondritic 143Nd/144Nd and 147Sm/144Nd at 4.553 Ga, the time-averaged 143Nd/144Nd ratios for the sources are calculated to be 0.210-0.216 (Fig. 3).

The Sm-Nd age of 156 ± 14 Ma are consistent with the previous U-Pb age of 212 ± 62 Ma [6] and Rb-Sr age of 173 ± 14 Ma [7] within analytical errors. The fact suggests that Y-793605 crystallized ~150-170 Ma from a volatile-rich (i.e., Pb-rich), LREE-depleted source materials. The Sm-Nd age and initial ε143Nd value of Y-793605 are in good agreement with those reported for LEW88516 [8] (initial ε143Nd = +8.5 ± 0.5, see Fig. 3), suggesting that they are genetically closely related. ALH77005 shows a slightly higher initial ε143Nd value of +11.0 ± 0.2. This is consistent with the Rb-Sr isotope systematics of lherzolitic shergottites [7,8] and possibly related to the petrologic features that the olivine composition of Y-793605 is nearly identical to that of LEW88516 [20].

It is suggested that most Rb-Sr, Sm-Nd and Lu-Hf mineral isochron ages of shergottites including lherzolitic...
were reset recently (i.e., \( \sim 180 \) Ma) by acidic aqueous solutions percolating throughout the Martian surface [21-23]. They interpreted that carrier phases of U, REE and Sr are phosphates and U-Pb, Sm-Nd, Rb-Sr and Lu-Hf isotopic systems are easily disturbed during acid leaching, and concluded that only Pb-Pb dates should be considered [23]. Figure 4 shows a \(^{207}\text{Pb}/^{206}\text{Pb}-^{204}\text{Pb}/^{206}\text{Pb}\) diagram for whole-rock samples of lherzolitic shergottites [6,24,25]. The second and third leachates (WR,L2 and WR,L3) and residue sample (WR,R) of Y-793605 define a linear array corresponding to a Pb-Pb “age” of \(~4.2\) Ga. However, this line intercepts laboratory blank Pb or modern terrestrial Pb. Moreover, the first leachate sample also plots a laboratory blank Pb region. The fact strongly suggests that the regression line represents a mixing between terrestrial and indigenous Pb components.

Fig. 2. Sm-Nd isochron diagram for Y-793605.

Fig. 3. Ages (T) versus initial \( \varepsilon_{143}\text{Nd} \) plot for lherzolitic shergottites.

Fig. 4. \(^{207}\text{Pb}/^{206}\text{Pb}-^{204}\text{Pb}/^{206}\text{Pb}\) diagram for lherzolitic shergottites. Data are from [6,26,27]. S & K = Modern terrestrial Pb isotopic compositions [28].