Rb-Sr ISOTOPIC STUDIES OF ANTARCTIC LHERZOLITIC SHERGOTTITE YAMATO 984028. C.-Y. Shih[1], L. E. Nyquist[2], Y. Reese[3], and K. Misawa[4]. [1]Mail Code JE-23, ESCG/Jacobs Sverdrup, P.O. Box 58477, Houston, TX 77258-8477, chi-yu.shih-1@nasa.gov; [2]Mail Code KR, NASA Johnson Space Center, Houston, TX 77058-3696, laurence.e.nyquist@nasa.gov; [3]Mail Code JE-23, ESCG/Muniz Engineering, Houston, TX 77058, young.reese-1@nasa.gov., [4]NIPR, Tokyo, Japan (misawa@nipr.ac.jp).

Introduction: Yamato 984028 is a Martian meteorite found in the Yamato Mountains of Antarctica. It is classified as a lherzolitic shergottite [1] and petrographically resembles several other lherzolitic shergottites, i.e. ALHA 77005, LEW 88516, Y-793605 and Y-000027/47/97 [e.g. 2-5]. These meteorites have similarly young crystallization ages (152-185 Ma) as enriched basaltic shergottites (157-203 Ma) [e.g. 6-11], but have very different ejection ages (~4 Ma vs. ~2.5 Ma) [e.g. 11, 12], thus they came from different martian target crater areas. Lherzolitic shergottites have mg-values ~0.70 and represent the most mafic olivine-pyroxene cumulates. Their parental magmas were melts derived probably from the primitive Martian mantle [e.g. 13].

Here we present Rb-Sr isotopic data for Y-984028 and compare these data with those obtained from other lherzolitic and olivine-phyric basaltic shergottites to better understand the isotopic characteristics of their primitive mantle source regions. Corresponding Sm-Nd analyses for Y-984028 are in progress.

Samples: Three pieces of Y-980459, weighing ~845 mg, were kindly allocated for the study by the National Institute of Polar Research of Japan. Two small chunks weighing ~51.6 mg were saved for Ar-Ar dating. Then, the sample was further crushed to grain size <149 µm. About 176 mg of the sample was taken as the bulk rock sample (WR). The rest of the crushed sample was sieved into two size fractions, 149-74 µm and <74 µm. Mineral separations were made from the coarser fraction sample (~386 mg) by combinations of both magnetic and density separations. The non-magnetic plagioclase sample (Plag) and the most magnetic opaque-rich sample (MM) were separated by a Frantz magnetic separator. The pyroxene and olivine samples were separated by density using heavy liquids of bromoform, methylene iodide and Clerici's solutions from the magnetic portion the the sample. At ρ>2.85-3.32 g/cm^3, we obtained plagioclase plus pyroxene (Plag+Px). At ρ=3.32-3.45 g/cm^3 and ρ=3.45-3.55 g/cm^3 we obtained pyroxene enriched samples (Px1 and Px2). The olivine (Ol) was concentrated in the density fraction ρ>3.55 g/cm^3. Samples of WR, Px1, Px2 and MM were washed with 2N HCl in an ultrasonic bath for 10 minutes. The Plag and MM samples were washed with 1N HCl. Seven acid washed bulk rock and mineral residues (r), one unwashed WR sample, one bulk rock and one combined mineral leachate (l) were analyzed for Rb and Sr using a Finnigan-MAT 261 multi-collector mass spectrometer. The ^{87}Sr/^{86}Sr results reported here were renormalized to the NBS 987 standard ^{87}Sr/^{86}Sr = 0.710250.

Rb-Sr Abundances: The C1-normalized Rb, Sr, Sm and Nd abundances of enriched basaltic and lherzolitic shergottites are summarized in Fig. 1. All the basaltic samples including three olivine-phyric samples (NWA 1068, LAR 06319 and RBT 04262) have higher abundances of these elements relative to the lherzolitic shergottites by factors 2-10x. The Rb and Sr of Y-984028 plot within the area defined by five lherzolitic shergottites, consistent with its petrography [1].

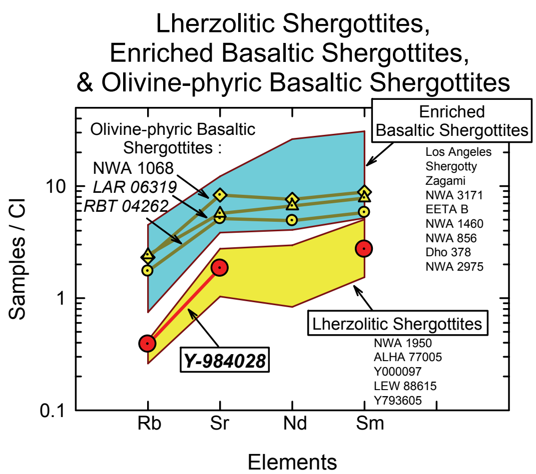

Figure 1. Rb, Sr, Sm and Nd of bulk rocks of enriched basaltic shergottites and lherzolitic shergottites. Y-984028 bulk rock samples are in solid red circles.

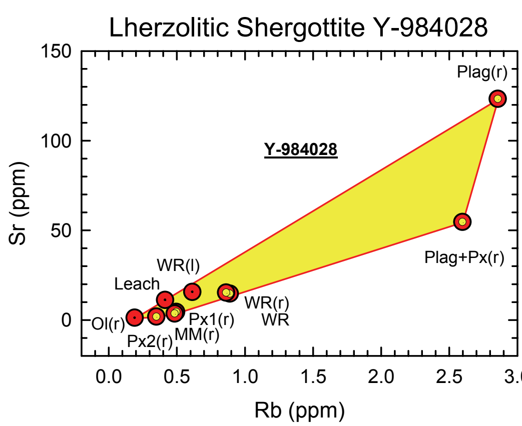

Figure 2. Rb and Sr distributions in bulk and mineral separates of lherzolitic shergottite Y-984028. Yellow dotted samples are used in our preferred Rb-Sr isochron calculation.

Fig. 2 summarizes Rb and Sr results for the ten bulk rock and mineral separates. In terms of Rb and Sr distributions in Y-984028, the rock is composed of four main components, Plag(r), Ol(r), Px2(r) and a fourth component enriched in the mixed sample, Plag+Px(r). The Y-984028 Plag(r) sample contains 123 ppm of Sr, which is only ~1/3 of the Sr abundance in the plagioclase sample reported in Y-000097[9]. The Y-984028 Ol(r) and Px2(r) samples have the lowest Rb and Sr abundances reported among lherzolitic shergottites.

Rb-Sr Isotopic System: The ^{87}Rb/^{86}Sr and ^{87}Sr/^{86}Sr data for one unwashed bulk rock, seven acid-washed bulk and mineral samples, one bulk rock leachate and one combined mineral leachate from Y-984028 are shown in Fig 3. Excluding two leachates, WR(l) and Leach, eight data form a linear array defining an isochron T=175±10 Ma for $\lambda(^{87}\mathrm{Rb})=0.01402\ \mathrm{Ga}^{-1}$ and I(Sr)=0.710379±0.000036 (MSWD=8.8). Omitting the Ol(r) sample, the remaining seven samples, shown by yellow dots in Fig 3, yield a better fit for T=170±9 Ma and I(Sr)=0.710389±0.000029 (MSWD=4.6). The Ol(r) sample has the lowest Sr concentration and may have been susceptible to terrestrial contamination. The non-linear distribution of Rb and Sr for these mineral samples show that the isochron is not a mixing line. The Rb-Sr isochon age represents the crystallization time of Y-984028, and is within the age range (152-185 Ma) reported for the other four lherzolitic shergottites.

T-I(Sr) Correlation: Fig. 4 summarizes age and I(Sr) data for five lherzolitic shergottites, represented by their error parallelograms. Most of the samples define specific times and I(Sr) values which suggest that the lherzolitic shergottites originated from different magma flows over a time span of ~40 Ma. The Y-984028 data overlap with the Y-793605 data suggesting their parental magmas could have come from the same mantle source.

Fig. 5 summarizes age and I(Sr) data for lherzolitic shergottites and enriched basaltic shergottites including olivine-phyric shergottites. Although basaltic shergottites and lherzolitic shergottites crystallized almost contemporaneously, their I(Sr) values differ significantly. Their source ^{87}Rb/^{86}Sr ratios calculated based on a single-stage model differ by a factor of two. Source ^{87}Rb/^{86}Sr ratios for lherzolitic shergottites were ~0.18, whereas those for basaltic shergottites were ~0.36. Although olivine-phyric shergottite RBT 04262 is petrographically indistinguishable from lherzoltic shergottite LEW 88516[14], the difference in their I(Sr) values is considerable.

Conclusions: The Rb-Sr isotopic study is consistent with Y-984028 being a lherzolitic shergottite, as suggested by its petrographic description. The Rb-Sr isotopic system was not severely altered by terrestrial contaminants. Y-984028 crystallized ~170 Ma ago like most other lherzolitic shergottites. The source ^{87}Rb/^{86}Sr ratio for Y-984028 was ~0.18.

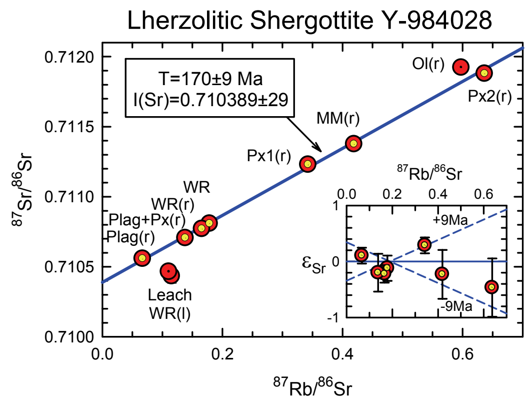

Figure 3. Rb-Sr isochron for lherzolitic shergottite Y-984028. Yellow dotted samples are used in the Rb-Sr isochron calculation.

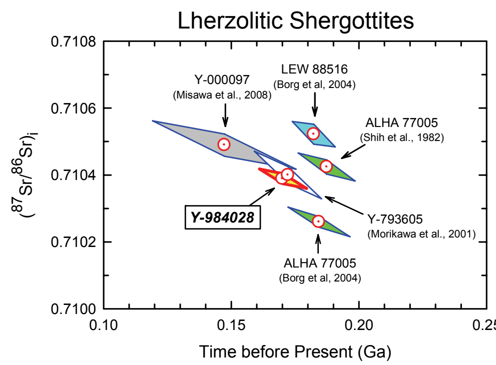

Figure 4. I(Sr) and age for lherzolitic shergottites. Y-984028 data are in red parallelogram.

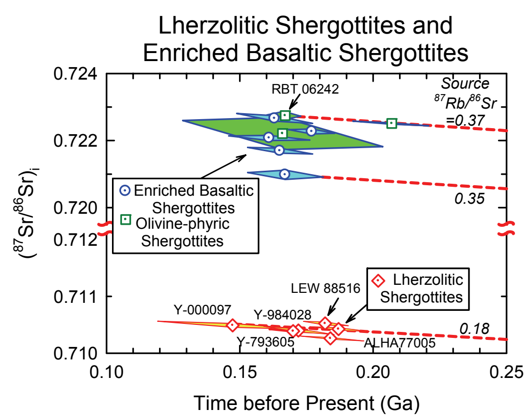

Figure 5. I(Sr) and age for enriched basaltic shergottites (blue circles) including three olivine-phyric shergottites (green squares) and lherozoltic shergottites (red diamonds).

References:

[1] *Meteorite Newsletter* 17 (2008), NIPR, Tokyo. [2] McSween H.Y. et al. (1979) *EPSL* **45**, 275-284. [3] Harvey R.P. et al. (1993) *GCA* **57**, 4769-4783. [4] Ikeda Y. (1997) *Ant. Met. Res.* **10**, 13-40. [5] Mikouchi T. and Kurihara T. (2007) *Ant. Met.* **XXXI**, 52-53.
[6] Shih C-Y. et al. (1982) *GCA* **46**, 2323-2344. [7] Morikawa N. et al. (2001) *Ant. Met. Res.* **14**, 47-60. [8] Borg L. et al. (2004) *GCA* **66**, 2037-2053.[9] Misawa et al. (2008) *Polar Sci.* **2**, 163-174. [10] Shih C.-Y. et al. (2009) *LPSC* **XXXX** , CD-ROM #1360. [11] Nyquist L.E. et al. (2001) *Chronology and Evolution of Mars*, 96, 105-164. Kluwer Academic Publ. Dordrecht/ Boston/London. [12] Christian F. et al. (2005) *Ant. Met. Res.* **18**, 117-132. [13] Dreibus G. et al. (1992) *Meteoritics*, **27**, 216-217.
[14] Mikouchi T. et al. (2008) *LPSC* **XXXIX**, CD-ROM #2403.