U-Th-Pb, Sm-Nd, and Ar-Ar Isotopic Systematics of Lunar Meteorite Yamato-793169. Noriko Torigoye,[1] Keiji Misawa,[1*] G. Brent Dalrymple,[2] and Mitsunobu Tatsumoto[1]; [1] U.S. Geological Survey, MS 963, P. O. Box 25046, Denver, CO 80225. [2] U.S. Geological Survey, MS 937, 345 Middlefield Rd., Menlo Park, CA 94025

U-Th-Pb, Sm-Nd, and ^{40}Ar-^{39}Ar isotopic studies were performed on Yamato (Y)-793169, an unbrecciated diabasic lunar meteorite whose chemical composition is close to low Ti (LT) and very low-Ti (VLT) mare basalts [1]. The isotopic data indicate that the meteorite was formed earlier than 3.9 Ga from a source with low U/Pb and high Sm/Nd and was disturbed by a thermal event at 751 Ma. Due to the small sample size (104 mg), a plagioclase crystal and glass grains were handpicked for Ar analysis, leaving four fractions for the U-Th-Pb and Sm-Nd studies; a fine-grained fraction (<63 μm; Fine) and three medium-grained fractions (63-150 μm). Medium-grained fractions were divided by density; a heavy fraction (ρ>3.3) consisting mainly of pyroxene (PX1), a lighter fraction (ρ<2.8)) consisting of plagioclase (PL), and a middle density fraction (predominantly pyroxene; PX2). The fractions were washed with acetone and alcohol, and then leached in 0.01 HBr and 0.1N HBr in order to remove any terrestrial Pb contamination. Analysis of the HBr leaches revealed that this meteorite was heavily contaminated with terrestrial Pb during its residence in Antarctic ice.

The residues of leached PX1 and PL exhibited the most radiogenic Pb compositions ($^{206}Pb/^{204}Pb$ values up to 125). The Pb isotopic composition is less radiogenic compared to Apollo mare basalts, but similar to Luna 24170 VLT basalt [2]. The three most radiogenic residues indicate a Pb-Pb age of 3916 ± 90 Ma (Fig.1). The Sm-Nd data for the four fractions yield an internal isochron age of 3470 ± 180 Ma and an initial $^{143}Nd/^{144}Nd$ value of 0.50841 ± 29 (Fig. 2). The $^{40}Ar/^{39}Ar$ age spectrum (Fig.3) for plagioclase is typical of a system disturbed by shock-induced heating, wherein the apparent ages increase with increasing temperature, except during the last 3 increments. The high temperature fractions show ages between 3.9 and 4.3 Ga, but without a plateau. The total fusion age of the glass is 751 ± 4 Ma, which is close to the age obtained from the lowest temperature fraction of plagioclase. Although we cannot define the age of this diabase exactly, our preferred interpretation is that this lunar meteorite was formed earlier than 3.9 Ga and was disturbed by a thermal event at 751 Ma.

If the Sm-Nd age (3.47 ± 0.18 Ga) represents the crystallization age of this lunar meteorite, the age is comparable to ages between 3.3 and 3.6 Ga for most LT and VLT mare basalts. The old Pb-Pb age may be an artifact of terrestrial Pb contamination, still remaining in the residues. However, the apparent Ar-Ar ages from the high temperature fractions strongly indicate a formation age for this meteorite older than 3.9 Ga, so it is apparent that the Sm-Nd age was disturbed by the later thermal event. If this was the case, the formation age of this meteorite may be older than most LT and VLT basalt, and similar to the age obtained from another lunar VLT-like meteorite, Asuka 881757 [3]. By applying a Pb isotopic single-stage evolution model between 4.56 and 3.9 Ga to the data, the source $^{238}U/^{204}Pb$ (μ) value is estimated to be as low as 10. This value is also similar to that obtained from Asuka 881757 [3] and much lower than those obtained for many Apollo mare basalts. The ε_{Nd} value of 5.8 (T=3.47 Ga) for Y-793169 is higher than 3.2 (T=3.3 Ga) for lunar 24170 [4] but lower than 7.3 (T=3.87 Ga) for Asuka-881757 [3] suggesting that the source for Y-793169 is different from that for Asuka-881757 and Luna 24170 VLT basalt. The low μ and high ε_{Nd} values for Y-793169 suggest that the meteorite was derived from a source with low U/Pb and high Sm/Nd in the deep lunar mantle.

* Present address: National Institute of Polar Research, Tokyo 173, Japan.

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Fig.1a

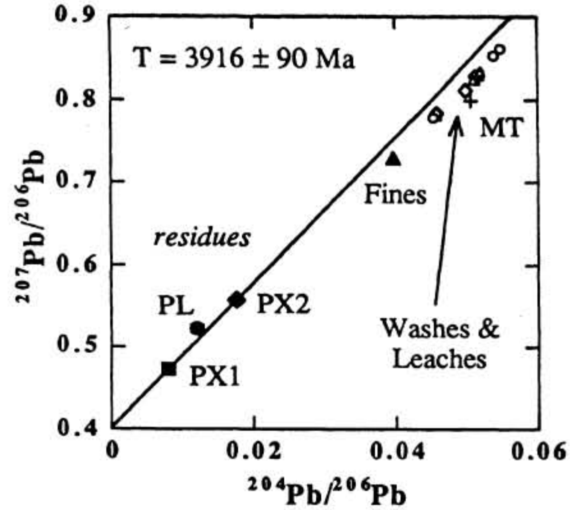
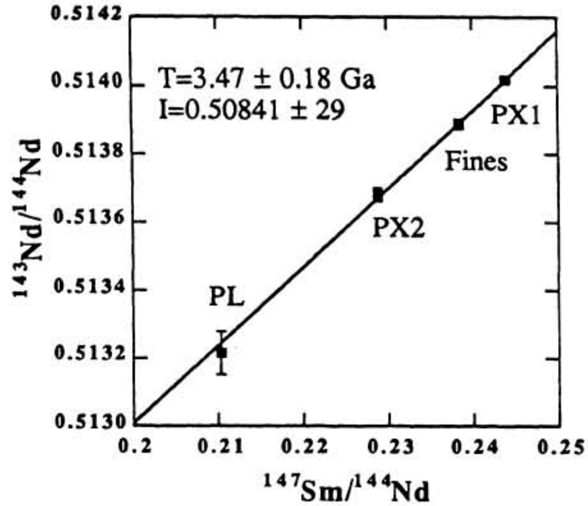


Fig.2



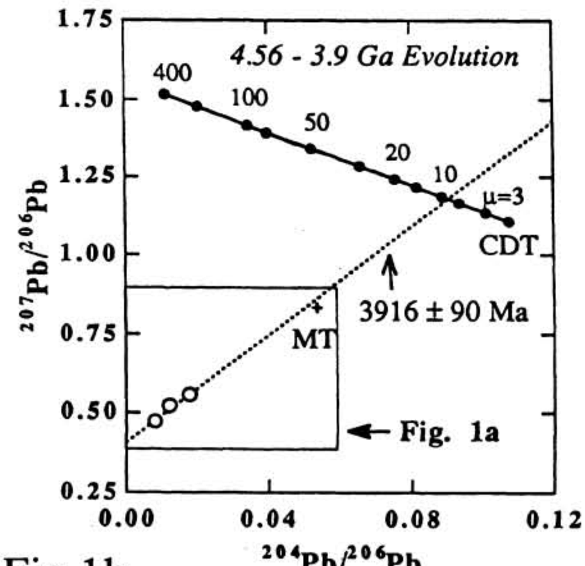


Fig.1b

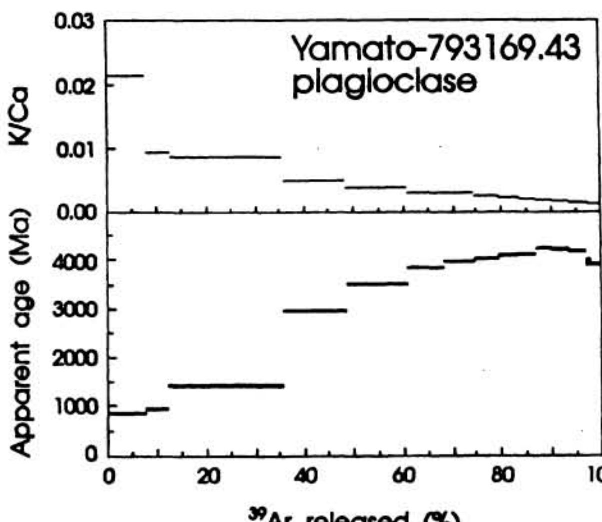


Fig.3

Fig.1(a) $^{204}Pb/^{206}Pb$ vs. $^{207}Pb/^{206}Pb$ diagram for Yamato 793169. The age is calculated from the line fit by three radiogenic residues (PX1, PX2, and PL). MT (+); modern terrestrial Pb. (b) A Pb isotopic evolution model for the source for Yamato 793169. The data indicate the source-μ value of 10. CDT; the Pb isotopic composition of Cañon Diabro troilite. Fig. 2. $^{147}Sm/^{144}Nd$ vs. $^{143}Nd/^{144}Nd$ diagram for the residues of Yamato 793169. Fig. 3. Ar-Ar age spectrum and K/Ca ratios for a plagioclase crystal (0.250mg) from Yamato 793169 were measured by laser incremental-heating. The total gas age is 3257 ± 8 Ma.