THE FIRST NAKHLITE FROM ANTARCTICA. N. Imae[1], R. Okazaki[2], H. Kojima[1], and K. Nagao[2]. [1]Antarctic Meteorite Research Center, National Institute of Polar Research, 9-10, Kaga 1-chome, Itabashi-ku, Tokyo 173-8515, Japan (imae@nipr.ac.jp), [2]Laboratory for Earthquake Chemistry, Graduate School of Science, Univ. of Tokyo, Bunkyo-ku, Tokyo 113-0033, Japan (okazaki@eqchem.s.u-tokyo.ac.jp).

Introduction: 27 meteorites from Mars have been identified adding of recent findings of 15 meteorites including paired specimen from hot deserts these five years. Most of these are classified to be shergottites, and nakhlites have been limited to be only four including one from a hot desert. Recent Japanese Antarctic Research Expedition (JARE) found the heaviest achondrite in Antarctica (Y000593) of 13.7 kg from the bare ice field around the Yamato Mountains [1]. The petrographical studies and noble gas analyses of the specimen (Y000593) and paired specimen (Y000749) assured that these are nakhlites coming from Mars, consisting with the recent classification [2]. The finding of nakhlites in Antarctica is for the first time and it suggests that the Yamato meteorite field potentially includes more unique meteorites. We describe the analytical results of the meteorite.

Field Occurrence: About 60 % of Y000593 is covered with black fusion crust, and the interior is greenish colored. Several days after the finding the quite similar specimen (Y000749 of 1.3 kg) was found. It is suggested that it is a paired specimen with Y000593. Two meteorites locate on a bare ice field of the north of JAREIV nunataks, and the area had insufficiently searched only by JARE-20. In the area, the heaviest meteorite in the Yamato bare ice field has been also found by the same expedition of JARE-41 [1].

Petrography and Mineralogy: A polished thin section (PTS) of Y000593 (area 47 mm^2) was studied by a polarizing microscope with transmitted and reflected light and an electron microprobe analyzer. The PTS shows that it mainly consists of coarse grained elongated shaped clinopyroxene, augite (~ 1 mm x 0.5 mm) mostly showing abundant polythinthetic twinning texture. As accessory minerals olivine with high fayalite content (Fa65 - 80) and minor amount of opaque mineral of oxide (magnetite with abundant Ti) with ~100 µm of grain size usually contact with silicates also occur. Mesostasis includes radial plagioclase crystals not transformed to maskelynite, and also abundant Ti rich small magnetite of ~ 10 µm. The morphological feature of constituting minerals is quite similar to Nakhla rather than other nakhlites (Lafaytte and Governador Valadares) at the first sight [2, 3]. Chemical compositions of pyroxne, olivine, plagioclase and Ti-rich magnetite are consistent with nakhlites (Fig. 1).

Noble Gases: Noble gas analysis was carried out using fragments of 0.2048 g chips from a paired sample (Y000749) judged from the field recognition and the petrographical features. In order to separate noble gas components, such as radiogenic, cosmogenic, and trapped ones, the sample was heated stepwise at 400, 600, 800, 1000, 1300, and 1750°C in a Mo crucible. Evolved gases were purified with two Ti-Zr and two Zr-Al getters and were measured separately as four fractions (1: He-Ne, 2: Ar, 3: Kr, 4: Xe) with a modified VG-5400 mass spectrometer (MS-II) at the Lab. for Earthquake Chemistry, Univ. of Tokyo [4].

Isotopic ratios of $^{40}Ar/^{36}Ar_{cos\text{-}corr.}$ (corrected for cosmogenic contribution) at 1300 and 1750 °C were 4918 and 569, respectively. The high-temperature-released Ar could be a trapped component because radiogenic ^{40}Ar would be released at lower temperature (<1000 °C) from a K-rich phase such as feldspar. High $^{129}Xe/^{132}Xe$ ratios were also observed in the 1300 and 1750 °C fractions. The high $^{40}Ar/^{36}Ar$ and $^{129}Xe/^{132}Xe$ ratios are characteristic of Martian atmosphere [5]. Elemental ratios of $^{36}Ar/^{84}Kr/^{132}Xe$ are also indicative of Martian origin. In a system of $^{129}Xe/^{132}Xe$ and $^{84}Kr/^{132}Xe$ ratios (Fig. 2), the 1300 °C fraction of Y000749 plot on a mixing line between Chassigny and iddingsite in Nakhla.

Cosmic-ray-exposure (CRE) ages based on cosmogenic ^{3}He (20.9 x10^{-8} cm^3 STP/g), ^{21}Ne (2.15 x10^{-8} cm^3 STP/g), and ^{38}Ar (1.71 x10^{-8} cm^3 STP/g) are T_3=13.1, T_{21}=11.3, and T_{38}=8.7 Ma, respectively. The T_{21} is within a range of CRE ages reported previously for nakhlites [6]. The variation among T_3, T_{21}, and T_{38} would result from uncertainties of production rates, calculated based on an equation in [7] using averaged chemistry of Nakhla and Lafayette [8] and cosmogenic $^{21}Ne/^{22}Ne$ (0.8394) determined at 1300 °C.

Generally, young K-Ar ages are also characteristic of Martian meteorites. Using ^{40}Ar concentrations determined at 400-1000 °C and an averaged K content (750 ppm) of Nakhla and Lafayette [8], we obtained 2.0 Ga of a K-Ar age for Y000749, which is consistent with Ar-Ar ages (about 1.3 Ga) reported for other nakhlites [9, 10].

Conclusion: Our mineralogical-petrographical and noble gas studies strongly suggest that Y000593 and the paired specimen Y000749 are a Martian meteorite subclassified into nakhlites.

References: [1] Imae N. et al. (2002) *Antarct. Meteorite Res.*, **15** (in press). [2] Kojima H. (2001) *Meteorite Newsletter* **10**, No. 2 (in press). [3] Meyer C. (1998) Mars Meteorite Compendium - 1998. [4] Nagao K. et al. (1999) *Antarct. Meteorite Res.* **12**, 81-93. [5] Pepin R. O. (1991) *Icarus* **92**, 2-79. [6] Eugster O. et al. (1997) *GCA* **61**, 2749-2757. [7] Eugster O. & Michel T. (1995) *GCA* **59**, 177-199. [8] Lodders K. (1998) *Meteoritics & Planet. Sci.* **33**, A183-A190, and references therein. [9] Podosek F. A. (1973) *EPSL* **19**, 135-144. [10] Bogard D. D. & Husain L. (1977) *Geophys. Res. Lett.* **4**, 49-71. [11] Drake M. J. et al. (1994) *Meteoritics* **29**, 854-859, and references therein. [12] Miura Y. N. et al. (1995) *GCA* **59**, 2105-2113.

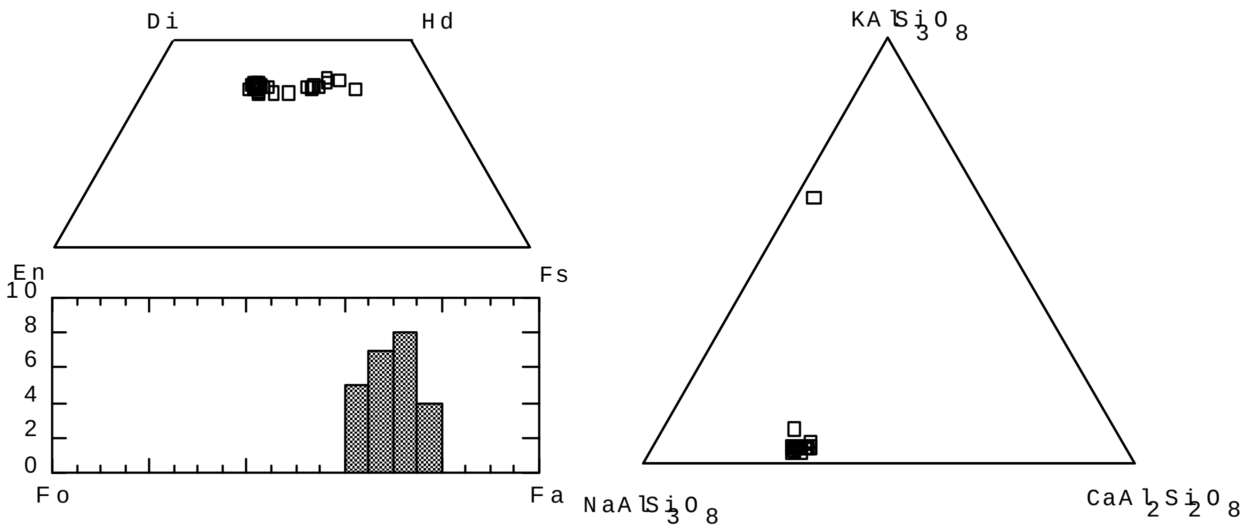

Fig. 1: Chemical compositions of pyroxene, olivine, and feldspar of Y000593.

Fig. 2: Correlation between $^{84}Kr/^{132}Xe$ and $^{129}Xe/^{132}Xe$. Stepwise heating data indicates that Y000749 is potentially a nakhla-type Martian meteorite. Data sources are from [11, 12].