NAGARA: A NEW JAPANESE IAB IRON METEORITE FIND.

T. Mikouchi[1], A. Yamaguchi[2], N. Shirai[3], J. Isa[4], M. Komatsu[5], S. Kawakami[6], N. Katsuta[7], T. Kawamata[8], K. Sugiyama[8], [1]University Museum, University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan (E-mail: mikouchi@um.u-tokyo.ac.jp), [2]National Inst. Polar Res. (NIPR), Midori-cho, Tachikawa, Tokyo 190-8518, Japan, [3]Dept. of Chemistry, Tokyo Metropolitan University, Minami-Osawa, Hachioji, Tokyo 192-0397, Japan, [4] University of Grenoble Alpes, CNRS, IPAG, 38000 Grenoble, France, [5]The Graduate University for Advanced Studies (SOKENDAI), Hayama, Kanagawa 240-0193, Japan, [6]Faculty of Education, Gifu Shotoku Gakuen University, Gifu, Gifu 501-6194, Japan, [7]Faculty of Education, Gifu University, Gifu, Gifu 501-1193, Japan, [8]Inst. Materials Res., Tohoku University, Katahira, Sendai, Miyagi 980-8577, Japan.

Introduction: Nagara is the newest Japanese iron meteorite found in Nagara, Gifu, Japan. A 6.5 kg piece was first found in 2012 and classified as a IAB iron meteorite in 2018 [1]. Then, the second piece (9.7 kg) was recognized to have been found ~300 m from the discovery site of the first sample and considered to be paired. In this abstract we report mineralogy and geochemistry of this IAB iron meteorite and compare this iron with other known IABs.

Macroscopic Description: Both samples show exterior with rounded ridges and the dark brownish surface is mostly coated by rust. Rare black fusion crust is preserved. The cut surfaces after etching exhibit a granular texture (~1 cm in grain size) and no typical Widmanstätten patterns are observed (Fig. 1). Small patches of silicate inclusions are present in the first sample (Fig. 1), but such inclusions were absent in the second one (~10 x 10 cm etched surface), probably due to sample heterogeneity (~tens of cm scale).

Mineralogy and Petrology: >95% of the polished sections (both samples) consist of kamacite with veins of terrestrial weathering products (~0.5 mm wide). Therefore, the granular texture of the etched surface is due to different orientations of kamacite grains (Fig. 1). The kamacite composition determined by electron microprobe (JEOL JXA-8530F @Univ. of Tokyo) shows a small variation (Fe=92.0-94.5, Ni=5.5-6.5 and Co=0.55-0.65, all in wt%) mainly due to atomic diffusion towards the interface to the schreibersite grains (Fe=45-54, Ni=30-38 and P=15, all in wt%) that are present at the center of weathered veins. Taenite is present as small elongated grains (~0.1 mm wide and ~0.5 mm long) with less than 0.1% abundance (Fe=61-65, Ni=34-39 and Co=0.1-0.2, all in wt%).

Silicate inclusions are up to 1 mm in size and consist of olivine (Fo_{95}, Molar Fe/Mn=12), orthopyroxene ($En_{93-91}Wo_{1-2}$, Al_2O_3=0.3, TiO_2=0.2, Cr_2O_3=0.3, all in wt%), augite ($En_{53-54}Wo_{44}$, Al_2O_3=0.8, TiO_2=0.7, Cr_2O_3=1.1, all in wt%) and plagioclase ($An_{16}Or_3$). These mineral compositions are close to those in other silicate-bearing IAB irons [2]. Two pyroxene thermometers gave 940-960 °C for equilibration temperature.

Trace Element Abundance: LA-ICP-MS analysis (average of 4 traverses (~5 mm long) on the section of the first sample by Thermo Element XR + CETAC LSX-213 @NIPR using Hoba and North Chile as standards) gave 6.10 wt% Ni, consistent with the electron microprobe analysis. The obtained trace element contents are Ge=402, Ga=91.4, As=11.2, Cr=4.53, Ir=4.24, Au=1.58, and W=1.43 (all μg/g), classifying Nagara as a IAB main group (MG) iron meteorite [3]. Although no LA-ICP-MS analysis has been done for the second piece, its high Ge content (~400 ppm) detected by electron microprobe analysis and their identical mineralogy suggest that they are likely paired.

Comparison with Other IABs: Among known IAB-MG samples, the trace element contents of Nagara are most similar to those of Yardea, Soledade, Duel Hill (1873) and Campo del Cielo [3] except for lower Cr content of Nagara. The ~1 cm granular texture of Nagara is especially similar to some samples of Campo del Cielo [2] although textures of Yardea, Soledade, and Duel Hill (1873) are not known in the literatures. These textural and geochemical similarities may suggest that Nagara and Campo del Cielo originated from the same region in the IAB-MG parent body [4,5].

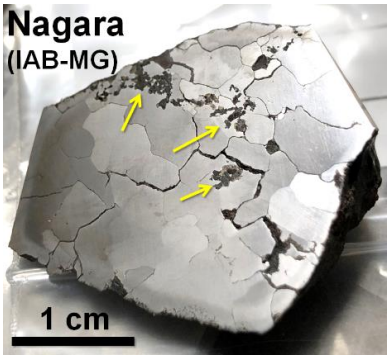

Fig. 1. The etched surface of Nagara (first sample), showing a ~1cm granular texture. Silicate inclusions are scattered on the surface (indicated by yellow arrows).

Pairing with Sakauchi?: In Gifu prefecture, there is one iron meteorite known (Sakauchi: 4.18 kg) whose recovery site is *ca*. 40 km from Nagara [6]. However, there is no detailed description of Sakauchi since it was found more than 100 years ago and the sample has been later lost. Because Sakauchi is reported to be hexahedrite, we cannot rule out their pairing.

References: [1] https://www.lpi.usra.edu/meteor/metbull.php?code=66476. [2] Ruzicka A. (2014) *Chemie der Erde* 74:3-48. [3] Wasson J. T. and Kallemeyn G. W. (2002) *Geochimica et Cosmochimica Acta* 66:2445-2473. [4] Worsham E. A. et al. (2017) *Earth and Planetary Science Letters* 467:157-166. [5] Hunt A. C. et al. (2018) *Earth and Planetary Science Letters* 482:490-500. [6] https://www.lpi.usra.edu/meteor/metbull.php?code=23103.