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COLLECTION OF YAMATO METEORITES BY THE 35TH JAPANESE ANTARCTIC RESEARCH EXPEDITION

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Abstract: The 35th Japanese Antarctic Research Expedition found 9 ordinary chondrites and 7 fragments around Camp 1 (latitude 71°32'49"S, longitude 35°24'07"E) located 5 km westward from Massif C in the Yamato Mountains. In this area meteorites have not been collected previously. Meteorite surveys were also carried out along the route of the Camp migrations and around the Camp 3, although no meteorites were found. The chondrites examined microscopically may be classified into either H4 or H6 categories. The biggest chondrite (Yamato-9403) which is classified as H6 was examined magnetically.

1. Introduction

The Yamato Mountains are situated 300 km south from Syowa Station, Lützow-Holm Bay, East Antarctica. They range 80 km from north to south and rock exposures are identified as Massifs A, B, C, D, E, F and G segmented by the glaciers streaming from east to west. The area of the bear ice field surrounding the mountains covers more than 4000 m^2 with the altitude of 1600–1800 m, and it has long been known for their meteorite concentrations, *i.e.*, YANAI (1976), MATSUMOTO (1978). About 6000 meteorites have been discovered up to now on the Yamato bare ice field by the Japanese Antarctic Research Expedition (JARE).

Four members of JARE-35 visited the Yamato Mountains for paleomagnetic sampling from December 11 to December 24, 1994. As members and cargo (1600 kg) were transferred by 2 small aircraft (Cessna, and Pilatus Porter) from Syowa Station to the mountains. The field program was done on foot in moving from camp to camp. Two Nansen sledges (3 m in length) were each pulled by two members of the field party. During the first half (from December 11 to 17) of the field schedule, it was fine weather but the winds were strong (8–30 m/s), while the latter half (from December 18 to 23) was predominantly cloudy with occasional snow and calm winds. As snow accumulated about 2 cm on the bare ice field on December 18 and 19, conditions for meteorite searching were almost impossible. Temperature was relatively mild from –8 to –17°C throughout the duration of the field program.

2. The Meteorite Search

A search for meteorites was carried out with the naked eye along the routes from

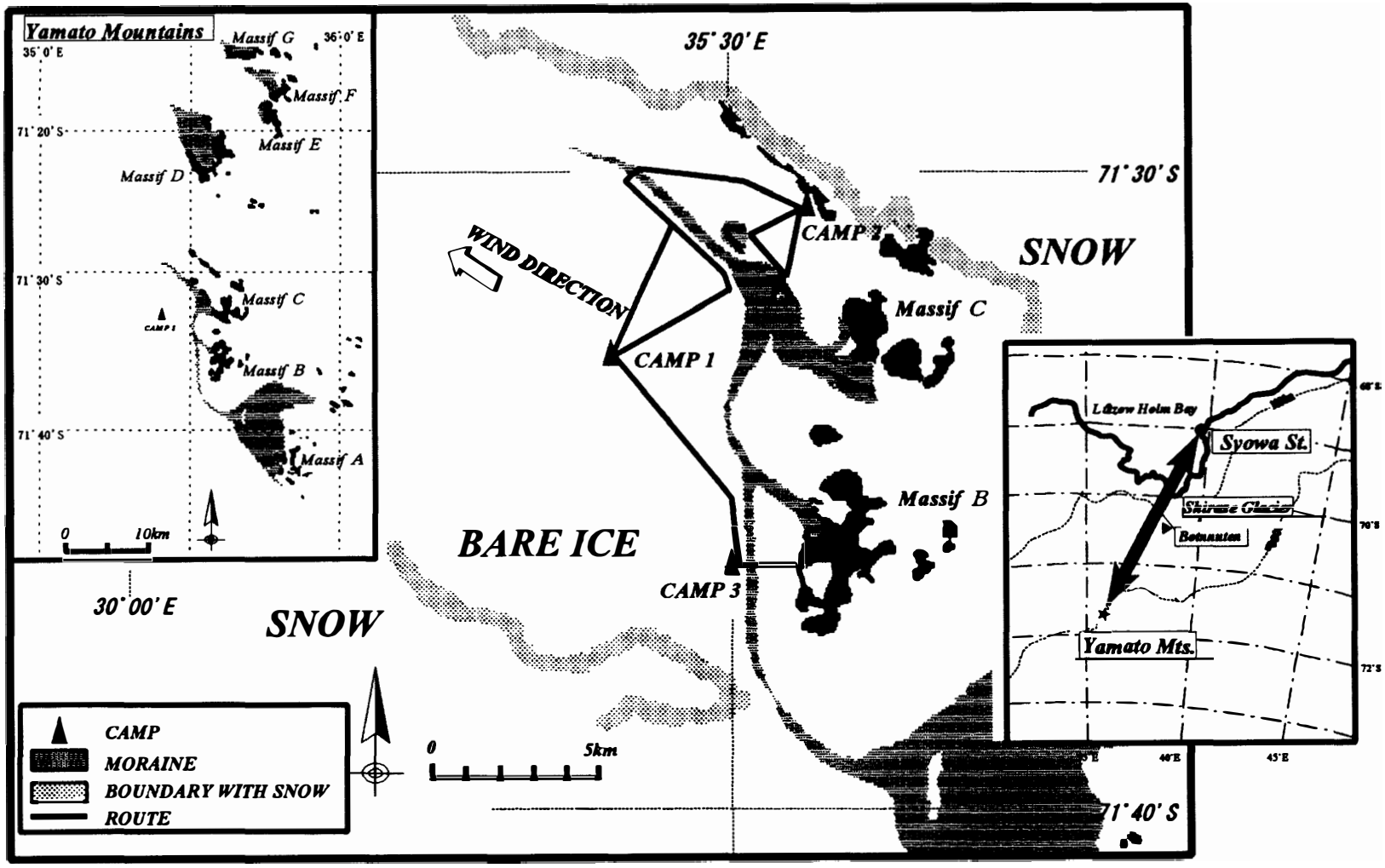

Fig. 1. Maps of the Yamato Mountains and activity area for search meteorites.

Camp 1 to 2, Camp 1 to 3 and around Camps 1 and 3 (Fig. 1). On returning from Camp 2 and 3 to the Camp 1, the routes were shifted 10 m to 100 m to allow more coverage for meteorites search. Two sledges side by side with 10 to 30 m separation were drawn by 2 people (without any snow vehicles). Within 10 m from both sides of the routes might be surveyed. A total track 30 km in distance was surveyed for meteorites. Westward of Camp 3 was also surveyed but it was impossible due to snow accumulation. Smaller pebbles less than 2 cm disappeared in the accumulation. When we returned to Camp 1 from Camp 3, the accumulation had diminished to about 1 cm. Detailed survey was carried out around the Camp 1, especially within 2 km from north to west. As every survey area was located leeward from a moraine belt and the mountains, innumerable small terrestrial pebbles from 1 to 3 cm in diameter were scattered on the ice field. If dark colored pebbles were found, they were picked up in order to confirm identification. No obvious crevasses are found in blue ice field along the survey routes.

3. Results and Discussions

A total of 16 ordinary chondrites were found in the vicinity of Camp 1 (latitude 71°32'49"S, longitude 35°24'07"E) where no meteorites were found previously (YANAI, 1983). The meteorites Yamato-9401, -9405 and -9416 were found about 300 m SW from the Camp 1 and -9403 was found 2 km NNW of Camp 1. All other meteorites were found within 1 km of Camp 1. No meteorites were found in the other survey areas, as

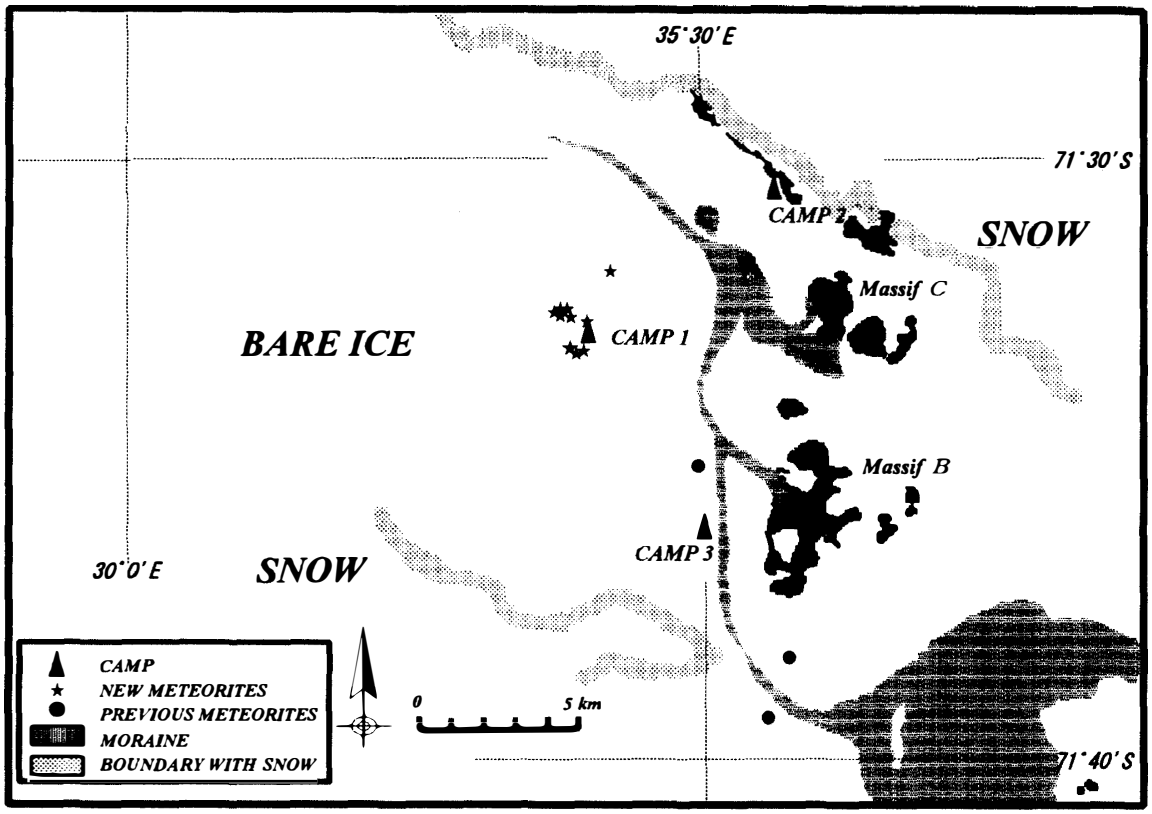

Fig. 2. Meteorite finding locations by JARE-35.

Table 1. Yamato meteorites collected by JARE-35.

Sample No.	Field No.	Dimension (cm)	Weight (g)	Type	Remarks
Yamato-9401	94121901	3.3×2.8×2.6	42.966	H4	Fusion crust
Yamato-9402	94122301	2.6×1.9×1.6	13.89	H4	Fusion crust
Yamato-9403	94122302-1	6.3×5.5×4.3	263.13	H6	Same chondrite
Yamato-9404	94122302-2	3.0×2.8×1.1	6.75	H6	Fusion crust
Yamato-9405	94122303	2.5×1.7×0.9	4.83	H4 or L4	
Yamato-9406	94122304	1.4×1.3×0.9	2.546	H6	
Yamato-9407	94122305-1	2.0×2.0×1.8	9.155	H4	Same chondrite
Yamato-9408	94122305-2	2.2×1.7×1.1	6.99	H4	
Yamato-9409	94122305-3	1.9×1.6×0.8	2.886	H4	
Yamato-9410	941223a-1	1.4×0.9×0.8	1.534		Same chondrite
Yamato-9411	941223a-2	1.8×0.9×1.0	1.84		
Yamato-9412	941223a-3	1.3×0.9×0.9	1.833		
Yamato-9413	941223a-4	1.2×0.9×0.5	0.843		
Yamato-9414	941223b-1	1.9×1.4×0.9	2.939		Same chondrite
Yamato-9415	941223b-2	1.3×0.8×0.6	0.749		
Yamato-9416	94122401	2.0×1.2×0.9	2.903		

shown in Fig. 2. Three chondrites were larger than 10 g in weight (Yamato-9403: 263.13 g, -9401: 42.966 g, -9402: 13.89 g), while 13 chondrites were less than 10 g, as indicated in Table 1 and shown in Fig. 3. The latter 13 chondrites seem to be fragments of several different falls. Yamato-9403 and -9404 may be the same meteorite, because they were found 5 cm apart and showed color and feature resemblance. The groups Yamato-9407 to -9409, -9410 to -9413, and -9414 to -9415 may also be matched respectively due to the same similarity reasons. Fusion crust was recognized on the surface of Yamato-9401, -9402, and -9405, but it was removed completely from the surface of other chondrites. Every chondrite suffered heavy weathering, being inferred from the dark-brown color.

Preliminary microscopical classification was carried out by the Meteorite Division in NIPR (private communication with H. KOJIMA) for the samples from Yamato-9401 to -9409, although the samples from Yamato-9410 to -9416 have not yet been analyzed. The results indicated that Yamato-9401, -9402, -9407, -9408 and -9409 are classified as H4 and Yamato-9403, -9404 and -9406 are classified as H6, while Yamato-9405 is either H4 or L4 pending more detailed analysis.

Yamato-9403 was examined magnetically in order to confirm a magnetic-petrologic classification. Thermomagnetic (*Js-T*) curves were obtained under the condition of 10^{-3} Pa in atmospheric pressure, 1.0 *T* in external steady magnetic field, and 300°C/h in heating and cooling rates. The 1st run cycle curve indicated irreversible curves (Fig. 4) with Curie point at 530°C and 705°C in the heating curves and 590°C and 525°C in the cooling curve. The original magnetization 20.8 Am^2/kg increased to 25.9 Am^2/kg after heating up to 750°C. The Curie point at 530°C and 525°C is probably a Curie point of taenite (γ phase) with 53 wt% of nickel content. Coercive force (H_C) and remanent coercive force (H_{RC}) of this sample are obtained as H_C= 43 mT, H_{RC}=173 mT for the original

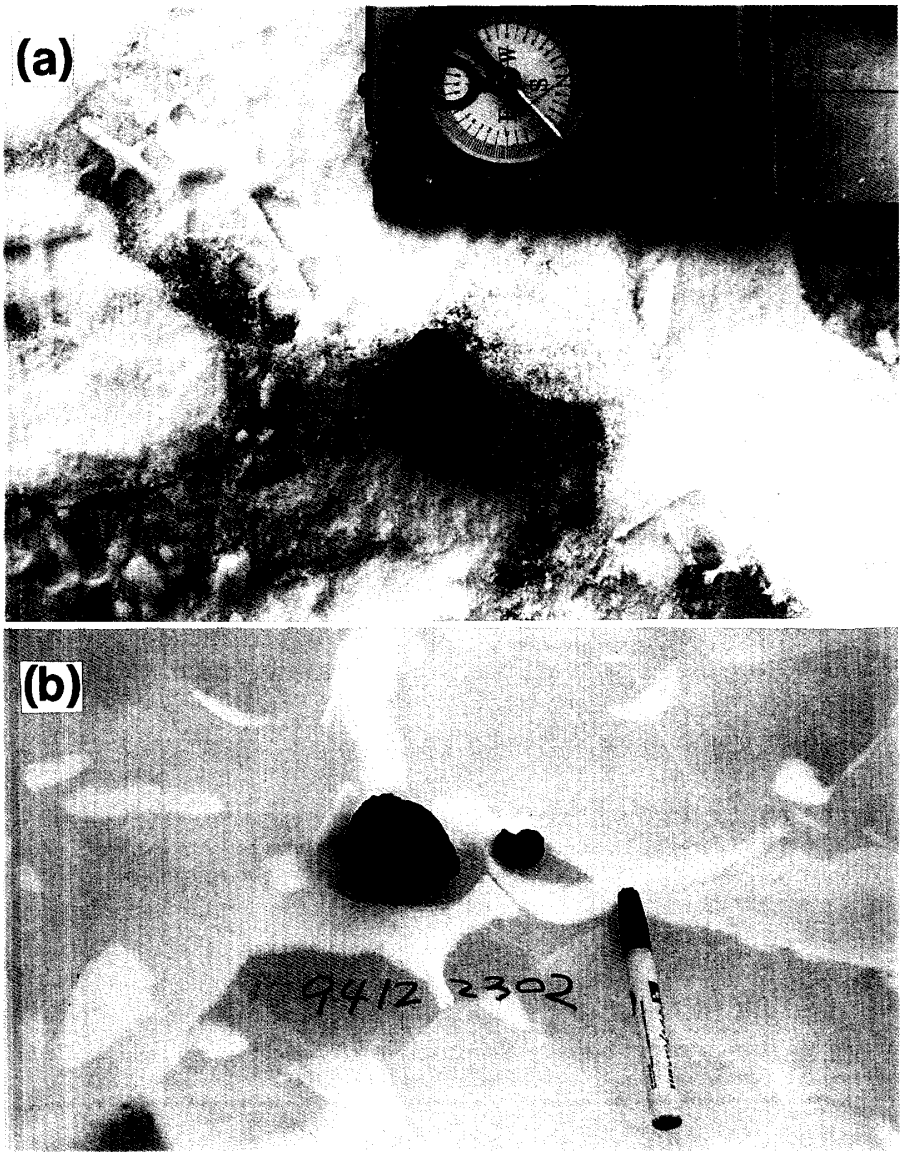

Fig. 3. Representative 3 meteorites collected by JARE-35. (a) Yamato-9401, (b) Yamato-9403 (left) and Yamato-9404 (right).

sample and H_C=90 mT, H_{RC}=326 mT after heating. These small H_C and H_{RC} values may suggest absence of tetrataenite.

NAGATA (1979) reported consistent classification for stony meteorites with mineralogical and magnetic methods, as shown in Fig. 5. Since the original $Is(\alpha)$ value of the α phase is roughly estimated to be 19.6 Am^2/kg at 30°C as shown dotted line in Fig. 4, the ratio $Is(\alpha)/Is$ is 94%. When the Is and $Is(\alpha)/Is$ values are plotted on the Fig. 5, the location in the domain of the L group near the boundary of the H group, suggesting contradiction with mineralogical classification. However, the samples are extensively oxidized by weathering, and consequently metallic iron grains can be easily oxidized to goethite (FeOOH) or hematite (Fe_2O_3). If increased magnetization at 30°C in the cooling curve is explained resulting from reduction of those minerals during heating treat-

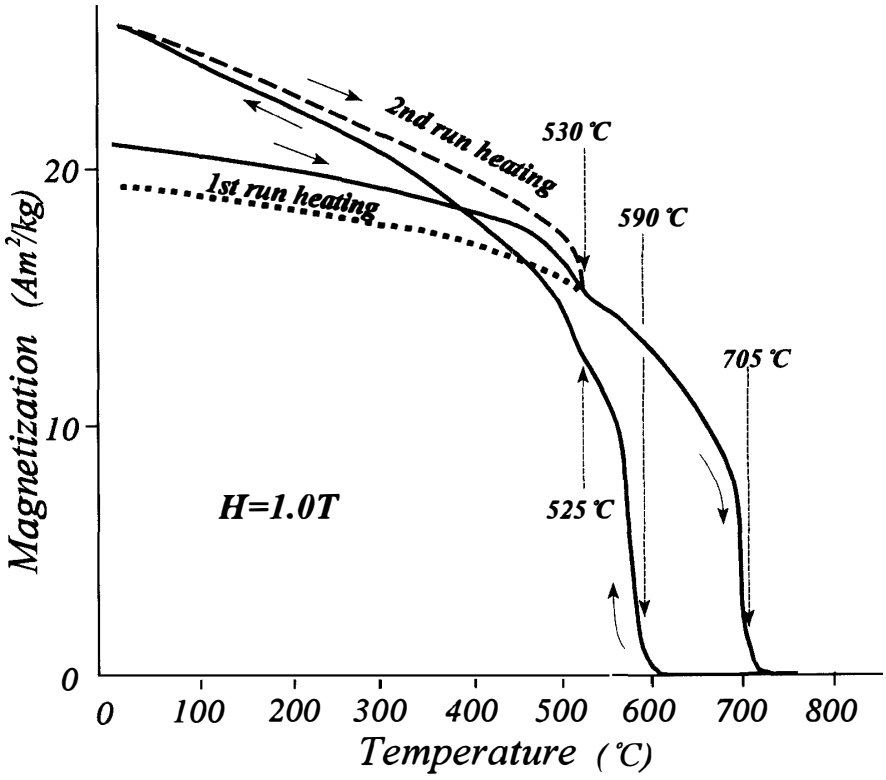

Fig. 4. The Js-T curves of Yamato-9403. External steady magnetic field: 1.0 T. Solid curves: 1st run Js-T curve, broken curve: 2nd run heating curve, dotted curves: roughly estimated Js-T curve of kamacite phase.

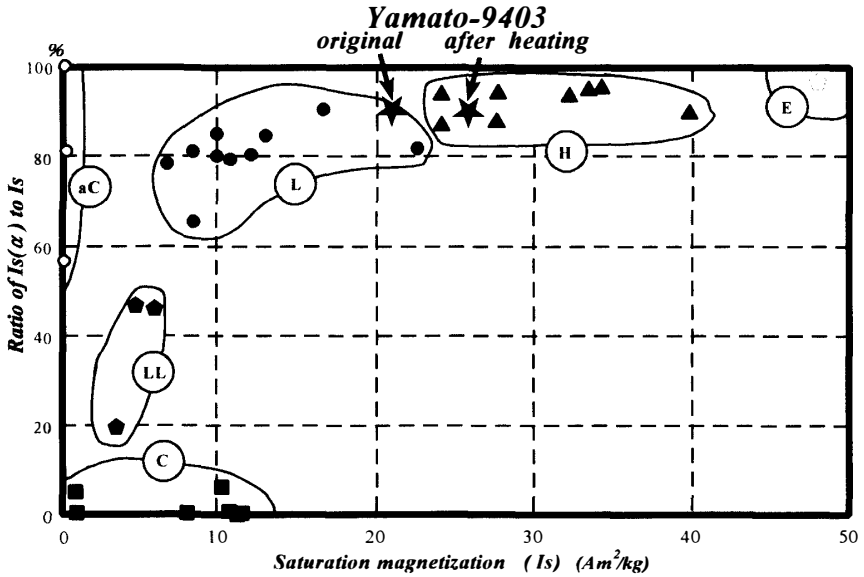

Fig. 5. Classification of Yamato-9403 chondrite by magnetic method proposed by NAGATA (1979).

ment in the vacuumed condition, the Is =25.9 Am^2/kg in the cooling curve is much close to the intrinsic Js value of this chondrite. From these viewpoints, significant classification by magnetic method may be revised to H group, as shown in Fig. 5.

4. Concluding Remarks

JARE-35 collected 9 chondrites and 7 fragments (catalog number: Yamato-9401 to Yamato-9416) on bare ice field around latitude 71°32'49"S, longitude 35°24'07"E, westward 5 km of Massif C in the Yamato Mountains. Three pieces are larger than 10 g (maximum 263 g) but the other 13 are less than 10 g in weight. Classification was carried out by microscope for 9 chondrites (Yamato-9401 to -9409) and by magnetic method for -9403. The results showed that they are H4 for 5 samples (-9401, -9402, -9407, -9408 and -9409) and H6 for 3 samples (-9403, -9404 and -9406), while -9405 is either H4 or L4. The main magnetic minerals in Yamato-9403 are identified to kamacite with 5 wt% Ni and taenite with 53 wt% Ni.

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