FIRST METEORITES FOUND IN VICTORIA LAND, ANTARCTICA, DECEMBER 1976 AND JANUARY 1977
—Report of the U. S.-Japan Joint Program Titled "Antarctic Search for Meteorites" 1976–1977—

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Abstract: Eleven new meteorites were recovered from the bare ice surface of South Victoria Land in Antarctica, during the period from December 15, 1976 to January 20, 1977, by a U. S.-Japan joint party of "Antarctic Search for Meteorites". Two of the specimens were found on the Mt. Baldr Glacier of the upper Wright Valley, Dry Valleys, and nine were collected from the plateau side of Allan Nunatak 100 km north of Mt. Baldr. These meteorites were named Mt. Baldr and Allan Nunatak meteorites respectively and were designated as Mt. Baldr No. 1 and No. 2, and Allan Nunatak No. 1 to No. 9 in order of discovery. They amounted to about 460 kg in total weight. Allan Nunatak No. 9, 407 kg in weight, is the largest meteorite ever found in Antarctica. Preliminary classification revealed that one specimen is an iron meteorite, one is an achondrite and the other nine are chondrites belonging to various petrological types. Some details of the field work and collection are described, suggesting possible discovery of more meteorites in these areas.

1. Introduction

A U. S.-Japan joint program titled "Antarctic Search for Meteorites" was initiated as a direct result of meteorite discoveries in Antarctica in 1969, 1973, 1974 and 1975 by Japanese parties (YOSHIDA *et al.*, 1971; SHIRAISHI *et al.*, 1976; YANAI, 1976; MATSUMOTO, 1977). K. YANAI had participated in the Japanese party in 1974 and collected 663 pieces of meteorites from the bare ice field around the Yamato Mountains in East Antarctica. The U.S. participants in this program were W. A. CASSIDY, Associate Professor of Department of Earth and Planetary Sciences, University of Pittsburgh and E. J. OLSEN, Chairman of Department of Geology, the Field Museum of Natural History, Chicago.

The members of this joint program searched for meteorites in selected bare ice fields near the Dry Valleys in South Victoria Land from early December 1976 to the end of January 1977.

Two new meteorite specimens were found on the surface of the 8 square km bare ice field west of Mt. Baldr, upper Wright Valley, on December 15, 1976.

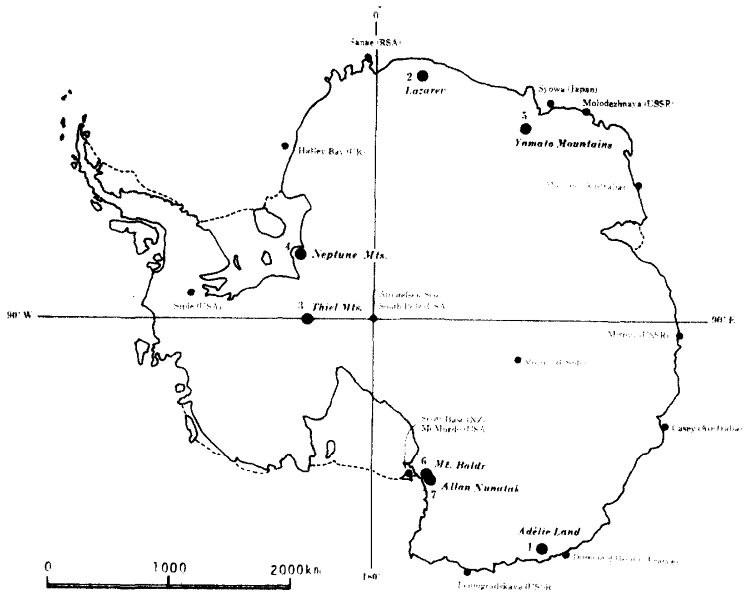

Fig. 1. The locations of meteorites collected in the Antarctic Continent (After BAYLY, *1923;* FORD, *1971;* HEY, *1966;* YANAI, *1976)*

They were named Mt. Baldr meteorites after the nearby mountain and were designated as Mt. Baldr No. 1 and No. 2 in order of discovery. The find is the first record in South Victoria Land and is the sixth such locality in the Antarctic Continent.

Nine new specimens were collected from the bare ice area on the plateau side of Allan Nunatak, 100 km north of Mt. Baldr, on January 18 and 20, 1977. These were named Allan Nunatak meteorite and designated as Allan Nunatak No. 1 to No. 9 in order of discovery. The find is the seventh in Antarctica. Allan Nunatak No. 9, of 407 kg weight, is the largest meteorite from Antarctica and also one of the largest stone meteorites in the world.

Preliminary analysis revealed that Allan Nunatak No. 2 is an iron meteorite, No. 5 is an achondrite and the rest are all ordinary chondrites of various petrological types.

The locations of meteorites collected in the Antarctic Continent are shown in Fig. 1.

2. Searching for Meteorites in South Victoria Land

This search for meteorites was started on the basis of the past experiences of collecting meteorites in Antarctica by Japanese parties. First of all, sites for the search were selected in bare ice areas at the following localities; (1) Wright Upper Glacier (its terminal area), (2) north of Mt. Fleming, (3) west of Mt. Baldr

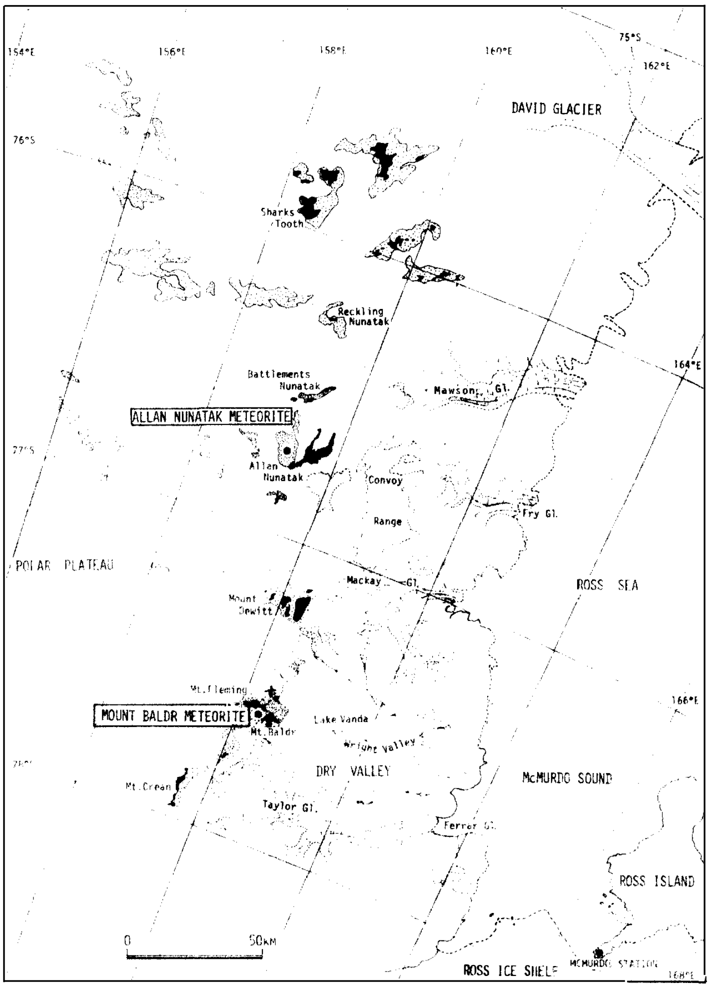

Fig. 2. The locations of meteorites collected in South Victoria Land and the searched areas.

(Mt. Baldr Glacier), (4) north of Horseshoe Mountain, (5) upper part of the Taylor Glacier, (6) east of Mt. Crean, (7) south of Mistake Peak, (8) north of Shapeless Mountain, (9) around Mt. DeWitt, Mt. Littlepage and Robinson Peak, (10) east of Carapace Nunatak and (11) plateau side of Allan Nunatak (see Fig. 2).

2.1. Search in the Wright Upper Glacier

The searching party camped near the terminal moraine of the Wright Upper Glacier by YANAI using binoculars. This meteorite was lying on the bottom of the party searched bare ice areas along the margin of the polar ice plateau by helicopter, and a stone meteorite was found on the bare ice surface of the Mt. Baldr Glacier by YANAI, using binoculars. This meteorite was lying on the bottom of a hollow of bare ice and was partly broken (see Fig. 12a). In the same bare ice field 700 m apart from the first locality, another meteorite was found also by YANAI. This specimen is also a stone meteorite 2–3 times larger than the first one in weight, almost entirely covered with fusion crust. These specimens were

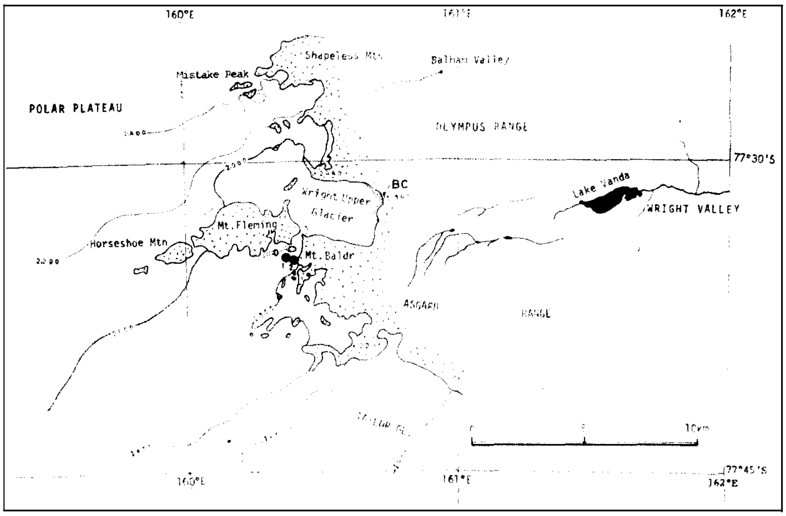

Fig. 3. The locations of Mt. Baldr meteorites and the searched areas near the Dry Valleys.

named Mt. Baldr No. 1 and No. 2 meteorites.

The Wright Upper Glacier is fed by two icefalls: namely, the Airdevronsix Icefall and the Baldr Icefall, consisting of bare ice without snow cover (Fig. 4 and Fig. 5). The glacier ice contains terrestrial rock fragments which make up the terminal moraine. The rocks are mainly Beacon sandstone and Ferrar dolerite from adjacent rocky areas, and range from blocks of a few tens of tons of fragments a few grams in weight (see Fig. 6). These rocks lie on the surface of the bare ice, or half buried in ice, some of them are almost entirely buried. The ice mass where it contacts rock often melts in the summer season.

The party searched on foot along routes having a total length of 70 km on the bare ice and moraines, but no meteorite was found there. This fact does not necessarily deny the possibility of the existence of meteorites, because searching on foot is limited to a very narrow band of looking for meteorites. Besides, it is very difficult to distinguish between meteorites and Ferrar dolerite because of their similar appearances. Also, it is almost impossible to find meteorites in a moraine area.

2.2. *Search on the Mt. Baldr Glacier*

Two meteorites had been found in this area, as stated before. Later the party pitched camp on the bare ice in the central part of the Mt. Baldr Glacier from December 19 to 22, and made a careful search for meteorites in this 8 square km bare ice field on foot, under severe climatic conditions of $-15°C$ and strong wind. But the party found no meteorites or even their fragments. Pieces of Ferrar dolerite are distributed on the surface of the bare ice looking very similar to meteorites, and since the discrimination between the two is hardly possible in this area, the party examined all materials that lay on the bare ice.

The glaciological features of ice of the Mt. Baldr Glacier are different from

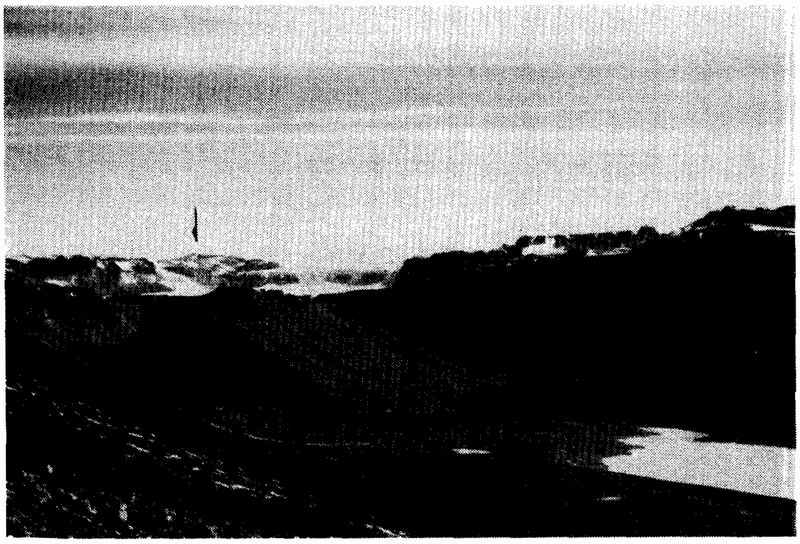

Fig. 4. Wright Valley and Wright Upper Glacier. Smaller icefall on the left is Baldr Icefall. Airdevronsix Icefall in the center. Arrow indicates Mt. Fleming.

Fig. 5. Geomorphological features of the extremity of the Wright Upper Glacier, about 1,000 m in altitude, and of the Wright Valley. Campsite is shown by arrow.

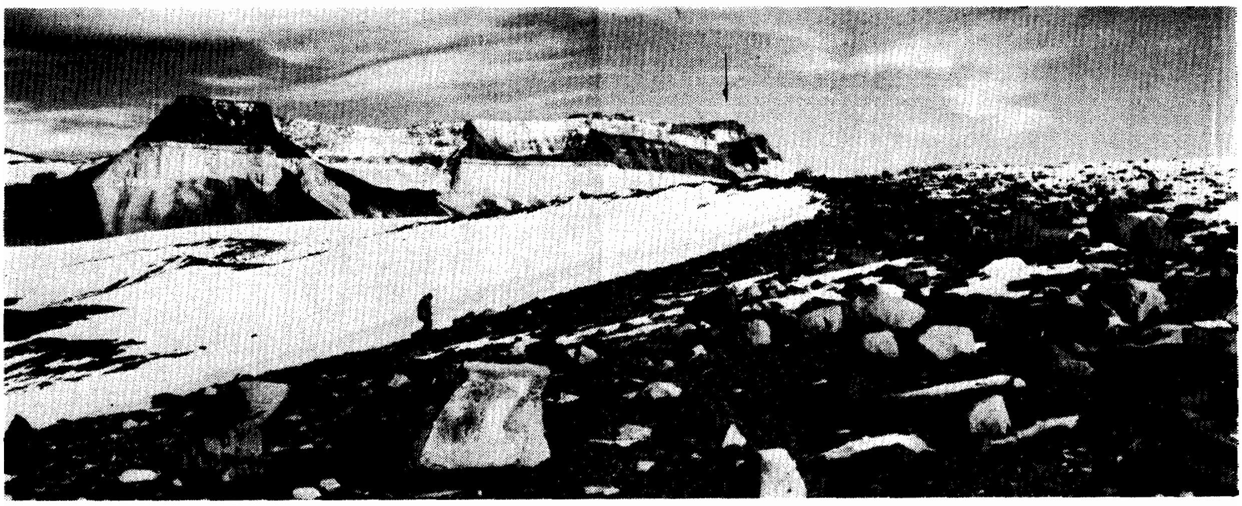

Fig. 6. Terminal moraine of the Wright Upper Glacier. The moraine consists mainly of Ferrar dolerite (black) and Beacon sandstone (white). Arrow: Mt. Baldr.

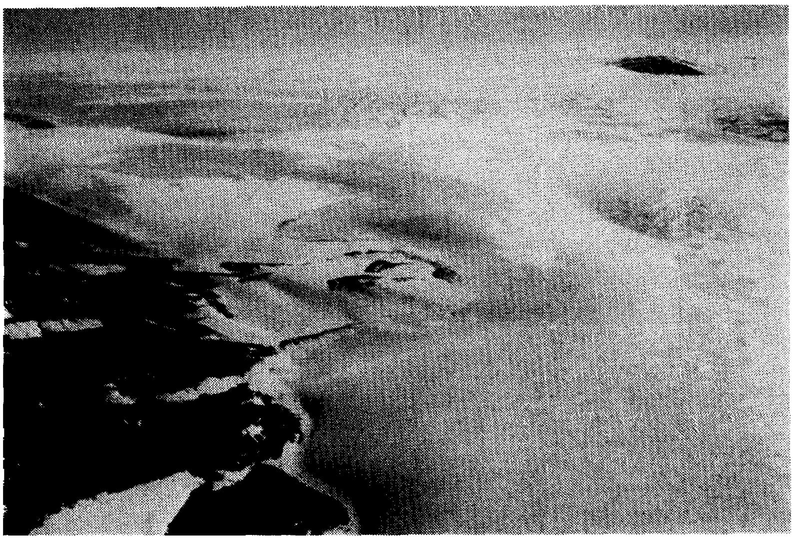

Fig. 7. Appearance of bare ice northwest of Mt. Fleming. Bare ice is about 500 m in width.

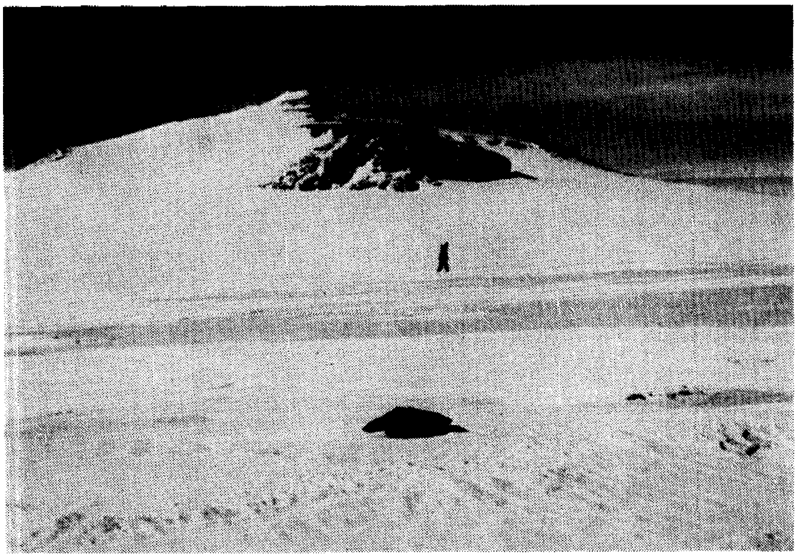

Fig. 8. Ferrar dolerite block on the firn surface. The mode of its occurrence in field is very similar to that of a meteorite. The block is located at about 800 m from Mt. Fleming (2,500 m, arrow).

Fig. 9. Surface feature of bare ice near Mt. DeWitt. Rippled surface is very similar to that in the areas around the Yamato Mountains. Black material is a fragment of Ferrar dolerite.

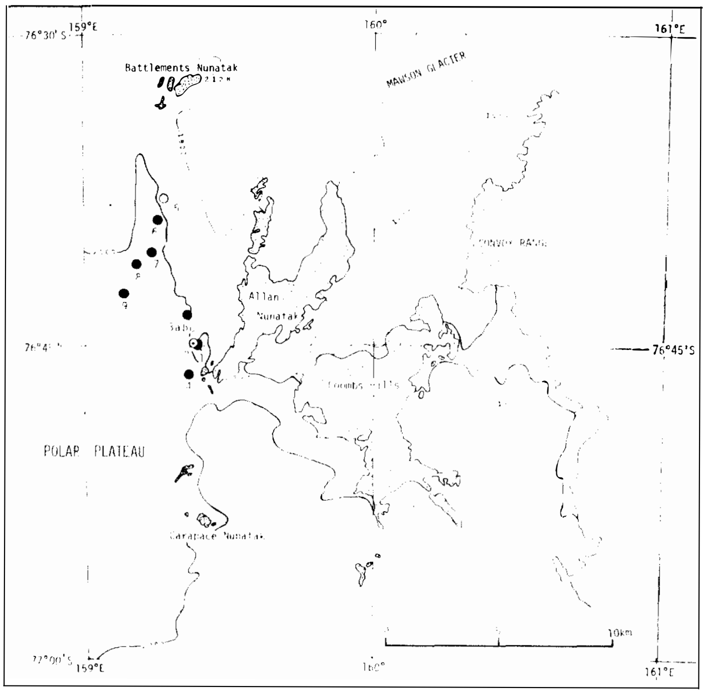

Fig. 10. The locations of meteorites collected from the plateau side of Allan Nunatak. Solid circle: chondrite. Open circle: achondrite. Dot in open circle: iron meteorite.

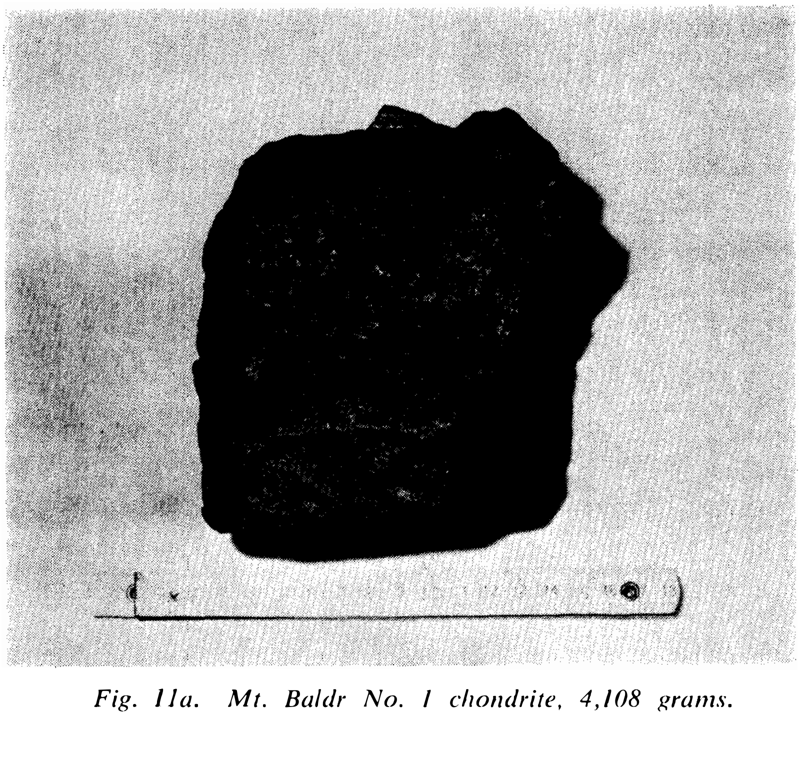

Fig. 11a. Mt. Baldr No. 1 chondrite, 4,108 grams.

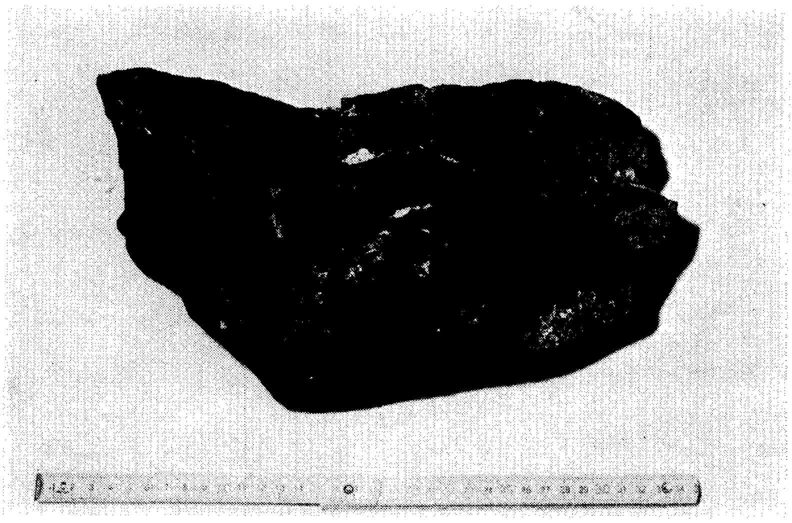

Fig. 11b. Mt. Baldr No. 2 chondrite, 13,782 grams with thumbprints.

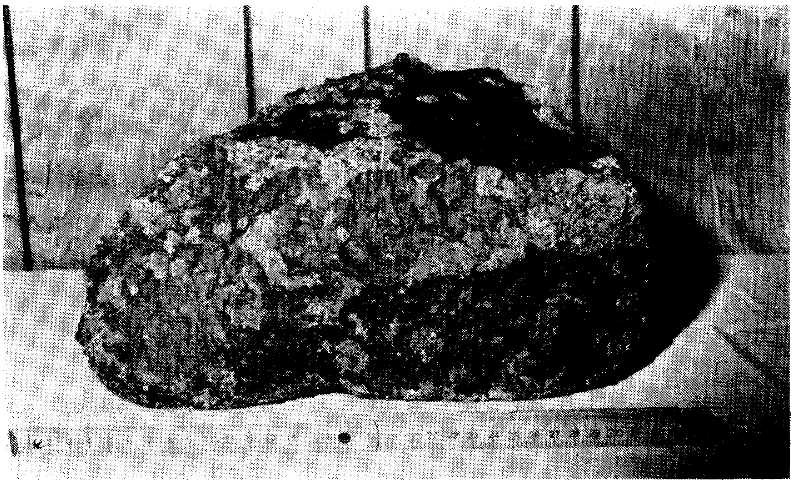

Fig. 11c. Allan Nunatak No. 1 chondrite, 20,151 grams with thumbprints.

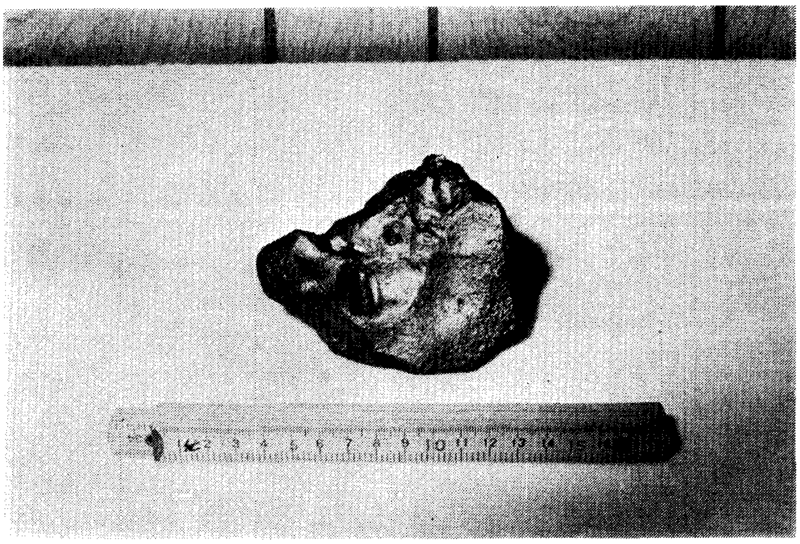

Fig. 11d. Allan Nunatak No. 2 iron meteorite, 1,510 grams.

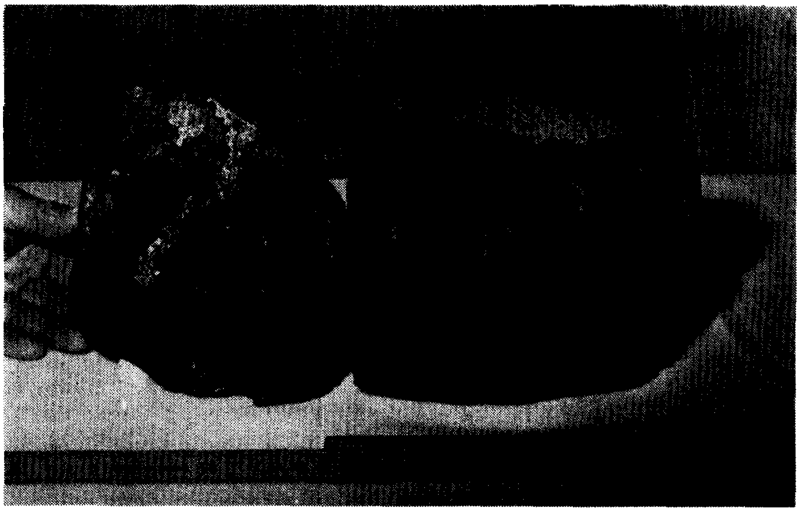

Fig. 11e. Allan Nunatak No. 3 chondrite, 10,495 grams, 3 fragments.

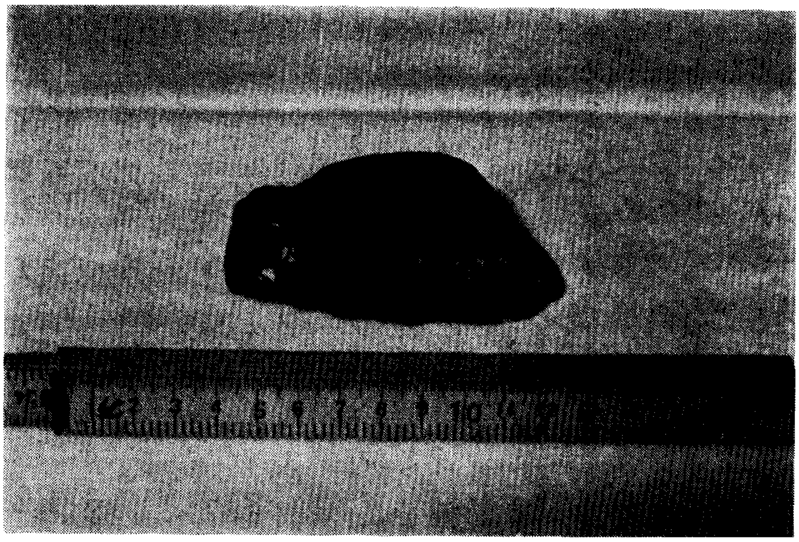

Fig. 11f. Allan Nunatak No. 4 chondrite, 305 grams, the smallest in the collection.

Fig. 11g. Allan Nunatak No. 5 achondrite, 1,425 grams. Show the shiny black fusion crust and flow lines on the surface.

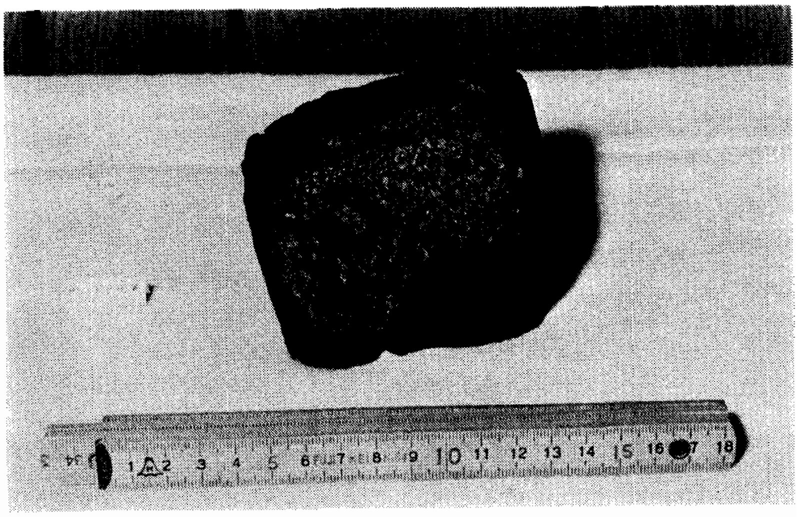

Fig. 11h. Allan Nunatak No. 6 chondrite, 1,137 grams.

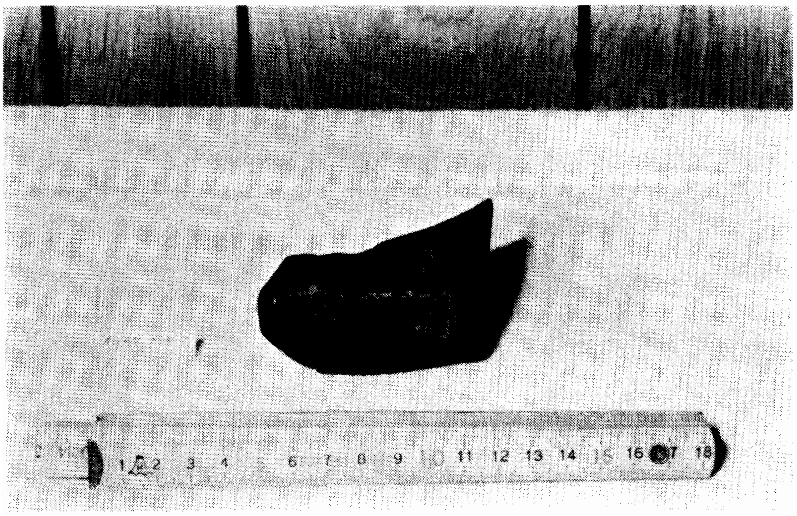

Fig. 11i. Allan Nunatak No. 7 chondrite, 410 grams.

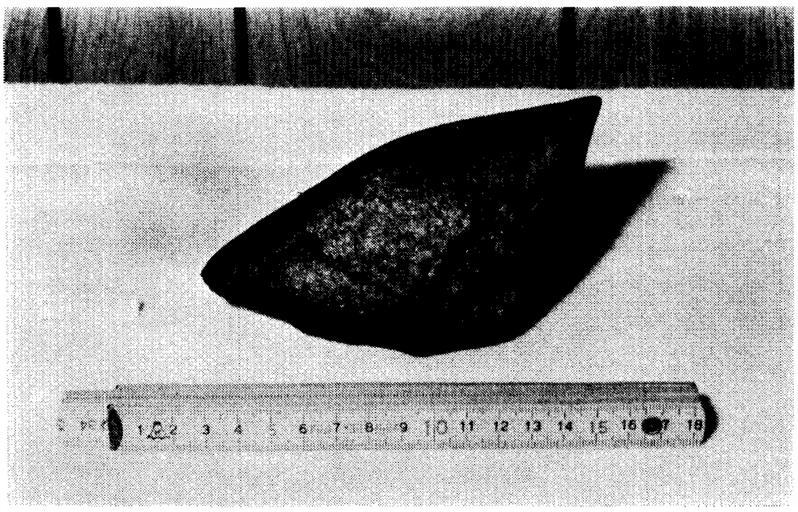

Fig. 11j. Allan Nunatak No. 8 chondrite, 1,150 grams, bomb-shaped.

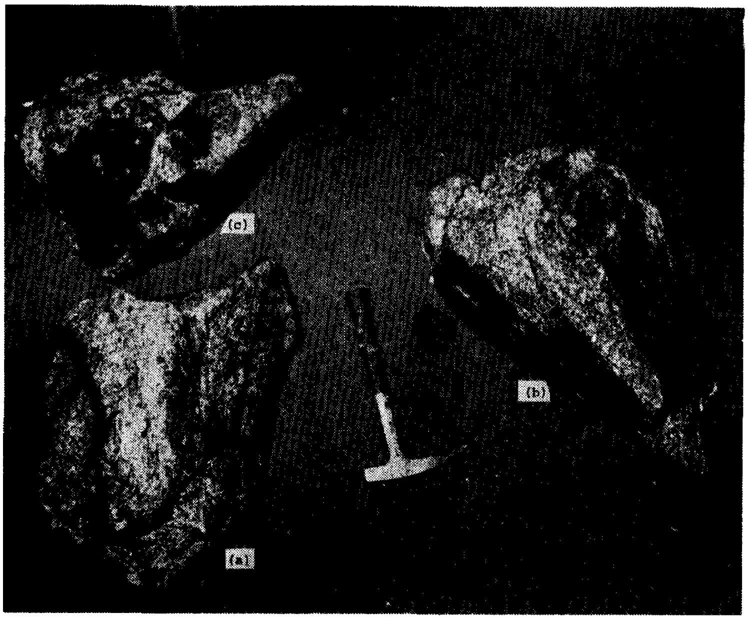

Fig. 11k-1. Allan Nunatak No. 9 chondrite, 407,041 grams, the largest meteorite from Antarctica. (a): 114,156 grams, (b): 102,831 grams, (c): 58,644 grams.

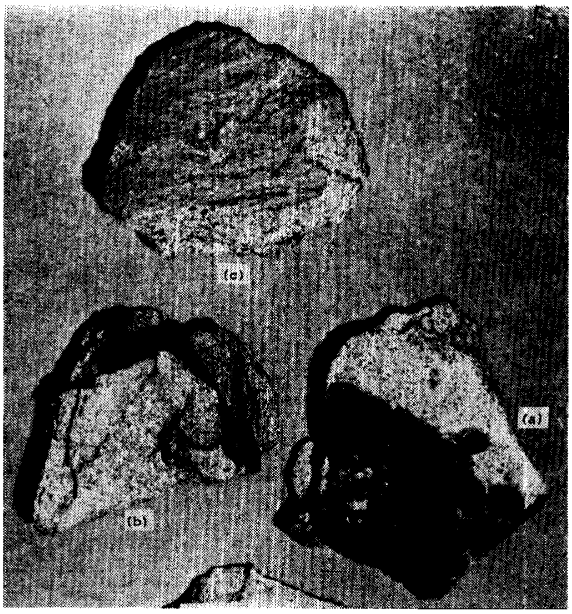

Fig. 11k-2. Ditto, (a): 33,749 grams, (b): 26,274 grams, (c): 18,025 grams.

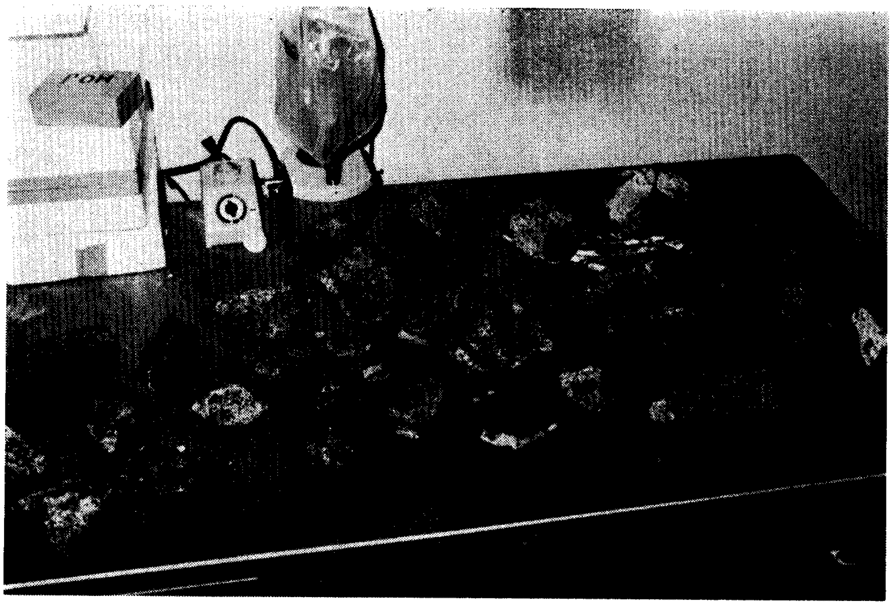

Fig. 11k-3. Ditto, 25 fragments under 10 kg.

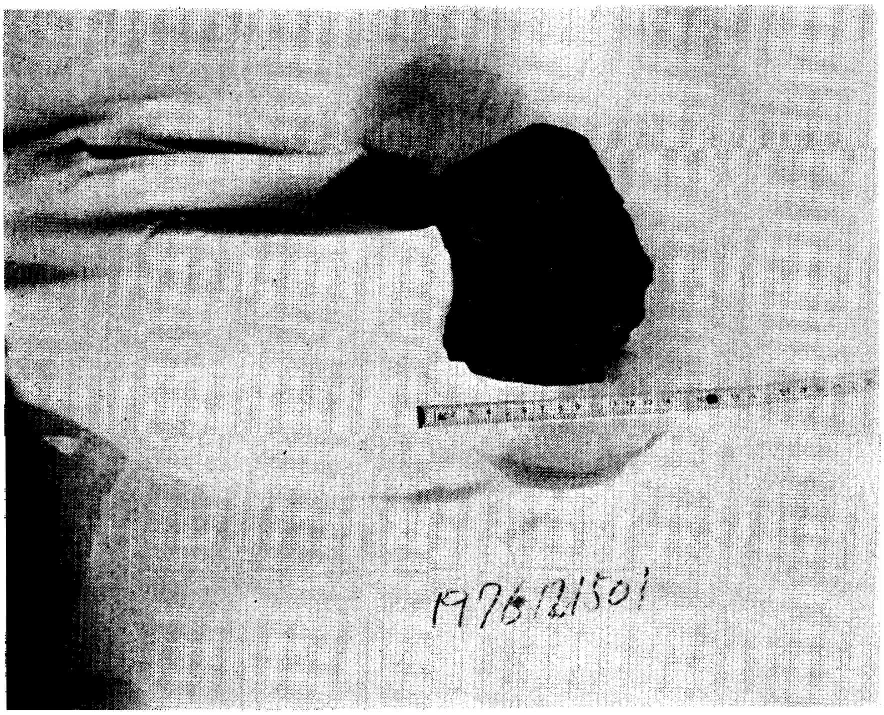

Fig. 12a. Mt. Baldr No. 1 chondrite, 4,108 grams with thumbprints, found on December 15 and collected on December 19, 1976.

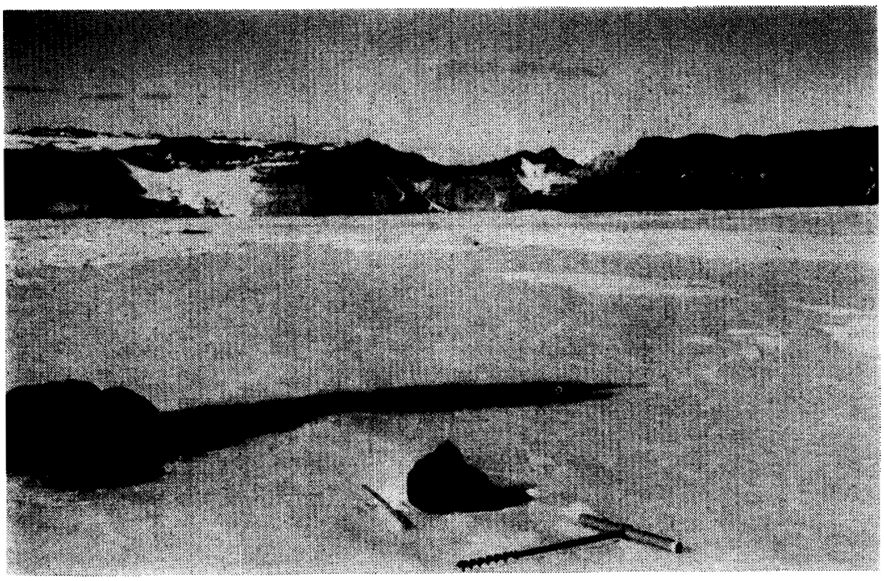

Fig. 12b. Mt. Baldr No. 2 chondrite, 13,782 grams, collected on December 19, 1976.

Fig. 12c. Allan Nunatak No. 1 chondrite, 20,151 grams, partially covered by a snow drift, collected on January 18, 1977.

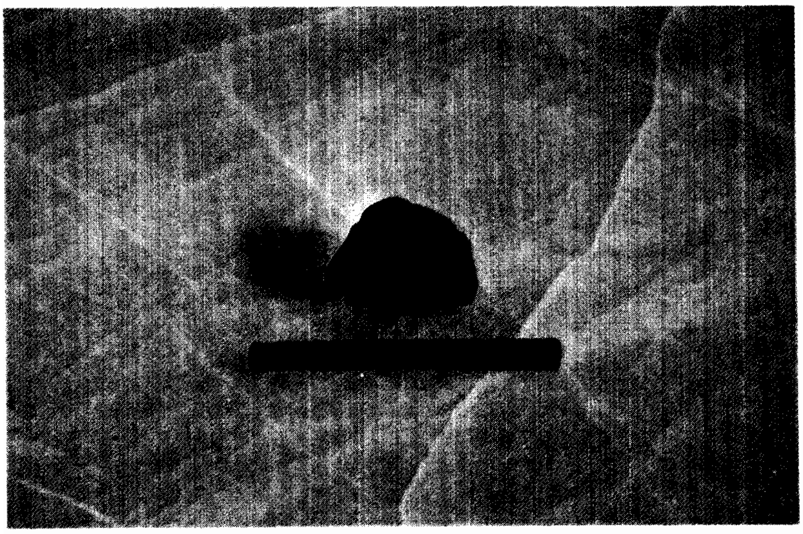

Fig. 12d. Allan Nunatak No. 2 iron meteorite, 1,510 grams, collected on January 18, 1977.

Fig. 12e. Allan Nunatak No. 3 chondrite, 10,495 grams, found as 3 fragments, collected on January 18, 1977.

Fig. 12f. *Allan Nunatak No. 4 chondrite, 305 grams, collected on January 18, 1977.*

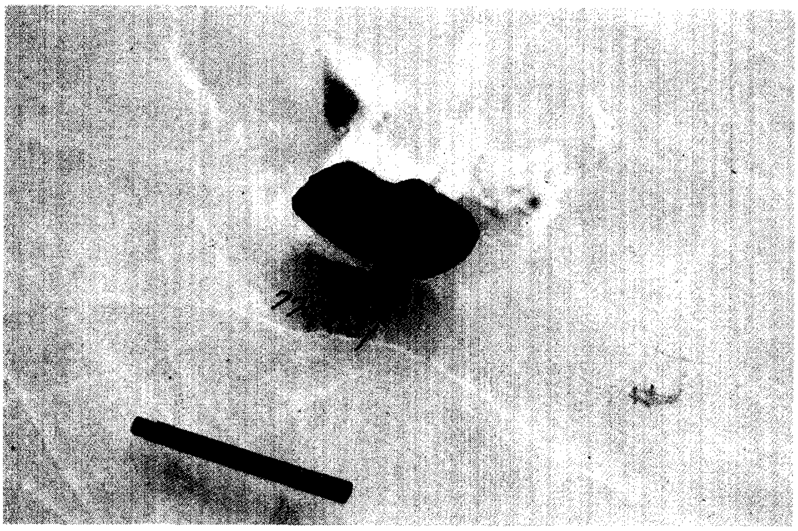

Fig. 12g. *Allan Nunatak No. 5 achondrite, 1,425 grams, collected on January 20, 1977.*

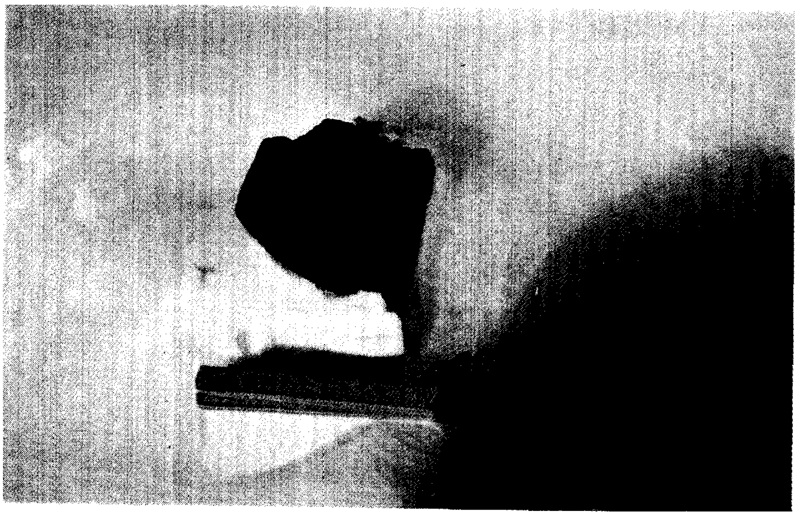

Fig. 12h. *Allan Nunatak No. 6 chondrite, 1,137 grams, collected on January 20, 1977.*

Fig. 12i. *Allan Nunatak No. 7 chondrite, 410 grams, collected on January 20, 1977.*

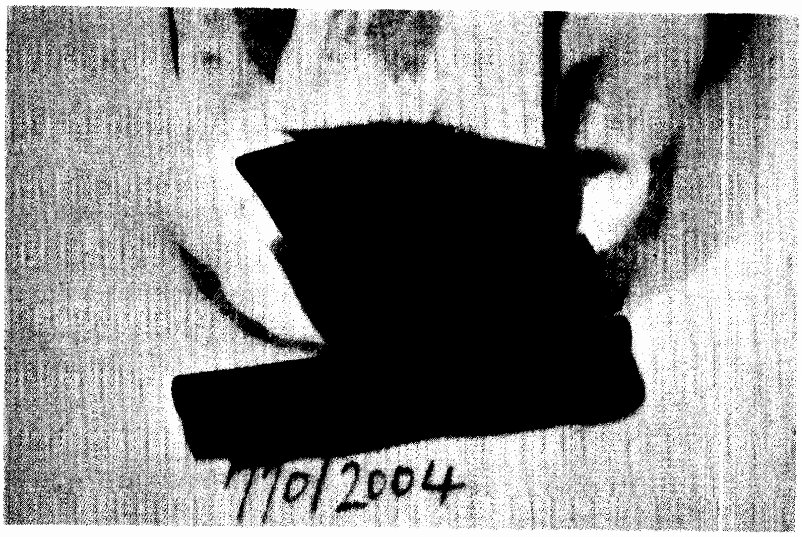

Fig. 12j. *Allan Nunatak No. 8 chondrite, 1,150 grams, collected on January 20, 1977.*

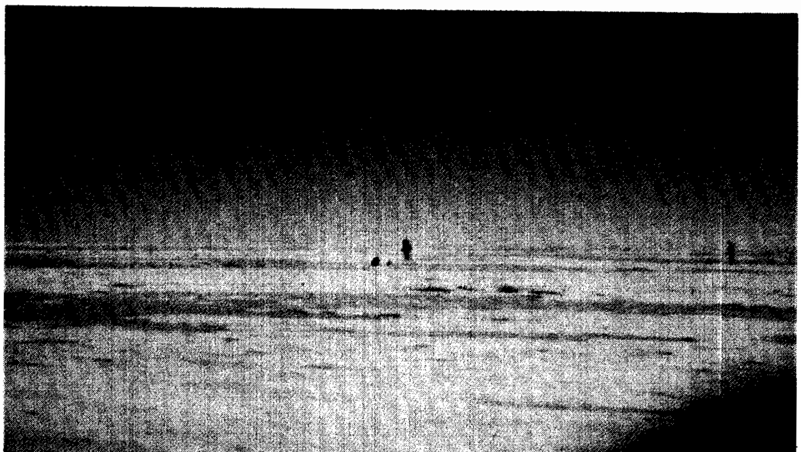

Fig. 12k. *Allan Nunatak No. 9 chondrite, 407,041 grams, found as 33 fragments, collected on January 20, 1977.*

(Figs. 11–12: Photograps by U.S. Navy.)

those in other places. The ice has a smooth surface different from the rippled surface of bare ice as seen around Mt. DeWitt (see Fig. 9) and the Yamato Mountains (YANAI, 1976), and appears to occur as a transitional stage between firn and ice. This fact may suggest less the effects of ablation, though it remains to be ascertained.

2.3. *Search in the areas around Mt. Fleming, Horseshoe Mountain, Taylor Glacier, Mt. Crean, Mistake Peak, Shapeless Mountain and Carapace Nunatak*

The party did not pitch camp in the above areas. The searching was done either by walking or by slowly taxying a helicopter at low altitude. However, no meteorite was found in the narrow bare ice fields of these areas (Fig. 7) and there were distributed an abundance of ordinary rocks. Fig. 8 shows the occurrences of Ferrar dolerite sitting on the firn surface 500–700 m from Mt. Fleming, 2,500 m in altitude. This mode of occurrence is quite common in the ice sheet around Victoria Land, and it was very difficult to distinguish meteorites from ordinary rocks because of their similar appearances.

2.4. *Search in the areas around Mt. DeWitt, Mt. Littlepage and Robison Peak*

From December 27, 1976 to January 3, 1977 the party camped on Mt. DeWitt and searched for meteorites by walking the bare ice in the neighborhood of Mt. DeWitt and Mt. Littlepage. As shown in Fig. 9 the bare ice in these areas has a rippled surface which is very similar to that of the Yamato Mountains area. Black materials were scattered on the surface, but no meteorite was found in spite of the careful search over a total distance of 200 km on foot. The black materials are mainly Ferrar dolerite and coal derived from the neighboring mountains.

In wider areas of the bare ice around these mountains the search was made often directly from a helicopter, but the party could not find a piece of meteorite there.

2.5. *Search on the plateau side of Allan Nunatak*

On January 18, 1977 the party searched for meteorites on the plateau side of Allan Nunatak by slowly taxying a helicopter over the bare ice from a height of 10–15 m. Through the helicopter's window CASSIDY found a stone meteorite lying on the bare ice. The meteorite is about 20 kg in weight and its surface was abraded by wind action as shown in Fig. 12c. At a place 80 m apart from this site, another iron meteorite was found lying on the bare ice by OLSEN (Fig. 12d).

On that day a total of four meteorites were found in the same bare ice field from the taxying helicopter. These meteorites were named Allan Nunatak meteorites after the name of the Nunatak, and were designated as Allan Nunatak No. 1 to No. 4 in order of finding. Allan Nunatak No. 3 was broken into 3 fragments. These specimens were not alphabetically designated because there was a very fair possibility of finding a very large number of meteorites in

Table 1. Initial data on meteorites found during 1976–1977 field season. See Fig. 1 for relative locations.

Name	Initial sample number	Weight (g)	Size (cm)	Latitude	Longitude	Date of find	Remarks
Mt. Baldr No. 1	1976121501	4,108	12×15×12	77°32′ 2″S	160°19′35″E	Dec. 15, 1976	Figs. 11a and 12a.
Mt. Baldr No. 2	1976121502	13,782	33×17×15	77°35′ 2″S	160°22′25″E	Dec. 15, 1976	Figs. 11b and 12b.
Allan Nunatak No. 1	1977011801	20,151	31×20×16	76°45′00″S*	159°22′34″E*	Jan. 18, 1977	Figs. 11c and 12c.
Allan Nunatak No. 2	1977011802	1,510	11×9.5×7	76°45′00″S*	159°22′34″E*	Jan. 18, 1977	Figs. 11d and 12d.
Allan Nunatak No. 3	1977011803 ~05	10,495	30×13.5×15	76°44′11″S	159°20′47″E	Jan. 18, 1977	Figs. 11e and 12e. 3 fragments.
Allan Nunatak No. 4	1977011806	305	9.5×6.5×2	76°46′30″S	159°21′05″E	Jan. 18, 1977	Figs. 11f and 12f.
Allan Nunatak No. 5	1977012001	1,425	19×9×7	76°37′46″S	159°15′53″E	Jan. 20, 1977	Figs. 11g and 12g.
Allan Nunatak No. 6	1977012002	1,137	9×9×8	76°38′59″S	159°14′42″E	Jan. 20, 1977	Figs. 11h and 12h.
Allan Nunatak No. 7	1977012003	410	7×7.5×5.5	76°40′36″S	159°13′14″E	Jan. 20, 1977	Figs. 11i and 12i.
Allan Nunatak No. 8	1977012004	1,150	15.5×8×5.5	76°40′44″S	159°10′24″E	Jan. 20, 1977	Figs. 11j and 12j.
Allan Nunatak No. 9	1977012005	407,041		76°42′26″S	159°07′43″E	Jan. 20, 1977	Figs. 11k-1–k-3 and 12 k. 33 fragments.
Total		461,514					

* Allan Nunatak Nos. 1 and 2 were found 80 m apart.

this area.

On January 20 the party searched the same area again and found five meteorites lying on the surface of the bare ice. These specimens were designated as Allan Nunatak No. 5 to No. 9 in order of finding. Allan Nunatak No. 9, comprising 33 fragments, amounted to 407 kg in weight, hence this is the largest meteorite so far obtained from Antarctica.

Fig. 10 shows the locations of nine specimens collected from the bare ice on the plateau side of Allan Nunatak.

2.6. Collections of the Mt. Baldr and Allan Nunatak meteorites

A total of eleven new meteorite specimens collected on the bare ice surface at the two localities are listed in Table 1.

Photographs of the specimens are shown in Fig. 11. In order to help to visualize the mode of occurrence in the field, some photographs taken *in situ* are presented in Fig. 12.

Preliminary identification and analysis revealed that one specimen is an iron meteorite, one is an achondrite (howardite), and the rest are H and L chondrites including the unequilibrated one.

3. Reconnaissance of Bare Ice Fields around the Transantarctic Mountains

On January 12, 1977 YANAI and CASSIDY surveyed the bare ice field around the Transantarctic Mountains between the Skelton Glacier and the Amundsen Glacier for future meteorite searches. There were no extensive bare ice fields as of the order of 1,000 square km, but narrow bare ice fields existed between the Transantarctic Mountains and the polar ice plateau at the following localities: west of Martin Dome, around Jacobs Nunatak, upper Beardmore Glacier, north-west of Mt. Ward, around Mt. Cecily, upper Shackleton Glacier and upper Amundsen Glacier.

4. Summary

Eleven new meteorite specimens were found on the bare ice surface near the Dry Valleys in South Victoria Land. Two of them were found on the Mt. Baldr Glacier of upper Wright Valley and nine were collected from bare ice on the plateau side of Allan Nunatak. These specimens were named Mt. Baldr and Allan Nunatak meteorites respectively, and designated as Mt. Baldr No. 1 and No. 2, and Allan Nunatak No. 1 to No. 9 in order of discovery. They were about 460 kg in total weight, of which Allan Nunatak No. 9 amounted to 407 kg. Thus No. 9 is the largest meteorite ever found in Antarctica.

Preliminary classification revealed that one specimen is an iron meteorite, one is an achondrite and nine are chondrites belonging to various petrological types.

Acknowledgments

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