

# The Antarctic Research Expedition Makes a Discovery! An Ancient Story Hidden in a 10-Million-Year-Old Martian Meteorite



Did you know that one of the most popular exhibits at the Japan Pavilion – the Martian meteorite – was discovered in Antarctica? This remarkable rock was found near the Yamato Mountains, about 350 km south of Showa Station, by the Japanese Antarctic Research Expedition Team, which explores Antarctica every year. Today, we interviewed Assistant Professor Naoya Imae of the National Institute of Polar Research, who made the initial discovery, to learn about the moment he found it and the fascinating world of meteorites.



## About the National Institute of Polar Research (NIPR)

The National Institute of Polar Research (NIPR) is an inter-university research institute conducting observations, experiments, and research in the Antarctic and Arctic Circle regions. NIPR also leads the Japanese Antarctic Research Expedition (JARE) under the Ministry of Education, Culture, Sports, Science and Technology (MEXT). Through diverse research – ranging from climate studies and atmospheric observations to the analysis of ancient ice samples and polar ecosystems – NIPR seeks to uncover the past, present and future of our planet. Among its key research areas is the study of meteorites found in Antarctica.

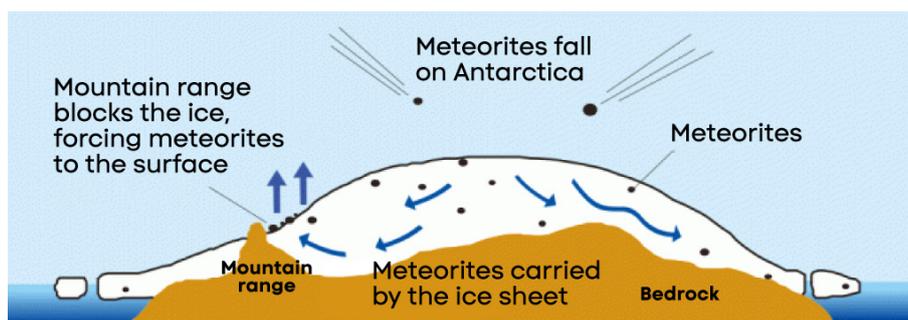


## More than 17,000 Valuable Meteorites Collected in Antarctica!

### — How did meteorite research in Antarctica begin?

**Imae** It all started in 1969, when the Antarctic Expedition Team discovered nine meteorites near the Yamato Mountains, about 350 km southwest of Showa Station. Team members were intrigued by black stones scattered on the bright blue ice. When they brought them back for analysis, they were confirmed to be meteorites. Interestingly, these nine meteorites had different compositions and origins, indicating that meteorites from different celestial bodies had landed in the same area over time. Isn't that incredible?

More meteorites were subsequently discovered in the same area, and further research revealed an interesting phenomenon: after meteorites fall in Antarctica, they are gradually buried by snow. Over hundreds of thousands to millions of years, they move with the ice sheet. When they reach mountain ranges, their path is blocked, causing them to accumulate and eventually emerge on the surface due to strong winds.



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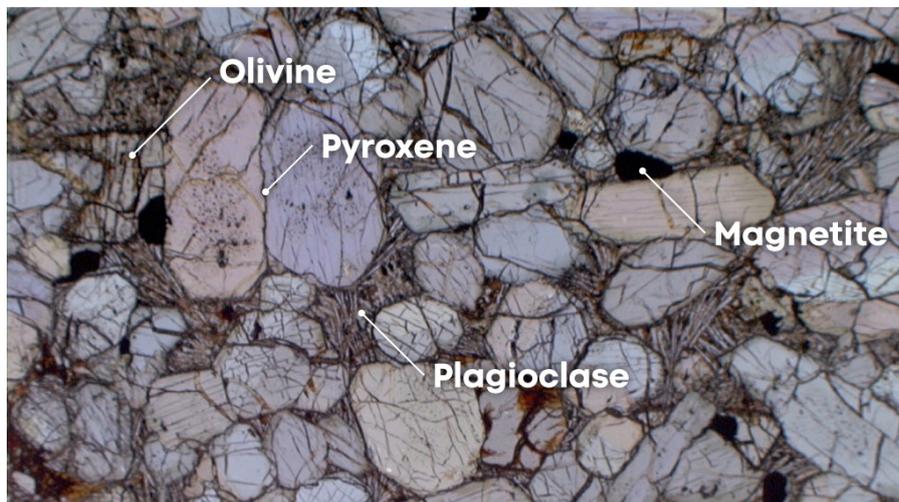
### — What kinds of meteorites have you found so far?

**Imae** We have discovered nine meteorites from the Moon and 15 from Mars. However, only 10% of all collected meteorites have been identified; the remaining 90% are of unknown origin. The Antarctic Meteorite Research Center at NIPR currently houses a collection of over 17,000 meteorites of various sizes.



### Imae

Each meteorite undergoes extensive analysis. They are sliced thin to allow light to pass through for optical microscope examination. Some are analyzed with x-rays to determine their chemical composition, while others are burned or melted to study their internal composition.



Courtesy of the National Institute of Polar Research



## A Stunning Meteorite the Size of a Rugby Ball, with a Unique Green Glow

— Can you describe the moment you discovered the Martian meteorite?

### Imae

It was November 2000, during Expedition 41. That day, we found over 300 meteorites near the Yamato Mountains. Most were small, just a few centimeters in diameter. But then, I spotted one that was different—it was the size of a rugby ball, about 29 cm wide and 17.5 cm high. Because meteorites are fragile, we typically transport them in special storage bags, but this one was too large. We had to use a trash bag! (laughs)

What struck me next was its color. Unlike other meteorites, this one had a greenish hue, which stood out against the white Antarctic ice. When meteorites enter Earth's atmosphere, friction burns their surface, revealing the dark green color of pyroxene, a mineral abundant in meteorites.

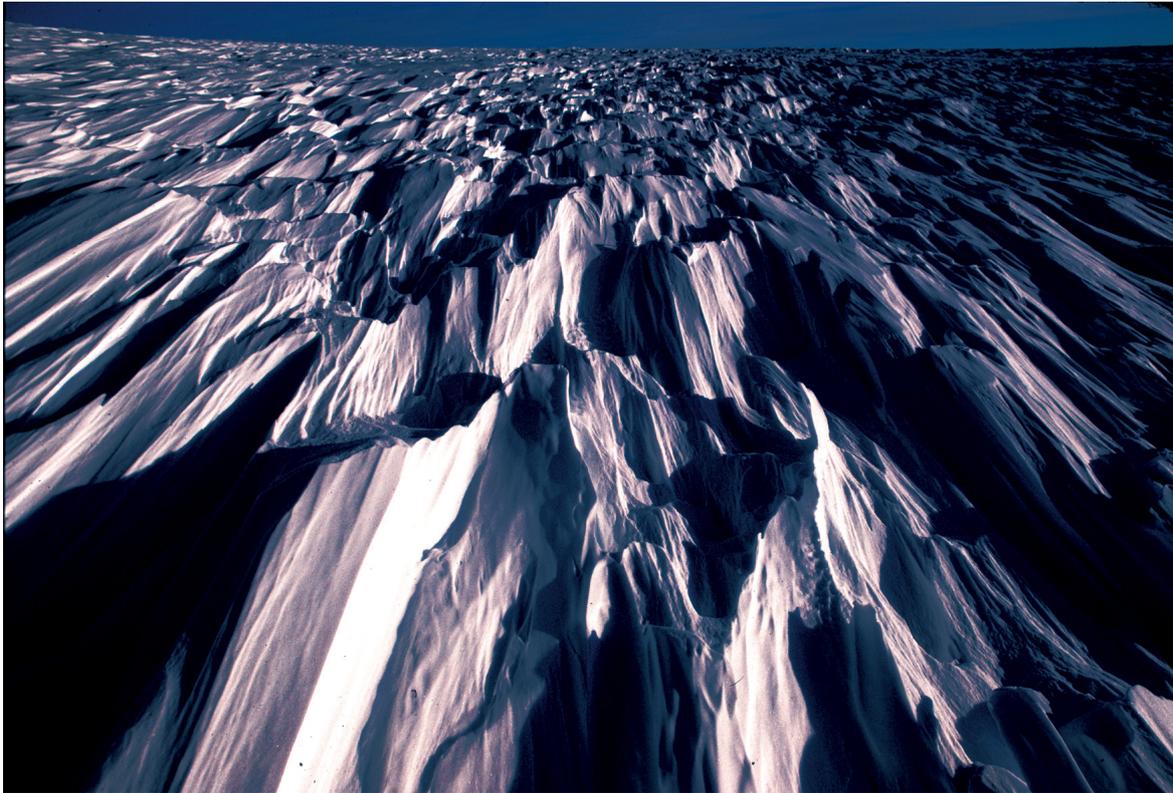


Courtesy of the National Institute of Polar Research

— **It's definitely quite large! How did you bring it back to Japan?**

**Imae**

The meteorites were all very fragile and frozen. We needed to transport them to our research center in the same state for as long as possible. First, we loaded the meteorites on sleds carefully so they wouldn't come into contact with each other. After we finished exploring the snowfields, over a nine-day period starting in mid-January, we transported them to the coast where the Antarctic research vessel Shirase was berthed. The snowfield was covered with meter-long landscape features called "sastrugi," which form when snow is eroded by strong winds. Our sleds had to proceed carefully because they were liable to tip over. It was a massive challenge.



Courtesy of National Institute of Polar Research

**Imae** The “sastrugi” zone with over waist-high undulations, up to two meters tall. The team had to proceed with caution when towing their sled with snowmobiles.

Once aboard the ship, the meteorites had to remain frozen. If they warmed up to room temperature, condensation could form, causing the metals inside to rust and alter their composition. The meteorites were placed in a freezer usually used for food, and transported by sea to Japan, arriving in May 2001.

The rugby ball meteorite was clearly different from the others, so we began analyzing it first. Our analysis revealed that it had in fact come from Mars.



## **A 10- to 13-Million-Year-Old “Memory” Etched in a Martian Meteorite**

### **— How did you determine that it came from Mars?**

**Imae** There were three pieces of evidence. First was the composition of the minerals, which was similar to rocks on Earth. We knew that rock comprised minerals deposited in a magma pool, where they then hardened. From this, we surmised that it came from a celestial body with a gravitational field.

Second was the age of the meteorite. Analysis revealed that it formed 1.3 billion years ago. Our solar system came into existence 4.6 billion years ago, so it was fairly young in comparison. Given that rocks are produced by volcanic activity, we know that volcanic activity was taking place from 4.6 billion years

ago to at least 1.3 billion years ago in the area where this meteorite originated. The fact that volcanic activity was occurring over such a long period of time suggests that the meteorite is from a somewhat large celestial body, again pointing at Mars as a candidate.

The third and most decisive factor was the air trapped inside. Air from when the rock formed on Mars remained inside, and its composition almost exactly matched the atmosphere observed by the Viking spacecraft launched by NASA when it landed on Mars in 1975.



Clarifying the true nature of the meteorite by comparing clues to established knowledge is “very difficult, but also ambitious and compelling,” says Imae.

### — Is there anything else that you came to understand?

**Imae** Yes, we discovered the Martian meteorite contained clay minerals, which are thought to be formed only in the presence of water. This serves as evidence that water has existed on Mars.

In addition to the meteorites on display in the Japan Pavilion, the same type of Martian meteorites have been found in Antarctica and the Sahara Desert, and strangely enough, almost all of them left Mars around the same time, about 10–13 million years ago. This suggests that a major event, such as a large meteorite impact, could have occurred on Mars during that time period.

On the other hand, even though the timing of their departure from Mars is the same, there are differences in the clay minerals they contain. This provides hints regarding the location of water on Mars. Some speculate that there was underground ice on the planet, which vaporized due to the heat from a meteorite impact.



— Will this help us to understand the origins of life?

**Imae** Related research is currently underway. In fact, a sample brought back by Hayabusa 2 from the asteroid Ryugu has been found to contain amino acids, which are believed to be closely related to the origin of life.

Some meteorites also have tunnel-like holes known as bio-weathering\* that some researchers believe could be traces of erosion due to bacteria or other life forms. While it was once thought these traces were left by organisms on Earth after the meteorites landed, similar traces have been found in meteorites that were collected immediately after landing. Could extraterrestrial life exist? It's an ongoing debate, and a breathtaking possibility!

\*Bio-weathering: There is another interpretation of the apparent bio-weathering phenomenon that suggests meteorites did in fact react with hot water or oxidized gas. This issue requires further research.



# Earth is 4.6 Billion Years Old, While Human History Spans Only One Million Years Shining Light on the Future Through the Past and Present

— The Martian meteorite will be on display at Expo 2025 Osaka-Kansai. How do you feel about that?

**Imae** The Martian meteorite at the Japan Pavilion is one of the largest of its kind in the world. This is a rare chance for visitors to see a meteorite of this size up close. I hope many people, from Japan and abroad, will come to see it at Expo 2025 Osaka, Kansai, Japan. I also hope they consider the vast flow of time and multitude of narratives that it carries, and feel the powerful legend hidden in this unique meteorite.  
I also hope it sparks curiosity about the vast timeline of our universe and the preciousness of our own planet's future.



In addition to the Martian meteorite, the Antarctic Meteorite Research Center at the Institute of Polar Research is home to other precious meteorites, some of which came from the Moon. Frozen meteorites are carefully brought to room temperature in a nitrogen gas environment to prevent oxidation during thawing, and then stored in a room maintained at 22°C and below 40% humidity to prevent deterioration.

**Imae** About 70 years have passed since the first Japanese observation team visited Antarctica in 1956. Since then, a wealth of observation and research has been conducted in the Arctic and Antarctic. Japanese observation teams have made great achievements in these locations, including the discovery of the hole in the ozone layer and research on prehistoric climates. The Earth was born 4.6 billion years ago, yet only a million years have passed since mankind appeared. What happened in the past and what seismic shifts have taken place to create our current natural environment? I hope that through our re-

search people will become more interested in NIPR, an organization devoted to understanding Earth's past, present and future.

— **Lastly, please tell us what captivates you about meteorite research.**

**Imae**

Meteorite research is often compared to a four-dimensional jigsaw puzzle. Considering our solar system across the eons, we are gradually revealing the true nature of meteorites by piecing together insight from individual discoveries to gradually uncover their interconnected nature. The moment when the pieces click into place is breathtaking, and I think many scientists see this process as the zenith of ambition and excitement. How was our solar system born 4.6 billion years ago? Where did we come from? The great appeal of meteorite research is that it brings us closer to unraveling these mysteries.



## **The Japan Pavilion Showcases One of the World's Largest Martian Meteorites!**

At the Japan Pavilion, visitors can view the Martian meteorite featured in this article, and touch a fragment of it! Had it never reached the Earth...had it fallen somewhere other than Antarctica...had it not been discovered by the Antarctic research team...where would it be now?



Given the series of coincidences it took for the Martian meteorite to arrive at the Japan Pavilion, it's nothing short of a miracle. The rock is a valuable cosmic sample with the potential to shed light on the origin of life, and has deep links to the theme of the Osaka-Kansai Expo: "Designing Future Society for Our Lives."

The Martian meteorite invites us to think about life on a cosmic scale. We hope you'll join us at Expo 2025 Osaka-Kansai to witness this miracle and reflect on the vast, interconnected cycle of life that ties us together "between lives."

For more, check out "A Whisper from a Martian Meteorite: The Connection Between Space and Life" in the Monthly JP Pavilion online magazine.

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Text: Yukiko Oki