In search for new meteorite dense collection area in the Sor Rondane mountains

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Ever since the 10th Japanese Antarctic Research Expedition (JARE-10) conducted a geological expedition in the Yamato Mountains in 1969 and recovered nine meteorites from a single exposed ice patch, the potential of Antarctica for discovering and investigating meteorite stranding zones has been recognized by the scientific community [1-3]. Indeed, the systematic search of stranding zones across the White Continent has become the most efficient way to collect meteorites and make them available for scientific research, with two-third of all meteorites collected coming from Antarctica (https://www.lpi.usra.edu/meteor/ in September 2023). It is understood that meteorite stranding zones are produced by the incorporation of meteorites into the ice after their fall, followed by their gradual transportation by glaciers towards the sea. However, when these ice masses encounter topographic barriers, their movement is redirected towards the surface. Over time, the layers of ice erode, unveiling distinctive, blue-coloured ice (unlike the predominantly snow-covered terrain of Antarctica), liberating and concentrating the entrapped meteorites within a delimited zone called blue ice area (BIA) [4, 5].

Nevertheless, it is important to note that not all BIAs necessarily lead to meteorite dense collection area (DCA) [6]. Practical evaluation through field visits remains indispensable despite the considerable logistical challenges associated with Antarctic expeditions. In an effort to help discover new possible DCA, Tollenaar et al. [7] harnessed machine learning techniques, leveraging satellite data to analyse physical parameters of the ice surface. These parameters included radar backscatter data for snow cover, surface temperature, ice velocity, and surface slope. This innovative approach yielded a probability index to predict the presence of meteorites anywhere in Antarctica, a valuable tool accessible through the website: http://wheretocatchafallingstar.science. It should be noted that in addition to the broader concentration of meteorites driven by glacier movements, localised and highly specific meteorite concentrations can also result from secondary processes such as wind activity [8, 9]. These secondary processes, which are strongly dependent on location, render each BIA distinct in its configuration and, consequently, its potential for meteorite concentration and dispersion.

Amongst the Antarctic DCAs is the Nansen BIA located in the Sør Rondane Mountains in East Antarctica, where more than 2000 meteorites have been recovered first by JARE-29 in 1987-1989 [10, 11] and then through a joint effort between Japan and Belgium departing from the Belgian Antarctic base (Princess Elisabeth Antarctica, PEA) to recover 974 meteorites more during the 2010-2011, 2012-2013 and 2019-2020 seasons [12-14]. After the Nansen BIA had successfully been entirely searched, the BELARE 2022-2023 expedition (December 2022-January 2023) was aimed to investigate new potential BIAs in the surrounding of PEA. Using the meteorite finding probability index map from Tollenaar, Zekollari [7] (Fig. 1a), several points of interest were identified in the surrounding of PEA, reachable either by camp or daily trips (Fig. 1b).

A camp was set up in the Nils Larsenfjellet area, accessible from the H.E. Hansenbreen (S72° 13.260' E22° 37.779'; altitude 1640 m) in December 2022 to search several BIAs and possible secondary accumulation areas (Fig. 1b). In January 2023, after return to PEA, day trips were organised to perform systematic searches in moraines and on BIAs, including the Verheyefjellet BIA, several BIAs surrounding an alignment of nunataks south of PEA, centred on S72° 18.403' E23° 13.191', and the Røysane nunatak at the eastern edge of Nils Larsenfjellet (Fig. 1b). In addition, nice surface ice samples and 18 kg of micrometeorite-bearing sediments were collected.

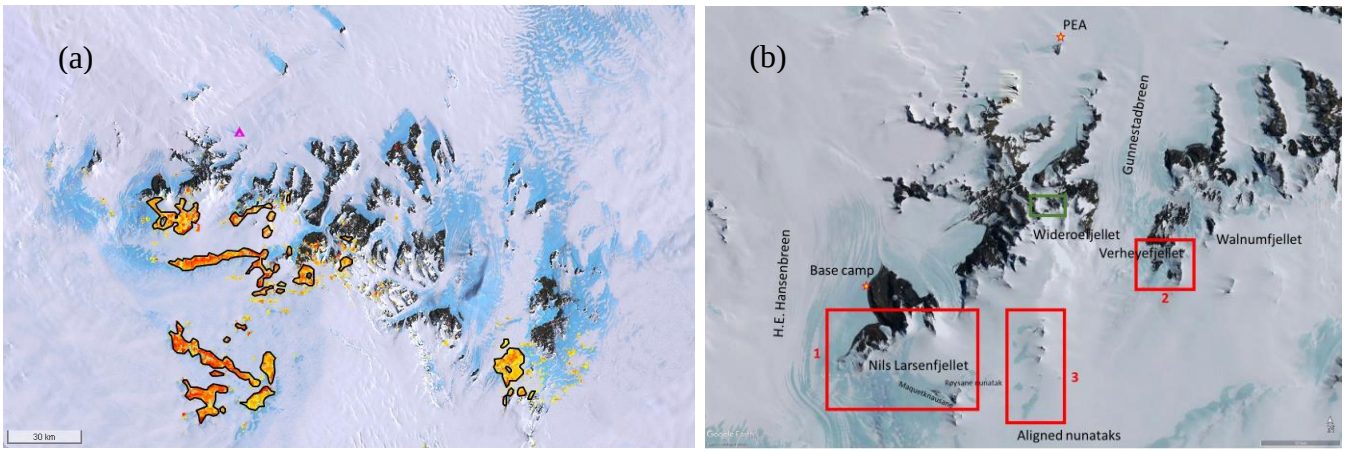

Figure 1: (a) map of the Sør Rondane Mountains (East Antarctica) including the meteorite probability index from Tollenaar et al. (2022). Blue ice areas are delimited and the probability is going higher from yellow to red. The pink hut is PEA. From http://wheretocatchafallingstar.science. (b) Zoomed Sør Rondane Mountains map, with the location of PEA (star) and the 3 different zones of interests searched for meteorites during the BELARE 2022-2023 campaign: 1: Nils Larsenfjellet; 2:Verheyefjellet; 3: aligned nunataks. Image based on Google Earth (US Geological Survey).

Five meteorites in total were recovered, all in the Nils Larsenfjellet area, one of 7.6 kg. The magnetic susceptibility of the meteorites was measured using a handheld A*METMET susceptibility meter developed at CEREGE (Aix-en-Provence) by Dr. M. Uehara, and refined for cold weather. This preliminary classification suggested that all samples are H and L ordinary chondrites. As the samples were brought back from the field in a frozen state, they will be thawed in vacuum conditions before their classification at the Royal Belgian Institute of Natural Sciences in Brussels. Tentatively, we suggest that the Nils Larsenfjellet could be identified as a potential new Dense Collection Area.

References

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