Why do we find so many meteorites on the Nansen blue ice field and where else could we look?

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Antarctic blue ice zones are the most productive locations for meteorite recovery on Earth. However, the mechanisms behind these meteorite traps remain a topic of ongoing debate. Here, we propose an interdisciplinary approach combining surface blue ice isotopic analysis, terrestrial age dating of meteorites, remote sensing observations and ice flow and surface mass balance modelling to improve our understanding of the Nansen blue ice field meteorite trap (Dronning Maud Land, East Antarctica). This ice field (2600-3100 m above sea level) was first explored by the 29th Japanese Antarctic Research Expedition (JARE-29) (1987-1989), during which more than 1582 meteorites were retrieved (Naraoka et al., 1990; Yanai et al., 1993). The northern part of the ice field (Nansen A) was subsequently revisited during the austral summer of 2010-11 (Belgian Antarctic Research Expedition, BELARE 2010-2011), resulting in more than 200 newly collected meteorites (Goderis et al., 2011). Two years later, during the austral summer of 2012-13, a meteorite search expedition (JARE-54, BELARE 2012-2013) was organized on the southwestern ice field (Nansen B) and the northern part of the eastern ice field (Debaille et al., 2013; Imae et al., 2013, 2015). During the 2012-13 expedition, more than 400 meteorites were collected, together with 185 surface blue ice samples (Imae et al., 2015; Zekollari et al., 2019).

The surface blue ice samples show one of the largest observed spatial patterns in oxygen isotopic variation to date. Relying on meteorites for which the terrestrial ages are determined using 14C and 36Cl, this surface ice is interpreted to date from the Last Interglacial up to the present-day. By combining state-of-the-art satellite derived surface velocities, surface mass balance modelling and ice flow modelling, we estimate that about 75% to 85% of the meteorites found on the ice field were supplied by ice flow after entering the ice sheet in an accumulation area of a few hundred square kilometres located south (upstream) of the ice field. Less than 0.4 new meteorites per year are supplied to the ice field through ice flow, suggesting that the hundreds of meteorites found 25 years after the first visit to this ice field mostly represent meteorites that were previously not found, rather than newly supplied meteorites. By combining these findings, the infall rate of meteorites from space is estimated, which is in line with values from the literature, but situated at the higher end of the range. This study introduces new concepts that can be used to better characterize, understand and identify other meteorite traps. In this presentation, we show some first results of our attempt to identify yet unexplored meteorite traps by combining remote sensing products and various datasets in a big data approach.

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