ExMAG Antarctic Meteorites at JSC – May 12, 2024 - K. Righter

- Fall 2022 AMN announced 147 new meteorites; received 30 sample requests for Fall deadline
- Spring 2024 AMN announced 125 new samples; received 25 sample requests for Spring deadline.
- Finished characterization of 2018-19 ANSMET season samples from Dominion Range
- Received 204 new ANSMET samples from DOM !!

- Currently characterizing 2019-20 and 2023-24 ANSMET season meteorites all from DOM
- Focusing on re-classifications and pairing updates:
  - UOCs (EET, GRO, LEW, MET areas), petrologic grade and sub-group of CV3s
  - Pairing of CO3 from DOM, MIL areas
  - Initiating CM and CO oxygen analyses to address classification and pairing
- Bibliography recently updated for papers reporting data from ANSMET samples through 2023. 57 papers from 2022, 45 for 2023.
- Lunar meteorite compendium updates – added new samples to comprehensive list, and new detailed write-ups for US Antarctic meteorites – DOM 18242, MIL 13317, MIL 090036, MIL 090034/070/076
- Smithsonian Transfers – hundreds of sample identified as less actively researched or less interest and transferred permanently to the Smithsonian Institution.

Received ANSMET 2023-24 season samples in late March 2024

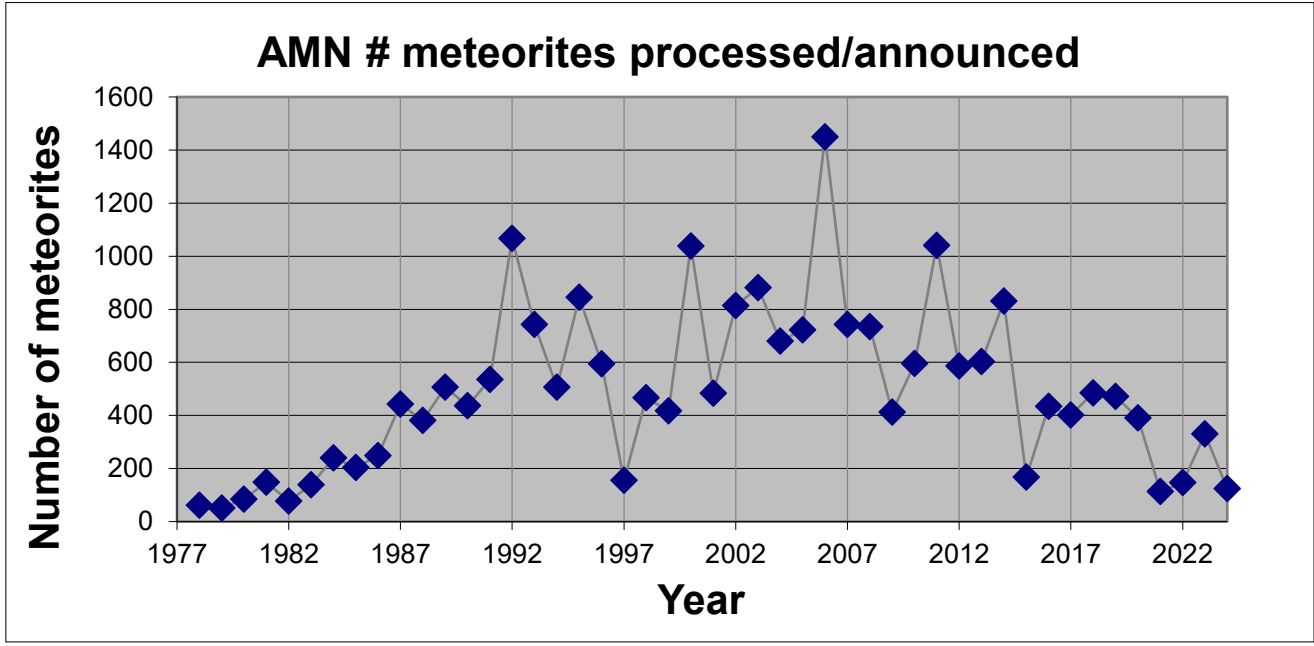


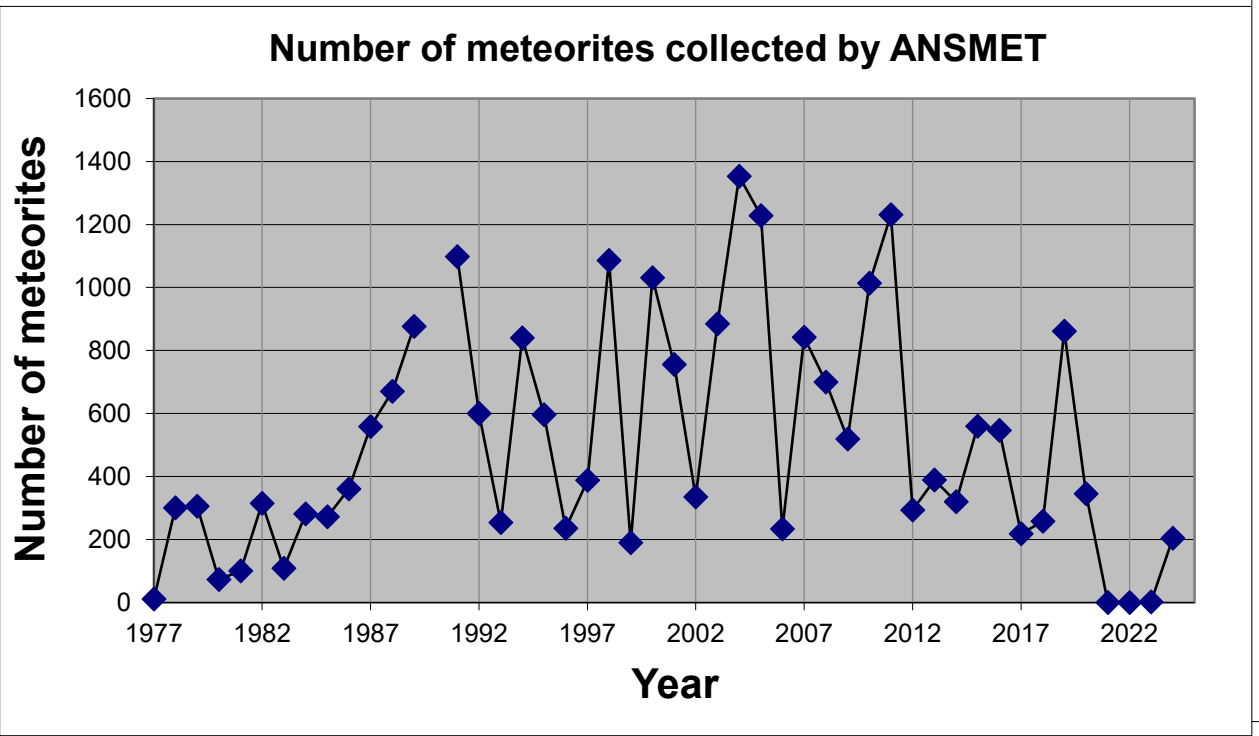


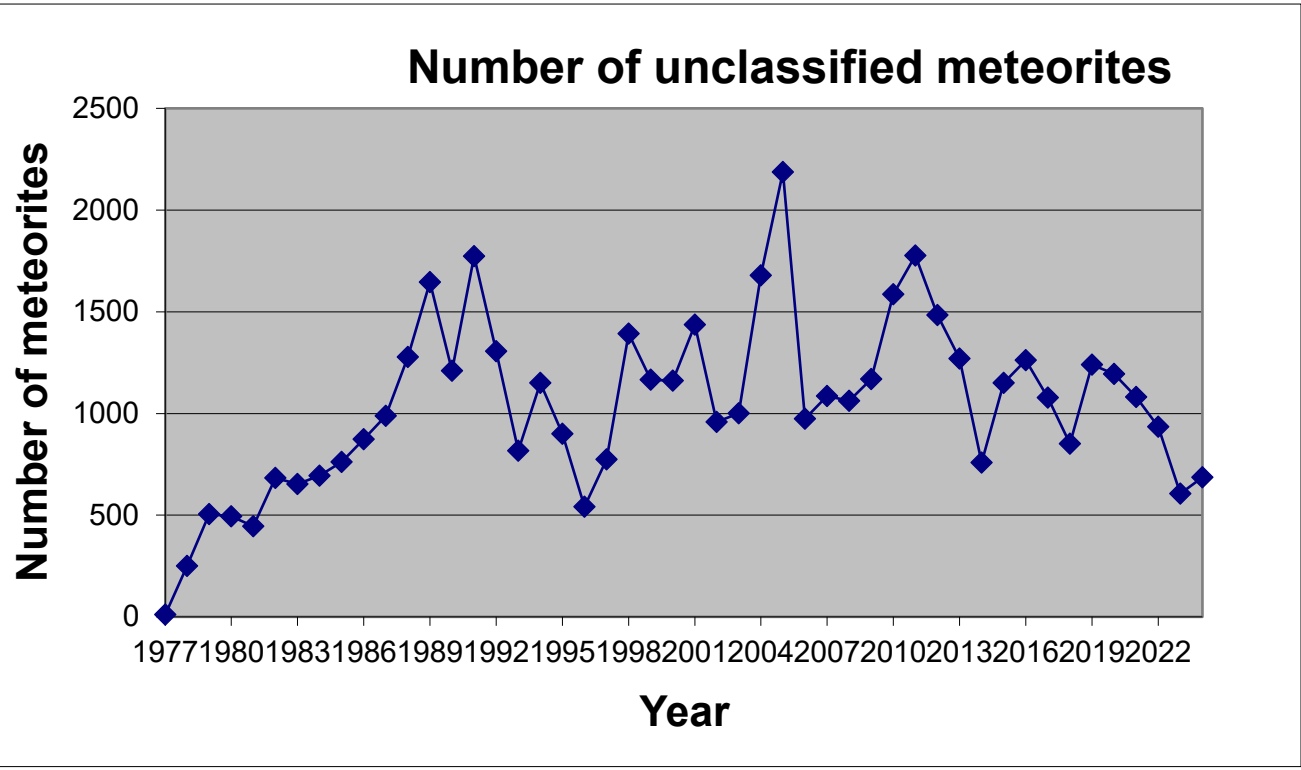


Classification statistics

Announced 147 in Fall 2023 and 125 in Spring 2024; ~680 to be classified (DOM 19 and 23); first samples from 23-24 season will be announced in Fall 2024 AMN

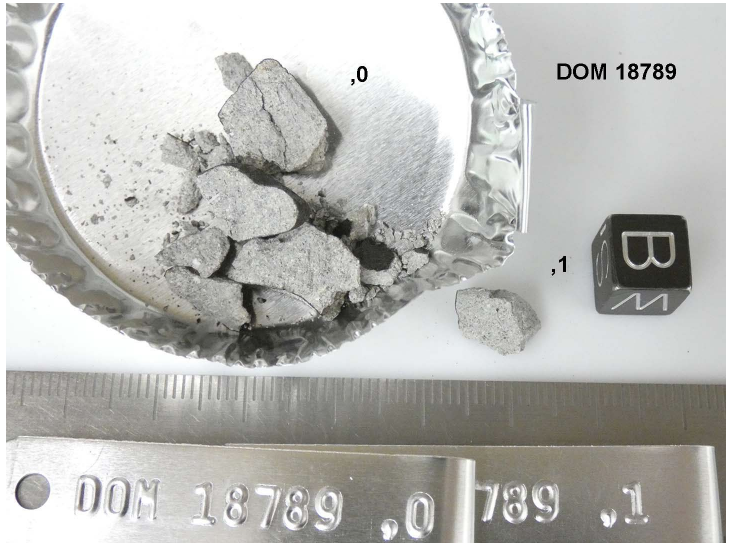


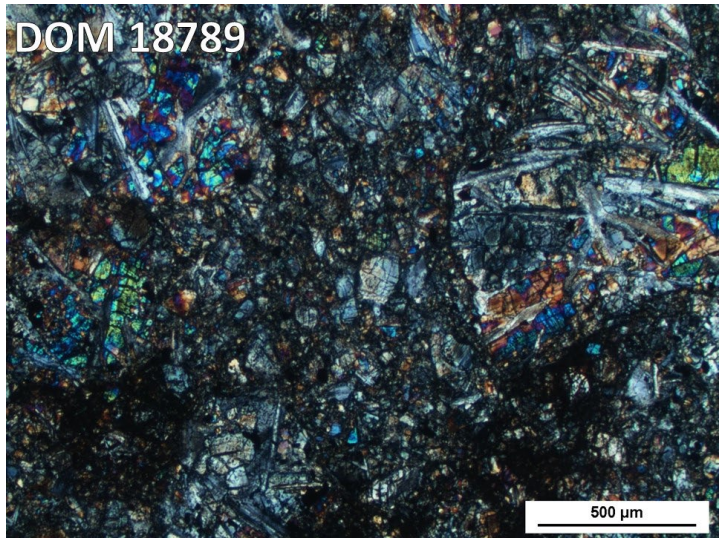




Currently characterizing 2018-19 and 2019-20 ANSMET season meteorites all from Dominion Range

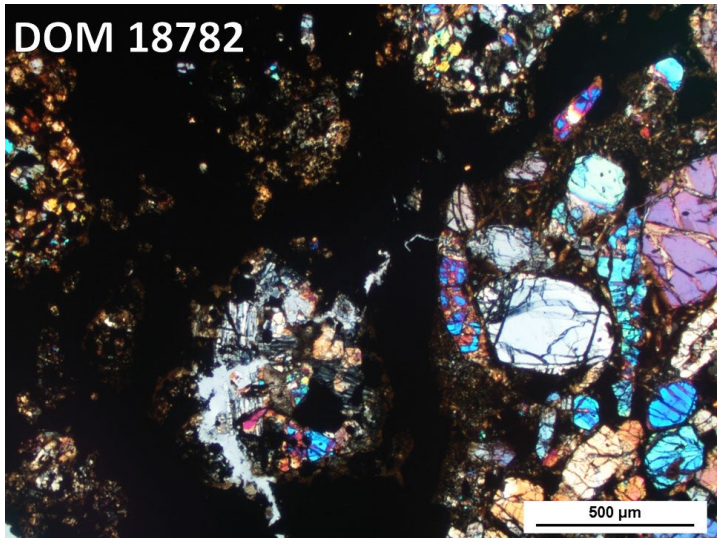
Brecciated eucrite





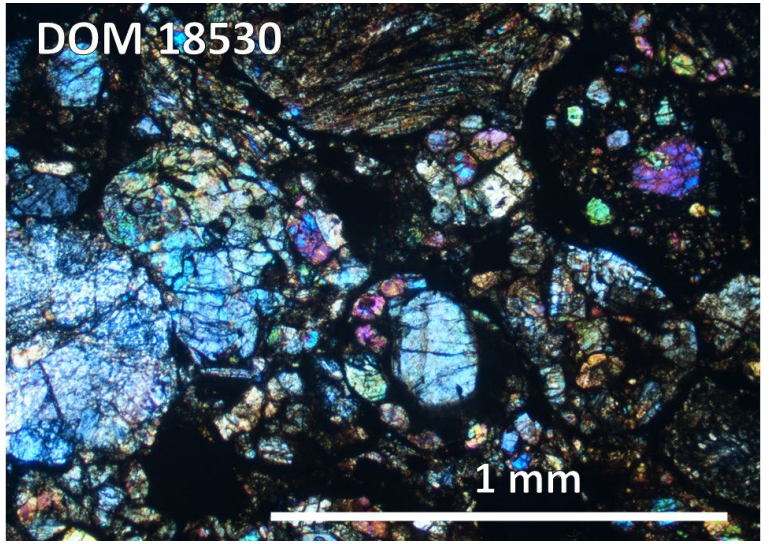
CR2 chondrite





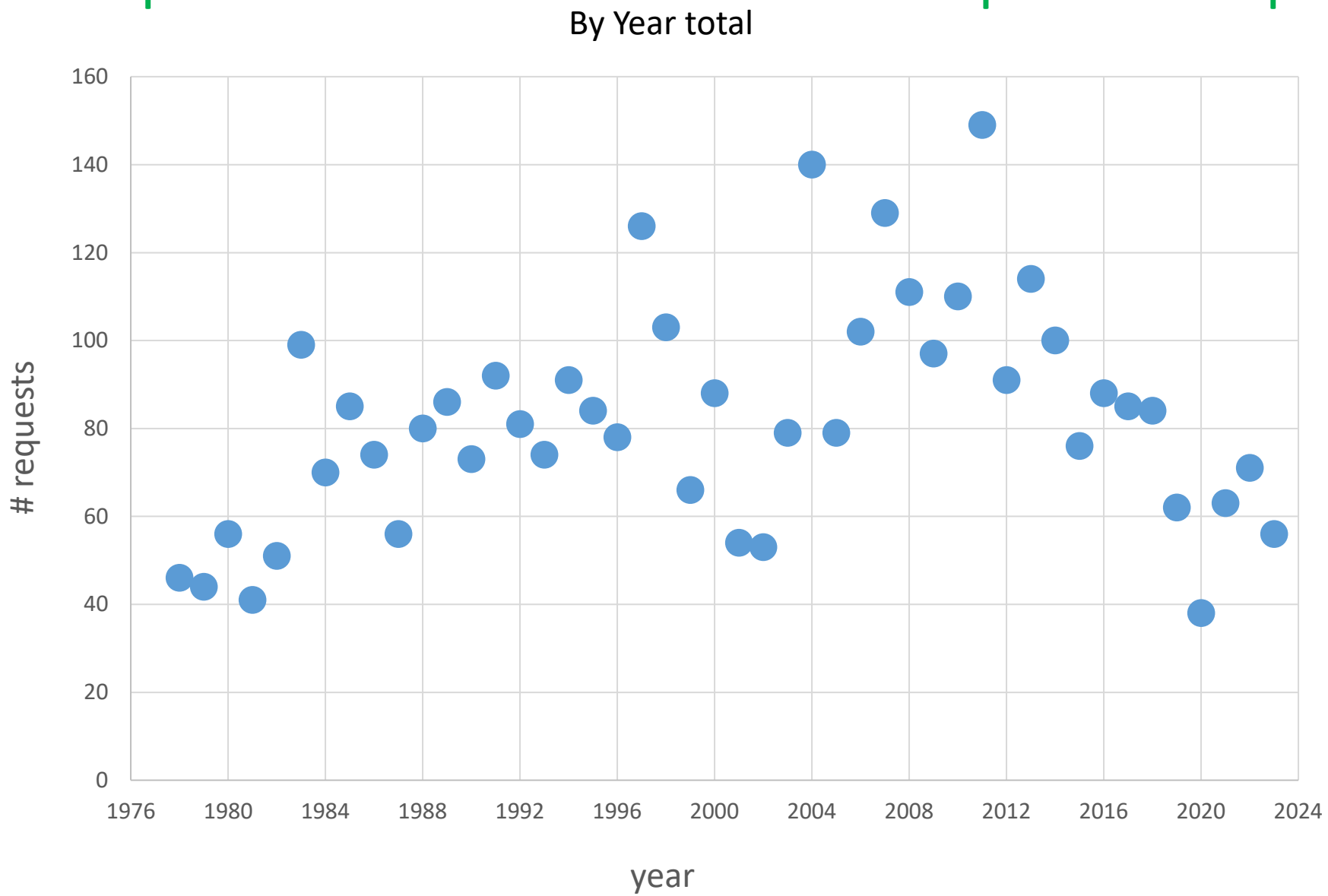
L3.5 chondrite



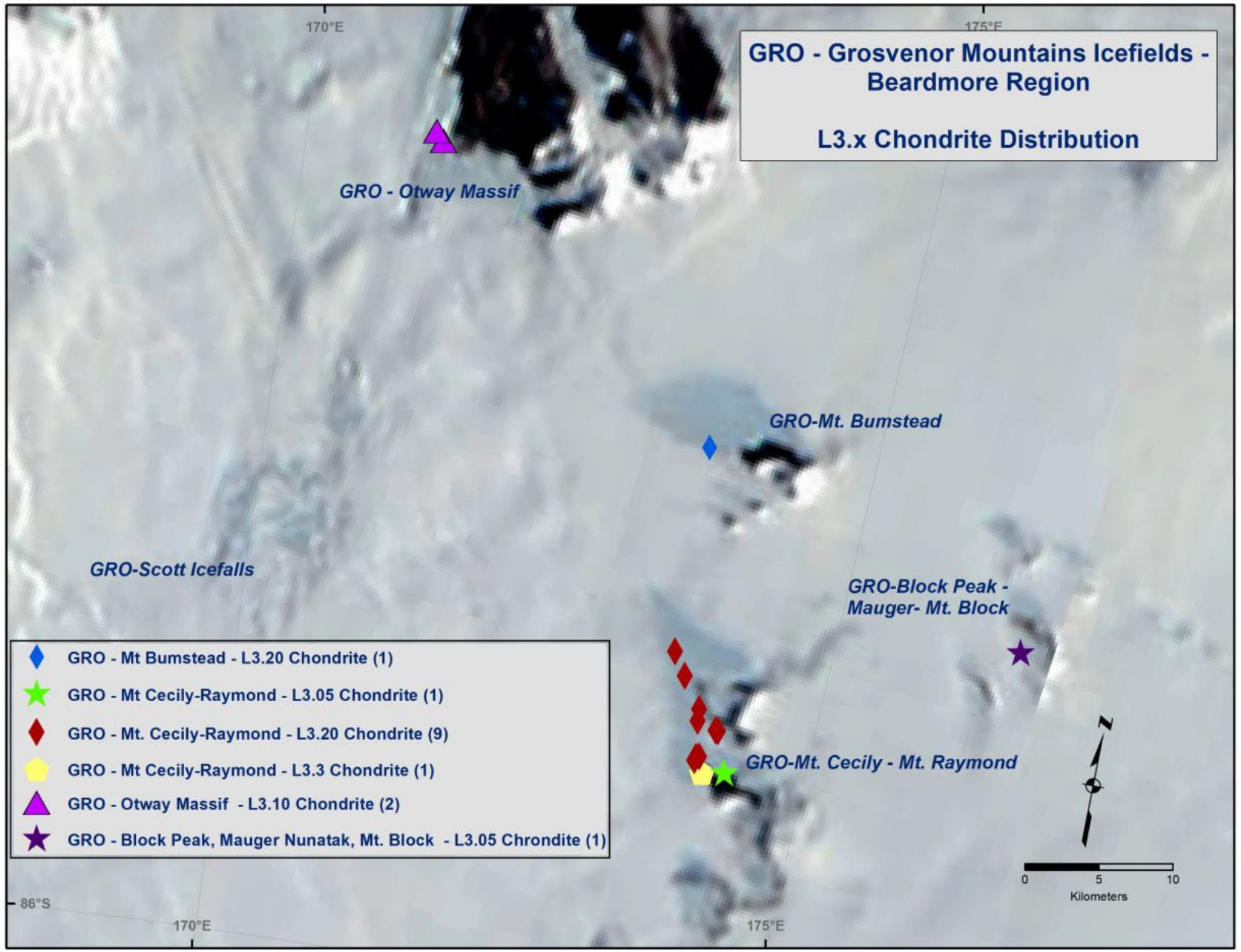


Request statistics

Received 56 requests in 2023 overall and 25 requests for Spring 2023



Focusing on re-classifications and pairing updates:



Unequilibrated ordinary chondrites - identified 23 primitive UOCs (≤3.10) from EET, GRO, LEW, and MET dense collection areas (previously 3.3-3.7)

Using Cr contents of Type II chondrule olivine

For example, these 4 were L3.5, 3.6:

3.05:
GRO 95558
GRO 06054

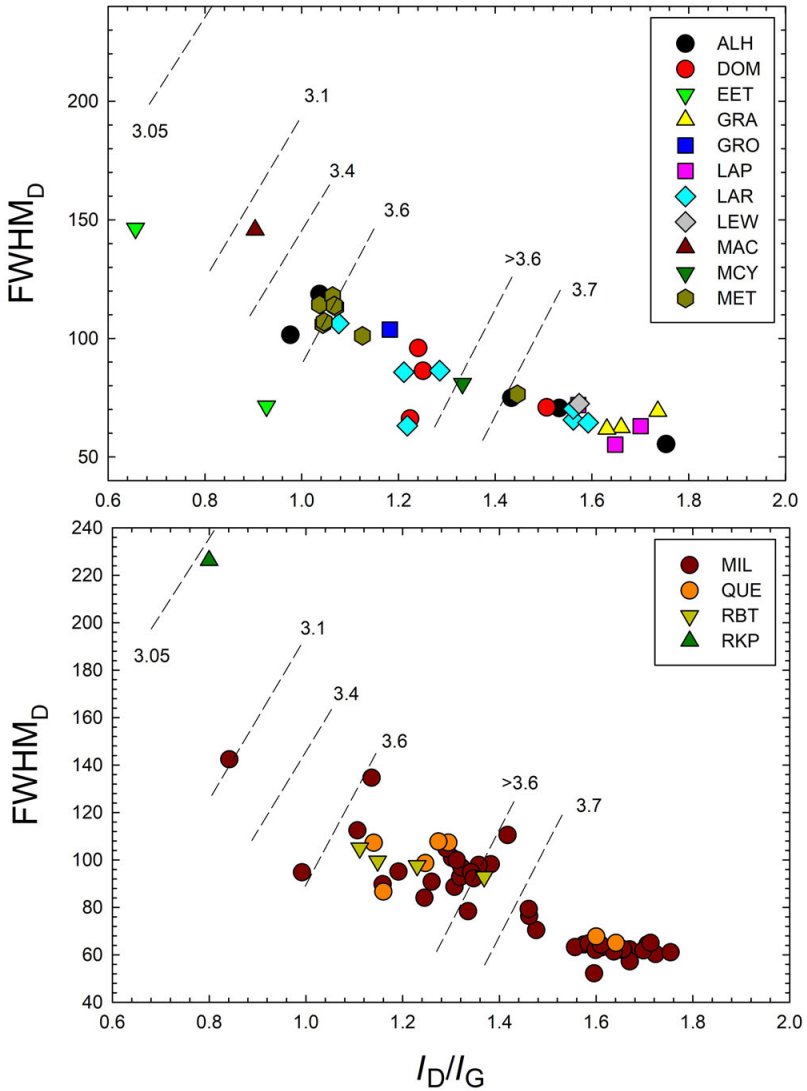
3.10:
GRO 03015
GRO 03061

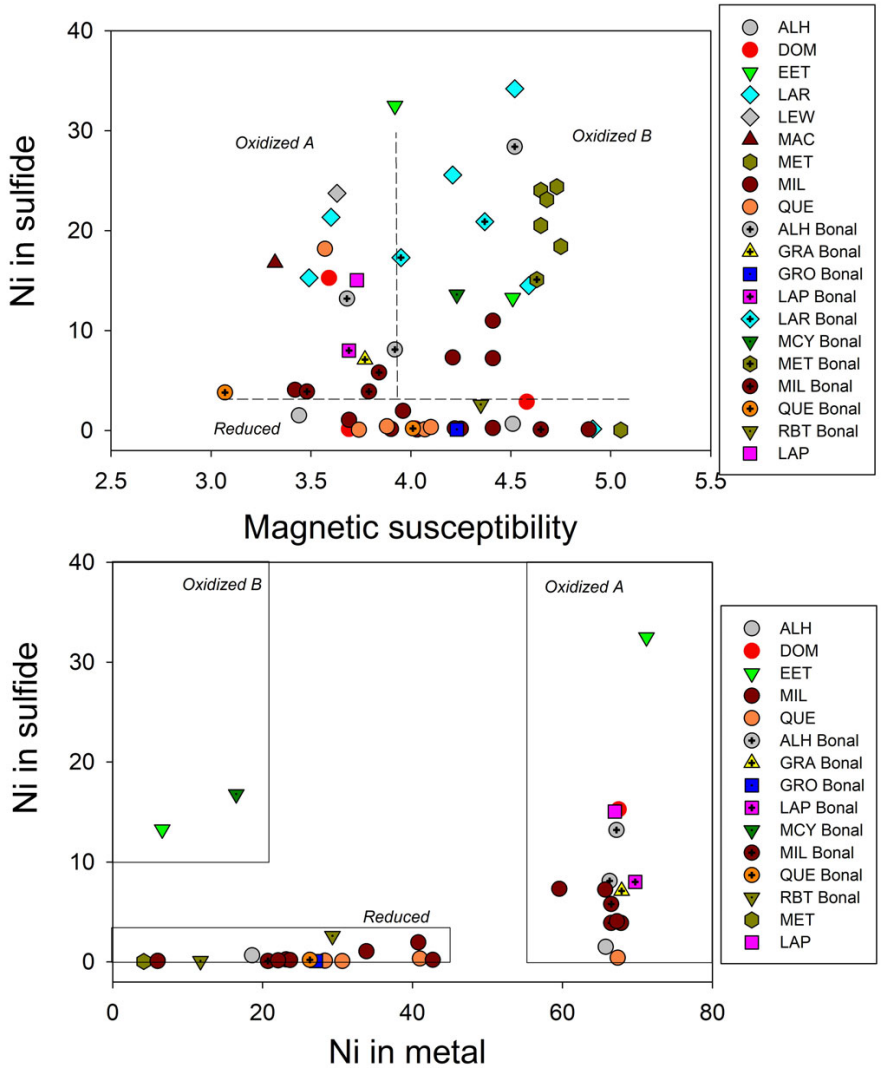
from Righter, K., Schutt, J., Lunning, N., Harvey, R. and Karner, J., 2021. Identification and pairing reassessment of unequilibrated ordinary chondrites from four Antarctic dense collection areas. *Meteoritics & Planetary Science*, *56*(8), pp.1556-1573.

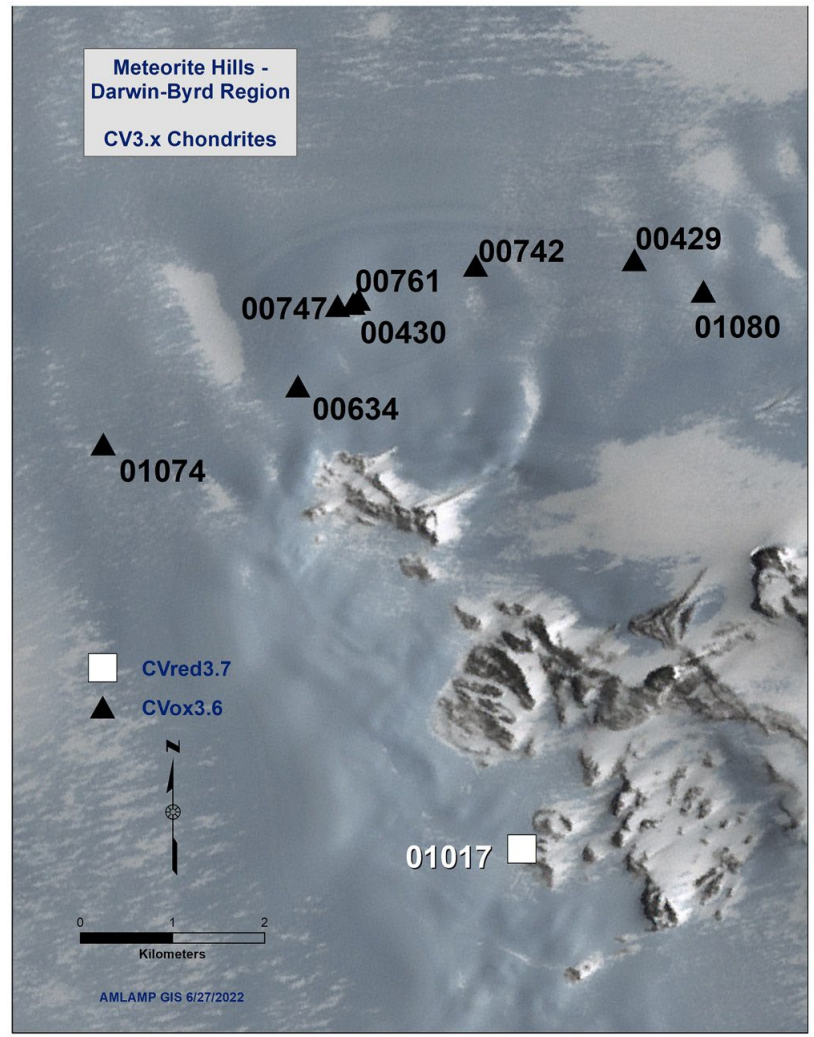
Focusing on re-classifications and pairing updates:

CV from entire collection

Used petrography, EMPA, CT scanning, and Raman D/G bands to assess CV classification and pairing





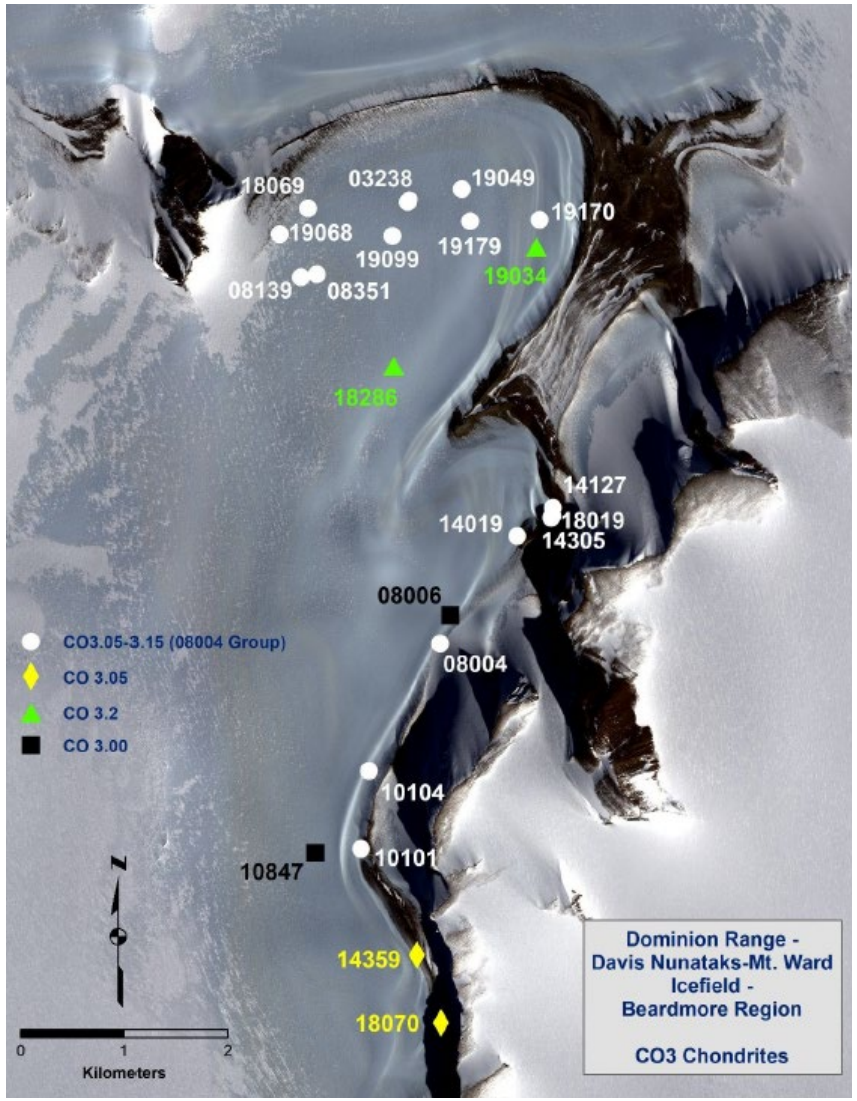


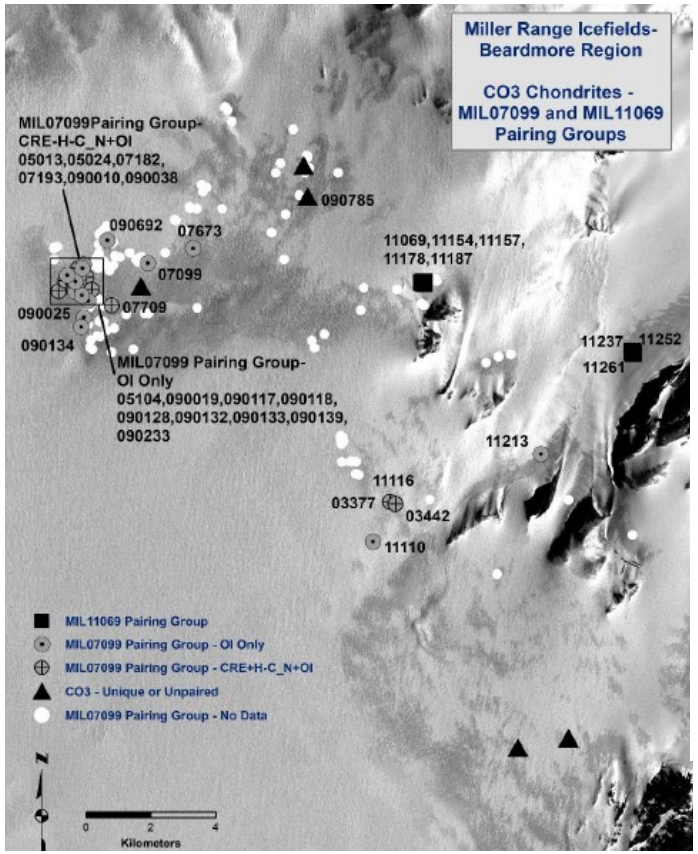
from Righter, K., Jakubek, R.S., Fries, M.D., Schutt, J., Pando, K. and Harrington, R., 2023. Assessment of petrologic subtypes, subgroups, and pairing within CV chondrites in the US Antarctic meteorite collection. *Meteoritics & Planetary Science*, *58*(1), pp.25-40.

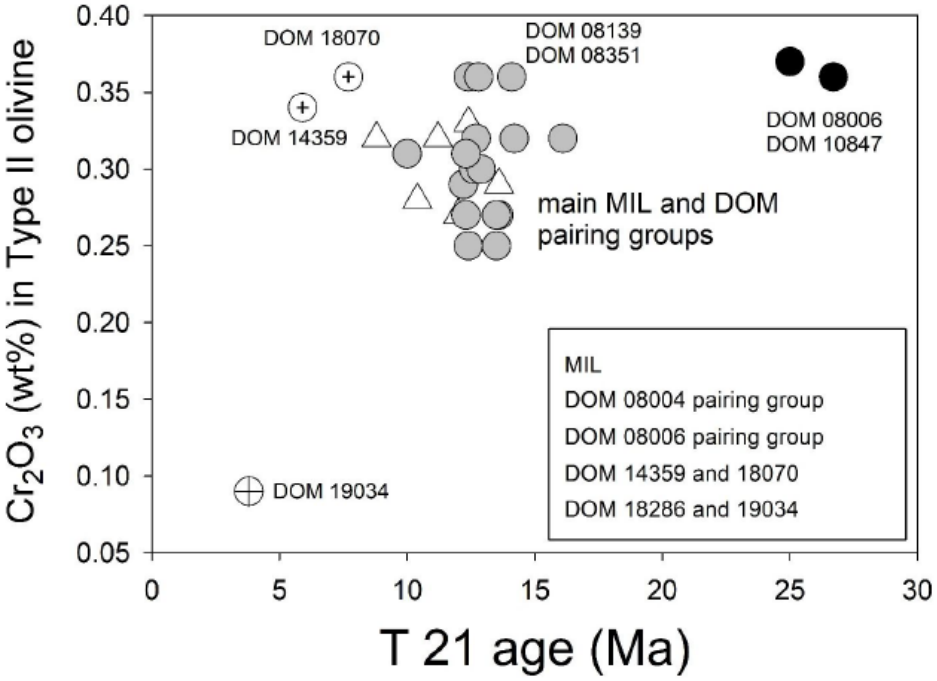
Focusing on re-classifications and pairing updates:

CO from DOM, MIL

Used EMPA of Cr in olivine, H/C/N bulk and isotopic, and noble gas CRE to assess classification and pairing







from Righter, Alexander, Foustoukos, Eckart, Mertens, Busemann, Maden, Schutt, Satterwhite, Harvey, Pando, Karner (in review) MaPS

CO from DOM, MIL

from Righter et al. (2023) MaPS

Miller Range

Group 1 (200, main MIL CO3 pairing group): 03377; 03442; 05013; 05024; 05104; **07099**; 07182; 07193; 07265; 07292; 07293; 07295; 07298; 07300; 07302; 07303; 07304; 07306; 07311; 07313; 07315; 07322; 07336; 07338; 07341; 07342; 07343; 07346; 07350; 07356; 07357; 07358; 07361; 07368; 07383; 07384; 07389; 07400; 07401; 07407; 07408; 07417; 07418; 07421; 07425; 07439; 07444; 07445; 07459; 07473; 07485; 07505; 07506; 07531; 07546; 07552; 07555; 07560; 07616; 07621; 07626; 07628; 07629; 07631; 07673; 07688; 07695; 07709; 090010; 090019; 090025; 090038; 090073; 090117; 090118; 090122; 090128; 090132; 090133; 090134; 090138; 090139; 090152; 090216; 090219; 090227; 090230; 090231; 090233; 090235; 090236; 090264; 090293; 090301; 090308; 090327; 090342; 090343; 090346; 090351; 090392; 090427; 090428; 090437; 090439; 090446; 090451; 090453; 090454; 090457; 090459; 090461; 090462; 090463; 090464; 090465; 090466; 090467; 090468; 090469; 090470; 090473; 090474; 090478; 090480; 090482; 090483; 090485; 090486; 090488; 090514; 090535; 090539; 090543; 090554; 090558; 090588; 090591; 090593; 090594; 090596; 090597; 090598; 090641; 090683; 090686; 090692; 090696; 090699; 090705; 090708; 090710; 090712; 090714; 090716; 090717; 090722; 090723; 090727; 090730; 090821; 090840; 090890; 090891; 090897; 090907; 090915; 090919; 090955; 090967; 090983; 090988; 090989; 11019; 11050; 11051; 11055; 11057; 11061; 11063; 11101; 11109; 11110; 11116; 11118; 11119; 11120; 11121; 11124; 11130; 11132; 11139; 11140; 11147; 11150; 11152; 11193; 11203; 11213; 11261; 11293.

Group 2 (7): **MIL 11069**; 11154; 11157; 11178; 11187; 11237; 11252.

Unpaired or unique:

MIL 090369
MIL 090785
MIL 13214
MIL 15464
MIL 15558



MIL 090073



MIL 05013

Dominion Range

Group 1 (16, main DOM pairing group): DOM 03238; **08004**; 08139; 08351; 10101; 10104; 14019; 14127; 14305; 18019; 18069; 19049; 19068; 19099; 19170; 19179.

Group 2 (2): **DOM 08006**; 10847

Unpaired or unique:

DOM 14359
DOM 18070
DOM 18286
DOM 19034



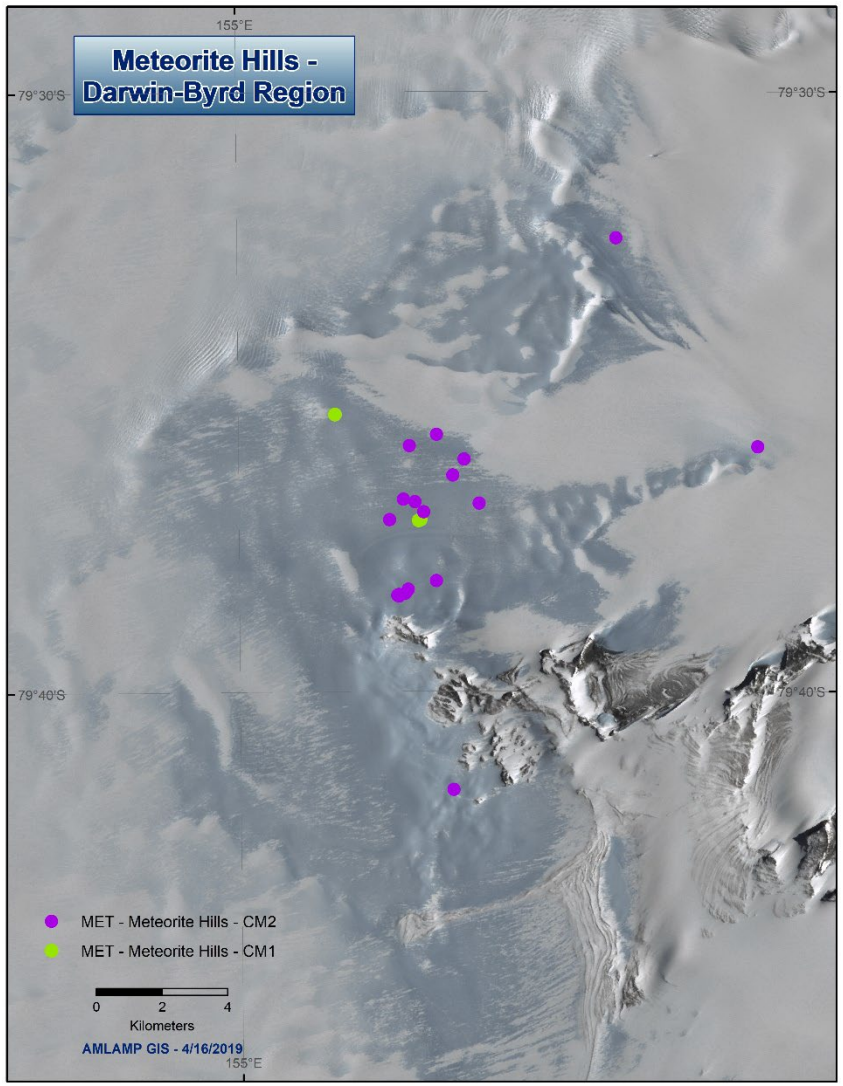
DOM08006



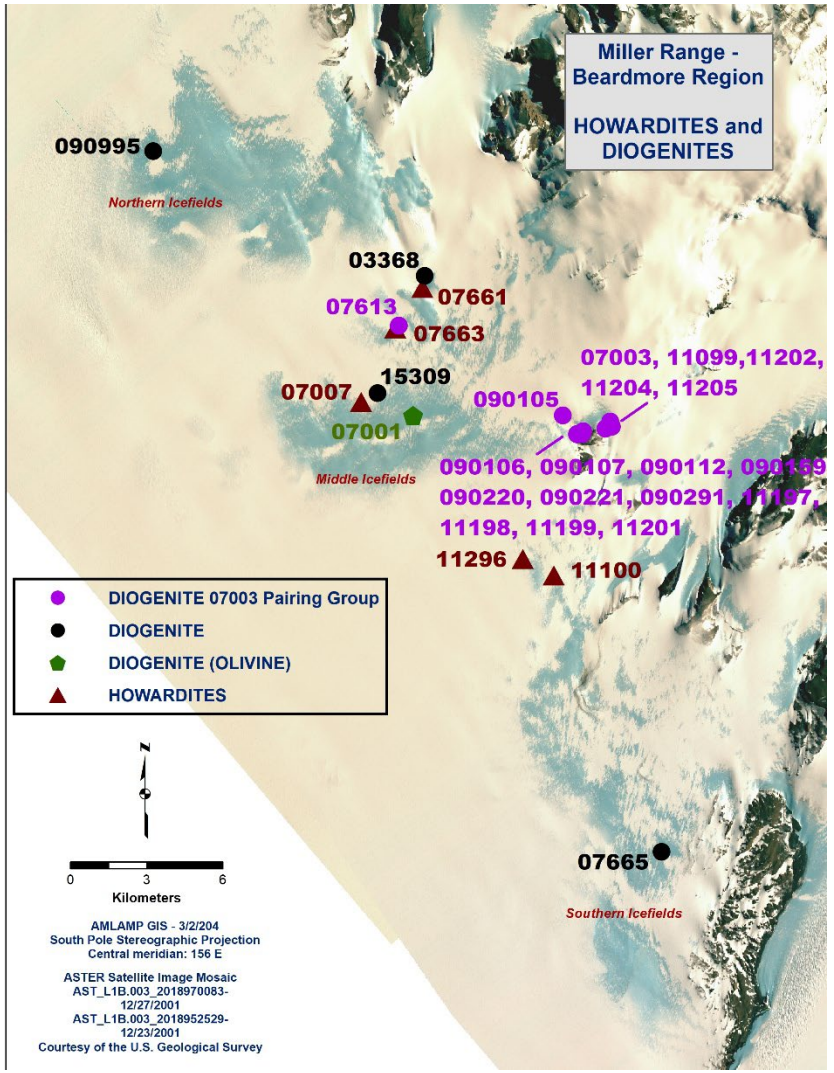
DOM 10847

Pairing assessments in focused areas

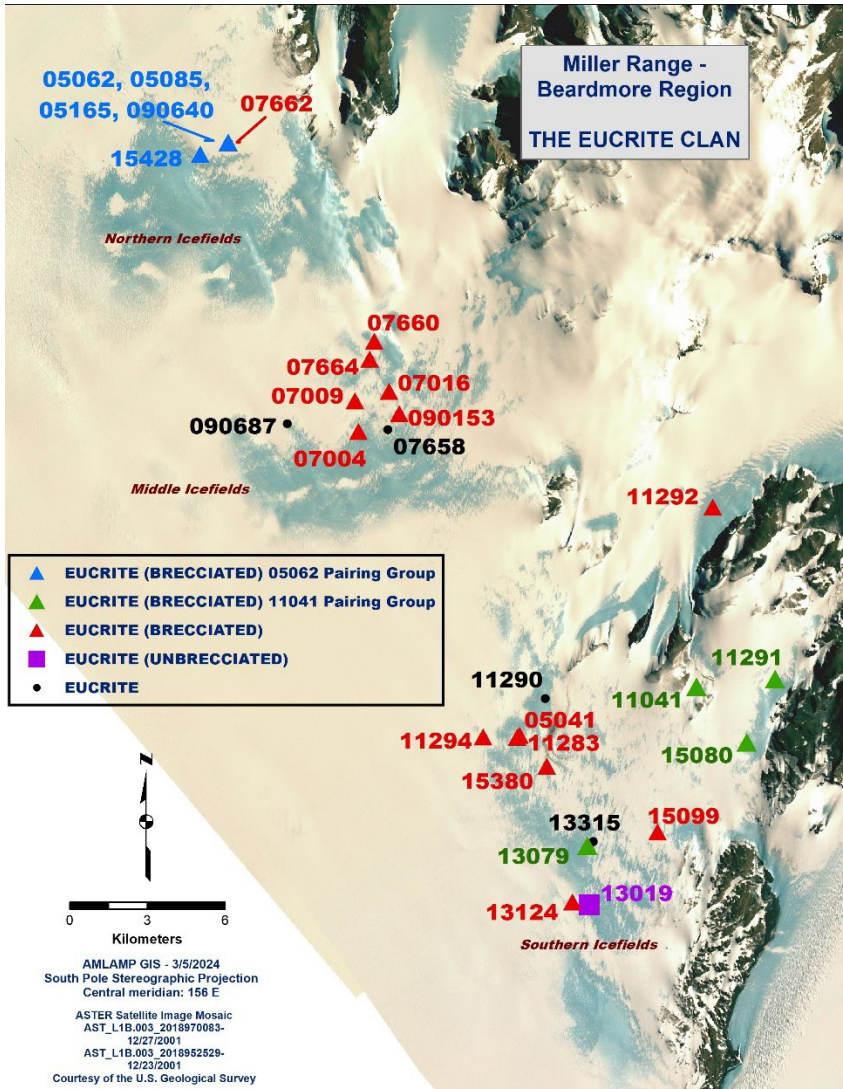
MET CM chondrites (in progress with A. King)



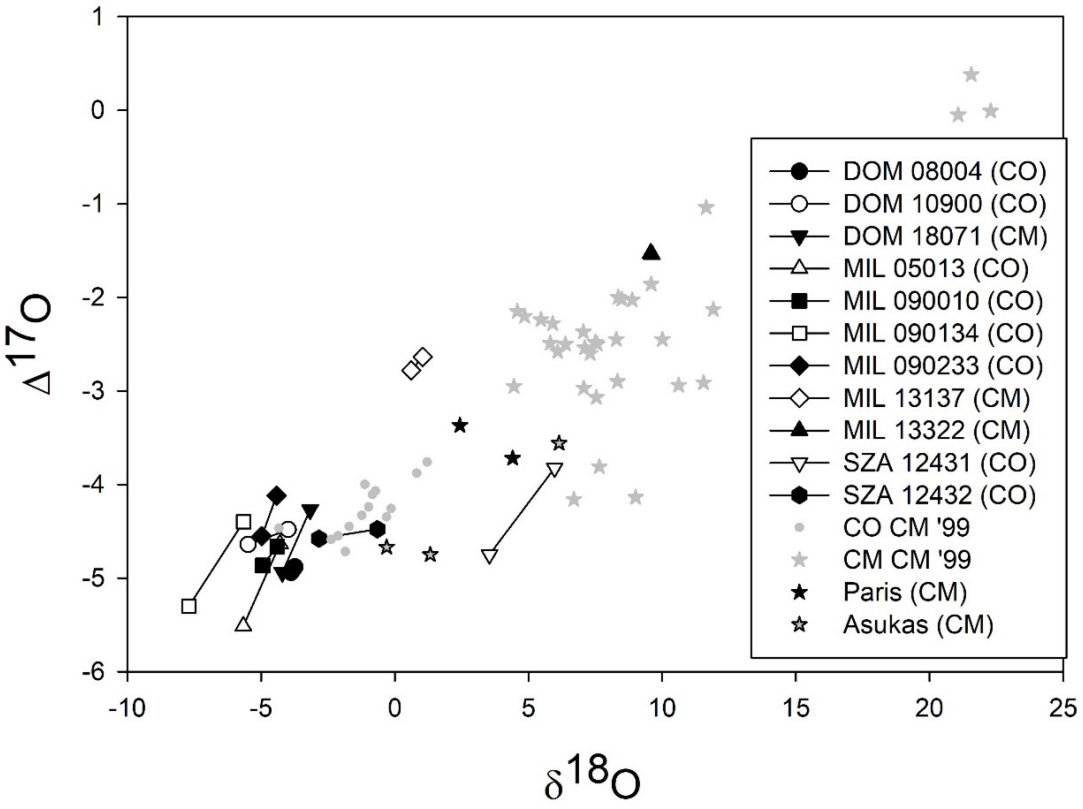
MIL How / Diog (Reported at LPSC 2024 – Welten, Nishiizumi, Caffee)



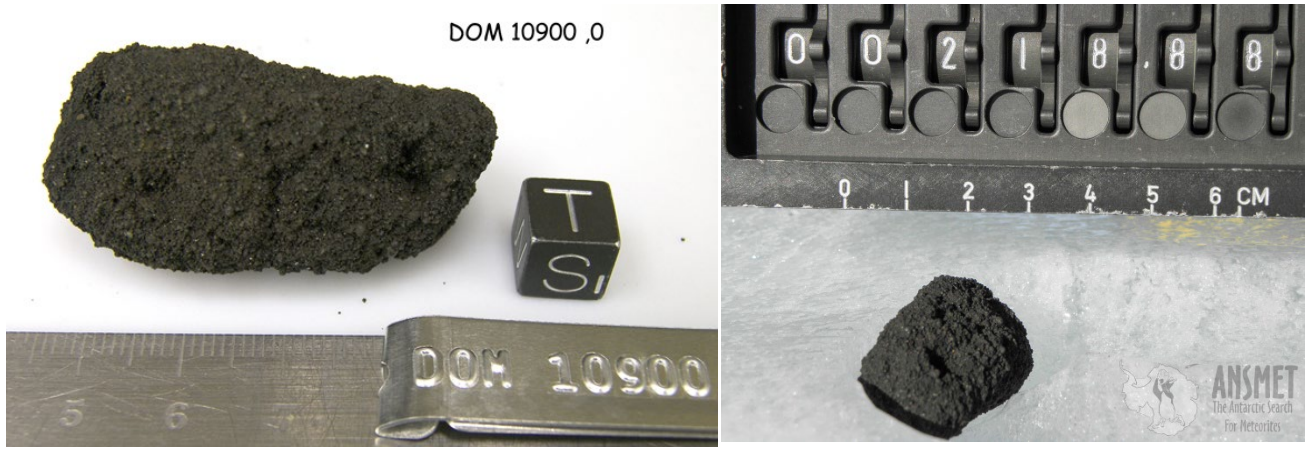
MIL Eucrites



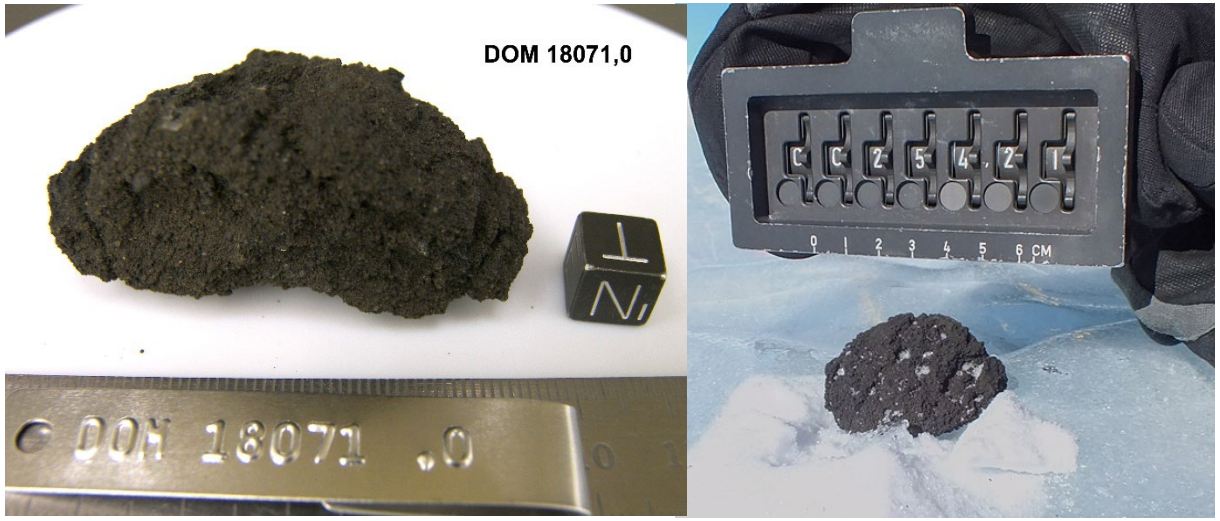
Focusing on re-classifications and pairing updates: Initiating CM and CO oxygen analyses to address classification and pairing



Working with Justin Hayles and Paul Niles on analyzing meteorites of uncertain classification – laser fluorination line at JSC (Spring 2024 Antarctic Meteorite Newsletter)

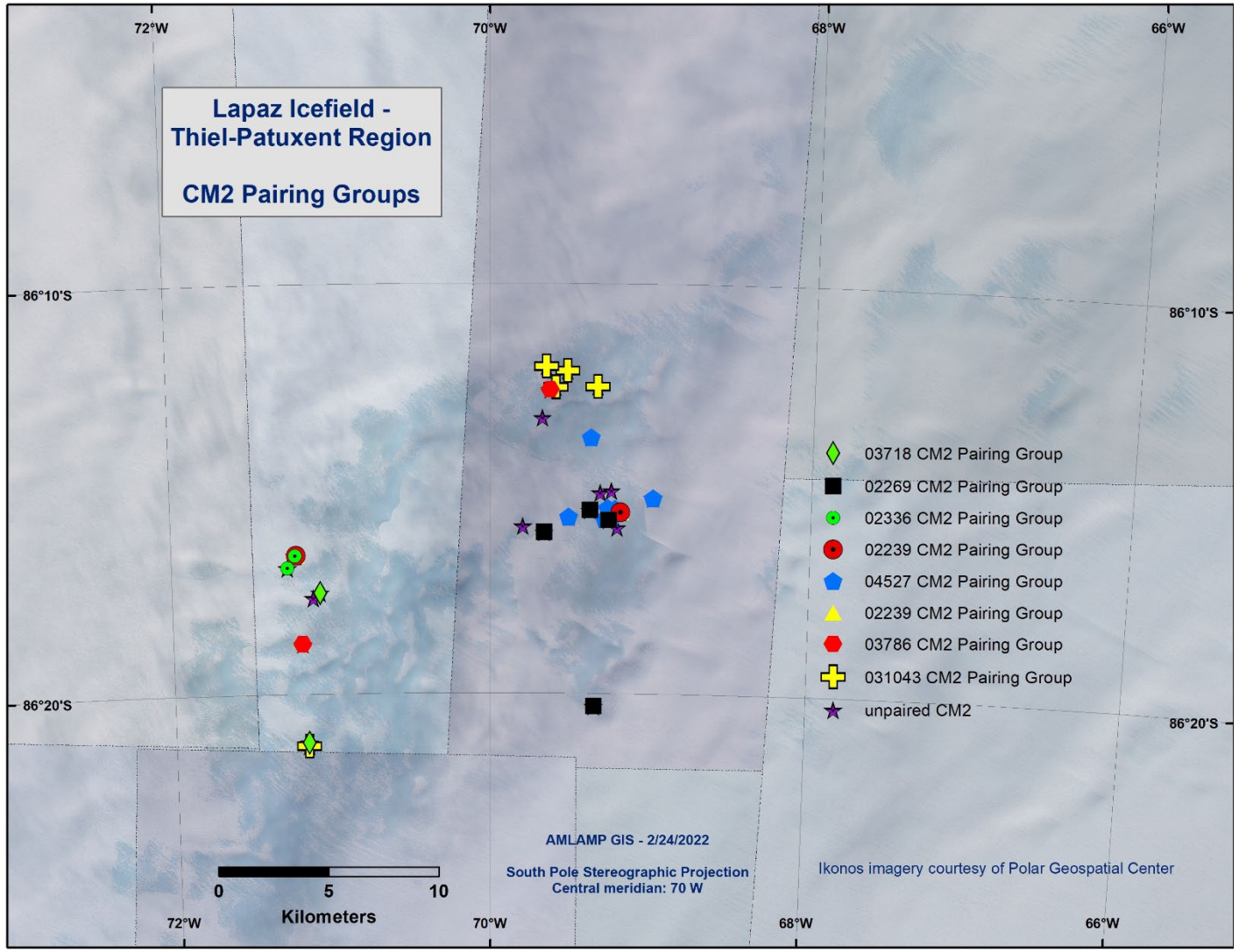


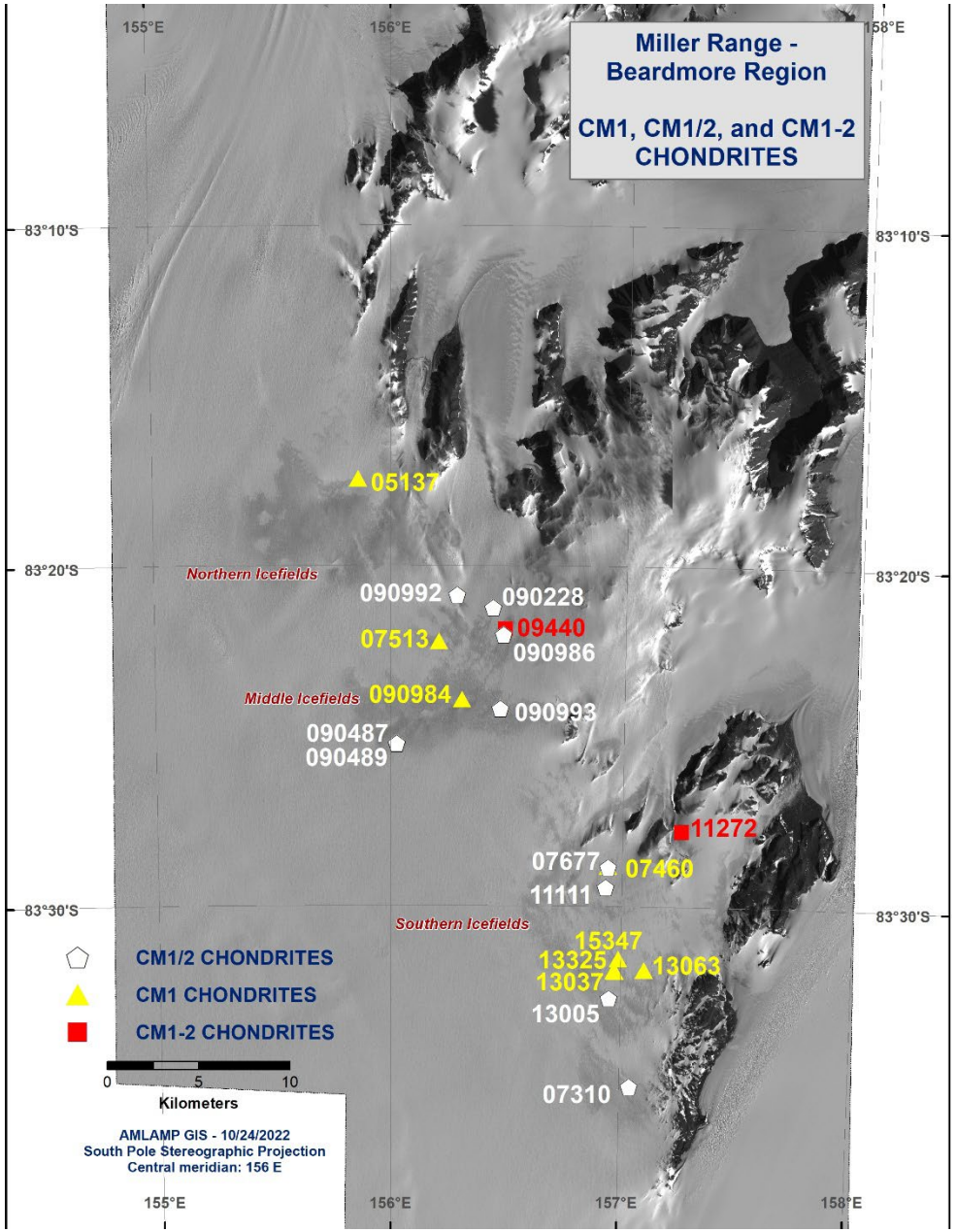
DOM 10900 - CO3



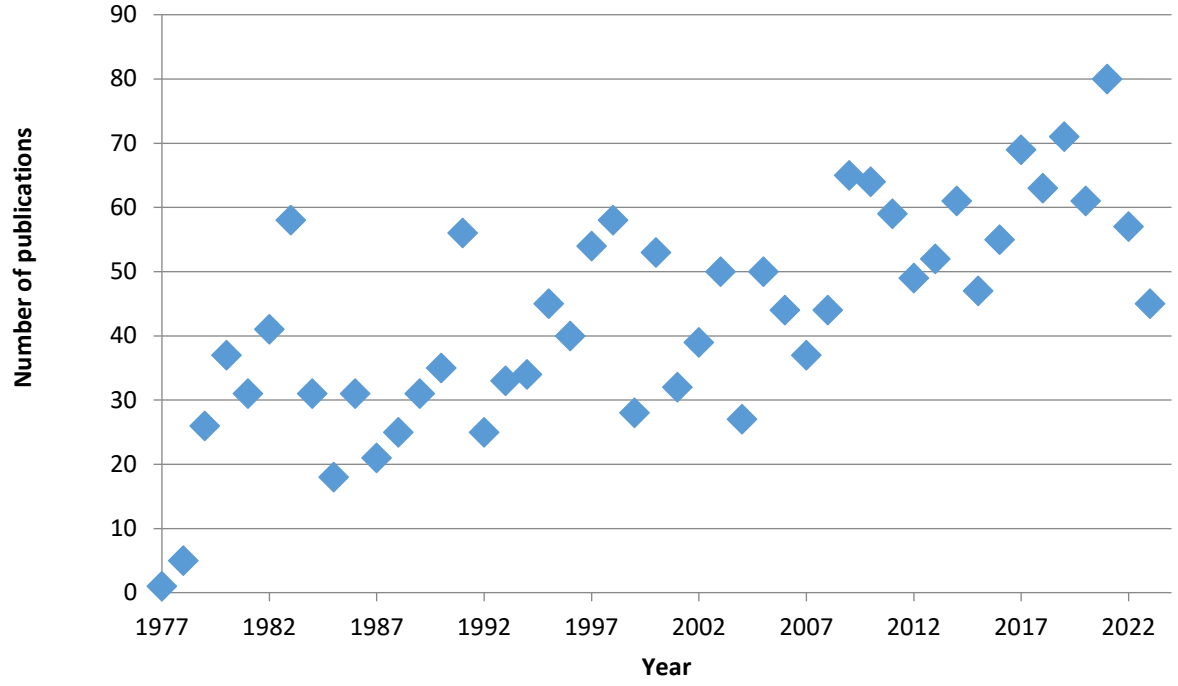
DOM 18071 - CM2

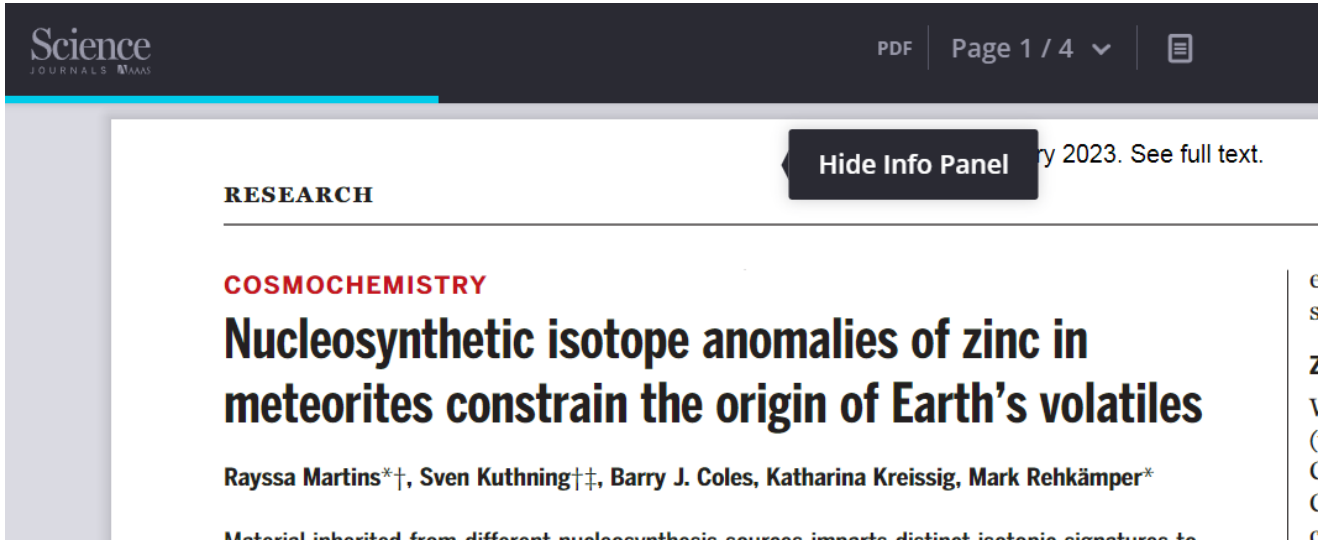
Miller Range CM1 and 1/2 chondrites
LaPaz Icefield CM2 chondrites





Bibliography updated for papers reporting data from ANSMET samples thru 2023.




Science JOURNALS AAAS

PDF | Page 1 / 4

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...y 2023. See full text.

RESEARCH

COSMOCHEMISTRY

Nucleosynthetic isotope anomalies of zinc in meteorites constrain the origin of Earth's volatiles

Rayssa Martins*†, Sven Kuthning†‡, Barry J. Coles, Katharina Kreissig, Mark Rehkämper*

Material inherited from different nucleosynthesis sources imparts distinct isotopic signatures to

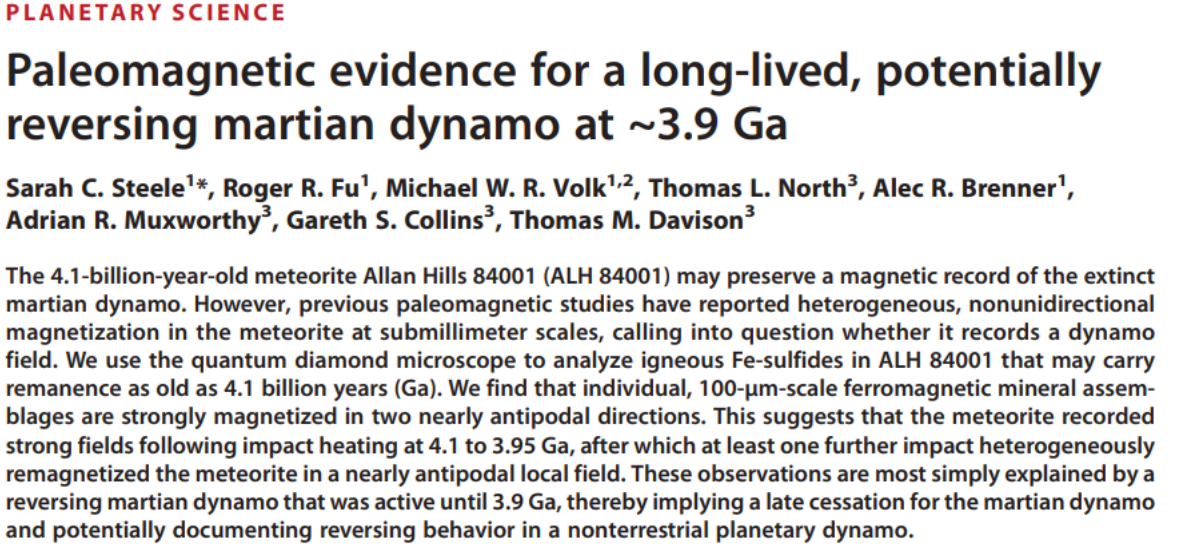
Article

Silicon isotope constraints on terrestrial planet accretion

https://doi.org/10.1038/s41586-023-06135-z
Received: 5 January 2022
Accepted: 26 April 2023
Published online: 14 June 2023
Open access
Check for updates

Isaac J. Onyett[1✉], Martin Schiller[1], Georgy V. Makhatadze[1], Zhengbin Deng[1], Anders Johansen[1,2] & Martin Bizzarro[1,3]

Understanding the nature and origin of the precursor material to terrestrial planets is key to deciphering the mechanisms and timescales of planet formation[1]. Nucleosynthetic variability among rocky Solar System bodies can trace the composition of planetary building blocks[2–5]. Here we report the nucleosynthetic composition of silicon (μ^{30}Si), the most abundant refractory planet-building element, in primitive and differentiated meteorites to identify terrestrial planet precursors.


SCIENCE ADVANCES | RESEARCH ARTICLE

PLANETARY SCIENCE

Paleomagnetic evidence for a long-lived, potentially reversing martian dynamo at ~3.9 Ga

Sarah C. Steele[1]*, Roger R. Fu[1], Michael W. R. Volk[1,2], Thomas L. North[3], Alec R. Brenner[1], Adrian R. Muxworthy[3], Gareth S. Collins[3], Thomas M. Davison[3]

The 4.1-billion-year-old meteorite Allan Hills 84001 (ALH 84001) may preserve a magnetic record of the extinct martian dynamo. However, previous paleomagnetic studies have reported heterogeneous, nonunidirectional magnetization in the meteorite at submillimeter scales, calling into question whether it records a dynamo field. We use the quantum diamond microscope to analyze igneous Fe-sulfides in ALH 84001 that may carry remanence as old as 4.1 billion years (Ga). We find that individual, 100-μm-scale ferromagnetic mineral assemblages are strongly magnetized in two nearly antipodal directions. This suggests that the meteorite recorded strong fields following impact heating at 4.1 to 3.95 Ga, after which at least one further impact heterogeneously remagnetized the meteorite in a nearly antipodal local field. These observations are most simply explained by a reversing martian dynamo that was active until 3.9 Ga, thereby implying a late cessation for the martian dynamo and potentially documenting reversing behavior in a nonterrestrial planetary dynamo.

Lunar meteorite compendium Updated in several ways:

Added detailed write-ups on US Antarctic meteorite lunars

Updated comprehensive listing of lunar meteorites

>140 samples

> 417 kg

Miller Range 090036

Anorthositic regolith breccia

244.83 g



Figure 1: *MIL 090036 as recovered in the field. Field photo image(s) courtesy of the* ***ANSMET*** *Program, Case Western Reserve Univ. and the Univ. of Utah.*

Introduction: The 2009-10 season ANSMET team recovered MIL 090036 which was classified as a lunar anorthositic breccia (**Figure 1**) and reported in the Antarctic Meteorite Newsletter 33

Miller Range 13317

Polymict regolith breccia

32.25 g



Figure 1: *MIL 13317 as recovered in the field. Field photo image(s) courtesy of the* ***ANSMET*** *Program, Case Western Reserve Univ. and the Univ. of Utah.*

Introduction: The 2013-14 season ANSMET team recovered MIL 13317 which was classified as a lunar anorthositic breccia (**Figure 1**) and reported in the Antarctic Meteorite Newsletter

Dominion Range

18242, 18244, 18262, 18509, 18543, 18545, 18666, 18678

Polymict regolith breccia

140.85 g



Figure 1: DOM 18666 (left) as recovered and interior of DOM 18545 (right).

Introduction: The 2018-19 season ANSMET team recovered eight lunar meteorites (**Figure 1**), reported in three different newsletters (Satterwhite and Righter, 2019, 2020, 2022). All were found near the northern edge of the blue ice tongue or at the edge in the moraine (**Figure 2**). The largest mass is 45.87 g, ranging down to lowest mass of 5.46 g (**Figure 3**; **Table 1**).

neralogy: All of the DOM lunar masses have greyish olive fusion crust, with ic lithic clasts up to 0.5 cm in size. In addition to the lithic clasts are mineral plagioclase feldspar) and glass spherules (Zeigler et al., 2020; Hayden et al.

Miller Range 090034, 090070, 090075

Anorthositic regolith breccia

195.57, 137.46, 143.52 g



Figure 1: *MIL 090034 (left), and MIL 090070 and MIL090075 (right) as recovered in the field. Field photo image(s) courtesy of the* ***ANSMET*** *Program, Case Western Reserve Univ. and the Univ. of Utah.*

Introduction: The 2009-10 season ANSMET team recovered MIL 090034, MIL 090070, and MIL 090075 which were classified as lunar anorthositic breccias (**Figure 1**) and reported in the Antarctic Meteorite Newsletter 33 no. 2 (Satterwhite and Righter, 2010). MIL 090034 was found