Antarctic Meteorite Newsletter

Volume 44, Number 2 September 2021

Curator Comments
Kevin Righter, NASA-JSC

We announce 90 newly classified Antarctic meteorites from the 2017, 2018, and 2019 ANSMET collection years, including the first group examined from the Dominion Range 2019-2020 team. Among this group of 90 are a brecciated eucrite, a ureilite, seven CO3, two CM2, and one CK chondrite, as well as an unequilibrated H3, and two L melt breccias (one heavily shocked). Antarctic meteorite program staff at both the Smithsonian Institution and NASA Johnson Space Center have been working under unusual conditions of limited access to the cleanrooms, analytical labs, and office spaces to assemble all the information reported in this newsletter. That we have a robust Fall 2021 newsletter is entirely due to admirable efforts at both institutions, coordinating the samples and work in an improvised and safe manner.

We also report some significant pairing re-assessments and re-classifications, the details of which are given below. Finally, we announce the availability of XCT data from 15 of our carbonaceous chondrites. These data were acquired to address issues of pairing, classification, and heterogeneity, and we also want to make them available to the community, as announced here.

Report from the Smithsonian
Cari Corrigan, Geologist (Dept. of Mineral Sci.)

The Smithsonian, at the time of this printing, has been reopened to the public after COVID closures. Staff, however, remain on extensive telework, severely restricting access. This newsletter is a return to a more normal classification structure, though analyses, photographs and observations were still conducted on the limited occasions we were able to enter the Museum. As conducting lab work is high on the priority list, we were able to classify 90 meteorites using both electron microprobe and EDS analyses for this newsletter. Our collaborative method of analyzing, describing, and classifying meteorites was still restricted due to our inability to spend extended periods of time in the same room and discuss the features of each meteorite together as we would usually do.

In more positive news, the Smithsonian has ordered a new scanning electron microscope to be delivered in October 2021. This new instrument, once installed certified, will eventually be used to classify ordinary chondrites using the dual EDS system.

Our collections are still closed to loans and will likely remain so until later in 2021 or early 2022. Once we return to work on a regular basis, we will work diligently to fulfill the recommended requests. We sincerely hope that you and your families are all safe and well.

A periodical to inform scientists of the basic characteristics of specimens recovered in the Antarctic.

Edited by Cecilia Satterwhite, Kellye Pando and Kevin Righter, NASA Johnson Space Center, Houston, Texas 77058

Inside this Issue

**Sample Request Deadline
October 1, 2021**

**AMAP Meets
October 20 2021**

ANSMET Report
Jim Karner, University of Utah

We've all had to deal with the disappointment of cancelled or completely transformed events since the pandemic hit full swing 18 months ago. Professionally, we've all been affected by the myriad cancellations, terminations, and suspensions of in-person classes, conferences, meetings, field work and laboratory time. Privately, it has not been much better- my beer-league hockey team was perched at number one going into the 2020 playoffs before dealing with the heartbreak of a completely cancelled season! A tough break for the Western Door team of the Salt Lake County, Division 2 Adult Hockey League, for sure.

Thus it is probably not a surprise that the 2021-22 ANSMET season has been cancelled. We predicted this about half a year ago, as the US Antarctic Program (USAP) had started to make a slow recovery from the pandemic but is still dry on critical resources like fuel and logistics. This coming season, the USAP will run at a reduced capacity and mainly support activities that are 1) required for safe and continuous operation of all three US stations and resupply of those stations, as well as 2) needed to minimize irreversible impacts on science, construction, and future operations. ANSMET falls into a third tier of activities not included in the above categories-USAP expects to support a very small number of these in the upcoming season, but ANSMET is not one of them.

We look forward to our next season in the field, which hopefully will be 2022-23! Seems like a long way off but we've already started thinking about our return to a final (?) season at Davis-Ward and a return (last visited in 2003) to the main Dominion Range icefield as our next target. We'll continue to plan for that next field season and also take the time to evaluate, replace, and upgrade vital equipment as well as turn field data and observations into scientific publications. I'll also continue to read, evaluate and file those volunteer application letters.

Figure 1. Indoors, absolutely no social distancing, and no masks?!? That was ANSMET life pre-pandemic.

Pairing re-assessments

a) unequilibrated ordinary chondrites

We have recently done a systematic re-assessment of pairing relations among unequilibrated ordinary chondrites from 4 dense collection areas in Antarctica (Righter et al., 2021a). Some of these have been paired for many years, but the discovery of distinct characteristics of individual members of the groups have led to both uncertainty in the members of pairing groups, as well as speculation that some rare or precious samples might be "hidden" in these groups. To identify more rare or interesting meteorites, and update the pairing groups as best as possible, Cr contents of olivines in Type II chondrules have been measured in many of these samples. Upon identification of new groupings and unique samples, we propose the following new classifications (while also noting that many classifications of samples from these dense collection areas remain unchanged). Paired samples are grouped below; some samples have been reclassified but are not paired with any others.

EET 83274 – L3.6 to L3.2

EET 90066 – L3.3 to L3.00
EET 90161 – L3.0 to L3.00
EET 90261 – L3.4 to L3.00
EET 90909 – L3.6 to L3.00

EET 87735 – L3.4 to L3.05
EET 90080 – L3.4 to L3.05
EET 90519 – L3.6 to L3.05
EET 90916 – L3.6 to L3.05
EET 90628 – L3.4 to L3.10

EET 92100 – L3.4 to L3.00

EET 96015 – L3.4 to L3.15
EET 96216 – L3.8 to L3.15

LEW 86134 – L3.0 to L3.05

LEW 87208 – L3.4 to L3.00

LEW 97202 – L3.4 to L3.05

LEW 87248 – L3.5 to L3.15
LEW 87284 – L3.5 to L3.15
LEW 88254 – L3.4 to L3.15
LEW 85434 – L3.4 to L3.15
LEW 85437 – L3.4 to L3.15
LEW 88462 – L3.7 to L3.15

LEW 86207 – L3.2 to L3.2
LEW 86102 – L3.4 to L3.2
LEW 88634 – L3.4 to L3.2
LEW 88520 – L3.5 to L3.2
LEW 86018 – L3.1 to L3.2
LEW 86144 – L3.0 to L3.2
LEW 86158 – L3.0 to L3.2
LEW 86270 – L3.1 to L3.2

GRO 95558 – L3.5 to L3.05

GRO 06054 – L3.6 to L3.05

GRO 03015 – L3.6 to L3.10
GRO 03061 – L3.6 to L3.10

GRO 95502 – L3.2 to L3.2
GRO 95504 – L3.5 to L3.2
GRO 95512 – L3.5 to L3.2
GRO 95539 – L3.1 to L3.2
GRO 95542 – L3.5 to L3.2
GRO 95545 – L3.5 to L3.2
GRO 95544 – L3.2 to L3.2
GRO 95550 – L3.5 to L3.2
GRO 95546 – L3.8 to L3.2

GRO 95505 – L3.4 to L3.2

MET 00452 – L(LL)3.05 – no change
MET 00526 – L(LL)3.05 – no change
MET 00621 – L3.6 to L(LL)3.05

MET 96503 – L3.10 – no change

MET 96515 – L3.5 to L3.10
MET 01051 – L3.6 to L3.10
MET 01056 – L3.6 to L3.10
MET 01057 – L3.6 to L3.10

MET 00506 – H3.4 to H3.10
MET 00552 – H3.4 to H3.10
MET 00607 – H3.4 to H3.10

b) Dominion Range CO3 chondrites (Righter et al., 2021b)

A large pairing group of CO3 chondrites from the Dominion Range was recognized among the 2008 (4) and subsequent collection years (additional 14 plus any newly collected in 2019-2020). As data was acquired by various scientists studying individual samples, it has become clear that DOM 08006 is more primitive than other members of this group. Because it is a large group of samples, and identification of additional primitive material is of high priority, we have undertaken a systematic look at these CO3s to make a re-assessment of pairing. We combine Cr contents of olivine from Type II chondrules with H, C, N bulk and isotopic measurements (C. Alexander and D. Foustoukos), and ^{21}Ne cosmic ray exposure age (CRE) dates (H. Busemann). Preliminary results are reported in the 2021 Meteoritical Society meeting (Righter et al., 2021b) and summarized here with any necessary pairing adjustments. We will present an additional update in a future newsletter regarding the rest of the DOM 18 and 19 samples not yet analyzed.

Two of the samples are among the lowest grade, un-equilibrated CO3, based on Cr contents of olivines, high pre-solar grain contents, and distinct inclusions, and also have distinctly higher CRE ages of ~25 Ma. (Righter et al., 2021b; Davidson et al., 2019; Nittler et al., 2018; Simon and Grossman, 2015). Therefore, they will be paired together:

DOM 08006 - CO3.00
DOM 10847 - CO3.00

Two of the samples have very high matrix contents, distinct H, C, N bulk and isotopic compositions, and have very young CRE age (2.5-2.6 Ma), all consistent with CM2 chondrites:

DOM 10121 – CM2
DOM 10299 – CM2

One sample has unique H, C, N bulk and isotopic compositions and CRE age (5.0 Ma), all indicating that it is not a member of either of the other CO3 pairing groups. We thus have unpaired it with any others:

DOM 14359 – CO3

The following other DOM samples are part of the main pairing group of CO3 chondrites that have a similar H, C, N bulk and isotopic composition and CRE age of 11-12 Ma.

DOM 08004 – no change
DOM 08139 – no change
DOM 08351 – no change
DOM 10101 – no change
DOM 10104 – no change
DOM 10900 – no change
DOM 14019 – no change
DOM 14127 – no change
DOM 14305 – no change

Additional note: DOM 18019, 069, 070, and 286 and the new DOM19 COs announced in this newsletter (DOM 19034, DOM 19049, DOM 19068, DOM 19099, DOM 19170, and DOM 19179) will be evaluated with respect to these groups.

Re-classification

Several eucrites from our collection will be re-classified based on data reported by Mittlefehldt et al. (2021): EET 87520, ALH 85001, and EET 87548.

a) EET 87520

Detailed analyses of EET 87520 and EET 87542 by Mittlefehldt et al. (2021) show that the original microprobe analyses reported for EET 87520 were most likely mistakenly acquired on a section of EET 87542. EET 87520 was (and is) classified as “Eucrite-Mg rich” because of the originally reported pyroxene compositions that were more magnesian than those for typical basaltic eucrites like Sioux County. However, new analyses reported by Mittlefehldt et al. (2021) show that EET 87520 pyroxene compositions are, in fact, as ferroan as those of Sioux County. The petrographic description of this eucrite in the initial description (*Antarctic Meteorite Newsletter* vol. 11, no. 2, 1988) is correct. We therefore will reclassify EET 87520 as an unbrecciated eucrite, which was its initial classification before reclassification as eucrite-Mg rich (*Antarctic Meteorite Newsletter* vol. 17, no. 1, 1994).

b) ALH 85001 and EET 87548

Two meteorites are classified as eucrite-Mg rich in the Meteoritical Bulletin Database: ALH 85001 and EET 87548. This classification type was designed to be used for those eucrites for which definitive evidence of a cumulate origin were not yet available. In the late 1980s, such evidence was not available and “eucrite-Mg rich” was an appropriate designation. However, now there is ample data to classify these samples as “Eucrite-cumulate”, including both trace elements, and textures, mineral compositions and bulk sample compositions for these rocks are all consistent with classification as cumulate eucrites (Mittlefehldt and Lindstrom, 2003; Warren et al., 2009); we therefore will reclassify both as “Eucrite-cumulate”.

References:

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Nittler, L. R., Alexander, C. M. D., Davidson, J., Riebe, M. E., Stroud, R. M., & Wang, J. (2018) High abundances of presolar grains and ^{15}N-rich organic matter in CO3. 0 chondrite Dominion Range 08006. *Geochimica et Cosmochimica Acta* 226, 107-131.

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Simon, S. B., & Grossman, L. (2015) Refractory inclusions in the pristine carbonaceous chondrites DOM 08004 and DOM 08006. *Meteoritics & Planetary Science* 50, 1032-1049.

Warren, P. H., Kallemeyn, G. W., Huber, H., Ulff-Møller, F., & Choe, W. (2009) Siderophile and other geochemical constraints on mixing relationships among HED-meteoritic breccias. *Geochimica et Cosmochimica Acta* 73, 5918-5943.

Newly available XCT scans

During 2020 and 2021 we have obtained XCT scans for a number of chondrites to help us address curatorial issues of identifying multiple lithologies, look for heterogeneity in general, textural variations such as lineation or brecciation, and in some cases help to address pairing questions. The following samples have new XCT scan tiff stack movies added to their petrographic description pages.

CM – assessing multiple lithologies

ALH 83100 ,98

ALH 84033 ,0

CO – to assess heterogeneity and also pairing

MIL 07343 ,0

MIL 090038 ,11

DOM 08006 ,106

DOM 08351 ,0

DOM 10847 ,8

CV – to assess heterogeneity, pairing, brecciation

MIL 07002 ,44

MIL 07671 ,26

RBT 04133, 51

GRA 06101 ,29

GRO 95652 ,34

LAP 02206 ,77

LAR 12002 ,61

MET 00430 ,39

New Meteorites
2017, 2018 and 2019 Collection

Pages 8-16 contain preliminary descriptions and classifications of meteorites that were completed since publica-tion of issue 44(1), March, 2021. Specimens of special petrologic type (carbonaceous chondrite, unequilibrated ordinary chondrite, achondrite, etc.) are represented by separate descriptions unless they are paired with pre-viously described meteorites. However, some specimens of non-special petrologic type are listed only as single line entries in Table 1. For convenience, new specimens of special petrologic type are also recast in Table 2.

Macroscopic descriptions of stony meteorites were performed at NASA/JSC. These descriptions summarize hand-specimen features observed during initial examination. Classification is based on microscopic petrography and reconnaissance-level electron microprobe analyses using polished sections prepared from a small chip of each meteorite. For each stony meteorite the sample number assigned to the preliminary examination section is included. In some cases, however, a single microscopic description was based on thin sections of several spec-imens believed to be members of a single fall.

Meteorite descriptions contained in this issue were contributed by the following individuals:
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Table 1
Newly Classified Antarctic Meteorites

Sample Number	Weight	Classification	Weathering	Fracturing	Fa	Fs	Magnetic Susceptibility
GRO 17128	38.740	CO3 CHONDRITE	B	A	1-51	1-7	4.74
DOM 18220	13.668	L6 CHONDRITE	C	B/C	25	21	4.67
DOM 18221	9.404	L6 CHONDRITE	B/C	B	25	20	4.63
DOM 18222	13.237	H5 CHONDRITE	B/C	B	19	17	5.00
DOM 18223	16.132	L5 CHONDRITE	C	B	25	20	4.83
DOM 18224	8.596	L MELT BRECCIA	C	A/B	24	21	4.54
DOM 18225	32.022	L5 CHONDRITE	B	B	26	21	4.74
DOM 18226	23.961	L6 CHONDRITE	B/C	B	25	21	4.52
DOM 18227	13.184	L5 CHONDRITE	B	A/B	26	20	4.55
DOM 18228	39.183	L5 CHONDRITE	B/C	B/C	26	21	4.62
DOM 18229	29.736	H6 CHONDRITE	B/C	A/B	19	17	5.07
DOM 18400	7.361	H6 CHONDRITE	B	A	19		5.14
DOM 18401	14.934	L5 CHONDRITE	B	B	26	20	4.67
DOM 18402	12.899	H6 CHONDRITE	B	A	20	18	5.07
DOM 18403	10.678	L5 CHONDRITE	B	B	25	20	4.62
DOM 18404	6.125	L6 CHONDRITE	B/Ce	B/C	25	21	4.51
DOM 18405	7.527	H3.8 CHONDRITE	B	A	17-33	8-18	4.98
DOM 18406	10.428	L5 CHONDRITE	B	A/B	25	21	4.59
DOM 18407	8.565	H6 CHONDRITE	B/C	A	20	17	5.21
DOM 18408	11.565	L6 CHONDRITE	B/C	A/B	25	21	4.61
DOM 18409	8.171	L5 CHONDRITE	Be	A/B	25	20	4.56
DOM 18410	7.611	H6 CHONDRITE	B/C	A/B	20	17	4.96
DOM 18411	8.054	H6 CHONDRITE	B/Ce	B/C	20	17	4.84
DOM 18412	15.607	L5 CHONDRITE	A/B	A/B	25	21	4.65
DOM 18413	21.083	L6 CHONDRITE	B	B	25	21	4.62
DOM 18414	7.632	L5 CHONDRITE	B	A/B	25	21	4.69
DOM 18415	6.715	L5 CHONDRITE	B	A/B	25	20	4.5
DOM 18416	6.876	L5 CHONDRITE	B	B	25	20	4.22
DOM 18417	12.728	H4 CHONDRITE	B/C	A/B	18	16	4.98
DOM 18418	6.155	H5 CHONDRITE	B	A/B	20	17	5.02
DOM 18419	11.650	L5 CHONDRITE	B/C	B	25	21	4.68
DOM 18540	5.380	H6 CHONDRITE	B/C	B	20	17	5.03
DOM 18541	4.600	L5 CHONDRITE	B/C	A/B	26	20	4.45
DOM 18542	9.490	L5 CHONDRITE	B	A	25	20	4.43
DOM 18544	9.120	L5 CHONDRITE	B	A	25	20	4.48
DOM 18546	2.300	L6 CHONDRITE	B/C	A/B	24	21	4.42
DOM 18547	9.340	L5 CHONDRITE	B	A	26	20	4.48
DOM 18548	12.780	L6 CHONDRITE	B/C	B	25	21	4.34
DOM 18549	8.400	H5 CHONDRITE	B/C	A	20	16	4.81
DOM 18560	1.243	L5 CHONDRITE	B/C	A/B	25	20	4.5
DOM 18561	0.800	H6 CHONDRITE	B	B	19	17	5.01
DOM 18562	1.869	H6 CHONDRITE	B/C	B	20	18	5.01
DOM 18563	1.579	L6 CHONDRITE	B/C	B	25	21	4.49
DOM 18564	3.400	H6 CHONDRITE	B/C	B	20	18	5.09
DOM 18565	3.689	H5 CHONDRITE	B/C	A	20	17	5.21

Sample Number	Weight	Classification	Weathering	Fracturing	Fa	Fs	Magnetic Susceptibility
DOM 18566	7.801	L5 CHONDRITE	B	A	25	20	4.57
DOM 18569	9.507	L6 CHONDRITE	A/B	A	25	22	4.73
DOM 18590	6.879	L6 CHONDRITE	A/B	A	25	21	4.23
DOM 18591	20.228	L5 CHONDRITE	B	A	26	20	4.59
DOM 18592	24.786	L6 CHONDRITE	B/C	A	26	20	4.49
DOM 18593	14.579	L5 CHONDRITE	B/C	A	26	20	4.6
DOM 18594	12.035	L5 CHONDRITE	B/C	A	26	21	4.62
DOM 18595	18.472	L5 CHONDRITE	B/C	A	26	20	4.55
DOM 18596	22.140	L6 CHONDRITE	B/C	A	25	21	4.71
DOM 18597	41.403	L5 CHONDRITE	B/C	A	26	21	4.7
DOM 18598	21.602	L5 CHONDRITE	B/C	A	26	20	4.58
DOM 18599	17.324	H6 CHONDRITE	B/C	A	20	17	5.07
DOM 18600	1.112	H5 CHONDRITE	B	A/B	19	17	5.05
DOM 18601	2.017	L5 CHONDRITE	B/C	B	25	20	4.53
DOM 18602	1.838	H6 CHONDRITE	B/C	B	20	17	5.07
DOM 18603	2.260	L5 CHONDRITE	B/C	B/C	26	20	4.52
DOM 18604	3.633	L5 CHONDRITE	B/C	B/C	26	21	4.59
DOM 18605	1.858	L5 CHONDRITE	B	A/B	25	21	4.51
DOM 18606	5.535	H5 CHONDRITE	B/C	B	19	16	5.07
DOM 18607	12.837	L6 CHONDRITE	B/C	B/C	25	21	4.53
DOM 18608	8.042	L5 CHONDRITE	B	B	25	20	4.63
DOM 18609	13.574	L5 CHONDRITE	B/C	B/C	26	20	4.54
DOM 18650	11.526	L5 CHONDRITE	B	A/B	26	20	4.63
DOM 18651	10.455	L6 CHONDRITE	B/C	B	26	20	4.18
DOM 18652	19.545	L5 CHONDRITE	A/Be	A/B	26	20	4.56
DOM 18653	12.381	L6 CHONDRITE	Be	B	25	21	4.58
DOM 18654	17.637	L5 CHONDRITE	B	B	25	21	4.69
DOM 18659	29.575	L6 CHONDRITE	A/Be	A/B	24	21	4.55
DOM 18673	9.287	L6 CHONDRITE	B/C	B/C	25	21	4.51
DOM 18674	8.477	L6 CHONDRITE	B/C	B	25	21	4.47
DOM 18675	4.348	L6 CHONDRITE	B/C	A/B	24	20	4.66
DOM 18676	6.625	H4 CHONDRITE	B/C	B	18	16	5.21
DOM 18724	15.687	L6 CHONDRITE	B/Ce	B/C	25	21	4.61
DOM 19019	58.480	CM2 CHONDRITE	Ae	B/C	1-46	1	2.77
DOM 19034	59.492	CO3 CHONDRITE	A/B	A/B	0-49	1-33	4.17
DOM 19035	18.520	CK6 CHONDRITE	A/B	A/B	32	4-27	4.65
DOM 19049	34.930	CO3 CHONDRITE	A/Be	B	1-56	1-2	4.75
DOM 19068	3.040	CO3 CHONDRITE	A/Be	A	1-44		4.78
DOM 19069	11.628	CM2 CHONDRITE	B/Ce	B/C	1-48	31	4.04
DOM 19099	24.290	CO3 CHONDRITE	A/Be	A/B	1-53	1-2	4.68
DOM 19117	15.900	UREILITE	A/Be	B	22	19	4.36
DOM 19170	32.825	CO3 CHONDRITE	Be	A/B	14-25	18-22	4.78
DOM 19179	30.875	CO3 CHONDRITE	Be	A/B	0-60		4.8
DOM 19340	13.840	L MELT BRECCIA	B	A	0-53	10-35	4.19
DOM 19346	326.390	EUCRITE (BRECCIATED)	A/B	A/B		20-60	3.47

Table 2
Newly Classified Meteorites Listed by Type

Achondrites

Sample Number	Weight(g)	Classification	Weathering	Fracturing	%Fa	%Fs
DOM 19346	326.39	EUCRITE(BRECCIATED)	A/B	A/B		20-60
DOM 19117	15.9	UREILITE	A/Be	B	22	19

Carbonaceous Chondrites

Sample Number	Weight(g)	Classification	Weathering	Fracturing	%Fa	%Fs
DOM 19035	18.52	CK6 CHONDRITE	A/B	A/B	32	4-27
GRO 17128	38.74	CO3 CHONDRITE	B	A	1-51	1-7
DOM 19034	59.492	CO3 CHONDRITE	A/B	A/B	0-49	1-33
DOM 19049	34.93	CO3 CHONDRITE	A/Be	B	1-56	1-2
DOM 19068	3.04	CO3 CHONDRITE	A/Be	A	1-44	
DOM 19099	24.29	CO3 CHONDRITE	A/Be	A/B	1-53	1-2
DOM 19170	32.825	CO3 CHONDRITE	Be	A/B	14-25	18-22
DOM 19179	30.875	CO3 CHONDRITE	Be	B	0-60	
DOM 19019	58.48	CM2 CHONDRITE	Ae	B/C	1-46	1
DOM 19069	11.628	CM2 CHONDRITE	B/Ce	B/C	1-48	31

Chondrites

Sample Number	Weight(g)	Classification	Weathering	Fracturing	%Fa	%Fs
DOM 18405	7.527	H3.8 CHONDRITE	B	A	17-33	8-18
DOM 18224	8.596	L MELT BRECCIA	C	A/B	24	21
DOM 19340	13.84	L MELT BRECCIA	B	A	0-53	10-35

**Notes to Tables 1 and 2:

"Weathering" Categories:

- A: Minor rustiness; rust haloes on metal particles and rust stains along fractures are minor.
- B: Moderate rustiness; large rust haloes occur on metal particles and rust stains on internal fractures are extensive.
- C: Severe rustiness; metal particles have been mostly stained by rust throughout.
- E: Evaporite minerals visible to the naked eye.

"Fracturing" Categories:

- A: Minor cracks; few or no cracks are conspicuous to the naked eye and no cracks penetrate the entire specimen.
- B: Moderate cracks; several cracks extend across exterior surfaces and the specimen can be readily broken along the cracks.
- C: Severe cracks; specimen readily crumbles along cracks that are both extensive and abundant.

Classification of the ordinary chondrites in Table 1 & 2 was done by Energy Dispersive Spectroscopic (EDS) methods using a Scanning Electron Microscope (SEM). This can include the analysis of several olivine and pyroxene grains to determine the approximate Fayalite and Ferrosilite values of the silicates, grouping them into H, L or LL chondrites. Petrologic types are determined by optical microscopy and are assigned based on the distinctiveness of chondrule boundaries on broken surfaces of a 1-3 g chip. While this technique is suitable for general characterization and delineation of equilibrated ordinary chondrites, those undertaking detailed study of any meteorite classified by optical methods alone should use caution. It is recommended that a polished thin section be requested to accompany any chip and appropriate steps for a more detailed characterization should be undertaken by the user. (Cari Corrigan, Smithsonian Institution)

Table 3

Tentative Pairings for New Meteorites

Table 3 summarizes possible pairings of the new specimens with each other and with previously classified specimens based on descriptive data in this newsletter issue. Readers who desire a more comprehensive review of the meteorite pairings in the U.S. Antarctic collection should refer to the compilation provided by Dr. E.R. D. Scott, as published in the Antarctic Meteorite Newsletter vol. 9 (no. 2) (June 1986). Possible pairings were updated in Meteoritical Bulletins 76, 79, 82 through 106, which are available online from the Meteoritical Society webpage:

http://www.lpi.usra.edu/meteor/metbull.php

CM2 CHONDRITE

DOM 19069 with DOM 19019

CO3 CHONDRITE

DOM 19034, DOM 19049, DOM 19068, DOM 19099, DOM 19170 and DOM 19179 with DOM 08004

Petrographic Descriptions

Sample No.	Location	Field No.	Dimensions (cm)	Weight (g)	Classification
GRO 17128	Grosvenor Mountains	25609	3.2 x 2.6 x 2.0	38.74	CO3 chondrite

Macroscopic Description: Cecilia Satterwhite
The exterior has 80% black/brown fusion crust with oxidation. Areas without fusion crust are weathered. The interior is a black matrix with light/white specks throughout and some oxidation visible; some inclusions/chondrules are light grey; sample was difficult to break.

Thin Section (,2) Description: Cari Corrigan, Tim McCoy
The section consists of abundant small (up to 1 mm) chondrules, chondrule fragments, CAIs, and mineral grains in a dark matrix. Metal and sulfide occur within and rimming the chondrules. Olivine ranges in composition from Fa_{1-51}. Pyroxene analyses range from Fs_{1-7}. Terrestrial weathering effects are modest. The meteorite is a CO3 chondrite.

Sample No.	Location	Field No.	Dimensions (cm)	Weight (g)	Classification
DOM 18224	Dominion Range	25139	2.0 x 1.6 x 1.7	8.596	L Melt Breccia

Macroscopic Description: Curtis Calva
The exterior is 50% fusion crust that is smooth with orange iridescent weathering spots. The exposed interior is smooth and rusty orange to brown. The interior is heavily rusted with grey areas and brown rust areas with metal.

Thin Section (,2) Description: Cari Corrigan, Tim McCoy
This meteorite is heavily shock blackened and shock veined. Most olivine grains range from having been mosaicized to micro-melted. Metal and sulfide grains as well as an opaque phase, perhaps chromite, are dispersed throughout the section, occasionally exhibiting micro-melted textures. Olivines are Fa_{24}, pyroxenes are Fs_{21}. The meteorite is an L melt breccia with one relict chondrule but is so heavily shocked that it is difficult to determine its petrologic type. Given the heterogeneity, this preliminary assignment should be followed up with more detailed work involving additional thin sections.

Sample No.	Location	Field No.	Dimensions (cm)	Weight (g)	Classification
DOM 18405	Dominion Range	25115	1.5 x 1.9 x 1.4	7.527	H3.8 Chondrite

Macroscopic Description: Curtis Calva
The fusion crust is dark brown and smooth with iridescent weathering spots. The exposed interior is very smooth and rusted. The interior is very rusted and grey with white inclusions up to 1 mm.

Thin Section (,2) Description: Cari Corrigan, Tim McCoy
The section exhibits numerous small, well-defined chondrules (up to 1.5 mm) in a black matrix of fine-grained silicates, metal and troilite. Weak shock effects are present. Polysynthetically twinned pyroxene is present. The meteorite is moderately to extensively weathered. Silicates are unequilibrated; olivines range from Fa_{17-33}, and pyroxenes from Fs_{8-18}. The meteorite is an H3 chondrite (estimated subtype 3.8).

Sample No.	Location	Field No.	Dimensions (cm)	Weight (g)	Classification
DOM 19019	Dominion Range	25991	5.3 x 3.3 x 4.0	58.480	CM2 Chondrite
DOM 19069		24269	2.9 x 2.5 x 1.2	11.628	

Macroscopic Description: Kellye Pando, Cecilia Satterwhite

For 019, about 10% of the exterior of this meteorite is covered with a black, vesicular fusion crust that exhibits mosaic fracturing. There are a few white specs that might be evaporites. The exposed surface is dark grey-green-brown with white inclusions visible and is heavily fractured. The fresh interior has a black matrix with small (<0.5 mm) white and light grey inclusions. There is a white substance along some fractures that could be evaporites. The whole rock has a very crumbly texture.

For 069, black fractured fusion crust covers the exterior. It has a pebbly texture and fractures penetrate the surface, some inclusions/chondrules are visible as well as some oxidation. The interior is a black matrix with mm- sized inclusions/chondrules of various sizes and colors. Some oxidation is heavy in areas and minor evaporites are visible.

Thin Section (,2) Description: Cari Corrigan, Tim McCoy

The sections both consist of a few small chondrules (up to 0.5 mm), mineral grains and CAIs set in a black matrix; rare metal and sulfide grains are present. Olivine compositions are Fa_{1-48} with a peak at Fa_{1-2}, pyroxene is Fs_{1-31}. Aqueous alteration of the matrix is substantial. Meteorites are similar enough that one description suffices and are likely paired. The meteorites are CM2 chondrites.

Sample No.	Location	Field No.	Dimensions (cm)	Weight (g)	Classification
DOM 19034	Dominion Range	25482	3.8 x 3.5 x 3.0	59.492	CO3 Chondrite
DOM 19049		26663	3.0 x 2.3 x 2.6	34.930	
DOM 19068		25932	2.0 x 1.0 x 1.1	3.040	
DOM 19099		25976	3.2 x 2.6 x 2.0	24.290	
DOM 19170		25457	3.9 x 2.5 x 1.7	32.825	
DOM 19179		26669	3.3 x 3.0 x 2.3	30.875	

Macroscopic Description: Curtis Calva, Kellye Pando, Cecilia Satterwhite

15% of the exterior of 034 is covered in a rough, black fusion crust that appears vesicular. The exposed exterior is frothy and dark brownish grey with a slight green tint. There are light grey and orange-brown inclusions in the exposed interior. The interior is a light grey matrix with some small areas of orange-brown rust. The interior texture is sugary with a few dark inclusions under 1 mm in size as well as a few very small metal grains.

70% of the exterior of 049 is covered with black, rough, vesicular fusion crust with mosaic fracturing. There are some white spots that might be evaporites and areas of dark brown rust. Exposed surface is coated with dark brown-red varnish with a few small, light colored inclusions visible. Fresh interior is very dark brown-black matrix with light grey and grey-brown inclusions up to 1 mm in size.

80% of exterior of 068 is covered by fusion crust that is dark brown and has some white spots that might be evaporites. Exposed surfaces are dark brown with dark orange rust spots all over. Fresh interior is very dark brown-black matrix with white and light brown inclusions. Shiny metals are visible throughout.

For 099, black, rough fusion crust that is fractured and vesicular in some areas covers about 75% of the exterior. There is some dark brown rust and a few small white specs (possible evaporites) on the crust. The exposed surface is dark brown-black and has some fracturing and possible white evaporites. The fresh interior reveals a black matrix with small (<0.5 mm) white inclusions. There is minor amounts of orange rust present and shiny metal flecks throughout.

170 and 179 are very similar, about 75% of the exterior has black fusion crust with fractures, pits, and some oxidation. Evaporites are present and exposed interior is a dark matrix with some inclusion/chondrules visible. The interior is black fine-grained matrix with some brown oxidation. The visible inclusions/chondrules are lighter than matrix and some are weathered.

Thin Section (,2) Description: Cari Corrigan, Tim McCoy
The sections consist of abundant small (up to 1 mm) chondrules, chondrule fragments, CAIs, and mineral grains in a dark matrix. Metal and sulfide occur within and rimming the chondrules. Olivine ranges in composition from Fa_{0-60}. Pyroxene analyses range from Fs_{0-33}. Terrestrial weathering effects are modest. Meteorites are similar enough that one description suffices, and they are likely paired. The meteorites are CO3 chondrites and may be members of the larger Dominion Range CO3 pairing group (named for DOM 08004).

Sample No.	Location	Field No.	Dimensions (cm)	Weight (g)	Classification
DOM 19035	Dominion Range	25498	3.5 x 2.4 x 2.0	18.520	CK6 Chondrite

Macroscopic Description: Curtis Calva, Kellye Pando
The exterior has small patches (covering ~5%) of black, mosaic fractured fusion crust. Exposed rock is black, very vesicular and has a few spherical inclusions (possible chondrules) visible. Fresh interior is dark grey matrix with round black inclusions up to 1 mm visible and some brown-orange rust throughout.

Thin Section (,2) Description: Cari Corrigan, Tim McCoy
The section consists of large (up to 2 mm), poorly defined chondrules in a matrix of finer-grained silicates, sulfides, and abundant magnetite. The meteorite is little weathered, but extensively shock blackened. Silicates are homogeneous. Olivine is Fa_{32}. Ca-rich pyroxene is Fs_{4-11} and orthopyroxene is Fs_{27}. The meteorite appears to be a CK6 chondrite.

Sample No.	Location	Field No.	Dimensions (cm)	Weight (g)	Classification
DOM 19117	Dominion Range	26645	2.9 x 2.5 x 1.3	15.900	Ureilite

Macroscopic Description: Kellye Pando
85% of exterior is covered with fusion crust that is slightly shiny on one side but rough and vesicular on the other. The shiny side also has some radial flow lines and a few white spots that might be evaporites. Exterior surfaces are dark red-brown and porous. Fresh interior is very dark grey-black matrix with a crystalline texture and some small (<0.5 mm) white inclusions. Orange rust is present throughout.

Thin Section (,2) Description: Cari Corrigan, Tim McCoy
The section consists of an aggregate of large olivine and pyroxene grains up to 2 mm across. Individual olivine grains are rimmed and crosscut by carbon-rich material containing traces of metal. Olivines have cores of Fa_{22}. Pigeonite is $Fs_{19}Wo_7$. The meteorite is a ureilite.

Sample No.	Location	Field No.	Dimensions (cm)	Weight (g)	Classification
DOM 19340	Dominion Range	24240	2.3 x 2.0 x 1.5	13.840	L Melt Breccia

Macroscopic Description: Cecilia Satterwhite

The exterior of this meteorite has some black/brown fusion crust with some rusty oxidation and abundant pits. Interior is a grey matrix with some small inclusions/chondrules of a lighter color and some areas have abundant rust.

Thin Section (,2) Description: Cari Corrigan, Tim McCoy

This meteorite consists of individual unmelted mineral grains, fragments, and clasts in a matrix of microcrystalline olivine grains, with metal-sulfide blebs, possibly including multiple sulfide phases, throughout. A few relict chondrules/chondrule fragments are present that show signs of micro-melting of their opaque components. Olivine ranges from Fa_{0-53}, and pyroxenes are Fs_{10-35}. Given the heterogeneity, this preliminary assignment should be followed up with more detailed work involving additional thin sections.

Sample No.	Location	Field No.	Dimensions (cm)	Weight (g)	Classification
DOM 19346	Dominion Range	26677	8.5 x 7.0 x 4.0	326.390	Eucrite (Brecciated)

Macroscopic Description: Nicole Lunning, Cecilia Satterwhite

The exterior of this achondrite has 90% fusion crust; 20% of the fusion crust has a vitreous (shiny) luster, the rest is black-grey matte. There are some evaporites visible and the exposed grey matrix has mm-sized light inclusions. The interior is a dark grey matrix containing clasts with sub-ophitic texture, and light-colored inclusions. In addition, some glassy vitreous inclusions are visible with a binocular microscope. About 10% of the interior exhibits rust spots.

Thin Section (,2) Description: Cari Corrigan, Tim McCoy

The section shows a groundmass of mm-scale comminuted pyroxene and plagioclase (with fine- to coarse-grained basaltic clasts ranging up to 4 mm. Some of the clasts are sulfide rich. Most of the pyroxene is orthopyroxene with compositions ranging from $Fs_{20-60}Wo_{3-8}$. The meteorite is a brecciated eucrite.

Sample Request Guidelines:

Requests for Antarctic Meteorites are reviewed twice per year, the deadline is posted on-line:
https://curator.jsc.nasa.gov/bboard.cfm

Information about requesting samples can be found on-line at:
https://curator.jsc.nasa.gov/antmet/requests.cfm?section=general

Samples can be requested from any meteorite that has been made available through announcement in any issue of the Antarctic Meteorite Newsletter (beginning with 1(1) in June 1978). Many of the meteorites have also been described in five Smithsonian Contributions to the Earth Sciences: Nos. 23, 24, 26, 28, and 30. Tables containing all classified meteorites since August 2006 have been published in the Meteoritical Bulletins and Meteoritics and Meteoritics and Planetary Science.

They are also available on-line at:
https://meteoritical.org/publications/the-meteoritical-bulletin

The most current listing is found on-line at:
http://curator.jsc.nasa.gov/antmet/us_clctn.cfm

All sample requests should be made electronically using the form at:
http://curator.jsc.nasa.gov/antmet/requests.cfm

The purpose of the sample request form is to obtain all information needed prior to deliberations to make an informed decision on the request.

The preferred method of request transmittal is via e-mail. Please send requests and attachments to:
JSC-ARES-MeteoriteRequest@nasa.gov

Type ***"Request"*** in the e-mail subject line.

Each request should accurately refer to meteorite samples by their respective identification numbers and should provide detailed scientific justification for proposed research. Specific requirements for samples, such as sizes or weights, locations (if applicable) within individual specimens, or special handling or shipping procedures should be explained in each request. Some meteorites are small, of rare type, or are considered special because of unusual properties. Therefore, it is very important that all requests specify both the optimum amount of material needed for the study and the minimum amount of material that can be used. Requests for thin sections that will be used in destructive procedures such as ion probe, laser ablation, etch, or re-polishing must be stated explicitly. Consortium requests should list the members in the consortium. All necessary information should be typed on the electronic form, although informative attachments (reprints of publication that explain rationale, flow diagrams for analyses, etc.) are welcome.

Antarctic Meteorite Laboratory
Contact Numbers

Please submit request to: **JSC-ARES-MeteoriteRequest@nasa.gov**

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Meteorites On-Line

Several meteorite web sites are available to provide information on meteorites from Antarctica and elsewhere in the world. Some specialize in information on martian meteorites and on possible life on Mars. Here is a general listing of ones we have found. We have not included sites focused on selling meteorites even though some of them have general information. Please contribute information on other sites so we can update the list.

JSC Curator, Antarctic meteorites	http://curator.jsc.nasa.gov/antmet/
JSC Curator, HED Compendium	http://curator.jsc.nasa.gov/antmet/hed/
JSC Curator, Lunar Meteorite Compendium	http://curator.jsc.nasa.gov/antmet/lmc/
JSC Curator, Martian Meteorite Compendium	http://curator.jsc.nasa.gov/antmet/mmc/
ANSMET	http://caslabs.case.edu/ansmet/
Smithsonian Institution	http://mineralsciences.si.edu/
Lunar Planetary Institute	http://www.lpi.usra.edu
NIPR Antarctic meteorites	http://www.nipr.ac.jp/
Meteoritical Bulletin online Database	http://www.lpi.usra.edu/meteor/metbull.php
Museo Nazionale dell'Antartide	http://www.mna.it/collezioni/catalogo-meteoriti-sede-di-siena
BMNH general meteorites	https://www.nhm.ac.uk/our-science/collections/mineralogy-collections.html
UHI planetary science discoveries	http://www.psrd.hawaii.edu/index.html
Meteoritical Society	http://www.meteoriticalsociety.org/
Meteoritics and Planetary Science	https://onlinelibrary.wiley.com/journal/19455100
Meteorite Times Magazine	https://www.meteorite-times.com/
Geochemical Society	http://www.geochemsoc.org
Washington Univ. Lunar Meteorite	http://meteorites.wustl.edu/lunar/moon_meteorites.htm
Washington Univ. "meteor-wrong"	http://meteorites.wustl.edu/meteorwrongs/meteorwrongs.htm
Portland State Univ. Meteorite Lab	http://meteorites.pdx.edu/
Northern Arizona University	https://www.cefns.nau.edu/geology/naml/
Martian Meteorites	http://www.imca.cc/mars/martian-meteorites.htm

Other Websites of Interest

OSIRIS-REx	http://osiris-rex.lpl.arizona.edu/
Mars Exploration	http://mars.jpl.nasa.gov
Rovers	http://marsrovers.jpl.nasa.gov/home/
Near Earth Asteroid Rendezvous	http://near.jhuapl.edu/
Stardust Mission	http://stardust.jpl.nasa.gov
Genesis Mission	http://genesismission.jpl.nasa.gov
ARES	http://ares.jsc.nasa.gov/
Astromaterials Curation	http://curator.jsc.nasa.gov/
Hayabusa2	http://www.hayabusa2.jaxa.jp/en/