MAKING MISFITS FIT. Timothy J. McCoy, Dept. of Mineral Sciences, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560-0119 USA (mccoyt@si.edu)

Introduction: After 40 years of U.S. collecting, meteorites from Antarctica have revolutionized our understanding of the early Solar System. In large part, this owes to the establishment or growth of numerous groups of meteorites. Dozens of unusual, ungrouped meteorites remain incompletely understood for a variety of reasons, including a lack of detailed follow-up studies, initial studies that lacked the analytical tools or paradigms that exist today, an absence of related meteorites, or disagreement even after multiple studies. These are the misfits. Although they don't fall conveniently into our classification schemes, they provide fuzzy clues to Solar System evolution.

Nebular Processes: Little attention has been paid to aluminum-rich chondrules, which are intermediate between ferromagnesian chondrules and CAIs, with bulk compositions controlled either by nebular condensation or through remelting of mixed components. The LEW 87234 pairing group contains an unusually high abundance of Ca- and Al-rich objects [1] and FeO-bearing pyroxene [2] for an enstatite chondrite, possibly indicating a parentage other than EH or EL chondrites [3]. MIL 07065, an otherwise unexceptional LL chondrite, contains a semicircular 1 mm diameter skeletal spinel [4]. Although suggestive that this Al-rich chondrite crystallized barred spinel akin to barred olivine chondrules, no experimental study has reproduced this texture.

Nebular or parent body?: While 90+% of all Antarctic meteorites are ordinary chondrites, a small number may expand the range of this well-known group. QUE 94570, EET 96010, and LAP 04757/773 exhibit olivine compositions (Fa_{10-13}) more magnesian than typical H chondrites (Fa_{16-20}). Chemically, QUE 94570 resembles L chondrites, while LAP 04757/773 are indistinguishable from H chondrites [5,6]. It is unclear whether these more magnesian compositions result from parent body metamorphism (e.g., incorporation of more oxidized than reduced material) on the nominal three OC parent bodies or indicate a fourth parent body.

Parent body alteration: Hydrated phases in CI, CM, CR and some OCs testify to the influence of water during parent body alteration. The Antarctics LAP 04840/10031/10033 and MIL 11207 contain biotite and amphibole as minor (~10 vol.%) phases and suggest that hydrogen may have been active during metamorphism in a variety of ways [7]. Insoluble organic material may have provided hydrogen, but required juxtaposition of a hot, dry R chondrite and a cooler, hydrogen-bearing rock, perhaps indicative of impact mixing.

Impact: Brecciated and impact-melted rocks are common among Antarctic ordinary and enstatite chondrites. Even among enstatite chondrites, the QUE 94204 pairing group is unusual. consisting of rounded-to-ovoid, polysynthetically twinned, mm-sized enstatite grains with interstitial metal, sulfide and feldspar. Several authors [e.g., 8] have argued for an impact melt origin, although [9] suggested an indigenous partial melt origin akin to acapulcoites. The origin of the unusual morphology of the enstatite is enigmatic, perhaps resulting from crystallization from relatively few nuclei during rapid cooling of a near-total melt.

Asteroid Differentiation: Meteorites from Antarctica have smaller masses than modern falls, with a peak in the cumulative distribution curve at ~10 g and significant recoveries less than 1 g [10]. Among these are some of the misfit differentiated meteorites. The coarse-grained QUE 93148 (1.09 g) has been variously linked to pyroxene pallasites and HEDs [11], but remains enigmatic in part because of its small, unrepresentative nature. The same may be true of a trio of irons. LEW 85369 (6.3 g), LEW 88055 (1.7 g) and LEW 88631 (3.2 g) are related to aubrites and the Si-bearing Horse Creek iron, containing combinations of Si-bearing metal, the silicide perryite, and/or phases typically associated with enstatite meteorites (e.g., alabandite). An unusually high percentage of Antarctic irons are ungrouped, with small masses sampling a broader range of parent bodies [12]. With the selection of the Psyche mission, revisiting Antarctic ungrouped irons seems warranted.

The New Misfits: After 40 years of collecting meteorites in Antarctica, why should we continue to collect new meteorites? Each year, new samples unlocking a new process or asteroid. Since the publication of *35 Seasons of U.S. Antarctic Meteorites*, DOM 14170 has joined the ranks of the misfits. While its metallographic texture and chemical composition (e.g., Ni, P) suggest it may be ungrouped, its most unusual feature is a series prominent central ridge formed during oriented flight, with regularly-spaced indentations along the ridge suggestive of a type of aerodynamic sculpting not previously seen in iron meteorites.

References: [1] Grossman et al. (1995) *Meteoritics* 30:514. [2] Weisberg et al. (2011). *GCA* 75:6556. [3] Weisberg and Righter (2015) *35 Seasons of U.S. Antarctic Meteorites*, 65. [4] Corrigan et al. (2016) *79th Met. Soc.*: #6479. [5] Kallemeyn et al. (1998) *MAPS* 33:A81. [6] Troiano et al. (2011) *GCA* 75:6511. [7] McCanta et al. (2008) *GCA* 72:5757. [8] van Niekerk and Keil (2012) LPSC 43, #2644. [9] Izawa et al. (2011) *MAPS* 46: 1742. [10] Corrigan et al. (2015) *35 Seasons of U.S. Antarctic Meteorites*, 173. [11] Goodrich and Righter (2000) *MAPS* 35:521. [12] Wasson (1990) *Science* 249:900