BARRED OLIVINE CHONDRULE FRAGMENTS AMONGST MICROMETEORITES. M. J. Genge[1] and S. Taylor[2]. [1]Impact and Astromaterials Research Centre, Department of Earth Science and Engineering, Imperial College London, Exhibition Road, London SW7 2AZ, UK. Email: m.genge@imperial.ac.uk. [2]U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire 03755, USA.

Introduction: Micrometeorites (MMs) are large (>25 μm) interplanetary dust particles that survive atmospheric entry to be recovered from the Earth's surface. Amongst those particles that escaped significant heating during atmospheric entry two groups have been identified [1]: (i) fine-grained MMs (fgMMs), which are similar to the fine-grained matrices of hydrated carbonaceous chondrites (CCs), and (ii) coarse-grained MMs (cgMMs), which are dominated by pyroxene, olivine and/or glass and often have igneous textures.

Some cgMMs have selvages of fine-grained matrix and thus indicate that cgMMs and fgMMs may be derived from the same asteroidal parent bodies [2]. These composite particles suggest that the source objects of cgMMs were small mm-sized objects on their parent asteroids and were, therefore, probably chondrules.

The CC-like nature of fgMMs implies that cgMMs likewise sample a CC-like chondrule population. Numerical models of the delivery of asteroidal dust to Earth, however, suggest that a significant fraction is derived from the S-type Koronis Family asteroids that cannot be CC-like materials [3]. Minor element compositions of olivines, pyroxenes and accessory phases from cgMMs have suggested that ~70% of cgMMs are derived from an ordinary chondrite (OC)-like chondrule population. Their parent body is, therefore, most likely to be the Koronis Family asteroids [4].

Despite the evidence that the majority of cgMMs represent chondrule fragments differences exist between the petrology of cgMMs and chondrules in meteorites. The most significant difference is the low abundance of fragments of barred olivine materials amongst cgMMs – only a single particle being reported to date. Barred olivine chondrules are in contrast relatively common (~4% of chondrules) within ordinary chondrites [5].

This paper reports the discovery of 3 new barred olivine cgMMs within a collection of 527 Antarctic MMs representing 3% of cgMMs.

Results: The 3 cgMMs with BO textures (Fig.1a and b) were previously misclassified as radiating pyroxene (RP cgMMs; Fig.1c) during preliminary examination. The fine grain-size of these particles, which have bar widths less than 5 μm, complicates positive phase identification due to matrix overlap. Repeat analyses by energy dispersive spectroscopy, however, confirm the particles consist of discontinuous bars of olivine contained poikolitically within low-Ca pyroxene.

The textures of all three particles comprise discontinuous sub-parallel bars of olivine within a polycrystalline pyroxene host. Two of the particles (CP94-050-214 and CP94-050-171) have olivine bars that have diverging orientations producing textures that resemble radiate pyroxenes. Barred olivine chondrules, however, can contain several domains of parallel olivine which likewise diverge at their intersections. Particle CP94-050-056 exhibits a central region of equant olivine with parallel bars of olivine at the margins of the particle.

Accessory phases in the BO particles include aluminosilicate glass and chromian spinel. Glass was identified by the presence of Na (0.3 wt%) and higher Al contents (~3 wt%) within spot analyses and is present as small vestiges adjacent to facited voids within the particles. The surface correlated distribution of voids within particle CP94-050-214 strongly suggests that glass may have been removed by etching during collection or by expansion of vesicles during entry heating.

Sub-micron chromian bearing iron oxides occur within all three particles and have cruciform habits. Discontinuous magnetite rims are observed on two of the particles and confirm these particles are extraterrestrial.

Discussion: The textures of BO cgMMs identified here, although more similar to BO than RP chondrules, differ from the overall textures of BO chondrules which comprise parallel growth olivine with a glassy mesostasis. Interstitial pyroxene, as observed in the reported particles, is however, relatively common in places within BO chondrules where it often occurs as dendritic crystals that poikolitically enclose barred olivine.

The absence of BO particles with interstitial regions dominated by glass is problematic but may be the result of preservation factors. The only previously described BO igneous object in MMs was discovered within a partially melted scoriaceous micrometeorite and exhibited the development of elongate vesicles within the glass phase present in the interstitial regions between bars. The formation of vesicles within glass in MMs during atmospheric entry has been suggested, on the basis of the observation of vesicles within chondrule mesostasis in meteorite fusion crusts, to result from oxidation of dissolved reduced volatiles [6]. The

formation of vesicles between parallel growth olivines within BO cgMMs may, therefore, result is disaggregation during atmospheric flight or storage in Antarctic ice.

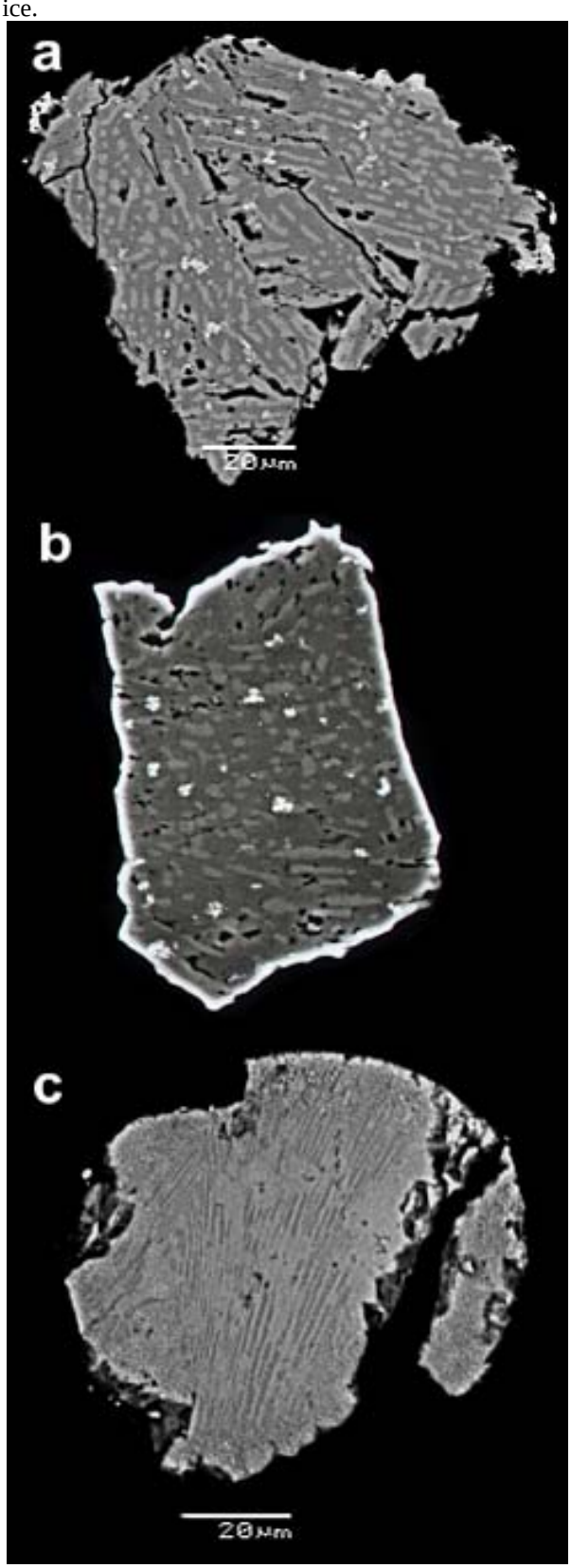

Figure 1. Barred Olivine and Radiate Pyroxene CgMMs. (a) CP94-050-171, (b) CP94-050-056, (c) CP94-050-036.

The pre-atmospheric abundance of BO cgMMs is probably somewhat higher than observed amongst Antarctic particles.

Implications: The identification of BO CgMMs amongst MMs suggests a minimum abundance of 3% of chondrule-derived dust similar to that of BO chondrules within ordinary chondrites. Furthermore the abundance of RP particles is reduced to 7% of cgMMs similar to RP chondrules in ordinary chondrites. These data strongly support the interpretation of the majority of cgMMs as fragments of chondrules from primitive asteroids.

Models of the delivery of asteroidal dust to Earth suggest that the majority of dust particles are derived from the dust bands associated with the Veritas, Themis and Koronis asteroid families [3,7]. Both Veritas and Themis are C-type asteroids and are, therefore, probably the main parent bodies of the CM2-like fgMMs. The Koronis asteroids are S-type asteroids and could be appropriate parent asteroids for OC-like materials if space weathering is responsible for reddening of their spectra. The discovery that the abundance of petrologic types of cgMMs is similar to that of equivalent chondrules in ordinary chondrites, together with the minor element compositions of their olivines and pyroxenes [4], implies that Koronis is a significant source of cgMMs found on Earth.

The dust band associated with the Koronis asteroids has been suggested to relate to the recent break-up (5.82 Ma) of the Karin group of the Koronis Family [4]. The high abundance of Koronis Family dust on Earth at present (~70% of cgMMs or ~20% MMs) is, therefore, probably only a relatively recent feature of the Earth's extraterrestrial dust flux. The relative abundance of cgMMs to fgMMs within older deposits of MMs on Earth, such as within deep sea sediments, is likely to fluctuate significantly over geological time depending on sporadic collisional events within the main asteroid belt and influxes of new comets.

References: [1] Genge et al. (1997) *GCA*, 61, 5149-5162. [2] Genge et al., (2005) *MAPS* 40, 225-238. [3] Kortenkamp et al., (1998) *Icarus* 135, 469. [4] Genge (2006), LPSC, 1759. [5] Brearley and Jones (1998) Min Soc Am. 36, [6] Genge & Grady (1999) MAPS, 34, 341. [7] Nesvorny et al., (2003) *ApJ*, 591, 486.