Lindgren, P., Sofe, M., Lee, M.R., and Mark, D.F. (2013) Porous zonation patterns in carbonaceous chondrites: possible fluid inclusions. In: 76th Annual Meeting of the Meteoritical Society, 29 Jul - 2 Aug 2013, Edmonton, AB, Canada.

POROUS ZONATION PATTERNS IN CARBONATES FROM CARBONACEOUS CHONDRITES: POSSIBLE FLUID INCLUSIONS?

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Background: Aqueous alteration took place on carbonaceous chondrite parent bodies early on in solar system history and resulted in the formation of secondary minerals, including carbonates [1,2]. The composition, pressure and temperature of the reactive fluids in the aqueous system are not so well understood [3], but one way to determine this is via fluid inclusion analyses. Fluid inclusions are microscopic voids filled with liquid and/or vapor that are trapped within minerals. If the fluid inclusions are primary, i.e. trapped during crystal growth, they act as a fingerprint of the fluid from which the mineral precipitated [4]. However, finding indigenous fluid inclusions in meteorites require careful sample preparation and laborious examination [5]. Thus far, aqueous fluid inclusions have been found in at least seven carbonaceous chondrites were they occur mainly in Ca-carbonates [6,7].

This study: Here we searched for fluid inclusions in zoned Ca-carbonate crystals in three CM2 carbonaceous chondrites, Mighei, Murray and Murchison. We located the zoned crystals using SEM-BSE and CL imaging in a FEI Quanta 200F field emission scanning electron microscope. For a closer examination of the zonation we used FIB-TEM. The FIB foils were prepared with an FEI Nova 200 Dualbeam FIB instrument and diffraction contrast images were acquired using a FEI T20 TEM.

Results and discussion: Several Ca-carbonate grains in all of the three samples show zonation patterns that are visible via BSE and CL imaging. The zonation ranges from sharp to gradual. A compositional change between the zones is not detectable via qualitative EDX-ray mapping in the SEM, but some zones within, and around the edges, of the Ca-carbonate grains have a porous appearance which is visible via BSE imaging. Porous regions do in some cases also cross-cut the zones. TEM imaging of porous zones in the Ca-carbonate grains shows a high concentration of voids, with diameters of around 200 nm. We hypothesize that these voids are remnant fluid inclusions. Unfortunately, if they are fluid inclusions, their small sizes would not enable fluid inclusion analyses. However, our results show that zoning of Ca-carbonates in carbonaceous chondrites could be a result of a high concentration of fluid inclusions.

Acknowledgements: We are grateful to the Natural History Museum in London for loan of the Mighei and Murray thin sections.

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