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MICROSTRUCTURES OF A CALCITE VEIN IN LON 94101: EVIDENCE FOR ASTEROIDAL FLUID FLOW?

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Introduction: The CI and CM carbonaceous chondrites have been subjected to extensive aqueous alteration. The most likely environment of alteration was within the asteroidal parent body, but the mechanism of alteration is poorly understood. The presence of veins, filled with alteration minerals, is an indicator of that alteration took place via fluid flow. Veins of sulphates, phyllosilicates, and fragments of ruptured carbonate veins, have been reported in CIs [1,2], and veins of Ca-sulphate, and Fe-oxyhydroxide, have been reported in CMs [3,4]. However, the formational environment of some of these veins is debated. For instance, sulphate veins in the CIs are shown to be the result of terrestrial weathering [5]. Recent analyses of the CM2 carbonaceous chondrites LON 94101 and QUE 93005 revealed Ca(Mg)-carbonate veining [6]. Since no carbonate veins have previously been observed in CMs, there is question to whether these veins are a result of terrestrial weathering in the Antarctic ice sheet, or represent indigenous asteroidal fluid flow.

Results and discussion: In this ongoing study, we are using electron backscatter diffraction (EBSD) to analyse microstructures of an irregular millimetre sized calcite vein, and of the surrounding calcite grains, in LON 94101. These analyses are conducted to better understand the vein's deformation history, and hence the timing of alteration. Since microstructures in calcite form as a result of deformation, such structures in an alteration vein imply that the minerals have been subjected to sufficiently high pressures post-alteration. Our results show that the calcite vein contains both twin and subgrain microstructures. The twins occur on the {-1018} planes, and hence they are calcite e-twins, with a misorientation angle of 78º between the twins and the host calcite. The stress threshold for the development of twins in calcite is not well-constrained, but e-twinning probably indicates pressures of at least 10 MPa [7]. These pressure conditions are more likely to have occurred by "impact gardening" or static compaction on the parent body, rather than within the Antarctic ice sheet. The subgrain microstructure is composed of numerous subgrains with low angle boundaries (5-10º misorientation) and several high angle subgrain boundaries (10-20º misorientation). The EBSD analyses also show that the crystallographic orientation of the calcite vein is similar to isolated grains of calcite located at a distance from the vein. This implies that the distant calcite grains are disrupted fragments of the host vein. Some of the calcite grains also exhibit e-twinning.

Conclusion: The observed microstructures suggest that the calcite vein in LON 94101 is a product of asteroidal fluid flow.

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