DARK INCLUSIONS IN THE MOKOIA CV3 CHONDRITE: RECORD OF AQUEOUS ALTERATION, THERMAL METAMORPHISM AND SHOCK METAMORPHISM. I. Ohnishi and K. Tomeoka, Department of Earth and Planetary Sciences, Faculty of Science, Kobe University, Nada, Kobe 657-8501, Japan.

Dark inclusions (DIs) are common in CV3 chondrites, particularly in Allende, and have been described mainly from this meteorite. Although previous workers favored that DIs are aggregates of primitive nebula condensates [e.g., 1], recent workers [e.g., 2–4] suggested that they were affected by aqueous alteration and subsequent dehydration on the meteorite parent body. Most of the DIs consist almost exclusively of anhydrous minerals and contain little hydrous minerals, which is a major reason against the secondary origin for the DIs. Mokoia is a unique member of the CV3 group, because it contains abundant hydrous phyllosilicates [5] that were formed by alteration of anhydrous silicates [6]. Thus, it was expected that if DIs were found in Mokoia, they would provide more direct information regarding the secondary processes that most DIs in CV3 chondrites may have experienced. We performed an extensive survey of Mokoia thin sections and found a total of six large DIs.

The DIs range in size from 0.5 to 2.5 mm. They are composed mostly of chondrules and chondrule fragments embedded in a fine-grained matrix. The constituent minerals of the DIs are mostly common with those in the host meteorite. However, the olivine grains in the DI matrix are distinctly more Fe-rich and more homogeneous in composition (Fa45-65) than those in the host meteorite matrix (Fa0-90). The matrix grains in the DIs are much more compacted than those in the host meteorite; the measured porosities of the DI matrix and the host meteorite matrix are 1–5% and 16-28%, respectively. Phyllosilicate, mostly saponite, indeed occurs in both chondrules and matrix in the DIs, but its abundance is much lower than that in the host meteorite.

Another notable characteristic of the DIs is the occurrence of high densities of fractures in the matrix that range in width from 2 to 10µm and in length from 100 to 1000 µm. They are mostly randomly oriented and form networks. Fractures terminate at the boundaries between the DIs and the host meteorite, which indicates that they formed prior to incorporation of the DIs to the present location. Olivine crystals in chondrules show planar fractures. One of the DIs has a large melt vein (~70µm wide and ~1mm long), which is probably a shock-induced melt. These features suggest that the DIs were shocked to shock stage S3-S4.

The results of our study suggest that the DIs in Mokoia are probably clasts that are genetically related to the host meteorite, and they have been once involved in an aqueous alteration process similar to that for the host meteorite. However, it is evident that the DIs have experienced additional metamorphic events that the host meteorite has not. The more homogeneous, Fe-rich compositions of olivines and the scarcity of phyllosilicates in the DIs suggest that they experienced thermal metamorphism and dehydration. These characteristics are consistent with the interpretation previously proposed for the DIs in other CV3 chondrites [2–4]. The DIs in Mokoia probably also experienced intense shock metamorphism after aqueous alteration. From these results, we suggest that the Mokoia parent body was a dynamically processing body, in which aqueous alteration, thermal metamorphism and shock metamorphism occurred heterogeneously.

References: [1] Kurat G. et al. (1989) *Z. Naturforsch., 44a*, 988–1004. [2] Kojima T. et al. (1993) *Meteoritics, 28,* 649–658. [3] Krot A. N. et al. (1995) *Meteoritics, 30,* 748–775. [4] Kojima T. and Tomeoka K. (1996) *GCA, 60,* 2651–2666. [5] Cohen R. E. et al. (1983) *GCA, 47,* 1739–1757. [6] Tomeoka K. and Buseck P. R. (1990) *GCA, 54,* 1745–1754.