TEXTURES, METAMORPHISM AND ORIGIN OF TYPE A CAI'S J. Teshima and G.J. Wasserburg; The Lunatic Asylum, Div. Geol. & Planet. Sci., Calif. Inst. of Tech., Pasadena, CA 91125.

Textural observations made on several compact Type A Allende CAI's suggested that metamorphism played a significant role in their formation. Textures exhibited by melilite, which composes 75-80% of these inclusions, suggestive of metamorphism are polygonal crystals meeting at 120° triple points, sutured and lobate grain boundaries, and kink bands and deformation twins in highly fractured crystals. Compact Type A inclusions which were first distinguished from the fluffy Type A's by [1] are composed primarily of melilite and accessory spinel, Ti-fassaite and perovskite. If metamorphic recrystallization was a pervasive factor in the history of compact Type A CAI's then we should observe homogeneity in the chemical compositions of the major mineral phases in these inclusions. We have analyzed in detail the chemical compositions of melilite and fassaite in three compact Type A's to test the occurrence and extent of a metamorphic episode of high enough grade to homogenize major mineral compositions. The three inclusions investigated are CIT BG82D(H)3, USNM 3898 and CIT Egg 4. Based on texture alone BG82D(H)3 was presumed to be the most metamorphosed. It is composed of densely packed completely recrystallized (< 50μm) polygonal melilite, green Ti-fassaite with reentrant grain boundaries that fill the intersticies between melilite polygons and rounded spinel poikilitically in melilite and fassaite. USNM 3898 shows intermediate textures. Melilite is coarse grained (0.5-1.5 cm), has sutured, lobate grain boundaries which commonly meet at triple points, and contains kink bands. These textures and the even anomalous grey interference color exhibited by the melilite indicate that some recrystallization was experienced by 3898. Ti-fassaite occurs as inclusions in melilite and as a rare large deep green crystal with a rhönite core [2]. Spinel ocurs as chains of euhedral and smaller isolated tabular crystals in melilite. Texturally, Egg 4 is the least metamorphosed. It contains very coarse interlocking zoned melilite with straight grain boundaries which meet at triple points. An unusually large (0.5 x 1 mm) concentrically zoned Ti-rich euhedral fassaite crystal, free of inclusions, is located in the core of the CAI. Other smaller fassaite crystals occur interstitially between melilite. Ragged spinel is abundant and poikilitically enclosed in melilite. The textures observed here are strikingly similar to the Ge-rich radially zoned coarse melilite mantles of Type B1 inclusions. Melilite compositions obtained on the electron microprobe are summarized for the three inclusions as histograms in Fig. 1. Fassaite analyses are compared to those in previously reported Type B and fluffy type A's in a plot of TiO_2 vs. Al_2O_3 (Fig. 2). Inset are the ranges in Ti^{3+}/Ti^{4+}, calculated assuming fassaite are stoichiometric and that a deficit of cations in the octahedral site are due to the presence of some Ti as Ti^{3+}, for BG82D(H)3, 3898 and Egg 4 which indicate a relatively higher oxidation state for Egg 4. Analyses of BG82D(H)3 confirmed our hypothesis that this inclusion completely recrystallized during a metamorphic event. Both the compositions of the melilite (ak30-ak40) and the fassaite (18wt% TiO_2) are homogeneous. USNM 3898 and Egg 4 show different compositional trends. USNM 3898 contains melilite which gradually increases in ak content from inclusion rim to core, varying from (ak9-ak36). The individual melilite crystals are not concentrically zoned but change regularly in composition going from the exterior of the inclusion to the interior. In Egg 4 ak content is constant in the inclusion interior (ak27-ak33) but jumps abruptly at the rim to more Ge-compositions (<ak10). Fassaite compositions are also heterogeneous. USNM

3898 contains a large fassaite crystal whose Ti contents range from 17-20wt% TiO_2. Individual fassaite grains poikilitically enclosed in melilite are compositionally similar to the large crystal. The large zoned fassaite crystal in Egg 4 contains a Ti-rich core surrounded by rim of lower Ti content (6-17wt% TiO_2). As in 3898 smaller fassaite grains are chemically similar to the large crystal. This textural and chemical study has shown that the metamorphic events which produced these textures in the three compact Type A inclusions varied in intensity. BG82D(H)3 is completely recrystallized throughout the inclusion and is composed of major minerals which are chemically homogeneous. USNM 3898 and Egg 4 contain melilite which are radially zoned and fassaite heterogeneous in composition and in the case of Egg 4 concentrically zoned. The preservation of chemical trends in the minerals in these inclusions suggests that metamorphism was less intense than for BG82D(H)3. Radial zoning within the incluson reflects a more primary character related to the original formation. Textures once exhibited by the inclusion have been altered but primary chemical relationships have been preserved. Highly zoned coarse euhedral fassaite and compositionally similar micron sized fassaite crystals in melilite in the same inclusion strongly suggest a liquid origin for the compact Type A's. We believe that compact Type A inclusions were once completely molten droplets [3] whose major phases fractionally crystallized in the order spinel, followed by melilite and fassaite very rich in Ti and V, possibly due to enrichment in the residual liquid. The textures observed in the melilite today were then produced by metamorphic processes which caused little to complete recrystallization. Alternatively, we also mention the possibility that the textures exhibited by fassaite and spinel are due to resorption during a metamorphic event in which fassaite and spinel were replaced by melilite. This study has found the high-Ti content of fassaite in compact Type A CAI's to be characteristic of this type of inclusion (Fig. 2). It is also tempting to suggest a genetic relationship between the compact Type A and Type B1 inclusions which have overlapping fassaite compositions and texturally similarly melilite. We infer that the compact Type A's have an origin distinctive from the fluffy Type A's. References: [1] Meteor. 14, 479 (1979); [2] Smith. Contr. Earth Sci. 25 (1982); [3] LPS XIII, 31 (1982); [4] GCA 39, 433 (1975); [5] Wark, D.A. Ph.D. Thesis (1983). (#503 4181)