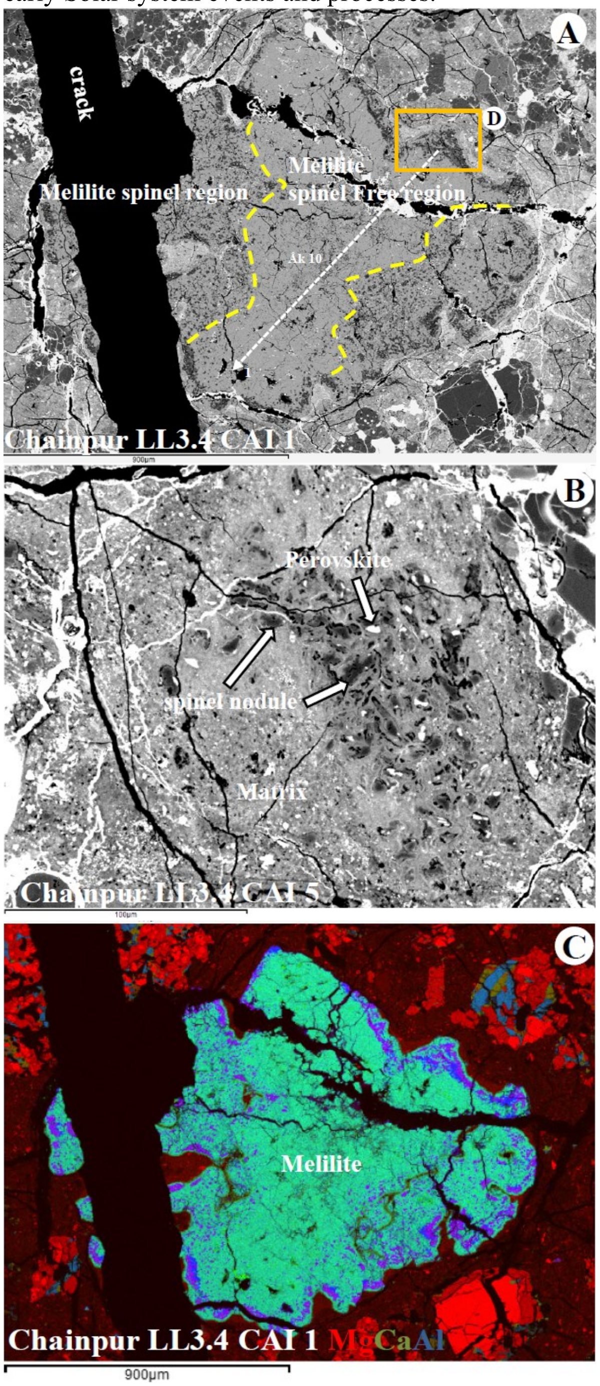
PETROGRAPHY AND MINERALOGY OF A LARGE CALCIUM, ALUMINUM-RICH INCLUSION IN CHAINPUR (LL3.4) ORDINARY CHONDRITE. R. K. Mishra[1], [1]Independent researcher, Vill: Dhawalpura, Po: Kaitha, District Bhagalpur, Bihar 813211, India (riteshkumarmishra@gmail.com).

Introduction: Preponderance of oxides of calcium, aluminum and other refractory elements like titanium, magnesium constituting multi-mineral phases aggregate or melt crystallized solid as inclusions within chondritic meteorites have given the first forming Solar system solids their eponymous name of Calcium, aluminum, -rich inclusions (CAIs). Modal abundance, mean size, constituent mineral phases vary significantly amongst different group of chondrites and are characteristic features of each group [1]. CAIs are extremely rare in ordinary chondrites (0.01-0.2 volume %) and are mostly 10-250 µm in size. The small size, altered, fragmented morphology of majority of these CAIs allowed only a limited relative chronology, in situ oxygen and other isotopic studies [2-11]. Since ordinary chondrites constitute about 80% by abundance of all meteorites, lack of comprehensive isotopic studies in CAIs from ordinary chondrite is an important missing information in the early Solar system studies. Obtaining isotopic signatures of these CAIs are crucial to understand isotopic evolution of protoplanetary disk due to mixing, transport, evaporative loss, and other physico-chemical processes prevalent during the first few million years of the Solar system. A systematic investigation of a suite of ordinary chondrites of low petrographic grades is being pursued to find large CAIs in ordinary chondrites to address the missing isotopic signatures [7,8]. In this pursuit, a thin section of Chainpur was examined. Seven CAIs, two spinel bearing amoeboid olivine aggregates and a few Al-rich chondrules [8] were found randomly distributed in the thin section (Fig. 1 A-B). A large type B CAI of 1500×1200 µm found amongst these is described here while others will be presented in a follow up report.

Chainpur (LL3.4) is an 8.2 kg observed 'fall' from (Chainpur, Uttar Pradesh) India that is classified to petrographic grade 3.4. It is an ordinary chondrite of with very low FeO content LL (low low) type. Petrography and mineralogy of a large type B2 rectangular shaped inclusion with undulated edges is reported. It is the largest sized CAI in the ordinary chondrite reported so far; the second largest (600×400 µm) being a recent 'find' of spinel- melilite bearing CAI from NWA 8276 (LL3.00) [11].

Petrography and mineralogy: The exposed surface of the CAI is irregular rhombus shaped with two of its constituting edges made by irregular undulated outer boundary while the other two edges having a nearly linear stretch (Fig 1 A-D). A triangular shaped spinel free melilite region is bounded on both sides by regions which have abundant spinels and perovskites scattered within melilite. The inward excursions in the outer boundary are filled by accretionary rim. A variably thick up to 100 µm wide Wark-Lovering (WL) rim is present along the periphery. The WL- rim consists of two layers. The outer melilite is bejeweled with abundant small irregular, melt drop shaped perovskite grains. The basal layer consists of hibonite, spinel, perovskite that are intergrowing and mostly anhedral. Melilite in the WL-rim are near gehlenitic end that rapidly changes in composition from ~3 to10 Åk mol % over ~50-100 µm from the rim. Elsewhere melilite has uniform composition of ~Åk 10 (Fig. 1E). A linear profile of elemental composition in spinel -free melilite indicated by line 1 is shown in Fig. 1E. Spinels in the WL-rim are anhedral with mostly Mg end member composition (FeO < 0.2 wt. %) but a few grains also have higher FeO abundance varying up to ~7 wt.%. The typical abundances of Al_2O_3, MgO, CaO, and TiO_2 in hibonite are about 80, 3.5, 8, 7 wt. %, respectively. Perovskites in WL-rim are hosted mostly within spinels, or as individual grains within melilite picketing the fence of the CAI. The melilite composition in both the regions (spinel free and spinel-bearing melilite) are similar. An Fe,- rich vein crossing the CAI was mostly lost during the preparation of the thin section.

Discussion: Less than 100 CAIs in ordinary chondrites (~65 in H, ~11 in L, and ~10 in LL) have been reported in literature [2-9] of which about ¾ of the entire inventory comes from a group of 4-5 (anomalous!) ordinary chondrites [5-6]. Only 7 of these are larger than 250 µm in size [2-4, 9]. A high concentration of refractory inclusions of large size greater than 200 µm in Chainpur makes the thin section atypical, but very important, for its kindred. Mineral composition (melilite ~3-10Åk mol%), and petrographical features (small spinel grains, absence of plagioclase and pyroxene) are suggestive of petrogenesis from a bulk type B CAI melt that cooled at a fast rate (>10 °C/hr) from a peak temperature of ~1500°C. Presence of WL-rim implies that the CAI subsequent to its formation experienced another high temperature event. Rather homogeneous and low abundance of sodium, sulphur, iron within the CAI is indicative of lack of nebular and parent body metamorphism. Furthermore, presence of other CAIs within Chainpur with morphological and mineralogic characteristics of significant alteration implies varying level of complex distinct histories of these objects and alteration in the nebular environment prior to accretion into Chainpur parent body. This observation agrees with previous inference of alteration in CAIs in ordinary chondrites show lack of any trend with petrographic type [1,12]. Detailed isotopic study of Chainpur CAI 1 will provide important missing information about the early Solar system events and processes.



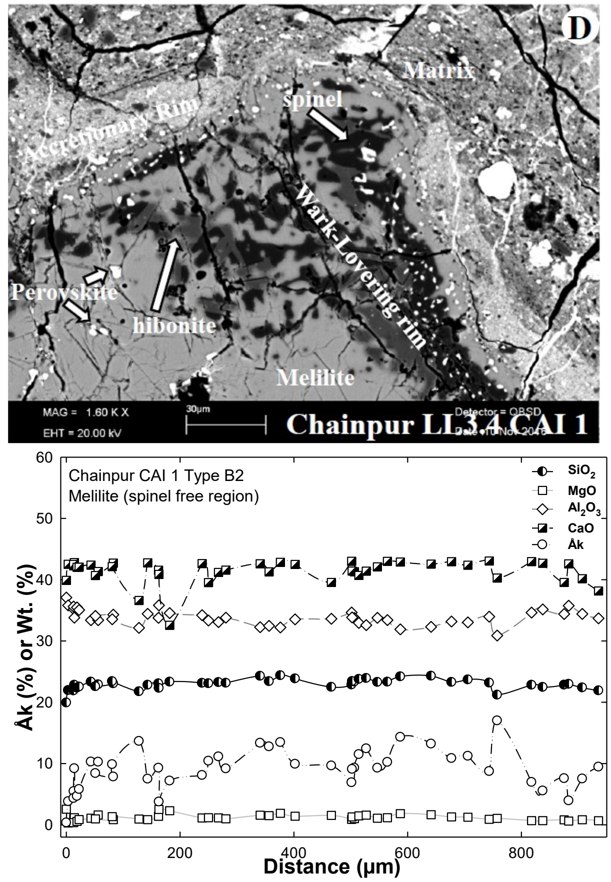


Fig. 1 (A) and (B) are BSE image of CAI 1 (type B2) and CAI 5 (fine grained spinel-pyroxene nodules) respectively. (C) Mg-Ca-Al (RGB) mosaic map of Chainpur CAI#1 (D) Magnified image of Wark-Lovering rim of CAI 1 inset in (A). (E) Elemental composition of a linear profile indicated as line 1 in Chainpur CAI 1 (Fig. 1 A). Scale bars are shown at the bottom of each panel.

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