

SJ101, A NEW FORSTERITE-BEARING CAI FROM THE ALLENDE CV3 CHONDRITE: SEM AND EPMA STUDIES. Michail I. Petaev^{1,2} and Stein B. Jacobsen¹, ¹Department of Earth & Planetary Sciences, Harvard University and ²Harvard-Smithsonian Center for Astrophysics, Cambridge MA 02138, USA.

Introduction: The forsterite-bearing Type B CAIs (FoBs) are rather rare but important members of the CV chondrite CAI's suite because of (1) their intermediate chemistry and mineralogy between the 'classic' CAIs and forsterite-rich AOA's and (2) rather high proportion of FUN CAIs among FoBs [1]. Only half a dozen FoBs are described in the literature [1] so far. In our recent search of the Allende CV3 chondrite for CAIs large enough for comprehensive petrologic, chemical, and isotopic studies [2] we found a large (6.34 g, ~2.5×1.5 cm), potato-shaped intact CAI labeled SJ101. The CAI was cut perpendicular to its longest axis into two pieces weighing 2.41 and 3.83 g. Here we report the results of SEM and EPMA studies of a thick polished section made from the smaller piece. Mg and Ba isotopic compositions of the same CAI are reported in the accompanying abstracts [3,4].

Petrography and Mineralogy: The overall texture of SJ101 is shown in an Al X-ray mosaic of the CAI's complete cross-section (Fig. 1). SJ101 is dominated by an Al-rich spinel-clinopyroxene (Sp-Cpx) lithology which forms rather large, contorted islands separated by sinuous bands and/or pockets of a forsterite-clinopyroxene (Fo-Cpx) lithology. The inclusion lacks the Al-enriched mantle typical of other FoBs [1]. No 'classic' Wark-Lovering rim was observed so far. Instead, the peripheral portions of SJ101 contain rather large, discontinuous anhedral masses of spinel in a reaction relationship with the Al₂O₃-poor and SiO₂-rich (up to 55 wt.%) clinopyroxene which, in many cases, is in direct contact with the Allende matrix. No perovskite or hibonite was found in these spinel masses so far. The inclusion contains cavities and was cross-cut by several more or less straight cracks extended to its very periphery.

Both the Sp-Cpx and Fo-Cpx lithologies display igneous textures (Fig. 2A) with Sp and Fo being poikilitically enclosed in clinopyroxene. A few grain boundaries observed in BSE images of the Sp-Cpx lithology suggests that the Cpx is polycrystalline and rather coarse-grained; this may also be the case of the Fo-Cpx lithology. The boundary between these lithologies is rather smooth and gradational, suggestive of their interaction during a late melting episode.

In addition to spinel and clinopyroxene the Sp-Cpx lithology typically includes irregular patches of Al-poor melilite (Åk ~82) with poikilitic inclusions of spinel. The melilite is partially replaced by grossular-monticellite intergrowths. In a few occurrences anorthite laths were observed at the melilite-clinopyroxene interfaces (Fig.

2B). All three silicates contain numerous poikilitic spinel grains of the same habits. In general, the melilite-clinopyroxene relationships are consistent with the melilite being a relict of the precursor material rather than a product of co-crystallization with clinopyroxene.

Essentially each band or pocket of the Fo-Cpx lithology contains a rather large number of Ni-rich metal grains, with some of them being completely or partially replaced by magnetite.

Secondary alteration of SJ101 is rather minor. Secondary minerals observed so far include grossular, monticellite, magnetite, and a few grains of wollastonite and nepheline.

Mineral and bulk chemistry: The chemical compositions of all minerals except for Cpx are rather constant. Forsterite, spinel, anorthite, grossular, monticellite, and wollastonite are essentially pure end-members. Forsterite contains ~1wt% CaO or more, indicative of its crystallization from a CaO-rich melt. Cpx shows a wide range of compositional variations apparently independent of lithology (Fig. 3). In general, there seems to be two compositional varieties of Cpx with low and high concentrations of Al₂O₃ (Fig. 4). Some elemental X-ray maps display polygonal areas with different Al contents consistent with the sector-zoning described in other FoBs [e.g., 1,5,6].

The bulk composition of SJ101, calculated by averaging 484 50-µm DBA spot analyses equally spaced along 4 traverses crossing the whole CAI, is as follows (wt%): SiO₂ 35.90, TiO₂ 0.96, Al₂O₃ 24.86, Cr₂O₃ 0.10, FeO 0.60, MgO 17.83, CaO 19.83, V₂O₃ 0.08.

Discussion: Mineralogically and chemically SJ101 is a rather typical FoB [e.g., 1,5,6]. The lack of an Al-rich mantle and the unfractionated Si isotopic composition [2] suggests that it is the only known FoB that did not experience substantial evaporation and, therefore, has retained its primary texture, mineralogy, and chemistry. The textural and mineralogical relationships between the Al-rich Sp-Cpx and Al-poor Fo-Cpx lithologies suggest that the latter formed by remelting of a forsterite and metal-rich precursor (AOA-like) that might represent accretionary rims around individual Sp-Cpx (Type B) CAIs. Such a scenario is consistent with the ideas expressed in [7].

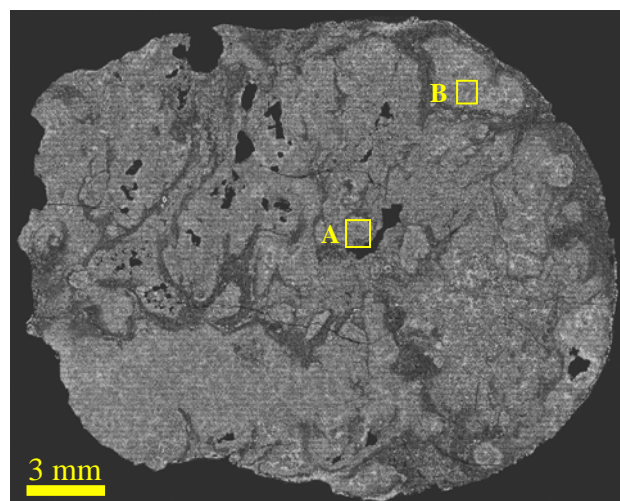


Fig. 1. Al X-ray map of SJ101. White - Al-rich Sp-Cpx lithology, gray - Al-poor Fo-Cpx lithology, black - epoxy. The horizontal streaking is an artifact of imperfect stitching of 14720 individual tiles.

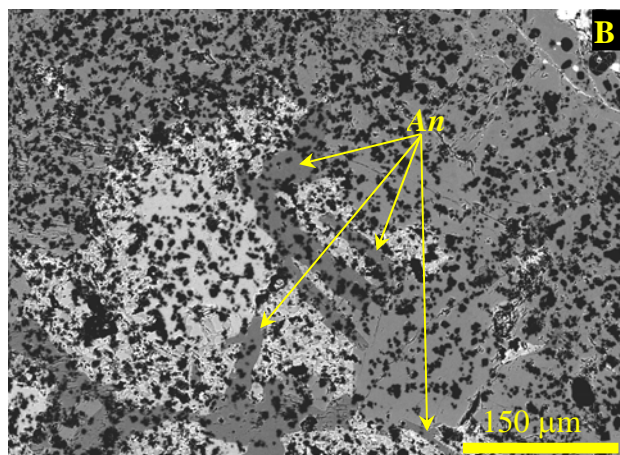
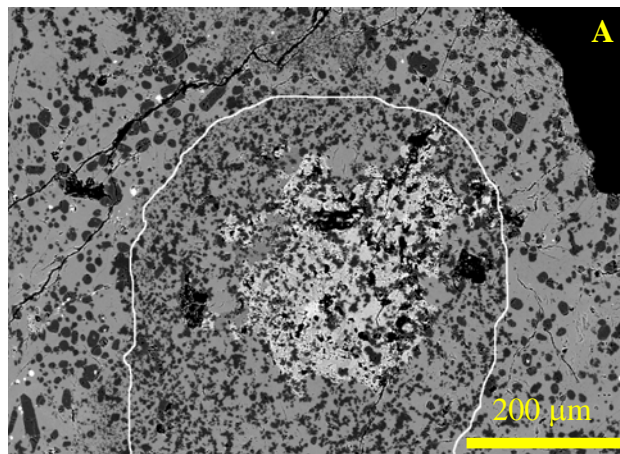


Fig. 2. BSE images of areas A and B of Fig. 1 rotated 90° counter-clockwise. Black - epoxy, tiny white spots - Fe,Ni metal. Dark gray are forsterite (small euhedral grains) and spinel (clusters of tiny grains). Light gray - melilite and its alteration products. Medium gray are clinopyroxene and anorthite (An, laths shown by arrows in B). White contour in A outlines Sp-Cpx lithology.

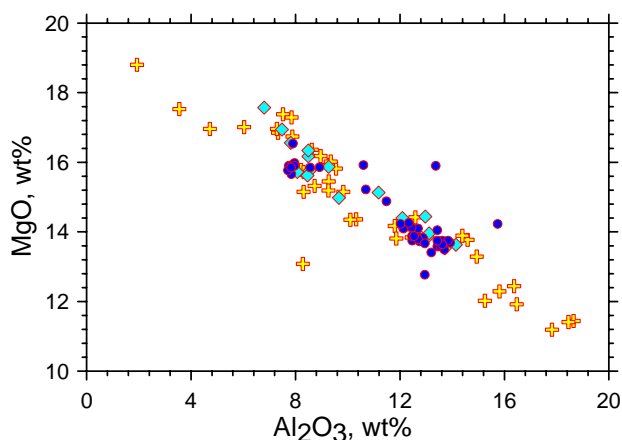
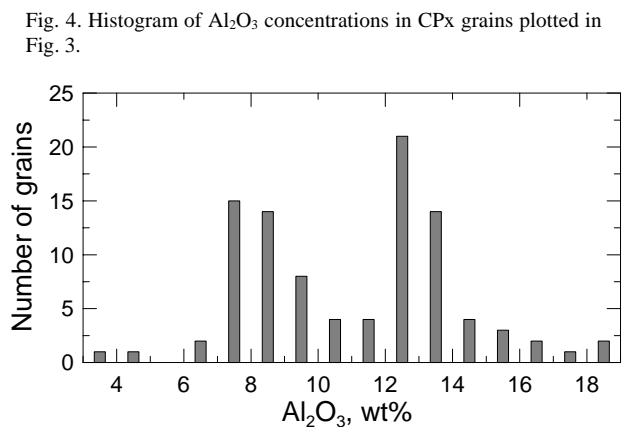


Fig. 3. Concentrations of MgO and Al_2O_3 in clinopyroxene. Yellow crosses - Sp-Cpx lithology, cyan diamonds - Ol-Cpx lithology, blue circles - random grains analyzed along a traverse across the whole CAI.



References: [1] MacPherson G. J (2005) *Treatise on Geochemistry*, vol. 1, 201-246. [2] Jacobsen S. B. et al. (2007) *CMES workshop*, 82-83. [3] Jacobsen S. B. et al. (2008) *this volume*. [4] Ranen M. C. and Jacobsen S. B. (2008) *this volume*. [5] Wark D. A. et al. (1987) *GCA* 51, 607-622. [6] Davis A. M. et al. (1991) *GCA* 55, 621-637. [7] Bullock E. S. et al. (2007) *MAPS* 42, A26.