Al-Diopside-Rich Refractory Inclusions in the CH Chondrite Acfer 182. Alexander N. Krot (sasha@pgd.hawaii.edu), Alexander A. Ulyanov, and Dietmar Weber. 1Hawai‘i Institute of Geophysics & Planetology, SOEST, University of Hawai‘i, Honolulu HI 96822, USA; 2Moscow State University, Russia; 3Institute of Planetology, Munster, Germany.

Introduction: The CH carbonaceous chondrite group includes Acfer 182, ALH85085, PAT91546, and PCA91467. Ca,Al-rich inclusions in the CHs are mineralogically different from those in other carbonaceous chondrites and are characterized by a highly refractory nature, with grossite, hibonite, spinel, and melilithe as the most abundant minerals [1-6]. Because of the unusual mineralogies, only the grossite-rich CAIs from CH chondrites have been extensively described in previous studies. In this paper, we characterize CAIs from Acfer 182 and PAT91546 which contain Al-diopside as the major mineral; hibonite, grossite, spinel, and melilithe are minor or accessory; the Al-diopside-rich cores are often surrounded by forsteritic olivine rims. In spite of their simple mineralogy, these CAIs are petrographically and mineralogically unique and have been found only in CH chondrites, possibly reflecting unusual environment of their formation.

Samples and Analytical Technique: Polished thin sections of the CH chondrites, Acfer 182, PL91022, UH184, and PAT91546, 13 were studied using a DSM 962 scanning electron microscope equipped with EDS and a Cameca SX-50 electron microprobe. In order to identify CAIs, the thin sections were mapped in Al, Mg, Ca, and Ti Kα at resolution 1024x1024 pixels with pixel size ~ 5 µm. Bright spots in Al Kα were examined in detail using backscattered electron imaging, X-ray mapping, qualitative EDS and quantitative microprobe analyses. To date more 20 CAIs and CAI fragments rich in Al-diopside have been identified.

Mineralogy and Petrography: The Al-diopside-rich CAIs occur as spherically-shaped objects with apparent diameters in the range of 20 to 300 µm (Fig. 1), probably indicating crystallization from liquids. They are characterized by simple mineralogies: Al-diopside is the dominant phase which may associate with grossite, hibonite, or spinel; perovskite and metal grains are absent. The Al-diopside±spinel spherules are commonly surrounded by forsteritic olivine rims (Figs. 1m-t), whereas those with melilithe, hibonite, and grossite lack the rims. Forsteritic olivines (Fa<1) contain high abundances of CaO (0.5-0.6 wt.%), possibly indicating fast cooling rates; spinel grains are Mg-rich [Mg/(Mg+Fe)>0.98] and Cr-poor (<1 wt.% Cr2O3). The Al-diopsides are Fe-poor (Fs <2) and show significant compositional variations (in wt.%; TiO2, 0.02-5.9; Al2O3, 5.8-42.3; MgO, 1.7-18.8) even within an individual inclusion. The distributions of these elements clearly seen in X-ray elemental maps (Fig. 1) do not exhibit a concentric pattern within the spherical inclusions. The compositional variations of Al-diopsides are largely due to the substitution Mg(IV)+Si(IV)→Al(IV)+Al(IV), suggesting the presence of hypothetical Ca-tschermakite molecule (CaAl2SiO6; Fig. 2). The observed deviation from the theoretically expected slope (0.5) is possibly due to the presence of Ti3+. One of the analyses corresponds to a nearly pure Ca-tschermakite [Ca1.00Al0.91Mg0.09Al0.91Si1.06O6.00]. Positive correlation of Al2O3 and TiO2 typical for Al-diopsides in CAIs from other carbonaceous chondrite groups [7] is absent in Al-diopsides from CH chondrites. The petrography and mineralogy of the Al-diopside-rich refractory inclusions are consistent with crystallization from liquids under highly disequilibrium conditions.

Fig. 1. Backscattered electron images (a,i,m,q) and X-ray elemental maps of the Al-diopside-rich refractory inclusions in the CH chondrites Acfer 182 (a-p) and PAT91546 (q-t). Al-di - Al-diopside, fo - forsterite, grs - grossite, hib - hibonite, sp - spinel. The inclusions are characterized by the (1) spherical shape, (2) simple mineralogy, (3) absence of perovskite and metal, (4) complex chemical zoning of Al-diopsides, and (5) presence of forsteritic olivine rims.