Two-step metallic partial melting on the acapulcoite-lodranite parent body

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Introduction: Acapulcoite-lodranite is the largest group of primitive achondrites. Primitive achondrites are the products of partial melting processes on the solar system planetesimals. Partial melting is the first stage of the early differentiation of planetary bodies. To investigate partial melting processes on primitive achondrite parent bodies will provide us the information of the early differentiation and core formation processes of protoplanets. Here, we report metal chemical compositions of several acapulcoite-lodranites and discuss metallic partial melting processes of their parent body.

Samples and methods: We have studied 5 acapulcoites (MET 01195/01198/01244 pairs, Y-74063 and Y 981505) and 3 lodranites (GRA 95209, Y-791491 and Y 981725). Among these meteorites, an acapulcoite Y-74063 have been reported as a relict chondrule-bearing primitive achondrite [1]. Several chips of each meteorite were ground into small grains and magnetic phases were separated by using a hand magnet. Chemical compositions of these magnetic phases were determined by ICP-MS and ICP-AES at Tokyo Metropolitan University.

Results and discussion: Chemical compositional data of magnetic fractions of primitive achondrites are shown in Figure 1a. Platinum group elements (Rh, Pd, Re, Ir and Pt) and W abundances are widely scattered. A lodranite Y-791491 has the highest and an acapulcoite Y 981505 has the lowest abundances of PGE and W. These elements are highly sensitive to solid-metal/liquid-metal segregation [2]. The wide variation of PGE and W abundances among acapulcoite-lodranites provides valid evidence of metallic partial melting processes on their parent body. We consider Y-74063 acapulcoite as the proxy of chondritic precursor for the following discussion.

Here, we focus on one acapulcoite Y 981505. Y 981505 shows a severe depletion in Re and Ir compared to the other acapulcoite-lodranites (0.44 and 0.45 times of Y-74063, respectively). According to solid-metal/liquid-metal partitioning behavior [2], such depletion is found in metallic liquid. On the other hand, Y 981505 has 0.57 times lower Cu and 1.25 and 1.29 times higher Ga and Ge abundances relative to those of Y-74063. This result is inconsistent with solid-metal/liquid-metal partitioning behaviors of Cu, Ga and Ge. To reconcile this problem, we consider two-step partial melting processes for the origin of Y 981505 metals. Fig. 1b shows Y-74063-normalized chemical compositions of our model calculation and the Y 981505 data. We modeled that 10% of eutectic (~31 wt% S content) partial melt liquids were removed from the precursor metal at the first step, and partial melting with 25 wt% S content had occurred up to 98.5% and 99% at the second step. In this model, the Y 981505 metal composition can be well explained.

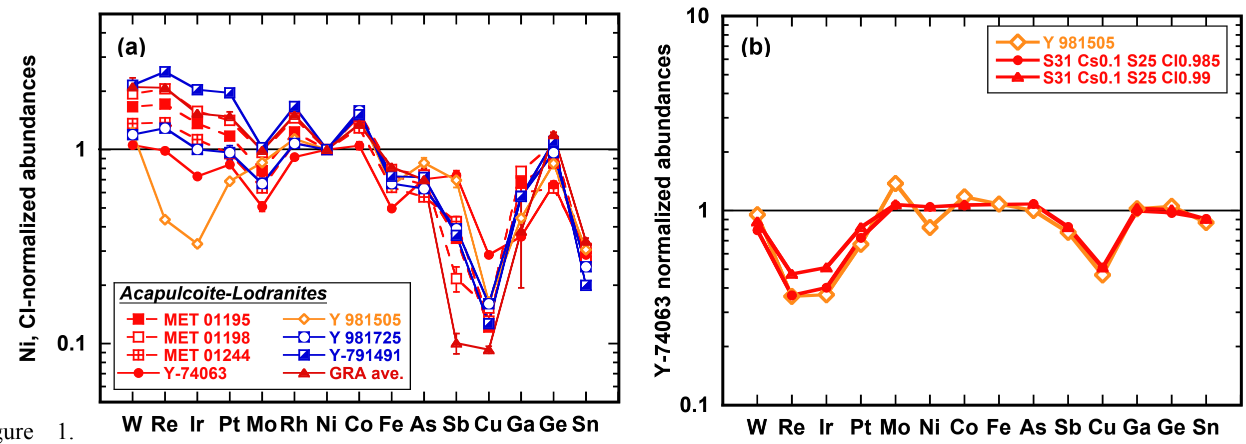

Figure 1. (a) Ni-, CI-normalized elemental abundances of acapulcoite-lodranite metals. CI chondrites data used for normalization is from [3]. (b) Y-74063-normalized elemental abundances of acapulcoite Y 981505 and model calculation results of two-step metallic partial melting. The partition coefficients for each element are calculated from the data of [2]. Shown data are liquid portions of the second partial melting. Y-74063 metal composition is used for the starting material.

References: [1] Yanai K., and Kojima H. (1991) *Proc. NIPR symp. Antarct. Meteorites* **4**, 118-130. [2] Chabot N. L. et al. (2014) *LPSC* XLV, #1165. [3] Anders E. and Grevesse N. (1989) *GCA* **53**, 197-214.