Platinum Group Elements in Howardites and Polymict Eucrites: Implications for Impactors on the HED Parent Body

Wee Boon Siong
University Malaysia Sarawak

PLATINUM GROUP ELEMENTS IN HOWARDITES AND POLYMICT EUCRITES: IMPLICATIONS FOR IMPACTORS ON THE HED PARENT BODY. B. S. Wee[1], A. Yamaguchi[2], M. Ebihara[1], [1]Department of Chemistry, Tokyo Metropolitan University, Hachioji, Tokyo 192-0397, Japan. (wee@ed.tmu.ac.jp), [2]National Institute of Polar Research, Tachikawa, Tokyo 190-8518, Japan.

Introduction: Most of the HED meteorites are breccias. These HED breccias consist of different proportions of eucrites, diogenites, and other minor components. Crystalline eucrites and diogenites generally have very low PGE (platinum group element) abundances due to metal-silicate fractionation. PGEs are strongly partitioned into FeNi metals (core). However, many HED breccias have relatively high abundances of PGEs. The presence of chondritic materials was inferred from siderophile elemental data [1] and carbonaceous chondrite clasts were found in howardites and polymict eucrites [2, 3]. Because of the low PGE abundances in crystalline rocks, PGEs can be used as signature elements to identify impactors [1,4]. By using PGE data of these polymict breccias, we aim to discuss the origin of impactor materials that caused wide spread brecciation on the parent body in the early solar system.

We analyzed 13 howardites and 4 polymict eucrites. All meteorites are from the Antarctica collection except Kapoeta. Bulk chemical compositions of brecciated matrix (0.3 – 1 g) of these meteorites including those of PGE have been determined by NAA and ICP-MS with fire assay. We used PGE elemental ratios to identify projectile materials [4].

Results and Discussion: Our Kapoeta sample shows high PGE abundances, being equivalent to the presence of ~10% chondritic materials (Fig. 1). This is much higher than the reported values of 2 – 3% CM chondrites [e.g., 1, 2]. The PGE results of Kapoeta are consistent with our previous data for siderophile elemental ratios [5]. Thus, major part of the PGE in Kapoeta could be from other types of chondrites than CM. The PGE elemental ratios of Kapoeta show resemblance to those of CK, CM, H and L chondrites. This may suggest the presence of multiple impactors in Kapoeta. The PGE abundances of Y-791573 are ~ 0.02 × CI values with slight Rh enrichment similar to ordinary chondrites [6]. The PGE elemental ratios of Y-791573 show that ordinary chondrites could be the impactor for this meteorite.

The QUE 99033 and EET 99400 show 0.001 – 0.002 × CI values with Pd enrichment. In PGE ratio plots, these two meteorites do not fall in any of chondrites groups. In MET 96500, the PGE abundance pattern shows unusual Ir and Rh enrichments which are not similar to any of the known chondrite groups. Thus, EET 99400, MET 96500 and QUE 99033 contain impactors with distinct chemical compositions. Paired howardites, EET 87503 and EET 87513 show nearly flat CI-normalized PGE abundance patterns, with PGE abundances in EET 87503 being ~2 times lower than those of EET 87513 except for Os. The high Os in EET 87503 seems anomalously high and could be due to analytical error. In PGE ratio plots, EET 87503 shows the presence of CI and EL whereas EET 87513 locates very near to H chondrites. Thus, PGE in the paired howardites are suggested to have been contributed by different types of impactors. Y-7308 shows PGE patterns with slight Pt depletion. From the PGE ratio plots, Y-7308 seems to contain of CI, EL, LL chondrites. LEW 85313 and QUE 97002, have similar PGE patterns with slight Pt depletions, which are similar to those of Y-7308. LEW 85313 and QUE 97002 show some presence of ordinary chondrites. For CRE 01400, the PGE pattern shows gradual upward trend from Pt to Pd, which resembles those of EL chondrites. It is shown from the PGE ratio plots that CRE 01400 contains LL, EH and EL chondrite impactor. The LAP 04838 shows nearly flat PGE pattern at ~0.005 × CI values. The presence of H and L chondrites in LAP 04838 is evidence from the PGE ratio plots. The QUE 97001 shows nearly the same PGE abundance pattern to those of CRE 01400 at ~0.007 × CI values. The enstatite chondrites are found to be a possible impactor and it may include some ordinary chondrites.

The PGE abundance patterns for polymict eucrites are presented in Fig. 2. Overall PGE ratios and slight enrichment of Rh of ALH 76005 are similar to those of H, L, LL and EL chondrites, and to CM to lesser extent. These facts imply that impactor materials are mainly from ordinary and enstatite chondrites. The PGE abundance suggests that ALH 76005 contains ~2 – 3 % of chondritic materials. Paired meteorites, Y-74450 and Y-75015 are depleted in Ir and Pt relative to Re, Ru and Pd, showing W-shaped patterns. Similar PGE patterns were also reported for Apollo 17 poikilitic impact melt breccias [7]. Y-74450 may contain smaller amounts of chondritic materials compare to those of Y-75015 although this variation could reflect heterogeneity of PGE-rich impactors (e.g., FeNi metals). We suggest that impactors are differentiated meteorites with enriched Os and Pd contents are not sampled as meteorites. For Y-792769, PGE abundances pattern is nearly flat, but has slight enrichment of Os and Pd relative to of Ir, Ru, Pt and

Rh (~ 0.002 × CI). The Pd/Os and Rh/Ir values of Y-792769 show some relationships to chondrites. Thus, it may be possible that Y-792769 contains chondritic components slightly rich in Os and Pd.

The present study shows that PGE abundances and the ratios among these PGEs are variable among howardites and polymict eucrites. Some howardites (EET 87513, Kapoeta, Y-791573) show relatively flat CI-normalized patterns compared to those of polymict eucrites (except ALH 76005) and other howardites. The origin of PGEs in these howardites may be linked to some chondrite groups. However, it is difficult to identify the type of chondritic impactors in each meteorite as the PGEs contents in chondrites may show some similarities among the chondrite groups. The PGE data show other types of impactor with fractionated PGE abundances. This study reveals the diversity of impactor materials during the bombardment of HED parent body. Further petrologic studies are required to identify carrier phases of PGEs (fragments of impactors).

References: [1] Chou C.L. et al. (1976) *LPSC* 7, 3501-3518. [2] Zolensky M.E. et al. (1996) *MAPS* 31, 518-537. [3] Lorenz K.A. et al. (2009) *Petrology* 27, 109-125. [4] Tagle R. and Hecht L. (2006) *MAPS* 41, 1721-1735. [5] Wee B.S. et al. (2009) *MAPS* 44, A215. [6] Fischer-Gödde M. et al. (2009) *GCA* in press. [7] Norman M.D. et al. (2002) *EPSL* 202, 217-228.

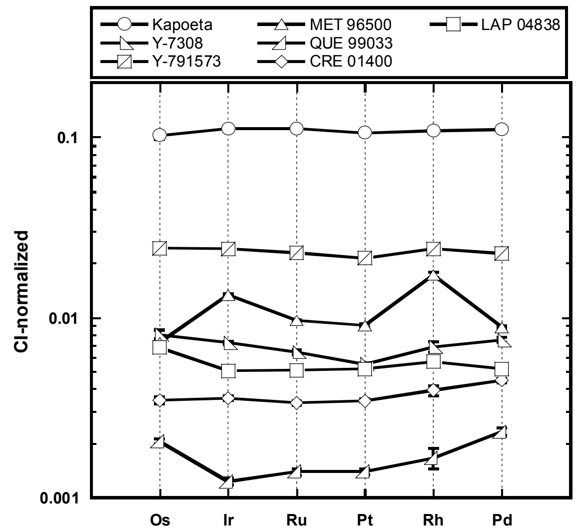

Fig. 1 CI-normalized PGE abundance patterns of howardites.

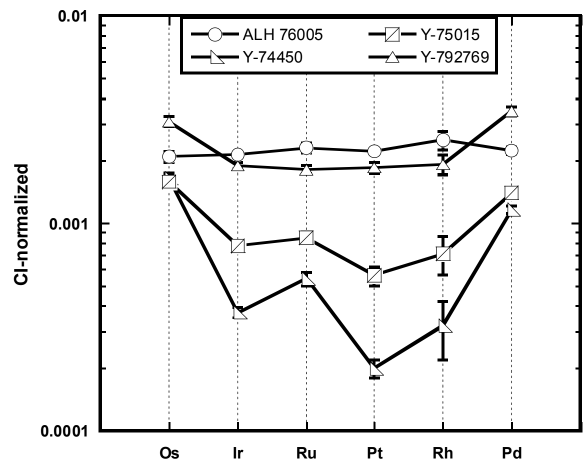

Fig. 2 CI-normalized PGE abundance patterns of polymict eucrites.