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はやぶさ回収試料の初期分析：中性子放射化分析による粒子全岩元素分析 Preliminary examination of Hayabusa asteroidal samples: Neutron activation analysis of single grain

海老原 充^{1*}, 関本俊², 浜島靖典³, 山本政儀³, 熊谷和也¹, 大浦泰嗣¹, 奈良岡 浩⁹, 白井直樹¹, トレバーアイルランド⁴, 北島 富美雄⁵, 長尾 敬介⁶, 中村 智樹⁷, 野口 高明⁸, 岡崎 隆司⁵, 土山 明⁹, 上相 真之¹⁰, 坎本 尚義¹¹, マイケル ゴレンスキー¹², 安部 正真¹³, 藤村 彰夫¹³, 向井 利典¹³, 矢田 達¹³

Mitsuru Ebihara^{1*}, Shun Sekimoto², Yasunori Hamajima³, Masayoshi Yamamoto³, Kazuya Kumagai¹, Yasuji Oura¹, Hiroshi Naraoka⁹, Naoki Shirai¹, Trevor R. Ireland⁴, Fumio Kitajima⁵, Keisuke Nagao⁶, Tomoki Nakamura⁷, Takaaki Noguchi⁸, Ryuji Okazaki⁵, Akira Tsuchiyama⁹, Masayuki Uesugi¹⁰, Hisayoshi Yurimoto¹¹, Michael E. Zolensky¹², Masanao Abe¹³, Akio Fujimura¹³, Toshifumi Mukai¹³, Toru Yada¹³

¹ 首都大学東京理工学研究科, ² 京都大学原子炉実験所, ³ 金沢大学低レベル放射能測定施設, ⁴ オーストラリア国立大学, ⁵ 九州大学理学院, ⁶ 東京大学理学系研究科, ⁷ 東北大学理学院研究科, ⁸ 茨城大学理学部, ⁹ 大阪大学理学研究科, ¹⁰ 大阪大学工学研究科, ¹¹ 北海道大学理学研究院, ¹² NASA ジョンソン宇宙センター, ¹³ 宇宙航空研究開発機構宇宙研究所

¹Grad. School of Sci., Tokyo Met. Univ., ²Kyoto Univ. Research Reactor Institute, ³Low Level Radioactivity Lab. Kanazawa U., ⁴Res. School of Earth Sci., ANU U., ⁵Grad. School of Sci., Kyushu Univ., ⁶Grad. School of Sci., Univ. of Tokyo, ⁷Grad. School of Sci., Tohoku Univ., ⁸Coll. of Sci., Ibaraki Univ., ⁹Grad. School of Sci., Osaka Univ., ¹⁰Grad. School of Eng., Osaka Univ., ¹¹Grad. School of Sci., Hokkaido Univ., ¹²Johnson Space Center, NASA, ¹³ISAS, JAXA

The Hayabusa spacecraft was launched on May 9, 2003 and reached an asteroid Itokawa (25143 Itokawa) in September 2005. After accomplishing several scientific observations, the spacecraft tried to collect the surface material of Itokawa by touching down to the asteroid in November. The spacecraft was then navigated for the earth. In encountering several difficulties, Hayabusa finally returned to the earth on June 12, 2010 and the entry capsule was successfully recovered.

When the Hayabusa mission was designed, a g-scale of solid material was aimed to be captured into the entry capsule. Although the sample collection was not perfectly performed, it was hoped that some extraterrestrial material was stored into the capsule. After careful and extensive examination, more than 1500 particles were recognized visibly by microscopes, most of which were eventually judged to be extraterrestrial, highly probably originated from Itokawa [1].

Several years before the launching of the Hayabusa spacecraft, the initial analysis team was officially formed under the selection panel at ISAS. As a member of this team, we have been preparing for the initial inspection of the returned material from many scientific viewpoints [2]. Once the recovered material had been confirmed to be much less than 1 g, a scheme for the initial analysis was updated accordingly [3]. In this study, we aim to analyze tiny single grains by instrumental neutron activation analysis (INAA). As the initial analysis is to be started in mid-January, 2011, some progress for the initial analysis using INAA is described here.

Initially, we planned to apply prompt gamma ray analysis (PGA) at the beginning of whole scheme for the initial analysis of g-sized material [4]. As this was not the case, PGA was canceled. In place of PGA, a conventional method of INAA was introduced at the last stage of the analytical flow scheme. In INAA of this study, a single grain is to be analyzed. A rocky grain sample (mostly silicate) is placed into a pit of synthesized clean quartz plate, which is covered with a plane quartz plate. An assembly of quartz plates with a sample grain in-between is wrapped with pure aluminum foil. The sample is irradiated by reactor neutron at Kyoto University Reactor Research Institute (KURRI). Assuming that a grain of diameter of 100 micro-m and density of 3 g/cm³ is similar to CI chondrite in chemical composition and irradiated with neutron flux of 3x10¹³ n/cm² for 50 h, calculated radioactivity (in parentheses in Bq) of neutron-captured nuclides of some constituent elements are as follows; ⁴⁶Sc (1.7), ⁵¹Cr (51), ⁵⁹Fe (11), ⁶⁰Co (2.5) and ¹⁹²Ir (0.83). The gamma ray measurement is to be done both at KURRI and at the low level Radioactivity Laboratory (LLRL), Kanazawa University, where a well-type Ge semiconductor detector is heavily shielded from environmental radioactivity.

Considering the background radioactivity at LLRL, a grain of 1micro-m can be analyzed for the elements mentioned above. If a metal grain of this size is included in a single silicate grain, we are confident that the source material for such a metal (and further silicate) is able to be identified.

References: [1] Nakamura, T. et al. (2011) in this abstract volume. [2] ISAS Report SP No. 16 (2003). [3] Tsuchiyama, A. et al. (2011) in this abstract volume. [4] Ebihara, M. and Oura, N. (2004) Adv. Space. Res. 34, 2305.

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