NEUTRON ACTIVATION ANALYSIS OF SINGLE GRAINS RECOVERED BY THE HAYABUSA SPACECRAFT M. Ebihara[1], S. Sekimoto[2], Y. Hamajima,[3] M. Yamamoto[3], K. Kumagai[1], Y. Oura[1], N. Shirai[1], H. T. R. Ireland[4], F. Kitajima[5], K. Nagao[6], T. Nakamura[7], H. Naraoka[5], T. Noguchi[8], R. Okazaki[5], A. Tsuchiyama[9], M. Uesugi[10], H. Yurimoto[11], M. E. Zolensky[12], M. Abe[13], A. Fujimura[13], T. Mukai[13] and T. Yada[13]
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Introduction: 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.

Initially, 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, higly 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.

Analytical procedure: 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 quarts plates with a sample grain in-between is wrapped with pure aluminum foil. The sample is irradiated by reactor neutron at either Kyoto University Reactor Research Institute (KURRI) or Japan Atomic Energy Agency (JAEA). Assuming that a grain of diameter of 100 μm and density of 3 g/cm^3 is similar to CI chondrite in chemical composition and irradiated with neutron flux of $3x10^{13}$ n/cm^2 for 50 h, calculated radioactivity of neutron-captured nuclides of some constituent elements are shown in Table 1.

Table 1 Radioactivity (in Bq) of some nucided produced in INAA for a small single grain

Element	n-captured nuclide	Radioactivity/ Bq	Count rate/ cps
Sc	^{46}Sc	1.7	0.017
Cr	^{51}Cr	51	0.043
Fe	^{59}Fe	11	0.060
Co	^{60}Co	2.5	0.025
Ir	^{192}Ir	0.83	0.0040

The gamma ray measurement is to be done at the low level Radioactivity Laboratory (LLRL), Kanazawa University, where a well-type Ge semiconductor detector is heavily shielded from environmental radioactivity.

Expected outcome: Conciderring the background radioactivity at LLRL, a grain of 1μm can be analyzed for elements listed in Table 1. If a metal grain of this size is included in a sigle 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 volume*. [2] *ISAS Report SP* No. 16 (2003) [3] Tsuchiyama A. et al. (2011) *in this volume.* [4] Ebihara M. and Oura N. (2004) *Space Sci. Rev*. **34**, 2305.