Comparative laboratory study of materials returned to Earth from the Itokawa asteroid with particles collected in the stratosphere

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**Description:** Samples from extra-terrestrial objects that are available for detailed investigation in the laboratory are particularly important to advance our understanding of the formation and evolution of our solar system, where sophisticated instrumentation can be deployed to unlock the secrets they contain. The most primitive and pristine materials are the most useful, but also the rarest samples. Such material falling to Earth as meteorites and dust is readily destroyed or modified during atmospheric entry, and that which does survive to the surface of Earth rapidly reacts with the terrestrial environment. Samples collected in space and returned by spacecraft offer the best opportunity to identify and study the most primitive materials from the earliest stages of solar system formation.

The JAXA (Japanese Aerospace Exploration Agency) Hayabusa mission was the first sample return mission to an asteroid, returning thousands of 10-100 µm particles from asteroid 25143 Itokawa to the Earth in 2010. Over the past few years we have gained better understandings of the structural, chemical, and mineralogical properties of Itokawa. Many of the grains are rocky mineral fragments that indicate that it is likely to be related to the parent body of LL4-6 ordinary chondrites [1]. However, some of the particles are composed of carbonaceous materials, but the origin of which is still unknown [2-5]. Some preliminary investigations indicated that the organic components might be derived from terrestrial contaminants. However, such particles would be particularly important if asteroidal in origin, and therefore careful reassessment of the organic content of additional Itokawa particles is deemed necessary in order to access whether indigenous organic compounds could have been present on the asteroid Itokawa, and the possible formation/destruction mechanism of the organics. The range in thermal processing recorded by the silicate particles studied to date indicates that the carbonaceous particles offers an excellent opportunity to study pristine extra-terrestrial carbonaceous material, the record of early solar system formation and the effect of parent body thermal processing.

Some primitive extra-terrestrial dust collected in the stratosphere is also available for comparison, this is known to also record very early solar system processes, but further work is required to understand the thermal modification experienced during atmospheric entry and during pre-terrestrial exposure to the interplanetary environment. These IDPs (interplanetary dust particles) are composed of highly-disordered carbon associated with compounds such as ketone and hydrocarbons with aliphatic and aromatic moieties [6-10]. The enrichment in heavy isotopes indicates that the IDPs are composed of primordial solar system materials that have been fractionated in a cold molecular cloud [11, 12].

The main goals of this project are to characterize the organic material contained in the carbonaceous 3 Itokawa particles and compare to that found in the most primitive IDPs. Samples of both the Hayabusa grains and IDPs have already been made available to the supervision team. The project seeks to compare the chemistry, mineralogy, and organic contents of Itokawa particles and IDPs with chondritic meteorite matrix in order to determine their possible formation pathways and relationship to cometary and asteroidal parent body processes. The work will involve a range of co-ordinated detailed analyses with carefully prioritized analytical techniques including micro-Raman
spectroscopy, SEM, TEM, and NanoSIMS as well as synchrotron FTIR and XANES and micro X-ray CT as appropriate.

We seek a highly motivated candidate who has an interest in planetary science, experience in practical laboratory work, and is enthusiastic in space-related projects. The project will involve the handling and analysing very small particles (<100 µm). The successful candidate will have the opportunity to work on extremely precious mission-returned samples alongside with other extraterrestrial materials such as meteorites and interplanetary dust particles and develop extensive experience with advanced analytical instrumentation.

References:


Qualifications required: A first class or upper second class MSci/BSc degree in Earth Sciences or related discipline.