Geophysical Research Abstracts,
Vol. 11, EGU2009-3500, 2009
EGU General Assembly 2009

I. T. – R. O. C. K. S. Comet Nuclei Sample Return Mission

N. Dalcher and the I. T. – R. O. C. K. S. Team
Universität Bern, Physikalisches Institut, Bern, Switzerland (nathalie.dalcher@space.unibe.ch)

Ices, organics and minerals recording the chemical evolution of the outer regions of the early solar nebula are the main constituents of comets. Because comets maintain the nearly pristine nature of the cloud where they formed, the analyses of their composition, structure, thermodynamics and isotope ratios will increase our understanding of the processes that occurred in the early phases of the solar system as well as the Interstellar Medium (ISM) Cloud that predated the formation of the solar nebula [1].

While the deep impact mission aimed at determining the internal structure of comet Temple1's nuclei [e.g. 3], the stardust mission sample return has dramatically increased our understanding of comets. Its first implications indicated that some of the comet material originated in the inner solar system and was later transported outward beyond the freezing line [4]. A wide range of organic compounds identified within different grains of the aerogel collectors has demonstrated the heterogeneity in their assemblages [5]. This suggests either many histories associated with these material or possibly analytical constraints imposed by capture heating of Wild2 material in silica aerogel. The current mission ROSETTA, will further expand our knowledge about comets considerably through rigorous in situ analyses of a Jupiter Family Comet (JFC). As the next generation of comet research post ROSETTA, we present the comet nuclei sample return mission IT - ROCKS (International Team - Return Of Comet's Key Samples) to return several minimally altered samples from various locations of comet 88P/Howell, a typical JFC.

The mission scenario includes remote sensing of the comet's nucleus with onboard instruments similar to the ROSETTA instruments [6, 7, 8] (VIS, IR, Thermal IR, X-Ray, Radar) and gas/dust composition measurements including a plasma science package. Additionally two microprobes [9] will further investigate the physical properties of the comet's surface. Retrieving of the samples will be performed by touch and go manoeuvres and a penetrator device [10]. Solar arrays are used as energy source and additional cooling is required to keep the samples at low temperatures (<135K) to prevent them from alteration during return [11]. The return of the samples will be performed by a re-entry capsule similar to that used in the stardust mission. A combined propulsion method of solar electric and chemical propulsion was chosen and an Ariane 5 ECB will be used as launching vehicle due to the payload of nearly 5.5 tons. The overall mission time is about 9 years and it will operate after 2025. The total costs will exceed 2000 million Euro.

The amount of material returned (at least 15 g in total) will enable a wide range of scientific analyses techniques. For future analyses on Earth, in laboratories capable of more sophisticated techniques, a certain amount (1/4 of total mass) of the samples will be stored under a sufficient protective environment which includes cooling systems, clean rooms and high vacuum conditions.

Different experimental techniques non-, semi-, and completely destructive will be applied to the samples including XRD, IR-VIS spectroscopy for mineralogical analysis, X-Ray tomography for physical properties, SEM, TEM for imaging, TOF-SIMS, Nano-SIMS for isotopic composition and Nano-SIMS, Raman-Spectroscopy for organic analyses .

This will aid us with understanding the nature of comets, the isotopic composition of presolar grains and the role comets played in delivering water and organics to Earth [2] and other celestial bodies.

[1] Irvine W. and Lunine J., The cycle of matter in the galaxy. In Comets II (M. Festou et al., eds.), p. 25. University of Arizona, Tucson (2005).
[2] Sagan C. And Druyan A., Comets, revised. First Ballantine Books Edition (1997).
[3] The shape, topography, and geology of Tempel 1 from Deep Impact observations
Thomas P.C., Veverka J., Belton M.J.S., Hidy A., A'Hearn M.F., Farnham T.L., Groussin O., Li J.-Y., McFadden

L.A., Sunshine J., Wellnitz D., Lisse C., Schultz P., Meech K. J., Delamere W. A. Icarus 187,4-15 (2007).
[4] Simon S.B., Joswiak D.J., Ishii H.A., Bradley J.P., Chi M., Grossman L., Aléon J., Brownlee D.E., Fallon S., Hutcheon I.D., Matrajt G., Mckeegan K.D.: Refractory Inclusion Returned by Stardust from Comet P81/Wild 2. Meteoritics and Planetary Science (2007).
[5] George D. Cody, Harald Ade, Conel M. O'D. Alexander, Tohru Araki, Anna Butterworth, Holger Fleckenstein, George Flynn, Mary K. Gilles, Chris Jacobsen, A.L. D. Kilcoyne, Keiko Messenger, Scott A. Sandford, Tolek Tyliszczak, Andrew J.Westphal4, Susan Wirick, and Hikaru Yabuta. Quantitative Organic and Light Element analysis of Comet 81P/Wild 2 particles using C-, N-, and O- μ-XANES, Meteoretics and Planetary Science: In Press.
[6] Stern, S. et al. Alice: The Rosetta Ultraviolet Imaging Spectrograph. Space Science Reviews 128, 507–527 (2007).
[7] Balsiger, H. et al. Rosina–Rosetta Orbiter Spectrometer for Ion and Neutral Analysis. Space Science Reviews 128, 745–801 (2007).
[8] Colangeli, L. et al. The Grain Impact Analyser and Dust Accumulator (GIADA) Experiment for the Rosetta Mission: Design, Performances and First Results. Space Science Reviews
128, 803–821 (2007).
[9] Yoshimitsu, T., Kubota, T., Nakatani, I., Adachi, T. & Saito, H. Micro-hopping robot for asteroid exploration. Acta Astronautica 52, 441–446 (2003).
[10] Lorenz, R. et al. Demonstration of comet sample collection by penetrator. ESA SP-542, 387-393 (2003).
[11] Küppers et al. Triple F—a comet nucleus sample return mission. Experimental Astronomy, Online First (2008).