Sample return and the Canadian Space Agency: Ongoing activities and avenues for international collaboration

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Canadian Planetary Exploration Overview: Broadly, the Canadian Space Agency's (CSA) planetary exploration program consists of participating in ongoing missions and conducting preparatory activities for missions yet to come. CSA's science goals are developed in conjunction with the Canadian academic community, and follow two general themes: (i) understanding the origin and evolution of planetary bodies within the solar system, and (ii) habitability and life detection. As these goals are squarely aligned with a variety of current and future sample return efforts, CSA – in collaboration with its international partners – has become increasingly involved in sample return mission operations and planning.

OSIRIS-REx: CSA's first formal participation on a sample return effort is with the NASA-led Origins Spectral Interpretation Resource Identification Regolith Explorer (OSIRIS-REx) mission. OSIRIS-REx aims to return at least 60g of material from asteroid Bennu, a primitive carbon-rich B-type asteroid believed to contain organic materials [1]. Canada's hardware contribution to the mission is the OSIRIS-REx Laser Altimeter (OLA) instrument (Fig. 1), built by MDA Corporation and led by Principal Investigator Dr. Mike Daly of York University. OLA is a scanning lidar that will provide high-resolution 3D topographic information about the asteroid, helping provide geologic context for the spacecraft's spectral instruments and aiding selection of a site where samples can be collected safely [2].

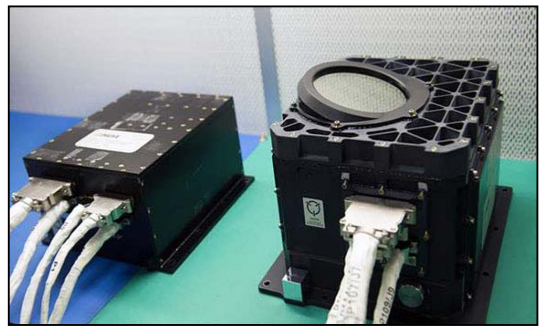

Figure 1: The OSIRIS-REx Laser Altimeter (Image credit: NASA / Goddard / Debora McCallum)

In return for its contribution of OLA and support of a number of mission Science Team members, Canada will receive 4% of the returned sample. A Canadian OSIRIS-REx Sample Advisory Committee is being targeted to assist in evaluating the appropriate curation partner and to review the proposed Curation Plan. This committee would seek input from international partners who have heritage in astromaterial curation. Upon successful return of the samples, Canada also aims to maximize the scientific use of its sample allocation, and would thus welcome discussions on potential sample access opportunities with interested parties.

Mars Sample Return – Mission Architecture and Science Management: Mars Sample Return (MSR) remains one of the highest priorities of the international planetary science community. Because MSR is likely too large an endeavor to be taken on by any individual country or space agency, international cooperation will be paramount to reaching this goal successfully. Several agencies throughout the world are evaluating possible contributions to this multi-mission endeavor, with coordination efforts discussed through the International Mars Exploration Working Group (IMEWG).

In 2014, IMEWG tasked the international Mars Architecture for the Return of Samples (iMARS) working group to define a mission architecture that could successfully achieve MSR and to outline a science management plan for the returned samples. Canada played a lead role in this effort, co-chairing both the science and engineering sub-teams. Over two years, the working group developed an extensive set of findings and recommendations, some of which have already been implemented. A summary presentation was presented at the Mars Exploration Payload Analysis Group (MEPAG) meeting in 2016 [3], with the full report expected to be published in fall of 2017.

Mars Sample Return – Caching and Retrieval: One of the key findings from the iMARS team was that a minimum of three flight missions would be required to achieve MSR: (i) sample collection and caching; (ii) sample retrieval, and; (iii) Earth return. A number of open scientific, technical, and operation questions remain open regarding the execution of the surface elements, (i) and (ii). With international cooperation coordinated via IMEWG, Canada led robotic field deployments near Hanksville, Utah (USA) to start answering some of these questions (Fig. 2).

Science operations for the sample cache mission were conducted over four weeks spanning 2015 and 2016. The mission team conducted operations using a combination of rover-integrated sensors and hand-held instruments, successfully capturing eight scientifically-selected samples and developing an environmental reconstruction of the "landing site". Additionally, a two week deployment in 2016 utilized the rover in its sample retrieval configuration, demonstrating successfully the adaptive caching approach currently preferred by the Mars 2020 mission [4]. These efforts have advanced international readiness for an eventual MSR campaign and paved the way for future deployments to further reduce risk.

Figure 2: Sample collection and retrieval configurations of CSA's Mars Exploration Science Rover (MESR) prototype (Image Credit: CSA)

Science Opportunities for the Future: As human presence expands through the solar system, the Canadian planetary science community is also interested in evaluating new opportunities for science enabled by human exploration of the Moon and Mars. In addition to developing potential rover concepts, CSA is conducting science definition work in support of a Human Lunar Exploration Precursor Program lunar sample return mission. With its international partners, terrestrial field demonstrations are anticipated in the coming years.

Moreover, a number of open competitions are seeking proposals for sample return missions from various destinations in the solar system. Although Canadian hardware contributions to these campaigns are not currently anticipated, in many cases Canadian scientists have been sought to provide expertise in a key mission roles. Depending on the outcome of the competitions, it is possible that science support will be enabled by CSA through a competitive co-investigator program.

References: [1] Lauretta D.S. et al. 2015. Meteoritics & Planetary Science 50:834. [2] Lauretta D.S. 2015. *In* Pelton and Allahdadi (eds). Handbook of Cosmic Hazards and Planetary Defense:544. [3] https://mepag.jpl.nasa.gov/meeting/2016-03/13_iMARS-FinalPresentation_MEPAG_2016-03-02_FINAL.pdf [4] http://www.asc-csa.gc.ca/eng/rovers/analogue-msrad.asp