Canada's Exploration Prototypes: A Science and Resource Prospecting Context

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Abstract

In 2010, the Canadian Space Agency (CSA) commenced a large program of exploration prototype developments geared towards rapid technology advancement, community development and international collaboration in preparation for future flight missions to the Moon and Mars. Termed the Exploration Surface Mobility (ESM) initiative, the program funded the development of an architecture with a central focus on surface mobility, including rovers, advanced technology payloads and science instruments. This paper provides a prospecting context for the use of three rovers, three technology payloads and three science instruments developed under ESM.

The Lunar Exploration Light Rover (LELR) is a rugged, medium-class lunar mobility platform designed for science, prospecting, surveying and a range of in situ resource (ISRU) activities with interfaces for advanced vision, corers, large drills and earth moving tools. LELR supports both teleoperation and fully autonomous modes including ground control and telepresence, e.g. from an orbital outpost. The Mars Exploration Science Rover (MESR) is a small-class, highly-terrainable system originally designed for Mars but fully compatible with operations on other bodies. MESR can support mission scenarios requiring a highly autonomous science prospecting and in situ geological analysis vehicle capable of operating under limited communication windows and bandwidth constraints. MESR can interface with a mini-corer, microscope and robotic manipulator as well as other payloads. The SL-Commander Rover (SLC) is an electric side-by-side all-terrain vehicle capable of carrying two onboard passengers. SLC is intended to enable EVA-astronaut analogue missions as well as perform autonomous, tele-operated and convoy-style driving. All vehicles support a wide range of payloads via standardized interface connections.

The Next Generation Communications System (NGCS) establishes the communications infrastructure required to operate a planetary mission including rover to lander relays that could be deployed at crater rims. The Next Generation Vision System (NGVS) combines a high performance lidar with a high resolution camera and multi-spectral imager to provide excellent situational awareness and remote prospecting capabilities. The Next Generation Power System (NGPS) provides a high-capacity fuel cell based range extending capability to facilitate large surveys, high power ISRU subsystems and long distance traverses. The Three-Dimensional Exploration Multi-spectral Microscopic Imager (TEMMI) instrument combines 3D topographic mapping with multispectral high-resolution imaging of samples. The Lunar Ground Penetrating Radar (LGPR) instrument enables survey and prospecting in the shallow subsurface region, supporting future lunar resource characterization. The Raman Sensor for the Identification of Carbon (RSIC) instrument is a stand-off, deck or mast mounted laser-based analytical sensor for remote mineralogy.

An exciting component of the ESM program has been the collaboration between a large number of key Canadian stakeholders from across the space program. Industry examples include Bombardier Recreational

Products Centre for Advanced Technology, Optech and Hydrogenics. Academic examples include the University of Toronto Institute for Aerospace Studies (UTIAS) Space Flight Lab and Autonomous Space Robotics Lab as well as the National Optics Institute (INO) in technology elements, and a variety of academic partners from the Canadian space science community. This community development is essential to Canadian and International preparation for future flight missions.

With some systems already delivered to CSA and many more nearing completion, the ESM fleet of vehicles, technology demonstration payloads and science instruments are now ready for near-term use in analogue environments as part of both Canadian and international deployments. The next step is to leverage the momentum created in science, technology, operations, and partnerships as the focus shifts to preparations for a near-term flight mission.