SPACE EXPLORATION SYMPOSIUM (A3)
Space Exploration Overview (1)

Author: Prof. Bernard Foing
European Space Agency (ESA/ESTEC), The Netherlands, Bernard.Foing@esa.int

ESTEC EXOGEOLAB PILOT PROJECT FOR LANDER AND ROVER INSTRUMENTS

Abstract

The ExoGeoLab research incubator project includes a sequence of activities: - Data analysis and interpretation of remote sensing data (MEX, SMART-1, VEX, Cassini-Huygens) and in-situ (Huygens, MER) , and merging of multi-scale data sets - Procurement and integration of geophysical, geochemical and astrobiological breadboard instruments in an surface station and rover (ExoGeoLab) - Research operations and exploitation of ExoGeoLab test bench for various conceptual configurations (Moon, Mars, NEO, Titan) - Contribution to the exploitation of surface lander results (MER, Phenix, MSL, preparation Exomars) - Scientific simulation of planetary surfaces using laboratory and modelling tools - Support research for definition and design of science sur-face packages on the Moon, Mars, NEO, Titan - Research support to community preparation of payload for surface lander opportunities

Surface science is one of the prime objectives of current and future Mars, Moon, Titan or planetary missions and encompasses a wide range of activities from global mapping via specific studies of localised regions until microscopic scales. The studies of rocks and soil in situ, or with sample return missions, require the development of systematic multi-instruments protocols, characterisation diagnos-tics, and merging of data from various techniques. Both photogeology and mineralogical wide scale map-ping have been performed to some extent previously so significant new surface science results may only come from co-ordinated multi-instrument operations operating from the surface. Constraints on the environmental conditions preva-lent during the formation or subsequent modification of altered or weathered surface materials can be provided by careful observations of the chemistry, mineralogy, and morphology. The results will have implications for the study of surface evolution processes on solid plane-tary bodies. The Moon and Mars are laboratories for geophys-ics. They allow to study planetary processes working on solid Earth-like rocky bodies. On the Moon we can study geological processes shaping the surface and geochemical signatures of the evolution due to impacts, volcanism, space weathering. On Mars various processes control the distribution history of water, car-bon dioxide and dust, the timing and duration of hydro-logic activity on Mars, the evolution of sedimentary processes through time, as well as climatic/atmospheric evolution, as evidenced with data from Mars Express and the MER rovers. On Mars, hydrated minerals stud-ies indicate constraints on the history of surface water and global atmosphere and climate. A coordination is needed with other diagnostic techniques tracing the related processes.

Specific goals and methods of ESTEC ExoGeoLab: We have started to have instruments integrated in an ExoGeoLab crossing various techniques, including: - low mass imaging systems from aerial view, panoramic context, 3D stereo, close-up, microscopic imaging, - atmospheric, ionospheric, meteo, UV radiation - geophysical study of surface and subsurface seismometry - geochemistry package to measure elemental and mineral composition from lander and rover - robotic mobility with instrumented regional rover, mole, arm and local nanorover - sub-surface water and volatiles detection/characterisation - sample extraction, handling and analysis systems

The methodic steps for this hands-on research are: 1) We are procuring and adapting instruments to equip a mid-size ExoGeoRover (made available in collaboration with ESTEC robotics section), and a small surface station. 2) This terrestrial payload (instruments, sensors, data han-dling) will be de-ployed, operated and used as collaborative research pilot facility (ExoGeoLab), first tested and operated

at ESTEC, and later transportable 3) We shall perform functional tests of these instruments, and operate them in terrestrial conditions to correlate meas-urements using various techniques. 4) We shall implement progressively the possibility of re-mote control of instruments from an adjacent mobile lab, and a remote science desk. 5) The suite of measurements includes a comprehensive set with telescopic imaging reconnaissance and monitoring, geophysical studies, general geology and morphology context, geochemistry (minerals, volatiles, organics), subsurface probe, sample extraction and retrieval, sample analysis. 6) We shall reproduce some simulation of diverse soil and rocks conditions (mixture of minerals, organics, ice, penetrations of water, oxydant, organics) and diagnostics 7) We shall use these instrument packages to characterise geological context, soil and rock properties, 8) Science investigations will include geology, geochemistry, measurements relevant to penetration/survival of water, oxydant, organics, mineral and volatiles diagnostics. 9) After first validations we shall exploit the facility for collaboration with partners that will provide some additional guest instruments, and perform specific investigations, 10) We shall organise field campaigns in specific locations of scientific and exploration interest, making use of the ExoHab habitat for logistics support and local operations