POSSIBLE MOBILE SURFACE PAYLOAD FOR THE EUROMOON MISSION. G. Kmínek¹, B. H. Foing² and the
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**Rationale for mobility.** The advantage of mobile elements is the chance to get a larger number of samples for in-situ analysis and the possibility to explore territory accessible from the planned landing site on the permanent illuminated south pole crate-rim. That is especially the case for the planned Euromoon mission (R. Riemann and B. H. Foing, 1997) where some areas of interest are partly in dark, hazardous areas. The thermal environment and the lack of sufficient sunlight to power the solar panels are further limitations. Rovers which are traditional in concept are useful in the proximity of the lander. Exploring the dark regions up to a few kilometers away from the lander and searching for water ice however, requires another strategy. Note also that to get the maximum scientific return, it is necessary to set up the right combination of mobility and scientific instrumentation.

**PROPOSED MOBILE ELEMENTS**

The Nanokhod Instrument Deployment Device (R. Rieder, 1997). The Nanokhod rover is a small unit of about 21 cm × 15.5 cm × 10 cm stowage volume consisting of a track body, an instrument box and a tether bridge with a tether for the connection to the lander. The instrument box is connected to the track box by two actuators. These actuators can move the instrument box and place the sensor heads of the instruments in each instrument box against the soil or rock sample.

The Nanokhod is designed to carry an instrument package consisting of an APX (alpha-proton-X-ray) spectrometer, a Moessbauer spectrometer and a close-up imager. The total weight including the instruments will be 2.5 kg. The main objective of the Nanokhod rover together with the described instrument payload is the geochemical analysis of rocks and surface. A simpler instrument was already used during the Lunar Surveyor program to analyze the chemistry of the lunar surface. The present version of the APX has shown its usefulness already in the Mars Pathfinder mission and has been selected for the Mars 2001 lander as part of the Athena instrument package. The APX bombards the sample with α-particles and detects the backscattered α-particles (Rutherford backscattering), protons produced by α-proton reactions and the X-rays produced by recombination of shell vacancies. All three modes together can determine absolute elemental abundance of most of the elements of interest (except helium and hydrogen). Nevertheless, it became evident during the Pathfinder mission that in addition to the APX, a close-up imager is required for useful data interpretation. Therefore, a close-up imager, the equivalent of a field geologist’s magnifying glass, should be part of the Euromoon payload. The close-up imager should have a resolution of about 40 μm. In addition to these two instruments, a Moessbauer spectrometer will be added to analyze the Fe-oxidation state of the sample. The close-up imager and a modified version of the Pathfinder-APX will be together in one instrument compartment of the instrument box and the Moessbauer spectrometer will be in the second instrument compartment.

The range of the Nanokhod rover will be determined by the tether which links the rover to the lander. The tether provides the data link and the required power for the drive mechanism and the instruments.

**The regional rover** (L. Richter, 1997). The regional rover has a proposed range of several kilometers and can carry several scientific instruments. The stowage volume is 0.4 m × 0.4 m × 0.4 m and the weight is approximately 10 kg. It is a 8 wheel drive system with multiple articulated levers. The rover has its own power supply (rechargeable batteries and a solar array) and is not tethered to the lander but uses radio link for data transfer. The rover can carry a penetrometer with a length of approximately 30 cm.

The self propelled penetrometer (V. V. Gromov et al., 1997) can be used for subsurface investigations. It may also be a reasonable alternative to a proposed lunar heat flow penetrometer with a length of almost 2 m (T. Spohn et al., 1997). The problem with this device is the awkward size. Because it is so long, it is not possible to put it on a rover. Therefore, the only alternative is to locate it on the lander. Although the problem of probe insertion has been successfully solved by using a hammering device, the immobility limits its usefulness. In addition, if the lander is not in permanent darkness, the heat flow probe has to be inserted to a depth greater than the diurnal boundary layer (which is not known for the polar regions). There is no doubt that heat flow measurements have a high priority, firstly to compare the data with the Apollo heat flow measurements and secondly because the polar region offers the possibility to measure the heat flow in permanent darkness as well as in partly illuminated areas. Nevertheless, mobility and multiple sampling in different locations are desirable. Using the small self propelled retractable penetrometer as heat flow probe is a reasonable alternative. Since it would be mounted on the rover, it would offer the required mobility and also permit multiple sampling. How the limited length affects the measurement has yet to be investigated.

**The remote deployment device.** In order to reach out a few kilometers into the dark region of the lunar south pole and to deploy a sensor to measure the presence of water ice, one has to think about something different.
than a rover. The thermal environment in the dark regions is neither favorable for the batteries nor for instruments and movable parts. Therefore, one has to hurry to get there, conduct the measurement as quickly as possible before the sensor and the battery terminate their function. Thus, a one-shot deployment to a single location is expected. In addition, the sensor has to be able to collect the data in a short period of time. Several preliminary alternatives were investigated.

A promising one is the use of a wire guided missile. The traditional wire guided missile weapon systems are optically tracked and connected with two thin copper wires to the launcher. For a higher data rate, a fiber optic data link could be incorporated into the system. The warhead would be replaced by a sensor with its own power supply. A system with a mass of 5 kg (excluding the sensor) could reach out up to 10 km (E. Cobleigh, 1998). The launch of the missile can be done as a soft launch using a loaded spring with the rocket motor ignition in flight. The soft launch has two advantages: it avoids the exhaust of the rocket motor in the immediate vicinity of the lander and it reduces the recoil on the lander from the launch. Experience with similar systems exists.

As for the instruments, there are several means for detecting the presence of water ice. An appropriate instrument would be a tunable diode laser spectrometer which can detect water vapor (e.g. A. Yen and R. May, 1995). A system to vaporize the ice could be another laser, an electron gun or a heater (R. Rieder, 1997). All these components have to work only for a short period of time and only once. Although the value of a one-shot system is open to question, alternative mobile elements that would survive for a longer period of time and provide multiple sample analysis are beyond the scope of this project.

Additional instrumentation that would profit from a mobile element is a proposed RAMAN-spectrometer (M. Wuest, 1997).

The RAMAN-spectrometer has a mass of 2 kg and a power requirement of less than 3 W. It can measure the surface mineralogy, organic material and also volatiles. By using fiber glass cables of several meters or even kilometers it is possible to put the spectrometer itself on the lander and carry the fiber optic probe around with a rover. The rover can than place the probe against the sample and the analysis can be done in about 15 minutes. In such a way, multiple sample locations can be addressed. By using multiple fiber optic cables, one can use one probe on a rover and combine others either with a penetrometer, the lander legs, or incorporate a sensor head into the missile. Putting the RAMAN sensor head into the missile would permit water vapor detection and also detection of other volatiles that may be present.

These different mobile-payload proposals will be further assessed during the next phase of the Euromoon study.