CLOSE-UP LIBS FOR SPACE EXPLORATION

I. Rauschenbach[1], E. K. Jessberger[1], S. G. Pavlov[2], S. Schröder[2] and H.-W. Hübers[2]. [1]Institut für Planetologie, Westfälische Wilhelms-Universität Münster, Germany. E-mail: irausch@uni-muenster.de. [2]DLR-Inst. of Planetary Research, Berlin, Germany.

Introduction: Laser-Induced Breakdown Spectroscopy (LIBS) is currently under development for future lander missions to Mars, asteroids and other planets and moons, like Europa [1] or the Earth´s moon [2]. LIBS provides rapid elemental analyses and has important advantages compared to established methods in space exploration: rapidity («1 min./analysis), high lateral resolution (≥ 50 µm), needs neither sample preparation nor pumps, detects simultaneously and quantitatively major, minor and trace elements, removes dust layers and "drills" through weathered rock surface. LIBS can profit from a combination with Mössbauer or APXS and synergetic integration with Raman spectroscopy or microscopy is easily feasible. Furthermore, we have demonstrated that LIBS directly detects ice and liquid pore or adsorption water inside rocks and on rock/soil surfaces [3, 4]. The stringent space mission requirements call for the development of a lightweight LIBS instrument, which we are currently pursuing in the framework of the GENTNER project [5, 6]. Here we report on our progress in developing calibration procedures and on the study of different laser parameters that are of importance for LIBS specifically in the Martian environment.

Experimental: We used a chamber filled with "Martian" gas mixture at 7 mbar. Our miniaturized prototype Nd:YAG laser operates at 1064 nm, with pulse width of 2 ns, spot diameter of 50 µm and normal incidence onto the sample surface. The laser energy can be varied from 0.1 to 2.8 mJ and the repetition rate from 1 to 50 Hz. The plasma emission was detected with an Echelle spectrometer equipped with an ICCD detector without amplification and temporal resolution to best simulate a probably compact and "simple" flight-spectrometer.

Instrument optimization: In order to analyze the influence of the instrumental parameters of our miniaturized LIBS laser, laser wavelength, spot diameter, pulse duration and ICCD settings were kept constant. We found that the best results for this fixed configuration are achieved with a minimum laser energy of 1.2 mJ, a frequency of 10 Hz, a pulse number between 20 to 50 for soils and >50 for rocks, with normal laser incidence and detection angle and the focus slightly below the sample surface.

Calibration and quantification: With the optimized parameters we performed calibration measurements using a series of certified standard materials from natural rock, soil and stream sediment samples. The resulting detection limits for quantitative analysis are in the range of a few 100 ppm with a precision of 5–20% for most studied elements.

References: [1] Jessberger E. K. et al. 2009. *The Int. Workshop "Europa Lander: science goals and experiments*, http://www.iki.rssi.ru/conf/2009elw/presentations. [2] Rauschenbach et al. 2009. *Lunar Base Symposium*. [3] Rauschenbach et al. 2008. *Spectrochim. Acta B* 63, 1205–1215. [4] Lazic. et al. 2007. *Spectrochim. Acta B* 62, 1546–1556. [5] Rauschenbach et al. 2010 doi:10.1016/j.sab.2010.03.018 *Spectrochim. Acta B* 65. [6] Jessberger et al. 2003. *ESA Call for Ideas of the Pasteur instrument payload for ExoMars rover mission.*