RAMAN SPECTROSCOPY OF EXPERIMENTALLY SHOCKED OLIGOCLASE. M. C. Langenhorst[1], V. Iancu[2], N. Tarcea[2], F. Langenhorst[3] and J. Popp[2], [1]Otto-Schott-Institut für Materialforschung, Friedrich-Schiller-Universität Jena, Fraunhoferstraße 6, 07743 Jena, Germany, [2]Institut für Physikalische Chemie, Friedrich-Schiller-Universität Jena, Helmholtzweg 4, 07743 Jena, Germany, [3]Institut für Geowissenschaften, Friedrich-Schiller-Universität Jena, Carl-Zeiss-Promenade 10, 07745 Jena, Germany.

Introduction: Raman spectroscopy is utilized and under extensive development for remote and surface exploration missions to planetary bodies in our Solar System [1]. It can provide essential information on the short-range order and chemical composition of the surface minerals that constistute the regoliths of such bodies. The minerals in regoliths are commonly subjected to impact events and changed their structural state. It is thus of great importance for the interpretation of remote Raman spectra to know the spectroscopic changes of typical surface minerals as a function of shock conditions, in particular shock pressure.

In this study we have analysed the structural changes of experimentally shocked (26 GPa to 52.5 GPa) plagioclase (i.e., oligoclase), a rock-forming mineral, using Raman spectroscopy. Optical, X-ray diffraction, Infrared (IR) spectroscopy and Electron Paramagnetic Resonance (EPR) data of some of our samples were previously reported by [2, 3].

Samples and methods: The plagioclase used for shock experiments was a single crystal oligoclase from Lake Muskwa, Canada, with the composition $Ab_{78}An_{20}Or_2$ [2]. Experiments were carried out at the Ernst-Mach-Institute, Freiburg (Germany), using a high-explosive (TNT, composition B) setup. According to graphical impedance matching techniques, the pressures achieved were 26, 30, 34, 37.5, and 52.5 GPa.

Raman spectroscopic measurements were performed using a RamanRXN1 device from Kayser Optical Systems Inc. equipped with a 785 nm laser. Other excitation wavelengths (514 nm, 532 nm and 1064 nm) have been tested. A large fluorescence background was observed for all tested laser wavelengths, especially in the spectra of highly shocked oligoclasse phases. Measurements with the 785nm laser proved to have the best quality for the given set of samples. Raman spectra were baseline and cosmic ray corrected.

Results and discussion: The experimentally shocked oligoclase samples display a sequence of prominent optical shock effects. Oligoclase shocked to 26 GPa shows irregular fractures, planar deformation features (i.e., amorphous lamellae) and mosaicism. The number of PDFs is distinctly higher at 30 GPa and above this pressure limit oligoclase is successively transformed into diaplectic glass (maskelynite). The conversion to maskelynite is also reflected in the densities, which decrease with increasing pressure. The densities are 2.622 g/cm^3 (26 GPa), 2.528 g/cm^3 (30 GPa), 2.468 g/cm^3 (34 GPa), and 2.455 g/cm^3 (37.5 GPa).

In Fig. 1, we compare the Raman spectrum of unshocked oligoclase with those of shocked oligoclase samples. The unshocked crystalline oligoclase shows several well-defined Raman active vibrational modes:

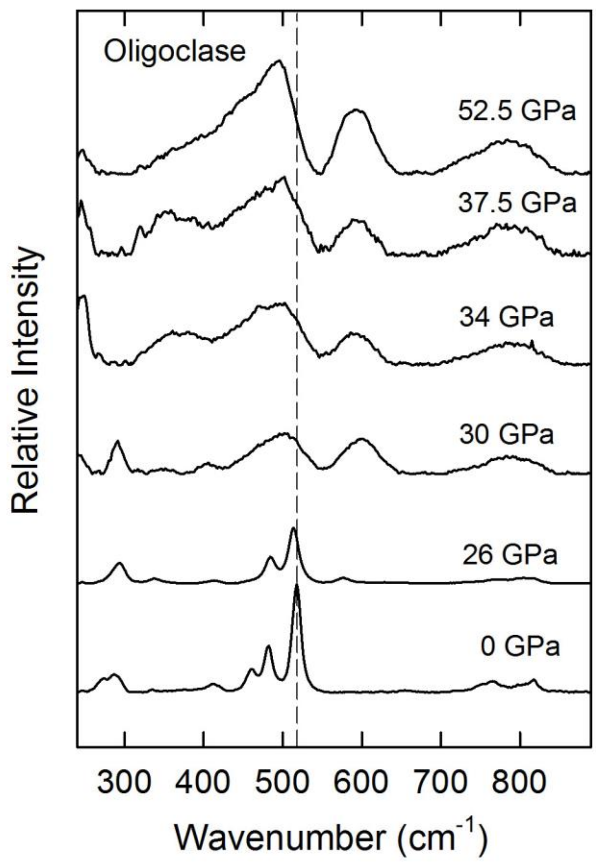

Fig.1 Baseline corrected Raman spectra of unshocked and experimentally shocked oligoclase.

lattice and deformation modes occurring between 100 and 350 cm^{-1}, symmetric T–O stretching modes and O–T–O deformation modes in TO_4 groups occurring between 400 and 550 cm^{-1}, and asymmetric T–O stretching modes and O–T–O deformation modes in TO_4 groups occurring at even higher wavenumber [4].

The Raman spectra of shocked oligoclase show much broader bands and an increase of the fluorescence background. The strongest Raman band is at 517

cm^{-1} for the unshocked sample. It systematically broadens and shifts to lower wavenumbers as function of increasing pressure. The band is centred at 513, 506, 497, and 495 cm^{-1} for pressures of 26, 30, 34 and 52.5 GPa, respectively.

In addition, we note the appearance and intensity increase of two broad bands in spectral range of the asymmetric modes at about 600 and 790 cm^{-1}. These observation point to a progressive distortion and amorphization of the oligoclase structure until it is completely transformed into maskelynite. Further Raman measurements are in progress to test the applicability of band shifts and broadening as pressure calibrants. When applying such calibration data to natural samples it has however to be taken into account that annealing in natural environments may results in relaxation effects.

Acknowledgments: V.I., N.T., F.L. and J.P. acknowledge 'Deutsches Zentrum für Luft- und Raumfahrt (DLR)' for the financial support (grant nr. 50QX1301). F.L. thanks the Deutsche Forschungsgemeinschaft for funds provided by the Leibniz programme (LA 830/14-1).

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