

3D RAMAN SPECTROSCOPICAL STUDY OF QUARTZ FROM Mt. OIKEYAMA, JAPAN, EMPHASIZING THE SHOCK-INDUCED MICRODEFORMATIONS H. Nishido¹, K. Ninagawa¹, M. Sakamoto², A. Gucsik³ (ciklamensopron@yahoo.com), T. Okumura¹, S. Toyoda¹, Sz. Bérczi⁴ and Sz. Nagy⁴, ¹Okayama University of Science, 1-1 Ridai-cho, Okayama, 700-0005, Japan; ²Neba Elementary School, 80 Neba Village, Naganano, 395-0701, Japan; ³University of West Hungary, Bajcsy-Zs. u. 4., Sopron, H-9400, Hungary; ⁴Eötvös Lóránd University of Budapest, H-1117 Budapest, Pázmány Péter sétány 1/c., Hungary,

Introduction: The origin of the Mt. Oikeyama structure in Central Japan has been debated for many decades. The purpose of this study is to provide new information about 3D Raman spectroscopy in addition to the previous scanning electron microscope-cathodoluminescence (SEM-CL) data of planar microdeformations in quartz samples to determine and confirm whether this area was formed by shock metamorphic events [1]. The study of Raman properties of shock-deformed minerals (e.g., quartz) has the potential to afford a useful tool, that can be applied in shock barometry, supplementary to the methods available so far (mainly optical microscopy; also birefringence and density measurements of shocked quartz are rarely done; cf. [2]). Micro-Raman spectroscopy is by now a fairly routine technique that is not too complicated in its use (unlike, e.g., the NMR technique of [3]), and the assignment of Raman spectra would allow to a) identify shocked minerals, and b) give information on the shock pressure useful for the study of impact structures.

Samples and Experimental Procedure: A polished thin section including shocked quartz from Mt. Oikeyama, Japan was used in this study. This quartz shows planar deformation features (PDFs) under polarized microscope and specific microstructures well defined as PDFs by SEM-CL and HF-etched SEM observations. Further details are referred to [1,4]. This sample was compared with a thin section containing well-developed PDFs from a confirmed, well-known Ries impact structure (Aumuhle, suevite). The Raman spectra were obtained using a Thermo Nicolet Almega micro-Raman spectrometer with a CW laser (532 nm) excitation system and a cooled CCD detector at 223K. The spectral measurements were carried out at 1 μm intervals over a sectional area of 30 μm square with a 1 sec exposure time. 3D spectral images can be pictured automatically with specialized software of the Atl μs .

Results and Discussion: Raman spectra of the sample two strong peaks at 214 cm^{-1} and at 472 cm^{-1} for A_1 vibration mode characteristic of quartz (Figs. 1,2). A vibrational peak at 472 cm^{-1} is somewhat higher than that at 464 cm^{-1} for quartz sample at ambient pressure [5]. Schmidt and Ziemann [5] revealed that the shift of

the 464 cm^{-1} peak depends quasilinearly on pressure. The frequency shift recognized in Oikeyama sample might be resulted from high pressure caused by shocked metamorphosis (Figs. 1,2).

Raman spectra of quartz have been described by [5]. They found changes in frequency and line-width of the 206 and 464 cm^{-1} A_1 Raman modes of quartz, which were determined over temperatures from 23 to 800°C and simultaneously at pressures between 0.1 MPa and 2.1 GPa, using a hydrothermal diamond-anvil cell (HDAC). The positions and widths of peaks in the Raman spectra of our measurements are in good agreement with these previous studies. Raman spectra of the coesite high-pressure polymorph of quartz have been reported by [6-8]. Schmidt and Ziemann [5] found that the strongest coesite line is at 521 cm^{-1} , with other characteristic lines at 117, 177, and 271 cm^{-1} . On the other hand, [9], in laser-heated diamond cell experiments, found that coesite exhibits three relatively strong Raman bands at 489, 552, and 790 cm^{-1} and stishovite shows a strong peak at 790 cm^{-1} . These authors concluded that stishovite was converted to coesite at 10 GPa and 2330 °C.

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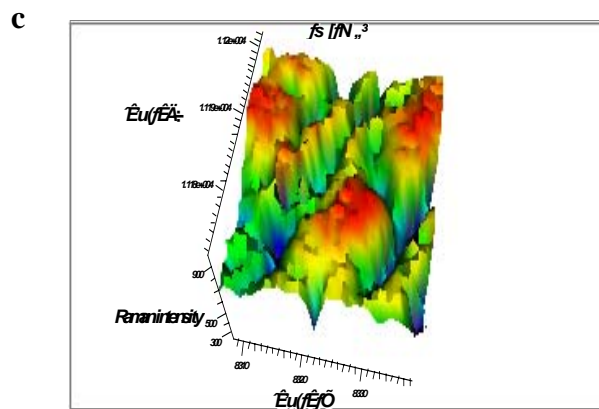
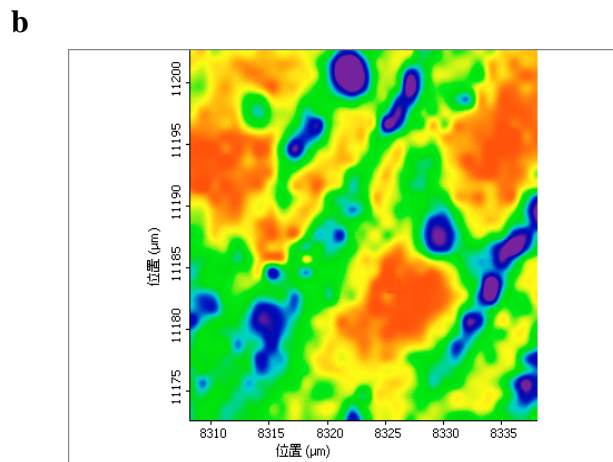
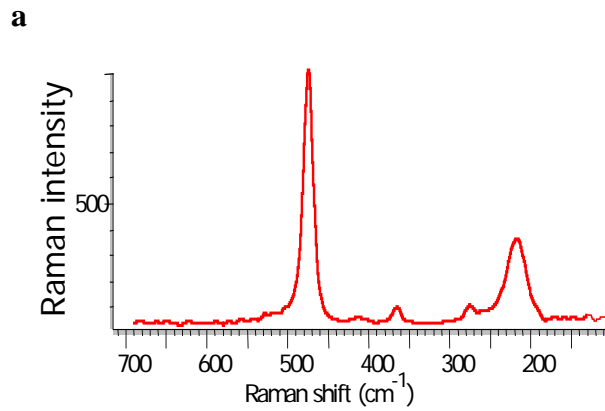


Fig.1. The micro-Raman spectrum (a) 2D (b) and 3D Raman features of the PDFs in quartz from the Ries impact structure exhibit the systematic absence of the main vibration mode at 464 cm^{-1} indicating the shock-induced deformation.

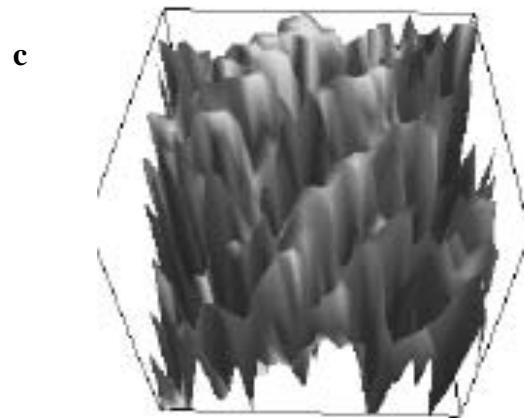
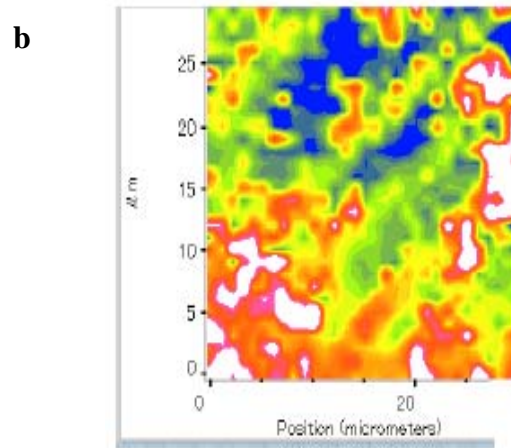
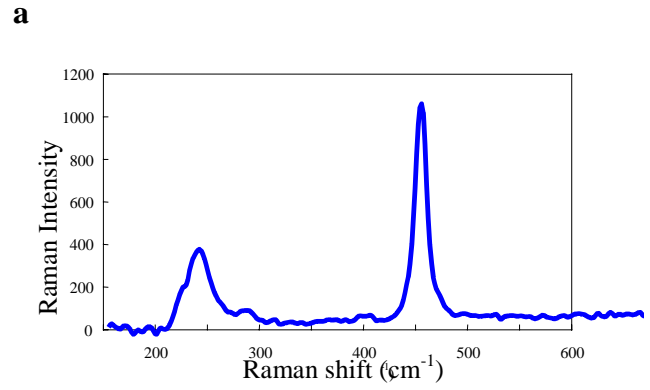


Fig. 2. The micro-Raman spectrum (a) 2D (b) and 3D Raman features of the planar microdeformations (PDFs) in quartz from the Oikeyama structure exhibit the systematic absence of the main vibration mode at 464 cm^{-1} indicating a similar nature of these microdeformations observed at Ries, which could be related to the shock-induced deformations.