Thermoluminescence Study of Shocked Rocks and Minerals

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A semi-circular topographical feature (approximately 900 meters in diameter) is located in the eastern side of Mt. Oikeyama on Shirabiso Highland, which lies in the southern part of the Akaishi Mountains, Nagano Prefecture in Japan. Planar microdeformations of the quartz were found in sandstone from this area [1]. These planar microdeformations might be so-called planar deformation features (PDFs) that were formed by the impact more than 10GPa, suggesting that this structure has been formed by hypervelocity impact event [1-4]. In the present study, thermoluminescence (TL) of following three samples was measured to confirm the evidence of impact shock metamorphism. (1) Sandstone collected from outside of the crater, (2) Sandstone experimentally shocked by railgun experiments at 10GPa (abbreviated to railgun sandstone), (3) Metamorphic sandstone collected from inside of the crater at Mt. Oikeyama.

Induced TL was measured after a dose of 250Gy 60Co gamma ray irradiation. A new, relatively large, peak appeared at 350 oC in the TL glow curve of the rail-gun sandstone, comparing with that of the sandstone collected from the outside of the impact crater, in addition to common TL peak at 150oC. There is a slight bulge TL peak at 350 oC even in the metamorphic sandstone.

The TL spectral measurements were carried out for three types of sandstone by a monochromator attached a 2D TL readout system. The new TL peak at 350 oC appeared at 390 nm for the railgun sandstone and the metamorphic sandstone, different from 420 nm emission at low temperature.

TL images were measured with the 2D TL readout system to determine the positions responsible for the TL at 350 oC. To specify the minerals emitting the TL at the high temperature we analyzed compositions of the positions in the sandstone samples by an EDS. The mineral responsible for the peak at 350 oC was albite, whereas potassium-rich feldspar was responsible for the TL at 150 oC.

These facts imply that albite is a mineral to record shock metamorphism, and the semicircular topographical feature at Mt. Oikeyama was formed by hypervelocity impact event.

References: [1] Sakamoto M. et al. 2001. Abstract on 2001 Annual Meeting of Japanese Society for Planetary Sciences (Okayama) pp.56. [2] French B.M. 1998. Traces of Catastrophe. LPI, Houston, pp.120. [3] Sakamoto M. et al. 2003. Evolution of Solar System Materials: A New Perspective from Antarctic Meteorites, pp.124. [4] Sakamoto M. et al. 2005. LPSC XXXVI, Abstract #1242.