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Development of laser-selective stepwise thermal demagnetization system

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Recent radioisotope micro-chronology has been able to determine the age of micron-sized spot of individual grains in thin sections by focused laser or ion beams. Single silicate grains and shock melt veins (SMVs) are good candidates as paleomagnetic field recorders because of the presence of minute magnetic inclusions protected by the host crystal or cryptocrystalline matrix. In order to heat these materials, the laser demagnetization technique at University of Rochester allows to stepwise demagnetize an oriented single silicate grain with CO2 laser coupled with DC SQUID magnetometer (Tarduno et al. 2007), prohibiting the use of non-destructive thin section. If we can heat the individual grains in oriented thin sections, the collaborative research of paleomagnetism with micro-chronology will provide a new wave of studies with the goal of answering some of the biggest questions about earth and planetary evolution. Therefore, in cooperation with a scanning magneto-impedance (MI) magnetic microscopy (Uehara and Nakamura 2008), we have been developing a laser-selective stepwise thermal demagnetization technique as a non-destructive spot heating for oriented thin sections and SMV chips in controlled atmospheric conditions in magnetic shield tube. We employed 25W Q-switch Nd:YAG green laser (532nm: Lee Laser Ltd.), two-color focused infrared thermometer (Impac Ltd.), X-Y stage (Sigma Koki Ltd.) and an optical irradiation unit (Wave Cyber Ltd.). The optical irradiation unit enables us to select the spot in a thin section by XY-stage, to heat the spot by laser and to measure the temperature by the infrared thermometer. simultaneously. The laser spot size is approximately 0.6 mm in diameter, being consistent with one for the thermometer. The optical absorption of laser to solid materials depends on laser wavelengths and material's absorption coefficients. At 532nm, green laser is absorbed 60 % by Fe and Ni, while it is absorbed only c.a. 10% by silicate glass. This difference could achieve a selective heating of metal-phase magnetic minerals from silicates. In this presentation, I will introduce the latest achievement of our development.