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Microwave applications to rock specimen drying in laboratory

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Microwave heating is the process in which electromagnetic wave with 300 MHz – 300 GHz heats dielectric material. Although in the beginning microwave was mainly used in food industry to cook or heat the food, it soon became clear that microwave had a large potential for other applications. It was thus introduced in geological fields of investigation like mineral processing, oil sand and oil shale extraction, soil remediation, waste treatment. However, the drying techniques using microwave was rarely treated in geology field. According to the ISRM suggested methods, experimental rock specimens in laboratory test were dried in 105°C oven for a period of at least 24 hours. In this method, hot air transmits heats to material by means of thermal conduction, and the heat was transferred from the surface to the inside of the rock specimens. The thermal gradient and moisture gradient can deteriorate the specimens, and energy can be wasted in bulk heating the specimens. The aim of our study was to compare physical property, microstructural property, and energy efficiency between microwave drying method and conventional oven drying method, and to suggest new method for rock drying. Granite, basalt, and sandstone were selected as specimens and were made in cylinder shape with 54 mm diameter. To compare two different methods, one set of saturated specimens were dried in 105°C conventional oven and the other set of saturated specimens were dried in microwave oven. After dried, the specimens were cooled and saturated in 20°C water 48 hours. The saturation-drying were repeated 50 cycles, and the physical property and microstructural property were measured every 10 cycles. Absorption and elastic wave velocity were measured to investigate the change of physical property, and microscope image and X-ray computed tomography image were obtained to investigate the change of microstructural property of rock specimens. The electricity consumption of conventional oven and microwave oven was also measured to compare energy efficiency. The energy efficiency of microwave oven was 2 times better than that of conventional oven. Physical and microstructural properties were deteriorated in both drying methods as saturation-drying cycle progresses. The difference of change rate of physical and microstructural properties of rock specimens between two methods were not significant. The results of the present study suggest that microwave oven could be used as new drying method in rock laboratory experiment.