Development of magnetic resonance surface scanners for the nondestructive in-situ measurement of water fractions in cultural heritages

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Nondestructive measurement techniques are essential for the maintenance and investigation of cultural heritages. Water is often responsible for the degradation of the outdoor cultural heritages, such as walls and pavements made of stones, plasters, clays, and bricks. Portable scanners that allow the nondestructive quantification of water contents are needed for the in-situ investigation of porous wet walls and pavements. I am developing such scanners to measure the water volume fraction of outdoor cultural heritages. The principle of the scanners is based on the low-field time-domain proton magnetic resonance (i.e. NMR) relaxometry employing a single-sided magnetic circuit [1]. Water protons in a static magnetic field produced by the single-sided permanent magnets are excited by the radio-frequency coil, and the resultant proton transverse relaxation signals are acquired as raw data, which can be translated into water volume fractions, and pore-size distributions and permeabilities of the wet porous media. The investigation depth (distance from the coil to the sensed region) is several to several tens of millimeters, depending on the magnet size. A surface scanner with an investigation depth of 30mm constructed for a different purpose [2] was as heavy as 50 kg, which is not a hand-held type. Thus I am constructing a new scanner employing a smaller magnet (4 kg in weight) as shown in the figure, which allows hand-held use and increase the operationability. The current status and future perspective of the new scanner being developed would be presented.

Reference

[1]: Nakashima, Y. et al. (2020) Nondestructive quantification of moisture in powdered low-rank coal by a unilateral nuclear magnetic resonance scanner. International Journal of Coal Preparation and Utilization (in press). https://doi.org/10.1080/19392699.2020.1722656

[2]: Nakashima, Y. (2019) Non-Destructive Quantification of Lipid and Water in Fresh Tuna Meat by a Single-Sided Nuclear Magnetic Resonance Scanner. Journal of Aquatic Food Product Technology 28, 241-252. https://doi.org/10.1080/10498850.2019.1569742

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Sensor unit consisting of a magnet and a coil with a tuning/matching box.