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Orientation of functional groups of soil organic matter on the surface of water repellent soils determined by pulse saturation magic angle spinning (PSTMAS) nuclear magnetic resonance (NMR) spectroscopy

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Orientation of functional groups of soil organic matter on soil particles plays a crucial role in the occurrence of soil water repellency. In addition to a general method to characterize soil organic matter using cross polarization magic angle spinning (CPMAS) nuclear magnetic resonance (NMR) technique, we determined the surface orientation of functional groups in water repellent soils by using pulse saturation magic angle spinning (PSTMAS) NMR technique. A preliminary experiment confirmed that the PSTMAS NMR spectrum successfully determined the high mobility of methyl group of octadecylsilylated silica gels when a comparison was made with that of CPMAS NMR. This means that the methyl group oriented towards the outside of the silica gel particle. Similarly, for an experimental system consisting of mixtures of octadecylsilylated silica gel and dimethyl sulfoxide (DMSO), the extremely high mobility of methyl group derived from DMSO was detected using the same methodology. For water repellent soils from Japan and New Zealand, it was found that the methyl and methylene groups were highly mobile. In contrast, the NMR signals of aromatic moiety, another hydrophobic moiety of soil organic matter, were not as intense in PSTMAS compared with CPMAS. From these results, we conclude that alkyl moiety (methyl and methylene groups) would be oriented towards the outside of the soil particle and would play an important role in the appearance of water repellency of soils.