Strong chemical treatment of sediments for environmental magnetic studies on mineral inclusions

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Chemical leaching techniques has been employed in sediment studies to separate components of different origins such as eolian, volcanic, biogenic, or authigenic component. However, in environmental magnetic studies, the use of chemical leaching is limited because aggressive treatment would also affect magnetic minerals. Recently, it is widely recognized that weak magnetic signals of magnetic mineral inclusions in silicate can be precisely measured by modern instruments. Moreover, occurrence of such inclusions in sediments has been reported. Such magnetic mineral inclusions are protected by silicate host, so they could survive strong chemical treatment. To test this idea, we chemically leached out minerals except quartz and feldspar and conducted rock magnetic measurements. The sample was pelagic red clay recovered from Minamitorishima in subtropical Western North Pacific. The magnetic mineralogy of bulk sediment was dominated by biogenic magnetite and oxidized detrital magnetite. The site locality suggests that the quartz in the sample is eolian dust from China, and the feldspar is either from China or the Izu-Mariana volcanic arc.

The intensity of saturation isothermal remanence (SIRM) of quartz and feldspar was on the order of 10^{-4} Am^2/kg. This is about 1-5 % of the SIRM of untreated sample. The signal can be readily measured using cryogenic magnetometers or MPMS. The remanence can also be detected in alternating gradient force magnetometers, but paramagnetic signal from feldspar introduces large background in induced magnetization, making determination of hysteresis difficult. Thermal demagnetization of IRM and low temperature measurements indicate that the magnetic mineral associated with quartz and feldspar is near-stoichiometric magnetite, which is distinct from the more oxidized detrital magnetite. This might reflect magnetite exsolution in feldspar. To check this, a pilot sample was further treated by H_2SiO_6 to isolate quartz. Low temperature measurements indicate that the quartz also contains near-stoichiometric magnetite, suggesting that the magnetite is primary inclusion and not exsolution. If confirmed, the near-stoichiometric magnetite inclusions may be the characteristics of eolian dust from China, and strong chemical treatment is a promising approach to reveal this hidden property. A comparison with sediment from different region is under way.

Keywords: environmental magnetism, magnetic mineral inclusion, eolian dust

