Low temperature oxidation of magnetite: Implications from micromagnetic modeling and experimental observations

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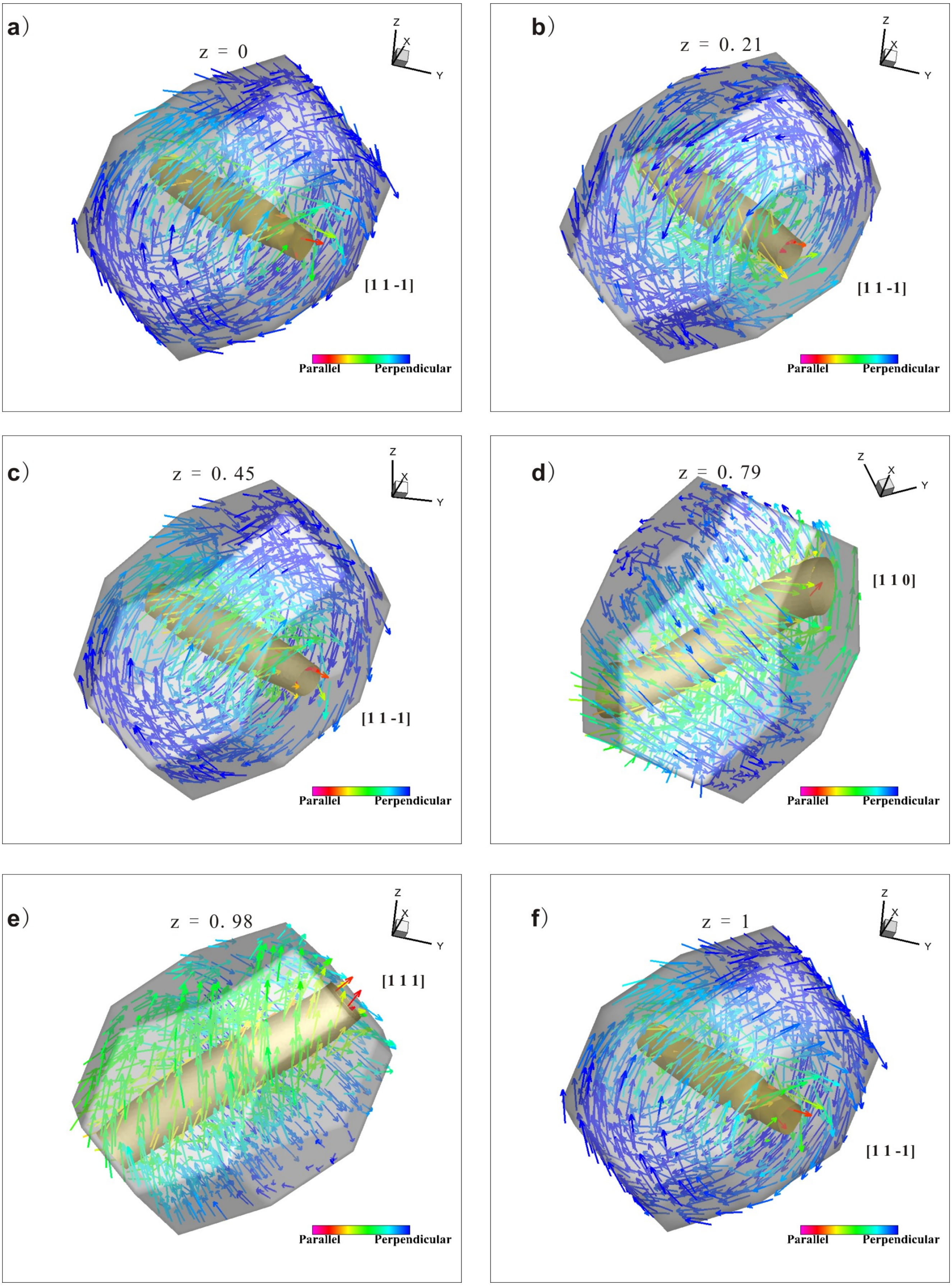
Long periods of oxidation after cooling of rocks may cause large changes in their remanence direction and intensity, and hence significantly affect the understanding of Earth geomagnetic field. It has been suggested that a magnetic core is preserved owing to the isolation effect of the oxidized maghemite shell.To characterize the effects of core-shell structrue and its potential transition zone on the magnetic properties of partially oxidized magnetite, micromagnetic models of hysteresis parameters and microstructures of a multi-layer core-shelled model were systematically investigated by MERRILL (Micromagnetic Earth Related Rapid Interpreted Language Laboratory). Compared with rock magnetic experimental observations, numerical simulations indicate that SD particles (<70 nm) remain highly uniform magnetization, but show decreasing coercivities as oxidation preceeds. The hysteresis parameters of fine SV particles (80 nm to 120 nm) increase and dramatic decrease at the early and late stage of oxidation respectively. Finally for larger SV (>130 nm) particles, the hysteresis parameters and inner microstructrues remain nearly unchanged during oxidation. It indicates that fine SV particle are more sensitive to oxidation, and dominate the dramatic change of experiment observation. Overall, low temperature oxidation of magnetite preferring a multi-layer coupled oxidation process from outside to interior and is capable of recording paleomagnetic signals.

Keywords: Micromagnetic modeling, Low temperature oxidation, Magnetite, Magnetic records, core-shell


a)
z = 0
[1 1 -1]
Parallel Perpendicular
b)
z = 0. 21
[1 1 -1]
Parallel Perpendicular
c)
z = 0. 45
[1 1 -1]
Parallel Perpendicular
d)
z = 0. 79
[1 1 0]
Parallel Perpendicular
e)
z = 0. 98
[1 1 1]
Parallel Perpendicular
f)
z = 1
[1 1 -1]
Parallel Perpendicular
Z
X
Y