

Parts-per-billion Trace Volatile Element Detection in Planetary Anhydrous Minerals by Nano-scale NMR Spectroscopy

YUNHUA FU^{1,2}, RENBIAO TAO¹, LIFEI ZHANG², SHIJE LI³, YA-NAN YANG⁴, DEHAN SHEN³, ZILONG WANG² AND THOMAS MEIER¹

¹Center for High Pressure Science and Technology Advanced Research (HPSTAR)

²Peking University

³Institute of Geochemistry, Chinese Academy of Sciences

⁴Guangzhou Institute of Geochemistry, Chinese Academy of Sciences

Presenting Author: renbiao.tao@hpstar.ac.cn

Nominally anhydrous minerals (NAMs) composing Earth and planetary rocks incorporate microscopic amounts of volatiles. However, volatile distribution in NAMs and their effect on the physical properties of rocks remain controversial. Thus, constraining trace volatile element concentrations in NAMs is tantamount to our understanding of the evolution of rocky planets and planetesimals. Here, we present a novel approach of trace-element quantification using nano-scale Nuclear Magnetic Resonance (NMR) spectroscopy. This approach employs the principle of enhanced mass-sensitivity in NMR micro-coils formerly used in in-situ high-pressure experiments. We were able to demonstrate that this method is in excellent agreement with standard methods across their respective detection capabilities. We show that by simultaneous detection of internal reference nuclei, the quantification sensitivity can be substantially increased, leading to quantifiable trace volatile element amounts of about 50 wt-ppb measured in a micro-meter sized single anorthitic mineral grain, greatly enhancing detection capabilities of volatiles in geologically important systems.

