Magnetic probing of flat solid surfaces, preparation for remote probing of extraterrestrial solid surfaces

G. Kletetschka[1]

S. Getty, A. Lunsford, T. Adachi, V. Mikula, P. Wasilewski

Abstract: Missions to the solid bodies within our solar system are becoming a reality. In situ exploration of the fragments from space requires focus on cleanliness and careful judgment about the order of the investigating procedures. Remote sensing techniques give first order of the information about the very surface of the space fragment. We are developing a new exploration tool that will provide additional information: the fine structure of the magnetic fields radiating from space fragments to provide knowledge of historical heating, shock experience, magnetic grain size and/or magnetic mineralogy. The surface to be explored is first prepared by polishing similar to abrasion tools on board of rovers Spirit and Opportunity on surface of Mars. Once such surface is prepared the probe can be designed for sensing the magnetic fields radiating from the surface. Such magnetic information senses not only the magnetic structure of the very surface but also from the grains underneath.

In order to observe fine structure of the magnetic fields, miniaturization of the sensors is required. We are developing the NanoCompass, which uses miniature iron needles suspended on a piezoresistive mat of single-walled carbon nanotubes (SWCNTs). Small scale magnetic fields deflect the iron needles and modulate the electrical resistance of the SWCNTs. This response can be calibrated to the exact value of the out-of-plane component of the magnetic field.

To this goal we developed a system capable of moving a magnetic probe in 3d over the surface of the space fragment. For the flat surface we used 5 large chondrules (Bjurbole meteorite) embedded within the nonmagnetic matrix and flattened to the roughness better than 10 micrometers. In this contribution we demonstrate magnetic testing using an axial hall probe (sensitivity ∼200 nT) attached to the 3D stage, scanning over the area of the fragments that can be encountered in space exploration (chondrules in this case). Our system is capable of showing the magnetic structure of the chondrules as well as magnetic dipole orientations. The level of magnetic intensity and the magnetic imaging reveal the fine magnetic structure and allow pointing space fragments with unique magnetic history. For example, during a sample return mission, this tool will allow for screening and selection of interesting samples for return to Earth.

[1] e-mail: kletetschka@nasa.gov