Physical properties of meteorites and their role in planetology

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Together with cosmic spherules, interplanetary dust particles and lunar samples returned by Apollo and Luna missions, meteorites are the only source of extraterrestrial material on Earth. They represent samples of various space bodies from asteroids to other planets. Some are remains of parent bodies, which completely disintegrated during giant collisions and no longer exist in the Solar System.

The physical properties of meteorites, especially their magnetic susceptibility, bulk and grain density and porosity, have wide applications in meteorite research such as meteorite classification, studies of their origin, level of terrestrial weathering, shock history and in the estimation of the physical appearance of their parent bodies – asteroids. For example, the comparison of a meteorite's density, porosity or magnetic susceptibility to that of a compositionally similar asteroid may reveal its internal structure. For such purposes, an expanded database of meteorite physical properties was compiled with new measurements done in meteorite collections across Europe using a mobile laboratory facility.

However, the scale problem may bring discrepancies in the comparison of asteroid and meteorite properties. Due to inhomogenity, the physical properties of meteorites studied on a centimeter or millimeter scale may differ from those of asteroids determined on kilometer scales.

Further difference may arise from shock effects, space and terrestrial weatherin g and from difference in material properties at various temperatures. As demonstrated on rock magnetic studies of the Neuschwanstein meteorite, compared to room temperature, sulphides present in extraterrestrial materials have distinct magnetic properties with newly discovered magnetic transitions at temperatures of the "cold" Solar System environment. This draws significant constraints on modeling the interaction of minor Solar System bodies with interplanetary magnetic fields.

Close attention was given to the reliability of the paleomagnetic and paleointensity information in meteorites. A modified method, based on coercivity distribution of the remanent magnetization efficiency, was tested on various terrestrial and extraterrestrial samples. The results show that impact related shock effects on remanent magnetization can be distinguished or atypical magnetic carriers can be identified. Further, the reliability of the thermoremanent magnetization efficiency as the paleointensity tool was studied and calibrated for various minerals of different grain sizes. These studies give us a tool for reliable interpretation of magnetic information carried in extraterrestrial materials. Such information provides constraints on ancient magnetic field intensities and on the evolution of minor bodies in our Solar System.