



## Magnetic susceptibility as a tool for characterization of an asteroid regolith and sample return

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### Abstract

Magnetic susceptibility is a reliable, non-destructive tool for distinguishing various types of extraterrestrial materials. It can provide diagnostic parameters to determine regolith mineralogy, homogeneity and meteorite analogues within various asteroid clans. Additionally, regolith maturity can be estimated from frequency dependence of regolith susceptibility.

### 1. Introduction

Magnetic susceptibility of a rock is dependent on concentration of ferromagnetic minerals. It is a reliable, non-destructive tool in distinguishing a range of extraterrestrial materials [1], [2], [3] and for identifying compositional variations in meteorite falls [4], [5].

### 2. Susceptibility measurement of the asteroid regolith

Once reliably determined, the magnetic susceptibility of an asteroid regolith can be compared to a database of known meteorites in order to diagnose its mineralogy, homogeneity and maturity (Figure 1).

#### 2.1 In-situ susceptibility measurement

A simple oscillator-driven susceptibility measurement coil can be incorporated into lander or surface drop probe. Its design is similar to commercially available handheld susceptibility meters or to one described in [6] or [7]. Advantages of this solution are robust construction (no moving parts), low mass (approx. 100 g), small dimensions (5 cm diameter) and low power consumption (3 mA). In combination with a hooping lander the regolith

homogeneity can be tested by spot measurements in various locations around asteroid. After contact with asteroid surface is achieved, the coil can also be used as a thermometer measuring diurnal temperature variations.

#### 2.1 Determination of regolith maturity

Regolith on airless bodies is subject to space weathering often associated with production of iron nanoparticles. These particles are often in superparamagnetic state exhibiting high frequency dependence of magnetic susceptibility. Thus degree of susceptibility frequency dependence is quantitatively related to regolith maturity [8].

### 3. Susceptibility measurement of the sample return

The magnetic susceptibility measurements of a sample return will provide similar information as in-situ measurements, but laboratory instrumentation provides higher precision. Additionally magnetic susceptibility results can be directly compared with mineralogical and chemical analysis. However, any sample return is likely to be a rather small quantity of the asteroid's regolith so its representability for the whole asteroid must be considered with caution.

### 4. Summary and Conclusions

Magnetic susceptibility, together with other methods of spectral and mineralogical characterization, can provide diagnostic parameters to determine regolith mineralogy, homogeneity and meteorite analogue within various asteroid clans. Additionally regolith maturity can be estimated from frequency dependence of regolith susceptibility.

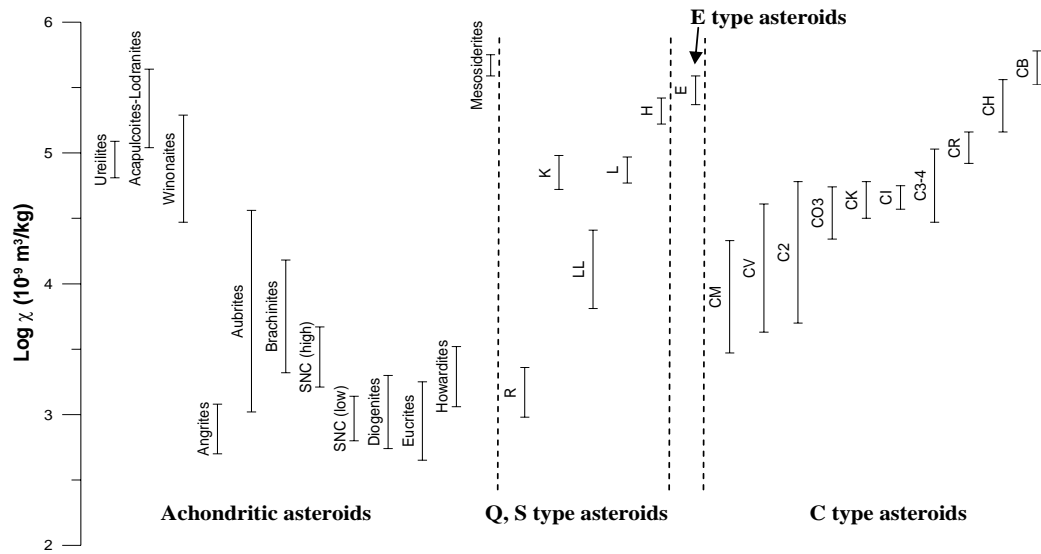


Figure 1: Magnetic susceptibility (logarithm) of common meteorite types and basic asteroid clans. Meteorite analogs can be determined from measured regolith susceptibility in each clan. Meteorite susceptibility data are compiled from [1], [2] and [3].

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