Magnetic susceptibility measurement as a guide to classification of ordinary chondrites : the case of Saharan meteorites.

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Introduction:

When acquiring a large collection of meteorites, scientific institutes have an interest in rapidly characterising the new specimens. Magnetic susceptibility measurement can make a useful contribution to this effort, especially in the case of ordinary chondrites, which seldom have a research priority but statistically represent about 80% of meteorites. A database of magnetic susceptibility values of ordinary chondrites was constructed by Rochette et al. (2003). The mass specific magnetic susceptibility, obtained by dividing by the density, is expressed as log χ in 10^{-9} m³/kg. As magnetic susceptibility is proportional to metal content, H chondrites have higher values. The published susceptibility values log χ of H chondrite falls are between 5.0 and 5.5, of L chondrite falls between 4.5 and 5.0, and of LL falls between 3.8 and 4.6. Falls are unweathered and contain mainly fresh metallic iron, so their susceptibility values are more genuine. Finds show a larger range, towards lower values because oxidation of the metallic iron tends to decrease the magnetic susceptibility. Published values for finds show a total range from 4.2 to 5.5 for H chondrites, from 3.8 to 5.0 for L chondrites and from 3.7 to 4.6 for LL chondrites (Rochette et al., 2003 ; Consolmagno et al., 2006), with a large overlap between the groups.

Following the same procedure and using the same hand-held SM-30 magnetic susceptibility meter of ZH Instruments (2006), and selecting only specimens heavier than 3 g (Rochette et al., 2003), we measured 106 specimens from known (officially classified) chondrites and 72 unknown chondrites from the Sahara. Corrections were applied for finite thickness and air gap between sample and instrument. We made no density measurements but assigned the average group density to the samples, i.e. 3.75 g/cm³ for H chondrites, 3.57 for L chondrites, 3.55 for LL chondrites, and the overall average of 3.66 g/cm³ to the unknown chondrites. The mass specific magnetic susceptibility thus calculated has an error estimated at 7%. For the known chondrites, the values measured by us generally are in good agreement with the expected range of the corresponding chondrite group. For 17 of the 106 specimens of known meteorites, magnetic susceptibility values were already published (Rochette et al., 2003), showing that our values are generally slightly lower than the published ones. This may be due to a different degree of weathering, to inherent heterogenetities in the meteorite, or to different shapes of the measured specimens.

The unknown Sahara chondrites, all finds, show susceptibility values over the whole published range of ordinary chondrites. We selected six specimens of unknown Sahara chondrites, with different magnetic susceptibility values, for classification according to the fayalite content of olivine and the ferrosilite content of low-Ca pyroxene, using EDS. The resulting classification generally confirms the suspected group of the unknown sample based on the susceptibility. H chondrites are easier to characterise with magnetic susceptibility, but there is considerable overlap between L and LL chondrites in finds.

In practice, the overlap between different groups does not enable a clear classification of finds on the basis of magnetic susceptibility alone, especially when alteration is apparent. Nevertheless, for the unknown specimens these results are a first indication of metal content, and a guide for further investigation.

References:

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