AN IMPACT RELATED ORIGIN FOR THE FOLIATION OF ORDINARY CHONDRITES

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Introduction: A large number of observations and anisotropy of magnetic susceptibility (AMS) measurements [e.g. 1] reveal the existence of a foliation in almost all chondrites, and a lineation in some of them. Accretional sedimentation, metamorphism, lithostatic compaction and impacts have been proposed as possible explanations, but the two former possibilities can be confidently ruled out [2]. Impacts and lithostatic compaction remain as the two possible explanations. The reason why no definitive conclusion could be reached is that the dataset of former studies was too limited to reach the necessary statistical significance in view of the numerous parameters that have a potential effect on petrofabric.

Our approach: We undertook a comprehensive study of ordinary chondrites petrofabric determined by AMS measurements. We performed AMS measurements on meteorites (mostly ordinary chondrites) with known metamorphism type and shock stage. H chondrites were discarded due to (shape) self demagnetization effects. After clarifying the influence of magnetic mineralogy on the AMS signal (using among other things image analysis), the 150 new AMS measurements and a review of the 60 published data allow a detailed discussion on the origin of petrofabric in meteorites, based on more than 200 data.

Preliminary results: Comparison of image analyses and AMS results indicate that the AMS signal in ordinary chondrites is due to the preferential orientation of the metallic grains (shape anisotropy).

Fabric consistency. The petrofabric appears to be remarkably consistent within a single meteorite, both in terms of orientation and intensity. This was evidenced for instance by measuring the AMS of 18 samples from Knyahinya L5 OC, and comparing the AMS and preferential grain orientation of several mutually oriented subsamples of individual chondrites.

Anisotropy degree vs. shock stage. The relation between the degree of AMS and shock stage depends on the magnetic mineralogy. For instance, LL ordinary chondrites that are rich in tetrataenite have a high AMS degree, due to the strong magnetocrystalline anisotropy of this mineral. As a consequence we focused our study on L chondrites whose main magnetic carriers are kamacite and taenite. Despite large variability for a given shock stage, it appears that gently shocked L chondrites (S1) have low AMS degree (<1.1), that AMS degree increases with shock stage up to S3, and that it tends to stabilize around 1.4-1.5 for higher shock stages.

Conclusions: These results clearly relate the petrofabric of ordinary chondrites to deformation/reorientation of metallic grains by compaction due to hypervelocity impacts. However, above shock stage S3 this process reaches a limit, and AMS measurements cannot be used to discriminate shock stages 3, 4, 5 and 6. This is likely due to an almost complete compaction by shock stage S3, and to annealing for the highest shock stage. We will also discuss preliminary measurements on Rumuruti chondrites, carbonaceous chondrites, and SNCs that indicate low AMS degrees (<1.1) with respect to ordinary chondrites, whereas HEDs show a large variability.

References: [1] Weaving B. 1961. *Geoch. Cosmoch. Acta* 26:451-455. [2] Sneyd D.S. et al. 1988. *Meteoritics* 23:139-149.