ALMAHATA SITTA MAGNETIC SUSCEPTIBILITY DATABASE – UPDATE OF THE ENSTATITE CHONDRITE LITHOLOGIES

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Almahata Sitta enstatite chondrite lithologies

We have significantly extended our database on the magnetic susceptibility (MagSus) of all by us investigated Almahata Sitta (AS) individuals [1,2]. In our contribution we focus on the enstatite chondrite lithologies of the Almahata Sitta fall: 36 of all reported 143 individuals [1-3], see figs. 1 and 2.

A new classification scheme for the enstatite chondrites was proposed by [18]. A new set of Almahata Sitta individuals (MS-MU 039-045) was classified by [19] whereby 3 new enstatite chondrites have been described and classified based on the new scheme. Further investigations reported on 63 additional Almahata Sitta stones/ individuals, stored at Univ. of Khartoum (sample set AhS) [4, 20]. However, we cannot include this sample set as long as neither sample material for own investigations nor (precise) magnetic classification (eg MagSus) data are available.

We decided to treat the AS enstatite chondrites in more detail and to also include all published enstatite chondrite fall MagSus data (3/2019). Enstatite chondrites are highly reduced meteorites and Fe is only present in metallic iron phases (kamacite, taenite) or Fe-bearing sulphides (eg troilite) [5-8]. Therefore enstatite chondrites are extremely sensitive to terrestrial weathering effects, consequently only falls can be included in any substantiated MagSus database. High iron (E-H) and low iron (E-L) enstatite chondrite groups are discriminated so far.

However, it was shown already by Macke [4] that the two groups do not significantly differ in their iron content, and that they are indistinguishable in physical parameters such as density, porosity, and magnetic susceptibility as well.

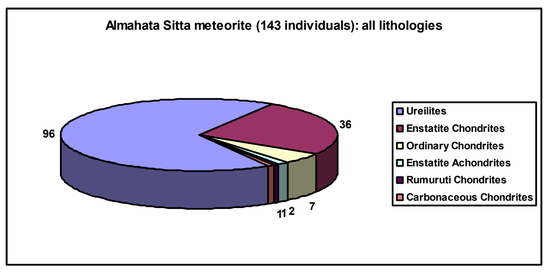

Figure 1: Statistical overview of the lithologies of all known AS individuals (see details concerning sample sets in text).

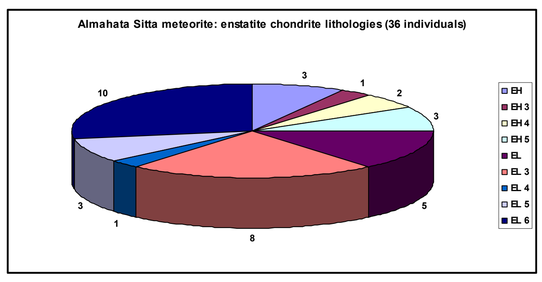

Figure 2: Statistical overview of all known individuals of the Almahata Sitta meteorite fall classified as enstatite chondrites (1 / 2019). Intermediate members are included within the lower petrographic group (eg EH 4/5 in EH 4). EH and EL means all E chondrites which do not clearly fit in a specific petrographic group, such as IMR (impact melt rocks) or breccias.

Figure 3: Typical example of an AS enstatite chondrite individual, an EL 3. © Meteorite Museum.

Sample	Class.	MS and magnetic class.	
039	EL	5.32 (2)	EL / EH
040	Ur - fg	5.02 (1)	Ureilite
041	EH 5	5.52 (1)	EL / EH
042	Ur - cg	4.87 (1)	Ureilite
043	H 4	5.09 (2)	H 4
044	EH 5	5.55 (2)	EL / EH
045	Ur - fg	5.05 (1)	Ureilite

Table 1: MagSus values of the new Almahata Sitta sample set [see 19] MS-MU 039-045.

Enstatite chondrite falls ← MagSus data → AS - Enstatite chondrite lithologies

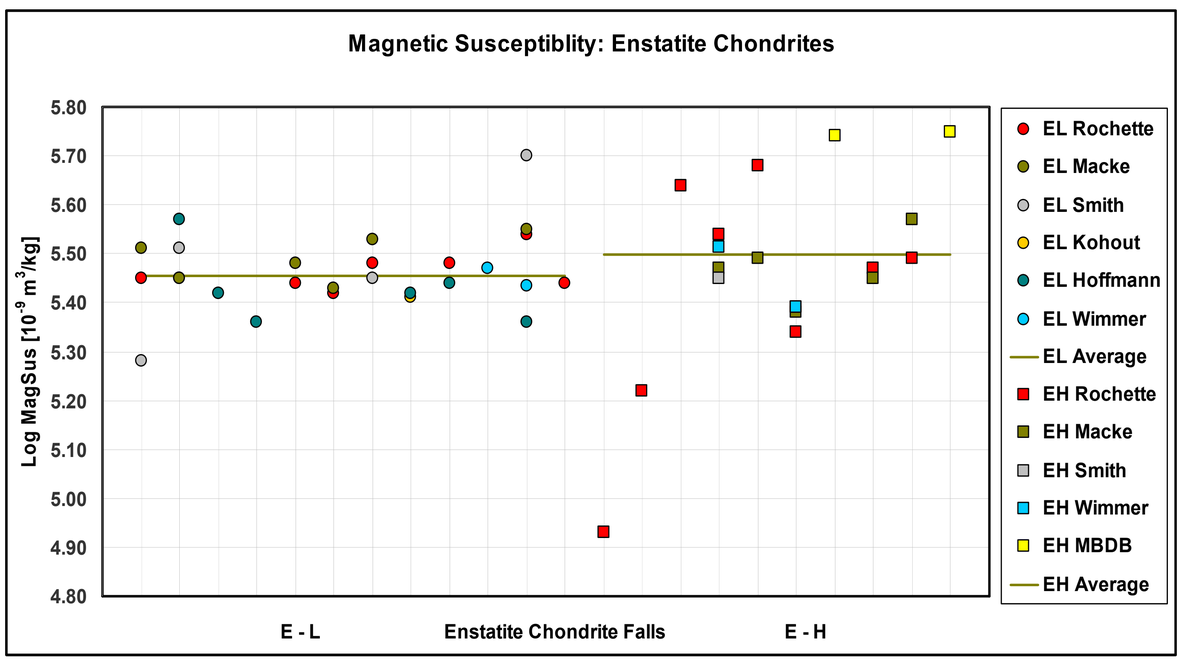

Figure 4: The distribution of the MagSus values (spec. X in log 10^{-9} m^3/kg) of all Enstatite Chondrite falls is given. Left side: the E – L group; right side: the E – H group. The category labels denote the source of the data (3 and refs). Hoffmann, Wimmer represent new and original data. MBDB: Meteoritical Bulletin database (last visit 2/2019). **Mean MagSus values are as follows: (a) E – L 5.46, (b) E – H 5.49. The difference between E – L and E – H in absolute specific MagSus is only 9.4 %.** Taking into into account that Fe in metal (mainly kamacite) is dominating MagSus, we can conclude that there is not really any meaningful difference in Fe content between both E chondrite groups, or in other words, it is within error and distribution of the measured MagSus values.

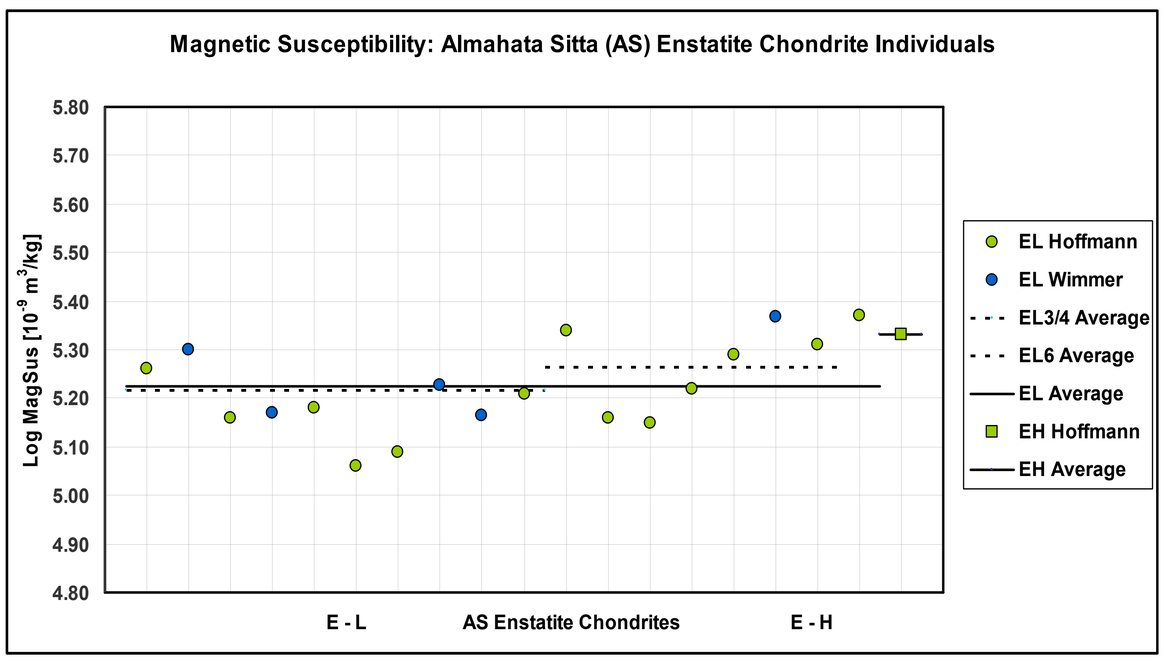

Figure 5: The distribution of the MagSus values (spec. X in log 10^{-9} m^3/kg) of all Enstatite Chondrite lithologies of the Almahata Sitta meteorite fall falls is given. Left side: the E – L group; right side: the E – H group. **The mean values of all E – L and E – H chondrite lithologies are as follows: (a) E – L 5.22, (b) E – H 5.33.** In both cases the average values are lower than for all other E – chondrite falls (see figure 3) which means that the average Fe – content, dominated by Fe-metal (mainly kamacite) is lower, (and / or the Si content of the metal higher, see below). All data are new and original.

Enstatite chondrites - compilation of MagSus data: interpretation and conclusions

We can summarize our results as follows [9-13]:

- For the first time, by incorporating AS E-C individuals, all petrographic types could be covered now for both E groups.
- *Please note that in our contribution we do not apply the newly proposed E-C classification system, mainly as many data of the AS individuals are still missing.*
- All MagSus values represent average values of 3 databases and several samples each, respectively. So we can consider the MagSus values as representative.
- The influence of local variations in Fe metal concentrations can be neglected: this was shown on Neuschwanstein 2 (EL 6) whereby a full profile across the stone was sampled and investigated and no significant variations in MagSus could be found [15-17].
- MagSus values of the AS E-C are generally lower, in case of both groups. This is specifically significant in the case of the EL 6.
- The Macke [14] findings can be confirmed – in our study only falls are taken into account.
- MagSus values do not provide a clear picture concerning grouping of E-C into high- and low-iron, respectively.
- E-H: we find a minor trend between MagSus and petrographic type – increase of MagSus with petrographic type, or degree of equilibration. The significance of the trend will have to be discussed
- E-L: we can not find any trend between MagSus and petrographic type, so the degree of equilibration seems not to play a major role in case of E-L.
- Bulk or total iron as well as Si content of the metal phases do not allow a clear classification into different E-C groups.
- Links between MagSus and parameters of the new E-C classification system will have to be tested.

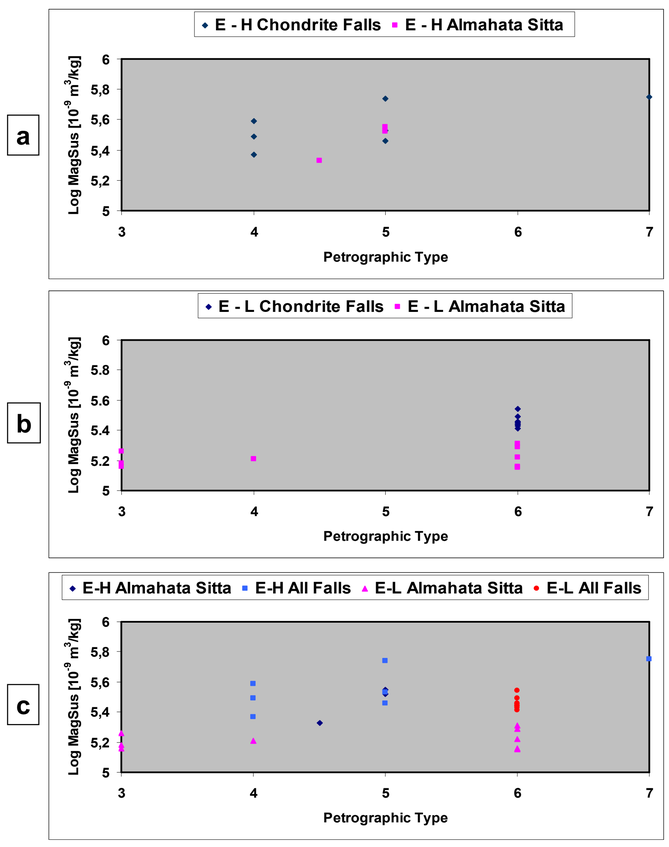

Figure 6: Plots of MagSus versus petrographic group: (a) All E - H chondrite falls including AS, (b) all E – L chondrite falls including AS, (c) all E – chondrite falls as a summary.

References

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