ALMAHATA SITTA METEORITE – COMPILATION OF MAGNETIC SUSCEPTIBILITY DATABASE

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Almahata Sitta meteorite fall 2008 – state of the art (July 2017)

The fall and discovery of a large number of individuals of the Almahata Sitta meteorite in the desert of N Sudan has significantly deepened our knowledge concerning the formation, structure and life cycle of asteroids [1,2]. In contrast to earlier findings, Almahata Sitta - classified as a polymict ureilite - does not only contain small clasts or fragments of different meteorite lithologies but consists of individuals of a growing number of different meteorite types and classes without any direct matrix contact (rubble pile asteroid parent body): various ureilite types and related lithologies (several unknown before) and a growing number of ordinary, carbonaceous and enstatite chondrites. Even unique and new meteorite lithologies such as Trachy-Andesites or an individual with affinity to Rumuruti chondrites have been discovered [2].

We will provide a compilation of the magnetic signature (focus on magnetic susceptibility, MagSus) of all so far by us investigated Almahata Sitta individuals and samples. Enstatite chondrites are treated in a different contribution. Three sample sets are discriminated in the following tables, details are found in earlier contributions [3] and in Horstmann and Bischoff [2]: AS (AhS), MS and MS-MU. Following the scheme given in our LPSC 2017 contribution [3] we have extended our MagSus database by incorporating now all investigated samples (fig. 1). The following abbreviations apply [see 3]: MagSus (decimal log X, in 10^{-9} m^3/kg); c-g: coarse grained ureilites; f-g: fine-grained ureilites (includes also variable grain size vgs/complex textured ureilites). Ureilite falls include Novo Urei, Haverö, Jalanash and Dyalpur (no samples of Lahrauli available), so we can incorporate 5 of the 6 ureilite falls. Fig. 1a/b provide an overview of all classified Almahata Sitta individuals (from LPSC 2017).

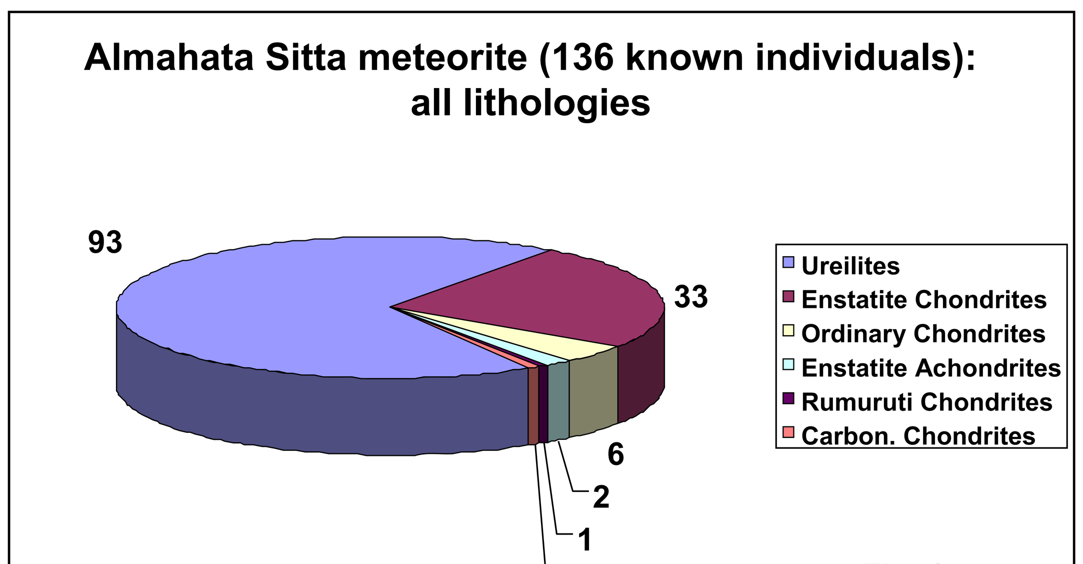

Fig. 1a

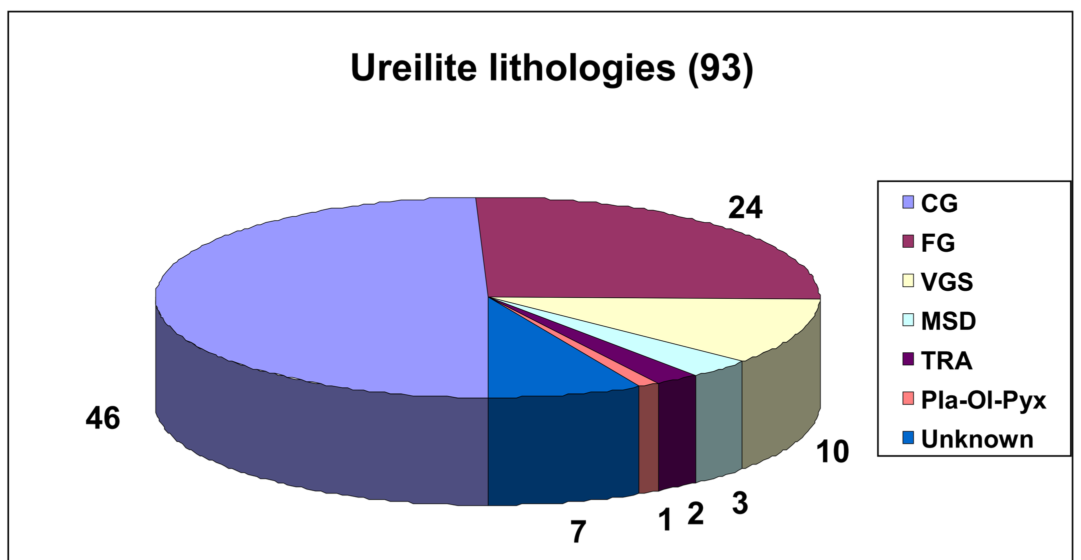

Fig. 1b

Fig. 2: Examples of new Almahata Sitta individuals under study in our projects: (a) Ureilite with complex texture (f-g, high-shock), (b) coarse-grained ureilite (the largest individual of all MS-MU, 221.5 gr), (c) Enstatite chondrite EL 3.

Almahata Sitta – MagSus of new and unique meteorite types

MS-MU-011/035

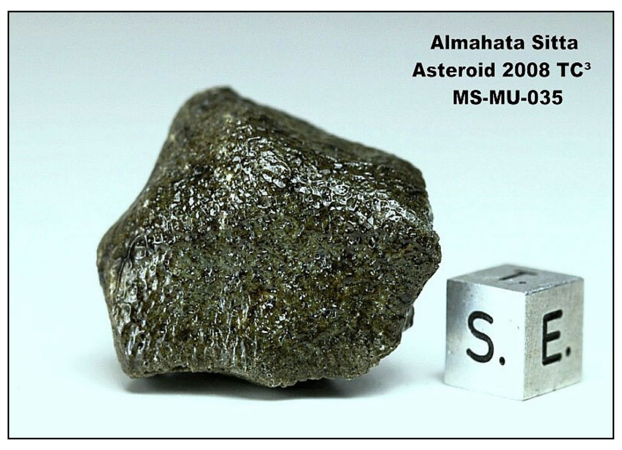

Fig. 3a: Trachy-Andesites

O-isotopy related to Ureilites; possibly first (rapidly crystallized) rocks from UPB crust(?).

Phases (Raman-S.)
Feldspar (plagioclase) dominating (no glass), pyroxene, graphite, spinel (chromite?).

MagSus classification
logX values (3.24, 3.66) are lower than for all other AS individuals studied [3], typical for terrestrial intrusives and in the range of Martian nakhlites.

MS-MU-012

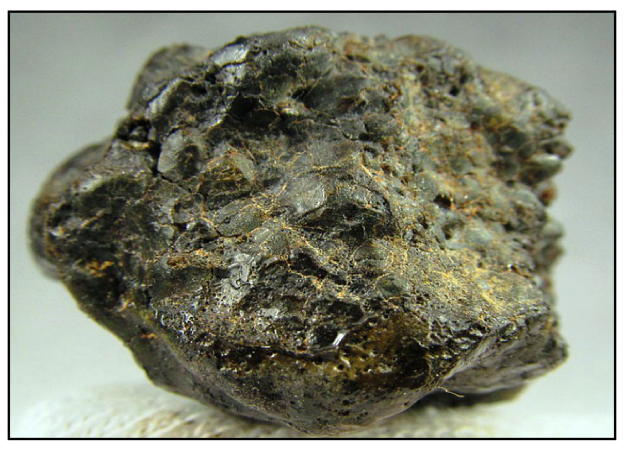

Fig. 3b: Ureilite

Unbrecciated ureilitic feldspar–olivine–pyroxene rock.

Phases (Raman-S.)
Pyroxene, graphite, olivine, metal (kamacite?), troilite, plagioclase.

MagSus classification
logX of 5.20 is one of the highest values of all studied AS individuals and of all ureilites, in the range of severely shocked, brecciated ureilites.

MS-MU-019/036

Fig. 3c: Enstatite Achondrites

Enstatite and metal rich achondrite, affinities to aubrites (O-isotopy).

Phases (Raman-S.)
Enstatite (very Fe-poor endmember), metal (iron), graphite, troilite, olivine.

MagSus classification
logX of 5.45/5.71 is much higher than for all known aubrites/ enstatite achondrites (average 3.79); NWA 8173/10271/Itqiy do have similar characteristics.

MagSus final compilation I

Tab. 1.: Final compilation of all investigated Almahata Sitta individuals with ureilitic lithologies and their respective MagSus values. The average value of 4 included ureilite falls (Novo Urei, Haverö, Jalanash and Dyalpur is given for comparison [see 3 for details].

Ureilite Type (or related)		Individuals / samples	MagSus / error
Trachy - Andesites MS-MU 011 / 035		**2 / 7**	3.24 / 3.66
AS	c - g	9 / several each	4.74 +/- 0.10
MS	c - g	1 / several	4.64
MS - MU	c - g	7 / 10	4.88 +/- 0.10
All	**c - g**		**4.80 +/- 0.15**
AS	f - g	2 / several each	5.03 +/- 0.10
MS	f - g	2 / several each	5.03 +/- 0.10
MS - MU	f - g	9 / 10	5.03(5) +/- 0.10
All	**f - g**		**5.03 +/- 0.10**
Pla – Ol – Pyx rich		**1 / 5**	**5.20 +/- 0.05**
Fine – grained, metal - rich		**1 / 2**	**5.26 +/- 0.02**
Ureilite falls		**4**	**4.99 +/- 0.10**

MagSus final compilation II and interpretation

Tab. 2a: the MagSus values of non – ureilitic lithologies detected within the Almahata Sitta sample suite are summarized (enstatite chondrites are treated in a different contribution). (b) compiles MagSus values taken from databases for comparison.

Sample / Individual	Meteorite Type	MagSus / error
MS - CH	Rumuruti – like chondrite	4.40 +/- 0.02
MS - 11	H 5/6	5.14 +/- 0.01
MS - MU 013	H 5	5.16 +/- 0.02
MS - 181	Cba Bencubbinite	5.50 +/- 0.02
MS - MU 019/036	Enstatite Achondrite, metal-rich	5.58 +/- 0.10

Tab. 2a

Meteorite MagSus values from databases [5 - 8]		
	Samples	Log X
R Chondrite	1 Fall	3.09
LL	All Falls	4.11 ± 0.30
L	All Falls	4.87 ± 0.10
H 5	All Falls	5.32 / 5.32
H 6	All Falls	5.35 / 5.34
Cba (Gujba)	1 Fall	5.65 / 5.76
Itqiy EH 7	Fall	5.75
Only falls are used for MagSus database compilation and interpretation.		

Tab. 2b

MS-CH, classified as a Rumuruti-like chondrite with affinities to L/LL does not fit the R-C MagSus range, it can be placed somewhere in between L and LL chondrites.
The MagSus values of the 2 investigated ordinary chondrites, classified as H 5/6 and H 6, respectively, are lower than to be expected for this petrographic type in generally (they better fit in between L and H).
The MagSus value of MS 181, a Bencubbinite Cba, fits well into the range of the only known bencubbinite fall, Gujba.
In terms of MS-MU 019/036, metal rich enstatite achondrites, there is no comparable fall. MagSus values belong to the highest known values at all of stony meteorites which certainly reflects the high metal content. O-isotopy shows affinities to aubrites.

MagSus values reflect the multitude of meteorite types agglomerated within the unique 2008TC3 rubble pile asteroid. Our database will now allow a quick and reliable identification and classification of the numerous existing Almahata Sitta individuals

Update july 2017:
Fioretti et al. [4] reported that recently investigations on 63 Almahata Sitta stones / individuals, stored at Univ. of Khartoum, have been started (sample set AhS). Mineralogical/petrological data of 34 samples are available, 32 have been found to be ureilites of various types, 2 non-ureilitic lithologies were identified: AhS 38 - E 6 enstatite chondrite, and AhS 202 was preliminarely classified as a carbonaceous chondrite – C 2.

A new "category" in MetBull?

As a consequence of the unique and extremely important findings on the Almahata Sitta meteorite – a rubble pile of numerous individuals of different lithologies: we would like to stimulate the discussion towards introducing and fully document these so valuable and really basic informations in the Meteoritical Bulletin. We should be aware of the fact that presently a number of new and unique meteorite types are simply missing in MetBull!

References

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Acknowledgements

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