



ALMAHATA SITTA METEORITE – THE SPACE “ROSETTA” STONE

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Almahata Sitta meteorite – numerous individuals and lithologies

The fall and discovery of numerous fragments 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].

In contrast to earlier findings, Almahata Sitta - classified as a polymict ureilite - does not only contain small clasts of different meteorite lithologies but consists of individuals of a growing number of different meteorites: various types of ureilites, numerous enstatite chondrites, a number of ordinary chondrites, even a carbonaceous chondrite (a Bencubbinite) and a unique and new meteorite lithology with an affinity to Rumuruti chondrites [1] have been found already earlier. Despite the official information of about 2-3 kg total mass (or even more?) existing, the major limitation for performing more detailed research on this unique material was the very limited access to these extraordinary samples.



Fig. 1: Typical Almahata Sitta meteorite find in the North Sudan desert (coarse-grained ureilite).

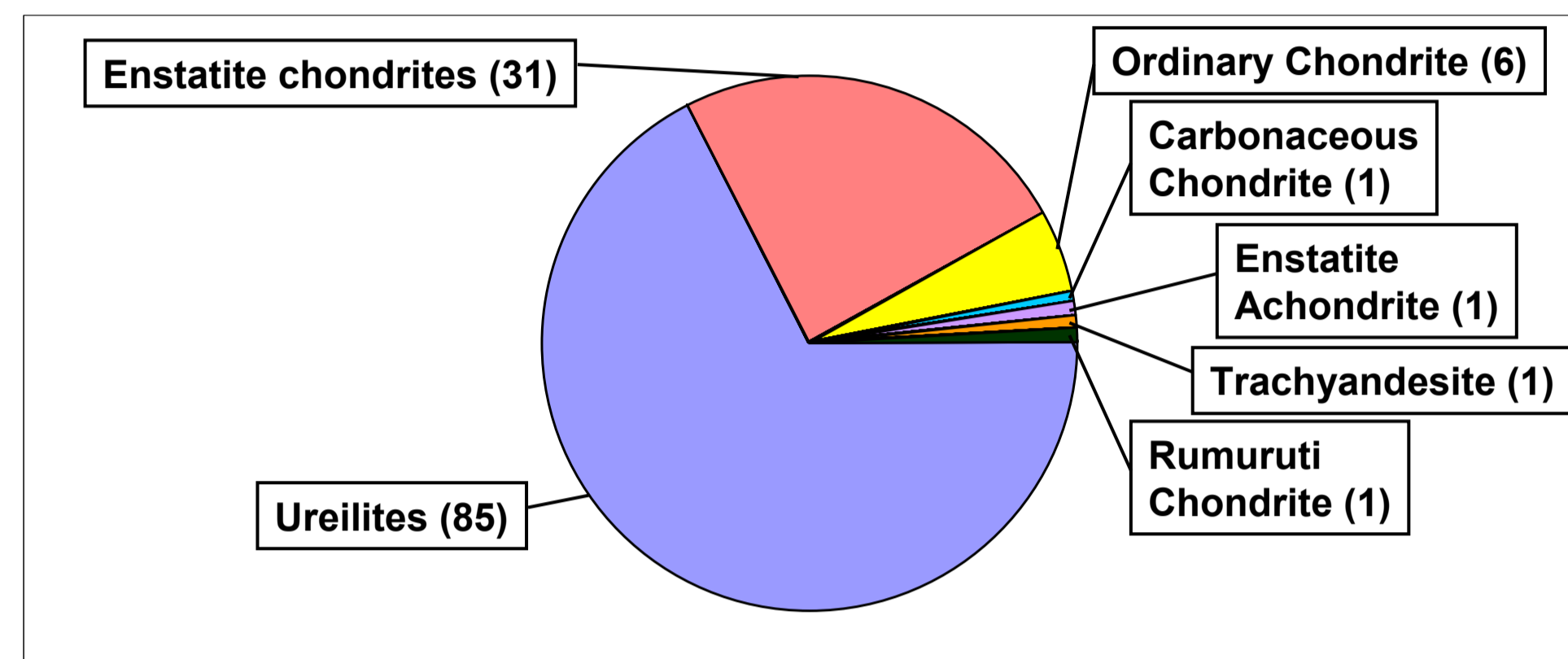







Fig. 2: Almahata Sitta meteorite lithologies – statistics (11/2015).

Recently however, due to the efforts of one of our contributing authors (S.D.) a significant and growing number of new individuals of the Almahata Sitta meteorite could be made accessible for our projects: sample set MS-MU-001–028.

Results and classification of Almahata Sitta MS-MU-001–011 have been reported in [1]. Amongst various types of ureilites and enstatite chondrites (see table 1-3), more fascinating new and unique meteorite individuals could be identified such as an enstatite achondrite or a trachyandesite [5-7]. It becomes obvious that the Almahata Sitta meteorite is unlike anything seen before. Classification of meteorites by magnetic susceptibility (MS) is a well established method in the meantime [8-10]. A large set of Almahata Sitta samples was classified by MS [2,3,8], first results on the new set MS-MU-001–028 are reported here.

Almahata Sitta – new and unique meteorite types

MS-MU-011	MS-MU-012	MS-MU-013	MS-MU-018	MS-MU-019
				
Trachyandesite [5,6]	Ureilite [7]	Ordinary Chondrite [7]	Ureilite [7]	Enstatite Achondrite [7]
Oxygen-isotopy: Ureilite, first (rapidly crystallized) rock from UPB crust?	Unbrecciated ureilitic feldspar–olivine–pyroxene rock	H 5 based on olivine/ pyroxene composition, O-isotopy: relation to L/LL	Fine-grained, high concentration of metal / sulfide, heavy shock	Enstatite and metal rich achondrite, likely unique type of meteorite
Phases (Raman-S.) Feldspar (plagioclase) dominating and no glass, pyroxene, graphite, spinel (chromite?)	Phases (Raman-S.) Pyroxene, graphite, olivine, metal (kamacite?), troilite, plagioclase	Phases (Raman-S.) Olivine, graphite, pyroxene, troilite, metal (kamacite)	Phases (Raman-S.) Olivine, pyroxene, graphite, spinel (chromite?), calcite (?), hematite (?), a quartz like phase, ...	Phases (Raman-S.) Enstatite (very Fe-poor endmember), metal (iron), graphite, troilite, olivine
MS classification MS value (3.66/3.32) is lower as for all other AS individuals studied so far [8]. MS is in the range of the Martian nakhlites, and is also typical for terrestrial intrusives.	MS classification MS of 5.37 is one of the highest values of all investigated AS individuals and of all ureilites in general, in the range of some severely shocked and brecciated ureilites.	MS classification The MS value of 5.17/5.14 clearly fits with the H 5 chondrite range.	MS classification The MS value of 5.35/5.17 is in the range of MS MU 012 and a few known severely shocked and brecciated ureilites.	MS classification The MS value of 5.46/5.38 is unique and much higher than for all known aubrites or ungrouped enstatite achondrites (average 3.79). NWA 10271 has similar characteristics.

Almahata Sitta – Rosetta Stone of Space, and Future?

Sample	Classification	Log MS (in 10 ⁻⁹ m ² /kg)
MS-MU-001	Ureilite (fine-grained)	4.93
MS-MU-002	Enstatite chondrite EL 3	5.26
MS-MU-003	Enstatite chondrite EL (brecc.)	5.43
MS-MU-004	Ureilite (fine-grained, vgs)	---
MS-MU-005	Ureilite (coarse grained)	---
MS-MU-006	Ureilite (coarse grained)	---
MS-MU-007	Enstatite chondrite EL 6	5.30 / 5.13
MS-MU-008	Ureilite (coarse grained)	---
MS-MU-009	Enstatite chondrite EH 4/5	5.33
MS-MU-010	Ureilite (coarse grained)	---

Sample	Classification	Log MS (in 10 ⁻⁹ m ² /kg)
MS-MU-011	Trachy-Andesite (rel. to Ureilites)	3.66/3.32/3.32
MS-MU-012	Ureilite (feldspar-olivine-pyroxene)	5.37/4.99
MS-MU-013	Ordinary chondrite (H 5, L/LL)	5.17/5.14
MS-MU-014	Ureilite (coarse-grained)	4.90
MS-MU-015	Enstatite chondrite (EL 6)	---
MS-MU-016	Ureilite (coarse-grained)	4.83
MS-MU-017	Ureilite (coarse-grained)	5.20
MS-MU-018	Ureilite (fine-grained, metal rich)	5.17/5.35
MS-MU-019	Enstatite achondrite (metal rich)	5.46/5.38
MS-MU-020	Ureilite (coarse-grained)	5.01

Sample	Classification	Log MS (in 10 ⁻⁹ m ² /kg)
MS-MU-021	Ureilite („unique texture“)	5.12
MS-MU-022	Ureilite (coarse-grained)	5.02
MS-MU-023	Enstatite chondrite (EL 3)	5.16
MS-MU-024	Enstatite chondrite (EL 6)	5.29
MS-MU-025	Ureilite (fine-grained)	4.95
MS-MU-026	Enstatite chondrite (EL 6)	5.21
MS-MU-027	Ureilite (fine-grained)	4.82
MS-MU-028	Ureilite (variable texture)	4.95

The new Almahata Sitta sample set provides the scientific community with several unique and new meteorite lithologies. Amongst these, the following individuals have to be mentioned:

MS-MU-002 the 1st known EL 3 fall
MS-MU-023 the 2nd known EL 3 fall
MS-MU-021 Ureilite with unique texture

Summarizing, in near future we can expect to get access to more unique and fascinating meteorites from the Almahata Sitta fall: a real Rosetta Stone of Space!

A new category in MetBull database?

As a consequence of the unique and extremely important findings on the Almahata Sitta meteorite which consists of numerous individuals of different lithologies: we propose that a new sub-category should be introduced in the Meteoritical Bulletin Database in order to officially report these new meteorites.

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