MINERALOGY OF THE NEUSCHWANSTEIN (EL6) CHONDRITE - FIRST RESULTS.

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Introduction: A brilliant fireball was seen by many eye-witnesses in Austria and Germany on April 6, 2002, 20:20 h (UT). The associated meteorite fall was well documented by the European Fireball Network (EN). Based on the EN photographs the meteoroid orbit and the impact area were calculated by Spurny et al. [1], which finally led to the recovery of a single stone of 1.75 kg in July 14, 2002. Being found close to the famous castle in Bavaria (position: 10°48.5' E; 47°31.5' N), the meteorite was named Neuschwanstein.

Mineralogy: Several thin sections of Neuschwanstein were studied by optical and electron microscopy. Selected mineralogical features are shown in Figs. 1-6. In addition, the compositions of the main silicates were obtained by electron microprobe (Table 1).

The meteorite has a recrystallized texture with a small number of chondrule relics (Fig. 1). Major phases are enstatite, plagioclase, and metal. Enstatite is very poor in Fe (Table 1). The FeO concentration of clean crystals containing no metal inclusions is considerably below 0.1 wt%. Plagioclase has an Ab- and Or-component of about 82 and 4.5 mol%, respectively (Table 1). First analyses indicate that the metals contain about 1.5 wt% Si.

Huge subhedral to euhedral crystals (up to ~300 µm) of sinoite (Si_2N_2O) exist. They often form larger aggregates (Fig. 2). The crystals are very pure containing only very small amounts of other elements (~0.1 wt% Al_2O_3 and FeO). A less abundant SiO_2-phase contains 1-2 wt.% Al_2O_3 (Table 1). Neuschwanstein has a significant abundance of graphite. Graphites occur as large lath-like crystals (up to 700 x 200 µm; Fig. 4) or as small inclusions in metals. Schreibersite ($(Fe,Ni)_3P$) is rare. Sulfides occur in paragenesis typical for EL6 chondrites. Fig. 3 shows the relationship of troilite (FeS), oldhamite (CaS), daubreelite ($FeCr_2S_4$), and alabandite ((Mn,Fe)S) in Neuschwanstein. Oldhamite is occasionally surrounded by an unidentified, Ca-rich phase (Fig. 6). It appears to be a corrosion product, but it is certainly not a sulfate. Similar alteration products (including portlandite) surrounding oldhamites were reported to occur in the Norton County aubrite [2]. It is possible that this phase in Neuschwanstein is also portlandite that formed during the residence time of about three months on the ground. A similar unidentified, Ca-rich phase was also found between graphite and troilite (Fig. 5).

Optical features indicate that the rock is very weakly shocked (S2; undulatory extinction of plagioclase[3]). The residence time of about three months on ground resulted in first signs of weathering (W0/1).

Chemistry: The chemical composition of Neuschwanstein is given in detail in an accompanied abstract by Zipfel et al. [4]. The abundances of moderately volatile elements are typical for EL-chondrites having low Mn/Mg (0.010) and Na/Mg (0.045) ratios and low Zn concentrations (<20 ppm). High concentrations of siderophile elements (Ni = 1.94 wt%; Ir = 0.76 ppm) reflect, however, higher than usual metal contents for EL chondrites.

Final remarks: Based on texture, mineralogy, and chemistry the meteorite Neuschwanstein is classified as an EL6-chondrite. Rubin [5,6] suggested that euhedral sinoites and graphite laths in enstatite chondrites may have formed by crystallization from an impact melt. Neuschwanstein does not look like an impact melt breccia. In case that sinoites and graphites crystallized from a melt, we cannot rule out, if either the metamorphic temperature was high enough to cause melting or if the melting is due to impact. The occurrence of relic chondrules speaks against significant melting in Neuschwanstein.

Table 1: Composition of main silicates (wt%)

	Enstatite		Plagioclase		SiO_2-phase	
Na_2O	-	<0.02	9.1	9.6	0.40	0.43
MgO	38.6	38.4	<0.01	0.05	0.05	0.03
Al_2O_3	0.22	0.21	20.1	19.6	2.03	1.54
SiO_2	59.2	59.2	65.3	66.7	95.1	95.0
K_2O	-	-	0.80	0.80	<0.01	<0.01
CaO	0.76	0.73	2.80	2.83	0.18	0.11
TiO_2	<0.02	<0.02	<0.01	-	-	-
Cr_2O_3	-	-	-	-	-	-
MnO	<0.04	-	-	-	-	-
FeO	0.05	<0.05	0.10	-	0.06	0.25
Total	98.89	98.63	98.22	99.58	97.83	97.37
En/Ab	98.2	98.5	81.5	82.1		

References: [1] Spurny P. et al. (2002) *Proc. Asteroids, Comets, Meteors Conf.*, ESA SP-500, in press. [2] Okada A. et al. (1981) *Meteoritics,* 16, 141-152. [3] Stöffler D. et al. (1991) *GCA,* 55, 3845-3867. [4] Zipfel et al. (2003) *this volume.* [5] Rubin A.E. (1997) *Amer. Min.*, 82, 1001-1006. [6] Rubin A.E. (1997) *Mineral. Mag.,* 61, 699-703.

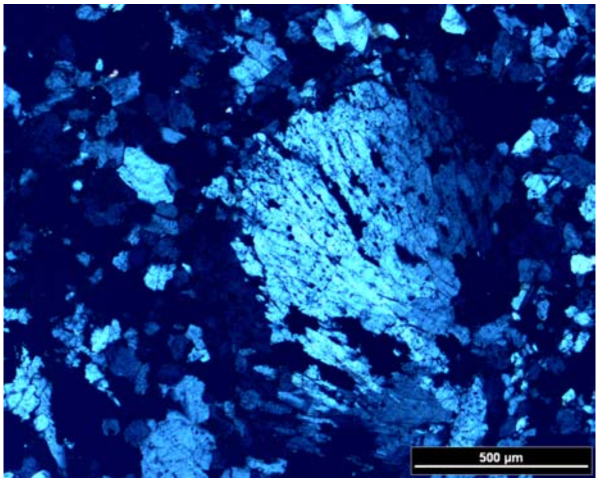

Abb. 1: Relic chondrule in Neuschwanstein

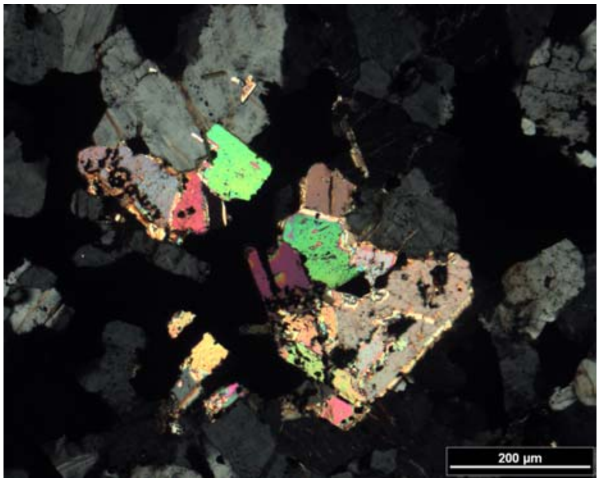

Abb. 2: Several crystals of sinoite

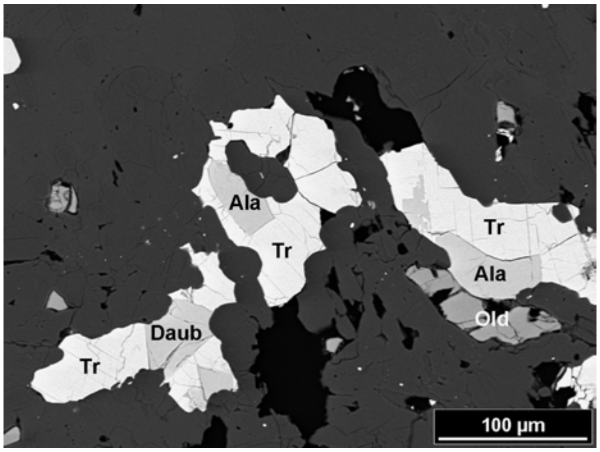

Abb. 3: Sulfide paragenesis; Tr-troilite, Ala-alabandite, Old-oldhamite, Daub-daubreelite; BSE

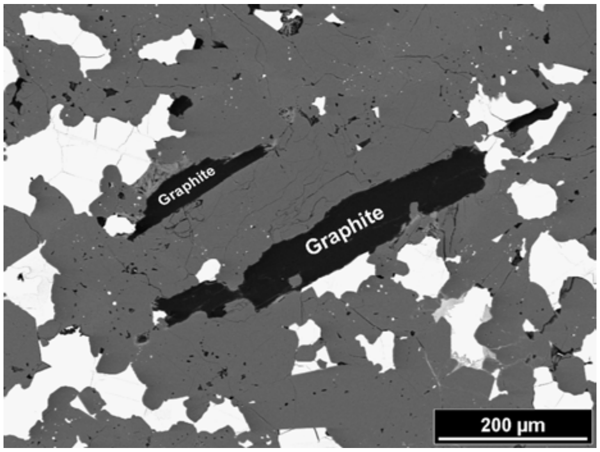

Abb. 4: Graphites in Neuschwanstein; BSE

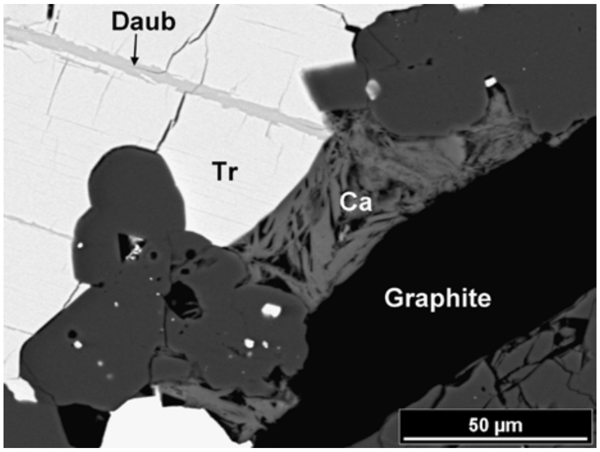

Abb. 5: Unidentified Ca-rich phase (Ca) between graphite and troilite (Tr); Daub-daubreelite; BSE

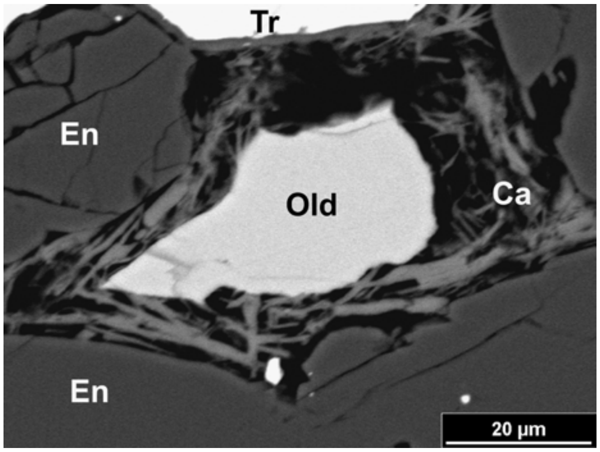

Abb. 6: Oldhamite (Old) surrounded by an unidentified, Ca-rich phase (Ca); Tr-troilite, En-enstatite; BSE