THE DERMBACH METEORTIE – A RELICT OF THE IVA PARENT BODY CORE? R. Bartoschewitz[1], R. Tagle[2], G. Nolze[3], B. Spettel[4], A. Greshake[5]. [1]Bartoschewitz Meteorite Laboratory, Lehmweg 53, D-38518 Gifhorn, Germany. E-mail: Bartoschewitz.meteorite-lab@t-online.de. [2]Bruker Nano GmbH, Schwarzschildstr. 12, D-12489 Berlin, Germany. [3]Bundesanstalt für Materialforschung und -prüfung, Werkstofftechnik, Unter den Eichen 87, D-12205 Berlin, Germany. [4]Abt. Biogeochemie, Max-Planck-Institut für Chemie, Joh.-J.-Becher-Weg 27, D-55128 Mainz, Germany. [5]Museum für Naturkunde, Leibniz-Institut für Evolutions- und Biodiversitätsforschung, Invalidenstr. 43, D-10115 Berlin, Germany.

Introduction: The Dermbach meteorite was described by Hoppe [1] as anomalous ataxite composed of metal nodules with very different composition (42% and 24% Ni) sealed by troilite and schreibersite, where a Ni-rich nodule is described in detail. We recently run INAA data, scanned a large surface for Ni-, Fe-, P-, and S-distribution by XRF and did EBSD and IPF investigation. The data were presented to initiate further studies on this unique meteorite during the 2. Deutsches Meteoriten Kolloquium in Dermbach/ Thuringia in Oct. 2011.

Analytical methods: Trace elements were determined by INAA at the Instituit für Kernchemie (Universität Mainz) in a TRIGA reactor (6 h, flux 7x10 n/cm/s, post-irradiation counting on Ge-detectors) on a 28.33 mg sample from a new discovered fragment. An additional INAA was provided by Wasson [2]. Element distribution maps have been either generated by micro-XRF measurements with 25 µm beam diameter and 60 µm step size using an M4 Tornado (specimen of Naturkundemuseum Berlin), or in higher resolution by hyperspectral EDS investigations using an XFlash 5030 (specimen BC 667.1, Bartoschewitz). The latter SEM analyses (LEO 1530VP) were combined with EBSD (electron backscatter diffraction) investigations using ESPRIT (Bruker Nano) which enables the extraction of crystallographic information like local phase distribution and crystal orientation. Typical step widths were in the scale of 0.5-1 µm.

Results: The low Ge/Ga-ratio of 0.04 in combination with the Co/Au- and Ga/Au-ratios (~1200 and 0.8 respectively) reflect a IVA relation, what is supported by high siderophile as well as volatile elements (Fig. 1) [3, 4].

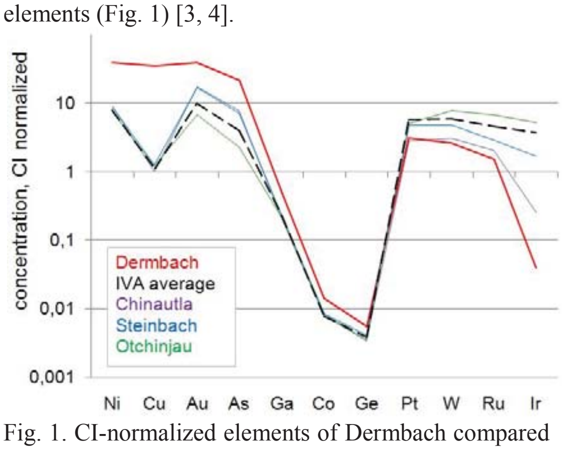

Fig. 1. CI-normalized elements of Dermbach compared with average IVA group and single IVA members

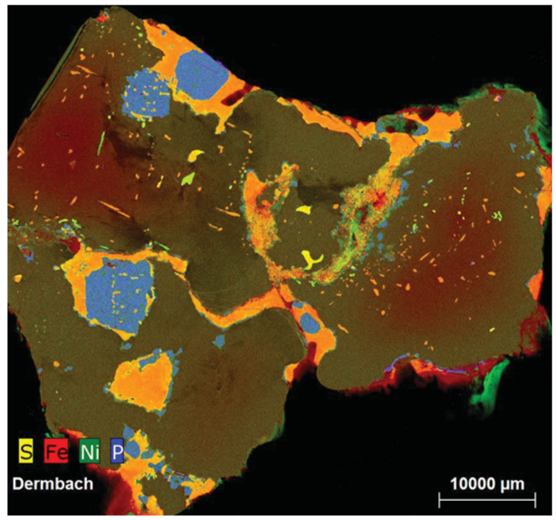

Fig. 2. XRF scan showing Fe-, Ni-, P-, and S-distribution. Dermbach nearly complete cross-cut.

The Ni-poorer area presents a very fine α-/γ-duplex structure (~1 µm) [1], while the high Ni-area is a single taenite crystal. Within the single taenite crystal (BC 667.1) beside well developed rhabdite crystals many rhabdites show decomposition to dominantly troilite, minor taenite and kamacite and close to the transformation interface few small phosphides (Fig. 3). If the transformation is completed, “feathery regions” of dominantly troilite remain (Fig. 4). These "feathery regions" depict decomposition areas of former or still not completely decomposed schreibersite containing mainly troilite and taenite, but also rarely kamacite (Fig. 4a). The orientation map in Fig. 4b (using inversepole figure (IPF) coloring) displays strong orientation variations of taenite around the former big schreibersite precipitates in the scale of 20-30 degrees. This extreme shock-deformation can be accumulated by the metallic matrix but not by the brittle schreibersites which shatter but nevertheless generate a network of micro-cracks around them within the metal and enable the inner weathering. Since schreibersites are shattered it will mainly start with a decomposition of themselves. The tiny rhabdites (light-blue) are not transformed since they are not linked with the observed network of micro-cracks.

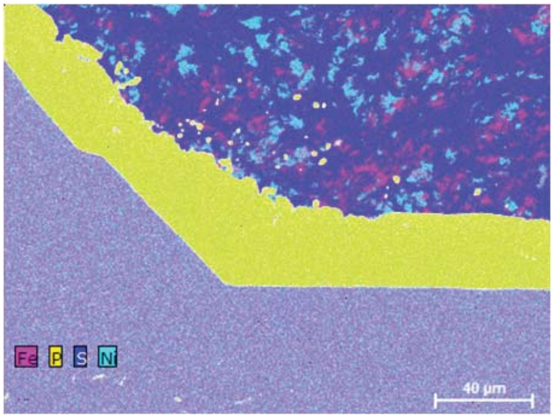

Fig. 3. Element distribution map derived from simultaneously acquired hyperspectral EDS data collected during an EBSD mapping. It shows the incomplete substitution of a schreibersite by troilite, taenite and kamacite.

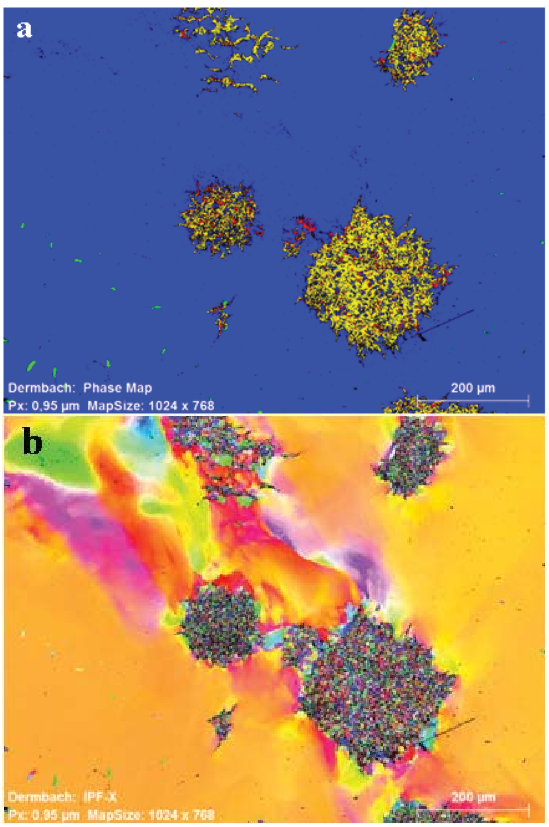

Fig.4. Decomposed schreibersite into troilite (yellow), taenite (blue) and kamacite (red) surrounded by a highly distorted taenite matrix. a) reflects the phase distribution, whereas b) displays the locally detected crystal orientations. Color variations mean orientation variations.

Discussion: The CI-normalized Ni, Cu, Au, As, Ga, Co, Ge, Pt, W, Ru, and Ir pattern as well as the Ge/Ge-, Co/Au-, and Ga/Au-ratios of the Dermbach iron follow the IVA trend (Fig. 1). The high Ni- versus the low Ir-content is consistent with the IVA group fractionated crystallization model, reflecting crystallization from the remnant 10% of IVA parent material [5]. Furthermore bulk S (~7%) and P (0.8%) meets the IVA crystallization path [6]. Although the very high Cu content seems not to meet the IVA trend it plots on the Cu vs. Au "S-curve" extension [7]. The chemical composition of the Dermbach meteorite suggests that it is a Ni-rich member of IVA group.

Dermbach's average Ni-content is about 35% with a very strong zoning of about 15% Ni difference within taenite nodules of 2-3 cm in diameter (Fig. 2) that might be due to slow cooling under high pressure in the IVA parent body core, where the ε-phase occurs.

For rhabdite decomposition and formation of "feathery troilite" we discuss two different procedures:

1. While parent body disruption accompanied by pressure release and rapid cooling the ε-phase transformed to super-saturated γ_2, and sulphur exsolved as "feathery" troilite together with kamacite (Fig. 4a). Due to accompanying volume expansion strong variation of taenite orientation occur (Fig. 4b). Already precipitated phosphide was partly resolved and substituted by troilite, taenite, and kamacite (Fig. 3).
2. Dermbach presents a net of fractures that are filled by very fine grained products. On these fractures terrestrial weathering might have transformed the rhabdites.

The fate of P disagree to the first model while schreibersite decomposition by terrestrial weathering as most stable mineral in iron meteorites is questionable.

Summery: The unique Dermbach meteorite is most probably a Ni-rich member of IVA group that formed during parent body core crystallization. The last stages of core crystallization seem not to meet the ideal fractionation process and are poorly understood due to missing S-rich meteorites from this late period [6]. Dermbach might be a candidate to bring some more light in our knowledge concerning core crystallization of iron meteorite parent bodies.

References: [1] Hoppe G. (1976) Chem. Erde, 35, 305-316. [2] Wasson J. T. (2011) INAA data of Dermbach (personal communication). [3] Koblitz, J. (2005) MetBase 7.1.© J. Koblitz, Fischerhude, Germany. [4] Walker R. J. et al. (2005) *LPSXXXVI, 36*,#1313. [5] Wasson J. T. et al. (2006) *Geochim. Cosmochim. Acta, 70*, 3149-3172. [6] Chabot N. L. and Haack H. (2004) Evaluation of Asteroidal Cores in *Meteorites and the early solar system II.* 747-771. [7] Chabot N. L. et al. (2009) *Meteoritics & Planet. Sci. 44*, 505-519.