POSSIBLE IRON METEORITIC CONTAMINATION IN IMPACT MELT PARTICLES FROM THE STEINHEIM BASIN (BADEN-WÜRTTEMBERG, GERMANY). M. Schmieder[1] and E. Buchner[1,2] [1]Institut für Planetologie, Universität Stuttgart, Herdweg 51, D-70174 Stuttgart, martin.schmieder@geologie.uni-stuttgart.de. [2]HNU Neu-Ulm University, Wileystrasse 1, D-89231 Neu-Ulm, Germany.

Introduction: The 3.8 km in diameter Steinheim Basin (Baden-Württemberg, Germany) is a small, complex impact structure hosted by a sequence of Triassic to Upper Jurassic sandstones, marls, and limestones that build up the Swabian Alb plateau [1-3]. The specific alignment of the Steinheim Basin, the ~24 km in diameter and ~14.4 Ma Ries crater, and the Central European tektite strewn field led [4] to propose that both impact structures formed simultaneously during the 'Ries-Steinheim event'. Recently, [5] newly reported suevitic (i.e., impact melt-bearing) portions of the predominantly lithic Steinheim impact breccia. *Flädle*-shaped altered impact melt particles mainly composed of hydrous phyllosilicates (ø ~50 wt% SiO_2, ~28 wt% Al_2O_3, ~3 wt% FeO, 1.9 wt% CaO, 1.4 wt% MgO, ~1.1 wt% K_2O, and ~1.1 wt% TiO_2), incorporated target rock clasts and droplets (mainly calcite and silica), and Fe-sulfides (Figs. 1 and 2) provide new insights into the Steinheim impact melt petrology and allow a first approach towards the identification of the Steinheim projectile.

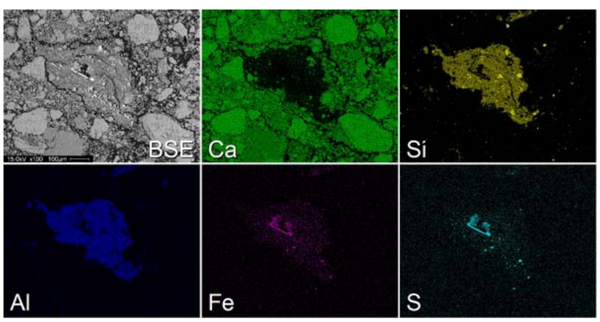

Fig. 1: Backscattered electron image and element distribution maps for a Steinheim impact melt particle ('micro-*flädle'*) within the largely carbonatic Steinheim suevite [5]; maps for Fe and S show concentration of Fe-sulfides (compare Fig. 2); also note the silicatic character of the melt particle.

Samples and Analysis: Impact breccia samples were recovered from the B-26 drill core (core depth 76-77 m, closely above the structural crater floor of the Steinheim Basin; see [2] for core description) drilled by the Geologisches Landesamt Baden-Württemberg in the 1960s [1] and now stored at the Meteorkratermuseum, Steinheim-Sontheim. Analysis of melt particles and Fe-sulfides was done using a CAMECA SX 100 electron microprobe.

Ni-Co-rich Fe-Sulfides: Among a notable amount of Fe-sulfides (commonly framboidal to spherule-shaped pyrite) within the altered impact melt particles, the majority is apparently free of Ni and Co. Microprobe analyses of spinifex-textured Fe-sulfides up to ~100 µm in crystal length (Fig. 2 A) and droplet-shaped aggregates of microcrystalline sulfides (Fig. 2B,C) yielded Ni contents of up to 1.17 wt% and Co contents of up to 0.1 wt% at an average Ni/Co ratio of 10.9. The Ni-Co-rich Fe-sulfides also contain minor amounts of Al, Si, Ca, and Ti (<1 wt% in total) and are largely free of Cr (however, some microprobe measurements yielded traces of Cr near the detection limit). Furthermore, an iron spherule adherent to the surface of the altered Steinheim melt particle shown in Fig. 1 yielded Ni: ~2.4 wt% and Co: ~1.2 wt% (Fig. 2D).

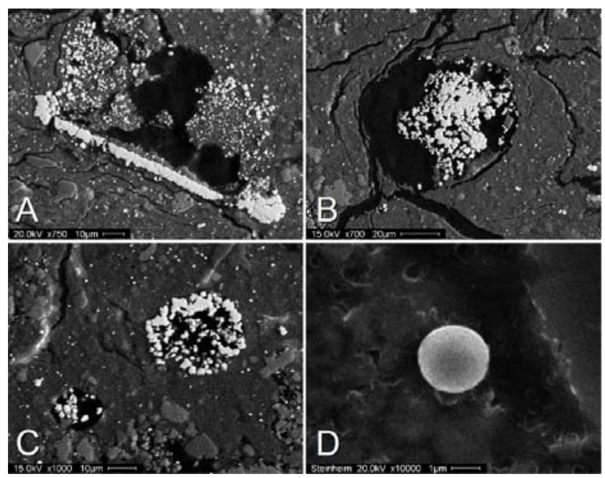

Fig. 2: Backscattered electron images of Ni-Co-rich Fe-sulfides (bright) in Steinheim suevite melt particles; A: detailed view of larger spinifex-textured Ni-Co-rich Fe-sulfide crystal (also shown in Fig. 1); this crystal contains up to 1.17 wt% in Ni and 0.1 wt% in Co; B and C: droplet-shaped aggregates of microcrystalline Ni-Co-rich Fe-sulfides (see also [5] for further details); D: Ni-Co-rich iron spherule (Ni: ~2.4 wt%; Co: ~1.2 wt%) adherent to the surface of the melt particle shown in Fig. 1.

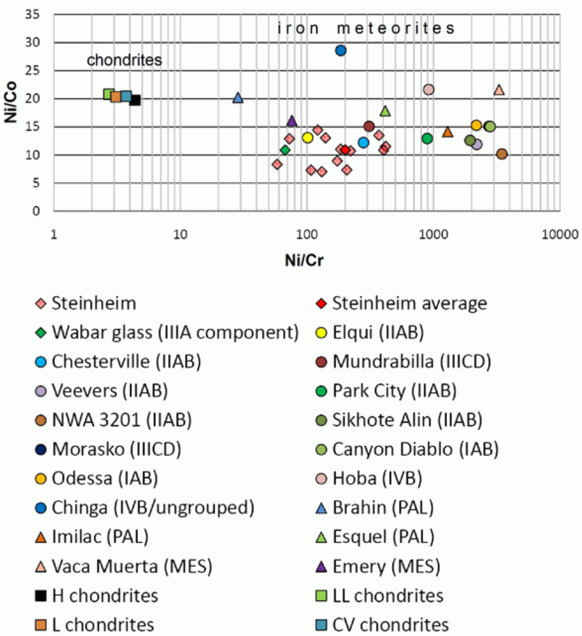

Fig. 3: Ni/Co vs. Ni/Cr plot for the Ni-Co-rich Fe-sulfides from the Steinheim Basin (single measurements and average value), Wabar glass (Saudi Arabia), some iron meteorites (IIAB, IIICD, IAB, IVB), stony-irons (pallasites: PAL; mesosiderites: MES), and chondrites (H, CV, L, and LL); data after [10-16].

Discussion: In contrast to essentially pure Fe-sulfides, Ni-Co-rich Fe-sulfides restricted to melt particles within a suevitic domain of the Steinheim Basin breccia are unlikely to originate from the sedimentary target rocks. The Middle Jurassic 'Eisensandstein' that also outcrops in the central uplift of the Steinheim Basin is associated with sedimentary iron ores that are known to contain up to ~100 ppm in Ni and ~10 ppm in Co (see [6] and references therein); therefore, we suggest that the high Ni and Co contents in the Fe-sulfides do not represent an indigenous component inherited from the target rock but that the sulfides contain a distinct meteoritic component. The spinifex-textured and microcrystalline nature of the Ni-Co-rich Fe-sulfides (Fig. 2A-C), furthermore, suggests rapid crystal growth (during post-shock heating) and the concomitant incorporation of impactor-derived siderophile elements into the sulfide phase. Our preliminary geochemical data point to an iron meteorite as the Steinheim projectile. The average Ni/Co ratio of 10.9, together with notably low Cr contents and a high (i.e., non-chondritic) average Ni/Cr ratio of ~200 are within the range for iron meteorites (e.g., [7-15]; see Fig. 3 for a summary of Ni/Cr and Ni/Co data for chondrites, stony-iron and iron meteorites, and Wabar glass, Saudi Arabia, which is known to carry a distinct IIIA iron meteorite component [17]). PGE and Ge/Ga analyses are planned in order to further characterize the Ni-Co-rich Fe-sulfides in the Steinheim impact melt particles.

Implications for the Ries-Steinheim Event: Given that no extraterrestrial component has so far been detected in the Ries impact melt lithologies (thus, an achondritic projectile was proposed) [18], the new finding of Ni-Co-rich Fe-sulfides as a potential iron meteoritic signature in melt particles from the Steinheim Basin still appears to be compatible with the formerly proposed Ries-Steinheim impact event [4]. The model works if one considers two compositionally different bodies – for example, an achondritic stony asteroid roughly 1 km in diameter (Ries impactor) with a smaller 'iron moon' ~100-150 m in diameter (Steinheim impactor) – that might have been involved in a binary asteroid impact scenario. The Ries crater, however, needs to be subjected to further impactor identification studies in oder to confirm (or disprove) the proposed achondritic Ries projectile.

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