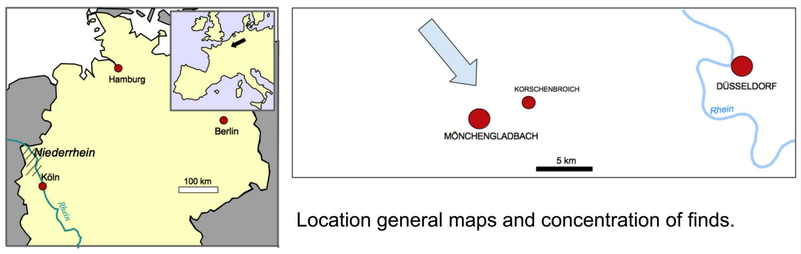
THE ENIGMATIC NIEDERRHEIN (GERMANY) DEPOSIT: EVIDENCE OF A MIDDLE-PLEISTOCENE METEORITE IMPACT STREWN FIELD

Georg Waldmann[1], Friedel Herten[2], Michael Hiltl[3], Kord Ernstson[4]

[1]Haus der Natur, Kloster Knechtsteden, 41540 Dormagen, Germany [2]ENERKO INFORMATIK GmbH, Markt 45-47, 52062 Aachen, Germany
[3]Carl Zeiss Microscopy GmbH, D-73447 Oberkochen, Germany [4]Faculty of Philosophy I, University of Würzburg, 97074 Würzburg, Germany



Location general maps and concentration of finds.

Introduction

In the last years during intense geologic field work on the Pleistocene in the Niederrhein district author G.W. regularly picked up conspicuous rocks of quite different form, material and facies, which appeared to belong to a common incidence but which however had never before been given consideration by local and regional geologists, not to mention any reference in the literature. Together with author F.H. and over time the sampled rock mass as well as the affected sample area increased. Likewise, with regard to the established geology in the Niederrhein district, the conviction of a strange geologic process and origin arose. We report on a provisional model for the origin of this enigmatic deposit that far from having clarified all observations and understanding the complete context focuses on an extraterrestrial component in the form of a probable meteorite impact event.

Geologic setting and sample conditions

The finds of the sharp-edged rocks under discussion concentrate on pit mines of fossil river terraces about 30 m below the present landscape and contrast markedly with the exploited well-rounded gravel material. Surface finds in more than 40 localities in the open landscape on eroded slopes are meanwhile completing the occurrence.

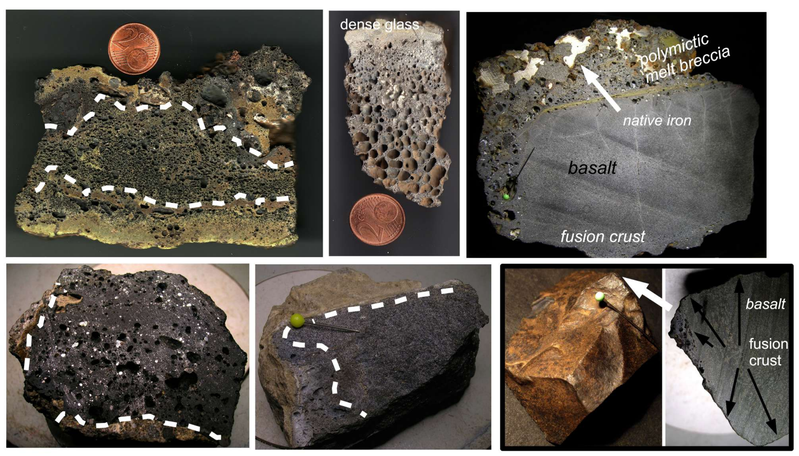
Typical loess landscape and find situations in the field.

In the beginning the rocks attracted attention because of their basically basaltic and frequently observed melt rock character. The sharp-edged basalts on the one hand were puzzling because the nearest basalt natural occurrences were about 100 km distant, and fluvial and glacial transport because of the sharpness of the fractured basalts could reasonably be questioned.

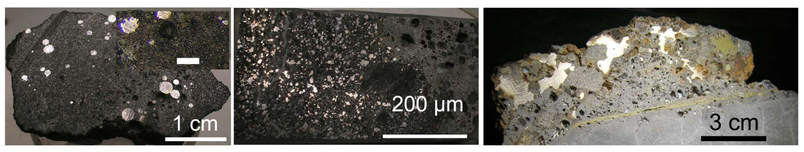
More startling was the observation of abundant native iron in the basalts in the form of both metallic spherules and irregularly shaped inclusions. Native iron in basalt is well known from Greenland deposits [1] but otherwise is extremely rare on Earth. One of these rare occurrences (Bühl) was exploited until the early 20th century near the city of Kassel, but the distance to the Niederrhein location is roughly 200 km practically excluding a direct connection. Apart from these early considerations the further preoccupation with the enigmatic rocks featured more and more surprising observations, which, at first vaguely, reminded of a meteoritic context and which is described in more detail below.

The peculiar rocks - form and material

Basalt and basaltic melt rocks with fusion crust

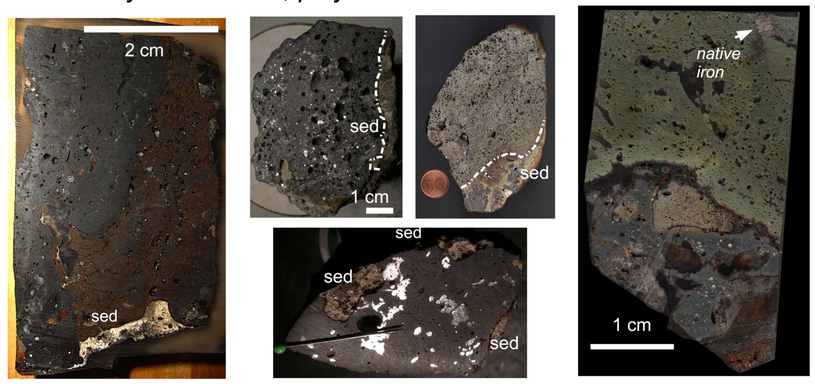


Native iron in basalt and fusion crust



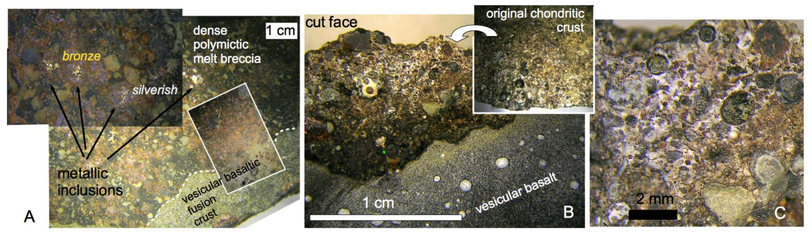
The peculiar rocks - form and material

Sedimentary contribution, polymictic melt breccias



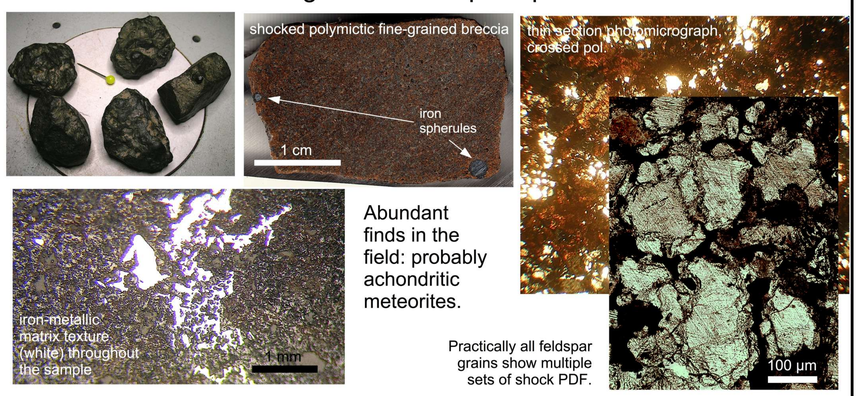
Fusion of basaltic, proposed extraterrestrial melt rock with sedimentary, terrestrial matter (sed) to form polymictic melt breccias.

"Achondritic" and "chondritic" breccias



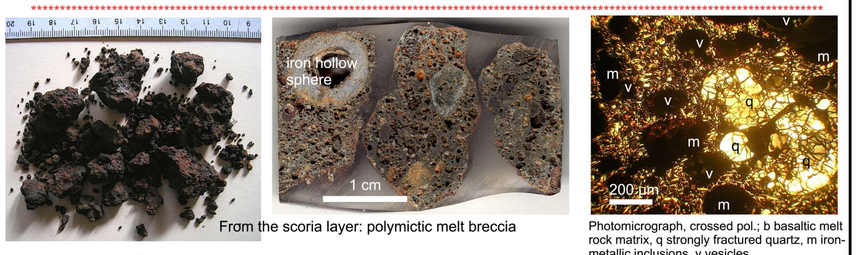
In relation to common meteoritic texture but for now genetically still irrelevant we define "chondritic" and "achondritic" breccias in contact with basaltic rock. The polymictic "chondritic breccia" (B, C) forms the crust of a slightly vesicular basalt while conversely the polymictic, metal-rich "achondritic breccia" has a vesicular basaltic crust (A).

Looking into the samples: peculiarities



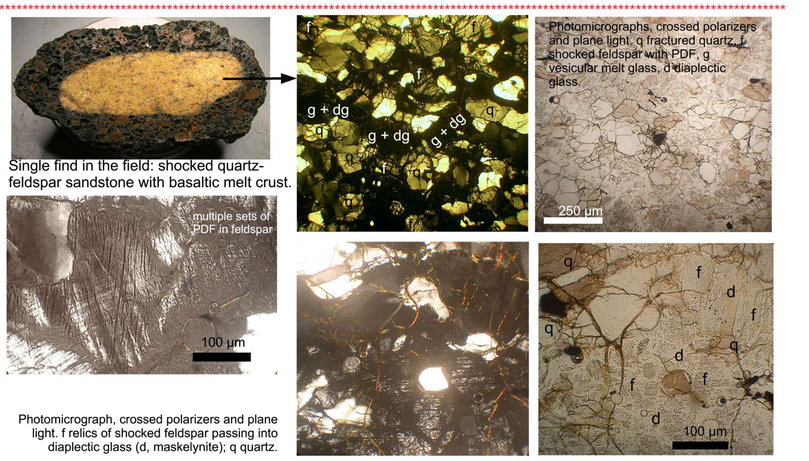
Abundant finds in the field: probably achondritic meteorites.

Practically all feldspar grains show multiple sets of shock PDF.



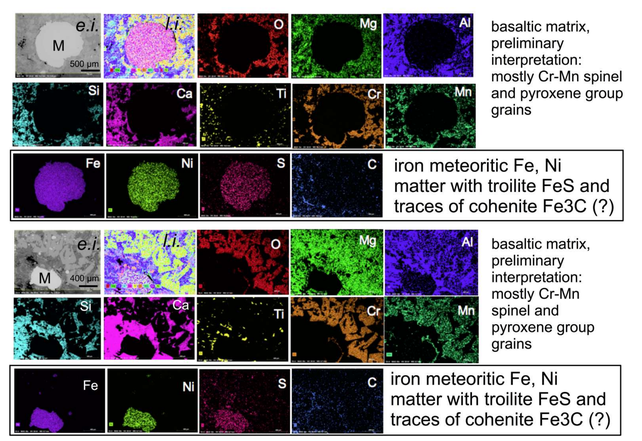
From the scoria layer: polymictic melt breccia

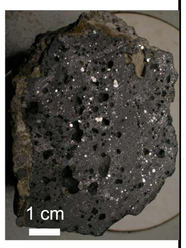
Photomicrograph, crossed pol.; b basaltic melt rock matrix, q strongly fractured quartz, m iron-metallic inclusions, v vesicles.



Photomicrograph, crossed polarizers and plane light. f relics of shocked feldspar passing into diaplectic glass (d, maskelynite); q quartz.

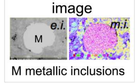
Looking into the samples - SEM-EDS





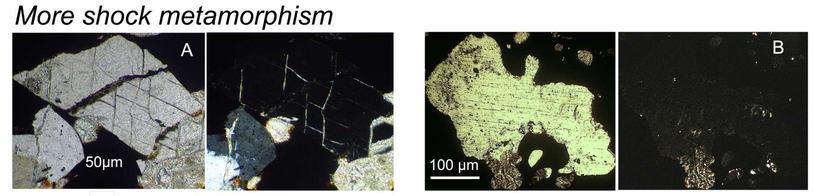
Metallic inclusions in basaltic melt rock

e.i. electron image
l.i. EDS layered image



M metallic inclusions

More shock metamorphism



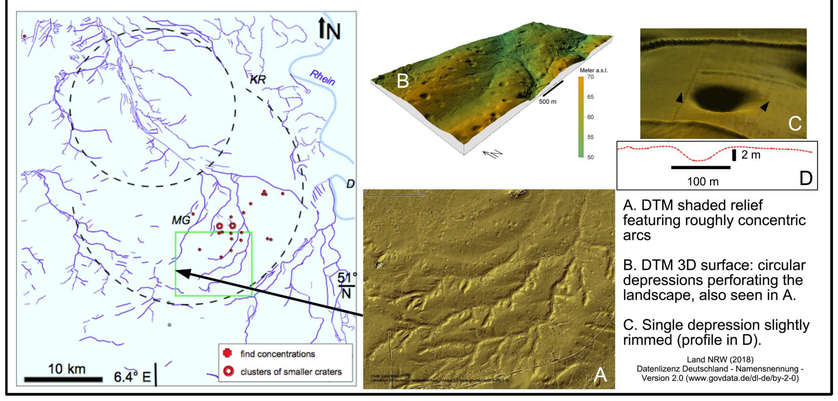
Shock metamorphism in polymictic breccias

Photomicrographs (A) Quartz grain completely transferred to diaplectic glass. The multiple sets of planar fractures (PF) are also a shock effect. (B) feldspar grain completely transferred to diaplectic glass (maskelynite). A, B plane light and crossed polarizers. C: Multiple sets of planar deformation features (PDF) in feldspar, plane light.

Possible impact topographic signature

Drainage pattern

Digital Terrain Model (DTM)



A. DTM shaded relief featuring roughly concentric arcs

B. DTM 3D surface: circular depressions perforating the landscape, also seen in A.

C. Single depression slightly rimmed (profile in D).

Discussion and conclusions

-- A peculiar geological element in the Niederrhein region completely alien to established geologic mapping and knowledge suggests an origin from an extended (50 km at least) meteorite impact event in the Middle Pleistocene.

-- Considerable amounts of the impactor are preserved as meteorites of various composition (basaltic, achondritic, chondritic (?)) and size.

-- The conspicuous nature of the proposed meteorites suggests an origin as impact ejecta from an extraterrestrial body (Moon, Mars or an asteroid with basaltic crust (e.g. Vesta) [2]).

-- The terrestrial impact has produced abundant phenomena well known from general impact research like impact melt rocks, poymictic breccias and in part strong shock metamorphism (melt glass, diaplectic glass, planar deformation features (PDF) in quartz and feldspar). Shock effects are observed in both the extraterrestrial and local rocks.

-- The considerable mass of preserved meteorites and the in part intense mixture of the extraterrestrial matter with local rocks are not compatible with a single large impactor (which would largely have vaporized) but suggest a cluster impactor ("rubble pile") of probably low velocity. This would explain the absence of a larger deep impact crater and the absence of excavated rocks from deeper stratigraphy. The today seen conspicuous drainage system and features in the Digital Terrain Model as well as clusters of small circular depressions (100 - 200 m) in the loose rock Pleistocene target would apply to the model.

-- Our investigations are at the very beginning. Forthcoming fieldwork will also include possible industrial and archeological aspects of the finds. An Ar-Ar dating has been initiated which could significantly substantiate our hypothesis.

References: [1] Bird, J.M. et al. (1981) *J. Geophys. Res., 86,* 11787-805. [2] Martin et al. (2017*) Meteoritics Planet. Sci.*, 52, 1103-1124. [3] https://curator. jsc.nasa.gov/antmet/lmc/lmc.cfm, accessed 1/6/18.