A POSSIBLE UPPER EOCENE-OLIGOCENE IMPACT SPHERULE LAYER IN THE NORTH ALPINE FORELAND BASIN, UPPER BAVARIA, GERMANY? [1]E. Buchner, N. J. Deinerth, and M. Schmieder, Institut für Planetologie, Universität Stuttgart, Herdweg 51, D-70174 Stuttgart, Germany, [1]elmar.buchner@geologie.uni-stuttgart.de.

Introduction: Layers of distal impact ejecta have been reported from various sites on Earth through geologic time [1]. Two ejecta layers are known from Late Eocene-Oligocene sections: first, the so-called clinopyroxene microkrystite layer that is derived from the ~100 km and 35.7 ± 0.2 Ma Popigai crater, Russia; second, the slightly younger North American mircotektite layer linked to the ~90 km and 35.5 ± 0.3 Ma Chesapeake Bay crater, Virginia, USA [1-3]. No spherule layers associated with the smaller impact structures of Lake Mistastin (Labrador, Canada; 28 km and 36.4 ± 4 Ma) and Lake Wanapitei (Ontario, Canada; 8 km and 37.2 ± 1.2 Ma) have been described. Apart from the Massignano stratotype section for the Eocene/Oligocene boundary, Marche, Italy, which is known to contain altered spherules of the clinopyroxene (Popigai) layer [4], no Eocene-Oligocene impact ejecta are known in Europe. Here we report a possible spherule layer in uppermost Eocene to Oligocene sediments of the North Alpine Foreland Basin of Upper Bavaria (Southern Germany).

Samples, Geological Setting, and Methods: Samples were obtained from two Upper Eocene to Oligocene sedimentary sections: first, a natural outcrop of parautochthonous, medium-grained marine sandstones at the Katzenlochgraben near the village of Hammer (within a sedimentary suite regionally known as the "Katzenlochschichten" [5]); second, from the top of red algae-bearig biohermal limestones (regionally known as the "Lithothamnienkalke" [6]) that outcrop in the active cement quarry at Rohrdorf operated by the Rohrdorfer Zement™ enterprise. Both sample locations are ~40 km apart (Fig. 1). Preliminary petrographic and geochemical studies were carried out using optical microscopy (magnifiers and polarization microscopes) and SEM-EDX (energy dispersive X-ray analysis).

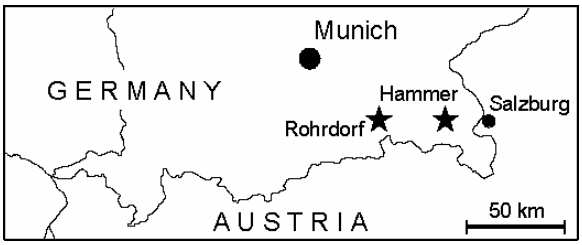

Fig. 1: Sample locations at Hammer and Rohrdorf in the North Alpine Foreland Basin (southern Upper Bavaria, Germany).

Petrography and Geochemistry: Black 'clayey' spheres of submetallic luster are abundant on (but limited to) one bedding plane of the Katzenlochgraben sandstones and the Lithothamnienkalke, respectively. Most of the spheres occur as individuals up to ~0.5 mm in diameter (Fig. 2); agglomerates of two or more spheres also exist (Fig. 3). The majority of the spheres is hollow or filled by secondary phases. The geochemical composition of the spheres is of mixed silicatic (and probably partially sulphidic) character, with a strongly variable distribution of Si, distinct EDX peaks for Mg, Al, K, Ca, Fe, S, and slight enrichment in Cl, P, Ti, Mn, and Ni (Table 1).

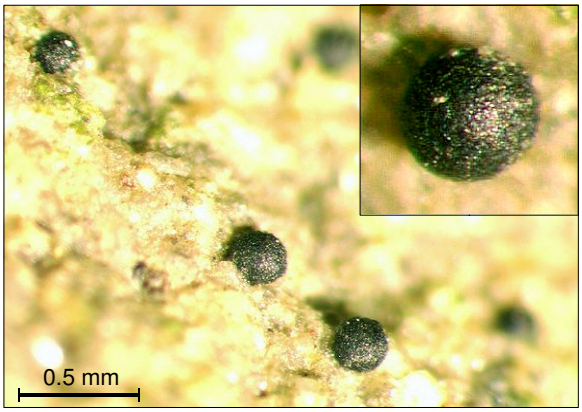

Fig. 2: Individual spheres on sandstone from the Katzenlochgraben near Hammer (same scale for inset).

	#1	#2	#3	#4	#5
Na_2O	0.00	0.00	0.00	0.35	0.14
MgO	4.94	2.40	2.87	3.58	2.89
Al_2O_3	19.92	17.02	20.10	19.52	21.79
SiO_2	34.08	53.72	42.25	46.55	49.91
P_2O_5	0.35	0.16	0.31	0.37	0.87
SO_3	6.08	2.01	1.91	2.66	2.74
Cl_2O	0.76	1.14	0.33	1.22	0.37
K_2O	3.20	3.50	3.74	3.70	4.54
CaO	16.80	5.47	7.70	8.01	5.24
TiO_2	0.88	2.77	0.48	0.59	0.96
MnO	0.54	0.87	0.54	0.63	1.86
FeO	11.62	10.34	19.59	12.83	8.14
NiO	0.82	0.61	0.17	0.00	0.56
Total*	100.00				

Table 1: Preliminary geochemical composition of the Katzenlochgraben spheres (EDX data without volatiles; measured at 15 kV).

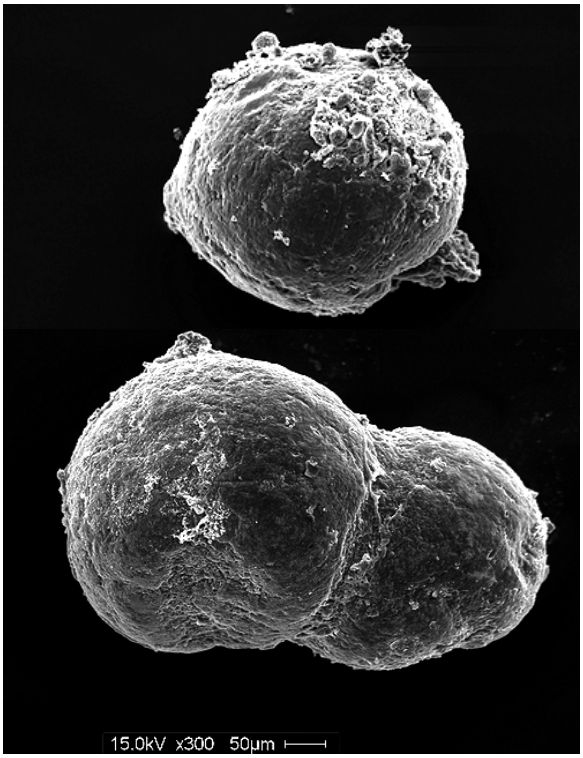

Fig. 3: Single (top) and double (bottom) spheres from the Upper Eocene-Oligocene section at the Rohrdorf quarry (SEM-secondary electron image).

Discussion and Results: The Hammer-Rohrdorf spheres occur locally within Upper Eocene to Oligocene sediments of the Katzenlochgraben and the Rohrdorf quarry sections; we did not detect the spheres in other sedimentary units. As many of the spheres are hollow (partially filled with secondary phases), an origin as small concretions or ooids can be ruled out. A strong variability in size, shape, and type of agglomeration also suggests that the spheres were not generated by organisms. The geochemical composition precludes that the spheres are reworked and rounded grains of authigenic glauconite linked to microfossils as earlier described by [6]; we also observed glauconite in the Katzenlochgraben sandstones and the Lithothamnienkalke, but these grains differ from the spheres in composition, shape, and colour. Taking the above facts into account, we propose that the spheres might represent altered and/or reworked impact spherules probably linked to one of the Late Eocene-Oligocene impact events. The hollow clayey character of the spheres, however, indicates strong alteration (compare [7-9]) and, accordingly, geochemical values different from their original composition.

The search for unmelted impact ejecta material, such as shocked quartz grains, did not yield reliable signs for an impact origin of the Hammer-Rohrdorf sphere layer but is currently continued. So far, we detected only quartz with one set of straight deformation lamellae that appear distinct from abundant Boehm lamellae in optical microscopy. Thus, convincing evidence for shock metamorphism still needs to to be presented. However, besides the spheres, irregularly shaped particles of devitrified-spherulitic feldspar glass occur in the Katzenlochgraben sandstones. It remains unclear whether these glass particles are of volcanic, tectonic-frictional, or possible impact origin.

Further petrographic work and geochemical analyses will be needed to harden evidence for an impact origin of the Hammer-Rohrdorf spheres. Moreover, C- and O-isotopic studies of the Upper Eocene-Oligocene sediments at the Rohrdorf quarry, as well as a refined biostratigraphic characterization of these sediments will be necessary to link the spheres with one of the Eocene-Oligocene large impact events and to establish (or discredit) the first occurrence of Upper Eocene-Oligocene distal impact ejecta in Central Europe.

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