SEDIMENTATION PATTERNS OF METEORITIC EJECTA IN ELTANIN IMPACT DEPOSITS AT SITE PS58/281. Frank T. Kyte1, Rainer Gersonde2, and Gerhard Kuhn2, 1Center for Astrobiology, Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90095-1567, USA (kyte@igpp.ucla.edu). 2Alfred Wegener Institut fur Polar- und Meeresforschung, Postfach 120161, D-27515 Bremerhaven, Germany.

Introduction: Deposits of the late Pliocene (2.5 Ma) Eltanin impact are unique in the known geological record. It is the only known km-sized asteroid impact into a deep-ocean (5 km) basin, and the central portion of the impact region is the most meteorite-rich locality known on Earth. Evidence for this deposit was first discovered as an Ir anomaly in sediments from three cores collected in 1965 [1,2] by the USNS Eltanin. These cores contained mm-sized shock-melted asteroidal materials and several percent unmelted meteorite fragments [3]. Based on mineral chemistry of unmelted meteorite fragments, and siderophole element concentrations in the impact melt, the parent asteroid is considered to be a low-metal (~4%) mesosiderite [4,5].

Two oceanographic expeditions have now explored the impact region, which was in the vicinity of the Freeden Seamounts (57.3˚S, 90.5˚W). These expeditions used detailed mapping of the seafloor, echosounding of near-surface sediments and collection of sediments using piston cores to examine the nature and extent of the impact deposits. In 1995, Polarstern expedition ANT-XII/4 recovered three cores containing ejecta deposits at the Freeden Seamounts and provided the first detailed understanding of the impact deposit [6]. In 2001 Polarstern expedition ANT-XVIII/5a returned to the impact region and recovered 17 new cores from a region covering ~80,000 km² of the ocean floor [7, 8]. Analyses of sediment ages, textures and compositions (size, microfossil, mineralogy, meteorite content), show that sediments as old as Eocene, and probably Paleocene were ripped up by the disturbance from the impact and redeposited in three distinct units. Features of these deposits are elucidated by xray-radiographs taken from slices of the cores. The lowermost unit is a chaotic assemblage of sediment fragments up to 50 cm in size (termed unit SU IV). Above this is a laminated sand-rich unit that was deposited as a turbulent flow (SU III), and this is overlain by a more fine-grained deposit of silts and clays that settled from a cloud of sediment suspended in the water column (SU II) [6]. Meteoritic ejecta are typically found to be concentrated near the base of the uppermost unit, where coarse ejecta caught up with the settling sediment following the impact. It is important to note that the impact deposit contains two distinct components: 1) seafloor sediments disturbed and redeposited by the impact comprise most of the impact deposit, and 2) asteroidal ejecta composed of melted and unmelted asteroid material that was ejected from the ocean, settled through the water column, and deposited in the upper portion of the impact deposit.

This Study: In this poster we will illustrate details of the distribution of meteoritic ejecta in a piston core from site PS58/281 (57.4˚S, 91.96˚W; 4772 m depth), which was recovered from a basin on the NW edge of the seamounts. This core is exceptional in its high concentrations of meteoritic ejecta and may have been close to the actual impact site. We estimate that the impact deposited 2.8 g/cm² of meteoric ejecta on the ocean floor at this site.

We measure the concentrations of meteoritic ejecta using two methods. First, Ir concentrations are measured in bulk sediments or in separated fractions of sediments, such as sieved fractions. Iridium concentrations are used to estimate the amount of asteroidal meltrock, using 188 ng/g as the current best estimate of the Ir content of this component [4]. Unfortunately, this method does not discriminate the unmelted meteorite fragments which are typically Ir-poor meteoritic basalts. The second method is to physically separate ejecta particles by hand picking from sieved fractions of sediments. Unfortunately this method is only practical in size fractions >500 µm, but it is useful in accounting for the larger unmelted meteorite fragments. Sediment samples are gently disaggregated and sieved to separate into clay, silt, and fractions >63, >125, >250, >500, >1000, and >2000 microns. All size fractions >500 µm have been hand picked and separated into terrestrial, impact melt rock, and unmelted meteorite fractions.

Piston core PS58/281-1 is 18.62 m long. It penetrated into the upper portion of unit SU II, the chaotic sediment fragments. The lowermost 657 cm (up to 1183 cm depth) consists of this unit. Above this is 134 cm (to 1049 cm) of laminated sediments (SU III), likely deposited under a laminar flow regime. The uppermost unit (SU II) is 36 cm thick (to 1013 cm), has higher concentrations of silt and clay, fines upwards, and the uppermost portion is lost due to bioturbation. The division between units SU II and II is somewhat arbitrary, but is placed generally where sediment laminations become less regular. We sieved 104 samples from near the base of the core at...
1849 cm up into the normal sediment above the impact deposit at 967 cm. Iridium was measured in 32 samples from 1081 to 967 cm, spanning the highest concentrations of meteoritic ejecta.

**Results:** The main portion of the meteoritic ejecta begins at ~1065 cm where we begin to get abundant large (>2 mm) ejecta particles. Coarse ejecta (>500 µm) is abundant over ~35 cm, to 1031 cm, with a peak in a 2.5 cm-thick layer at 1037 cm, which we estimate to be 80% meteoritic by weight, based on Ir concentrations of 155 ng/g. Above 1031 cm only traces of coarse ejecta are found, but Ir in bulk sediments concentrations indicate that it is still abundant in the medium- and fine-sand fractions to the top of the analyzed section.

PS58/281-1 is distinct from all other cores recovered in that it contains significant meteoritic ejecta below the main deposit. We recovered a 9 g unmelted meteorite at 1091 cm, some 25 cm below the main deposit. We interpret this large meteorite to have settled through the 5 km water column faster than the rest of the ejecta. We also find small, but significant amounts of meteoritic ejecta (almost entirely meltrock), in nearly every sieve sample to a depth of 1410 cm, well into the disturbed sediment fragments of SU IV. Our best interpretation of this phenomenon is that this might be a portion of the meltrock that was injected into the water column by the impact, and settled much more quickly than meltrock and meteorites that were ejected on ballistic trajectories and then had to settle through the entire 5 km ocean column. This phenomenon leads us to suspect that PS58/281 was the site closest to the actual impact.

We observe a distinct sorting of meteoritic ejecta by type and by size, which is also distinct from the size distribution of the disturbed terrestrial sediments. Unmelted meteorites, which comprise 9% of the coarse ejecta in the sieved samples, are most concentrated in the lower part of the main deposit, from 1050 to 1065 cm (Fig 1), where they are 25 to 100% of the coarse ejecta. This probably reflects the higher density and greater settling rate of meteorites, relative to the vesicular meltrock. Note that the high concentrations of unmelted meteorites, are not reflected by high Ir concentrations. Another interesting observation is that once the main ejecta deposit arrives, the ejecta dominates the coarsest fractions of the sediments. From 1065 to 1035 cm nearly 100% of the >500 µm fraction is meteoritic. In samples up to 1025 cm, where we have measured Ir in the fine sand fractions, meteoritic ejecta is 50-80% of the >63 µm fraction. Although we have not measured Ir in the silt and clay fractions yet, estimates based on bulk Ir indicate that very little of the meteoritic ejecta is in this fraction in samples as high as 1025 cm.

The deposition pattern of meteoritic ejecta at site PS58/281 indicates that it was probably close to the impact site. Meteoritic meltrock particles were injected into the water column and settled into the top of the chaotic sediment fragments in unit SU IV, and were included as traces during subsequent deposition of SU III. The earliest portion of the main ejecta deposit is dominated by more dense, unmelted meteorites, and followed by high concentrations of the vesicular meltrock. This ejecta is significantly larger than the surrounding disturbed sediments, and had to settle through the 5 km water column and the turbulent sediment disturbed by the impact, prior to deposition on the ocean floor.

**References:**

![Figure 1](https://example.com/figure1.png)

*Figure 1. Profiles of Ir and meteoritic ejecta from the main ejecta horizon in piston core PS58/281-1. Elevated Ir concentrations reflect high concentrations of vesicular asteroidal melt rock, which has ~188 ng/g Ir. Note that most of the unmelted meteorites are concentrated in the base of the horizon, from 1065 to 1050 cm. We measured Ir in the fine-sand fractions of several samples to estimate the concentrations of ejecta in these components, which are most significant above 1040 cm.*