



The late Pliocene impact of the Eltanin asteroid into the Southern Ocean – Documentation and environmental consequences.

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The late Pliocene impact of the Eltanin asteroid is the only known impact in a deep-ocean (~5 km) basin and was first discovered in 1981 as an Ir anomaly in sediment cores collected by the USNS Eltanin in 1965 [1]. In 1995 an expedition with *RV Polarstern* we collected extensive bathymetric and seismic data sets as well as sediment cores from an area in the Bellingshausen Sea (Pacific Southern Ocean) that permitted the first comprehensive geoscientific documentation of an asteroid impact into a deep ocean (~ 5 km) basin, named the Eltanin impact [2]. Further extensive survey and sampling followed during a second *RV Polarstern* expedition in 2001. Impact deposits are now available from a total of more than 20 sediment cores collected in an area covering about 80,000 km². Sediment texture analyses and studies of sediment composition including grain size and microfossil distribution reveal the pattern of impact-related sediment disturbance and the sedimentary processes immediately following the impact event. The pattern is complicated by the Freeden Seamounts (~57.5 S, 90.5 W), a large topographic elevation that rises up to 2200 m above the surrounding abyssal plain in the area affected by the Eltanin impact. The impact ripped up sediments as old as Eocene that have been re-deposited in a chaotic assemblage on and near by the seamounts. This is followed by a sequence sedimented from a turbulent flow at the sea floor, overprinted by fall-out of airborne meteoritic ejecta that settled through the water column. Grain size distribution of reworked sediments and ejecta reveals the timing and interaction of the different sedimentary processes. One of the

most remarkable characteristics of this impact deposit is the high concentration of melted (87%) and unmelted (13%) meteoritic material distributed across a large area of ocean floor. Our interpretation is that there is a region in the vicinity of the Freeden Seamounts comprising at least 20,000 km² in which the average amount of meteoritic material deposited was > 1 g/cm² and up to 6 g/cm². This is clearly the most meteorite-rich region known on the surface of the Earth. High-resolution integrated magnetobio-stratigraphic analyses constrain the Eltanin impact age to 2.5 Ma. This represents a climate period of rapidly fluctuating climate affected by major glaciations on the Northern hemisphere. The Eltanin asteroid size was around or larger than 1 km in diameter. This places the energy released by the impact at the threshold of those considered to cause environmental disturbance at a global scale. Tsunami modeling [3] revealed that only few hours after the impact tsunamis with a height of more than 50 meters must have reached the Antarctic and South American coast lines, having potential to destabilize Antarctic ice shelf areas in the Pacific sector. Unfortunately only little geological evidence of such a devastating tsunami is available until now from the coastal areas surrounding the Pacific. The impact also represents a possible transport mechanism explaining the presence of extinct Cenozoic microfossils in the transantarctic Sirius Unit. These microfossils were originally interpreted as evidence of a significant mid-Pliocene reduction of the East Antarctic Ice Sheet [4].

References: [1] Kyte, F. T., et al. (1981) *Nature* 292, 417-420. [2] Gersonde et al. (1997) *Nature* 390, 357-363. [3] Ward, S.N. and Asphaug, E. (2002) *Deep-Sea Res. II* 49, 1073-1079. [4] Webb et al. (1984) *Geology* 12, 287-291.