# Search for supernova-produced $^{60}$Fe in Earth's microfossil record

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## INTRODUCTION

The radioisotope $^{60}$Fe ($T_{1/2} = (2.62 \pm 0.04)$ Ma [1]) can be produced in copious amounts during different phases of evolution of massive stars. It is possible that $^{60}$Fe-rich supernova debris is deposited into solar system reservoirs [2]. Samples from Pacific Ocean sediment were chosen as sample material for this work. Considering an enrichment of the ocean water with $^{60}$Fe after deposition of SN material on Earth, all minerals being formed during that time in the sediment will incorporate $^{60}$Fe and preserve the original concentration of $^{60}$Fe/Fe, except for natural radioactive decay. One particularly interesting reservoir of in situ formed iron-bearing minerals are magnetosomes. Chains of these magnetite crystals are built up by magnetotactic bacteria, who use it similar to a compass needle for magnetotaxis. After cell death, the magnetosome chains can be preserved over geologically significant timescales and represent a very interesting sample material to look for a $^{60}$Fe isotope anomaly.

## MATERIALS AND METHODS

As sample material for this project, two sediment cores from the Eastern Equatorial Pacific (ODP Leg 138, Sites 848 and 851) were chosen. In order to extract iron from $^{60}$Fe rich minerals, the chemical CBD extraction procedure was employed. It was carefully calibrated to only dissolve particles of $\leq$ 200 nm diameter. In this way, dilution of $^{60}$Fe from iron-bearing grains from other sources (wind, water), which are typically larger, is reduced. A thorough study of the magnetic properties of the samples was also performed [3]. The concentration of $^{60}$Fe/Fe was then measured using accelerator mass spectrometry (AMS) at the GAMS setup at the MLL. Its unique ability to separate isobaric background in a gas-filled magnet allows for sensitivities reaching down to $^{60}$Fe/Fe$\approx 10^{-16}$ and even lower.

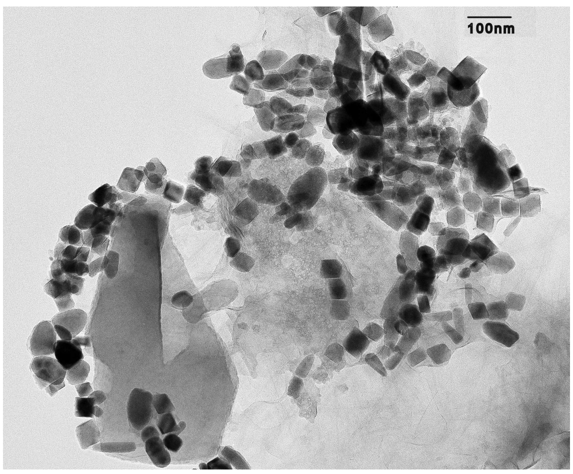


Figure 1: Electron microscopy image of a magnetic extract from a sediment sample (848 - 2.4 Ma). Most smaller grains are biogenically produced magnetite, forming chains and chain fragments, and sticking to larger particles.

## RESULTS AND OUTLOOK

At this point, AMS measurements on the smaller one of the two cores have been completed. Measurements of the larger core are underway and are expected to be completed in mid 2014. The $^{60}$Fe/Fe concentration determined in core 848 (smaller core) can be seen in Fig. 2. A total of 7 counts

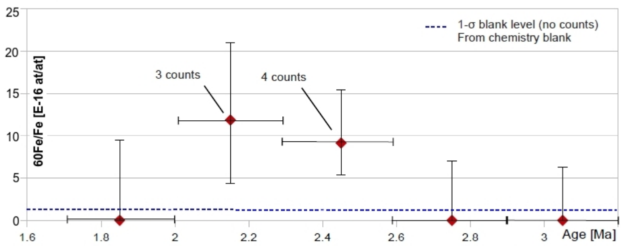


Figure 2: $^{60}$Fe/Fe concentration determined using AMS in sediment core 848. Three samples are grouped together for each data point. X-errors indicate sampling range, Y-errors represent 1-$\sigma$ statistical uncertainties.

of $^{60}$Fe have been observed in a depth range corresponding to an age of 2.0 to 2.6 Ma. The signal is above the expected background. Both, this age and the observed average concentration in this range ($^{60}$Fe/Fe$\approx 1 \times 10^{-15}$) agree well with earlier results from a ferromanganese crust [2]. In order to improve statistics and time resolution, the larger core has to be examined as well. In this larger core 851, a total of 12 counts of $^{60}$Fe have been detected so far, but measurements have not been completed yet.

In addition to measurements of $^{60}$Fe, $^{10}$Be and $^{26}$Al are also currently being measured in the smaller core, to obtain an independent dating, at the DREAMS facility in Dresden.

## REFERENCES

[1] G. Rugel et al., Phys. Rev. Lett., 103(2009) 072502

[2] K. Knie et al., Phys. Rev. Lett., 93(2004) 171103

[3] P. Ludwig et al., Global Planet. Change 110(2013) 321-339