Extraterrestrial Matter in Deep Sea Manganese Crusts

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The dominant input of extraterrestrial matter on earth is due to cosmic dust particles (about 65% with a radius less than 100μm [1]). On account of spallation reactions of Solar Cosmic Rays (SCR) with the constituents of the dust different stable and unstable nuclides are produced.

Since the earth's surface is shielded by its atmosphere, this production almost stops after sedimentation on the earth's surface. To quantify the extraterrestrial input one can measure the content of enclosed radionuclides, which exist only in much smaller concentration on earth. ^{53}Mn ($\tau_{1/2}$=3.7Ma) is well suited as a tracer because of its negligible terrestrial background.

Knowing the concentration of ^{53}Mn in extraterrestrial dust [3] one is able to deduce the extraterrestrial input by measuring the ^{53}Mn concentration in archives on the earth.

As archive we have chosen a deep sea hydrogenetic$^{\diamond}$ manganese crust with an accretion rate in the order of 1mm in one million years [4].

The gas filled analyzing magnet system GAMS [2] enables extremely sensitive AMS measurements of heavy long lived radio isotopes. The isobaric suppression (here of ^{53}Cr) is important for ^{53}Mn measurements.

A very effective natural suppression of the disturbing ^{53}Cr takes place already during the build up of the mineral phase of the crust which expels the too large Cr-ions.

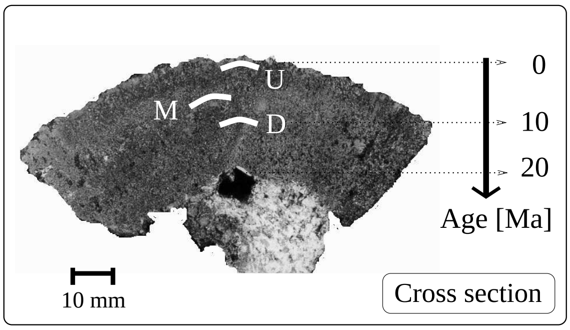

Fig. 1: The cross section shows the Manganese Crust DS111-1, collected from the research vessel "Sonne" in the pacific ocean near Pitcairn (19° S, 148° W) from a depth of 1300m. The white lines indicate the depth position of our three samples **U**,**M** and **D** in the crust. Its total thickness of about 39mm bridges a time gap of 20 million years.

As shown in fig. 1, three samples from different positions have been taken, to study a depth profile corresponding to a sample age of 1 Ma (**U**p), 5 Ma (**M**iddle) and 10 Ma (**D**own) within an accuracy of 1 Ma respectively. After chemical separation and purification of the manganese fraction (18.9% of the crust material) we measured the ratio of ^{53}Mn/^{55}Mn by AMS. A typical ^{53}Mn measurement (here the meteorite **S**ikhote **A**llin) can be seen in fig. 2, where the fourth of five energy loss signals is plotted versus the horizontal position in the ionization chamber behind the GAMS.

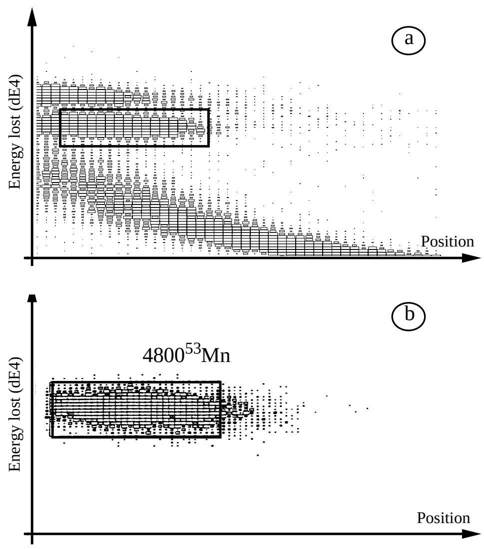

Fig. 2: The fourth of five energy loss signals is plotted versus the horizontal position in the ionization chamber behind the GAMS. In spectrum a one can see the events of the meteorite sample **S**ikhote **A**llin (**SA**) without any software window (TV=13.5MV, 13^{+}, t=12min, I_{55}=30nA). Spectrum b shows the same measurement (with different scaling) after setting software windows (e.g energy loss and x resp. y-angle signals).

In spectrum a, one can see the events without any software window. The spectrum b shows the same measurement after setting software windows. To quantify the background, we performed blank measurements. Down to a ratio of ^{53}Mn/^{55}Mn$\leq 10^{-13}$ no events have been detected in the window of interest.

The ^{53}Mn events can be clearly separated from the ^{53}Cr isobars. The ratio of ^{53}Mn/^{55}Mn in this sample (**SA**), used as a standard for the following measurements, corresponds to 4.4x10^{-9}.

The concentrations of ^{53}Mn/^{55}Mn in the samples **U** (6.6x10^{-13}), **M** (4.0x10^{-13}) and **D** (2.2x10^{-13}) resp., when corrected for the loss due to the decay of the radio nuclide indicate a constant input of extraterrestrial matter, assuming a constant SCR flux within the last 10Ma [5].

The result corresponds to an extraterrestrial input of about 4400$\pm$500 tons/a.

A possible uncertainty are transport mechanisms in the pacific sea. Therefore we will compare the deduced extraterrestrial input in the surface sample of the crust with ^{53}Mn measurements in the Greenland ice core.

References

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$^{\diamond}$accretion out of the elements solved in sea water