Extraterrestrial ^{53}Mn in Hydrogenetic Ferromanganese Crusts from the Pacific Ocean

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The cosmogenic radionuclide ^{53}Mn is of special interest for different reasons:

- ^{53}Mn has a very long half-life ($T_{1/2} = 3.7$ Myr) compared to other radionuclides (e.g. ^{10}Be, ^{14}C, ^{26}Al). Thus dating of very long time spans of terrestrial formations should be possible.

- ^{53}Mn is not significantly produced in the atmosphere but mostly by nuclear reactions on iron in extraterrestrial dust particles. Therefore, its fluence on earth is not influenced by geomagnetic field fluctuations, as it is in case of ^{10}Be, ^{14}C and ^{26}Al.

- The possibility that the observation of a constant ^{53}Mn fluence would suggest a constant input of extraterrestrial matter onto the Earth.

The main sources of extraterrestrial matter in our solar system are the Kuiper and Asteroids belts. Dust particles, e.g. produced by evaporation of comets and collisions of asteroids in the Asteroid belts by the strong gravitation of Jupiter, can reach the Earth and be accumulated into terrestrial formations. A possible archive of these extraterrestrial particles, particularly for cosmogenic radionuclides, are ferromanganese crusts and sediments.

Hydrogenetic deep-sea ferromanganese crusts reflect the changes of the chemical composition of sea water in geological time scales. They grow extremely slowly with only a few mm/Myr and cover time spans up to 60 Myrs. Therefore, they are an important archive for the reconstruction of paleooceanographic, paleogeographic, paleoclimatic, and even "paleoastronomic" [1,2] events.

In this study we have determined the ratio of the radionuclide ^{53}Mn to stable manganese in five manganese crusts originating from different locations in the Pacific with accelerator mass spectrometry at the GAMS setup [3]. The initial concentration of ^{53}Mn at the time of uptake for four samples is approx. $1.3 \cdot 10^{-13}$. As an example figure 1 shows a profile for the crust labeled VA13. One can clearly see the decrease of the ^{53}Mn concentration with the depth, due to radioactive decay. With a growth rate of (2.54±0.17) mm/Myr we derive an age of approx. 18 Myr. These results are in very good agreement with the growth rate determined by the ^{10}Be-method [4]. The error is to a large extent of statistical nature and can be still reduced by increasing the measurement time.

Another crust (see fig. 2) shows a quite different pattern. The initial concentration is only $4.0 \cdot 10^{-14}$. But the growth rate measured with ^{10}Be is high: approx. 9 mm/Myr. Because of its origin close to a continent (South America) this could be explained by a high flux of terrestrial manganese into the ocean and therefore a decrease of the ^{53}Mn concentration.

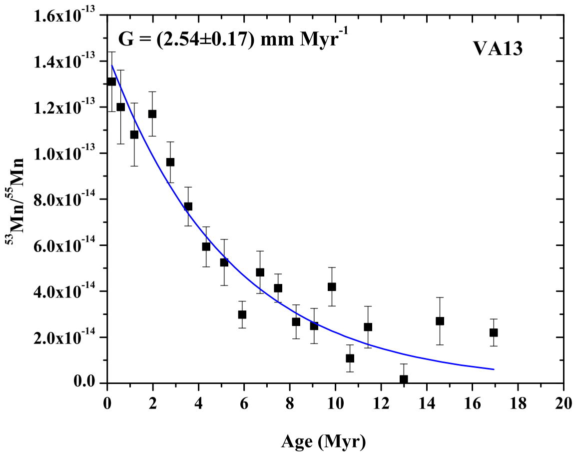

Fig. 1: ^{53}Mn/^{55}Mn ratio versus age in the manganese crust 237KD from cruise VA13/2 with the determined growth rate G.

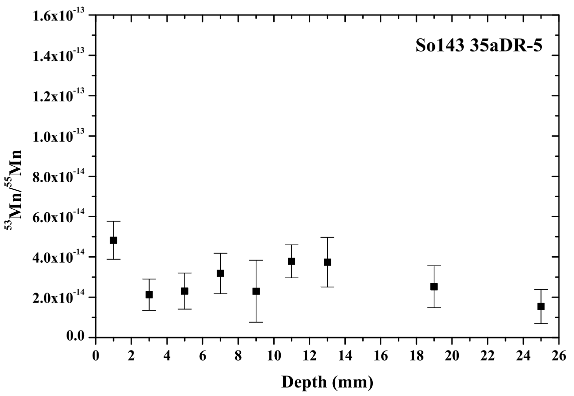

Fig. 2: ^{53}Mn/^{55}Mn ratio versus layer depth in the manganese crust, near the continent.

References

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