EVIDENCE FOR DEPOSITION OF INTERSTELLAR MATERIAL ON THE LUNAR SURFACE

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INTRODUCTION

Astronomical observations indicate that one or more supernovae (SN) occurred in the vicinity of our solar system in the recent past (~10 Myr) [1,2]. One possible indication of the arrival of SN (or perhaps AGB) ejecta locally was the detection of ^{60}Fe/Fe excesses in a ferromanganese crust from the Pacific Ocean [3,4]. We looked for evidence of this event in samples from the lunar surface. The concentration of ^{60}Fe and ^{53}Mn were measured in samples of three Apollo missions. Additionally, samples from iron meteorites were analyzed; the activities measured in these samples were used to establish reference levels for the local production of these radioisotopes by cosmic rays.

MATERIALS AND METHODS

Through the courtesy of CAPTEM and the Astromaterials Laboratory of the Johnson Space Center we obtained 2 samples from the Apollo 12 12025 core, 4 samples from the Apollo 15 15008 core and samples collected near a small boulder during the Apollo 16 mission. Fe_2O_3 and MnO_2 were extracted from these samples and the concentration of ^{60}Fe/Fe and ^{53}Mn/Mn were measured via accelerator mass spectrometry (AMS) at the GAMS setup at the MLL. The elemental composition of the samples was determined via inductively coupled plasma mass spectrometry (ICP-MS).

RESULTS

^{60}Fe is synthesized not only in stars but also in spallation processes in extraterrestrial matter by cosmic rays. For this reason, the contribution of local, galactic cosmic ray (GCR) production of ^{60}Fe was estimated from measurements in a set of iron meteorites. These meteorites are composed mainly of iron and nickel and serve as reference for the cosmogenic production of ^{53}Mn and ^{60}Fe. The expected contribution of solar cosmic rays (SCR) to production in the lunar samples can be neglected [5]. A ^{60}Fe depth profile can be seen in Fig. 1. From the integrated deposition of about 10^7 at/cm^2 a local interstellar fluence of ^{60}Fe of 4×10^7 at/cm^2 is inferred.

In Fig. 2 the activities of ^{53}Mn and ^{60}Fe are compared with those of iron meteorites. Samples 1, 2, 4, 5, 6, and 7 have a significant ^{60}Fe activity (1σ or 2σ above the estimated GCR contribution).

The elevated ^{60}Fe activities of the lunar samples are inconsistent with the production by SCR, GCR or meteoritic contamination. Thus, it is inferred that interstellar material from a SN and/or AGB source is present in the lunar surface.

For further detail, the reader is referred to [5].

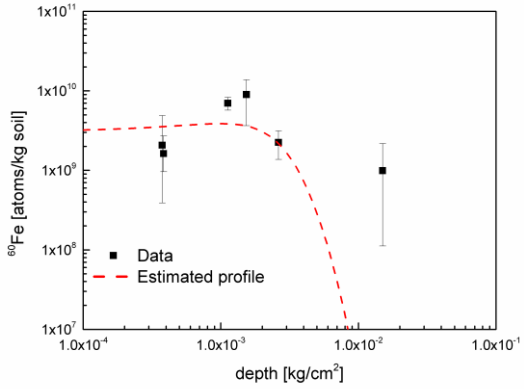

Figure 1: ^{60}Fe depth profile in the lunar surface. The expected cosmogenic contribution of ^{60}Fe has already been subtracted.

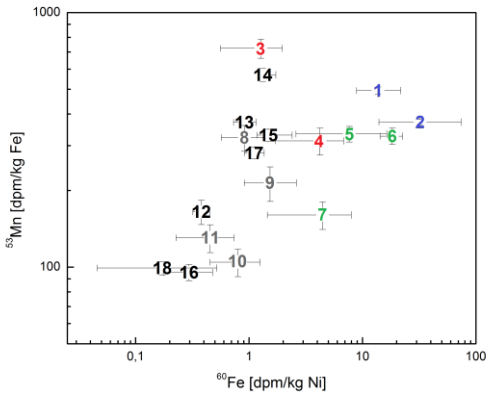

Figure 2: ^{53}Mn vs ^{60}Fe. 1: 12025,14, 2: 12025,23 (blue); 3: 69921, 4: 69941 (red); 5: 15008,1050, 6:15008,1051, 7: 15008,1053 (green); 8-11: samples from Apollo 16 60007/6 core (grey); 12-18: iron meteorites (12-13: [6], 14-18: [7]) (black).

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