D18

N86-32366

STUDIES ON COSMOGENIC NUCLIDES IN METEORITES WITH REGARD TO AN APPLICATION AS POTENTIAL DEPTH INDICATORS

R.Sarafin, U.Herpers and P.Englert
Institut für Kernchemie der Universität zu Köln,
D-5000 Köln 1

R.Wieler and P.Signer
Institut für Kristallographie und Petrographie der ETH Zürich,
CH-8092 Zürich

G.Bonani, H.J.Hofmann, E.Morenzoni, M.Nessi, M.Suter and W.Wölfli
Laboratorium für Mittelenergiephysik der ETH Zürich,
CH-8093 Zürich

Measurements of stable and radioactive spallation products in meteorites allow to investigate their histories, especially with respect to the exposure to galactic cosmic ray particles and the pre-atmospheric size of the object. While the concentrations of spallation products lead to the determination of exposure and terrestrial ages, production rate ratios are characteristic for the location of the sample in the meteorite. So, one of the aims of our investigations on meteorites is to obtain depth indicators from suitable pairs of cosmogenic nuclides.

Because of the different depth profiles for nuclide productions it is necessary to determine the concentrations of a larger number of spallation products in aliquots of a single small sample. Such "same sample" measurements of ^{10}Be and light noble gases were performed on 15 ordinary chondrites (7 H- and 8 L-chondrites) which had previously been studied for ^{26}Al and ^{53}Mn at Cologne [1,2]. ^{10}Be was determined by accelerator mass spectrometry using the AMS-facility at the ETH Zürich, the noble gases were measured by static mass spectrometry. The experimental details are given elsewhere [3], some of the results are summarized in table 1. The errors of the ^{10}Be- and ^{26}Al-values are 3-5%, based on counting statistics. In the case of the ^{22}Ne/^{21}Ne-ratios and the ^{53}Mn-data the errors are estimated to be 2% and 5-10% respectively, including statistical and systematical uncertainties.

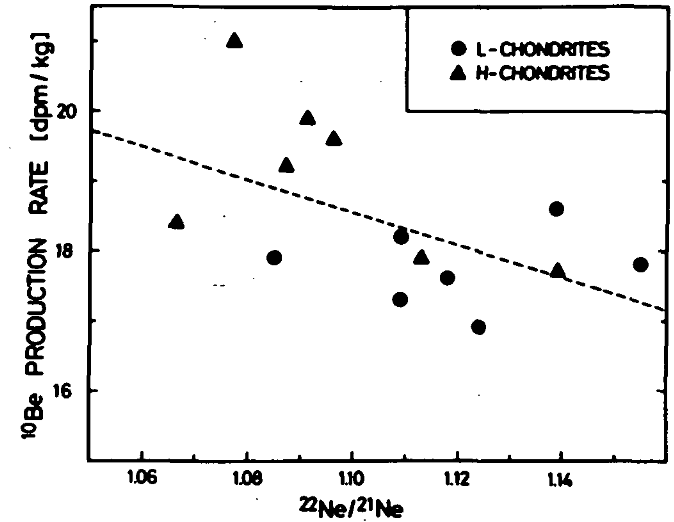
Tab. 1: Compilation of data on cosmogenic nuclides from aliquot samples of 15 ordinary chondrites. The production rates were calculated from the ^{21}Ne-ages [3] and normalized to chemical composition. (^{10}Be- and Ne-data from [3] and recent measurements, ^{26}Al and ^{53}Mn unless otherwise cited cf. [1]).

Meteorite	Class	spall. $^{22}Ne/^{21}Ne$	Production - Rates ^{10}Be [dpm/kg]	^{26}Al [dpm/kg Si_{equ}]	^{53}Mn [dpm/kg Fe]
Armel Yuma	L5	1.155	17.8	354	500
Atwood	L6	1.124	16.9	195	413
Bledsoe	H4	1.087	19.2	251	555
Calliham	L6	1.109	18.2	294	497
Claytonville	L5	1.139	18.6	314	407
Eva	H5	1.113	17.9	241	271
Floyd	H4	1.091	19.9	386	470
Hardtner	L	1.085	17.9	288	181
Kiel	L6	1.251	18.3		317 [2]
Loop	L6	1.118	17.6	309	294
Portales No.3	H4-5	1.077	21.0	311	599
Potter	L6	1.109	17.3	274	440
Seminole	H4	1.096	19.6	329	424
Toulon	H5	1.139	17.7	408	319
Willowdale	H	1.066	18.4	328	492

Since long the ratio $^{22}Ne/^{21}Ne$ has been applied as an indicator for irradiation hardness. The results of our measurements allow to investigate the shielding dependence of the radionuclides mentioned above.

As an example the correlation between ^{10}Be production rates (normalized to H-group chemistry according to Moniot et al. [4]) and the shielding parameter $^{22}Ne/^{21}Ne$ is given in figure 1, showing that the ^{10}Be production rates slightly depend on sample depth and/or meteorite size. It should be mentioned, that recent results on documented samples of the Knyahinya chondrite exhibit a clear correlation between ^{10}Be production and irradiation hardness [5]. In the corresponding plot for ^{26}Al no trend can be detected. $^{53}Mn/^{26}Al$ systematics [1] indicate the possibility of considerable terrestrial ages for some of the meteorites. Even taking corrections for terrestrial residence times into account the data show no distinct relationship. The correlation line ^{53}Mn vs. $^{22}Ne/^{21}Ne$ falls close to the ones derived from core samples of the St.Severin and Keyes chondrites [6,7]. Plots of ^{26}Al vs. ^{10}Be and ^{53}Mn vs. ^{10}Be do not

Fig. 1: Shielding dependence of the normalized ^{10}Be production rates [3, updated].



reveal strong dependences between the respective production rates. More analyses, especially on meteorite falls, will be necessary to ensure these results. In addition, it is essential to investigate samples from documented locations to confirm the theoretical production profiles. The absence of correlations discussed might be a hint, that there is an opportunity to distinguish between size and depth effects by measuring various spallation nuclides.

Acknowledgements

The Cologne part of this work was supported by the Bundesministerium für Forschung und Technologie, the Zürich part by the Swiss National Science Foundation, grants No. 2.263-0.81 and 2.443-0.82.

References

[1] U.Herpers and P.Englert (1983) Proc. Lunar Planet. Sci. Conf. 14th, in J. Geophys. Res. 88, B312 - B 318 and references cited therein.

[2] P.Englert et al. (1981) Proc. Lunar Planet. Sci. 12 B, 1209 - 1215.

[3] R.Sarafin et al. (1984) Nucl. Instr. and Meth. (in press).

[4] R.K.Moniot et al. (1983) Geochim. Cosmochim. Acta 47, 1887 - 1895.

[5] R.Wieler et al. (1984) this volume.

[6] P.Englert and W.Herr (1980) Earth Planet. Sci. Lett. 47, 361 - 369.

[7] P.Englert (1984) Lunar Planet. Sci. XV, 248 - 249.