DEPTH PROFILES OF LONG-LIVED COSMOGENIC RADIONUCLIDES IN MBALE. S. Merchel[1], U. Herpers[1], S. Neumann[2], R. Michel[2], P. W. Kubik[3], M. Suter[4], D. Faestermann[5], K. Knie[5], G. Korschinek[5], T. Schätz[5], and N. Bhandari[6], [1]Abteilung Nuklearchemie, Universität zu Köln, 50674 Köln, Germany, [2]Zentrum für Strahlenschutz und Radioökologie, Universität Hannover, 30167 Hannover, Germany, [3]Paul Scherrer Institut c/o Institut für Teilchenphysik, ETH Hönggerberg, 8093 Zürich, Switzerland, [4]Institut für Teilchenphysik, ETH Hönggerberg, 8093 Zürich, Switzerland, [5]Fakultät für Physik, Technische Universität München, 85748 Garching, Germany, [6]Physical Research Laboratory, Navrangpura, Ahmedabad 380009, India.

Measurements of cosmogenic nuclides in meteorites are necessary to test and improve the physical models with which we try to understand the course of events in space. Furthermore, radionuclides serve as an archive for information about the meteorites themselves, e.g., their exposure history. Studies of how cosmogenic nuclides vary with depth below the surface of a meteoroid play an important part, but unfortunately are still very scarce. Additionally, as far as we know, the investigations on Mbale are the first of radionuclide data in connection with sample locations in the strewn field of a meteorite shower of such a great number of fragments.

The meteorite shower Mbale (L5/6) consists of 863 fragments with a total mass of 150 kg [1]. We received nine aliquot samples from G. Heusser in which concentrations of some radionuclides are known from γ spectrometry [2]. We present the results for the long-lived cosmogenic nuclides ^{10}Be, ^{26}Al, and ^{53}Mn, which were determined in nine bulk samples using accelerator mass spectrometry (AMS) after radiochemical separation. Furthermore, cosmic-ray tracks could be measured in six fragments. Figure 1 gives a selection of our data. Investigations of other radionuclides (^{36}Cl, ^{41}Ca, ^{59}Ni) are in preparation.

Based on a ^{21}Ne-exposure age of 26.9 m.y. [3] we are sure that all investigated radionuclides are in saturation. Therefore it is possible to compare our results with theoretical production rates, which are calculated on the elemental abundances of Al, Ca, Fe, Mg, Mn, and Ni (measured via ICP-AES) in Mbale, and a mean L-chondrite composition of other main target elements like C, O, and Si.

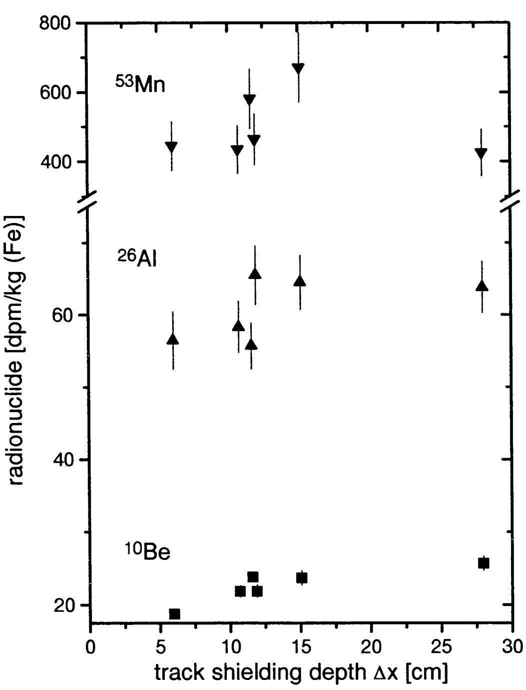

Fig. 1. Measured radionuclide activities vs. cosmic-ray track shielding depths.

We conclude that our samples originate from locations close to the surface up to the center of a meteoroid with a preatmospheric radius greater than 30 cm. Furthermore, there is no indication of a complex exposure history of Mbale. Complete data obtained will be discussed in detail in the context of theoretical model calculations [4].

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THE GEOCHEMICAL LIMIT FOR BARIUM-130 DOUBLE BETA DECAY: FIRST RESULTS. A. Meshik, C. M. Hohenberg, K. Kehm, and O. Pravdivtseva, McDonnell Center for the Space Sciences, Washington University, One Brookings Drive, Campus Box 1105, St. Louis MO 63130, USA (am@howdy.wustl.edu).

In recent years, the phenomena of nuclear double $\beta\beta$ decay ($\beta\beta$) has generated great scientific interest because of the ability of this process to probe fundamental issues in neutrino physics [1]. One of the ways to investigate this extremely slow decay is to measure $\beta\beta$ daughters accumulating in old minerals over geologic timescales. The most promising cases for detection occur when $\beta\beta$ products fall into the Xe isotopes, where the natural low abundance of indigenous Xe may permit the resolution of small radiogenic additions to the isotopic structure.

Xenon isotopes produced by $\beta\beta$ of ^{130}Te and ^{128}Te have been previously measured [2]. Other possible $\beta\beta$ nuclides yielding Xe isotopes are ^{130}Ba ($Q_{\beta\beta}$ = 2.578 MeV) and ^{132}Ba ($Q_{\beta\beta}$ = 0.833 MeV) [3]. Measurement of the latter processes presents two main difficulties: low natural abundances of ^{130}Ba and ^{132}Ba (~0.1%), and the possible contribution of double electron capture to two other $\beta\beta$ modes [3]. The only published attempt to obtain evidence for $\beta\beta$ of ^{130}Ba yielded a null result [4]. Interferences from Xe produced by spallation and n-induced reactions, together with strong isotope mass fractionation, obscured possible contributions to ^{130}Xe from $\beta\beta$ of ^{130}Ba [4]. The purpose of this work was to improve upon the previous experiment by using higher amounts of better-selected, terrestrial barite samples ($BaSO_4$) in order to increase ^{130}Xe signal and decrease contributions from interfering reactions.

Our experiment was performed in three stages. The first one was the selection of "best" barite from a variety of samples based on three criteria: deep lodging (to eliminate Xe derived from μ^--induced n-reactions), low U and Th content (to reduce the n-capture production of Xe isotopes from fission), and an old, well-constrained age. The second stage was bulk measurements of Xe isotopic composition by melting ~100-mg fragments of these preselected barites. Among these, we looked for a sample with unfractionated atmospheric trapped Xe composition with no overlying Xe anomalies. As a result, one barite specimen (referred to as CAU-1) from the northern Caucasus (southern part of the former USSR) was selected for detailed analyses. The age of the host rocks for CAU-1 was determined to be 200–210 Ma. Finally, Xe isotopes were measured by step-heating 0.423-g and 3.783-g fragments of CAU-1.

The data from these measurements suggest the presence of an extremely small monoisotopic excess ^{130}Xe released at ~900°C. The main trapped Xe fraction of essentially atmospheric composition was released in the 1000°–1700°C extractions. The excess ^{130}Xe was determined to be 135,000 ± 130,000 atoms (1σ) in the 0.423-g sample of CAU-1 and 25,350 ± 11,000 atoms (1σ) in the 3.783-g fragment. The fact that both excesses are monoisotopic and fall in the same temperature interval is an argument in favor of its $\beta\beta$ origin. If so, the half-life for ^{130}Ba (all decay channels) can be estimated as

$$4 \times 10^{22} \text{ yr} < T_{1/2} < 1 \times 10^{23} \text{ yr } (1\sigma)$$

This calculation assumes that the ^{130}Xe-retention age is equal to the age of the host rock. Although the uncertainties are large, this preliminary result