Geophysical Research Abstracts,
Vol. 10, EGU2008-A-06691, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-06691
EGU General Assembly 2008

Cross sections for the production of He, Ne, and Ar isotopes by proton induced reactions on iron and nickel

K. Ammon (1,5), I. Leya (1), B. Lavielle (2), E. Gilabert (2), J.-C. David (3), R. Michel (4)

(1) University of Bern, Switzerland, (2) Laboratoire de Chimie Nucléaire Analytique et Bio-environnementale (CNAB), Universités Bordeaux, France, (3) DSM DAPNIA/Sphn, CEA-Saclay, France, (4) Center for Radiation Protection and Radioecology, University of Hannover, Germany, (5) Now at the School of GeoSciences, University of Edinburgh, UK.

(Katja.Ammon@ed.ac.uk / Phone: +44 (0) 131 650 9140)

Introduction: For proper modeling cosmogenic production rates in terrestrial and extraterrestrial matter the differential particle spectra and the excitation functions for all relevant nuclear reactions have to be known. While calculating differential particle spectra using state-of-the-art Monte Carlo codes is now more reliable, the thus calculated cross sections are accurate within a factor of 2 at best, which is far not sufficient for cosmochemical applications. Therefore, experimental cross sections are still essential for the study of cosmogenic nuclides in meteorites and planetary surfaces. While the cross section database for most rock-forming elements is fairly complete by know, which directly translates into reliable model calculations [1,2], the database for Fe and Ni, which are the major elements for the study of iron meteorites, is rather scarce and scattering. Fe can also be a major element in the most commonly used minerals to date exposure ages and erosion rates in geomorphology, e.g., olivine, pyroxene, and Fe-Ti-oxides [e.g., 3, 4]. We therefore measured the excitation functions for the production of He, Ne, and Ar isotopes from Fe and Ni from the respective reaction thresholds up to 1.6 GeV. These data have been used to establish the first set of purely physical model calculations for cosmogenic nuclides in iron meteorites [5] but are also useful for terrestrial exposure dating.

Experimental: The cross section database is obtained from 30 irradiation experiments performed between 1993 and 1997 either using the stacked foil-technique or the mini-stack approach. The noble gas isotopic concentrations were measured either in Bern or Bordeaux using static noble gas mass spectrometry. Tritium diffusive losses during irradiation and / or storage have been corrected and new data for the ^{3}H/^{3}He branching ratios have been considered [6].

Results: We present consistent excitation functions for the proton-induced production of ^{3,4}He, ^{21,22}Ne, and ^{36,38}Ar from Fe and Ni from the respective reaction thresholds up to 1.6 GeV. In general our cross sections, where overlapping, reasonably agree with earlier data, e.g. [7,8]. For the production of ^{4}He our data fit well into the systematic expected for evaporation processes. Some of the ^{21}Ne data, however, are compromised by recoil effects from directly neighbored Al monitor foils. For the production of ^{38}Ar from Fe and Ni precise and consistent excitation functions are obtained. For ^{36}Ar, however, the database still (slightly) scatters, because the cross sections are rather low as most of the production on isobar 36 stops at ^{36}Cl. With our new measurements the cross section database for Fe and Ni is fairly complete by now, which enable for the first time detailed studies of cosmogenic production rates in iron meteorites.

References: [1] I. Leya et al. 2000. MAPS 35, 259-286. [2] I. Leya et al. 2001, MAPS 36, 1547-1561. [3] S.Niedermann 2002. Rev. in Min. and Geochem. Vol. 47. [4] F. Kober et al. 2005. EPSL 263, 404-418 [5] K. Ammon et al. 2008. Submitted to MAPS. [5] C.-M. Herbach et al. 2006. Nucl. Phys. A765, 426-463. [6] R. Michel et al. 1997. NIMB, 153-193. [7] R.H. Bieri & W. Rutsch 1962. Compte Rendu de la Reunion de la Society Suisse de Physique 35, 553-554.