CAN MORASKO AND MUNDRABILLA HELP RECONSTRUCTING PRODUCTION RATES AND NUCLEAR REACTION CROSS-SECTIONS FOR LIGHT COSMOGENIC NUCLIDES?

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Introduction: The reconstruction of pre-atmospheric sizes and exposure and terrestrial ages of meteorites including shielding depths of individual samples has advanced in the last decades. Technical developments in noble gas and accelerator mass spectrometry (AMS) led to cosmogenic nuclide data of higher accuracy. Additionally, progress in Monte-Carlo calculations [1] seems to produce more reliable interpretation of the experimental data than earlier "classical" semiempirical approaches. However, some problems regarding both experimental data and calculations are persistent. One of these is the production of lighter nuclides such as ^{10}Be, ^{21,22}Ne, and ^{26}Al from inhomogeneously distributed sulfur- and phosphorus-rich inclusions or from trace elements in iron meteorites or metal phases of stony-iron meteorites. As we lately experienced again, the uselessness of ^{26}Al and ^{21,22}Ne for deciphering the history of a newly discovered iron meteorite, i.e. Gebel Kamil [2], we follow an approach to measure cosmogenic nuclides in schreibersite and troilite inclusions from iron meteorites compared to bulk metal to get more quantitative insights into these difficulties. First, samples from Morasko and Mundrabilla (metal, troilite, schreibersite) were investigated.

Experimental: Lighter stable nuclides of He, Ne, and Ar have been measured by noble gas mass spectrometry at the University of Bern [3], radionuclides (^{10}Be, ^{26}Al, ^{36}Cl, and ^{41}Ca) at the DREsden Accelerator Mass Spectrometry facility (DREAMS) [4,5] after radiochemical separation [6].

Results and discussion: Data of ^{36}Cl and ^{36}Ar of the metal yield to partially consistent exposure ages, i.e. (247 ± 26) Ma for Mundrabilla (compared to (350 ± 90) Ma [7]) and (210 ± 22) Ma for Morasko (compared to (130 ± 15) Ma [8]). Our Morasko exposure age is validated by the corresponding troilite analyses giving an age of (246 ± 49) Ma proving the ^{36}Cl-^{36}Ar-system not being influenced by contributions from sulfur within uncertainties. All our ages are based on three to four individual ^{36}Cl-^{36}Ar-analysis.

Terrestrial ages based on the ^{41}Ca-^{36}Cl-system should be the most reliable and least influenced by S- and P-abundances. Data of Morasko was indistinguishable from saturation activities, thus, confirming the young terrestrial age of 5 ka determined by earlier luminescence-dating of the corresponding crater [9]. However, high ^{41}Ca/^{36}Cl of 1.5 and 2.9 for troilite and metal fractions of Mundrabilla, respectively, do not allow calculating a reasonable terrestrial age pointing to unexplained discrepancies in either the AMS measurements or Monte-Carlo calculations for shielded samples. Further work is needed.

As expected, ^{26}Al is most severely influenced by S- and P-abundances. In Mundrabilla ^{26}Al (mean of four individual samples each; standard deviation) is as high as (4.618 ± 0.071) dpm/kg$_{troilite}$ compared to neighboring metal fractions (0.1635 ± 0.010) dpm/kg$_{metal}$, resulting in ^{26}Al/^{10}Be-ratios of 20.8 (troilite) compared to 0.9 (metal). Same observations (mean of three samples each; standard deviation) can be made for ^{26}Al in Morasko: (7.36 ± 0.18) dpm/kg$_{troilite}$vs. (0.2399 ± 0.0063) dpm/kg$_{metal}$. with ^{26}Al/^{10}Be of 19.4 (troilite) and 0.8 (metal). A single analysis of Morasko schreibersite produced intermediate ^{26}Al-data of (3.286 ± 0.081) dpm/kg$_{schreibersite}$ resulting in ^{26}Al/^{10}Be of ~1.6.

Conclusions and outlook: It has been clearly shown that even traces of troilite influence the ^{26}Al-concentration. It seems obvious that careful sample inspection under a binocular is essential to overcome the most severe influences by S- and P-inclusions. However, the determination of S and P in aliquots of each metal sample is analytical challenging and mean bulk values might not be representative for the individual sample. Nevertheless, we are aiming at deciphering thick-target production rates and cross-sections for ^{10}Be, ^{21,22}Ne, and ^{26}Al - from S and P - from this first data and future analyses to include them into Monte-Carlo calculations for later use.

References: [1] Ammon K. et al. 2009. *Meteoritics and Planetary Science* 44:485-503. [2] Ott U. et al. 2014. *Meteoritics and Planetary Science* 49:1365-1374. [3] Ammon K. et al. 2008. *Meteoritics and Planetary Science* 43:685-699. [4] Akhmadaliev et al. 2013. *Nuclear Instruments and Methods in Physic B* 294:5-10. [5] Rugel G. et al. 2016. *Nuclear Instruments and Methods in Physics B* 370:94-100. [6] Merchel S. and Herpers U. 1999. *Radiochimica Acta* 84:215-219. [7] Maruoka T. and Matsuda J. 2011. *Chemical Geology* 175:751-756. [8] Hutzler A. 2015. PhD thesis, Aix-Marseille Université. [9] Stankowski W.T.J. et al. 2007. *Geochronometria* 28:25-29.

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