THE INFLUENCE OF MINERAL INCLUSIONS ON THE PRODUCTION RATES OF COSMOGENIC NUCLIDES IN GRANT (IIIAB) AND CARBO (IID)

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Introduction: Beside the major elements iron (Fe) and nickel (Ni) iron meteorites also contain other elements like sulphur (S), phosphorous (P), and carbon (C), which affect production rates of cosmogenic nuclides. The most common mineral inclusions are troilite (FeS), schreibersite (Fe,Ni_3P), and graphite (C) [1]. Related to this, the production of cosmogenic Ne, which is of major importance for exposure age studies, is very sensitive to contributions from S- and/or P-rich inclusions. For example, since the production rates of cosmogenic Ne from S and/or P are about ten times higher compared to production from Fe and Ni [2,3,4], only about 1% of S and/or P increase the cosmogenic Ne concentration by about 10%. Iron meteorites contain between 0.1 - 2% P and 0.03 – 17% S [1 and ref. therein], therefore such effects have to be considered for detailed exposure ages studies

Experimental: SEM images of Grant and Carbo clearly demonstrate that there are many troilite and schreibersite inclusions with sizes of a few hundred microns only, which makes the separation of a pure metal sample, i.e. without any inclusions, impossible. Such small inclusions, however, are nevertheless sufficient to substantially increase the production rates and a reliable quantification is therefore necessary. The finding that ^{21}Ne in Grant and Carbo is affected by such inclusions is confirmed by the extensive dataset measured by us for both meteorites. The data clearly demonstrate that the scatter for ^{21}Ne is larger than for, e.g., ^{4}He and ^{38}Ar and is also larger than expected considering the external reproducibility.

Quantifying contributions from S and P: The procedure performed by us to quantify contributions from S and P to cosmogenic ^{21}Ne is based on the observation that, for outliers in our Grant and Carbo database, the ^{22}Ne/^{21}Ne ratios correlate with ^{21}Ne concentrations. Furthermore, most of the ^{22}Ne/^{21}Ne ratios measured by us are higher than expected from nuclear reaction mechanism. We basically assume simple mixing of two components. Component one is a typical meteoritic mixture for Fe and Ni having a ^{22}Ne/^{21}Ne ratio of about 1.02 and the second component is pure S and P having a ^{22}Ne/^{21}Ne ratio of about 1.28. Note that our procedure does not allow distinguishing between S and P contributions. Assuming that the production rates for ^{21}Ne from S and P are about ten times higher than for Fe and Ni, we calculate that about 20% of total ^{21}Ne measured in Grant and Carbo is due to reactions on S and P.

Exposure ages and model calculations: The finding that a significant part of the measured ^{21}Ne is not from Fe and Ni but from S and P has also a major impact for the ^{41}K-^{40}K dating technique [e.g., 5]. We therefore present a re-evaluated version of the ^{41}K-^{40}K dating technique, which, beside the aforementioned results, also based on new sophisticated model calculations.

References: [1] D. W. Mittelfehldt et al., 1998 *Rev. in Mineralogy* 36, 4.1-4. [2] F. Begemann, 1965 *Z. Naturforsch.* 20a, 950-960. [3] L. Levsky & A. N. Komarov, 1974 *Geochem. et Cosmochem. Acta* 39, 275-284. [4] I. Leya et al., 2004 *MAPS* 39, 367-386. [5] H. Voshage & H. Feldmann, 1979 *Earth and Planet. Sci. Let.* 242, 1-15.