RE-ESTABLISH THE POTASSIUM DATING SYSTEM FOR IRON METEORITES.
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Introduction: Cosmic ray exposure (CRE) ages are valuable tools studying exposure histories of small bodies in the solar system, i.e., the length of exposure to cosmic rays, shielding depths, and terrestrial residence times. There exist a variety of methods determining such ages. For the metal phase of stony meteorites and for iron meteorites the $^{36}$Cl-$^{36}$Ar method has been proven reliable and successful. If not enough metal is available, the $^{10}$Be-$^{26}$Ne, $^{26}$Al-$^{21}$Ne, and/or the $^{81}$Kr-Kr methods have been proven useful. All these methods are based on a cosmogenic radionuclide and a stable noble gas isotope and the measured radionuclide activity concentration is used as a proxy for the production rate of the stable nuclide. In doing so, the radionuclide covers the irradiation history over the last few half-lives, which is for most of the established radionuclides a few million years. If we are interested in longer timescales, we need a radionuclide with a longer half-life. Such a nuclide is $^{41}$K with a half-life of 1.25 Ga and the method is the $^{41}$K-K dating method applicable to iron meteorites.

Some studies [3,4,5] have shown that CRE ages calculated via $^{10}$Be-$^{21}$Ne, $^{26}$Al-$^{21}$Ne, and/or $^{36}$Cl-$^{36}$Ar are lower than those measured earlier by H. Voshage [1,2] using the $^{41}$K-K method. Though, later studies questioned this finding [4,5], it became clear that there is a need for more and more precise $^{41}$K-K CRE ages for iron meteorites. This is because all ages date before 1984, i.e., there is new data for more than 30 years, and some of the ages have relatively large uncertainties in the range of 100 Ma, limiting their use in CRE age studies. We therefore decided to initiate a project to re-establish the $^{41}$K-K dating system.

Experimental: For the extraction of the extremely low potassium amounts from the studied iron meteorites, which are in the range $10^{-13}$ ng/g, we have designed and build a system for in-vacuum melting and electric melt-extraction of potassium from iron meteorites. The basics of the system are very similar to the original approach by H. Voshage [1] but we have made some changes and adjustments, possible thanks to modern techniques. Briefly, the iron meteorite samples are molten at about 1800°C in a Mo crucible heated via RF techniques. A BN-liner inside the Mo crucible prevents the latter from corrosion. Holding the temperature for about one hour and by applying an electrical field of 320 V/m, potassium ions are electrically extracted from the metal melt and are separated onto preconditioned filaments ready for later TIMS measurements. First tests were successful and we are able to extract the potassium out of the metal sample and concentrating it onto a filament. The filaments are later analyzed using TIMS. In total, we are able to extract the tiny amounts of potassium and to reliably measure the $^{40}$K/$^{39}$K isotope ratio with a precision of less than 10% in less than 0.5 ng of potassium.

In a next step we extracted and measured the potassium isotopes from the Nantan (IAB) iron meteorite. However, the $^{40}$K/$^{39}$K ratio is only about 5 times higher than terrestrial potassium, i.e., the cosmogenic signal is still low. Though, the first measurements clearly indicate that we are able to extract and measure cosmogenic potassium, we need to reduce the blank in order to increase the cosmogenic signal relative to the still remaining contamination.