CONSTRAINING THE FORMATION AND EVOLUTION OF IAB IRONS - HIGH PRECISION $^{40}Ar/^{39}Ar$ AGES ON PLAGIOCLASE SEPARATES FROM SILICATE INCLUSIONS OF THE CAMPO DEL CIELO METEORITE.

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Abstract: In order to better constrain the history of IAB iron meteorites, we will present the first high precision $^{40}Ar/^{39}Ar$ ages on different grain size separates of pure plagioclase from silicate inclusions of the Campo del Cielo IAB iron meteorite. These measurements are performed in the framework of a larger study of IAB irons including also Ocotillo, Caddo County and Landes inclusions. Comparing the age information contained by the inclusions of the different meteorites will help elucidating the formation and thermal history of the IAB parent body, which is not yet agreed on.

Introduction: IAB iron meteorites, unlike other groups of irons, cannot be classified as igneous rocks, and the processes that led to the assembly of primitive silicate inclusions embedded in a once molten metal groundmass have not yet been fully understood (e.g., [1, 2, 3]). Radioisotopic dating of the silicate inclusions, e.g., by the $^{40}Ar/^{39}Ar$ technique, can provide information on their formation and cooling history and thus help deciphering the evolution of the IAB parent body. Previous Ar-Ar dating of mostly "whole rock" samples revealed ages for the inclusions of up to 4.54 Ga (e.g., [2]), close to the formation age of the solar system (4.57 Ga, [4]). However, the analyses are often impaired by uncertainties due to possibly present excess ^{40}Ar and redistribution or loss of K and/or Ar isotopes during the history of the meteoroid and during neutron irradiation, resulting in complex age spectra that often are not easy to interpret. Furthermore, mounting evidence for overestimation of the ^{40}K decay constants and (partially related) underestimation of standards' ages (e.g., [5]) admits the possibility that argon retention ages are actually very similar to those from high-temperature geochronometers. This would imply a rapid cooling history early in the nascent solar system.

Samples and methods: In order to reduce the above uncertainties, which arise from measuring mixtures of different minerals and grain sizes we decided to determine $^{40}Ar/^{39}Ar$ ages on distinct size fraction separates of pure plagioclase, the main carrier of K and thus radiogenic ^{40}Ar in IAB silicate inclusions. So far, we separated silicate inclusions from Campo del Cielo, Ocotillo, Landes, and Caddo County. These were carefully crushed to their natural grain size spectra and several size fractions (e.g., 100-200 μm, 200-300 μm) of plagioclase from individual inclusions were obtained by sieving, magnetic and density separation, and hand picking. The separates of Campo del Cielo inclusions have already been irradiated at the Oregon State University TRIGA reactor and will be ready for the Ar analyses within the next few weeks. To yield maximum precision and resolution of the age spectra, the Ar-analyses will be performed by stepwise laser heating of the plagioclase separates or – if possible – of single grains to produce isochrons as described, e.g., in [5]. Additionally, we plan to measure trapped noble gases and determine He, Ne, and Ar cosmic ray exposure ages of the inclusions from unirradiated olivine and pyroxene separates.

Discussion: Compared to previous 'whole rock' inclusion analyses, our pure plagioclase separates will in general simplify the age spectra and thus provide more precise ages. The question about whether recoil and/or diffusion losses have to be taken into account can be addressed by comparing the age spectra of the different grain size separates with calculated diffusive Ar losses for a given grain size. If recoil losses are minor, conclusions on the cooling history of the inclusions can be drawn from the grain size separates.

The same is possible, e.g., by comparing existing Rb-Sr, Sm-Nd, and U-Pb ages with our $^{40}Ar/^{39}Ar$ data, so that the cooling history of the parent body can be deciphered over a fairly large temperature interval.

Outlook: With high-precision $^{40}Ar/^{39}Ar$ age determinations on pure plagioclase separates from silicate inclusions of IAB iron meteorites we hope to be able to contribute to the long standing question about the formation and thermal evolution of the IAB meteorites and their parent body. Using different size fractions, with different closure temperatures, we hope to obviate (and actually clarify) systematic miscalibration issues plaguing the $^{40}Ar/^{39}Ar$ system.

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