SEARCH FOR MASS-INDEPENDENT MOLYBDENUM ISOTOPE ANOMALIES IN IRON METEORITES. C. Burkhardt[1], T. Kleine[1], F. Oberli[1], and B. Bourdon[1]. [1]Institute of Isotope Geochemistry and Mineral Resources, Clausiusstrasse 25, ETH Zurich NW C80, CH-8092 Zurich (burkhardt@erdw.ethz.ch).

Introduction: Primitive meteorites contain components such as presolar grains and some refractory inclusions that are isotopically different from the average solar system. These isotope anomalies are witness of an initial isotopic heterogeneity of the solar nebula. In spite of this initial isotopic heterogeneity, the isotope composition of larger planetary bodies in the solar system seems to be more or less uniform for most elements, suggesting efficient and large-scale mixing of the solar nebula prior to accretion of planetary bodies.

However, Mo isotope studies of meteoritic and planetary materials reveal differences in the Mo isotope composition among different solar system objects. The various Mo isotopes are produced by different nucleosynthetic processes (^{92}Mo and ^{94}Mo are almost exclusively produced by the p-process, ^{96}Mo is a pure s-process and ^{100}Mo a pure r-process nuclide, ^{95}Mo, ^{97}Mo and ^{98}Mo are produced in the s- and r-process) and it was thus suggested that the Mo isotope variations reflect incomplete mixing of gas and dust in the solar nebula. However, other Mo isotope studies could not find resolvable Mo isotope variations among different meteorite parent bodies and the reasons for these discrepancies are yet unclear. We developed new analytical techniques for precise Mo isotope measurements using MC-ICP-MS and present here our first results obtained for magmatic iron meteorites.

Samples and analytical techniques: Samples investigated for this study are from the iron meteorite groups IIAB (North Chile, Negrillos), IIIAB (Cape York, Henbury) and IVA (Duell Hill). Samples were cleaned with abrasives, ultrasonicated in ethanol, and leached in dilute HNO_3. Then the iron meteorites were completely digested in 6M HCl. A small aliquot for the determination of Mo concentrations by isotope dilution was taken at this stage. The remaining solution was dried and Mo was separated from the matrix elements and interfering Ru and Zr by a combination of anion and cation exchange chromatographic methods. The separation procedure reduced the Ru/Mo ratio from initially ~1 to $<10^{-5}$. Mo yields are >85% for all samples, as determined by isotope dilution measurements on a small aliquot of the purified Mo.

The Mo isotopic compositions of all samples were measured using the Nu 1700 MC-ICP-MS at ETH Zurich. With this machine all Mo isotopes as well as ^{90}Zr, ^{99}Ru, ^{102}Ru and ^{104}Ru can be measured simultaneously. Mo isotope measurements were performed with ~3 V on ^{96}Mo, which was obtained for a ~100 ppb Mo standard solution. For all samples 60 ratios (3 blocks of 20 ratios) were measured, resulting in within-run precisions ranging from ~0.2 to ~0.5 ε units (2σ) (1 ε = 0.01%) for the various Mo isotope ratios. Instrumental mass bias was corrected relative to ^{96}Mo/^{98}Mo= 0.688149. To assess possible matrix effects or artifacts due to improper mass bias correction, measured Mo isotope ratios were also normalized to ^{92}Mo/^{98}Mo = 0.607898. The Mo isotope ratios of all samples were determined relative to two standard runs bracketing the sample run and are reported in ε units as deviations relative to the terrestrial standard value. The reproducibility of the standard during one measurement session is ~0.5 ε units for the ε^{94}Mo, ε^{95}Mo, ε^{96}Mo, and ε^{97}Mo values and is ~1 ε unit for the ε^{92}Mo and ε^{100}Mo values.

Results and discussion: To investigate the effects of Zr and Ru interferences on measured Mo isotope ratios, we analyzed Mo standard solutions doped with various amounts of Zr and Ru. Results of these measurements are summarized in Figs. 1b and 1d. These experiments reveal that the presence of even small Zr and/or Ru quantities of 0.1‰ can result in spurious Mo isotope ratios. Our experiments reveal that a mass bias correction relative to ^{92}Mo/^{98}Mo provides results that appear more robust than those that are mass bias corrected relative to ^{96}Mo/^{98}Mo. This probably reflects the fact that ^{96}Ru is more abundant than ^{98}Ru. The Duel Hill sample analyzed for this study had slightly elevated ^{90}Zr/^{96}Mo ratios of $8*10^{-5}$ and the Mo isotope ratios reveal small isotope anomalies when mass bias corrected relative to ^{96}Mo/^{98}Mo. However, these anomalies are not present when the Mo isotope ratios are mass bias corrected using ^{92}Mo/^{98}Mo, highlighting the need for eliminating interferences and the importance of chosing the 'right' ratio for mass bias correction. The ^{90}Zr/^{96}Mo and ^{99}Ru/^{96}Mo ratios of all other iron meteorites analyzed for this study are always lower than $4*10^{-5}$, such that interference corrections are smaller than ~20 ppm for all samples.

Our first preliminary Mo isotope data set for 5 iron meteorites shows no resolvable Mo isotope anomalies outside the external reproducibility of the Mo isotope measurements (i.e, at the ~1 ε unit level for ^{92}Mo and ^{100}Mo, and at the ~0.5 ε unit level for all other Mo isotopes). For Negrillos the data obtained here is in good agreement with the one of [1] and [2] but for Henbury and Cape York the data obtained here suggest

that Mo isotope anomalies in these samples may be smaller than those previously reported [3,4]. Repeated analyses and investigation of a more comprehensive set of samples combined with further improvements of analytical techniques are needed to firmly establish the degree of Mo isotope homogeneity (or heterogeneity) in the proto-planetary disk.

References: [1] Becker H. and Walker R.J. (2003) *Nature, 425,* 152–155. [2] Yin Q.Z. et al. (2002) *Nature, 415*, 881-883. [3] Dauphas N. et al. (2002) *ApJ, 565,* 640-644. [4] Chen et al. (2004) *LPS XXXV,* Abstract #1431.

Fig.1: Mo isotopic composition of iron meteorites. Error bars in b and d represent reproducibility of standard measurements.