U-Th-Pb SYSTEMATICS IN CHONDRITES

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Introduction: Over the past 30 years continuous improvements have been made in the analytical capabilities to measure Pb isotopic composition. Since the return of the first lunar samples by the Apollo 11mission, chemistry Pb blanks have been lowered from ~1ng to ~1 pg . Also, the increased sensitivity of the mass spectrometer now makes it possible to measure quite precisely the isotopic composition of 100 pg of Pb. However, most of the existing U-Th-Pb data for meteorites were obtained prior to these significant improvements, and mainly on bulk rock samples before very clean mineral separates were available.

U-Th-Pb isotope systematics in chondrites have always presented us with an unsolved problem in cosmochemistry. Although their Pb-Pb isochrons give ages close to 4.55 Ga, the U-Pb and Th-Pb systems are heavily disturbed. In most cases they contain more radiogenic Pb than can be accounted for by the present U and Th concentrations. The origin of this so-called excess Pb component has been under discussion for many years.

Results: We present here the results of a study, in which we have measured U, Th, and Pb isotope systematics in fragments and mineral concentrates from four different chondrites (Pantar H5, Leighton H3/5, Rumuruti and Zag). In particular, we designate the fragments as being of dark or light lithology, and identify the mineral concentrates as plagioclase or sulfide. Also, included are the fused crusts of two of the chondrites. Although the dark lithology has been shown to be enriched in volatile elements, such as Cl Br, K, compared to the light lithology, we do not find the dark lithology to be preferentially enrichment in radiogenic Pb.

Discussion: While on a $^{207}Pb/^{204}Pb$ vs. $^{206}Pb/^{204}Pb$ diagram the samples lie close to a 4.57 Ga Pb-Pb isochron, they are heavily disturbed on a $^{206}Pb/^{204}Pb$ vs. $^{238}U/^{204}Pb$ diagram. In the latter diagram about half of the data plot above a 4.57 Ga reference isochron, indicating that the Pb is more radiogenic than would be produced by the measured $^{238}U/^{204}Pb$ ratio. However, at least one sample does plot significantly below the reference isochron and suggests the possibility of some internal re-distribution of Pb. In the $^{208}Pb/^{204}Pb$ versus $^{232}Th/^{204}Pb$ diagram the samples plot only on or above the reference isochron, implying that disturbed systems only gained radiogenic Pb.

Conclusions: While some of the excess Pb could be explained by the infiltration of terrestrial Pb into the chondrites, many aspects of these data cannot be explained this way. Nonetheless, the Pb re-distribution must be a young event, possible related to shock metamorphism at the time of excavation from the parent body. Such data hold promise of giving better insight into the mechanism and timing of Pb re-distribution. We plan to extend this study to other meteorites and an examination of the relationships within coexisting mineral suites.