TIESCHITZ CHONDRULES: I-Xe SYSTEMATICS; *R.H. Nichols, Jr., B.E. Hagee, and C.M. Hohenberg*, McDonnell Center for the Space Sciences, Physics Department, Washington University, St. Louis, MO 63130 USA

I-Xe studies were performed on nine chondrules from the Tieschitz meteorite by step-wise pyrolysis and ion-counting mass spectrometry. I-Xe chronometry, while yet to be established as a viable dating scheme, can nevertheless help constrain the conditions of post-formational metamorphism of meteoritic components, including the chondrules reported here.

The I-Xe technique is based on the decay of now extinct ^{129}I (half-life 17.2 million years) to stable ^{129}Xe. The ratio of radioactive ^{129}I to stable ^{127}I at xenon retention in the host phases can be established with precision by neutron irradiation, which converts a portion of the stable ^{127}I to ^{128}Xe by neutron capture. The iodine isotopic composition at xenon retention is thus proportional to the ratio of radiogenic ^{129}Xe to I-derived ^{128}Xe. Straight lines on plots of ^{128}Xe/^{132}Xe vs. ^{129}Xe/^{132}Xe (isochrons) imply unique values of the initial iodine at xenon closure, given by the slopes. In the chronometric interpretation, slope differences reflect the relative age differences, i.e. different closure times for I-derived xenon, if the host phases began with the same initial iodine. Alternatively, differences in the I-Xe system could be due to I isotopic heterogeneity, in which case apparent age differences become upper limits to actual differences in xenon closure times. However, the regular nature observed in any single sample in which the inferred initial ^{129}I/^{127}I ratio increases with increasing extraction temperature supports the I-Xe system as a chronometer in the stricter sense. Moreover, no evidence for isotopic heterogeneity on such a macroscopic scale (few grams for bulk meteoritic I-Xe isochrons) and of such magnitude (more than a factor of two in some cases) has been found for any other element. We, therefore, tend to interpret I-Xe structure observed in these chondrules (and that observed in other meteoritic components) as reflecting chronometry, although it is not clear exactly what is being dated. Sodalite is the only demonstrated major iodine carrier phase in meteoritic material and is a likely product of post-formation alteration [1]. Even halogen minerals, such as chlorapatites, contain little iodine as shown by the scarcity of radiogenic ^{129}I [2], suggesting a I/Cl ratio about two orders of magnitude lower than characteristic of the solar system. Iodine is most likely sited interstitially or at grain-boundaries, and the I-Xe systematics are likely to reflect secondary processes, rather than primary mineralization or structural events such as chondrule formation. Features observed in the Tieschitz chondrules reported here, and those in Allende [3,4] and other meteorites [5,6], are consequently best interpreted as chronological in origin, but also as reflecting post-formational processes.

Apparent ages are calculated relative to a Bjurböle standard which was irradiated at the same time as the Tieschitz chondrules. This normalizes the neutron capture conditions for all samples in the reactor so that slopes of the individual isochrons, when compared with the slope of the Bjurböle isochron, give xenon closure ages relative to the Bjurböle standard. Only the higher extraction temperatures provide linear isochrons, demonstrating uniform ^{129}I/^{127}I among the more retentive iodine-bearing sites, and some of the Tieschitz chondrules do not define "good" isochrons even at the highest release temperatures. Some of the better isochrons are shown in Figures 1-3, for chondrules 4, 6 and 7, with closure ages of 1.3, 4.9 and 3.6 million years after Bjurböle, respectively (although the last two ages are indistinguishable from each other within the estimated precision). All of the chondrules, even those that do not provide a single linear isochron at high temperatures, do display the regular I-Xe structure expected for the systematic monotonic progression of xenon closure from the high temperature sites, closing first with higher values of ^{129}I/^{127}I, to lower temperature sites, closing last with lower ^{129}I/^{127}I ratios (Figures 4 and 5). This orderly structure, which suggests slow cooling (compared with the ^{129}I half-life), is not expected if the I-Xe structure is simply due to isotopic heterogeneity. Cooling rates of these objects can be estimated, as first noted for Allende chondrules and CAIs by Swindle *et al.* [1,3]. This effect is most apparent for the low temperature fractions, when cooling was slowest, with the rapid cooling of the high temperature sites preserving the observed "isochrons". While the cooling, or the monotonic relaxation of conditions driving metamorphism, is confirmed by the progressive trend of the data, temperatures associated with xenon closure in nature are not expected to accurately correspond to laboratory extraction temperatures. They do, however, provide a guide. Using a non-diffusive (Arrhenius), activation energy dependent model [7], or any other simple model, rates corresponding to a few hundred degrees per million years, for the high temperature sites, down to a few degrees per million years, for the lower temperature sites, are estimated. This is the same range of values observed for the Allende CAIs and chondrules [1,3,4]. These slow "cooling" rates, coupled with the near-equivalent trends observed for

TIESCHITZ CHONDRULES: Nichols R.H. Jr. et al.

Allende chondrules and rims [4], suggest that post-formational processes in the regolith, rather than the nebula, are likely responsible for the I-Xe fine structure. The near antiquity (from the short half-life of ^{129}I) and near-isochronism suggested by the overall I-Xe patterns in all objects, including refractory inclusions [3], indicate that such regolith processing must have occurred quite early.

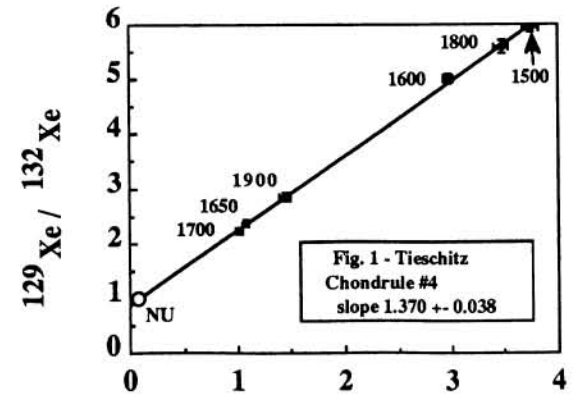

Fig. 1 - Tieschitz Chondrule #4 slope 1.370 +- 0.038

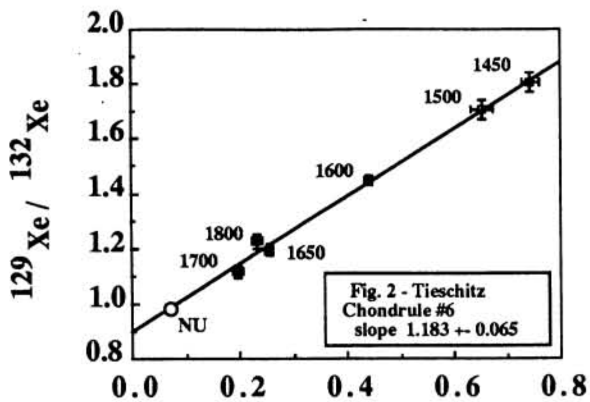

Fig. 2 - Tieschitz Chondrule #6 slope 1.183 +- 0.065

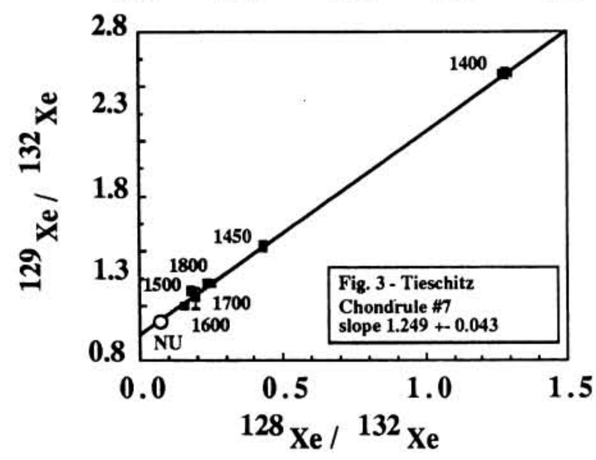

Fig. 3 - Tieschitz Chondrule #7 slope 1.249 +- 0.043

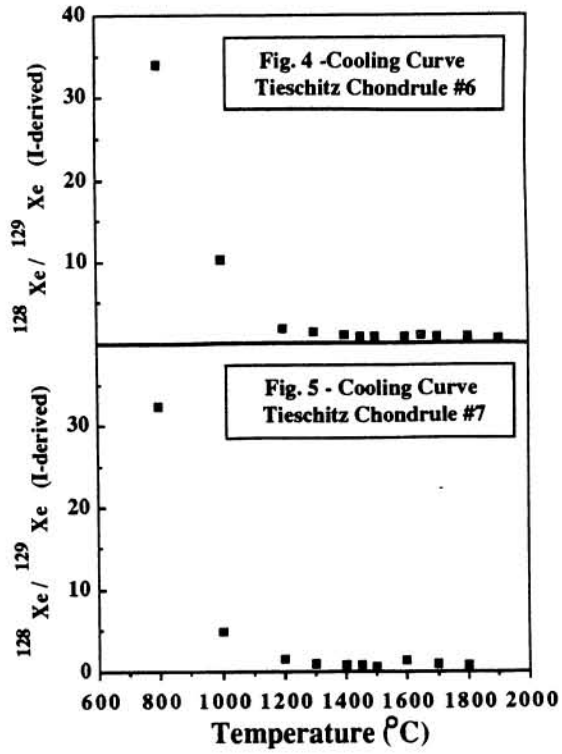

Fig. 4 - Cooling Curve Tieschitz Chondrule #6

Fig. 5 - Cooling Curve Tieschitz Chondrule #7

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