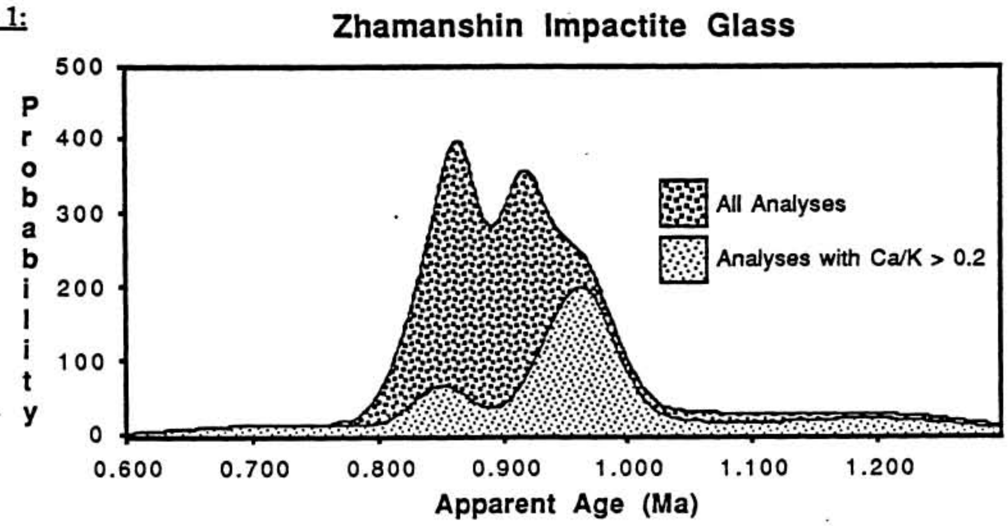
LASER-FUSION $^{40}AR/^{39}AR$ AGES OF ACID ZHAMANSHINITE; A.L. Deino and T.A. Becker, Institute of Human Origins Geochronology Center, 2453 Ridge Road, Berkeley, CA 94709, and J.B. Garvin, NASA/GSFC, Geodynamics Branch, Code 621, Greenbelt, MD 20771

All existing evidence compiled to date (e.g. 1, 2, 3, 4) suggests that the Zhamanshin impact crater in the Aktyubinsk region of Kazakhstan, USSR, represents the youngest, complex-morphology impact feature in the continental geologic record. In spite of its apparent youthfulness, Zhamanshin poses an enigma on the basis of its extremely subdued geomorphic expression, as its setting within semi-arid steppe desert indicates relatively low erosion rates, at least for the Holocene. The best estimate of the diameter of this multi-ring impact feature is 13.5 km, on the basis of drainage network divides (5) and geophysics (1). The abundant distribution of impact glass fragments at the surface of the crater interior, many of which resemble tektites in appearance and geochemistry, has prompted Soviet geologists such as E. Izokh and colleagues to examine in detail the geochemistry of these impactites. A macroscopically pristine sample of a so-called zhamanshinite was provided us by Izokh (his sample no. 45b, with a total SiO_2 content of 75.6%) for age determination. This report summarizes preliminary results of a detailed study of the argon isotopic systematics of this well-characterized sample.

Si-rich zhamanshinite glass was dated by the single grain laser-fusion $^{40}Ar/^{39}Ar$ technique (6) to examine the argon isotopic heterogeneity of a ~3 gram sample. The sample was gently crushed to 18-20 mesh sieve size, individual grains were examined and photographed under the binocular microscope, and irradiated for subsequent isotopic analysis. Twenty-three single-grain total-fusion dates were obtained. The samples exhibit a wide range of radiogenic *vs.* atmospheric argon contamination, from ~5 to 85% radiogenic argon. In at least two cases of high atmospheric contamination, the samples were observed to contain large bubble inclusions. Dates range from 723 to 1600 Ka. Typical uncertainties are on the order of 10–30 Ka for the more radiogenic samples and as high as 217 Ka for analyses with the greatest atmospheric contamination. The overall weighted mean of the 23 dates is 897 ± 11 Ka (1σ standard error of the mean). However, this is an inadequate expression of the age of this sample since it is apparently composed of multiple isotopic components. Figure 1 is a composite age-probablility diagram of the sample suite, similar to that used to express the age spectrum of multiple fission-track analyses (e.g. 7). This diagram has the advantage over simple bar histogram plots in that bar plots cannot readily convey the variable uncertainties encountered in a suite of ages such as this, but the probablity spectrum specifically encorporates the age uncertainties. The ideogram is essentially the sum of the gaussians of the individual analyses. The curve incorporating all the data shows an overlapping bimodal structure, with modes at ~870 and ~920 Ka, with a prominent shoulder toward older ages.

Figure 1:



We observe a correlation between age and Ca/K ratios of the analyzed material (Ca/K is obtained as a by-product of $^{40}Ar/^{39}Ar$ dating). Ca/K ratios range from ~0.12 to 0.24. Ten of the 23 analyses have Ca/K values above the approximate median of 0.2, and these are plotted as a separate ideogram in Figure 1. The more calcic glasses tend to be older in apparent age, and are responsible for the shoulder on the older-age side of the overall distribution. The mode of the principle peak defined by these relatively calcic glasses is 970 Ka. Inverse-isochron correlation diagrams ($^{36}Ar/^{40}Ar$ vs. $^{39}Ar/^{40}Ar$) of the relatively calcic and less-calcic glasses yield similar 'trapped' argon isotopic ratios of ~301 ± ~2, close to the anticipated atmospheric $^{40}Ar/^{36}Ar$ ratio of 295.5. These initial $^{40}Ar/^{36}Ar$ ratios suggest a minimal influence of inherited radiogenic argon. The isochron intercept dates are congruent with those of the probability plot, giving preliminary results of 943 ± 16 and 868 ± 11 Ka, respectively.

In addition we note a correlation between date, Ca/K, and color of the individual glass fragments. The fragments range in color from dark brown to light amber with some grains containing both dark and light bands. The fragments were subjectively ranked by color and divided into two categories. Darker glass (average Ca/K~ 0.22±0.02) yields a weighted mean date of 938 ± 10 Ka (N=11), while lighter glass (average Ca/K~ 0.16±0.02) yields 883 ± 6 Ka (N=12).

These dating results are not easily reconciled with recent fission-track ages on Si-rich zhamanshinite of 1.07 ± 0.02 and on Si-poor zhamanshinite of 1.09 ± 0.09 Ma (3). We have no reason to suspect the validity of the $^{40}Ar/^{39}Ar$ dating process in this circumstance. Neutron-induced isotopic interference corrections to the measured Ar abundances in this study are trivial and contribute less than 1% uncertainty to the age. The irradiation parameter (*J*) is determined to a precision of 0.7% using Bishop Tuff sanidine as the fluence monitor (741 ± 14 Ka; (8)). Whole-rock chemistry of this sample indicates that this glass is non-hydrated (0.2% H20; (9)), and shows no visual signs of alteration. Therefore, we find no physical evidence for isotopic fractionation or K exchange that would result in erroneous $^{40}Ar/^{39}Ar$ dates. Excess initial Ar, if present, would force the $^{40}Ar/^{39}Ar$ ages to be *older* than fission-track ages, not younger as in this situation. The relatively young $^{40}Ar/^{39}Ar$ ages are even more strange in that fission-track ages on glass are usually minimum ages due to ambient temperature partial annealing (10).

At this stage, our best estimate for the age of the Zhamanshin impact site is that of the youngest principal mode in the ideogram of ~870 Ka. In any case, the complexity of the age spectrum obtained on a single specimen of acid zhamanshinite is intriguing, and indicates the need for a systematic examination of small age domains within other Zhamanshin samples and potentially related tektites.

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