K/T AGE FOR THE POPIGAI IMPACT EVENT?; A.L. Deino, Geochronology Center, Institute of Human Origins, 2453 Ridge Road, Berkeley, CA 94709, J.B. Garvin, NASA/GSFC, Geodynamics Branch, Code 621, Greenbelt, MD 20771, S. Montanari, Dept. of Geology and Geophysics, U.C. Berkeley, Berkeley, CA 94720.

The multi-ringed POPIGAI structure, with an outer ring diameter of over 100 km (analysis of a digital elevation model for the region by Garvin and others suggests 105 km), is the largest impact feature currently recognized on Earth with an Phanerozoic age [1]. The shallow depression which defines the structure occurs in the taiga of north-central Siberia within the Anabar crystalline shield. The target rocks in this relatively unglaciated region consist of upper Proterozoic through Mesozoic platform sediments and igneous rocks overlying Precambrian crystalline basement. Extensive field studies by Masaitis and colleagues [1], many of which are unpublished (Masaitis, 1989, pers. comm.), suggests that huge sheets of impact melt are preserved within the outer ring which defining the structure, and as isolated deposits of ejecta to the southwest beyond the rim. The apparent volume of the present-day structure exceeds 1000 cubic km, with a depth/Diameter ratio of only 0.004. The maximum present-day depth of the structure is only ~ 400 m, a factor of at least 5 smaller than the predicted pre-erosional depth; this suggests that over 1000 cubic km of materials may have been excavated by the impact event, with at least 100 cubic km of internal impact melt.

The reported absolute age of the Popigai impact event is 39 ± 9 Ma (K-Ar) [1], 38.9 (average of K-Ar ages) [2], and 30.5 ± 1.2 Ma (fission-track) [3]. With the intent of refining this age estimate for comparison to Eocene/Oligocene marine microtektites, a melt-breccia (suevite) sample from the inner regions of the Popigai structure provided to JBG by V. Masaitis was prepared for total fusion and step-wise heating $^{40}Ar/^{39}Ar$ analysis.

Sample #74034 (V. Masaitis designation) is a suevitic grayish-brown rock, somewhat vesicular, with abundant round to sub-round clasts 0.5 to 0.8 cm in diameter, within a clastic-appearing matrix (grain size less than 0.3 mm). Smaller glassy clasts grade into the matrix. The glass is translucent green, dark green to black, occasionally vesicular, or tan with pronounced vesicles, as well as vitreous gray or clear. The dark green to black glass clasts have textures apparently associated with schlieren (flowing or stretching, as evidenced by the stretched vesicles). In addition, there appear to be mineral clasts which are either clear or milk white in color. The gray, white, or colorless mineral clasts are mostly quartz with occasional potassium feldspar (mostly in the darker schlieren clasts). Some quartz grains exhibit multiple sets of shock lamellae.

Middle infrared emission/reflectance spectroscopic analysis of a range of features observed within the sample suggest the presence of fused silica (lechatelierite?), silica glass, and a component of obsidian-like glass (felsic, perhaps melted K-spar). Fig. 1 is a plot of several representative hemispherical mid-IR reflectance spectra for sub-regions of the sample. Our conclusion is that sample #74034 represents a typical heterogeneous suevite from the crater interior (fall-back ejecta mixed with impact melt).

The major and minor element composition of the vesicular glass has been analyzed with the electron microprobe along eight 100 micron transects within a thin section. With the exception of one transect that intersected glass with a K-feldspar composition, the glass shows only slight compositional variation, and is practically anhydrous as indicated by microprobe totals generally greater than 99%. The general range of glass composition is 60% to 61.5% SiO_2, 0.7% to 1.0% TiO_2, 16% to 17.3% Al_2O_3, 4.1% to 4.8% MgO, 3.4% to 4% CaO, 0% to 0.2% MnO, 6.3% to 7.1% FeO, 2.0% to 2.3% Na_2O, and 2.3% to 2.9% K_2O.

Glass fragments separated from this sample have been dated by the laser-fusion $^{40}Ar/^{39}Ar$ technique. Our initial experiments consisted of five total-fusion analyses of individual 90 to 260 microgram grains, which yielded ages of 52.2, 59.0, 64.2, 64.4, and 65.9 Ma with 1σ analytical errors of about 0.2 Ma. All of these yielded >98% $^{40}Ar^*$, suggesting that very little alteration has affected the glass. We also performed a preliminary 7-step incremental-heating experiment on approximately 350 microgram of sample (Fig. 2). About 72% of the ^{39}Ar release from this sample yielded ages between ~65–68 Ma, while the remainder was contained in an abrupt 'hump' reaching a maximum of 243 Ma at about one-third of the ^{39}Ar released. The integrated total-fusion age of this experiment is 77.7 ± 0.5 Ma, with a 'plateau' (of only three steps but 58% of the gas) of 65.5 ± 0.5 Ma. A much more detailed spectra of 38 release steps showing generally similar behavior to the first experiment was subsequently obtained from 1.57 mg of sample. This spectra started off with an apparent age of (coincidentally?) 242 Ma, followed by a rapid decrease to a loosely defined 'plateau' ranging between ~72 and 60 Ma, and a mean of 65.4 ± 0.3 Ma. Aside from the initial release, the spectra is characterized by a broad hump again reaching a maximum within the first half of gas release. The integrated total-fusion age of this spectra is 66.3 ± 0.4.

Although the total fusion and step-heating experiments suggest some degree of age heterogeneity, the recurring theme is an age of around 64 to 66 Ma. There is no suggestion of a late Eocene age component similar to that of previous K-Ar and fission-track dating results from Popigai samples. We cannot explain this discrepancy except to postulate 1) either that the prior results are incorrect, or 2) that the glass of sample #74034 contains a more or less uniformly distributed quantity of initial argon inherited from the target rocks. However, this sample consists of unaltered, non-hydrated, vesicular (likely degassed) moderately-high-potassium melt glass. If correct, the new ages suggest that the Popigai impact event is approximately the age of the K/T boundary (66 Ma; [4]). We would stress, though, that these results are preliminary since they were obtained from one sample only. They must be corroborated by analysis of additional high-quality samples of suevites and tagamites from throughout the crater area.

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References:

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Fig. 1

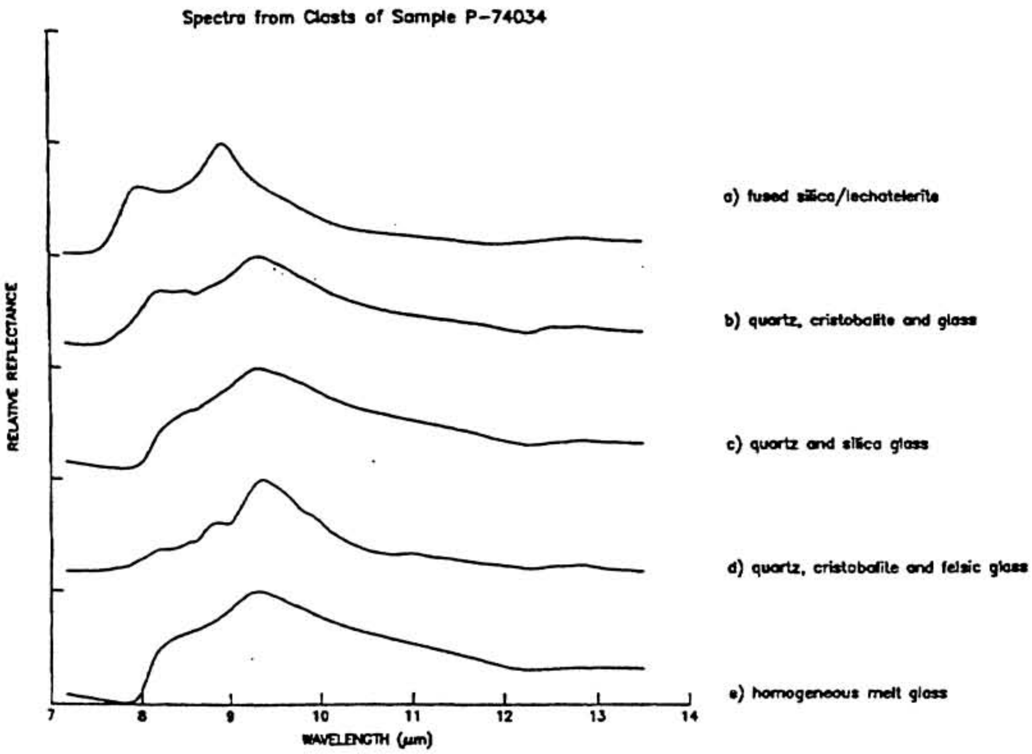

Fig. 2