THERMOLUMINESCENCE AND TRACKS IN ALHA-81005: CONSTRAINTS ON THE HISTORY OF THIS UNUSUAL METEORITE S. R. Sutton and G. Crozaz, Earth and Planetary Sciences Department and McDonnell Center for the Space Sciences, Washington University, St. Louis, MO 63130.

Thermoluminescence measurements and a search for nuclear particle tracks were made in 3 fragments of ALHA-81005.

THERMOLUMINESCENCE: Equivalent dose (E.D.) curves determined for 1 mg aliquots of the three fragments are shown in figure 1a along with those of two Antarctic chondrites, ALHA-77003 and ALHA-77272. The ALHA-81005 chips plot well below the chondrites (factor of 10 lower at high glow curve temperatures and up to a factor of 100 lower at low glow curve temperatures). The small, high-temperature E.D. is best explained as the object's "pre-earth" equilibrium dose which is lower than that of chondrites because ALHA-81005 exhibits substantial anomalous fading. (In one week storage at room temperature, ALHA-81005 artificial TL decays by 25% compared to $\leq$ 5% for chondrites.) Comparing ALHA-77003 (short terrestrial age of 0.04 Ma) with ALHA-77272 (long terrestrial age of 0.54 Ma) (1) demonstrates that, at Antarctic storage temperatures, less than a factor of two thermal decay occurs for glow curve temperatures $\geq 275^{o}$C. ALHA-81005's TL is actually more thermally stable than these chondrites (Artificial TL decayed by a factor of 6 for chondrites stored for 40 minutes at 180^{o}C while ALHA-81005 TL decayed by only a factor of 3.) Consequently, ALHA-81005's E.D. at 275^{o}C would be expected to be about the same as its high-temperature E.D. of $\sim 10^4$ rads. The fact that its E.D. is a factor of about 5 lower indicates the object has been heated above the Antarctic storage temperature (about 0^{o}C). This interpretation is supported to some extent by the observation that a 15 krad artificial glow curve measured after pre-heating to 290^{o}C closely reproduces the natural glow curve in both shape and intensity (figure 2).

The object could have been heated during atmospheric entry, in a near-sun orbit or during a parent-body impact event. Atmospheric entry heating would seem to be ruled out because the high temperature required to explain the TL data ($\sim 300^{o}$C) occurs only within several mm of the fusion crust (2) and our three chips are random samples of a ~1.5 cm diameter fragment with fusion crust removed. A near-sun orbit is possible and a few meteorites show evidence of solar heating (figure 1b). However, such orbits are rare and probably occur for only a few percent of meteorites (2). Impact heating is the more likely interpretation. In this case, the low E.D. value at 275^{o}C constrains the object's space exposure to be less than a few thousand years. Such a brief earth transit time lends support to the notion of a lunar origin for ALHA-81005.

TRACKS: Feldspar grains from all fragments were mounted, polished and etched in boiling 6.25N NaOH. In this solution, feldspar etching times vary from 30-60 minutes (revelation of solar flare tracks with densities in excess of 10^8 t·cm^{-2} in lunar samples) to 6 hours (full revelation of galactic cosmic ray tracks in the Estherville mesosiderite). Most feldspar grains from ALHA-81005 were so highly shocked that they fractured rapidly when etched. However, we succeeded in finding grains which resisted a 6 hr. etch. Despite the fact that these samples contain large amounts of solar gases (Bogard, private

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communication), no nuclear particle track was observed. Whether depth or temperature history is responsible for the lack of solar flare tracks is unclear. However, it should be noted that if the thermoluminescence was mainly acquired on the parent body (our preferred interpretation), the temperature reached by the material during the impact event (~300°C) would be insufficient to erase the tracks. The absence of galactic tracks is compatible with a short transit time between parent body and the earth but could also be explained, because of the rapid decrease of the cosmic ray track production rate with depth, by the shielding of ALHA-81005 in space, or on the parent body, by only ~10 cms of material.

REFERENCES: (1) Nishiizumi, K. and J. R. Arnold, 1982, "Terrestrial Ages of Antarctic Meteorites," in "Workshop on Antarctic Glaciology and Meteorites," LPI Technical Report No. 82-03, pp.45-6. (2) Melcher, C. L., 1981, "Thermoluminescence of meteorites and their orbits," EPSL 52, pp. 39-54.

Fig.1a
E.D. Curves for Antarctic Meteorites

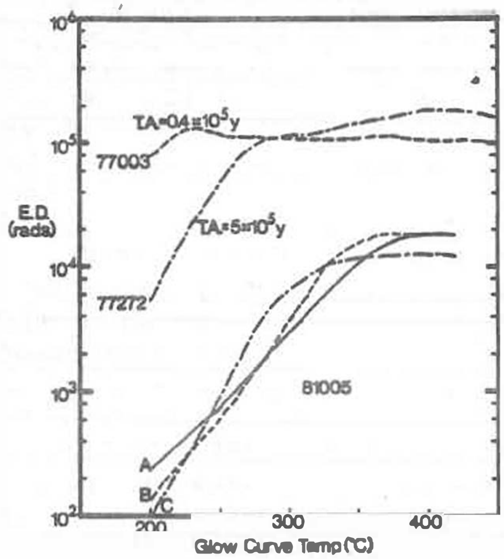

Fig.1b
E.D. Curve Comparison with Two Meteorites Showing Evidence of Solar Heating-77001 & Malakal

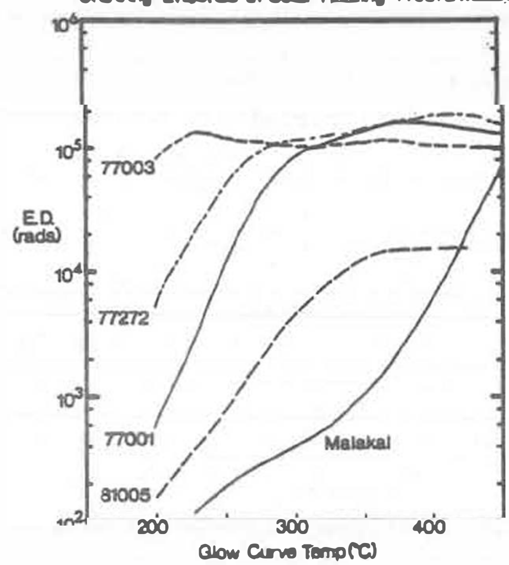

Fig.2
Natural vs Preheated Artificial Glow Curves