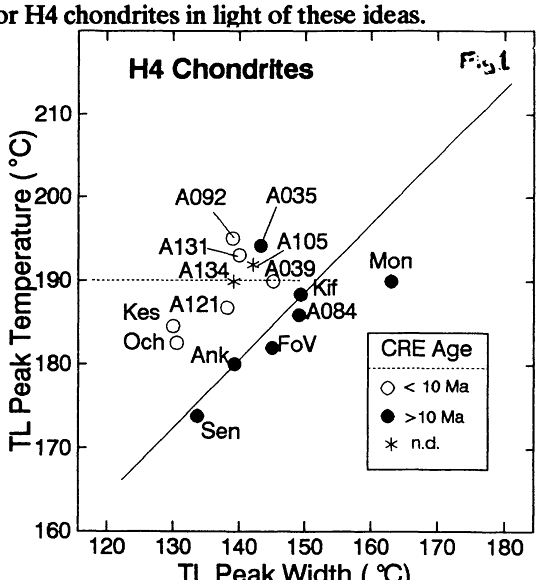
THE GREAT 8 MA EVENT AND THE STRUCTURE OF THE H-CHONDRITE PARENT BODY. P.H. Benoit and D.W.G. Sears, Cosmochemistry Group, Dept. Chemistry and Biochemistry, University of Arkansas, Fayetteville, AR 72701 USA.

We have recently identified two groups of H5 chondrites with distinct thermal histories, one of which (the "unusual" group) has cosmic ray exposure ages of ~ 8 Ma and is only found in the Antarctic meteorite collection and the other which is found in both Antarctic and non-Antarctic collections. We suggested that these groups are indicative of changes in the meteorite flux over the last million years. We have extended our work to H4 chondrites and find that the groups are also apparent. The most likely origin of the unusual group of H-chondrites is thermal processing during the 8 Ma event which was the source of large numbers of meteoroid fragments.

INTRODUCTION. The H-chondrites have been the subject of several recent controversies, including the question of whether Antarctic and non-Antarctic meteorites are or are not the same [1] and whether there is or is not evidence for stratigraphic layering in the original parent body [2,3,4]. We have identified two distinct groups of H5 chondrites in the Antarctic collection [5,6]. One group has induced thermoluminescence (TL) peak temperatures <190 °C and metallographic cooling rates between 5 to 50 K/Myr, similar to modern H5 falls. It also has a variety of cosmic ray exposure ages, many being >10^7 years. The other group has TL peak temperatures >190 C, metallographic cooling rates of 100 K/Myr and cosmic ray exposure ages of ~ 8 Ma. The members of this group were generally smaller than those of the >190 °C group (including the modern falls) during cosmic ray exposure. Detailed study of the cosmogenic nuclide concentrations of these groups indicates that they are not solely the result of pairing of a few unusual meteorites [7]. It is likely that the >190 °C group was an important part of the H-chondrite flux about 1 million years ago, but has since decreased in importance relative to the <190 °C group [5]. In [6] we discussed several possible origins for the >190 °C group, including multiple H-chondrite parent bodies, unusual parent body structure, and creation during the 8 Ma event. In this paper, we present new data for H4 chondrites in light of these ideas.

RESULTS. We collected induced TL, metallographic cooling rate, and petrographic data for 13 H4 chondrites, 9 of which were from Antarctica and for which cosmogenic noble gas data were available [8]. Unlike our H5 samples, most of the H4 samples had not been previously examined in detail and thus it was necessary to eliminate some heavily shocked meteorites. Our data are shown in Fig.s 1 and 2. On a plot of TL peak temperature vs. peak width (Fig. 1) four meteorites, including three non-Antarctic falls, plot close to the trend defined by the larger non-Antarctic H-chondrite database. All four have cosmic ray exposure (CRE) ages in excess of 10 Ma. The remainder cover a broad range of TL peak temperatures from 185 to 196 °C, and all, with the exception of A035, have CRE ages <10 Ma. There is no clear clustering of two groups, with a separation at a peak temperature of 190 °C, but there are three groups, one following the trend for non-Antarctic H-chondrites, a second with peak temperatures between 185 and 195 °C and a third with peak temperatures > 195 °C. We obtained metallographic cooling rates for all our samples except for A262 and Kesen (Fig. 2) The data show that, with the exception of FoV, (1) the H4s, like the H5s, show two major groups of metallographic cooling rates, one between 5 - 50 K/Myr and the other with rates of ~ 150 K/Myr and (2) the samples with the highest TL peak temperatures also have the highest cooling rates. The TL groups of H4 chondrites are less resolved than H5 chondrites on the Berne plot, probably because there is less diversity among the present samples since their meteoroid bodies were fairly large. In addition, the group with the highest TL peak temperatures and the highest metallographic cooling rates also have significant amounts of implanted gases, as their $^{22}Ne/^{21}Ne$ is much greater than most ordinary chondrites.



CONCLUSIONS. We have previously discussed several possible origins for the unusual, fast-cooled, >190 °C group of H-chondrites [6]. Among the possiblilities are (1) stratification in the parent body (2) multiple parent bodies (3) a "rubble pile" parent and (4) alteration of a stratified body during the 8 Ma event. We discuss each of these possibilities in light of the current data.

The existence of a single metamorphically stratified H-chondrite body has been the subject of much discussion [2,3,4]. Metallographic cooling rate data have argued against such a simple structure [4], but recent metallographic work and Ar-Ar dating of meteorites selected for their very low degree of shock seems to support stratification [2,3]. The present TL and metallographic data indicate that the >190 °C group is very unlikely to represent the near-surface of a simple stratified body. Since both TL groups are found in both the H4 and H5 chondrites, one would have to suggest a layering of H5-H4-H5-H4, which is not in accord with a simple concentric metamorphic sequence. The second possibility, that of origin of the groups in different H-chondrite parent bodies, also seems unlikely. In this case, it would be necessary for the two bodies to impact each other in the 8 Ma event, with large numbers of fragments of both bodies surviving the event, or both bodies would have to be impacted at about the same time by other objects. The rubble pile model is vastly more flexible than the others; It would be possible to generate the two groups in all petrologic types by depth placement within the reassembled parent body, with the >190 °C group forming the outer layer of the body (Fig. 3a). During the 8 Ma event, this outer layer would be more subject to communution than the more protected <190 °C group and hence might be fragmented into smaller pieces. If this is the case, however, why do *all* the H-chondrites with CRE ages >8 Ma belong to the <190 °C group? It would seem more likely that previous less-catastrophic events would preferentially sample this outermost layer of >190 °C material but this is not observed. The final possibility, that of formation of the >190 °C group *during* the 8 Ma event has the advantage of simplicity. It is apparent from CRE ages that, if there is only one H-chondrite parent body, fragments have spalled off it many times over the last 40 Ma [9]. The event which produced all the fragments with ~8 Ma CRE ages was clearly a very large one, considering about a third of all H-chondrites were involved in it. If the event was a large-scale collision/impact (Fig. 3b), the >190 °C group might be the product of a rapid pulse of heat in the area around the impact region. The rest of the body might be fragmented, but would be less affected by the heat pulse, and thus could serve as a source for the "normal" <190 °C group, including most modern falls. The rocks in the >190 °C source region would be prone to heavy comminution and thus might be expected to produced smaller meteoroid bodies. In this model one would expect the H6 chondrites to have metallographic cooling rate and TL trends similar to those of the H5 chondrites; preliminary TL results suggest that this is the case [6]. The present data and our earlier results [5,6] indicate that, while the great 8 Ma event has severely affected the H-chondrites, it should be possible, by careful sample selection, to examine the original stratigraphy of the H-chondrite parent body. Metallographic and nuclear track cooling rates seem to bear this out [2,3] and suggest a stratified body similar to the L and LL bodies.

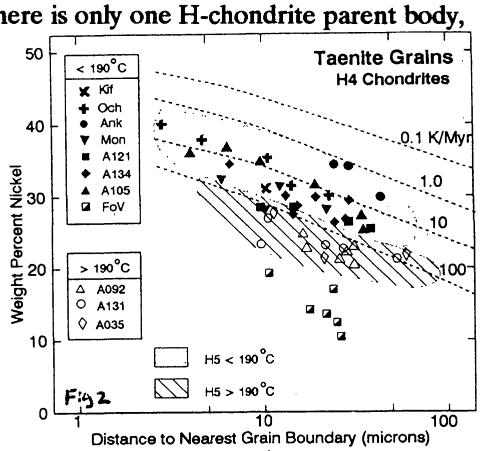


Fig 2

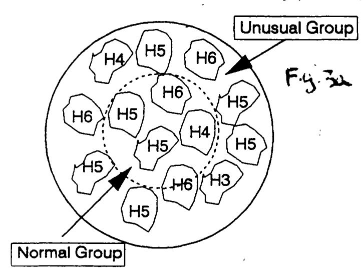


Fig. 3a

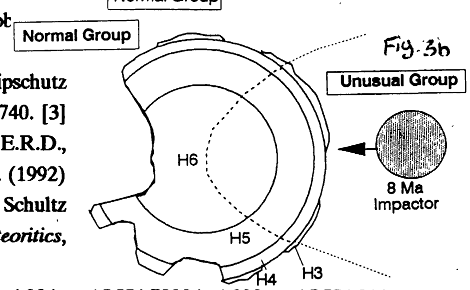


Fig. 3b

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References: [1] Dennison J.E. and Lipschutz M.E. (1987) *GCA*, 51, 741. [2] Lipschutz M.E., Gaffey M.J., and Pellas P. (1989) in *Asteroids II*, Univ. Arizona Press, 740. [3] Pellas P. and Fiéni C. (1988) *LPS XIX*, 915. [4] Taylor G.J., Maggiore P., Scott E.R.D., Rubin A.E., and Keil K. (1987) *Icarus*, 69, 1. [5] Benoit P.H. and Sears D.W.G. (1992) *Science*, 255, 1685 [6] Benoit P.H. and Sears D.W.G. (1993) *Icarus*, in press. [7] Schultz L. Weber F. and Begemann, *GCA*, 55, 59. [8] Schultz L. and Kruse H. (1989) *Meteoritics*, 24, 155. [9] Graf T. and Marti K. (1989) *Meteoritics*, 14, 271.

Meteorite name abbreviations used: A035 = ALHA79035; A039 = ALHA79039; A084 = ALHA78084; A092 = ALHA81092; A105 = ALHA81105; A121 = ALHA80121; A131 = ALHA80131; A134 = ALHA78134; A262 = ; Ank = Ankober; FoV = Forest Vale; Kif = Kiffa; Kes = Kesen; Mon = Monroe; Och = Ochansk; Sen = Sena.