EXPOSURE AGES OF BASALTIC ACHONDRITES AND IMPLICATIONS FOR THE STRATIGRAPHY OF THEIR PARENT BODY

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Some classes of meteorites show statistically significant peaks in their exposure age distribution. The most pronounced case is the 7 Ma peak of H-group chondrites which contains about 45% of all analysed samples with no preference for any particular chemical-petrological type of this meteorite class (Crabb and Schultz, 1981). Clustering in exposure age distributions is taken as strong evidence that the meteorites are produced in a relatively small number of collision events.

Eucrites, howardites and diogenites are believed to come from the same parent body, the eucrite parent body (EPB). Information about structure and stratigraphy of its surface layers can be obtained from possible clustering in the exposure age distribution of these basaltic achondrites (e.g. Heymann et al.,-1968; Ganapathy and Anders, 1969; Herzog and Cressy, 1977). The small number of available analyses and uncertainties in production rates of cosmogenic nuclides have hampered the interpretation of the exposure age distributions of these meteorites. With a continuously expanding data base (Kruse and Schultz, 1984, 1986) and new determinations of production rates for cosmogenic noble gas isotopes in basaltic achondrites (Freundel et al., 1986), exposure ages of 32 different eucrites, 18 howardites and 11 diogenites can now be calculated and discussed.

Exposure ages are calculated from the concentration of cosmogenic ^{38}Ar. This isotope was chosen because:

(1) Its elemental production rate P(38) (in 10^{-8}ccSTP/gMa) was determined using the reliable ^{81}Kr-Kr-method:

$$P(38)=1.58\times[Ca] + 0.086\times[Fe+Ni] + 0.33\times[Ti+Cr+Mn] + 11\times[K] \quad (1)$$

In brackets are the weight fractions of the respective elements. This production rate corresponds to a ^{21}Ne production rate for L-chondritic chemistry of 0.32×10^{-8} ccSTP/gMa.

(2) In eucrites and howardites ^{38}Ar is mainly produced from Ca and the production does not strongly depend on shielding.

(3) Possible diffusive losses of ^{38}Ar should be less than those for ^{21}Ne or ^{3}He.

Exposure ages have been calculated using a production rate calculated from eq.(1) and - if available - the chemical composition of the meteorite. For some of the meteorites the mean chemical composition of the respective group (Mason, 1979) was used. No shielding corrections are applied. Results are given in Fig. 1.

For all three classes clustering is apparent and, for howardites and eucrites, individual peaks are separated by distinct gaps. For eucrites 78% of all stones are included in the four peaks at about 13, 21, 26 and 40 Ma. About 55% of all diogenits belong to a cluster at 17 Ma and more than 60% of all howardites have an exposure age around 10 or 24 Ma. The standard deviation of each cluster age is less than 12% and can easily be explained by uncertainties in the cosmogenic gas concentrations and variations of the production rate due to shielding effects. No systematic grouping is observed for meteorites with special properties like the presence of solar gases or specific textures.

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There is no obvious overlapping of the individual clusters of eucrites, howardites or diogenites as found for H-group chondrites of different chemical-petrological type. Howardites are surface regolith breccias and may have been exposed to cosmic rays at the surface of the parent body. In such a case a few Ma pre-exposure could explain the difference between the 21 Ma eucrite peak and the 24 Ma howardite peak if one event is assumed. However, the 17 Ma peak of the diogenites is very isolated and, with the production rate used here, cannot be correlated with any other impact.

If all basaltic achondrites are ejected by impacts from the same parent body its surface layer must consist of distinct units. Anders (1978) has calculated that on the H-chondrite parent body impacts sample material from depths up to one kilometer only. In this one km thick layer howardites, eucrites and diogenites must have existed in separated units with at least a few km in lateral extension. An alternate explanation would be the existence of different larger fragments of the original parent body which was destroyed earlier in a catastrophic event. In this case, internal parts of the EPB are now accessible to sampling by impacts and individual clustering of predominantly similar material can be obtained from one impact.

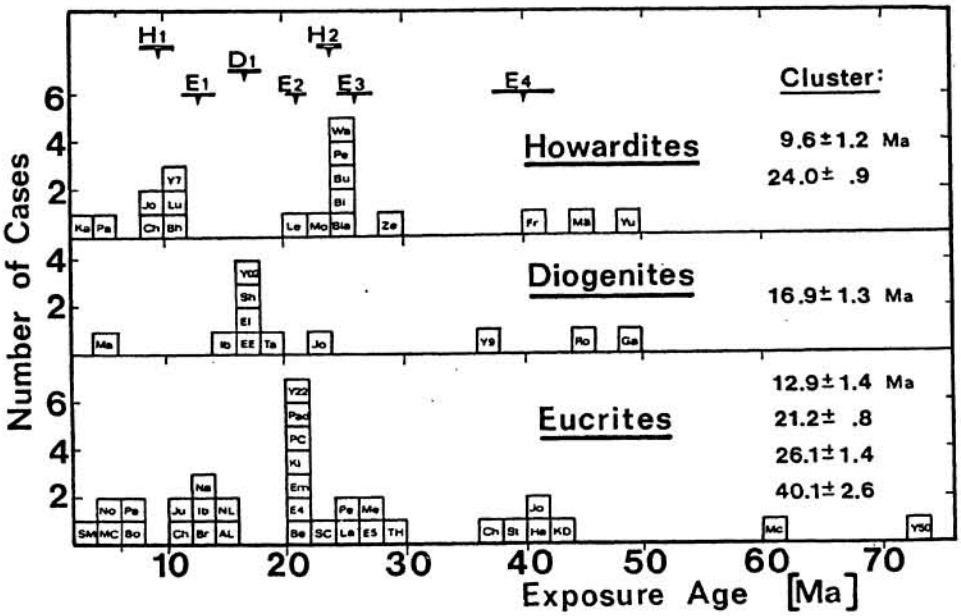

Fig.1: Exposure age distribution of basaltic achondrites

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