244Pu CONTENT OF PHOSPHATES AND COOLING HISTORY OF ACAPULCO METEORITE. P. Pellas and C. Fiéni, Equipe Météorites, Muséum-CNRS, 61 rue Buffon, 75005 Paris, France.

SUMMARY. Pu fission tracks (FT) registered in two minerals (merrillite and adjacent opx) indicate a low cooling rate of $\sim 1.7 \text{K/Myr}$ in the temperature range 560-380K. The Pu/Nd ratio of bulk phosphates (at track retention in opx) is $1.3 \times 10^{-3}$, the highest value obtained from phosphates of chondritic materials.

Acapulco is a highly crystallized unshocked object, chondritic in composition with an achondritic texture (1). Many singularities - e.g. O and N isotopic compositions (2,3,4), redox state, high abundance of volatiles and trapped noble gases together with very high estimated equilibration temperatures of 1320-1520K (although the metal does not show any evidence of eutectic reaction) - point to a peculiar early history of this material (1). Its bulk K-Ar age (4.7 $\pm$ 0.3 Ga) (1), and a $^{147}\text{Sm-}^{143}\text{Nd}$ internal isochron age of 4.605 $\pm$ 0.032 Ga (5) seems to indicate (with the presence of live $^{146}\text{Sm}$) that Acapulco could have been one of the earliest "frozen" solar system materials (like ADOR, for ex.). Metallographic and FT cooling rates appear indeed to agree with a fast cooling (table 3, ref.1). Furthermore, recent results using the Ca-zoning profile in olivines give a very fast, instantaneous, cooling rate of about 50 000K/Myr in the temperature interval 920-730K (6). In short, all conditions are apparently fulfilled for having an excellent material in which it is possible to study and compare the registration efficiencies of FT in minerals (CPX, OPX, OLV) which are sometimes adjacent to merrillite (MRL) and apatite (APT), two phosphates enriched in actinides to different degrees. These phosphates in Acapulco are 3 times more abundant than in "equilibrated" H chondrites (1). The FT systematics in Acapulco phosphates however, as described in (1), shows some inconsistencies which needed first to be clarified. For ex., (1) has observed that MRLs and APTS have approximately the same track densities (TD) (1.8 and 1.6 $10^8$/cm², respectively), at variance with what is observed for the same phosphates of OCs in which, on average, Pu is enriched 2.5 more in MRLs than in APTs (when the same track retention temperature is considered : Pellas, to be published). The case for Pu in Acapulco phosphates can easily be checked for by looking at OPX planes adjacent to phosphates: these planes having registered (at the same retention temperature) fission fragments coming from both phosphates mirror the real Pu + U distribution. This was done, and after gentle crushing and etching, 191 OPX planes from 51 crystals were studied by SEM, along with the separated phosphates. The results are as follows : 1) In the~1 g sample selected, an abundance of 29.3 % of MRL was found (statistics is given for 259 crystals). 2) The averaged FTDs (corrected for the cosmic ray TD background, and normalized to $4\pi$ geometry) were found to be for OPX-PHOSPH contacts : 6.1 $\pm$ 0.8 and 2.9 $\pm$ 0.8 $10^8$/cm² for MRLs and APTs, respectively. After due corrections for the U contributions ($\sim$1 and $\sim$10 ppm, respectively), a Pu(MRL)/Pu(APT) ratio of $\sim$1.77 was found, in perfect agreement with the value 2.5 $\pm$ 0.2 obtained from the phosphates of 9 equilibrated OCs (Pellas, to be published). 3) The Pu contents of MRLs and APTs (at FT retention in OPX) correspond to $\sim$77 and $\sim$33 ppb, respectively, thus leading to a bulk phosphate content of ~46.7 ppb, in excellent agreement with the ~49 ppb found by mass spectrometry on another phosphate sample (K. Marti, priv. comm. Nov. 1991). This agreement suggests that retentions of fission xenon in phosphates and fission tracks in OPX can be effective at about similar temperatures. Such an abundance of Pu in phosphates gives a Pu/Nd ratio of $1.34 \times 10^{-3}$, by using the Nd value (34.8 ppm) measured by (5). This ratio is in strong disagreement with that obtained by (1), which is about 6 times less. It is also in strong disagreement (due perhaps to the low retention temperature of Xe) with the ratios obtained on equilibrated OCs and/or on their phosphates (see ref.7). The high Pu/Nd ratio of Acapulco phosphates confirms the
conclusions reached by Crozaz et al. (8) that it cannot be used as a chronometric tool. 4) The Pu content derived at the FT retention in MRLs corresponds to ~31.7 ppb, thus allowing to define a metamorphism interval of 105± 29 Ma between the track retentions in OPX and MRLs (i.e. between ~560 and ~380 K). This result gives a low cooling rate (between these temperature limits) of 1.7 K/Ma, in total disagreement with the conclusions reached by (1), at least in the case of Pu FT cooling rates. This metamorphism interval is two times longer than in the case of H6 chondrites (Pellas, to be published), for which the absolute U/Pb-Pb ages are in the range of 4.504 - 4.521 Ga (9). This observation, of course, does not signify that the absolute U/Pb-Pb age of Acapulco should be younger than 4.50 Ga, as we don't know the effective closure temperature of this radiometric system. We can predict, however, that the 40Ar-39Ar plateau age of Acapulco must be younger than that of Forest Vale (H4) chondrite (4.52±0.03 Ga) (10), because we have some knowledge about the 40Ar retention temperature in dry meteoritic systems, which might be rather close or even perhaps a little inferior, to that of FT retention in OPX. 5) The previous results strongly suggests that an important fraction of "tracks" in Acapulco APTs, could be "cracks". Therefore annealing experiments of APTs were carried out to distinguish both features. From these experiments it became clear that the total "track" density of Acapulco APTs contained an important "crack" component of about 10^8 cm^-2. In these experiments, no similar crack component was found in MRLs.

From the above results and those of other groups cited, the following landscape emerges:

A) Very early (around 4.565 Ga) a specific condensation process, followed by a very efficient heating due to 26Al decay (not detected by Bernius et al. (ref. 11) because of the long posterior metamorphic history which has induced feldspar equilibration) has brought the original Acapulco material to the observed equilibration temperatures (around 1350K). B) This heating episode must have been immediately followed by a very fast cooling (in 10^4-10^6 yr), which would have to slow down progressively, probably as the accretion was proceeding. C) The following accretional layers must have in some way acted as very efficient insulating blankets, in order to explain the long metamorphism interval derived from the Pu FT systematics. Some observations have indeed indicated in silicate inclusions of IAB irons the early presence of an internal atmosphere which has been detected by high values of the trapped ratios 129Xe/132Xe, 40Ar/36Ar during stepwise heating analyses. This has been the case for El Taco (12) and Landes (13) silicates. It could be that a closed system evolution be the valid explanation of the large amount of trapped noble gases found in Acapulco and other similar materials, like Lodran (14). In the latter case, it is worth noting that a similar cooling history, very fast at the beginning (700 K/Ma) and decreasing later (30 K/Ma) in the low temperature regime, has also been suggested (15). And the fact that Lodran and Acapulco, together with ALH 77081 belong to the same group of O isotopic compositions (2) must also be noted. From the above considerations, the final proof that 26Al has been the very efficient heat source of metamorphism and planetary differentiation of asteroidal bodies, must be looked for in the feldspathic phases of H4 chondrites which have cooled very fast, a suggestion already presented 10 years ago (16).