

ALHA 77005: URANIUM CONTENT OF PHOSPHATES AND THERMOLUMINESCENCE STUDIES. R.K. Bull and S.A. Durrani. Dept. of Physics, University of Birmingham, P.O. Box 363, Birmingham B15 2TT England.

The meteorite Allan Hills 77005 is a unique achondrite consisting mainly of pyroxene, olivine and maskelynite. Minor phases include whitlockite. Petrological and chemical studies show similarities with the shergottites (1,2). It has been suggested that either ALHA 77005 originated as a cumulate from a liquid parental to that from which the shergottites crystallized or it represents a relict sample of the source peridotite from which the shergottites formed (1,2).

We have previously reported cosmic-ray track densities in the pyroxene, olivine and whitlockite (3). For any reasonable assumption of the cosmic-ray age (as yet unknown) the thickness of material shielding these samples must have been relatively small (\sim few cm). We report here on measurements of the U-content of the whitlockites and of the thermoluminescence (TL) properties of 77005.

Experimental Procedures

Slices through the chip 77005,14 and also some bulk grain mounts were irradiated with $\sim 7 \times 10^{17}$ nvt of thermal neutrons in the VTL facility of the Herald reactor at AWRE, Aldermaston. Induced ^{235}U -fission tracks were measured in adjacent mica sheets of low (~ 1 ppb) uranium content. NBS reference glasses (type SRM 616) were included in the irradiation package.

For TL studies, meteorite fragments were gently crushed to $< 63 \mu\text{m}$ and a hand magnet used to remove magnetic grains. Aliquots of 10 (± 0.5) mgm from the non-magnetic fraction were heated at a rate of approximately 5°C sec^{-1} in an atmosphere of oxygen-free nitrogen. The light output was measured using an EMI-9804 QB photomultiplier tube.

Uranium Contents

Analyses of 30 whitlockites show U-contents ranging from 0.5 - 1.3 ppm. The whole rock U-content is 18 ppb (2). Fossil track densities in pyroxenes are around $3 \times 10^6 \text{ cm}^{-2}$ whereas those in whitlockites are $\sim 4 - 5 \times 10^6 \text{ cm}^{-2}$. The U-content of the pyroxenes is generally low (not more than a few ppb) and the track densities in this phase are therefore predominantly of galactic cosmic-ray origin. The cosmic ray contribution to the track density in the whitlockite is not well known but is probably at least as large as that in the pyroxene. It is not possible, therefore, to assign a meaningful track retention age to these whitlockites. We note, however, that at ~ 1 ppm U, a fission track density of $\sim 2 \times 10^6 \text{ cm}^{-2}$ would accrue in $\sim 4 \times 10^9$ yr. The presence of a large excess of fission tracks due to ^{244}Pu is therefore precluded by the data and this is consistent with the low Rb-Sr (4) and $^{39}\text{Ar} - ^{40}\text{Ar}$ (5) ages obtained for this meteorite.

Thermoluminescence

Natural glow curves for ALHA 77005 show a very low level of thermoluminescence with a low temperature (LT) peak at $\sim 200 - 250^\circ\text{C}$ and a high temperature (HT) peak at $\sim 320 - 400^\circ\text{C}$. The peak height ratio is rather variable from sample to sample mainly owing to variations in the LT output. Typically LT/HT is ~ 0.2 . Drained samples were irradiated with about 100 krad of gamma rays from a ^{60}Co source. Glow curves obtained after this artificial irradiation showed a broad LT peak and a smaller less distinct HT peak. The natural equivalent dose at a glow curve temperature of 400°C is ~ 100 krad. There is evidence of considerable loss of natural TL in the glow curve below

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350°C which could be the result of either a long terrestrial age or some solar heating in space. We have previously noted (3) some evidence for thermal shortening of cosmic ray tracks in the olivine.

Conclusions

The U-contents of whitlockites from ALHA 77005 are 0.5 - 1.3 ppm. Whilst it is not possible to determine a track retention age, a large contribution from fission of ^{244}Pu is unlikely. There is some evidence from both thermoluminescence and cosmic-ray track studies of heating of the meteorite either on earth or in orbit.

References

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