Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 450

U/Pb Study of Feldspars: Constrains on the Initial Pb of Equilibrated Meteorites

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Non-differentiated meteorites represent pieces of early planetesimals that escaped the accretion and internal differentiation of planets. Precise age determinations carried out on these samples allows us:

• to study the primitive material of the solar system from a physical-chemical point of view

• to constrain the accretion mechanism of the first planetary objects and

• to identify the nature of the heat source(s) that affected these first bodies at the same time with variable intensities.

The U/Pb chronometer is a suitable tool for precise age determinations of old samples characterised high U/Pb ratios: because of the coupled nature of the $^{238}U/^{206}Pb$ and $^{235}U/^{207}Pb$ decay systems and the short half life of ^{235}U, chronological information with age resolutions of a few million years or less can be obtained. However a precise U/Pb chronology on bulk meteorites is not yet established until today because of the systematically observed discordant character of the whole rock samples.

Phosphates in ordinary chondrites represent ideal objects for this purpose. This mineral is major hosts for U, it shows high $^{238}U/^{204}Pb$ ratios and highly radiogenic compositions today.

We determined the U/Pb systematics of phosphates from equilibrated chondrites. The time interval observed, $60x10^6$ years, reflects the thermal processing of the equilibrated chondrites and is consistent with that previously derived from other chronologies (Göpel et al., 1994). The U/Pb system of these phosphates is concordant, indicating that the in situ decay of U took place in a closed system since 4.5 Ga.

The Pb/Pb model ages for these phosphates range from 4.563 to 4.504 Ga. These single stage calculations are model ages. They are calculated assuming that the material included an initial Pb component that has an isotopic composition identical, or close to that determined in Canon Diablo.

In order to better constrain the composition of this initial Pb, we analysed feldspars from highly equilibrated meteorites. Feldspar is a mineral phase that is characterised by low very $^{238}U/^{204}Pb$ ratios and therefore its isotopic composition is susceptible to furnish information on a) the source material of these objects and/or on their primitive evolution and b) to precise the chronological information obtained on the phosphates.

Feldspars from two highly equilibrated meteorites, Acapulco and Guarena, were selected for this study.

The Acapulco meteorite represents the transition between chondritic and achondritic material. Its major element composition is close to that of ordinary chondrites, volatile elements are enriched nearly to the level of carbonaceous chondrites (Zipfel et al., 1995). The U/Pb systematics of the phosphate are concordant. The age (4.5562 Ga) can be interpreted as translating the closure of the U/Pb system during the cooling of the Acapulco material on its parent body.

Guarena belongs to the group of H6 chondrites. The meteorite is strongly recrystallised. Its mineralogy is composed of peroxide, feldspar, chromate, phosphate. The Pb/Pb age is young, 4.505 Ga, the U/Pb system concordant.

Both feldspars show low $^{238}U/^{204}Pb$ values (Acapulco: 0.0022; Guarena: 0.072). Their isotopic compositions are nonradiogenic and primitive

However when looking in more detail, it becomes evident that the Pb isotopic composition is distinct from primordial Pb and characterised by relatively high $^{207}Pb/^{204}Pb$ values.

Acapulo: $^{206}Pb/^{204}Pb = 9.382$, $^{207}Pb/^{204}Pb = 10.370$;

Guarena: $^{206}Pb/^{204}Pb = 9.876$, $^{207}Pb/^{204}Pb = 11.286$

This Pb signature indicates that the Pb contained in the feldspars must have been produced in the early history.

When one calculates the ages of the phosphates with the primitive isotopic composition contained in the feldspars, they correspond to 4.500 Ga for Guarena and to 4.555 for Acapulco. The age differences between these ages and the previously published Pb/Pb model ages are small: max. 4×10^6 years for Guarena and 2×10^6 years for Acapulco and they validate the chronological information which was obtained for the first time on the equilibrated meteorites in the absence of these measurements.

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