X-ray Reflectivity Study of Fluorapatite (100) – Water Interface

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Direct observation of the interfacial structure at the molecular scale is crucial to understand the surface chemistry of the apatite-water system. We report recent results of the structure of the apatite (100) – water interface obatined with high-resolution specular x-ray reflectivity from a natural growth surface of Durango fluorapatite (FAP). These data demonstrate that the FAP crystal has a crystallographically-uniform termination corresponding to the crystallographic unit cell boundary. The best-fit result of the X-ray reflectivity data indicates 1) the deficiency of the surface Ca and/or F ions and 2) the presence of a layered interfacial structure of the adsorbed water, with minimal structural relaxations of the crystal. The surface deficiency is intimately related to the population of the oxygen reactive sites for speciation reactions, based on the obtained atomistic model for the surface structure. The derived interfacial water structure (as seen by a one-dimensional electron density profile) shows a strong similarity with that of the octacalcium phosphate (OCP), the so-called “hydrous defective apatite”. The metastable structural templating is thought to be characterisitc for this particular interface, which should become an important constraint (or at least an initial reference) for adsorption processes of radionuclides and heavy metal contaminants in aqueous environments.

Noble gases in Hiroshima H-chondrite

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Hiroshima meteorite, weighing 414 g, fell on Hiroshima, Japan, Feb. 2003. It is admitted as 49th meteorite fallen in Japan and considered as H-chondrite (Okada, personal communication). Hiroshima meteorite was analysed by using a mass spectrometric system (modified-VG5400/MS-II). Noble gases in Hiroshima meteorite were extracted by total melting method (10.3 mg at 1800°C) and stepwise heating method (48.0 mg at 400, 700, 1000, 1300 and 1750°C).

Table 1. The cosmic-ray exposure ages, K-Ar ages and the ^{22}Ne/^{21}Ne ratios of Hiroshima meteorite

Hiroshima	T_3	T_{21}	T_{38}	K-Ar age	^{22}Ne/^{21}Ne
	Ma			Ga (K=782ppm*)	
SH	86.6	87.5	54.1	4.55±0.23	1.07
TM	74.5	87.3	50.7	4.24±0.23	1.10

(SH: stepwise heating method, TM: total melting method)
* Kallemeyn et al. (1988)

The concentration of the cosmogenic nuclides ^{3}He, ^{21}Ne, and ^{38}Ar (10^{-9}cm^{3}STP/g) are (1) SH-1184, 285, 25.8, (2) TM-1377, 286, 27.5, respectively. K-Ar ages and cosmic-ray exposure ages of Hiroshima meteorite are given in Table 1. This meteorite shows the longest ejection age, compared with other chondrites summarized in Marti and Graf (1992). K-Ar age is estimated by using ^{40}Ar concentrations and the average K concentrations of 782ppm for H-chondrite (Kallemeyn et al, 1988). The obtained age is about 4.2~4.5 b.y., which is a typical for H-chondrite. The (^{22}Ne/^{21}Ne)$_c$ ratios of 1.07 and 1.10 for Hiroshima meteorite are lower than the average chondrite value of 1.11 (e.g., Eugster, 1988). Considering that the depth profile of ^{22}Ne/^{21}Ne ratios show monotonous decrease from surface to central part of meteoroids with radius <85 cm (Leya et al. 2000), Hiroshima meteorite could have been expelled from deeper part of relatively large meteoroid (>30cm). Trapped heavy noble gas concentrations of ^{36}Ar, ^{84}Kr and ^{132}Xe (Hiroshima-27.82, 0.267, 0.147 in 10^{-9}cm^{3}STP/g) show clear correlation with the petrologic type of chondrites (Marti, 1967), therefore, Hiroshima meteorite is classfied as H5 chondrite.

References

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