NA VARIATION AND REDOX STATE OF PLAGIOCLASE IN CK4 CHONODRITES: POSSIBLE RECORD OF THERMAL METAMORPHISM.

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Introduction: CK chondrites are only type of carbonaceous chondrites that have undergone various degrees of thermal metamorphism with petrologic grades from 3 to 6 [e.g. 1]. Also, CK chondrites are known to have formed under the most oxidized condition among all classes of meteorites [2]. Mineralogy of CK chondrites record shock metamorphism and subsequent annealing, i.e. shock darkening in silicates and andulary extinction [3]. Plagioclases in matrices show reverse zoning with wide range of compositional variation indendent of petrologic types [4]. Unequilibrium mineralogical composition in matrices, independen of degree of thermal metamorphism in CK chondrites, infer that they were heated after parent body process either on the parent body or in the meteoroids that left the parent body. Solar radiative heating has been suggested as heat source for the secondary heating process, on the basis of the temperature and duration of thermal metamorphism of CK chondrites [5].

Na depletion and heterogeneity are reported for meteoroids of Geminid meteor shower [6]. Possible cause of Na depletion in Geminids meteoroids are Na loss by solar heating of meteoroids or of its parent body (3200) Phaethon [6], because the peak temperature at its perihelion of 0.14 au is up to 1000 K, which is high enough for Na loss in Na-bearing silicate minerals, such as plagioclase.

(3200) Phaethon is a B-type asteroid with the bluest spectra in the solar system. Though meteorite analogues for B-type asteroids are not yet clearly defined, possible meteorite analogue for Phaethon is CK 4 or 5 chondrite [7]. In this study, Na variation of plagioclase and redox state of Fe in plagioclase are studied to understand thermal process that CK4 chondrite experienced.

Samples and methods: Two CK4 chondrites, NWA 735 and KOBE are studied. KOBE meteorite was kindly loaned by K. Tomeoka of Kobe university for this study. The chemical compositions of plagioclase were measured with electron microprobe (JEOL JXA 8900L at Univ. of Tokyo) using well-characterized natural and synthetic standards. The accelerating voltage was 15 kV and the beam current was 6 nA. We employed 5 micron beam size to minimize volatile loss. The Fe valence states of plagioclase were estimated using synchrotron radiation Fe-XANES (BL-4A, PF, KEK in Tsukuba, Japan). The beam size of synchrotron X-ray was about 5 microns. The analytical conditions and calculation procedures to estimate Fe3+/SFe from XANES data were mainly based on [8].

Results and discussion: Most plagioclase grains in both samples tend to show reverse zoning of Na (An=31-60), which is consistent with previous studies. Plagioglase generally show high FeO content (up to a few wt%) due to inclusion of magnetite. Modal abundance of plagioclase are nearly 10 vol% both in NWA735 and Kobe. The high abundance of plagioclase suggests they underwent extensive thermal metamorphism, causing partial melting. Reverse zoning may have caused by partial melting for short duration and subsequent Na loss from the melts.

Because plagioclase in both meteorites contains abundant opaque inclusions, there are not many plagioclase grains that can be analyzed by 5 micron synchrotron X-ray beam. We could analyze two grains from Kebe and one grain from NWA 735, respectively. The obtained Fe3+/SFe ratios are 0.53-0.58 and 0.73 for Kobe and NWA 735, respectively. These results show that plagioclase in CK chondrites contain significant amounts of Fe3+, which is consistent with oxidizing environment of CK chondrites during thermal metamorphism [7].

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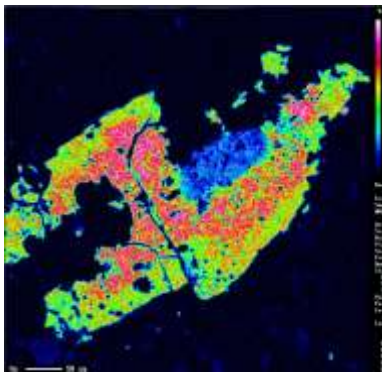

Fig. 1. Na elemental map of a reversely zoned plagioclase in NWA735 CK4 chondrite.