THERMAL HISTORY OF UREILITE AS INFERRED FROM MINERALOGY OF PECORA ESCARPMENT 82506. M. Miyamoto, Dept. of Pure and Appl. Sci., College of General Education, Univ. of Tokyo, Komaba 153, Tokyo, Hiromi Toyoda and Hiroshi Takeda, Mineralogical Institute, Faculty of Science, Univ. of Tokyo, Hongo, Tokyo 113, Japan.

It is generally understood that most ureilites experienced a high temperature episode, a shock event and rapid cooling (1)(2). However, quantitative estimate of some of the parameters of these processes has been difficult, partly because large unshocked specimens were not available for detailed mineralogical studies. Pecora Escarpment 82506 (PCA82506) is a new Antarctic ureilite weighing 5.3 kg. Mason (Antarctic Meteorite Newsletter, 1983) reported that the meteorite appears to be relatively unshocked compared to most ureilites. We investigated olivine and pigeonite from PCA82506, by combined single crystal X-ray diffraction, microprobe, and transmission electron microscope (ATEM) techniques, to gain better understanding of the thermal history of ureilite. A computer program written by Miyamoto (3) to reproduce a diffusion profile of a chemically zoned pyroxene has been applied to estimate the cooling rate of olivine.

A polished thin section (PTS), PCA82506,24 has been investigated by an electron microprobe. Quantitative analyses were made of olivine crystals, for every 4 microns from core to rim along the c axis, to obtain a diffusion profide towards the carbonaceous (C) matrix. Two crystals with a face coated with carbon nearly perpendicular to the plane of the PTS have been selected for the measurements. Several crystals separated from a small chip, PCA82506,13 were examined by an X-ray precession camera and 4-circle diffractometer to identify the orientation and the degree of shock deformation. After X ray study, the crystal for ATEM work was mounted in thick resin with the b axis perpendicular to the plane of a glass slide.

The pigeonite and olivine grains are present in subequal amount (Oliv. 52 : Pyx 48) The crystals gave very sharp diffraction spots in comparison with known ureilite minerals, except for ALH78019, for which no pigeonite crystal was available. Some large crystals of pigeonite show slight splitting of diffraction peaks. The pigeonite crystal show no evidence of exsolution. Faint diffuse streaks along a* indicate the presence of stacking faults. The observed cell dimensions are: a 9.660(2) A, b 8.870 (2), c 5.212(1), β 108.53(1) with possible space group, $P2_1/c$. The chemical composition of pigeonite is uniform $Ca_6Mg_{77}Fe_{17}$ (Fig. 1) and does not show variation at the grain boundary. The olivine crystals Fa_{20} show Mg enrichment zoning at the rim with C-matrix. A thin layer of enstatite about 10 microns thick was produced at the extreme rim, and fine iron particles at the most Mg-rich rim of the olivine crystal. The chemical zoning was observed within about 30 microns from the rim.

The reverse zoning at grain boundary of ureilite olivines is generally thought to be formed by reduction by C-matrix. We assumed that iron atomic diffusion in olivine controlls the formation of the zoning profile. We have numerically solved the diffusion equation taking both temperature and concentration dependence of diffusion coefficient of Buening and Buseck (4) into consideration. Boundary condition is that Fa content at edge of grain is zero. Initial profile is assumed to be a step function. We approximated an olivine grain as spherical shape. We have calculated the linear cooling rate from the initial temperature (1300, 1250, 1200, 1150°C) to 800°C to fit the calculated profile to the observed profile. The initial temperature

(1150 to 1250°C) was estimated from the chemical compositions of three coexisting pyroxenes in Y74130 (5) and the pyroxene geothermometer of Lindsley and Anderson (6). The calculated profiles of four typical cooling rates are compared with the observed profile in Fig. 2. 10°C/hr gives the best fit for the outer profile.

The estimated cooling rate, 10°C/hr is in good agreement with the rates estimated for Y74130 and Y790981 pyroxenes (3 to 20°C/hr) from the wave length of the spinodal decomposition of Ca-rich pyroxenes by Mori and Takeda (7). The cooling rates suggest very rapid cooling from high temperature. We attribute this event to destruction of a ureilite parent body or to an impact-induced excavation of the ureilite parental mass from their deep seated residence. The parental mass may be small, if the sample was resided in the center.

In summary, crystallography and mineralogy of the pigeonite and olivine crystals in PCA82506 indicate that this meteorite is relatively less shocked than others, and cooled rapidly from high temperature at cooling rate of 10°C/hr. The results are in agreement with our proposed working hypothesis on the origin of ureilites (8).

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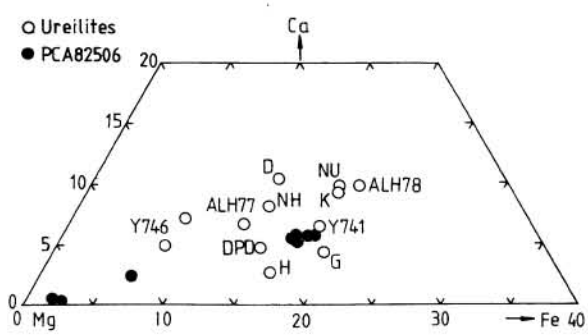

Fig. 1. A part of pyroxene quadrilateral of ureilites.

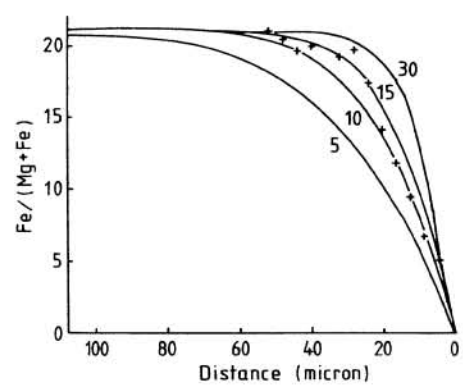

Fig. 2. Examples of calculated diffusion profiles (lines) for cooling rates, from 5-30°C/hr +: observed prophile.