**TIMING OF BASALTIC VOLCANISM IN UREILITE PARENTBODY INFERRED FROM THE 26AL AGES OF PLAGIOCLASE-BEARING CLASTS IN DAG-319 POLYMICT UREILITE.** N. T. Kita[1], Y. Ikeda[2], H. Shimoda[1], Y. Morishita[1] and S. Togashi[1], [1]Institute of Geoscience, Geological Survey of Japan, AIST, AIST Central 7, Tsukuba 305-8567, Japan (noriko.kita@aist.go.jp), [2]Ibaraki University, Mito 301-8512, Japan.

**Introduction:** Ureilitic meteorites are ultramafic rocks with highly depleted REE abundance, while showing primitive signatures, such as abundant noble gases and oxygen isotopic heterogeneities. A lack of basaltic components among ureilitic meteorites is the major cause of our poor understanding of their evolution. Especially, chronological studies of ureilites are limited because of depletion of incompatible trace elements (U, K, Rb, REE) used for radiometric dating. DaG-319 polymict ureilites contains variety of plagioclase-bearing clasts, corresponding to the products of basaltic magma generated on the ureilite parent body [1,2]. In-situ oxygen isotopic analyses of these clasts showed that they plot along CCAM line, thus confirming their ureilitic origins [3]. The SIMS trace element analyses in plagioclase indicated that (1) ureilite parent body evolved from a chondritic precursor with CI-like alkali to refractory elements ratios, and (2) low degree (1% -10%) partial melts were extracted repeatedly from solid residue to produced depleted mafic residue [4].

Here we report the results of the $^{26}$Al-$^{26}$Mg age determination in DaG-319 plagioclase-bearing clasts. Previous studies on similar clasts in other polymict ureilites gave only the upper limits of initial $^{26}$Al/$^{27}$Al ratios ($<10^{-6}$; >3.5 m.y. after CAIs [5]). The high precision (≤1‰) SIMS Mg isotopic analyses are newly developed in order to detect a small $^{26}$Mg excess in ureilitic plagioclase. Our new results demonstrate a short time scale of million years or less for the igneous differentiation of their parent body.

**Samples:** We have analyzed 10 plagioclase-bearing clasts from two thin sections of DaG-319 (AMNM 4963-1, 4963-3, named as "□" and "□", respectively) listed in Table 1, covering a wide range of plagioclase compositions (An0-100). The previous SIMS trace element study showed that calcic plagioclase (An>40) is often depleted in incompatible trace elements such as K, Ti, and Ba, while those in albitic plagioclase (An<30) is consistent with fractional crystallization process [4]. Among the listed samples, □18, □8, and □22A are highly depleted in incompatible trace elements, while □21A, □15 and □34A are the most evolved ones by fractional crystallization process.

**SIMS analyses:** Cameca IMS-1270 at the Geological Survey of Japan is used for Mg isotopic analyses. The primary ion beam of $O_2^-$ (5, 12, 20 μm; 0.03-0.5 nA) was exposed to the sample surface with acceleration voltage of 23 kV. The Mg ions are collected by electron multiplier (EM) in pulse counting mode. The dead time of the counting system (18-25nsec) was carefully evaluated in each analytical session with precision of 4nsec. In order to minimize the effect of dead time correction, $^{24}$Mg ion current was kept less than 0.1M cps. The 200-400 ratios are taken in each analytical position, resulted in 0.5-2 ‰ precision for $^{26}$Mg excess after mass fractionation corrections. The $^{27}$Al ions were collected by Faraday Cup sequentially with Mg isotopes by peak switching method. The measured $^{27}$Al/$^{24}$Mg ratios were corrected for the relative sensitivity factor determined from terrestrial plagioclase standards (An60-95). The variation of the factors among different standards was 10%, which is assigned as the uncertainty of the SIMS $^{27}$Al/$^{24}$Mg ratios.

**Results:** The results of 20 analyses from 10 clasts are shown in Fig. 1. All data lie on a single line with a slope of ~ $4\times10^{-7}$, corresponding to ~5M.y. after CAI formation by assuming ($^{26}$Al/$^{27}$Al)$_{CAI}$=$5\times10^{-5}$ [6]. High $^{27}$Al/$^{24}$Mg ratios (800-1,500) are observed from plagioclase in □21A, □15 and □34A. The $^{26}$Mg excesses of up to 4‰ are well resolved for these samples. By fitting these data to the normal Mg isotopic compositions ($^{26}$Mg/$^{24}$Mg=0.13932 [7]), the initial $^{26}$Al/$^{27}$Al ratios of individual clasts are estimated in Fig.2. For □21A, □15 and □34A, the ages inferred from the initial Al isotopic ratios (~5M.y) are identical to each others within analytical errors. In the rest of the samples, the $^{27}$Al/$^{24}$Mg ratios were in the range of 100-400 and the $^{26}$Mg excesses are 1‰ or less, which are not well resolved. Yet, most of data plot along the same isochron for □21A, □15 and □34A, indicating that they also formed ~5M.y. after CAI. Imprecise but similar initial $^{26}$Al/$^{27}$Al ratios of $(3\text{-}4)\times10^{-7}$ are obtained for □5 and □22A. For other five clasts, only the upper limits of the initial $^{26}$Al/$^{27}$Al ratio were obtained, which correspond to the formation age younger than 4-5M.y. after CAI formation.

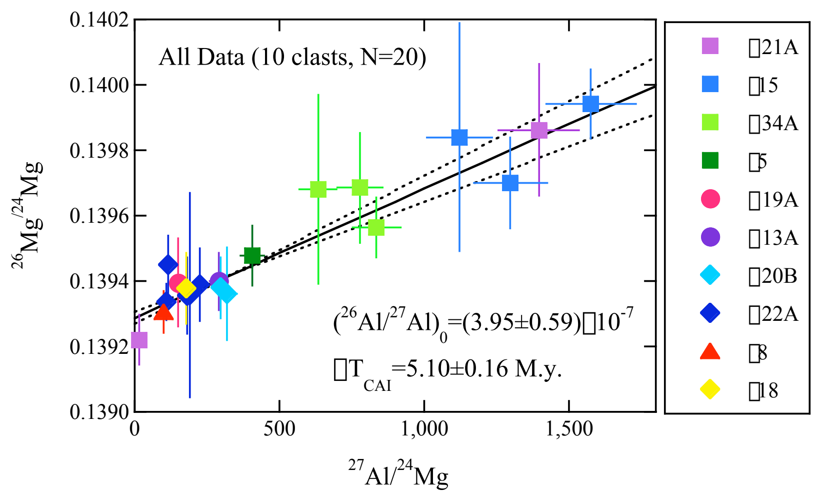
**Discussion:** The $^{26}$Al ages of the plagioclase-bearing clasts indicate the time of basaltic activities on ureilite parent body to be ~5M.y. after CAI formation. The $^{53}$Mn-$^{53}$Cr age of glass in polymict ureilite DaG-165, which is not plagioclase-bearing but having a similar compositions to albitic plagioclase-bearing clasts, also gives relative age of ~5M.y. from CAIs [8]. The incompatible trace element depleted clasts were derived from depleted source after the repeated partial melting process, indicating that they might form at the relatively later stage in the basaltic activities. The age inferred from one of the depleted clast, □22A, is indistinguishable from those of other clasts, indicating that the basaltic activities lasted only a short time, possibly less than million years, or maximum of 2M.y. considering the large error in □22A data. The same fractional melting process might further produce the olivine-pigeonite solid residue. It should be noted that the old U-Pb age of monomict ureilite MET-78008 (4,563±6 Ma [9]), the only monomict ureilite dated precisely, gives the relative age of 4±6M.y from CAIs, by assuming the Pb-Pb age of CAIs to be 4,567.2±0.6 Ma [10].

The presence of live-$^{26}$Al in plagioclase bearing clasts is the strong evidence for $^{26}$Al as a heat source of the parent body. Considering that the parent body accumulated at 2.4M.y. with the initial temperature of 500˚C, temperature of the parent body reached 1200˚C at 5M.y., if no heat loss is considered. Therefore, the ages inferred from plagioclase bearing clasts may indicate the time of on-set of basaltic activities on the parent body. Later than 5M.y., internal heat generation from $^{26}$Al was too small, so that olivine-pigeonite residue never reached its solidus temperature. Thus, igneous differentiation processes on the ureilite parent body might not last longer than million years. A short period of igneous process may be responsible for the conservation of primitive signature of its parent body.

**References:** [1] Ikeda Y. et al. (2000) *Antarct. Meteorite Res.* **13**, 177-221. [2] Ikeda Y. and Prinz M. (2001) *Meteorit&Planet. Sci.* 36, 481-499. [3] Kita N.T. et al. (2000) *Meteorit & Planet. Sci.*. **35**, A88. [4] Kita N.T. et al. (2001) *11th Annual V.M. Goldschmidt Conf.* #3577. [5] Davis A. M. et al. (1988) *LPS XIX,* 251-252. [6] MacPherson G. J. et al. (1995) *Meteoritics*, **30**, 365-386. [7] Catanzarro E. J. et al. (1966) *J. Res. NBS* **70a**, 453-458. [8] Goodrich C. A. et al. (2002) *Meteorit & Planet. Sci.*. **37**, A54. [9] Torigoye-Kita N. et al. (1995) *GCA*, **59**, 2319-2329. [10] Amelin Y. et al. (2002) *Science*, **297**, 1678-1683.

Table 1. List of plagioclase-bearing clast in DaG-319

| Name | Clast Type (co-existing minerals) | Mineral compositions | Ref |
|---|---|---|---|
| □18 | plagioclase | An93-96 | |
| □8 | troctolitic (olivine) | An87-89, Fo93 | 1 |
| □ 22A | plagioclase (with magmatic inclusion) | An18-47 | 1,2 |
| □ 20B | plagioclase | An28-40 | |
| □ 13A | porphylitic (augite) | An11-22, Wo38En46 | 1 |
| □ 19A | porphylitic (augite, ulvöspinel) | An2-10, Wo37En49 | |
| □5 | porphylitic (augite, pigeonite, apatite) | An11-17, Wo37En47, Wo9En63 | 2 |
| □ 34A | porphylitic (pigeonite, augite, whitlockite) | An3-21, Wo10En53, Wo37En48 | 1,2 |
| □15 | porphylitic (augite, pigeonite, whitlockite, apatite, ilmenite) | An2-9, Wo9En46, Wo38En38 | 1 |
| □21A | porphylitic (with rhyolitic glass) | An2-4 | |



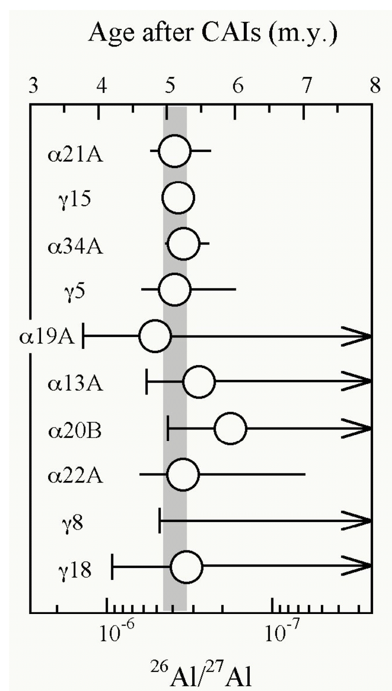




Fig. 1 (left). The $^{26}$Al-$^{26}$Mg isochron diagram of plagioclase-bearing clasts in DaG-319 polymict ureilite. The solid and dotted lines indicate the best fit line and its error, respectively.

Fig. 2 (right). The $^{26}$Al age of plagioclase-bearing clasts.