PETROLOGY AND MINERALOGY OF THE NORTHWEST AFRICA 8179 POLYMICT UREILITE. T. Mikouchi[1], [1]Department of Earth and Planetary Science, The University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan, E-mail: mikouchi@eps.s.u-tokyo.ac.jp.

Introduction: Northwest Africa 8179 (NWA 8179) is a 245 g ureilite discovered in 2013 [1]. Although its initial description does not say about a detailed texture, the sample studied shows clear brecciation in spite of similar mineral compositions in [1]. Brecciated ureilite is rare among ureilites and they are typically polymict rocks. In the Meteoritical Bulletin Database, only 27 samples are registered as "polymict ureilite" although the total number of ureilites is 435 (as of Jan. 9, 2017). Polymict ureilites are important samples to trace evolution history of the ureilite parent body (UPB) [e.g., 2]. In this abstract I report petrology and mineralogy of NWA 8179 and discuss its thermal history using ureilite lithologies.

Sample and Analytical Methods: A polished thin section (PTS) was prepared from a small rock chip (1.2 g) of NWA 8179 purchased from a meteorite dealer. It was first observed by optical microscopy and then mineral compositions were determined after X-ray elemental mapping was performed by JEOL JXA-8530F electron microprobe at the University of Tokyo.

Results: The PTS shows two distinct textures with similar abundances: unbrecciated typical ureilite lithology and brecciated ureilite lithology (Fig. 1). Olivine and pyroxene show extensive undulatory extinction, suggesting strong shock metamorphism. Clear difference is not found for shock degrees between two lithologies. The terrestrial alteration is severe and the fractures of PTS is filled with Fe rust. The unbrecciated ureilite lithology is at least 5 x 3 mm in size and shows a wavy contact against the brecciated lithology.

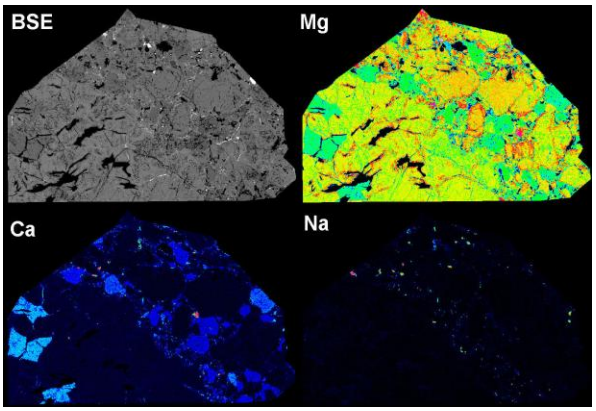

Fig. 1. BSE and X-ray maps of NWA 8179 (9 mm wide). An unbrecciated lithology is located at the lower left half of the PTS while a brecciated lithology is present at upper right, which is obvious in Ca & Na maps.

The unbrecciated lithology is composed of ~1 mm grains of ~70% olivine, ~20% pigeonite and ~10% elongated carbon mineral at interstices to olivine and pigeonite. The olivine grains show reduction rims (~40 μm) with Fe metal. The olivine core composition is Fo_{76-77} with 0.4 wt% CaO and 0.7 wt% Cr_2O_3 (Fig. 2). The pigeonite composition is $En_{77-70}Wo_{8-11}$ with 0.9 wt% Al_2O_3 and 1.1 wt% Cr_2O_3, but Mg-rich and Ca-poor pyroxene ($En_{80}Wo_6$) is locally present by patchy zoning (Fig. 3). Both olivine and pigeonite compositions are Fe-rich among ureilites, but within their ranges [e.g., 2].

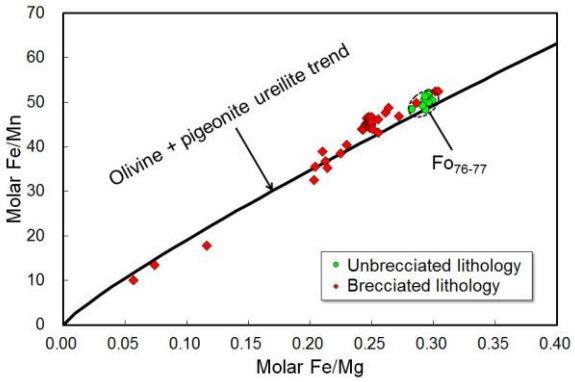

Fig. 2. Fe-Mn-Mg compositions for olivine in two lithologies of NWA 8179. The olivine-pigeonite ureilite trend is from [3].

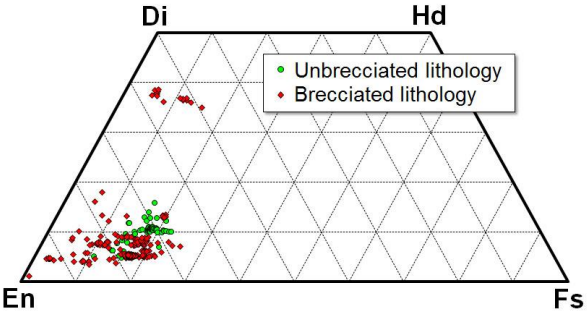

Fig. 3. Pyroxene compositions of two lithologies in NWA 8179.

The brecciated lithology shows a cataclastic texture mostly composed of various shaped olivine and pyroxene grains plus carbon mineral with smaller amounts of lithic clasts and some unusual components such as plagioclase. The sizes of olivine and pyroxenes fragments are up to 1.5 mm, but most of them are smaller than 0.5 mm and angular in shape. Lithic fragments are small

(<100 μm) and most of them are igneous clasts. However, fine-grained lithic clasts similar to the matrix of carbonaceous chondrites are also present (Fig. 3) although no obvious chondrule was found. They are mainly composed of phyllosilicates and magnetites. The olivine core composition of most olivine fragments is slightly more Mg-rich (Fo_{80}) than that in the unbrecciated lithology (Figs. 1 and 2), but more Mg-rich olivine exceeding Fo_{90} is present and usually associated with tiny Fe metal. Because most plots are on the ureilite trend on the Fe-Mn-Mg diagram, most mineral fragments have ureilite origins. Pyroxenes are mainly pigeonite, but both orthopyroxene and augite are present. Pigeonite is more Ca-poor and Mg-rich compared to that in the unbrecciated lithology as shown in Ca and Mg maps in Fig. 1. The pyroxene compositional range is clearly wider than that of unbrecciated lithology (Fig. 3), suggesting that each pyroxene grain is from different ureilite rocks or exotic components unrelated to ureilites. Thus, this meteorite is a polymict breccia, which is consistent with the presence of chondrite-like clasts. Plagioclase is present as small mineral fragments (up to 100 μm), which is common for polymict ureilites. Its composition is variable, and the analyzed fragments are An_4Or_4, An_9Or_2, $An_{21}Or_1$, $An_{41}Or_{0.5}$, and $An_{99.5}Or_{0.1}$.

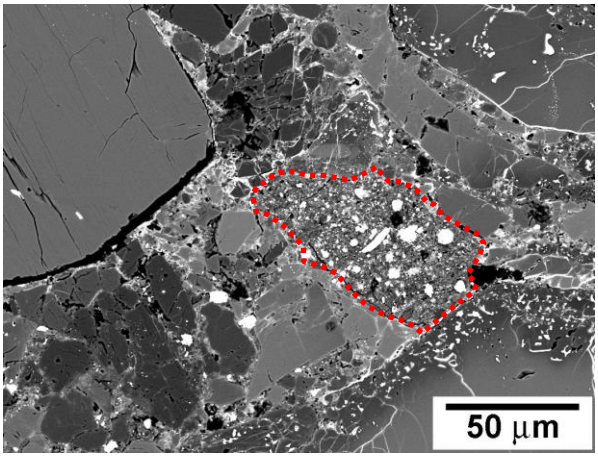

Fig. 3. BSE image of the brecciated lithology, showing variable mineral and lithic fragments. A fine-grained lithic fragment near the center of the image (surrounded by red dotted line) is similar to the matrix of carbonaceous chondrite.

Discussion and Conclusion: The petrology and mineralogy of NWA 8179 shows that it is a polymict ureilite. The description in [1] appears to correspond to the unbrecciated lithology of the PTS studied. Because the PTS size is small, it is not clear whether the obtsined petrology (e.g., equal amounts of unbrecciated and brecciated portions) from this study is representative of this meteorite or not.

The unbrecciated lithology shows a typical ureilite texture composed of olivine and pigeonite. A chemical zoning of Fe-Mg at the olivine reduction rim gives ~1 °C/hr cooling (1250 °C to 800 °C, logfO_2=IW-1, $D_{Fe\text{-}Mg}$ from [4]), which is consistent with most ureilites [5] (Fig. 4).

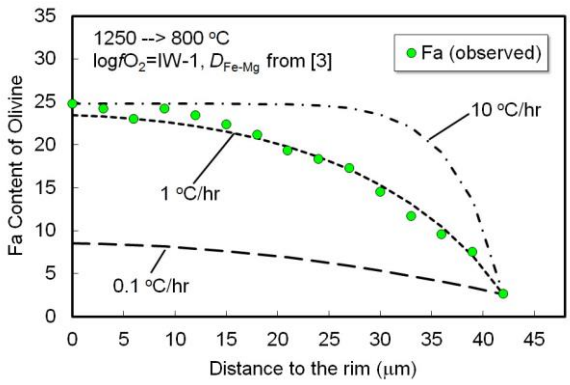

Fig. 4. Calculation of cooling rate of olivine in the unbrecciated lithology using the reduction rim.

In the brecciated lithology, there are not many lithic fragments showing contact of two pyroxenes. One of such clasts has coexisting Mg-rich orthopyroxene ($En_{88}Wo_4$) and pigeonite ($En_{80}Wo_8$). This pair is close to that found in Yamato 791538 [6], suggesting equilibrium at high temperature (~1250 °C).

Thus, the above thermal history (rapid cooling from high temperature, perhaps caused by explosive destruction of UPB) and accumulation into a daughter body as polymict breccia agree with a previous model of the ureilite history [e.g., 2,7].

The scrutiny of smaller constituents in the brecciated lithology is far from complete, but is promising to be encountered by unusual components unrelated to ureilites [e.g., 2,8]. In fact we have already found anorthite plagioclase that may be related to angrites and many small lithic clasts of aqueously altered carbonaceous chondrites, which is also common for other polymict ureilites [e.g., 8].

References: [1] Meteoritical Bulletin Database, https://www.lpi.usra.edu/meteor/metbull.php?code=58666. [2] Goodrich C. A. et al. (2004) *Chemie der Erde*, *64*, 283ï 327. [3] Goodrich C. A. and Delaney J. S. (2000) *GCA*, *64*, 149-160. [4] Misener D. J. (1974) *Geochem. Transport & Kinetics*, ed. Gilleti B. J. et al., 117-129. [5] Miyamoto M. et al. (1985) *Proc. 16th LPSC*, *JGR*, *90*, Suppl., D116-D112. [6] Takeda H. (1989) *EPSL*, *93*, 181-194. [7] Takeda H. (1987) *EPSL*, *81*, 358-370. [8] Ikeda Y. et al. (2000) *Antarct. Meteorite Res.*, *13*, 177-221.