REACTIONS ALONG THE BOUNDARIES BETWEEN PLAGIOCLASE AND DIOPSIDE OF UNGROUPED ACHONDRITE NORTHWEST AFRICA 7325

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Introduction: Northwest Africa (NWA) 7325 is an ungrouped achondrite with a unique green-colored fusion crust. It mainly consists of anorthite, diopside and forsterite [e.g., 1-2]. The mineralogical and geochemical properties of this meteorite indicate formation under highly reducing conditions [1-3]. The similarities in major element abundances, redox state and magnetic properties between NWA 7325 and the surface of Mercury suggest possible genetic relationship between them [1,3-4]. However, such planetary origin of this unique meteorite was proved unlikely, because of its very old age based on U-Pb dating and Al-Mg system [5-7]. In addition, NWA 7325 may experience shock-induced partial melting, as indicated by the presence of microlites of diopside and troilite along the boundaries between anorthite and diopside or olivine [8-9]. Micron-sized spinel-like inclusions were also reported in plagioclases, and they were interpreted as a reaction: plagioclase+diopside=Wo-enriched pyroxene+Mg-rich spinel+Na-enriched plagioclase [9]. In order to clarify formation and evolution of this unique meteorite, we are conducting a corrdinated analysis of petrography, geochemistry and Al-Mg isotopes. Here we report FIB-TEM analyses of the micron textures in plagioclase in contact with diopside or olivine.

Results and Discussion: Presence of abundant diopside microlites in the margins of plagioclase in contact with diopside and olivine is a common phenomenon as reported in previous studies [8-10]. This texture can be explained by crystallization of diopside from melt during a fast cooling process, and the melt could be produced by shock-induced partial melting of diopside and plagioclase. Beside diopside, the spinel-like microlites, Al-, Mg-rich and Si-, Ca-poor, were also found in plagioclase but locating relatively far from the boundaries. These micro-inclusions are similar with those reported by [9]. However, X-ray mapping revealed Na-depletion instead of presence of hot spots of Na.

Several focus ion beam (FIB) slices were prepared from these spinel-like microlites. Bright-field (BF)-TEM images reveal that these microlites occur as clusters of euhedral crystals embedding in the plagioclase matrix. The individual grains range from 30 nm to 200 nm in size. STEM-EDS mapping clearly shows that these euhedral crystals are high in Mg and Al and poor in Si and Ca, and contained 6-10 at% Mg and 25-32 at% Al. The Mg/Al atomic ratio of these microlites is between 1:5 to 1:2.5, and this composition is consistent with Al-rich Mg-Al-spinel. The selected area electron diffraction (SAED) patterns confirm that most of them are spinel. However, there are a few grains that do not match the patterns of spinel or corundum. A few needle-like Al-rich grains coexist with the spinel-like microlites, and their compositions are consistent with Al_2O_3 based on spot analyses.

The presence of Mg-Al-spinel with a few corundum in plagioclase could be produced by reaction between plagioclases and diopsides, as diopside+plagioclase=Al-rich spinel+corundum+melt(Na,Ca,Si,O). A scenario is that the parental asteroid of NWA 7325 was impacted, causing partial melting along the boundaries of plagioclase and diopside. During the post-shock remelting and fast cooling, certain amount of diopside-melt diffused into the interior of plagioclases and reacted to generate spinel and corundum. Along the boundaries of plagioclase, microlites of diopside were recrystallized. Very low content of sodium in the producing melt might be migrated together with silicon, as we found Ab-enriched plagioclases in the margins of coarsed diopside and plagioclase.

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