Mineralogy and noble gas of NWA 8707 L melt rock: Implications for thermal and shock history of an L chondrite parent body

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NWA 8707 is a newly found L melt rock showing an obvious igneous texture with evidence of strong shock. It is faintly brecciated (cm-to-mm scale) and thin shock melt veins cut through the sample. It is mainly composed of olivine, pyroxene and feldspathic glass with variable grain sizes (0.05-1 mm). Most pyroxenes are larger than 0.5 mm and poikilitically enclose small olivine. Olivine is rounded in shape and ranges 0.05-0.5 mm. Feldspathic glass is interstitial to olivine and pyroxene and forms network. There are some areas where feldspar is birefringent under petrographic microscope. Both olivine and pyroxene exhibit undulatory extinction and some olivine grains in shock melt are transformed to ringwoodite. Although shock metamorphism is extensive, original igneous texture is well preserved.

All phases are fairly homogeneous in compositions close to equilibrated L chondrites. Olivine is $Fa_{23.6\pm0.9}$ (FeO/MnO=35-60). CaO and Cr_2O_3 are both <0.05 wt%. Orthopyroxene is $Fs_{19.7\pm0.9}Wo_{3.3\pm1.0}$ with 0.3-0.6 wt% Cr_2O_3. High-Ca pyroxene is $Fs_{9.0\pm1.0}Wo_{42.0\pm1.9}$ with 0.5-1.0 wt% Al_2O_3, 0.3-0.4 wt% TiO_2, 0.7-1.0 wt% Na_2O and 1.1-1.7 wt% Cr_2O_3. Equilibration temperatures of both olivine-spinel and two-pyroxene pairs are similar (*ca.* 950 ºC). Feldspathic glass is Si-rich (71±2.2 wt% SiO_2, 23.2±1.1 wt% Al_2O_3) and does not show a stoichiometric composition of feldspar.

Low abundance of trapped noble gas components (e.g., $^{132}Xe \sim 3x10^{-12}$ cc/g) suggests degassing at high temperature, which is consistent with the above mineralogy. Young K-Ar age (~1600 Ma) is obtained (bulk K abundance of 860 ppm) and may correspond to an observed shock event in the sample.

NWA 8707 is a unique L melt rock showing later strong shock metamorphism. Its original igneous texture was likely formed by crystallization from melt and slowly cooled (or later metamorphosed). The heat source to form the original igneous texture is unclear, but NWA 8707 is different from other L melt rocks that were likely impact melts containing vesicles (e.g., PAT 91501). Such vesicles are absent in NWA 8707. These results suggest that an L chondrite parent body experienced a melting event and subsequently highly shocked. Such a series of events was probably common among parent bodies of ordinary chondrites.