Petrography, Mineral Chemistry and Shock Metamorphism of Martian Meteorite NWA 8657

S. Hu, Y. T. Lin and T. Zhang, Institute of Geology and Geophysics, Chinese Academy of Sciences, 19 Beitucheng West Road, Chaoyang District, Beijing, China, husen@mail.iggcas.ac.cn.

Introduction: At present, martian meteorites are the only samples that can be used in terrestrial laboratory to study the volcanic evolution history of Mars. NWA 8657 is a new basaltic martian meteorite recovered from desert of Northwest Africa. Irving and Kuehner have found that the sample mainly consists of complexly zoned, prismatically-twinned clinopyroxene and maskelynite laths with accessory ilmenite, ulvospinel, pytthotite, merrilite, chlorapatite and vesicular glass (Meteoritical Bulletin Database). In this work, we report the details of the petrography, mineral chemistry and shock metamorphism of NWA 8657.

Sample and Experiments: A polished section of NWA 8657 with area ~ 2×2 cm^2 was used in this work. EDX mapping was acquired using FE-SEM at the Institute of Geology and Geophysics, Chinese Academy of Sciences and the details of petrography were observed using FE-SEM at the National Astronomical Observatories, Chinese Academy of Sciences. Raman was carried out using Renishaw (inVia-Reflex type) at the Technical Institute of Physics and Chemistry, Chinese Academy of Sciences and the Guilin University of Technology. Mineral chemistry was determined using EPMA (JEOL 5230 type) at the Guilin University of Technology.

Petrography and Shock Metamorphism: NWA 8657 shows typical texture of basaltic shergottite, mainly consisting of pyroxene (64.3 vol%) and maskelynite (32.8 vol%) with minor opaque minerals (1.6 vol%) and phosphates (1.3 vol%). Pyroxene shows patchy zonation and usually has lamellae exsolution around shock melt zones. The accessory ilmenite, ulvospinel, pytthotite, merrilite, apatite and quartz are usually coexisted with maskelynite in the interstitial areas. The abundance of merrilite (grain size up to 400 μm with smooth surface) is significant higher than that of apatite (grain size up to 200 μm with smooth surface). Apatite tends to be enriched in Cl contents in melt pockets/zones compared with non-melt zone based on EDX analyses. The mesostasis is mainly consisting of K-rich maskelynite and quartz. Several tiny baddeleyite was found in interstitial areas or enclosed by ilmenite. Although any shock melt vein was not found on the section, small melt pockets and large melt zones were widely dispersed in the section with ~ 5 vol%. In melt zones, pyroxene started to recrystallize from the melt in micrometer sizes with detrital textures. In one melt zone, quartz has euhedral tiny crystals at the cores and detrital texture at the outer areas. Any high pressure polymorphism was not found in the section.

Mineral Chemistry: Pyroxene of NWA 8657 shows significant variations from $Fs_{19.1}En_{44.4}Wo_{36.5}$ to $Fs_{63.3}En_{22.2}Wo_{14.5}$. Makelynite is rich in Ca with composition varying from $An_{55.7}Ab_{43.0}Or_{1.3}$ to $An_{41.0}Ab_{50.5}Or_{8.5}$. However, plagioclase occurred in mesostasis and in melt inclusions is K rich with compositions varying from $An_{4.1}Ab_{45.7}Or_{50.2}$ to $An_{17.4}Ab_{46.2}Or_{36.4}$.

Discussions: Except highly zonation of the major elements, the minor Al, Ti, Mn and Cr are also zoned from pyroxene cores to rims. Ti and Mn abundances are significantly positive correlation with pyroxene Mg number (Mg/(Mg+Fe) mole fraction), while Cr abundances are reverse. These compositions suggest that the pyroxene of NWA 8657 crystallized in a fractionating closed system. The crystallization temperature of pyroxene is 1100 ºC to 1000 ºC under 1 atm based on the pyroxene thermometry [1]. The pyroxene composition of NWA 856 is significantly different with Shergotty, Zagami, NWA 480 and NWA 856 [2-4]. After crystallization, the parent rock of NWA 8657 experienced a strong impact based on the large amount of melt zones and pockets. However, any high pressure polymorphism was not found in the section and recrystallization of pyroxene in melt zones suggests the impact pressure and the cooling rate are not able to support the formation of high pressure minerals.

Acknowledgements: This work was financially supported by the National Natural Science Foundation (41430105, 41490631, 41573057 and 41521062).

References: [1] Lindsley D. H. 1983. *American Mineralogist* 68: 477-493. [2] Stolper E. and McSween H. Y. 1979. *Geochimica Et Cosmochimica Acta* 43:1475-1498. [3] Barrat J. A. et al. 2002. *Meteoritics & Planetary Science* 37:478-500. [4] Jambon A. et al. 2002. *Meteoritics & Planetary Science* 37:1147-1164.