NORTHWEST AFRICA 032, A NEW LUNAR MARE BASALT. T. J. Fagan[1], T. E. Bunch[2], J. H. Wittke[3], E. Jarosewich[4], R. N. Clayton[5], T. Mayeda[5], O. Eugster[6], S. Lorenzetti[6], K. Keil[1], G. J. Taylor[1], [1]Hawai'i Institute of Geophysics and Planetology, School of Ocean and Earth Science and Technology, University of Hawai'i at Manoa, Honolulu, HI, USA (fagan@pgd.hawaii.edu), [2]NASA Ames Research Center, Space Science Division, Moffett Field, CA 94035, USA, [3]Department of Geology, Northern Arizona University, Flagstaff, AZ 86011, USA, [4]Department of Mineral Sciences, Smithsonian Institution, Washington, DC 20560, USA, [5]Enrico Fermi Institute, University of Chicago, Chicago, IL 60637, USA, [6]Physikalisches Institut, Universität Bern, CH-3012 Bern, Switzerland.

Abstract: Mineralogy, textures, oxygen isotopic composition, and whole-rock and mineral major element compositions attest to a lunar origin for Northwest Africa 032 (NWA 032), an unbrecciated basaltic meteorite found in October 1999 [1]. NWA 032 is similar to Apollo 12 and 15 olivine basalts; however, low whole-rock MgO combined with high olivine phenocryst abundance suggests that NWA 032 represents a previously unsampled mare basalt.

Mineralogy, Textures and Composition: Northwest Africa 032 is a crystalline basalt (SiO_2 = 44.7 wt.%) with olivine and pyroxene phenocrysts. The groundmass is composed mostly of bundles of elongate pyroxene and plagioclase (An_{86}) crystals radiating from common nucleation sites. Groundmass pyroxenes are zoned from ~ Wo_{10} to Wo_{40} and En_{05} to En_{45}. Other groundmass minerals include elongate splays of ilmenite, equant grains of troilite and rare Fe metal.

Phenocrysts of olivine (~12 vol.%) and pyroxene (~5 vol%) range up to ~ 200 µm across and are surrounded by FeO-rich rims <5 µm wide. Small equant chromite phenocrysts are typically included within or occur adjacent to olivine. Pyroxene phenocrysts exhibit complex variations in CaO, Al_2O_3, MgO, and FeO, but both olivine and pyroxene are characterized by decreasing Mg/(Mg + Fe) from core to rim. Phenocryst interiors have broad zoning profiles with Mg/(Mg + Fe) ranging from 0.65 to 0.55. Steeper compositional profiles, with Mg/(Mg + Fe) descending to ~0.5, occur adjacent to the FeO-rich quenched margins. The quenched margins have Mg/(Mg + Fe) as low as 0.15. Where olivine and pyroxene phenocrysts are intergrown, an FeO-rich margin does not occur along the olivine/pyroxene interface, indicating that the phenocrysts grew together before the groundmass crystallized.

Shock effects include whole-rock melt veins, maskelynitization of feldspar, and undulatory to mosaic extinction in olivine phenocrysts, suggesting shock pressures in excess of 25 GPa [2].

The whole-rock oxygen isotopic composition ($\delta^{18}O$ = +5.6‰, $\delta^{17}O$ = +2.9‰) falls on the terrestrial fractionation line. Mn/Fe ratios in pyroxene and olivine are within the ranges identified for lunar rocks and are distinct from values associated with the Earth, Mars, and Vesta [3,4]. The major element composition is similar to low-Ti (TiO_2 = 3.0 wt. %) mare basalt.

Petrogenesis and Lunar Origin: The broadly zoned phenocrysts with distinct FeO-rich rims and the radiating texture of groundmass crystals indicate that rapid crystallization followed relatively slow phenocryst growth in NWA 032. Preliminary modelling using MELTS [5] suggests that spinel, olivine, and pyroxene crystallize from a melt of NWA 032 composition as temperature drops from ~ 1200 to 1150°C under low pressure (1 bar), whereas high pressure (5 kb) suppresses olivine crystallization.

NWA 032 is similar in major element composition to mare basalts collected during Apollo 15 [6], but has a higher concentration of olivine phenocrysts (12 vs. 0.1 to 8.6 vol.%). NWA 032 is similar to Apollo 12 basalts in olivine phenocryst abundance [6], but has significantly lower whole-rock MgO (8.5 vs. 11.5 to 16.5 wt.%). These data suggest that NWA 032 represents a previously unsampled mare basalt.

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