NORTHWEST AFRICA 5298: A STRONGLY SHOCKED BASALTIC SHERGOTTITE EQUILIBRATED AT QFM AND HIGH TEMPERATURE.
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Among the 51 known unpaired Martian meteorites, at least 15 are “enriched” shergottites characterized by relatively high LIL element abundances and Lu/Yb ratios, high intrinsic magmatic oxygen fugacities and young crystallization ages (165-225 Ma). Petrologically these specimens range from more primitive, olivine-bearing “basalts” (such as NWA 1068/1110, NWA 4468 and RBT 04261/2) to pigeonite “basalts” (Shergotty, Zagami, NWA 3171, etc.) to more ferroan, evolved examples (Los Angeles, Dhofar 378, NWA 2800) [1]. All of these specimens plausibly are related as a series of fractionally crystallized magmatic liquids from primary olivine-saturated magmas generated by recent partial melting of a peridotitic mantle source.

Northwest Africa 5298: This moderately-evolved “enriched” basaltic shergottite has more complex pyroxene zoning, more phosphates, more silica, and is more highly shocked and oxidized than most. It is composed mainly of intergrown elongated grains of zoned pyroxene (FeO/MnO = 26.3-39.4) and lath-shaped regions of vesicular, extensively devitrified plagioclase glass (~An21.3Or1.0), with accessory titanomagnetite (Us3p3Sp33Ch63a), ilmenite (Im0.9-2.4;Hem0.0-1.3;Gk0.6-1.0;Py1.7), silica, Na-Fe-merrillite, Cl-apatite, pyrrhotite, fayalite and baddeleyite. Silica forms subhedral grains (up to 0.4 mm) within plagioclase glass. Pyroxene grains are compositionally zoned from subcalcic augite cores (Fs23.8Wo28.4) to pigeonite mantles (Fs36.2Wo11.7) to ferropigeonite rims (Fs68.0Wo15.3), with highly irregular and curvilinear zone boundaries that may reflect dissolution/resorption of growing crystals in response to changes in fluid fugacities in evolving residual liquids or possibly subsolidus processes. Oxygen fugacities during crystallization deduced [2] from compositions of coexisting Fe-Ti oxides are essentially at QFM, T = 1012 ± 20°C. NWA 5298 is thus more oxidized than all other known shergottites except NWA 1068 [3].

Metasomatism of the Martian Mantle?: By analogy with processes operative in Earth’s mantle [4], we propose that the mantle source regions for “enriched” shergottite parental magmas were metasomatized (perhaps long before their young eruption times) by hydrous and chlorine-bearing fluids or magmas, which not only added Fe and LIL elements but also ferric iron. Patterns of LIL trace element abundances and radiogenic isotope ratios also support such a model [5]. This may explain why the most primitive olivine-bearing examples (NWA 1068, NWA 4468) have Mg/(Mg+Fe) ratios (0.59) significantly lower than those (0.68) for the older depleted olivine-phyric shergottites like Yamato 980459, NWA 1195, etc.