LODRANITES AND LODRANITES: RECENT FINDS DEMONSTRATE WIDE MINERALOGICAL AND TEXTURAL DIVERSITY WITHIN THE ACAPULCOITE-LODRANITE PARENT BODY

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Introduction: Since the fall of Lodran in 1868 and petrologic studies of mostly Antarctic lodranite and acapulcoite specimens in the 1990s [1], many more examples have been recovered in Northwest Africa. The grainsize continuum between acapulcoites and lodranites evident from this larger suite [2] begs the question about the need for two separate names. Furthermore, the modal mineralogy of coarser grained specimens is much more diverse than previously thought. Like terrestrial ulramafic rocks, lodranites comprise not only protogranular-textured lherzolitic/olivine websteritic lithologies, but wehrlites, olivine orthopyroxenites and various breccias. Oxygen isotopes have been measured on most of the samples described here and plot within the broad field defined by earlier studies [3].

Lodranite breccia Northwest Africa 8118/8216/8251/11129: Several paired stones found near Tait Rih, Morocco are breccias composed of angular mineral grains of olivine ($Fa_{11.3\text{-}11.8}$, FeO/MnO = 22-33), orthopyroxene ($Fs_{9.8\text{-}12.0}Wo_{1.7\text{-}4.9}$, FeO/MnO = 14-31) and distinctly green clinopyroxene ($Fs_{4.4\text{-}5.7}Wo_{43.0\text{-}45.1}$, FeO/MnO = 9-15, Cr_2O_3 = 0.9-1.0 wt.%) with accessory Cr-rich chromite, altered low-Ni kamacite and troilite in a sparse, finer grained matrix.

Lodranite breccias Northwest Africa 10368 and Northwest Africa 10652: NWA 10368 is composed of clasts (up to 3.8 mm) of single mineral phases plus some composite clasts in a sparse matrix. Major minerals are olivine ($Fa_{10.6\text{-}10.7}$, FeO/MnO = 22-23), clinopyroxene ($Fs_{3.7\text{-}3.9}Wo_{45.3\text{-}45.2}$, FeO/MnO = 9-10) and orthopyroxene ($Fs_{9.7\text{-}9.8}Wo_{1.2\text{-}2.5}$, FeO/MnO = 14-16) with accessory Cr-rich chromite, altered kamacite, pyrrhotite and pentlandite. NWA 10652 is a different matrix-poor breccia with clasts composed mainly of protogranular olivine (grainsize up to 8 mm; $Fa_{10.6\text{-}11.3}$, FeO/MnO = 28-37) with subordinate clinopyroxene ($Fs_{4.0\text{-}4.6}Wo_{44.5\text{-}44.2}$, FeO/MnO = 12), plus accessory chromite, Ni-free metal and pyrrhotite. Neither of these breccias nor the Tait Rih stones are paired with Northwest Africa 4478 [4].

Annealed lodranite breccia Northwest Africa 10857: This specimen is a heterogeneous, highly recrystallized and partly annealed breccia composed of polymineralic clasts and related mineral debris. Some deformed orthopyroxene grains are up to 4 mm in size, but most mineral grains are much smaller and variable in size. Minerals are olivine ($Fa_{10.6\text{-}10.9}$, FeO/MnO = 33-35), orthopyroxene ($Fs_{9.9\text{-}10.0}Wo_{1.0\text{-}2.2}$, FeO/MnO = 18-19), clinopyroxene ($Fs_{3.6\text{-}4.4}Wo_{46.3\text{-}43.5}$, FeO/MnO = 10-13), chromite, altered Ni-poor kamacite and troilite.

Wehrlitic lodranite Northwest Africa 10265: This specimen is a coarse grained (up to 6.5 mm) protogranular aggregate of predominantly clinopyroxene (finely exsolved) and olivine ($Fa_{11.0\text{-}11.2}$, FeO/MnO = 33-36) with accessory chromite, Ni-poor kamacite and troilite. Pyroxenes consist of clinopyroxene host ($Fs_{4.1\text{-}4.6}Wo_{42.7\text{-}44.0}$, FeO/MnO = 12, Cr_2O_3 = 1.1-1.3 wt.%) with orthopyroxene exsolution lamellae ($Fs_{9.7\text{-}10.6}Wo_{0.9\text{-}2.3}$, FeO/MnO = 18-24).

Olivine-bearing orthopyroxenitic lodranite Northwest Africa 11494: This protogranular specimen is dominated by orthopyroxene ($Fs_{14.0\text{-}14.3}Wo_{2.2\text{-}2.5}$, FeO/MnO = 17-19) with accessory chromite, clinopyroxene ($Fs_{6.3\text{-}6.5}Wo_{43.2\text{-}42.3}$, FeO/MnO = 11-16), olivine, merrillite, kamacite and pentlandite. Olivine inclusions within orthopyroxene are more ferroan ($Fa_{16.1\text{-}16.4}$, FeO/MnO = 35-38) than olivine associated with chromite grains ($Fa_{11.4\text{-}12.8}$, FeO/MnO = 25-30).

Reduced plagioclase-bearing olivine orthopyroxenitic lodranite(?) Northwest Africa 11511: This specimen is a protogranular aggregate of mafic silicates (orthopyroxene with subordinate olivine, grainsize 0.2-0.7 mm) with accessory sodic plagioclase, tabular graphite and rare schreibersite. Both orthopyroxene ($Fs_{10.4\text{-}10.5}Wo_{4.5\text{-}4.4}$, FeO/MnO = 13; rim $Fs_{1.1}Wo_{0.4}$) and olivine ($Fa_{12.6\text{-}12.7}$, FeO/MnO = 22-23; rim $Fa_{6.8}$) have thin reduced, Mg-rich rims containing minor blebs of Fe metal. There are some similarities to reduced lodranites NWA 8410 and NWA 8422 [5], but NWA 11511 differs in being very orthopyroxene-rich, lacking Ca-rich pyroxene and containing graphite.

References: [1] McCoy T. *et al.* (1997a, b) *Geochim. Cosmoschim. Acta* **61**, 623-637 and 639-650. [2] Bunch T. et al. (2011) *74th Meteorit. Soc. Mtg.*, #5225. [3] Greenwood R. (2017) *Chemie der Erde* **77**, 1-43. [4] Irving A. et al. (2007) *70th Meteorit. Soc. Mtg.*, #5129. [5] Kuehner S. et al. (2015) *Lunar Planet. Sci.* **XLVI**, #2411.