Reference List

NWA2046 – 63 grams
Depleted Olivine-phyric Shergottite

Figure 1: *Photo of "bottom" of NWA2046 (from internet)*

Introduction
Russell et al. (2004) report that a 63 gram complete and partially crusted stone was purchased in Moracco in 2003 by M. Farmer. The interior is fresh (figure 1).

Petrography
Irving *et al.* (2004) report the petrology of NWA2046. Olivine phenocrysts (2 mm) are euhedral to subhedral and found in clumps (figures 2, 3). Long prismatic pyroxenes (2 mm) have low-Ca cores (orthopyroxene?) are overgrown with pigeonite (figure 4). These phenocrysts are set in a fine-grained groundmass composed mainly of intergrown pigeonite and maskelynite (figure 5). Irving *et al.* find that the pyroxene and olivine phenocrysts have preferred orientation (figure 7).

Minor phases include chromite, ilmenite, ulvospinel, pyrrhotite, merrillite, chlorapatite, and fayalite. Olivine also includes magmatic melt inclusions (described in Irving *et al.* 2004).

Mineralogy
Olivine: Olivine is zoned from Fo_{84-52}.

Pyroxene: Pyroxene cores are $En_{80}Fs_{18}Wo_{2.5}$ and zoned to high-Ca pigeonite (figure 4 a,b)(Irving et al. 2004; Papike et al. 2009).

Plagioclase: Maskelynite is An_{75-62}.

Chemistry
Irving classifies NWA20146 as depleted, but I don't know how he knows that.

Radiogenic age dating
None

Figure 2: *Sawn surface of NWA2046 (photo from Irving et al. 2004). Sample is 3 cm across.*

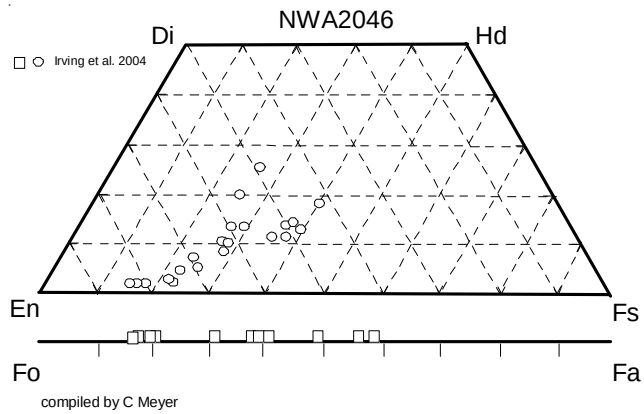

Figure 4a: *Pyroxene and olivine composition of NWA2046 (replotted from Irving et al. 2004).*

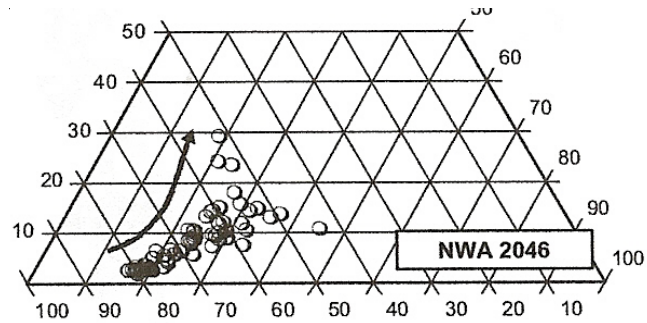

Figure 4b: *Pyroxene analyses by Papike et al. (2009).*

Cosmogenic nuclides

Berezhnoy et al. (2010) reported activity of ^{26}Al and ^{53}Mn. Nishiizumi and Caffee (2004) reported preliminary ^{10}Be CRE age of 1.1 m.y.

Other

Oxygen isotopes were reported by Rumble and Irving (2009); Delta 17O = 0.3 ‰.

References for NWA2046

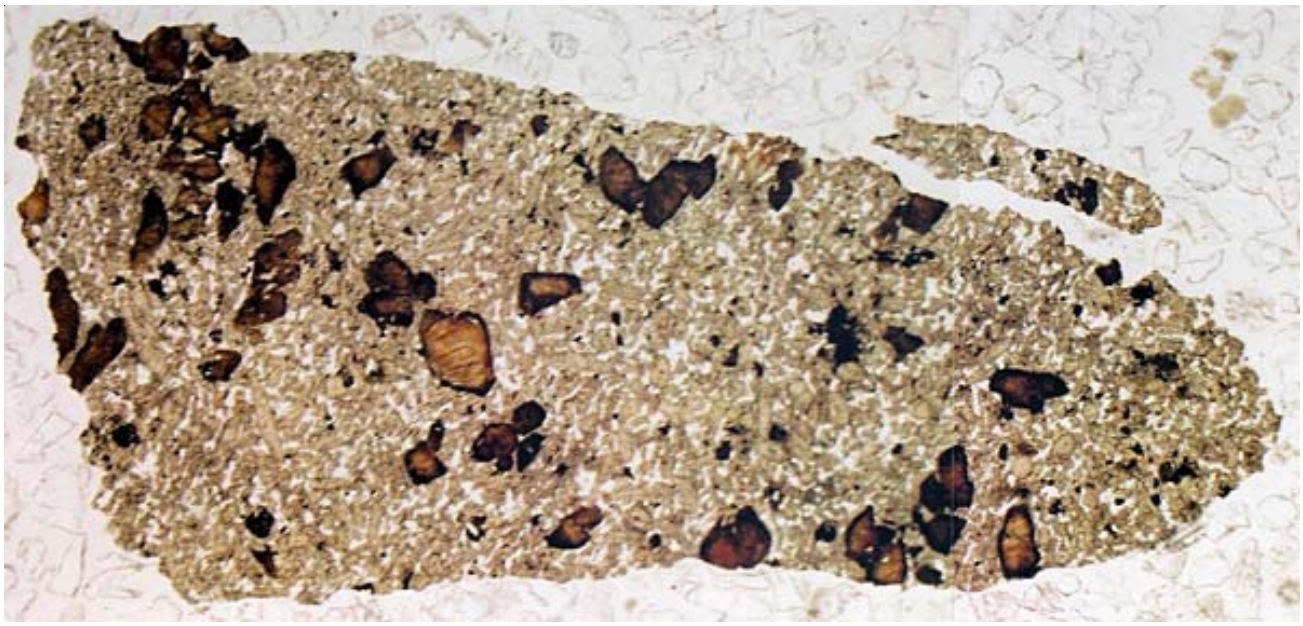

Figure 3: *Photomicrograph of thin section of NWA2046 (from Wittke and Bunch 2004).*

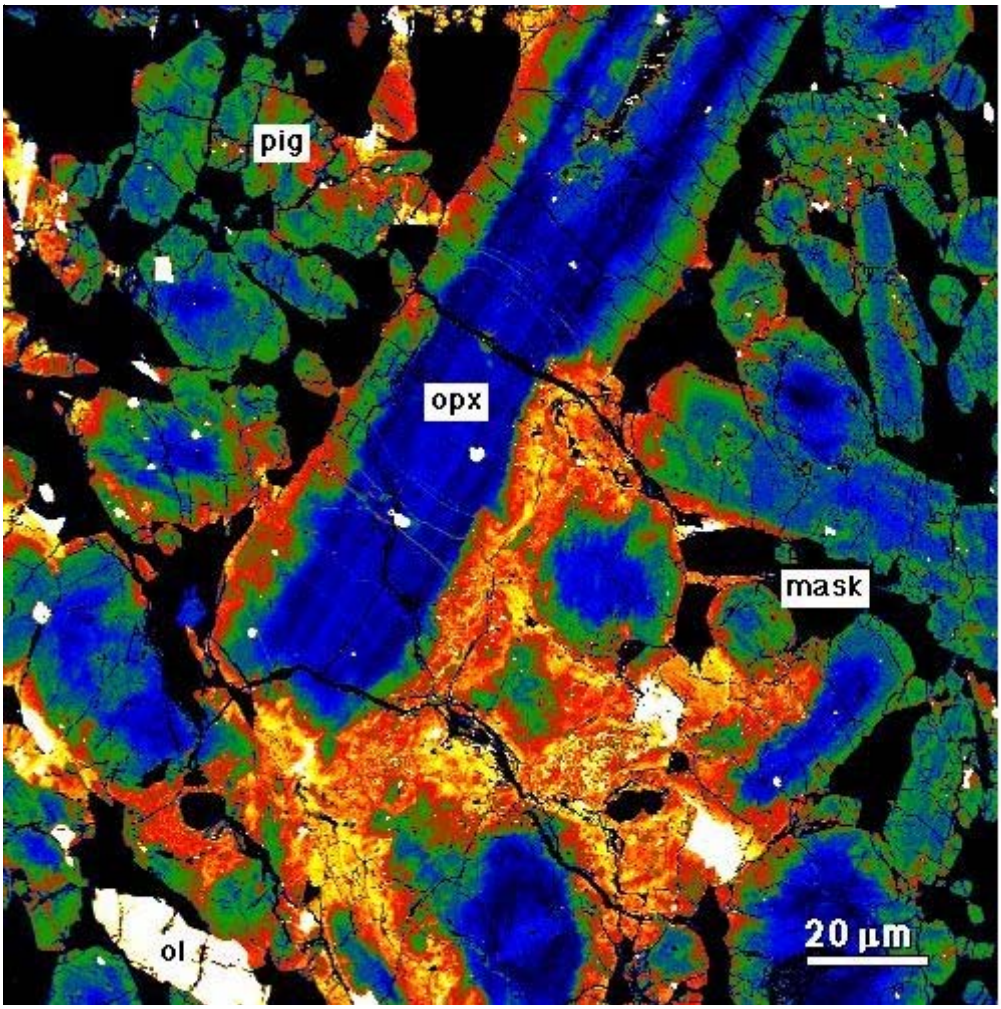

Figure 5: *Element map (Fe?) from Tony Irving showing large, zoned orthopyroxene (this is figure 3 in Irving et al. 2004).*

Figure 6: *Another picture of NWA2046 (from Mike Farmer).*

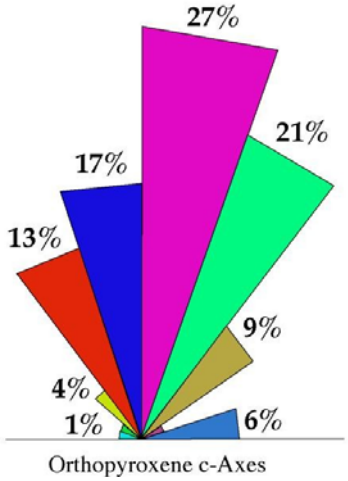

Figure 7: *Rose diagram plot of the long axes orientations of 148 prismatic orthopyroxene phenocrysts in a thin section of NWA 2046, indicating that 87% of the orthopyroxene grains are preferentially oriented within +/-36deg in the same direction (in planer projection). Diagram from Theodore Bunch.*