Reference List

NWA1950 – 797 grams

Intermediate Diabasic Shergottite

(2 stones)

Figure 1: *Photo of NWA1950 (from Barrat). Cm scale belongs to Bruno Fectay and Carine Bidaut who first obtained these nice specimens.*

Introduction

Two stones (414 and 383 grams) were found in the Atlas Mts. Morocco in 2001 (Russell *et al.* 2004; Gillet *et al.* 2005). They each have a complete fusion crust (figures 1 and 4). Together, they are also known by their field name "Jules Verne". Perhaps more specimens will be found.

A preliminary age for NWA1950 is 382 m.y., and a cosmic ray exposure age (~3 m.y.) has been determined.

Petrography

The texture of NWA1950 is similar to that of ALH77005 (figure 2). Two lithologies are present; characterized as poikilitic and "non-poikilitic" (Gillet *et al.* 2005; Mikouchi 2005). The poikilitic lithology has large low-Ca pyroxene (up to 6 mm) surrounding large euhedral olivine and small chromite. The "non-poikilitic" lithology has intergrown augite, pigeonite and maskelynite as well as numerous accessory minerals including chromite, ilmenite, sulfide, phosphate, rare baddeleyite and a K-rich phase (glass?).

Mineralogical Mode of NWA1950

	Russell et al. 2004	Gillet et al. 2005	Walton and Herd 2007
Olivine	55 vol. %	55	45.3
Pyroxene	35	35	34.5
Maskelynite	8	8	11
Chromite			5.7
Melt pockets			1.8

Figure 2: *Photo of interior of NWA1950 (from web site by Jim Strope).*

Magmatic melt inclusions are common in both olivine and pyroxene. These petrographic features are more like those of a diabase than a lherzolite.

Walton and Herd (2007) and Walton *et al.* (2008) studied the melt pockets in NWA1950. They find these are due to shock melting, presumably at the time of launching off of Mars.

Fractures in NWA1950 contain calcite (from terrestrial weathering).

Mineralogy

Olivine: Olivine Fo_{66-75} has FeO/MnO = 50 ± 10 (Gillet *et al.* 2005). Olivine often contains chromite and magmatic melt inclusions. Van de Moortele et al. (2007) and Kurihara et al. (2009, 2010) studied the brown color of olivine.

Pyroxene: Both pigeonite ($En_{78}Fs_{19}Wo_2$-$En_{60}Fs_{26}Wo_{14}$.) and augite ($En_{53}Fs_{16}Wo_{31}$-$En_{45}Fs_{14}Wo_{41}$) are present in NWA1950 (figure 4). They are relatively homogeneous and unzoned (Mikouchi 2005).

Plagioclase: All of the plagioclase in NWA1950 is shocked to maskelynite An_{57-40} (Gillet *et al.* 2005; Mikouchi 2005).

Chromite: Small (20-100 microns) euhedral chormite inclusion in olivine and pyroxene have compositions similar to those in ALH77005 (Gillet *et al.* 2005). Walton and Herd (2007) found a lot of chromite, in their sample.

Sulfide: The sulfide phase is pyrrhotite with high Ni, some pentlandite, and trace Cu.

Phosphates: Channon *et al.* (2011) reported in apatite.

Chemistry

The composition of NWA1950 has been determined by Gillet *et al.* (2005)(table 1). The rare earth elements (figure 5) are found to be between ALH77005 and NWA480. The light REE are slightly depleted compared with the heavy REE, so this rock appears to be "intermediate" between the "enriched" and "depleted" shergottites.

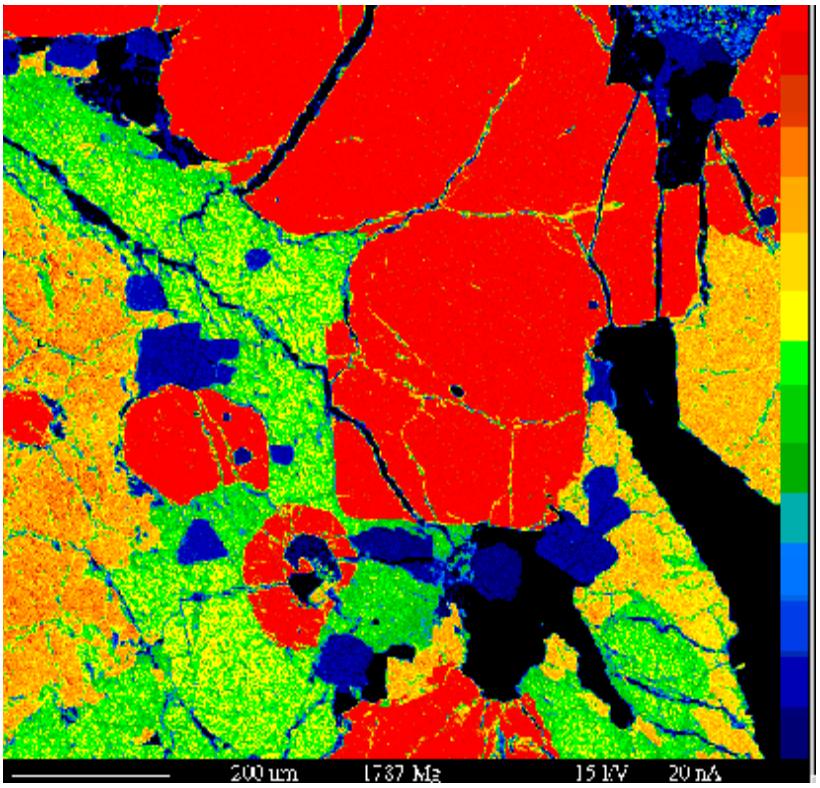

Figure 3: *Texture of polished section of NWA1950 (courtesy J-A.Barrat and Marcel Bohn). Minerals generally lack chemical zonation. This striking photo is a map of Mg content of olivine (red), chromite and or ilmenite (blue), maskelynite (black), pigeonite (orange) and augite (green).*

Radiogenic age dating

Walton *et al.* (2008) reported an age of 382 ± 36 m.y. based on Ar/Ar laser probe data.

Cosmogenic isotopes and exposure ages

Gillet *et al.* (2005) report cosmic ray exposure ages ^{3}He = 5.3 ± 3.0 m.y., ^{21}Ne = 3.5 ± 0.8 m.y., and ^{38}Ar = 2.3 ± 1 m.y. Christen *et al.* (2005) determined a exposure ages of ^{3}He = 4.1 ± 0.6 m.y., ^{21}Ne = 5.3 ± 0.8 m.y., and ^{38}Ar = 2.9 ± 0.4 m.y. (average is 4.1 ± 1.4 m.y.). Walton *et al.* (2008) reported a CRE age of 1.5 ± 0.3 m.y. based on Ar laser probe data. Berzhnoy *et al.* (2010) determined the activity of ^{10}Be, ^{26}Al and ^{53}Mn and reported a cosmic ray exposure age of 2.7 m.y. Note that there is not a lot of agreement !

Other isotopes

Oxygen isotopes are reported as delta^{17}O = 2.54 ‰, delta^{18}O = 4.28 ‰, and DELTA^{17}O = 0.31 ‰ by Gillet *et al.* (2005).

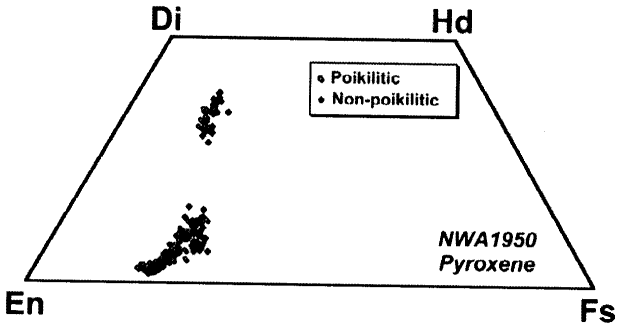

Figure 4: *Pyroxene compositions in NWA 1950 (Mikouchi 2005).*

References for NWA1950

Table 1. Chemical composition of NWA1950.

reference	Gillet 2005		
weight		fusion crust	
SiO2 %		43.97	(a)
TiO2	0.55	0.56	(a)
Al2O3	4.02	4.02	(a)
FeO	21.65	21.77	(a)
MnO	0.46	0.52	(a)
MgO	25.06	20.87	(a)
CaO	4.09	5.13	(a)
Na2O	0.81	0.82	(a)
K2O	0.1	0.02	(a)
P2O5	0.65	0.7	(a)
S %			
sum			
Sc ppm			
V			
Cr	6400		(a)
Co	71		(b)
Ni	306		(b)
Cu	7.6		(b)
Zn	48.8		(b)
Ga	9.3		(b)
Ge ppb			
As			
Se			
Rb	0.78		(b)
Sr	21.5		(b)
Y	9.61		(b)
Zr	26		(b)
Nb	1.12		(b)
Mo			
Ru			
Rh			
Pd ppb			
Ag ppb			
Cd ppb			
In ppb			
Sn ppb			
Sb ppb			
Te ppb			
Cs ppm	0.041		(b)
Ba	9.94		(b)
La	0.586		(b)
Ce	1.51		(b)
Pr	0.24		(b)
Nd	1.34		(b)
Sm	0.739		(b)
Eu	0.343		(b)
Gd	1.37		(b)
Tb	0.261		(b)
Dy	1.77		(b)
Ho	0.367		(b)
Er	0.984		(b)
Tm	0.141		(b)
Yb	0.81		(b)
Lu	0.12		(b)
Hf	0.82		(b)
Ta	0.064		(b)
W ppb	119		(b)
Re ppb			
Os ppb			
Ir ppb			
Pt ppb			
Au ppb			
Th ppm	0.083		(b)
U ppm	0.019		(b)

technique: (a) ICP-AES, (b) ICP-MS

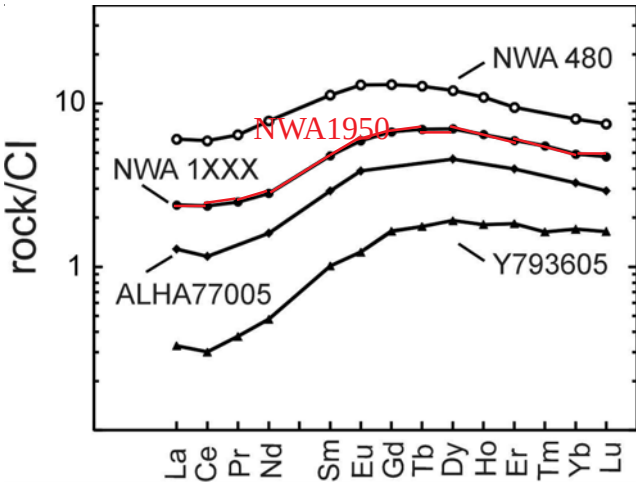

Figure 5: *Rare-earth-element pattern for Jules Verne (NWA1xxx) showing that has "intermediate" composition compared to other shergottites (from Barrat).*

Figure 6: *Another photo of Jules Verne #2 (photo courtsey Bruno Fectay and Carine Bidaut). Scale is in cm.*

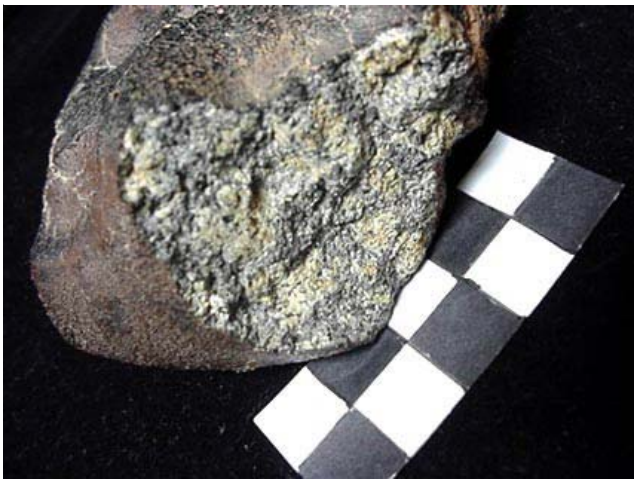

Figure 7. *Photo of NWA1950 (courtsey of Bruno Fectay and Carine Bidaut). Scale is in cm. (nice clean fingers unknown).*

Figure 8: *Photo of smaller piece with broken end. scale is in cm.*