Northwest Africa 3163, 4483, 4881

Anorthositic granulitic breccia

1634, 208, 606 g

Figure 1: Northwest Africa (NWA) 3163 with a 1 cm cube for scale.

Introduction

Northwest Africa (NWA) 3163 was found in Mauritania or Algeria and purchased in August 2005 (Fig. 1). It is almost completely covered with a thin transparent greenish fusion crust (Connolly et al., 2006). It has a pale grey interior with thin glass veins and multiple shock fractures (Fig. 2). NWA 4483 and 4881 were found in 2005; NWA 4881 consists of a single, broken, irregular conical stone partially covered by translucent, pale greenish fusion crust and with a pale grey-brown interior.

Petrography and mineralogy

The dominant texture is a poikiloblastic recrystallized breccia with about 70% plagioclase enclosing pyroxene (20%) olivine (10%), and minor chromite, ilmenite, and troilite (Fig. 3). Pigeonite contains exsolution lamellae of two pyroxenes recording temperatures of 1070 °C Irving et al., 2006). Plagioclase is almost completely converted to maskelynite.

Mineralogical differences between the Apollo granulitic breccias and NWA 3163/4483/4881 include the absence of large Fe-Ni metal grains in the meteorites, which are common in the Apollo Gbx and the widespread presence of maskelynite, which is not common in the Apollo Gbx, indicating the meteorites were exposed to higher shock pressures (>28 GPa). Shock effects in the Apollo Gbx suggest shock pressures of <5 – 22 GPa (Hudgins and Spray, 2009).

Chemistry

Although the mineralogy is dominantly feldspathic, the bulk composition includes 5.8 wt% FeO, which is more mafic than most feldspathic highlands meteorites (Korotev, 2006; Irving et al., 2006). Incompatible trace elements such as Sm and La/Yb are significantly lower than any feldspathic lunar meteorites (Fig. 4; Hudgins and Spray, 2009; Fernandes et al., 2009). Analyses of NWA 4483 overlap with those for NWA 3163 (Korotev et al., 2008). In comparison to Apollo granulitic breccias, NWA 3163/4881 contains lower concentrations of incompatible trace elements (e.g., 0.6-1.64 ppm Th for Apollo Gbx vs. 0.11 ppm Th for NWA 3163/4881; Hudgins and Spray, 2009). In addition, siderophile element contents such as Ir (Fig. 4) are very low. In fact, NWA 3163/4881 contains lower concentrations of several siderophile elements (e.g., 3.6-15.8 ppb Ir for Apollo Gbx vs. 2.3 ppb Ir for NWA 3163/4881; Hudgins and Spray, 2009; Korotev et al., 2008; Fernandes et al., 2009).

Figure 2: slab cut of NWA 3163 illustrating the feldspathic nature of the sample, as well as the thin veins (photo from R. Korotev).

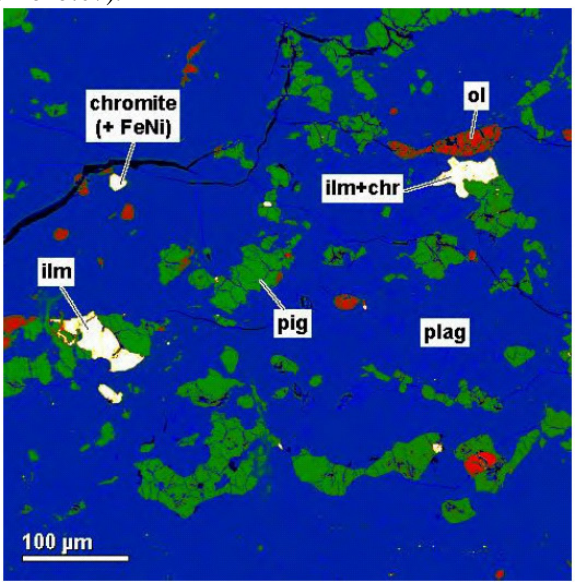

Figure 3: BSE image of NWA 3163 from Irving et al. (2006)

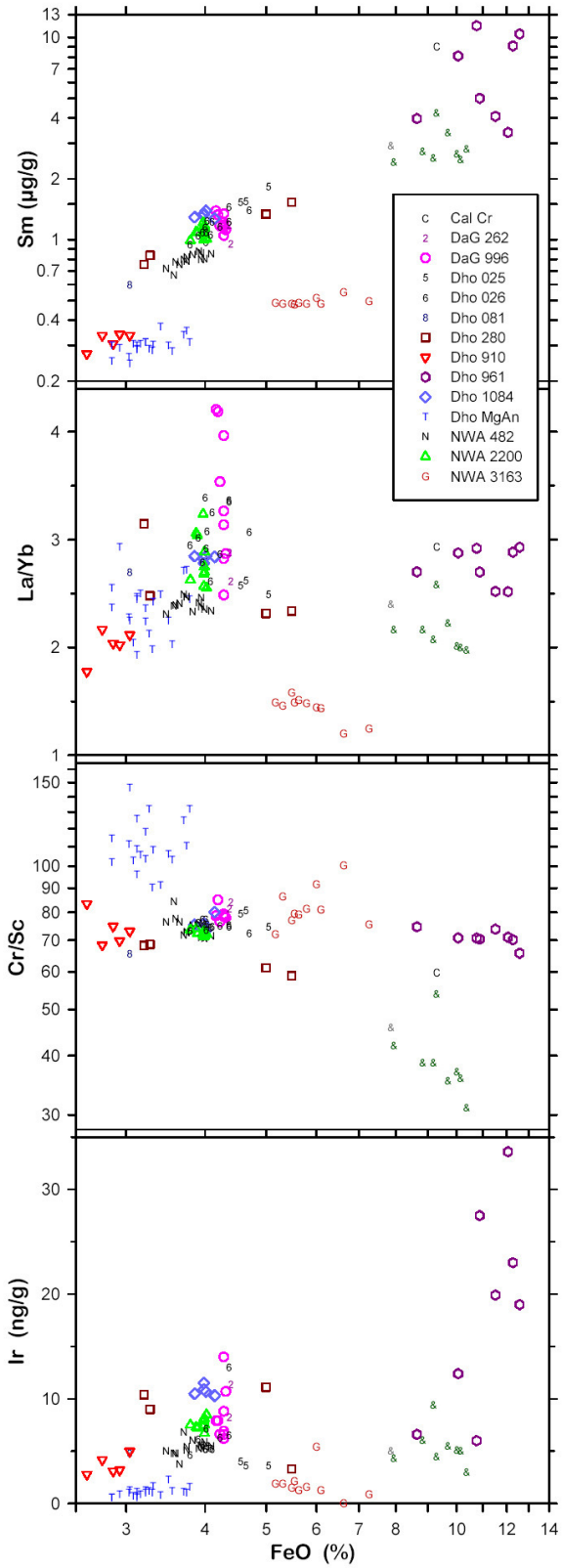

Figure 4: Chemical composition of NWA 3163 (small red 'G') from Korotev (2006).

Radiogenic age dating

Ar release from NWA 3163/4481 is complex and Ar systematics have most likely been disturbed by post-peak metamorphic events. Hudgins et al. (2009) report ages of 4.0 to 4.1 Ga, whereas Fernandes et al. (2009) report an age of 1.34 Ga. One interpretation is that the older age represents the protolith ore pre-metamorphic crystallization age, and the younger age is that of a thermal event such as an impact or contact metamorphism during burial beneath and impact melt sheet (Hudgins and Spray, 2009; Fernandes et al., 2009). In contrast with previous studies of NWA 3163/4881, Hudgins and Spray (2009) believe that these samples were formed by contact metamorphism as opposed to deep burial in the lunar crust. The higher shock pressures registered by the lunar meteorites indicate that the lofting process may be responsible for this overprint (Hudgins and Spray, 2009).

Cosmogenic isotopes and exposure ages

None yet reported.

Table 1: Chemical composition of NWA 3163/4483/4881

reference	1	1	1
weight			
method	d	h	e
SiO_2 %	45.5	44.2	
TiO_2	0.21	0.21	
Al_2O_3	25.8	26.2	
FeO	6	5.67	
MnO	0.1	0.08	
MgO	5.86	4.43	
CaO	15.9	15.3	
Na_2O	0.28		
K_2O	0.03		
P_2O_5	0.05	0.03	
S %			
sum	100		
Sc ppm			14.6
V		27	
Cr	650	445	
Co			14.5
Ni			60
Cu			
Zn			
Ga			
Ge			
As			
Se			

Rb	
Sr	
Y	
Zr	
Nb	
Mo	
Ru	
Rh	
Pd ppb	
Ag ppb	
Cd ppb	
In ppb	
Sn ppb	
Sb ppb	
Te ppb	
Cs ppm	
Ba	86
La	0.91
Ce	2.5
Pr	
Nd	
Sm	0.53
Eu	0.64
Gd	
Tb	0.13
Dy	
Ho	
Er	
Tm	
Yb	0.59
Lu	0.086
Hf	0.33
Ta	
W ppb	
Re ppb	
Os ppb	
Ir ppb	2.3
Pt ppb	
Au ppb	
Th ppm	0.11
U ppm	

technique (a) ICP-AES, (b) ICP-MS, (c) IDMS, (d) FB-EMPA, (e) INAA, (f) RNAA, (g) PGA, (h) XRF

Table 1b. Light and/or volatile elements for NWA 3163/4483/4881

Li ppm	
Be	
C	
S	

F ppm
Cl
Br
I

Pb ppm
Hg ppb
Tl
Bi

Reference: 1) Fernandes et al. (2009)