Northwest Africa 4898

Unbrecciated basalt

137 g

Figure 1: Slice through NWA 4898, with close up of matrix (upper right) and 1 cm cube for scale.

Introduction

Northwest Africa 4898 (Fig. 1) was found in northwest Africa in 2007, and consists of one fragment almost completely covered with fusion crust and weighing 137 g (Connolly et al., 2008). Inspection of the interior reveals it basaltic texture (Fig. 1).

Petrography and Mineralogy

The texture of this sample is spherulitic with lath-shaped plagioclase, pyroxene, and skeletal ilmenite. Olivine is present as larger crystals ($Fa_{26.3\text{-}27.2}$; FeO/MnO = 73-92), and often contains chromite inclusions. The calcic plagioclase ($An_{92.6\text{-}96.5}$) has been completely transformed into maskelynite during shock metamorphism. And the pyroxenes ($Fs_{25.1\text{-}58.7}Wo_{13.2\text{-}34}$; FeO/MnO = 42-76) are compositionally zoned Ti-rich pigeonite and augite. FeNi-metal and troilite are present as minor phases (Connolly et al., 2008; Greshake et al., 2008). Finally, according to Greshake et al. (2008) the meteorite belongs to shock stage 2b, and experienced an equilibration shock pressure of ~28-34 GPa and a post-shock temperature of ~200-250°C.

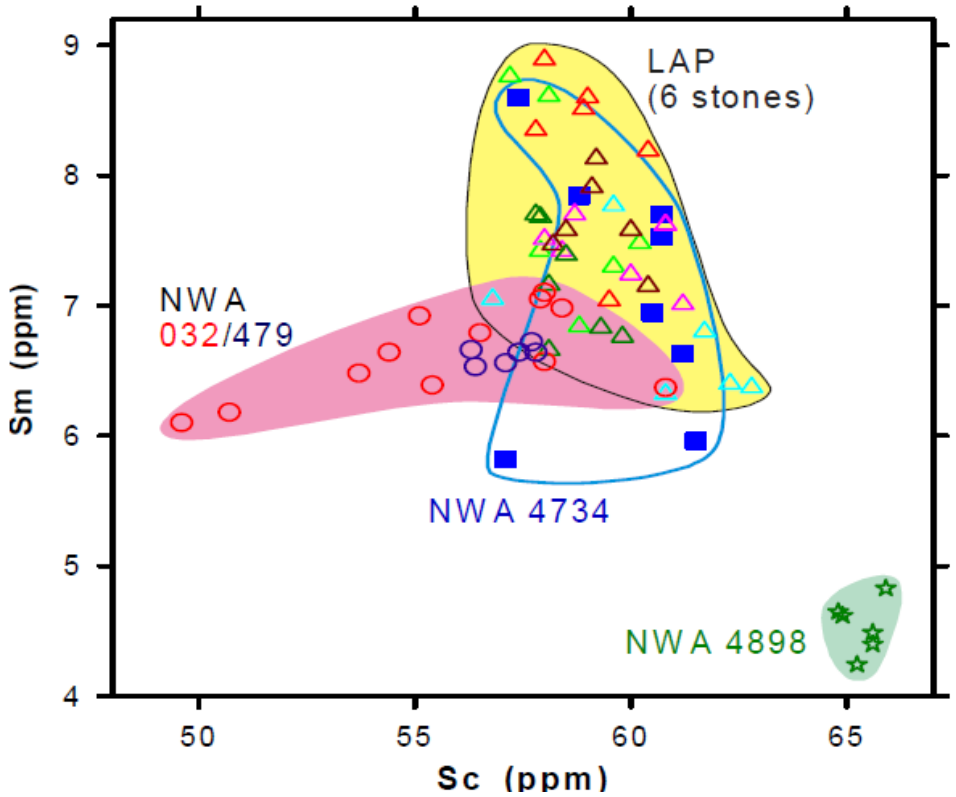

Figure 2: Sm – Sc diagram showing the distinct composition of NWA 4898 compared to the LAP basalts, NWA 032/479 and NWA 4734 (from Fernandes et al., 2009c).

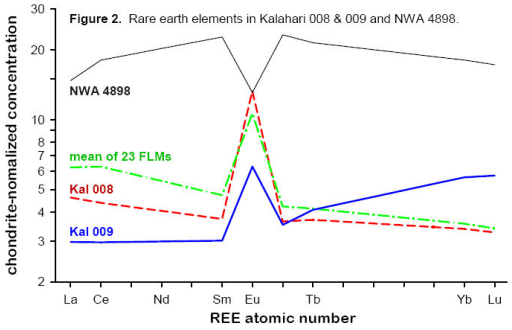

Figure 3: Rare earth element diagram for NWA 4898 illustrating a Eu anomaly (from Korotev et al., 2008).

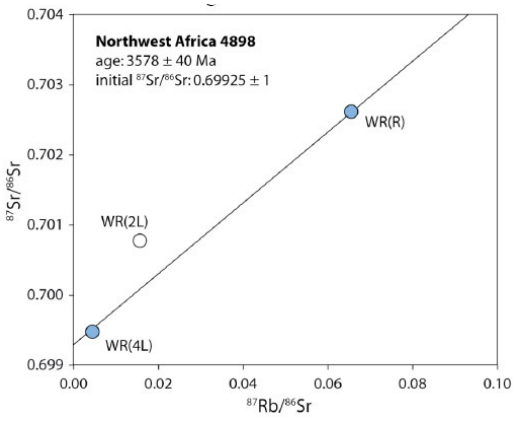

Figure 4: Whole rock isochron for NWA4898 indicating an age of 3.58 Ga (from Gaffney et al., 2008).

Chemistry

INAA analyses of 6 small (133 mg total) chips of NWA 4898 reveal its low FeO nature (Table 1) and Eu anomaly (Fig. 2). Similarly, the Sm-Sc trends are distinct from several of the other LAP and NWA basalt groups (Fig. 3).

Radiogenic age dating

A whole rock Rb-Sr isochron based on three measurements from NWA 4898 yields an age of 3.58 Ga (Fig. 4; Gaffney et al., 2008). Ar-Ar measurements on four different aliquots of NWA 4898 by Fernandes et al. (2009c) illustrate a 3.5 Ga age (Fig. 5)

Additional Nd isotopic analyses show that NWA 4898 may have been derived from one of the most LREE depleted lunar mantle sources known (Fig. 6; Gaffney et al., 2008).

Cosmogenic isotopes and exposure ages

^{38}Ar cosmic-ray production rates of 1.031×10^{-8} cc/g/Ma for NWA 4898 were calculated by Fernandes et al. (2009c). The resulting calculated CRE-age for NWA 4898 aliquots is ~31 Ma.

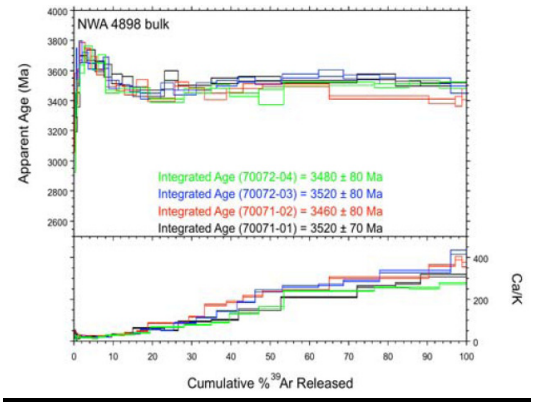

Figure 5: Apparent age vs. % 39Ar-release for four aliquots from lunar basalt NWA 4898.

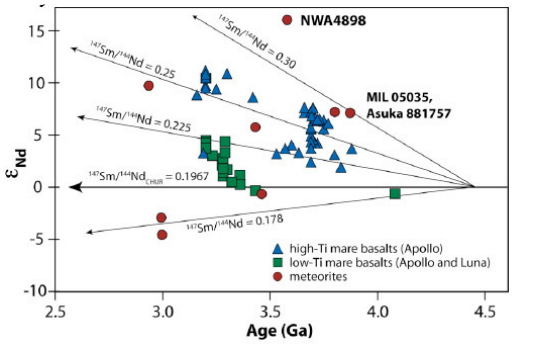

Figure 6: Results of Nd isotopic analyses of Gaffney et al (2008) showing the depleted nature of this sample relative to other Apollo, Luna and meteorite samples.

Table 1. Chemical composition of NWA 4898

reference	1	2
weight	133	
technique	INAA	INAA, XRF
SiO_2 %	-	46.15
TiO_2	-	2.39
Al_2O_3	-	11.98
Cr_2O_3	-	0.43
FeO	17.2	17.34
MnO	-	0.25
MgO	-	8.31
CaO	-	11.43
Na_2O	0.296	0.30
K_2O	-	
P_2O_5	-	<0.06
S %	-	
sum	-	
Sc ppm	65.4	65.4
V		120
Cr	3020	
Co		24.8
Ni	<180	<180
Cu		
Zn		
Ga		
Ge		
As		
Se		
Rb		
Sr		
Y		
Zr		145
Nb		
Mo		
Ru		
Rh		
Pd ppb		
Ag ppb		
Cd ppb		
In ppb		
Sn ppb		
Sb ppb		
Te ppb		
Cs ppm		
Ba		
La		4.71
Ce		14.8
Pr		
Nd		12
Sm	4.55	4.55
Eu	0.997	0.997
Gd		
Tb		1.06
Dy		
Ho		
Er		
Tm		
Yb		4.00
Lu		0.57
Hf		4.45
Ta		0.24
W ppb		
Re ppb		
Os ppb		
Ir ppb		
Pt ppb		
Au ppb		
Th ppm	0.44	0.44
U ppm		

References: 1) Korotev et al. (2008); Greshake et al. (2008).

K. Righter, Lunar Meteorite Compendium, 2010