NWA5990 - 59 grams
Depleted Olivine-phyric Shergottite

Figure 1: *Photo of sawn surface of NWA 5990 (Irving et al. 2010). Photo taken by S. Ralew. Cube is 1 cm.*

Introduction

NWA5990 is a small round stone found on Hamada du Draa, Morocco in 2009. It is a fine-grained diabase that is ~ 400 m.y. old with an exposure to cosmic rays of about 2.1 m.y. It may be unique, but has been compared with QUE94201.

Petrography

Irving *et al*. (2012) reported the discovery, modal mineralogy and petrography of NWA5990. It has a fine-grained diabasic texture (figures 1 and 2). The plagioclase is shock melted. The pyroxene is more homogeneous than for other shergottites (figure 3). Besides olivine, pyroxene and plagioclase, it has chromite-ulvospinel, pyrrhotite, merrillite and rare magnetite.

Mineralogical Mode for NWA5990

	Irving et al. 2010
Olivine	25 %
Pyroxene	35
Plagioclase	35
Chromite	tr.

Mineralogy

Olivine: Olivine is $Fo_{59.3-53.1.}$

Pyroxene: figure 3

Plagioclase: Plagioclase is $An_{64.3}$

Chromite: ranging to ulvospinel

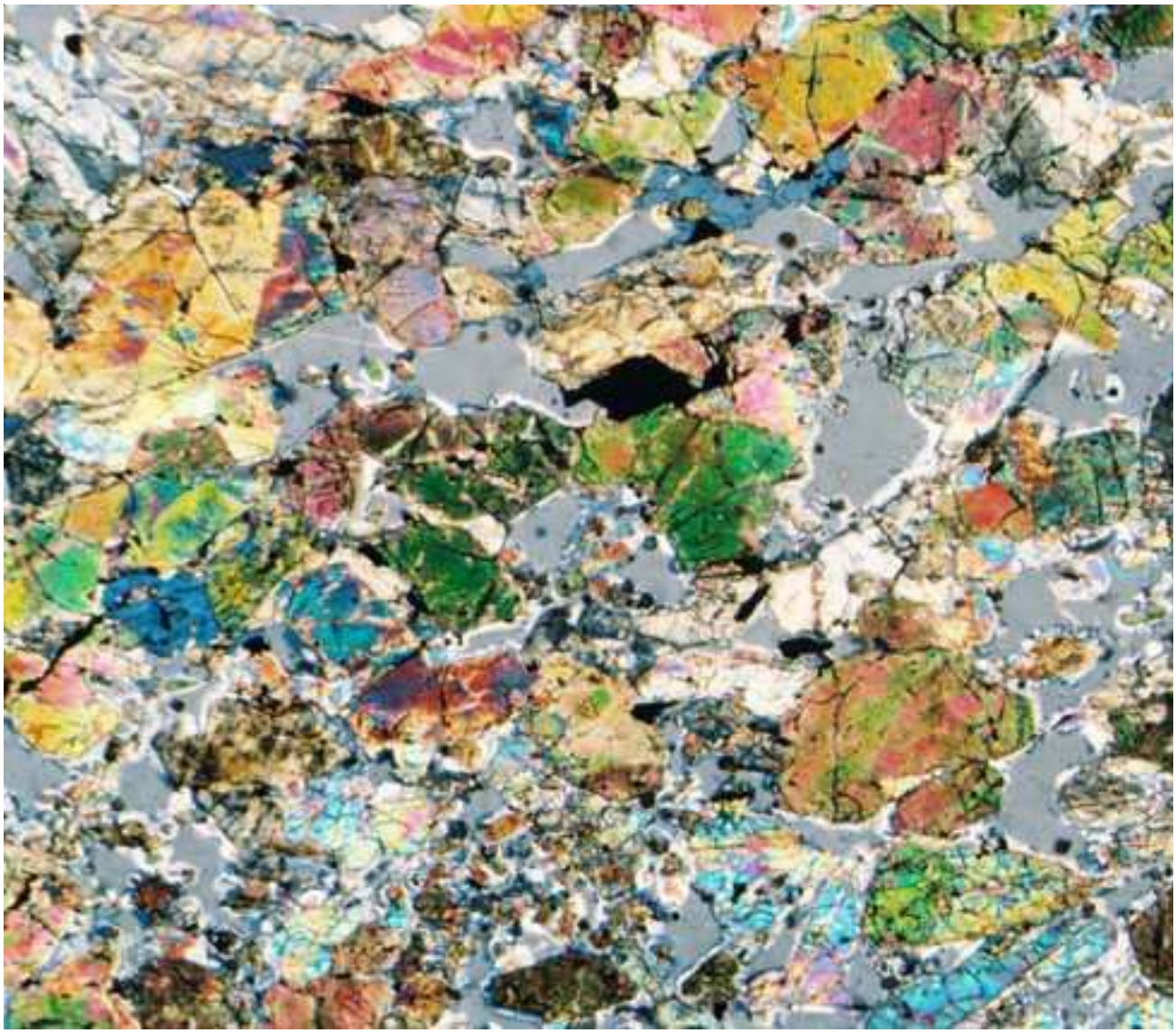

Figure 2: *Thin section photo (partially crossed-polarized light) of NWA 5990 (photo by Ted Bunch). Photo 9 mm across.*

Chemistry

Irving *et al*. (reported the composition of dust obtained from cutting NWA5990 (table 1; figure 4). It is depleted in large-ion-lithophile and light rare-earth elements

Radiogenic age dating

Shih *et al*. (2011) obtained a crystallization age of 402 ± 22 m.y. by Sm-Nd and 389 ± 12 m.y. by Rb-Sr (figures 5 a, b). It comes from a highly "depleted" source region.

Cosmogenic isotopes and exposure ages

Huber *et al.* (2012) reported an exposure age of 2.1 m.y. by ^{38}Ar method.

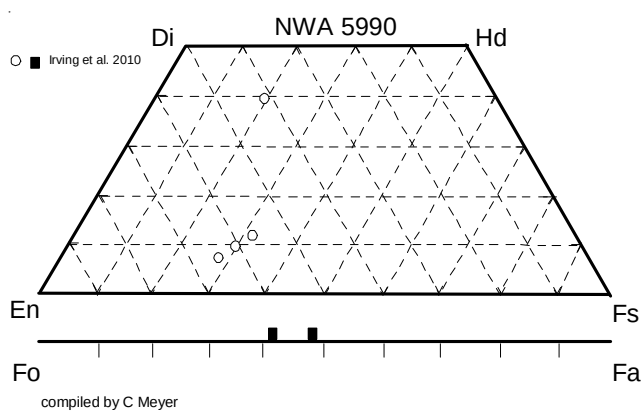

Figure 3: *Olivine and yroxene compositions plotted from Irving et al. (2010).*

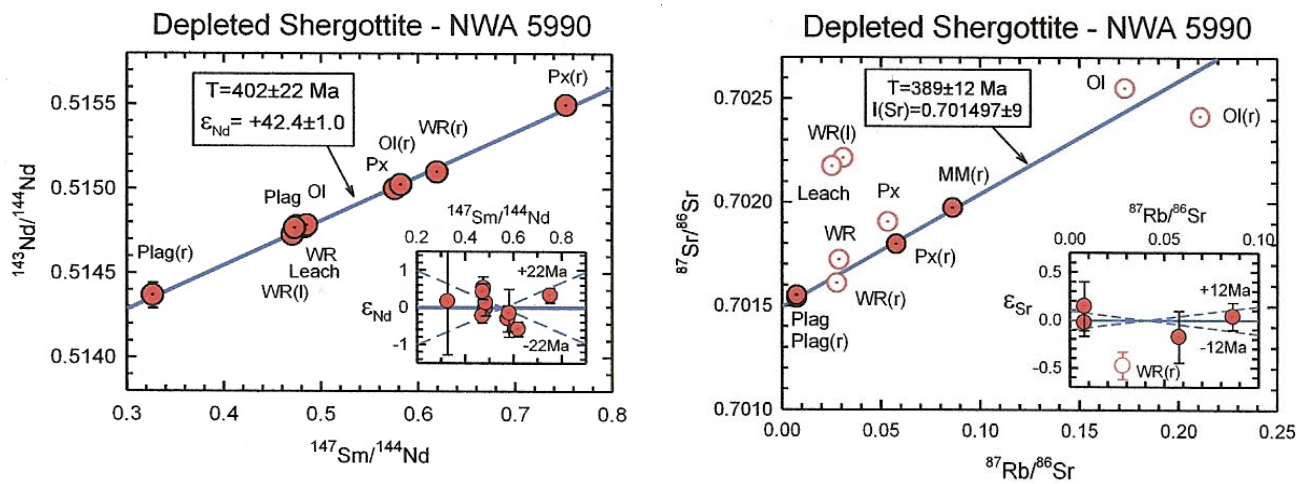

Figure 4 a,b: *Age data for NWA 5990 (Shih et al. 2011).*

Other Studies

The oxygen isotopic composition was reported by Irving *et al.* (2010).

Processing

NWA5990 has been cut by saw.

References for NWA5990

Franz H.B., Farquhar J. and Irving A.J. (2011) Acid-volatile sulfur isotopic compositions of six Shergottites (abs#2338). *42nd Lunar Plaent. Sci. Conf.* Lunar Planetary Institute @ The Woodlands.

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Irving A.J., Kuehner S.M., Herd C.D.K., Gellissen M., Rumble D., Lapan T.J., Ralew S. and Altmann M. (2010a) Olivine-bearing diabasic Shergottite Northwest Africa 5990: Petrology and composition of a new type of depleted Martian igneous rock (abs#1833). *Lunar Planet. Sci.* **XLI,** Lunar Planetary Institute @ The Woodlands.

Shih C-Y., Nyquist L.A., Reese Y. and Irving A. (2011) Rb-Sr and Sm-Nd ages, and petrogenesis of depleted Shergottite Northwest Africa 5990 (abs#1846). *42nd Lunar Planet. Sci. Conf.* @ Lunar Planetary Institute @ The Woodlands.

Weisberg M.K. et al. (2010a) Met. Bull #97. *Meteorit. & Planet. Sci.* **45**, 449-493.

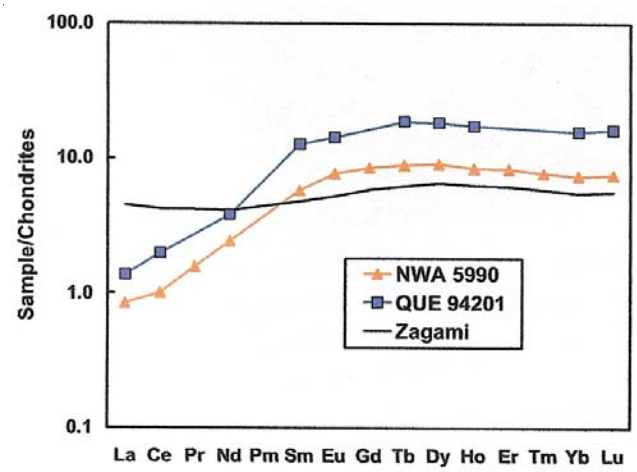

Figure 5: Normalized rare-earth-element diagram for NWA5990 compared with that of Zagami (Irving et al. 2010).

Table 1. Chemical composition of 5990.

reference	Irving 2010	
weight		
SiO2 %	42.26	(a)
TiO2	0.72	(a)
Al2O3	6.94	(a)
FeO	22.06	(a)
MnO	0.46	(a)
MgO	17.09	(a)
CaO	6.54	(a)
Na2O	0.79	(a)
K2O	0.02	(a)
P2O5	0.99	(a)
S %		
sum		
Sc ppm		
V		
Cr	2805	(a)
Co		
Ni	146	(b)
Cu		
Zn		
Ga		
Ge ppb		
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		
La	0.27	(b)
Ce	0.83	(b)
Pr	0.193	(b)
Nd	1.5	(b)
Sm	1.16	(b)
Eu	0.59	(b)
Gd	2.3	(b)
Tb	0.44	(b)
Dy		
Ho		
Er	1.81	(b)
Tm		
Yb	1.65	(b)
Lu	0.25	(b)
Hf	1.47	(b)
Ta		
W ppb		
Re ppb		
Os ppb		
Ir ppb		
Pt ppb		
Au ppb		
Th ppm		
U ppm		
technique	*(a) XRF, (b) ICP-MS*	