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Michael K. WEISBERG^{1, 2*}, Caroline SMITH^{3, 4}, Gretchen BENEDIX³, Luigi FOLCO⁵, Kevin RIGHTER⁶,
 Jutta ZIPFEL⁷, Akira YAMAGUCHI⁸, and Hasnaa CHENNAOUI AOU DJEHANE⁹

¹Department of Physical Science, Kingsborough Community College and the Graduate School of the City University
 of New York, 2001 Oriental Blvd., Brooklyn, New York 11235, USA

²Department of Earth and Planetary Science, American Museum of Natural History, Central Park West New York, New York 10024, USA

³Department of Mineralogy, The Natural History Museum, Cromwell Road, London SW7 5BD, UK

⁴School of Geographical and Earth Science, University of Glasgow, Scotland, G12 8QQ

⁵Museo Nazionale Antartide, Via Laterina 8, I-53100 Siena, Italy

⁶Code ST, NASA Johnson Space Center, Houston, Texas 77058, USA

⁷Sektion Meteoritenforschung, Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganlage 25, D-60325
 Frankfurt am Main, Germany

⁸Antarctic Meteorite Research Center, National Institute of Polar Research, 1-9-10 Kaga, Itabashi, Tokyo 173-8515, Japan

⁹Université Hassan II Casablanca, Faculté des sciences, Département de Géologie, BP 5366, Mâarif, Casablanca, Morocco

*Corresponding author. E-mail: meteorite@kingsborough.edu

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Abstract—The Meteoritical Bulletin 94 reports over 900 (119 non-Antarctic and 803 Antarctic) newly approved meteorite names and their recovery histories, macroscopic descriptions, petrography, mineral compositions, and geochemistry. Meteorites reported include lunar, Martian, howardites, eucrites, diogenites, mesosiderites, aubrites, irons, angrites, ureilites, acapulcoites, lodranites and H, L, LL, R, CO, and CV chondrites. Eight of the meteorites in this bulletin are falls, including 4 from India (Jodiya, Kaprada, Kavapura, Mahadevpur), 1 from Mali (Chergach), Turkey (Didim), Libya (Werdama), and the U.S. (Berthoud).

From the editor, Michael K. Weisberg

This is the Meteoritical Bulletin 94. The Meteoritical Bulletin reports newly approved meteorite names and their recovery histories, macroscopic descriptions, petrography, mineral compositions, and geochemistry. Herein are reports of 119 non-Antarctic and 803 Antarctic (from ANSMET) newly approved meteorite names in detailed written descriptions and table format. The meteorites span a wide range of achondrites including lunar, 4 Martian, eucrites, mesosiderites, aubrites, irons, angrites, ureilites, acapulcoites, and lodranites. Chondrites reported in the bulletin include H, L, LL, R, CO and CV. The bulletin also contains descriptions of eight newly approved falls including 4 from India, 1 from Mali, Turkey, Libya, and the U.S.

Meteoritical Bulletin 94 marks the first bulletin published by me as editor; I took over the editorship as of April. I very much look forward to serving the meteoritical community as editor of the bulletin. My goals will be to help improve the procedures for new submissions and their review and maintain the high level of meteorite reporting as achieved by previous editors.

AFRICA

Algeria

Acfer 370

27°40.35'N, 4°21.40'E

Acfer, Algeria

Find: November 2002

Ungrouped chondrite

History: A small single meteorite, weighing 129 g, was found during an expedition for meteorite recovery in the Acfer area of the Algerian Sahara. The sample was recovered by the late Filiberto Ercolani.

Physical characteristics: The hand-size sample has been split into two end cuts weighing 67 and 62 g, respectively, both displaying no fusion crust.

Petrography: (Moggi Cecchi, V., Pratesi G., *MSP*) The thin section displays chondrules and chondrule fragments set in a fine-grained interchondrule matrix. Chondrules range in size from 150 to >2000 μm (mean = 460 μm). Chondrule types are PO, POP, PP, GOP, RP, BO, and C. Chondrule fragments are common. Mineral fragments (mainly orthopyroxene) are rare.

A partially devitrified glass is present in some chondrules. Matrix is composed of olivine, orthopyroxene, Fe,Ni alloys, troilite, and Fe-oxides. Opaque phases can be found in two extremely different occurrences: in large (100–300 μm) aggregates of kamacite and taenite associated with troilite, minor schreibersite and weathering products and as extremely fine-grained spots inside PP chondrules. Modal abundances of the components are: chondrules and chondrule fragments 75 vol%, mineral fragments 5%, silicate matrix 5%, metal 10%, troilite 3%, schreibersite 1%.

Geochemistry: Olivine (inside and outside chondrules) $\text{Fa}_{5.65}$ (mean on 20 analyses, $\text{PMD} = 3.82\%$); low-Ca pyroxene $\text{Fs}_{6.94-22.63}$ (mean = 15.64 on 20 analyses); clinopyroxenes $\text{Fs}_{11.5}\text{En}_{48.9}\text{Wo}_{32.6}$. Oxygen isotopes (Greenwood, R., *OU*): $\delta^{17}\text{O} = 2.673\%$, $\delta^{18}\text{O} = 4.172\%$, $\Delta^{17}\text{O} = 0.504\%$ (mean of 3 runs on 1 g of the bulk sample).

Classification: Ungrouped type 3 chondrite with textural affinities to an H3 chondrite but low Fa mol% (Folco et al. 2004; Bridges et al. 1999); shock stage S3; weathering W2.

Type specimens: All the specimens, including the main mass (67 g) and one thin section are on deposit at *MSP* (Museo di Scienze Planetarie).

Ethiopia

Bouri

10°16'N; 40°34'E

Middle Awash, Ethiopia

Find: Fall 1996

Ordinary Chondrite (H4)

History: Over 30 fragments scattered over 100 m radius were collected from the surface of Pliocene sediments, with which they bear no apparent relationship, and none were found in situ. The meteorite fragments were discovered and collected by Prof. Tim White of the Department of Integrative Biology, University of California at Berkeley, in the fall of 1996 and subsequently, in the framework of the Middle Awash Project (see Asfaw et al. 2002). A total of 9.1 kg with one piece weighing more than 5 kg was collected and none is left in the field. All meteorite fragments are stored at the National Museum of Ethiopia (*NME*) in Addis Ababa.

Dr. Giday WoldeGabriel took a fragment weighing about 40 g to the United States for characterization. Recently Dr. Tamrat Endale took an additional fragment (35 g) for analysis at CEREGE, France.

Results from Los Alamos National Laboratory: Preliminary petrographic analysis indicates thermally metamorphosed, strongly fractured, and altered coarse mafic minerals embedded in highly weathered metallic oxide. The bulk chemistry is SiO_2 (34.7 wt%), iron oxide ($\text{Fe}_2\text{O}_3\text{T} = >33$ wt%), and MgO (22 wt%). Neutron activation analysis yielded Ni (13,747 ppm) and Cr (3516 ppm).

Physical characteristics: The exterior of the specimen is weathered but shows a glassy fusion crust. The interior is black-brown with visible metal and chondrules. Magnetic

susceptibility is $\log\chi = 4.68$ (10^{-9} m^3/kg), in agreement with a weathered H.

Petrography: (M. Bourot-Denise, *MNHNP*, J. Gattacceca, *CEREGE*) microscopic observation of a polished section reveals a chondrite texture. Chromite-plagioclase assemblages are present. Metallic copper is found associated with taenite-kamacite grains. Weathering grade is estimated to be W4 in the *MNHNP* sample and W6 in the Los Alamos sample examined by M. Killgore.

Mineral compositions and geochemistry: Olivine is homogeneous ($\text{Fa}_{20.1} \pm 0.4\%$), and low Ca pyroxene displays the typical scatter for a type 4 chondrite ($\text{Fs} 14.8 \pm 3.8\%$).

Classification: H4, W4, S4.

Type specimens: The type specimens include a 15 g piece on deposit at *CEREGE* and the main mass of ≥ 9 kg at the National Museum of Ethiopia (*NME*), Addis Ababa.

Libya

Werdama

32° 47.839'N, 21° 47.228'E

Werdama village, Al-Beda, Al-Jabal Al-Akhdar, Libya

Fall: 21 May 2006, 7:30 a.m. local time (UT + 2)

Ordinary chondrite (H5)

History (M. Abu Anbar, *TantaU*; R. Kryza, *UTWroc*, T. Przylibski, *WTWroc*, and G. El Bahariya, *TantaU*): A bombing sound and cloud of dust was observed in the village during the infall on an apple farm. A crater of 30×20 cm and ~ 10 cm deep. No exact information about the meteorite finder. (probably, the owner of the apple farm). Geologist Mohamed Abu Anbar, *TantaU* got a few pieces for research from the finder during his visit to the site, shortly after the fall.

Physical characteristics: Reportedly, five pieces were found, with estimated total mass about 4–5 kg. The diameter of the stone was about 25 cm and it had a light gray color, a brown to black fusion crust ~ 1 mm thick.

Petrography: (R. Kryza, *UWroc*; T. Przylibski, *UTWroc*) The stone shows a low degree of shock: locally, opaque minerals are fractured and the cracks rarely continue into the neighboring silicates. The matrix (10 vol%) has a fine, inequigranular texture. The main component is olivine, subordinate low-Ca pyroxene and Ca pyroxene. Secondary feldspar grains, 20–90 μm large, are minor. Occasionally apatite is found. Opaque minerals vary between 2 and 15 vol%. Kamacite dominates over taenite, together = 6–8 vol%. Troilite and chromite are also common. The grain sizes of the opaques are 0.01–1.5 mm. Chondrules constitute 60 vol%, with a size range of 0.23–1.86 mm (mean 0.57 mm, standard deviation = 0.33).

Geochemistry: Olivine ($\text{Fo}_{79.7}$, $\text{Fa}_{19.7}$); pyroxene ($\text{Wo}_{1.3}\text{En}_{81.0}\text{Fs}_{17.7}$); feldspar ($\text{Ab}_{82.8}\text{An}_{11.8}\text{Or}_{5.4}$); kamacite (Ni 6.1–9.4 wt%); taenite (Ni = 27.4–51.8 wt%).

Classification: Ordinary chondrite (H5), S1, W0.

Type specimens: Main mass of 2 kg (20 cm in length) and

300 g are deposited in *GMAIBeda Geological Museum*, and 250 g in *PDAIBeda*; 2 g and four thin sections are deposited in *UWroc*.

Mali

Chergach 23° 41'47"N, 5° 00'53"W

SW El Mokhtar, Erg Chech, Timbuktu district, Mali

Fall: 2 or 3 July 2007, daytime

Ordinary chondrite (H5)

History: In fall and winter, 2007 ~100 kg of meteorites were collected in the Erg Chech, north of Taoudenni. Nomads reported the stones fell after a smoke cloud was seen and several detonations were heard over a wide area during daytime in July 2007. The finder of the first meteorites was Mr Ouled Bleila, who died in a car accident on his way back from the trip to the Chergach strewn field in October 2007. According to the Tuareg people from Algeria who visited the fall site in September 2007, the elliptical strewn field stretches for more than 20 km in a northeasterly direction. No fireball was reported.

Physical characteristics: A large number of fusion-crust stones have been recovered, the largest ones are 17.8 and 13.9 kg, the smallest ones about 1.5 g. Total known weight ~100 kg.

Petrography: (E. Gnos, *MHNGE*; B. Hofmann, *NMBE*, M. Eggimann, *UBE/NMBE*) Mean chondrule size is 0.38 mm ($n = 61$). Mean size of plagioclase grains is ~20 μm . Troilite is polycrystalline, rich in silicate inclusions, and shows diffuse boundaries to metal. Some metal is rich in silicate- and troilite inclusions. No Cu metal observed. Shock stage is S3, some shock veins are visible, no weathering (W0). In addition to this dominant lithology, a significant number of stones consist of chondritic clasts (H5 S3–4 W0, identical to the homogeneous lithology) set in a fine-grained, black, silicate impact melt matrix with abundant droplets of metal and metal-troilite. Shock stage of small clasts is up to S4.

Mineral compositions and geochemistry: Olivine $\text{Fa}_{18.2}$ (chondrite fragments in impact melt are $\text{Fa}_{18.4}$), pyroxene $\text{Fs}_{15.5} \text{Wo}_{1.2}$ (fragments in impact melt are $\text{Fs}_{16.0}$, $\text{Wo}_{1.4}$).

Cosmogenic radionuclides: (Patrick Weber, Particle Physics Group, Institute of Physics, University of Neuchâtel) Gamma-spectroscopy performed in November, 2007 showed the presence of the following short-lived radionuclides: ^{46}Sc , ^{56}Co , ^{54}Mn , ^{58}Co , ^7Be , ^{57}Co , ^{22}Na , ^{60}Co , ^{26}Al . Recalculated to July, 2007, ^{22}Na was 44.0 ± 1.1 dpm/kg and ^{26}Al 20.8 ± 0.8 dpm/kg. The $^{22}\text{Na}/^{26}\text{Al}$ activity ratio of 2.1 is consistent with a fall in July, 2007 and demonstrates that this material is not identical with Bassikounou.

Classification: Ordinary chondrite (H5), some stones suggest an H impact melt breccia. S3, W0.

Type specimens and distribution: 115 g at *NMBE*; 17.8 kg P. Hermann, Canada; 13.9 kg D. Gheesling, USA; 4.9 kg S. Buhl, Germany.

Mauritania

Noktat Addagmar 25° 42'09"N, 10° 46' 54"W

Mauritania

Find: October or November 2006

Ordinary chondrite (LL5)

History: Two stones with a mass of 591 and 188 g, respectively (total known weight 779 g), were found by a Moroccan mineral collector (Sajid Ait Ben Chouk) near the caravansary of Noktat Addagmar after locals reported an abundance of "stones that recently fell from sky", close to the track from Assa (Morocco) to Nouakchott (Mauritania).

Physical characteristics: The main mass is partly covered with a black fusion crust. The interior is greenish grey with slight rust haloes around metal. Porosity 8.2% based on alcohol absorption.

Petrography: (E. Gnos, *MHNGE*; B. Hofmann, *NMBE*, M. Eggimann, *UBE/NMBE*) Olivine $\text{Fa}_{27.7 \pm 0.6}$ ($n = 27$), pyroxene $\text{Fs}_{23.1 \pm 1.0} \text{Wo}_{1.6 \pm 0.3}$ ($n = 20$). Shock stage is S2, some shock veins are visible, no weathering (W0). The mean diameter of chondrules is ~1 mm.

Cosmogenic radionuclides: (Patrick Weber, Particle Physics Group, Institute of Physics, University of Neuchâtel) Gamma-spectroscopy performed in December-January 2006 demonstrated the absence of short-lived radionuclides (no ^{22}Na detected). The fall must have occurred at least several decades ago.

Classification: Ordinary chondrite (LL5), shock stage S2, no weathering (W0).

Type specimens: 22.4 g plus polished thin section at *NMBE*, main mass: Svend Buhl, Hamburg, Germany.

Morocco

Toufassour 29°39'.135 N, 07°44'.958 W

Toufassour, Tata, Morocco

Find: 16 November 2007

Mesosiderite

History: A small impact structure about 3 m in diameter was found in the vicinity of the village of Toufassour (Tata, Morocco). A number of stones have been collected since 2003 by nomads and sold to dealers in Erfoud. In particular two stones totaling 3 kg and a number of fragments were sold by one nomad, but the most significant mass (an ~70 kg stone) was found by a woman hunting for meteorites. More recently many small stones were collected by Moroccan scientists (*IZU. Agadir*) around the impact structure: Three pieces of 61.0, 15.5 and 13.1 grams and fragments ranging 1 to 5 grams, totaling about 320 grams. Total mass exceeds ~73.3 kg.

Physical characteristics: The fusion crust is absent and the surface appears dark brown. Larger nodules of metal protrude here and there, and larger inclusions of silicates are seen, as greenish spots. Many of the smaller specimens were rich in metal, the phase, which best resisted weathering.

Petrography: (A. Ibhi and H. Nachit, *IZU*, and A. Jambon, O. Boudouma and D. Badia, *UPVI*) Mode (wt%): kamacite and (minor) sulfide, (partly oxidized) = 27, pyroxene = 56, plagioclase = 20, silica = 5, and chromite = 0.9. Rutile and schreibersite are also present.

Mineral compositions and geochemistry (EMPA): Pyroxene FeO/MnO = 27, En₇₀ Fs₂₆ Wo₄ to En₅₉ Fs₃₃ Wo₈. Chromite Cr/(Cr + Al) = 0.76. Plagioclase Ab₇, An₉₃. Kamacite, Ni = 6%. Merrillite contains significant amounts of MgO.

Classification: Mesosiderite. Moderately to significantly weathered, depending on the grain size.

Type specimens: 2 polished thin sections and 89.6 g at *IZU*, one polished thin section and 22 g at *UPVI*. An anonymous dealer holds 300 g.

Table 1 lists all newly approved (non-NWA) meteorites from Africa and their data.

Morocco and Other Northwest Africa (NWA) Regions

Northwest Africa 1709

Northwest Africa

Find: March 2002

Ordinary chondrite (H3.8)

History: A small stone was bought at an Erfoud market by an anonymous buyer.

Physical characteristics: A single dark brown piece of 9 g with fusion crust traces.

Petrography: (V. Moggi Cecchi, G. Pratesi, *MSP*) The overall texture consists of chondrules 250–550 μm in size, of different types (PO, POP, BO, RP) and their fragments embedded in a fine-grained matrix; matrix silicates are mainly olivine and orthopyroxene, with minor clinopyroxene; some olivine grains in BO and PO chondrules are zoned and contain a glassy mesostasis. Opaque phases are kamacite and troilite.

Geochemistry: Olivine Fa_{1.2–21.2}, mean Fa_{15.4} (P.M.D.Fa_{47.5}); low-Ca pyroxene (Fs_{4.8–16.9}En_{95.0–82.4}Wo_{0.2–0.8}, mean Fs_{11.6}En_{86.1}Wo_{1.5} P.M.D.Fs 38.70); diopside Fa_{11.7}En_{51.0}Wo_{37.2}. Oxygen isotopes (R. Greenwood, I. Franchi, *OU*) δ¹⁸O = 2.840‰; δ¹⁷O = 4.448‰; Δ¹⁷O = 0.527‰.

Classification: Ordinary chondrite (H3.8); S2; W3.

Type specimens: A total of 1.7 g, one polished thin section and a block are on deposit at *MSP*. An anonymous collector holds the main mass.

Northwest Africa 3211

Northwest Africa

Find: 2005

Achondrite (eucrite)

History: A single stone of 89.2 g was purchased 2005 in Erfoud by M. Chinellato.

Physical characteristics: The sample has no fusion crust.

Petrography: (V. Moggi Cecchi, G. Pratesi, *MSP*) A polymict breccia consisting of basaltic and mineral clasts set into a fine-grained matrix of exsolved pyroxene, clinopyroxene and plagioclase. The large clasts are predominantly plagioclase and exsolved pyroxene, with minor clinopyroxene. Minor phases include silica, ilmenite and Al-Ti-chromite. Exsolution lamellae in pyroxene are generally very fine (1–2 μm width).

Geochemistry: Plagioclase An_{86.6}; Pyroxene ranges Fs_{43.9–55.6}, En_{36.2–54.2}, Wo_{2.0–21.5}. Oxygen isotopes (I. Franchi, R. Greenwood, *OU*) δ¹⁷O = 1.71‰, δ¹⁸O = 3.85‰, Δ¹⁷O = –0.25‰.

Classification: Achondrite (eucrite) with moderate degree of shock and low degree of weathering. Possibly paired with NWA 3212.

Type specimens: A total of 17.9 g and one thin section are on deposit at *MSP*, Prato. *M. Chinellato* holds the main mass.

Northwest Africa 3212

Northwest Africa

Find: 2005

Achondrite (eucrite)

History: A single stone of 176.6 g was found purchased in 2005 in Erfoud by M. Chinellato.

Physical characteristics: The sample displays no fusion crust.

Petrography: (V. Moggi Cecchi, G. Pratesi, *MSP*) A polymict breccia consisting of basaltic and mineral clasts set into a fine-grained matrix of exsolved pyroxene, clinopyroxene and plagioclase. The large clasts are predominantly plagioclase and exsolved pyroxene, with minor clinopyroxene. Silica and spinel ilmenite, and Al-Ti-chromite are commonly minor phases. Exsolution lamellae in pyroxene are very fine (1–2 μm width).

Geochemistry: Plagioclase An_{89.4}; pyroxene ranges Fs_{35.6–54.1}, En_{37.4–43.9}, Wo_{2.0–29.2}. Oxygen isotopes (I. A. Franchi, R. Greenwood, *OU*) δ¹⁷O = 1.74‰, δ¹⁸O = 3.84‰, Δ¹⁷O = –0.26‰.

Classification: Achondrite (eucrite) with moderate degree of shock and low degree of weathering. Possibly paired with NWA 3211.

Type specimens: A total of 20 g specimen and one thin section are on deposit at *MSP*, Prato. *Chin* holds the main mass.

Northwest Africa 3333

Morocco

Find: May 2005

Achondrite (lunar basaltic fragmental breccia)

History: Fabien Kuntz purchased a 33 g specimen from a Moroccan dealer. The original main mass was broken into at least 5 pieces and distributed to several dealers.

Physical characteristics: A partially weathered blackish-brown fusion crust was present on the specimen. Cut and

polished surfaces on two different specimens reveal a coarsely brecciated texture, while a third specimen exhibits three different lithologies.

Petrography: (R. Zeigler, *WUSL*) The specimen examined consists of one basalt clast (1.5 cm) and one clast of cumulus olivine gabbro (1.2 cm) set in a fragmental breccia matrix. The basalt consists of phenocrysts composed of large zoned olivine and smaller chromite set in a fine-grained matrix of spinifex olivine, skeletal pyroxene, and glass. The gabbro (vol%) is 50% olivine, 35% pyroxene, and 15% plagioclase. A vein of black shock melt separates the cumulate clast from the fragmental breccia. The breccia is composed predominantly of pyroxene and olivine clasts, with minor plagioclase, and trace silica, Fe-Ti-Cr oxides, troilite, chromite, ilmenite, FeNi, apatite, and RE-merrillite.

Mineral compositions and geochemistry: Matrix pyroxene and olivine is $\text{Fs}_{17-65}\text{Wo}_{12-29}\text{En}_{8-61}$ and Fa_{40-95} ; plagioclase clasts are $\text{An}_{86-95}\text{Or}_{<2}$. Olivine in the basalt is zoned (Fo_{47-72}). Mineral compositions in the olivine cumulate are Fo_{68} , $\text{Fs}_{63}\text{Wo}_{15}$ and $\text{Fs}_{52}\text{Wo}_{32}$, and $\text{An}_{92}\text{Or}_1$. $\text{Fe}/\text{Mn} = 85-110$ (olivine) and 40–77 (pyroxene).

Bulk composition: (R. Zeigler and R. Korotev, *WUSL*) The basalt ($\text{TiO}_2 = 0.8\%$, $\text{FeO} = 21\%$, $\text{MgO} = 14\%$, $\text{Th} = 1.4 \mu\text{g/g}$) is compositionally similar to that of NWA 3160; the cumulate olivine gabbro ($\text{TiO}_2 = 0.4\%$, $\text{FeO} = 20\%$, $\text{MgO} = 27\%$, $\text{Th} = 1.2 \mu\text{g/g}$) is similar to NWA 773 and 2977. All lithologies are characterized by low concentrations of Na_2O ($= 0.15 \pm 0.06\%$) and Eu ($= 0.4 \pm 0.2$ ppm) compared to other lunar basalts. The oxygen isotope composition (I. A. Franchi, R. C. Greenwood, *OU*) is consistent with lunar origin ($\delta^{17}\text{O} = 2.94$, $\delta^{18}\text{O} = 5.59$, $\Delta^{17}\text{O} = 0.032$).

Classification: Achondrite (lunar basaltic fragmental breccia). The specimen is part of the NWA 773/2700/2727/2977/3160 pairing group.

Type specimens: A mass of 6.55 g is on deposit at *DuPont* and 0.4 g (neutron irradiated) and one thin section at *WUSL*.

Northwest Africa 4222

Northwest Africa

Find: 2006

Martian (shergottite)

History: A small fragment was purchased in Erfoud by a Moroccan dealer for M. Chinellato.

Physical characteristics: The sample weighs 16.5 g and is partially covered with a black fusion crust.

Petrography: (V. Moggi Cecchi, G. Pratesi, *MSP*) Cumulitic fine-grained porphyritic texture consisting of few very large rounded and zoned phenocrysts of brown olivine up to 1350 μm in maximum size set in a fine-grained basaltic groundmass of twinned tabular pyroxene crystals from 80 to 240 μm wide and from 130 to 820 μm long surrounded by an interstitial glassy matrix. Pyroxene is primarily pigeonite with subordinate enstatite. Other minerals are chromite, titanian chromite and ilmenite, up to 100 μm in size, merrillite, and

rare pyrrhotite grains up to 50 μm in size; shock features include strong mosaicism and planar deformation in olivine, undulose extinction and twinning in pyroxene.

Geochemistry and mineralogy: Olivine $\text{Fo}_{58.9-68.7}$; orthopyroxene (core $\text{Fs}_{17.2}\text{En}_{80.3}\text{Wo}_{2.4}$; rim $\text{Fs}_{31.4}\text{En}_{63.9}\text{Wo}_{4.7}$, $\text{FeO}/\text{MnO} = 30.2-42.4$); pigeonite (core $\text{Fs}_{24.1}\text{En}_{65.5}\text{Wo}_{10.3}$; rim $\text{Fs}_{32.6}\text{En}_{58.4}\text{Wo}_{8.9}$), $\text{FeO}/\text{MnO} = 32.5-46.5$). Plagioclase ($\text{An}_{61.1}\text{Or}_{0.2}$). Oxygen isotopes (I. A. Franchi, R. Greenwood, *OU*): $\delta^{17}\text{O} = 2.85\%$, $\delta^{18}\text{O} = 4.91\%$, $\Delta^{17}\text{O} = 0.30\%$ (mean on 2 analyses).

Classification: Martian (shergottite). Low weathering and high shock.

Type specimens: A total of 3.55 g of sample and one thin section is on deposit at *MSP*. *Chin* holds the main mass.

Northwest Africa 4395

Northwest Africa

Find: 2004

Achondrite (diogenite)

History: The meteorite was bought by the main mass holder in Erfoud, Morocco, in 2006.

Physical characteristics: One brownish fragment without fusion crust weighing 240 g was found.

Petrography: (A. Greshake, *MNB*) The meteorite is composed of large blocky orthopyroxene. Minor phases include plagioclase, Ca-phosphates and FeNi metal.

Mineral compositions and geochemistry: Low-Ca pyroxene, $\text{Fs}_{30.5}\text{Wo}_{2.7}$; plagioclase, $\text{An}_{90.5-91.7}$. Oxygen isotopes (I. A. Franchi and R. C. Greenwood, *OU*) mean of two replicates $\delta^{17}\text{O} = 2.09\%$, $\delta^{18}\text{O} = 4.39\%$, $\delta^{17}\text{O} = -0.19\%$.

Classification: Achondrite (diogenite), low degree of shock, moderate degree of weathering.

Type specimens: A total of 20.1 g plus one polished thin section are on deposit at *MNB*. *Ralew* holds the main mass.

Northwest Africa 4415

Northwest Africa

Find: 2006

Enstatite chondrite (EL6)

History: A small fragment was purchased at the Erfoud market by an anonymous collector.

Physical characteristics: A single dark brown piece of 10 g with no fusion crust and traces of marked staining.

Petrography: (V. Moggi Cecchi, G. Pratesi, *MSP*) The overall texture is characterized by rare relic chondrules and chondrule fragments set in a fine-grained matrix mainly composed of pyroxene. Several multiple subparallel and anastomosing thin veinlets, about 200 μm large, filled with iron oxides/hydroxides can be easily observed in reflected light in the thin section. Enstatite accounts for about 90% of the total volume. Relic chondrules are mainly RP type, with minor PP, and range from 0.2 to 0.8 mm in diameter. Minor phases are altered kamacite, altered troilite, and plagioclase. Accessory phases are schreibersite and daubreelite as blades.

Geochemistry: Enstatite ($\text{En}_{98.5}\text{Wo}_{1.5}$), plagioclase ($\text{An}_{15.8}\text{Or}_{4.4}$). Oxygen isotopes (R. Greenwood, I. Franchi, *OU*), $\delta^{17}\text{O} = 3.340\%$; $\delta^{18}\text{O} = 6.388\%$; $\Delta^{17}\text{O} = -0.007\%$.

Classification: Enstatite chondrite (EL6); S1; W3. This specimen is probably paired with NWA 4416.

Specimens: A total of 2 g, one polished thin section and a block are on deposit at *MSP*. An anonymous collector holds the main mass.

Northwest Africa 4416

Northwest Africa

Find: 2006

Enstatite chondrite (EL6)

History: A single stone was purchased at the Erfoud market by an anonymous collector.

Physical characteristics: A single dark brown stone of 259.1 g with no fusion crust and traces of staining.

Petrography: (V. Moggi Cecchi, G. Pratesi, *MSP*) The overall texture is characterized by rare relic chondrules and chondrule fragments set in a fine-grained matrix mainly composed of pyroxene. Thin veinlets about 200 μm wide in a subparallel and anastomosing array and filled with iron oxides/hydroxides can be easily observed in reflected light. Enstatite accounts for about 90% of the total volume. Relic chondrules are mainly RP type, with minor PP, and range from 0.3 to 0.8 mm in diameter. Minor phases are altered kamacite, altered troilite and plagioclase. Accessory phases are schreibersite and daubreelite, frequently associated with troilite.

Geochemistry: Enstatite ($\text{En}_{98.9}\text{Wo}_{1.1}$), plagioclase ($\text{An}_{15.3}\text{Or}_{4.7}$). Oxygen isotopes (R. Greenwood, I. Franchi, *OU*) $\delta^{17}\text{O} = 3.342\%$; $\delta^{18}\text{O} = 6.385\%$; $\Delta^{17}\text{O} = -0.009\%$.

Classification: Enstatite chondrite (EL6); S1; W3. This specimen is probably paired with NWA 4415.

Specimens: A total of 22 g, one polished thin section and a block are on deposit at *MSP*. An anonymous collector holds the main mass.

Northwest Africa 4418

Northwest Africa

Find: 2006

Mesosiderite

History: A complete stone was purchased in Erfoud by a Moroccan dealer for M. Chinellato.

Physical characteristics: The sample is a single stone of 103.8 g, partially covered with black fusion crust.

Petrography: (V. Moggi Cecchi and G. Pratesi, *MSP*) The meteorite exhibits a heterogeneous texture with large metal areas embedded in a silicate matrix. Metal accounts for 30 vol% of the total surface, with kamacite more abundant than taenite. Schreibersite is accessory. The silicate portion consists of a microbreccia with olivine grains no larger than $\sim 40 \mu\text{m}$ and clasts of orthopyroxene with very small (1 μm) exsolution lamellae, olivine (up to 200 μm) and plagioclase

(up to 100 μm), with minor clinopyroxene. The matrix is formed by orthopyroxene, olivine and minor plagioclase, with orthopyroxene more abundant than plagioclase, thus indicating class B. Textural features indicate type 3.

Geochemistry and mineralogy: Orthopyroxene is $\text{Fs}_{29.59}\text{En}_{67.32}\text{Wo}_{3.09}$, $\text{FeO/MnO} = 26.3\text{--}37.0$. Clinopyroxene ($\text{Fs}_{14.04}\text{En}_{43.93}\text{Wo}_{42.03}$) and exsolution lamellae ($\text{Fs}_{21.59}\text{En}_{49.84}\text{Wo}_{28.57}$); Plagioclase is $\text{An}_{90.6}\text{Or}_{0.6}$. Oxygen isotopes (I. Franchi, R. Greenwood, *OU*): $\delta^{17}\text{O} = 2.145\%$, $\delta^{18}\text{O} = 4.524\%$, $\Delta^{17}\text{O} = -0.207\%$.

Classification: Mesosiderite, B class; low shock, moderate weathering.

Type specimens: A total of 20.1 g and one thin section are on deposit at *MSP*. *Chin* holds the main mass.

Northwest Africa 4419

Northwest Africa

Find: 2006

Rumuruti chondrite (R4)

History: A complete stone was recovered in northwest Africa and sold in Erfoud to an anonymous buyer.

Physical characteristics: The sample is a single stone, weighing 103.15 g, partially covered with a black fusion crust.

Petrography: (V. Moggi Cecchi, G. Pratesi, *MSP*) The section consists of well-defined, chondrules (up to 1 mm), accounting for $\sim 50\%$ of the section by area, as well as chondrule and mineral fragments set in a slightly recrystallized matrix of silicates and sulfides (both troilite and pentlandite). Various textural types of chondrules are visible. Main phases are olivine, augite and plagioclase. The meteorite appears unbrecciated in the thin section studied.

Geochemistry: Mineralogy: Olivine $\text{Fa}_{39.8}$, low-Ca pyroxene mean $\text{Fs}_{22.8}$; range $\text{Fs}_{13.9\text{--}29.1}$. Oxygen isotopes (I. Franchi, R. Greenwood, *OU*): $\delta^{17}\text{O} = 5.469\%$, $\delta^{18}\text{O} = 6.031\%$, $\Delta^{17}\text{O} = +2.333\%$.

Classification: Rumuruti chondrite (R4): S2; moderate weathering.

Type specimens: A total of 20.8 g and one thin section are on deposit at *MSP*. An anonymous dealer holds the main mass.

Northwest Africa 4459

Algerian-Moroccan border

Find: June 2006

Ordinary chondrite (L3)

History: The sample was purchased in Erfoud by P. Thomas in June 2006.

Physical characteristics: A complete stone of 60.07 g, entirely covered with a very thin, slightly reddish, fusion crust.

Petrography: (M. Bourot-Denise, *MNHN*) Sample displays a typical chondritic texture with small, round chondrules (100–200 μm in size) the major component. Matrix is abundant, little altered, and contains small metal grains. Large, rounded metal-sulfide nodules, which are slightly

deformed and quite weathered occur in the matrix between chondrules. In BSE images the chondrite appears unequilibrated. Type I porphyritic chondrules contain FeO-poor olivines and low-Ca pyroxene, and FeO-rich silicates are only found in type II chondrules.

Geochemistry: Olivine, $Fa_{12.0 \pm 11.4}$, range $Fa_{0.49-39.6}$, CaO up to 0.39, Cr_2O_3 in the range 0.11–0.76 (wt%); Low-Ca pyroxene, $Fs_{7.7 \pm 8.2}$, range $Fs_{1.15-26.1}$. Magnetic susceptibility (J. Gattacceca, *CEREGE*) $\chi_{log} = 4.32$ (10^{-9} m³/kg) is consistent with an altered L chondrite.

Classification: Ordinary chondrite (L3, estimated subtype 3.3), weathering grade W3, shock stage S2.

Type specimens: A total of 14.4 g (1 sawn fragment) and one polished mount are on deposit at *MNHNP*. *Thomas* holds the main mass.

Northwest Africa 4483

Algeria

Find: July 2006

Achondrite (lunar, granulitic breccia)

History: Purchased by Stefan Ralew in July 2006 from a dealer in Erfoud, Morocco.

Physical characteristics: Twelve broken fragments of very fine-grained, pale grey rock with a combined weight of 208 g.

Petrography: (A. Irving and S. Kuehner, *UWS*) Fine grained recrystallized breccia composed of larger plagioclase grains (converted mainly to maskelynite) poikilitically enclosing very small grains (mostly 30–80 μ m) of low-Ca pyroxene (some with very fine augite exsolution lamellae), olivine, Ti-chromite, ilmenite, troilite, and metal.

Geochemistry: Olivine ($Fa_{30.9-60.8}$, FeO/MnO = 88.1–106), plagioclase ($An_{96.2-98}Or_{<0.1}$), orthopyroxene ($Fs_{14.3}Wo_{2.0}$, FeO/MnO = 52.6), pigeonite ($Fs_{36.4-75.1}Wo_{6.3-13.5}$, FeO/MnO = 62.9–66.5).

Classification: Achondrite (lunar, granulitic breccia). Possibly paired with Northwest Africa 3163 (Irving et al. 2006).

Specimens: A total of 20 g and one polished mount are on deposit at *UWS*. *Ralew* holds the main mass.

Northwest Africa 4529

Algeria

Find: September 2006

Achondrite (lodranite)

History: Purchased by Greg Hupé in September 2006 from a Moroccan dealer in Tagounite.

Physical characteristics: A single, dense, dark colored stone (60.0 g) lacking fusion crust.

Petrography: (A. Irving and S. Kuehner, *UWS*) The overall texture is coarse-grained (grain size 0.6–1.6 mm) and relatively equigranular, but plagioclase grains (0.2–0.45 mm) are interstitial to other phases. The specimen is composed predominantly of orthopyroxene (with minor clinopyroxene exsolution lamellae) and olivine, with lesser amounts of sodic plagioclase (6.5 vol%), chromite, clinopyroxene (with minor orthopyroxene exsolution lamellae), Na-Mg-merrillite (grain

size up to 0.5 mm), kamacite (some as relatively large grains up to 1.1 mm) and troilite.

Geochemistry: Orthopyroxene ($Fs_{12.6}Wo_{2.5}$, FeO/MnO = 14.7–15.9), olivine ($Fa_{14.3}$, FeO/MnO = 24.7–27.1), plagioclase ($An_{17.8-20.1}Or_{4.8-3.7}$), chromite ($Cr/(Cr+Al) = 0.853$, $Mg/(Mg+Fe) = 0.337-0.342$, mean $TiO_2 = 0.77$ wt%) Oxygen Isotopes (D. Rumble, *CIW*): $\delta^{18}O$ (‰) = 3.168, 3.189, 3.467, 2.894; $\delta^{17}O = 0.829, 0.757, 0.939, 0.613$; $\Delta^{17}O = -0.837, -0.920, -0.884, -0.909$.

Classification: Achondrite (lodranite).

Specimens: A total of 12.0 g and one polished thin section are on deposit at *UWS*. *GHupé* holds the main mass.

Northwest Africa 4536

Northwest Africa

Find: December 2006

Achondrite (eucrite)

History: Purchased in Erfoud (Morocco) in December 2006.

Physical characteristics: One piece with nearly complete (90%) shiny dark, cracked fusion crust and deep, well-formed regmaglypts. Interior is light greenish-yellow in color. Sawn section displays two lithologies: one fine-grained with millimeter length laths, dark needles (plagioclase and pyroxene) and white spots, the other is gray and brecciated with dominant pyroxene. Total weight, 283.1 g.

Petrography: (A. Jambon, O. Boudouma and D. Badia, *UPVI*) Fine-grained lithology dominated by equant grains of plagioclase and pigeonite. Accessories phases are ilmenite, augite, silica, and troilite. Plagioclase and pigeonite form equant sub-hexagonal crystals of about 5–20 μ m. Mode (vol%): Plagioclase 44, pigeonite 27, augite 16, silica 10, ilmenite and troilite 1, fractures and voids 3. The coarse-grained lithology is dominated by shocked basaltic eucrite with grains of 0.2 to 1 mm. Laths of plagioclase interstitial to pyroxene.

Mineralogy: (EMPA and SEM). Plagioclase An_{89} ; pigeonite $En_{35}Fs_{63}Wo_2$, FeO/MnO = 33, Mg# = 0.36; augite $En_{30}Fs_{30}Wo_{40}$, FeO/MnO = 34, Mg# = 0.50.

Classification: Basaltic, dimict eucrite; fresh sample, no weathering is observed.

Type specimens: A total of 20 g and one polished section are on deposit at *UPVI*. *P. Thomas* at Meteoritica (France) holds the main mass.

Northwest Africa 4537

Morocco

Find: 2005

Achondrite (aubrite)

History: Purchased in 2006, by Matteo Chinellato, from a Moroccan dealer in Erfoud.

Physical characteristics: A single green complete stone lacking fusion crust with a total weight of 261 g and displaying minute spots of yellow-orange staining and larger dark brown on the exterior.

Petrography: (V. Moggi Cecchi and G. Pratesi, *MSP*) The thin section displays a uniform very fine-grained

equigranular texture consisting of bladed grains of enstatite with sporadic clasts of enstatite (up to 0.7 mm across). The grain size is variable from 80 to 210 μm in width and up to 270 μm in length. Relatively few enstatite grains exhibit lamellar twinning. Other silicate phases include plagioclase, blades of daubreelite up to 50 μm in width, and rare troilite, Fe,Ni metal and schreibersite grains rounded. Minor barite and calcite are present, probably due to terrestrial weathering.

Geochemistry: Pyroxene ($\text{En}_{98.5}\text{Wo}_{1.5}$; $\text{Al}_2\text{O}_3 = 0.19$ wt%), plagioclase ($\text{An}_{14.3}\text{Or}_{4.1}$). Oxygen isotopes (R. Greenwood, I. Franchi, *OU*) $\delta^{17}\text{O} = 2.650\%$; $\delta^{18}\text{O} = 5.021\%$; $\Delta^{17}\text{O} = +0.039\%$.

Classification: Achondrite (aubrite). Minor weathering effects on troilite, and minor yellow-orange staining on exterior surface.

Type specimen: A total of 136 g, one polished thin section and one block are on deposit at *MSP*; the *Museo di Storia Naturale dell'Università di Firenze* holds the remaining 125 g mass.

Northwest Africa 4642

Northwest Africa

Find: 2006

Enstatite achondrite

History: The meteorite was found by an anonymous finder in northwest Africa and bought by the main mass holder in Erfoud, Morocco.

Physical characteristics: One fragment of 483.2 g partly covered with fusion crust was found.

Petrography: (A. Greshake, *MNB*) The meteorite predominantly consists of subhedral enstatite grains. Minor phases include feldspar, Fe-Cr-sulfides, and rare Fe,Ni-metal; no chondrules were found.

Geochemistry: Pyroxene, $\text{Fs}_{0-1.2}$. Oxygen Isotopes (I. A. Franchi and R. C. Greenwood, *OU*): $\delta^{17}\text{O} = 2.975\%$, $\delta^{18}\text{O} = 5.614\%$, $\Delta^{17}\text{O} = 0.056\%$.

Classification: Enstatite achondrite; low degree of shock, moderate degree of weathering.

Type specimens: A total of 22.6 g and one polished thin section are on deposit at *MNB*. *HSSH* holds the main mass.

Northwest Africa 4722

Morocco

Find: January 2006

Ordinary chondrite (LL3)

History: Stones were purchased in Erfoud by C. Giessler in January 2006.

Physical characteristics: 48 small, crusted stones with brownish interiors, totaling 294 g.

Petrography: (M. Bourot-Denise, *MNHNP*) The meteorite displays a homogeneous texture with mm-sized chondrules. BSE images point to an unequilibrated chondrite, with large type II FeO-rich chondrules, and small (<500 μm in size) type I, FeO-poor chondrules. In the type I chondrules, olivines are sometimes zoned. Rare metal and sulfide occur in large

nodules (100–200 μm). Terrestrial alteration has significantly affected the matrix and the opaque minerals in the matrix.

Geochemistry: Olivine, $\text{Fa}_{13.5 \pm 11.1}$, range $\text{Fa}_{0.8-36.5}$, CaO up to 0.18, $\text{Cr}_2\text{O}_3 = 0.15$ (both wt%); low-Ca pyroxene, $\text{Fs}_{10.3 \pm 9.5}$, range $\text{Fs}_{1.1-27.7}$. Magnetic susceptibility: (J. Gattacceca, *CEREGE*) $\log\chi = 3.23$ (10^{-9} m^3/kg) is consistent with a weathered LL chondrite.

Classification: Ordinary chondrite (LL3, estimated subtype 3.4); weathering grade W3; shock stage S1.

Type specimens: A total of 24.3 g of sample (4 sawn fragments) and one polished mount are on deposit at *MNHNP*. C. Giessler holds the main mass.

Northwest Africa 4735

Erfoud, Morocco

Find: 2003

Primitive achondrite (acapulcoite/lodranite)

History: Bought in Erfoud in 2003.

Physical characteristics: One single stone of 64 g, prismatic shaped, about $2 \times 1.5 \times 5$ cm. The thin dark brown fusion crust is rather fresh. Discrete, millimeter-sized regmaglypts are visible. One surface is broken.

Petrography: (A. Jambon, O. Boudouma and D. Badia, *UPVT*) Study of a polished section of 1 cm^2 reveals the rock is composed mostly of mm-sized low Ca pyroxene. Interstitial metal patches from 0.1 up to 1 mm are observed (kamacite sometimes enriched in Ni due to secondary oxidation). Most are rimmed by iron oxide. Iron sulfide may or may not be associated with metal. Olivine crystals may be as large as low Ca pyroxene mostly altered and replaced by clay minerals. Plagioclase and diopsidic pyroxene are subsidiary smaller interstitial phases. Some μm -sized rounded clinopyroxene crystals are poikilitically enclosed in plagioclase. The texture is equilibrated granulitic. Thin irregular fractures are filled with iron oxides. Mode (vol%): Low-Ca pyroxene 50.4, olivine and its alteration products about 5–10, diopsidic pyroxene 6.0, plagioclase 6.6, kamacite 17 (4.2 metal plus 8.8 oxidized), chromite 4, troilite 8.1, voids 1.3. Minor serpentine and chlorite.

Geochemistry: Olivine Fa_{10} . Low Ca pyroxene $\text{En}_{91}\text{Fs}_8\text{Wo}_1$. Diopside: $\text{En}_{50}\text{Fs}_4\text{Wo}_{46}$ with 1.1 wt% Cr_2O_3 . Chromite ($\text{Cr}_2\text{O}_3 = 62.6\%$, $\text{Al}_2\text{O}_3 = 5.7\%$, $\text{MgO} = 9.3\%$, $\text{MnO} = 2.6\%$, $\text{FeO} = 15.8\%$, $\text{TiO}_2 = 0.9\%$) kamacite (Ni = 7.0%; Co/Ni = 0.063). Feldspar $\text{Ab}_{81}\text{An}_{12}\text{Or}_7$. $\log\chi$ (nm^3/kg): 5.6.

Classification: Primitive achondrite (acapulcoite-lodranite) According to grain size this rock could be classified as a lodranite; according to its opx/olivine ratio it could be considered as an acapulcoite.

Type specimens: A total of 12.2 g and one polished section are on deposit at *UPVI*. *Moroccan Import (Asnières, France)* holds the main mass.

Northwest Africa 4742

Morocco

Find: 2001

Achondrite (polymict ureilite)

History: This meteorite was purchased from nomads in Erfoud and acquired by *MNHN* in 2007.

Physical characteristics: The meteorite comprises a single stone, light tan in color, with altered fusion crust and prominent crystals. It also contains numerous bright crystallites (diamonds). A one-cm splinter on one edge is covered with some thin desert varnish. The total mass of the stone is 376 g.

Petrography: (M. Denise, *MNHNP Paris*; A. Jambon, O. Boudouma, D. Badia, *UPVI*; C. Le Guillou and J-N Rouzaud, *ENS Paris*) Classification by EMPA, SEM, and Raman spectroscopy is based on examination of one polished section. The sample contains abundant mm-sized clasts (~30 vol%) of olivine with Fo-rich rims. Within the clasts, reduction rims extend over about 50 μm . The clasts are surrounded by a matrix composed of olivine, low-Ca pyroxene, and subsidiary augite of typically 20–30 μm with a mosaic texture. Numerous mm-sized, interconnected clusters of carbon infill fractures in the matrix. Carbon (~3.5 vol%) is partly amorphous, mostly polycrystalline aggregates of diamond and lonsdaleite (TEM, Raman, XRD) up to several mm and is found in systematic association with oxidized iron sulfide and metal. The thin section also shows rare Ca-carbonate filled veins.

Mineral compositions and geochemistry: Olivine clasts (core) Fo_{79} ; Cr_2O_3 0.6%, CaO 0.3%; $\text{FeO/MnO} = 44$; rims and interstitial olivine up to Fo_{96} . Abundant low-Ca pyroxene: $\text{En}_{84}\text{Fs}_{15}\text{Wo}_1$; $\text{FeO/MnO} = 42$. Minor high-Ca pyroxene variable up to: $\text{En}_{45}\text{Fs}_{10}\text{Wo}_{45}$; $\text{FeO/MnO} = 29$, Mg\# 75 to 81. Remnants of kamacite with 2% Ni are usually altered. Oxygen isotopes (R. Greenwood and I. Franchi, *OU*) $\delta^{17}\text{O} = 4.71\text{‰}$, $\delta^{18}\text{O} = 9.61\text{‰}$, $\Delta^{17}\text{O} = -0.29\text{‰}$.

Classification: Polymict ureilite

Type specimens: A specimen of 32 g and one polished section are on deposit at *UPVI*. *MNHNP Paris* holds the main mass. 10 g *Moroccan Imports*, Asnières, France.

Northwest Africa 4748

Northwest Africa

Find: 2005

Achondrite (eucrite, polymict)

History: The meteorite was bought by the main mass holder from a Moroccan dealer during the Munich Mineral Fair, Germany, 2005. The exact find location is not known.

Physical characteristics: Single oval stone of 80 g with a partly weathered shiny black fusion crust. The half of the stone that was wedged in the ground is covered with carbonate.

Petrography: (J. Schlüter, *Hamb*) Breccia, rich in mineral fragments with few lithic fragments. Rich in troilite and metal with metal grains up to 2 mm in size. Troilite occurs finely dispersed throughout the meteorite, attached to metal grains and frequently as symplectitic intergrowths with clinopyroxene (up to 400 μm in size). The main silicate

phases are calcic plagioclase and clinopyroxene (pigeonite), which shows fine exsolution lamellae. Microprobe analyses of such grains give intermediate values. Further subordinate to rare components are chromite, orthopyroxene, olivine and silica.

Geochemistry: Plagioclase ($n = 18$) $\text{An}_{94.09}\text{Ab}_{5.79}\text{Or}_{0.12}$, pigeonite ($n = 13$) $\text{Fs}_{44.49}\text{En}_{53.23}\text{Wo}_{2.28}$. Several further clinopyroxene grains with differing chemistry (higher Wo or lower Fs). Orthopyroxene ($n = 2$) $\text{Fs}_{26.62}\text{En}_{70.63}\text{Wo}_{2.75}$. Olivine in a lithic fragment ($n = 2$) $\text{Fa}_{33.60}$. Metal with 5.09 wt% Ni ($n = 3$) and 40.15 wt% Ni ($n = 1$).

Classification: Achondrite, brecciated (eucrite, polymict). Appears to have a low degree of shock and minor weathering.

Type specimens: A 17 g sample and one polished thin section are on deposit at *Hamb*. *Wuthenau*, holds the main mass.

Northwest Africa 4799

Algeria

Find: May 2007

Achondrite (aubrite)

History: Purchased by Greg Hupé in May and October 2007 from a Moroccan dealer in Tagounite.

Physical characteristics: Eighty-six light brown stones and fragments (total 365 g); most are complete, some are broken, and some have remnant fusion crust.

Petrography: (A. Irving and S. Kuehner, *UWS*) The overall texture is that of a brecciated igneous rock, with larger angular to rounded clasts (some showing cumulus texture) in a matrix of smaller grains. The dominant mineral is pure enstatite with lesser amounts of interstitial albite (some in graphic intergrowths with a silica polymorph) and accessory Si-bearing kamacite, Ti-Cr-bearing troilite, oldhamite, niningerite, Ti-bearing daubreelite and schreibersite. The enstatite grains exhibit polysynthetic twinning indicative of inversion from former clinoenstatite. Grain boundary coatings of goethite or limonite and orange staining along enstatite cleavage planes, as well as veinlets of calcite, are evidently products of terrestrial desert weathering.

Geochemistry: Enstatite ($\text{En}_{99.5}\text{Fs}_{0.1}\text{Wo}_{0.4}$), kamacite (Fe 92.1 wt%, Ni 4.5 wt%, Si 3.4 wt%).

Classification: Achondrite (aubrite).

Specimens: A total of 20.1 g and one polished thin section are on deposit at *UWS*. *GHupé* holds the main mass.

Northwest Africa 4801

Algeria

Find: May 2007

Achondrite (angrite)

History: Greg Hupé purchased the single stone in Erfoud, Morocco. The stone is broken into four pieces (total weight 252 g) and was found in Algeria in May 2007.

Physical characteristics: Friable specimen composed of relatively coarse dark reddish-brown, pale yellow-green, white and black grains, with some large white patches

(polycrystalline anorthite aggregates). No fusion crust is evident.

Petrography: (A. Irving and S. Kuehner, *UWS*) The overall texture is granular with the presence of some polygonal grain aggregates and triple grain junctions. Grain size ranges from 0.1–1.2 mm. It is composed mostly of Al-Ti clinopyroxene and pure anorthite (some as polycrystalline aggregates up to 0.5 cm across), with sporadic large Cr-pleonaste grains (up to 200 μm across), calcic olivine, pleonaste, poikilitic merrillite and minor troilite and altered kamacite. Subhedral olivine grains are enclosed by clinopyroxene, and both these and pleonaste are surrounded by interstitial anorthite and merrillite. Pleonaste occurs as small grains throughout the specimen, but also as mantles around the large Cr-pleonaste grains, and those mantles contain abundant chadacrysts of subhedral olivine and clinopyroxene. Small cavities (2–5 μm across) within clinopyroxene contain olivine and anorthite grains. Kirschsteinite is absent, and merrillite is more abundant than in most other known angrites.

Geochemistry: Clinopyroxene ($\text{Fs}_{11.8}\text{Wo}_{56.9}$; $\text{Al}_2\text{O}_3 = 10.6 \text{ wt\%}$, $\text{TiO}_2 = 2.4 \text{ wt\%}$, $\text{FeO/MnO} = 133$), olivine ($\text{Fa}_{45.5}\text{Ln}_{2.4}$, $\text{FeO/MnO} = 88$), spinel (Cr-pleonaste: $\text{Cr}_2\text{O}_3 = 6.3 \text{ wt\%}$, $\text{Cr}/(\text{Cr} + \text{Al}) = 0.070$, $\text{Mg}/(\text{Mg} + \text{Fe}) = 0.451$; pleonaste: $\text{Cr}_2\text{O}_3 = 1.9\text{--}2.4 \text{ wt\%}$, $\text{Cr}/(\text{Cr} + \text{Al}) = 0.021\text{--}0.026$, $\text{Mg}/(\text{Mg} + \text{Fe}) = 0.462\text{--}0.467$). Oxygen isotopes (D. Rumble, *CIW*): $\delta^{18}\text{O} = 3.595, 3.544$; $\delta^{17}\text{O} = 1.809, 1.823$; $\Delta^{17}\text{O} = -0.082, -0.041 \text{ ‰}$.

Classification: Achondrite (angrite).

Specimens: A total of 20.0 g, one polished thin section and one polished mount are on deposit at *UWS*. *GHupé* holds the main mass.

Northwest Africa 4812

Northwest Africa

Find: 2006

Carbonaceous chondrite (CK)

History and physical characteristics: A 68 g stone was purchased in Erfoud, Morocco, by Stefan Ralew in 2006. Patchy distribution of dark gray fusion crust and desert etching.

Petrography: (T. Bunch and J. Wittke, *NAU*) dark interior with very dark chondrules and shock-melt clasts, the matrix is nearly opaque. Highly shocked and shock-darkened by melting to partial melting of matrix and redistribution of fine-grained magnetite similar to shock darkening of ordinary chondrites and redistribution of fine-grained metal droplets. Contains olivine, orthopyroxene, pigeonite, plagioclase, felsic glasses, Cr-magnetite, FeS, and pentlandite. The shock level is S5 and weathering grade is low.

Mineral compositions: Olivine, $\text{Fa}_{30.3}$ ($\text{FeO/MnO} = 110$); orthopyroxene, $\text{Fs}_{26.4}\text{Wo}_{0.7}$ ($\text{FeO/MnO} = 74$); pigeonite, $\text{Fs}_{21.1}\text{Wo}_{12.1}$ ($\text{FeO/MnO} = 64$); plagioclase, $\text{An}_{59.3}$ and magnetite, $\text{Cr}_2\text{O}_3 = 3.64 \text{ wt\%}$ and $\text{Al}_2\text{O}_3 = 1.26 \text{ wt\%}$.

Classification: Carbonaceous chondrite (CK). High shock effects preclude further subtype classification.

Type specimen: A total of 6.9 g and one thin section are on deposit at *NAU*. *S. Ralew* is the main mass holder.

Northwest Africa 4816

Northwest Africa

Find: 2006

Achondrite (acapulcoite)

History and physical characteristics: A 63 g stone was purchased in Erfoud, Morocco, in 2006 by Stefan Ralew. The partial stone has moderate surface weathering of broken areas. Small metal spherules and droplets protrude through a thin, residual fusion crust.

Petrography: (T. Bunch and J. Wittke, *NAU*) Highly enriched in kamacite metal, mineral modes (in vol%) are orthopyroxene, 33; olivine, 25; kamacite, 24; diopside, 15, plagioclase and felsic glass, 3 and FeS + chromite, 1.0. Silicates are fine-grained (mean = 0.60 mm) and show euhedral to subhedral grain outlines. Orthopyroxene contains micrometer-sized glass blebs. Rare, round to ovoid granular clusters may represent relict chondrules. Shock level is S2 and the weathering grade is W1.

Mineral compositions: Olivine, $\text{Fa}_{5.6}$; $\text{FeO/MnO} = 12$. Orthopyroxene is $\text{Fs}_{6.2}\text{Wo}_{2.1}$, $\text{FeO/MnO} = 9$ and diopside is $\text{Fs}_{2.8}\text{Wo}_{45.5}$, $\text{FeO/MnO} = 7$. Plagioclase is An_{66} , chromite $cr\# = 69$ and kamacite contains 6.1 wt% Ni. Felsic glass is (in wt%): $\text{SiO}_2, 51.2$; $\text{Al}_2\text{O}_3, 20.3$; $\text{CaO}, 10.8$; $\text{Na}_2\text{O}, 2.6$; $\text{K}_2\text{O}, 0.8$; $\text{MgO}, 12.0$ and $\text{FeO}, 3.1$.

Classification: Achondrite (acapulcoite).

Type specimen: A 12.4 g sample is on deposit at *NAU*. *S. Ralew* holds the main mass.

Northwest Africa 4824

Northwest Africa

Find: 2007

Achondrite (eucrite, monomict breccia)

History and physical characteristics: A 97 g fully crusted, fresh stone was purchased in Tucson at the Tucson Gem and Mineral Show in January 2007.

Petrography: (J. Wittke and T. Bunch, *NAU*) Highly shocked monomict, basaltic eucrite breccia. Partially recrystallized with plagioclase glass, mosaic to recrystallized pyroxenes, and dark, shock-melt clasts.

Mineral compositions: Pigeonite host, $\text{Fs}_{56.6}\text{Wo}_{5.7}$; augite lamellae, $\text{Fs}_{33.2}\text{Wo}_{32.6}$. Plagioclase is $\text{An}_{90.8}$.

Classification: Achondrite (eucrite, monomict breccia).

Type specimen: 19.7 g is on deposit at *NAU*. The main mass holder is anonymous.

Northwest Africa 4825

Northwest Africa

Find: 2006

Achondrite (eucrite, polymict)

History and physical characteristics: A 226 g complete stone with moderately fresh fusion crust was purchased in Tucson at the Tucson Gem and Mineral Show in January 2007.

Petrography: (J. Wittke and T. Bunch, *NAU*) A brecciated polymict eucrite with cataclastic flow veins and partially recrystallized matrix. Consists of cumulate, subophitic, and ophitic basalt clasts. A portion of the plagioclase was converted to maskelynite by shock and most pyroxenes are shock-decorated. Weathering grade is very low.

Mineral compositions: subophitic orthopyroxene host, $\text{Fs}_{56.8}\text{Wo}_{3.6}$ ($\text{FeO/MnO} = 30\text{--}32$); exsolution lamellae, $\text{Fs}_{29}\text{Wo}_{39.5}$. Pigeonite is $\text{Fs}_{56.7}\text{Wo}_{8.8}$ and plagioclase is $\text{An}_{90.2\text{--}94.5}$. Minor minerals include silica, chromite, ilmenite, and FeS.

Classification: Achondrite (eucrite, polymict).

Type specimen: A total of 23.1 g is on deposit at *NAU*. The main mass holder is anonymous.

Northwest Africa 4826

Northwest Africa

Find: 2006

Achondrite (howardite)

History and physical characteristics: A 344 g fully crusted stone with fine-grained, light grey interior was purchased in Tucson at the Tucson Gem and Mineral Show in January 2007.

Petrography: (T. Bunch and J. Wittke, *NAU*) Consists mostly of two major eucrite lithologies and diagenetic fragments that display complicated sector and reverse zoning. The medium-grained eucrite (lithology A) is enriched in ilmenite and chromite and contains polygonized pyroxene, plagioclase is partially converted to maskelynite. Eucrite lithology (B) is less shocked and contains pigeonite with well-developed exsolution lamellae and is present as matrix fragments. Diagenetic fragments consist of those that are unzoned, those that are sector zoned, and several large fragments that show dramatic reverse zoning and patches of augite. The weathering grade is low.

Mineral compositions: Lithology (A) orthopyroxene host, $\text{Fs}_{50.3}\text{Wo}_{1.3}$ ($\text{FeO/MnO} = 31$), lamellae, $\text{Fs}_{23.7}\text{Wo}_{45.2}$. chromite $cr\# = 63$ and plagioclase is $\text{An}_{93.8\text{--}97.8}$. Lithology (B) Ca-poor pyroxene is $\text{Fs}_{40.2}\text{Wo}_{4.6}$ ($\text{FeO/MnO} = 29$) and the lamellae are $\text{Fs}_{28.3}\text{Wo}_{30.1}$. Sector zoned orthopyroxene cores are $\text{Fs}_{25.3}\text{Wo}_{2.6}$ ($\text{FeO/MnO} = 28$) and rims are $\text{Fs}_{36.9\text{--}44.6}\text{Wo}_{2.3\text{--}3.2}$. Most pigeonite cores with reverse zoning are $\text{Fs}_{45}\text{Wo}_{14}$, rims are $\text{Fs}_{32.5}\text{Wo}_{19}$, and included augite is $\text{Fs}_{29}\text{Wo}_{35.7}$. One FeO-rich orthopyroxene grain has a core of $\text{Fa}_{70.5}\text{Wo}_{2.8}$ ($\text{FeO/MnO} = 35$) and a rim of $\text{Fs}_{56.6}\text{Wo}_{2.8}$.

Classification: Achondrite (howardite).

Type specimen: A 21.3 g specimen is on deposit at *NAU*. The main mass holder is anonymous.

Northwest Africa 4830

Northwest Africa

Find: 2006

Achondrite (eucrite, monomict)

History and physical characteristics: A 38 g fully crusted stone with moderately fresh fusion crust was purchased at the Denver Gem and Mineral Show in September 2006.

Petrography: (T. Bunch and J. Wittke, *NAU*) This stone is a

monomict, eucrite basalt with granoblastic texture. Most of the sample was recrystallized into an assemblage of very fine-grained polygons (<0.03 mm). Vestiges of the original texture show a fabric of divergent plagioclase laths and interstitial pyroxenes. Maximum length of the plagioclase laths is <0.4 mm. Weathering effects are minimal.

Mineral compositions: (relict and recrystallized minerals are essentially the same). Orthopyroxene, $\text{Fs}_{60.5}\text{Wo}_{2.1}$ ($\text{FeO/MnO} = 32$); augite, $\text{Fs}_{37.4}\text{Wo}_{35.5}$; plagioclase, An_{93} ; chromite $cr\# = 84$.

Classification: Achondrite (eucrite, monomict).

Type specimen: A total of 7.7 g is on deposit at *NAU*. The main mass holder is anonymous.

Northwest Africa 4831

Northwest Africa

Find: 2006

Achondrite (eucrite)

History and physical characteristics: A 154 g, partial stone with moderately fresh fusion crust, was purchased at the Denver Gem and Mineral Show in September 2006.

Petrography: (J. Wittke and T. Bunch, *NAU*) A monomict cumulate eucrite with breccia-within-breccia texture. Clasts tend to be subrounded and contain orthopyroxenes that are commonly devoid of exsolved Ca-pyroxenes. Plagioclase contains μm -sized oriented pyroxene inclusions. Weathering grade is low.

Mineral compositions: Orthopyroxene, $\text{Fs}_{46.7\text{--}52}\text{Wo}_{2.2\text{--}3.1}$ ($\text{FeO/MnO} = 32$); augite, $\text{Fs}_{36.4}\text{Wo}_{44.7}$; plagioclase $\text{An}_{88\text{--}91.1}$.

Classification: Achondrite (eucrite, monomict cumulate).

Type specimen: A total of 21.4 g is on deposit at *NAU*. The main mass holder is anonymous.

Northwest Africa 4832

Northwest Africa

Find: 2006

Achondrite (aubrite)

History and physical characteristics: Hundreds of platey fragments, the largest weighing 33.1 g, were found in northwest Africa and purchased by A. Aaronson in 2007. The total known weight is 268 g. Fragments tend to break along the preferred orientation plane of constituent enstatite grains. Most of the dark brown pieces are moderately to heavily weathered, a few show small, fresh metal nuggets.

Petrography: (T. Bunch and J. Wittke, *NAU*) composed mostly of fine-to medium-grained (0.3 to 1.2 mm), euhedral to subhedral cumulate enstatite together with interstitial metal, schreibersite, graphite, FeS, a silica phase present as round inclusions in FeS, daubreelite, brezinaite and very fine-grained intercumulus plagioclase. Much of the metal is oxidized. The stone is unbrecciated with a low shock level.

Mineral chemistry: Enstatite is essentially Fe-free ($\text{En}_{99.6}\text{Fs}_{0.1}\text{Wo}_{0.3}$). Kamacite contains 4.5 to 5.6 wt% Si and FeS contains 2.6 wt% Ti. The rare mineral brezinaite contains S, 45.2 wt%; Cr, 36.9 to 46.6 wt%; Fe, 18.7 to 9.0 wt% and 1.1 wt% Mn.

Classification: Achondrite (aubrite)

Type specimen: A total of 20.6 g is on deposit at *NAU*. *Aaronson* is the main mass holder.

Northwest Africa 4833

Northwest Africa

Find: 2007

Achondrite (lodranite)

History and physical characteristics: A 608 g dark stone with a dull desert varnish and no remaining fusion crust was found in northwest Africa in 2007 and purchased by *A. Aaronson* in July 2007.

Petrography: (T. Bunch and J. Wittke, *NAU*) The stone displays a coarse-grained (olivine grains up to 6 mm) hypidiomorphic texture. Orthopyroxene shows a common lobate grain boundary relationship with olivine. Orthopyroxene is highly decorated with exsolved linear to bleb-shaped diopside (0.002 to 0.04 mm in size) that is oriented parallel to at least three crystal planes of the orthopyroxene host. Olivine is decorated with 0.005–0.02 mm sized ovoid-shaped microlites of plumose chromite set in anhedral diopside. Mineral modes (vol%) are: olivine = 65, orthopyroxene = 30, metal and oxidized metal = 2, chromite and diopside = 3, no plagioclase was found. The shock level is S3 based on moderate mosaic extinction in olivine and orthopyroxene and minor shock twinning in both.

Mineral compositions: Olivine (Fa_{10.1}; FeO/MnO = 23), orthopyroxene (Fs_{9.4}Wo_{2.3}; FeO/MnO = 14), diopside (Fs_{8.0}Wo_{45.9}; FeO/MnO = 11), metal (2.98 wt% Ni) and FeS Cr = 1.1 wt%. Chromite *cr#* = 85.

Classification: Achondrite (lodranite).

Type specimen: A 22.2 g sample is on deposit at *NAU*. *A. Aaronson* holds the main mass.

Northwest Africa 4858

Morocco or Algeria

Find: 2004

Achondrite (howardite)

History: Purchased in July 2004 in Erfoud, Morocco, by Edwin Thompson.

Physical characteristics: A single stone weighing 329 g with a partial brown/black fusion coating.

Petrography: (A. Ruzicka and T. J. Schepker, *Cascadia*) In hand specimen, sample is light gray with numerous bright green crystals. It is clearly a polymict breccia with angular to subrounded clasts. These include coarse-grained diogenitic orthopyroxene clasts, which make up greater than 10% of the total material. Additionally, there are coarse-grained plagioclase mineral clasts, eucritic rock clasts that contain inverted pigeonite and plagioclase ± a silica mineral, pigeonite mineral clasts, fine-grained clasts that are interpreted to be crystallized impact melts, and some fine-grained pseudotachylite veins. Relatively rare oxide minerals are also present.

Mineral compositions and geochemistry: Most

pyroxene and plagioclase grains show modest chemical zoning, but compositions between clasts differ significantly. Pyroxene types include diogenitic orthopyroxene (Wo_{0.7–5} En_{58–77} Fs_{21–39}, n = 22), non-inverted pigeonite (Wo_{5–15} En_{37–56} Fs_{36–55}, n = 9), inverted pigeonite, which contains lamellae of orthopyroxene (Wo_{3–5} En_{34–49} Fs_{46–62}, n = 9), and augite (Wo_{41–43} En_{31–36} Fs_{21–29}, n = 2). Plagioclase is fairly calcic (Ab_{3–15}, An_{84–97}, Or_{0–1}, n = 33).

Classification: Achondrite (howardite). Degree of shock varies from clast to clast and evidence of shock melting in a few clasts. Weathering is minimal.

Type specimens: A total of 42 g and one thin section are on deposit at *Cascadia*. *Thompson* holds the main mass.

Northwest Africa 4864

Northwest Africa

Find: 2007

Achondrite (Martian, basaltic shergottite)

History: On July 16, 2007, a person brought 10 pieces totaling 94 g to the Institut für Planetologie (Münster) for classification.

Physical characteristics and petrography: (A. Bischoff, *Mun*) The rock is slightly weathered and relatively coarse-grained. The main constituents, pyroxene and maskelynite, have sizes up to 2 mm (Fig. 1). Near equal abundances of these phases are estimated. In some pyroxenes, glassy melt veins and pockets are visible. Minor phases include ilmenite, Fe-sulfide, and phosphate.

Mineral compositions and geochemistry: The mean composition of pyroxene is Fs_{50 ± 5}; Wo_{13 ± 2}. Maskelynite An_{51 ± 3}. Oxygen isotopes (A. Pack and A. Suessenberger, *University of Göttingen*) revealed: 1st analysis: δ¹⁸O = +5.3 ± .25‰, δ¹⁷O = +3.5 ± 0.15‰, Δ¹⁷O = +0.31 ± 0.03‰, 2nd analysis: δ¹⁸O = +5.1 ± 0.25‰, δ¹⁷O = +3.4 ± 0.15‰, Δ¹⁷O = +0.33 ± 0.03‰.

Classification: Achondrite (Martian, basaltic shergottite)

Type specimens: 19 g and one polished thin section is on deposit at *Mun*. An anonymous collector holds the main mass.

Northwest Africa 4869

Algeria

Find: 2006

Achondrite (howardite)

History and physical characteristics: A 191 g dark brown stone with little fusion crust was purchased in Morocco in July 2007 by *A. Aaronson*.

Petrography: (J. Wittke and T. Bunch, *NAU*) A complex breccia rich in silica minerals and basaltic eucrites, microbasalts, FeO-rich ferrosilite/hedenbergite/fayalite lithologies, shock melt clasts, and diogenitic pyroxene fragments that comprise 14 vol% of the stone. A silica polymorph is enriched in many of the eucrite lithologies and may account for up to 15 vol% of the

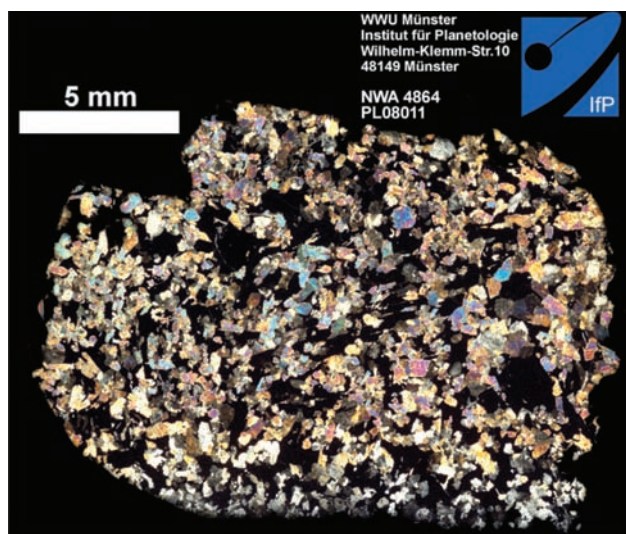


Fig. 1. Cross-polarized light photomicrograph of NWA 4864.

gabbroic basalts and as much as 21 vol% of medium to fine-grained basalts. The shock level is high with most plagioclase present as maskelynite. Weathering grade is moderate.

Mineral compositions: Subophitic orthopyroxene host, $Fs_{53}Wo_{4.5}$ ($FeO/MnO = 26$); exsolved augite, $Fs_{26.3}Wo_{44}$; plagioclase (maskelynite), An_{92} . Cumulate unexsolved pigeonite, $Fs_{45.5}Wo_{12.6}$ and maskelynite, An_{84} . Silica-rich basalt host pyroxene, $Fs_{61.1}Wo_{3.1}$; lamellae, $Fs_{32.7}Wo_{42}$; olivine, $Fa_{60.6}$ ($FeO/MnO = 44$); maskelynite, An_{69} . Diogenitic pyroxenes, $Fs_{28-34.4}Wo_{1.1-1.4}$ ($FeO/MnO = 29$). Minor minerals include chromite, $cr\# = 78-88$, merrillite, Ni-poor metal, ilmenite and FeS.

Classification: Achondrite (howardite).

Type specimen: A total of 20.1 g is on deposit at *NAU*. *Aaronson* holds the main mass.

Northwest Africa 4871

Morocco

Find: 2006

Achondrite (aubrite)

History and physical characteristics: Sixty-one pieces with a total weight of 906 g were purchased in Tagounite, Morocco in May 2007. Most of the stones are medium to dark brown with some remnant fusion crust.

Petrography: (T. Bunch and J. Wittke, *NAU*) A brecciated cumulate rock with clasts as large as 2 cm. The intact lithology is dominated by subhedral to anhedral polysynthetically twinned enstatite with fine-grained intercumulus intergrowths of feldspathic glasses and a silica phase. Other minerals include graphite, FeS, daubreelite, schreibersite, niningerite, perryite as exsolution lamellae in Si-bearing kamacite and Zn-bearing brezinaite. Large clasts show a multitude of sub-parallel, closely spaced compression fractures. Shock level is S3 and the weathering grade is W5 for small pieces (<3 cm) and W3 for the interiors of larger specimens.

Mineral compositions: Enstatite is essentially Fe-free ($Fs_{0.1}Wo_{0.3}$), kamacite Si content is 3.1 to 3.6 wt% and perryite is (in wt%): Si, 12.4; Fe, 4.5; Ni, 77.5 and P, 3.8. ferroan brezinaite is (in wt%): Cr, 43.2; S, 44.1; Fe, 6.3; Mn, 1.2; Zn, 5.1.

Classification: Achondrite (aubrite), possibly paired with NWA 4799.

Type specimen: A total of 22.3 g is on deposit at *NAU*. *Aaronson* holds the main mass.

Northwest Africa 4875

Northwest Africa

Find: 2007

Achondrite (lodranite)

History and physical characteristics: A 904 g dark brown stone was purchased by A. Aaronson in Morocco in July 2007. The irregular-shaped stone has no remnant fusion crust and has been desert-polished.

Petrography: (T. Bunch and J. Wittke, *NAU*) This coarse-grained harzburgite-like specimen is brecciated and contains olivine and orthopyroxene grains of ~equal size (up to 5 mm in diameter). In addition, intact lithologic clasts contain minor interstitial clinopyroxene, kamacite, troilite, and pentlandite, no plagioclase was found. Olivine shows small (<0.02 mm), randomly oriented irregular- to ovoid-shaped inclusions of chromite and diopside. Some of these inclusions exhibit a symplectitic relationship with host olivine. Orthopyroxene has twin lamellae and tiny metal and sulfide inclusions oriented parallel to the (100) crystallographic plane. Oxidation of kamacite is extensive and imparts a dark stain throughout the sample. Shock level is S3.

Mineral compositions: Olivine is $Fa_{10.3}$ and $FeO/MnO = 24$; orthopyroxene is $Fs_{9.6}Wo_{1.4}$ and $FeO/MnO = 14$; clinopyroxene is $Fs_{3.6}Wo_{45.7}$ and contains 1.35 wt% Cr_2O_3 . Chromite $cr\#$ is 84 and troilite contains 2.5 to 5.4 wt% Ni.

Classification: Achondrite (lodranite), possibly paired with NWA 4478, but not with NWA 4833.

Type specimen: A total of 21.2 g is on deposit at *NAU*. *Aaronson* holds the main mass.

Northwest Africa 4925

Erfoud, Morocco

Find: 2007

Achondrite (Martian, olivine-phyric shergottite)

History: The meteorite was found by an anonymous person in northwest Africa and bought by the main mass holder in Erfoud, Morocco.

Physical characteristics: One fragment partly covered by fusion crust weighing 282.3 g was found.

Petrography: (A. Greshake, *MNB*) The meteorite displays a porphyritic texture with large chemically zoned olivine megacrysts set into a fine-grained groundmass composed of pyroxene and maskelynite. Minor phases include chromite, sulfides, phosphates, and small Fe-rich olivines. The olivine

megacrysts often contain melt inclusions and small chromites.

Geochemistry: Mineral composition (EMPA): Olivine, $\text{Fa}_{27.6-46.8}$; pyroxene, $\text{Fs}_{20.0-37.7}\text{Wo}_{3-14.8}$; maskelynite, An_{67-69} .

Classification: Achondrite (Martian, olivine-phyric shergottite); severely shocked with some melt pockets; moderately weathered.

Specimens: A total of 20.1 g plus one polished thin section are on deposit at *MNB*. Ralew holds the main mass.

Northwest Africa 4932

Algeria

Find: October 2007

Achondrite (lunar, feldspathic breccia)

History: Purchased by Greg Hupé from a Moroccan dealer in Tagounite, Morocco, in October 2007.

Physical characteristics: A single, light colored 93.3 g stone. The interior is light gray, mostly very fine grained with a few white clasts (Fig. 2), and prominent but sparsely distributed metal grains (surrounded by hydroxide staining).

Petrography: (A. Irving and S. Kuehner, *UWS*) Breccia composed of small gabbroic to troctolitic clasts (granular aggregates of rounded olivine grains and calcic plagioclase enclosed within low-Ca pyroxene with accessory Ti-chromite and troilite), sparse large grains of kamacite (up to 1 mm, partly altered to iron hydroxide) and rare large grains of silica polymorph in a dominant, very fine grained matrix of the same phases. There are secondary (terrestrial) veinlets and small patches of calcite.

Geochemistry: Low-Ca pyroxene ($\text{Fs}_{22.3-22.8}\text{Wo}_{5.9-5.3}$, $\text{FeO/MnO} = 51.9-53.0$; $\text{Fs}_{20.8-36.1}\text{Wo}_{7.4-12.0}$, $\text{FeO/MnO} = 56.5-58.3$), olivine ($\text{Fa}_{27.2-36.9}$, $\text{FeO/MnO} = 87.7-96.3$), plagioclase ($\text{An}_{94.9-96.4}\text{Or}_{0.3-0.1}$). Bulk composition (R. Korotev, *WUSL*): FeO 8.5 wt%, Sc 19.2 ppm, Sm 1.1 ppm, Th 0.6 ppm, Ni 450 ppm.



Fig. 2. Hand sample of NWA 4932 showing a cut surface with white clasts.

Classification: Achondrite (lunar, feldspathic breccia).

Specimens: A total of 18.7 g and one polished thin

section are on deposit at *UWS*. The main mass is held by *Mr. G. Hupé*.

Northwest Africa 4937

Morocco

Find: May 2007

Achondrite (winonaite)

History: Purchased by an anonymous Moroccan dealer in Bir Elmalh Mahbas, Morocco, in May 2007.

Physical characteristics: A brown, somewhat weathered stone (212 g, broken into several fragments) with visible metal and patches of brown fusion crust. Interior silicates are fresh, but metal is partly altered to reddish-brown iron hydroxides.

Petrography: (A. Irving and S. Kuehner, *UWS*) Coarse grained (0.6–1.5 mm) protogranular aggregate of silicate phases (mostly sodic plagioclase, orthopyroxene and clinopyroxene) with abundant rounded to cusped grains of metal (kamacite) and accessory olivine, schreibersite and troilite. No chromite was found. The estimated mineral mode is metal (+ altered metal) 40, plagioclase 28, orthopyroxene 20, clinopyroxene 10, others 2 (see image). Olivine is very rare, and occurs only as small round inclusions (up to 100 μm) within clinopyroxene.

Geochemistry: Orthopyroxene ($\text{Fs}_{7.4-7.9}\text{Wo}_{2.4-2.7}$, $\text{FeO/MnO} = 8.2-9.8$, 0.52 wt% Cr_2O_3), clinopyroxene ($\text{Fs}_{3.7-4.1}\text{Wo}_{40.6-42.5}$, $\text{FeO/MnO} = 6.3-8.1$, 1.2 wt% Cr_2O_3), plagioclase ($\text{An}_{14.9-18.6}\text{Or}_{2.3-2.1}$), olivine ($\text{Fa}_{7.0}$, $\text{FeO/MnO} = 12.8$). Oxygen isotopes (D. Rumble, *CIW*): $\delta^{18}\text{O} = 4.370, 4.206$; $\delta^{17}\text{O} = 1.763, 1.738$; $\Delta^{17}\text{O} = -0.535, -0.474$ (all‰).

Classification: Achondrite (winonaite). This specimen is a metal-rich gabbro-norite that contains less than 0.1 vol% olivine, and is much coarser grained than typical winonaite, yet it has oxygen isotope affinities to the latter group.

Specimens: A total of 20.1 g of sample and one polished mount are on deposit at *UWS*. The main mass is held by an anonymous collector.

Northwest Africa 5151

Algeria

Find: 2007

Achondrite (lunar, feldspathic breccia)

History and physical characteristics: A 289 g stone was purchased in Rissani, Morocco, in 2007. The exterior is reddish-brown to dark gray with minor, translucent residual fusion crust.

Petrography: (J. Wittke and T. Bunch, *NAU*) The fragmental to melt matrix contains abundant breccia-within-breccia clasts together with typical highlands lithic components that mostly include anorthosites, noritic and troctolitic anorthosites, troctolites (olivine >40 vol%), gabbros, granulites, cataclastic breccias, shock melt clasts, in addition to mare basalt clasts and mineral fragments. Several small to mm-size metal globules are scattered throughout the matrix. Numerous dark brown, shock-melt veins are present along large clast margins. Interior weathering grade is very low with no apparent alteration veins.

Mineral compositions: Noritic anorthosite orthopyroxene is $\text{Fs}_{24.4}\text{Wo}_{3.8}$ (FeO/MnO = 60), plagioclase = $\text{An}_{94.2}$. Gabbro olivine is $\text{Fa}_{34.1}$ (FeO/MnO = 97), plagioclase is $\text{An}_{88.1}$, pigeonite is $\text{Fs}_{27.9}\text{Wo}_{9.2}$ (FeO/MnO = 55), chromite Cr/(Cr + Al) = 0.65 and Ni in metal is 5.8 to 6.6 wt%.

Bulk chemistry (R. Korotev, *WUSL*): Na_2O = 0.478 wt%; Sc = 16.7 ppm, Cr = 1440 ppm; FeO = 8.52 wt%; Ni = 171 ppm; Ba = 183 ppm; Th = 1.76 ppm.

Classification: Achondrite (lunar feldspathic breccia).

Type specimen: A total of 20.3 g is on deposit at *NAU*. The main mass holder is anonymous.

Northwest Africa 5152

Morocco

Find: 2006

Achondrite (lunar, feldspathic breccia)

History and physical characteristics: A 38 g complete stone was purchased in Rissani, Morocco, in 2007. The dark gray fusion crust is mostly eroded away by wind ablation.

Petrography: (J. Wittke and T. Bunch, *NAU*) The vesiculated melt matrix regolith breccia contains an abundance of typical anorthositic lithologies that include anorthosites, anorthositic norites, troctolitic anorthosites, granulites, devitrified shock melts, breccia-in-breccias, in addition to mare basalts and mineral fragments. Interior weathering effects are minimal.

Mineral compositions: Troctolite olivine, $\text{Fa}_{27.6}$ (FeO/MnO = 95); maskelynitized plagioclase fragments, $\text{An}_{91.2-97.6}$, norite orthopyroxene, $\text{Fs}_{25.5}\text{Wo}_{3.8}$ (FeO/MnO = 62); subophitic basalt pigeonite, $\text{Fs}_{29.7}\text{Wo}_{7.8}$.

Bulk chemistry (R. Korotev, *WUSL*): Sc = 16.8 ppm; Cr = 1460 ppm; FeO = 9.03 wt%; Ni = 210 ppm; Ir = 210 ppm.

Classification: Achondrite (lunar feldspathic breccia).

Type specimen: A total of 7.7 g is on deposit at *NAU*. The main mass holder is anonymous.

Northwest Africa 5153

Morocco

Find: 2007

Achondrite (lunar, feldspathic breccia)

History and physical characteristics: A 50.4 g nearly complete stone was purchased in Erfoud, Morocco, in January 2008. The aeolian-modified fusion crust is dark gray to reddish-brown.

Petrography: (T. Bunch and J. Wittke, *NAU*; Dolores Hill, *UA*) Fragmental to melt-matrix breccia that contains an assortment of lunar highland lithologies and Mare basalts and glasses. Highland components include cataclastic gabbro, troctolite, fragments of granophyric intergrowths of K-feldspar, felsic glasses and silica. Mare components include ophitic pigeonite and olivine basalts. Interior is very fresh and lacks alteration veins.

Mineral/phase compositions: Gabbro olivine is $\text{Fa}_{31.7}$ (FeO/MnO = 99) and pigeonite is $\text{Fs}_{25.7}\text{Wo}_{9.3}$ (FeO/MnO = 53). Troctolite olivine is $\text{Fa}_{22.3}$ (FeO/MnO = 80), Ca-pyroxene is $\text{Fs}_{22.1}\text{Wo}_{17}$, chromite Cr/(Cr + Al) = 0.63, and

granophyric K-feldspar is $\text{An}_{14.5}\text{Or}_{54.3}$ with BaO = 2.6 wt%. Mare ophitic pigeonite basalt olivine is $\text{Fa}_{36.7}$ (FeO/MnO = 106), pigeonite is $\text{Fs}_{7.1}\text{Wo}_{13.3}$ (FeO/MnO = 65) and ilmenite MgO = 5.2 wt%. Olivine basalt olivine is $\text{Fa}_{36.2}$ (FeO/MnO = 94) and Ca-poor pyroxene is $\text{Fs}_{32.1}\text{Wo}_{13.3}$ (FeO/MnO = 62).

Bulk chemistry: (R. Korotev, *WUSL*): Na_2O = 0.476 wt%; Sc = 25.6 ppm; Cr = 1963 ppm; FeO = 12.72 wt%; Ni = 150 ppm; Co = 42.4 ppm and Sr = 132 ppm.

Classification: Achondrite (lunar feldspathic breccia).

Type specimen: 5 g and one thin section are on deposit at *NAU* and one thin section and 0.3 g are on deposit at *UA*. *D. Pitt* holds the main mass.

Northwest Africa 5191

Northwest Africa

Find: June 2006

Achondrite (brachinite)

History: A single stone was found in 2006 by anonymous finder in northwest African desert.

Physical characteristics: Partially crusted stone of 26.5 g.

Petrography: (A. Ibhi, Laboratory of Petrology, Mineralogy and Materials, Faculty of Sciences, Agadir (*LPMM*), and M. Van Ginneken and L. Folco, *MNA-SI*) It is a fine-grained (average grain size in the 100–200 μm range) granoblastic rock, consisting mainly of polygonal olivine, minor polygonal chromite and interstitial augite, and lesser, Fe-sulfide, enstatite and metal. Mafic silicates are devoid of shock features. Although the silicate minerals are fresh, terrestrial weathering has altered some of the primary sulfides and metal to hydroxides, which may also form thin veinlets along grain boundaries.

Geochemistry: Olivine ($\text{Fa}_{32.5}$), augite ($\text{Fs}_{10}\text{Wo}_{45}$).

Classification: Brachinite, S1, moderate weathering. Texture, mineral mode and mineral composition of mafic silicates suggest pairing with NWA 3151.

Type specimen: A total of 26.5 g and one thin section are on deposit at *LPMM*, one polished thin section at *MNA-SI*.

Northwest Africa 5207

Morocco

Find: 2007

Achondrite (lunar feldspathic breccia)

History and physical characteristics: A 101 g stone was purchased in Rissani, Morocco, in 2007 by A. Aaronson. The exterior is dark in color.

Petrography: (T. Bunch and J. Wittke, *NAU*) The fragmental matrix contains a wide variety of lithic, glassy, and shocked components that mainly include plagioclase-olivine orthocumulates, recrystallized noritic and troctolitic anorthosites, gabbros and coarse to fine-grained basalts, microbreccias, shock-melted lithologies, symplectites (from pyroxferroite decomposition), very sparse Apollo-like “green glasses” (A), and irregular-shaped light to dark green glasses

(B), some of which are vesicular and contain tiny metal-sulfide spherules. The interior weathering grade is very low.

Mineral/phase chemistry: Orthocumulate olivine, $Fa_{26.5}$ ($FeO/MnO = 96$) and plagioclase, $An_{99.3}$. Coarse-grained basalt olivine is Fa_{30} ; Ca-pyroxene core, $Fs_{45.1}Wo_{30.4}$ and rim, $Fs_{62.7}Wo_{16.8}$; plagioclase, $An_{87.7}$. Fine-grained basalt olivine is $Fa_{56.9}$ ($FeO/MnO = 93$); Ca-pyroxene, $Fs_{28.5}Wo_{34.7}$; plagioclase, $An_{91.2}$. Green glasses (B) in wt%: $SiO_2 = 43.8$; $Al_2O_3 = 18.7$; $Cr_2O_3 = 0.50$; $TiO_2 = 0.78$; $FeO = 12.5$; $MgO = 7.0$; $CaO = 15.2$; $K_2O = 0.33$ and $Na_2O = 0.58$ ($N = 17$).

Bulk chemistry ((R. Korotev, *WUSL*): $Na_2O = 0.484$ wt%; $Sc = 15.52$ ppm; $Cr = 1065$ ppm; $FeO = 7.56$ wt%; $Co = 26.7$ ppm; $Ni = 233$ ppm; $Th = 1.26$ ppm and $Ba = 123$ ppm.

Classification: Achondrite (lunar, feldspathic breccia).

Type specimen: A total of 20 g is on deposit at *NAU*. The main mass holder is anonymous.

Northwest Africa 5217

Morocco

Find: 2007

Achondrite (aubrite)

History and physical characteristics: A 39.1 g complete and fully crusted stone was found in Morocco in 2007 and given to the present owner at the Tucson Gem and Mineral Show in January 2008.

Petrography: (T. Bunch and J. Wittke, *NAU*) The fine to medium-grained (<1.2 mm) unbrecciated, cumulate-textured stone is composed essentially of enstatite with interstitial Si-bearing kamacite; sulfides (troilite, daubreelite, brezinaite, oldhamite, alabandite, niningerite, caswellsilverite), graphite, plagioclase, a silica phase, and schöllhornite, a weathering product of caswellsilverite. Weathering grade is low.

Mineral compositions: (EMPA analyses, all in wt%) Enstatite is $En_{99.4}Fs_{0.2}Wo_{0.4}$; metal is Si-rich kamacite ($Ni = 5.8-6.6$; $Si = 3.9-4.5$); Oldhamite: $S = 38.7$, $Ca = 59.2$, $Cr = 1.4$, $Mn = 1.2$; brezinaite: $S = 46.0$, $Cr = 54.1$; caswellsilverite: $S = 45.3$, $Cr = 38.4$, $Na = 14.7$, $Fe = 0.7$; troilite: $Cr = 2.68$, $Ti = 3.38$; plagioclase: $An_{17}Or_{3.7}$; and schöllhornite: $S = 46.0$, $Cr = 37.3$, $Fe = 1.1$ (remainder is oxygen and hydrogen).

Classification: Achondrite (aubrite).

Type specimen: A total of 8.5 g and one thin section are on deposit at *NAU*. The holder of the main mass is anonymous.

Northwest Africa 5247

Morocco

Find: 2005

Carbonaceous chondrite (CO3)

History: One black stone was purchased by an anonymous buyer in Munich, October 2005.

Physical characteristics: The single piece weighing 15.2 g is black and covered with black fusion crust.

Petrography: (M. A. Ivanova, *Vernad*) meteorite consists of chondrules, CAIs, matrix, mineral and chondrules fragments.

Average chondrule size is 0.2 mm. The main minerals are olivine, pyroxene, plagioclase. Chondrules contain feldspathic glass. The minor phases are melilite, spinel, chromite, ilmenite, sulfides, kamacite, and tetraenaite. Hydroxides present around metal grains.

Mineral chemistry and geochemistry: Olivine (EMPA) is $Fa_{0.3-49}$, $Cr_2O_3 = 0.17$, $CaO = 0.20$; $MnO = 0.21$ (wt%); orthopyroxene $Fs_{0.9}Wo_{1.1}En_{98}$, augite $Fs_{2.3}Wo_{39.8}En_{57.9}$, diopside $Fs_{0.6}Wo_{47.9}En_{51.5}$, plagioclase $An_{71.5}Ab_{28.2}Or_{0.3}$; spinel contains 21.8 wt% FeO and 12.0 wt% MgO ; Oxygen isotopic compositions (I. A. Franchi and R. C. Greenwood, *OU*, by laser fluorination,): $\delta^{18}O = 1.54\text{‰}$; $\delta^{17}O = -2.89\text{‰}$; $\Delta^{17}O = -3.69\text{‰}$.

Classification: Carbonaceous chondrite (CO3). The meteorite shows moderate weathering features.

Type specimens: A total of 3.72 g sample and one thin section are on deposit at *Vernad*. The anonymous buyer holds the main mass.

Northwest Africa 5289

Northwest Africa

Find: 2007

Iron (IVA)

History: A single iron mass was purchased from a Moroccan dealer in August 2007 by M. Graul (Bernau, Germany).

Physical characteristics: The 296 g mass, measuring approximately $81 \times 54 \times 30$ mm, has a flattened shape. The portion of the surface originally sitting into the soil is partially covered with caliche deposit, whereas the remaining portion appears to be polished by wind-driven sand. No fusion crust is preserved.



Fig. 3. Hand sample of NWA 5298 showing its weathered exterior.

Petrography: (M. D'Orazio, *DST-PI*) Widmanstätten pattern with kamacite lamellae (bandwidth = 0.32 ± 0.04 mm)

and plessite fields in approximately 1:1 volumetric ratio. The kamacite lamellae show abundant Neumann bands and occasionally are displaced along shear planes. Accessory phases: schreibersite, troilite, chromite (tiny euhedral crystals included in troilite) and anhydrous Fe-phosphate (up to 1.3 mm in maximum length and surrounded by swathing kamacite).

Geochemistry: (M. D'Orazio, *DST-PI*) Composition of the metal (ICP-MS) is Co = 0.404, Ni = 9.02 (both in wt%), Cu = 111, Ga = 2.0, Ge < 1, As = 12.0, W = 0.36, Re = 0.08, Ir = 0.80, Pt = 3.76, Au = 2.33 (all in ppm).

Classification: Iron meteorite (IVA), fine octahedrite.

Type specimen: A 20.3 g etched endcut sample and 11.3 g of shavings are on deposit at DST-PI. M. Graul holds the main mass.

Northwest Africa 5298

Northwest Africa

Find: March 2008

Achondrite (Martian, basaltic shergottite)

History: Found near Bir Gandouz, northwest Africa, in March 2008 and purchased by an anonymous dealer.

Physical characteristics: A single 445 g stone lacking fusion crust with a brown exterior weathered surface (Fig. 3). The fresh interior is composed of yellow green grains with interstitial dark gray patches containing small vesicles.

Petrography: (A. Irving and S. Kuehner, *UWS*) The rock is composed mainly of intergrown prismatic grains of zoned pyroxene (up to 1.5 mm long) and lath-shaped regions of similar size composed of vesicular material with plagioclase composition. Some of this material is clear isotropic glass, but the majority consists of intersecting domains of subradiating, fibrous, birefringent plagioclase crystallites. Accessory minerals are titanomagnetite, ilmenite, silica polymorph, Na-Fe-merrillite, Cl-apatite, pyrrhotite, fayalite and baddeleyite. Silica is relatively abundant and forms subhedral grains (up to 0.4 mm across) within plagioclase composition material. Pyroxene grains have complex compositional zoning, with highly irregular and curvilinear zone boundaries between augite and pigeonite. Titanomagnetite and ilmenite commonly coexist in adjacent portions of composite grains.

Geochemistry: Pyroxene is zoned from subcalcic augite cores (Fs_{23.8}Wo_{28.4}, FeO/MnO = 26.3) to pigeonite mantles (Fs_{30.2}Wo_{11.7}; FeO/MnO = 30.7) to ferropigeonite rims (Fs_{68.0}Wo_{15.3}, FeO/MnO = 39.4). The average composition of the plagioclase is An_{51.8}Or_{1.9}. Titanomagnetite (TiO₂ 23.7–24.5 wt%, FeO 68.7–67.6 wt%, Al₂O₃ 2.1–2.1 wt%); ilmenite (TiO₂ 48.2–49.0 wt%, FeO 48.4–47.7 wt%).

Classification: Achondrite (Martian, basaltic shergottite).

Type specimens: A total of 20 g and one polished thin section are on deposit at *UWS*. The main mass holder is anonymous.

Table 2 lists all newly approved meteorites (and their data) from Northwest Africa.

THE AMERICAS

North America

Canada

Whitecourt

Alberta, Canada

Find: 1 July 1 2007

Iron, medium octahedrite (IIIAB)

History: Four small fragments were found buried adjacent to a circular depression by two local residents using a metal detector. The circular depression was subsequently confirmed as a 36 m diameter Late Holocene impact crater based on morphology, identification of impact ejecta and crater fill, and presence of impact melt (C. Herd and D. Froese, University of Alberta), and further fragments were recovered.

Physical characteristics: The meteorite consists of 74 samples with a total mass of 5372 g. The samples were found buried up to 25 cm and have a red-brown exterior.

Petrography: (C. Herd, *University of Alberta, UAb*) Widmanstätten pattern with an average bandwidth of 0.8 ± 0.2 mm and areas of plessite are evident on polished and etched surfaces. Locally, kamacite lamellae are coarser and taenite lamellae are offset as a result of shock deformation and recrystallization. Rare Fe-Ni phosphide inclusions are present.

Mineral compositions and geochemistry: Bulk composition: INAA data (J. Duke, *UAb*): Ni = 8.11 ± 0.13 wt%, Co = 4950 ± 100 µg/g, Ir 10.3 ± 0.5 µg/g, (uncertainties 1σ, 68% confidence level), Ge ≤ 40 µg/g, indicate the IIIAB group.

Classification: Iron, IIIAB medium octahedrite, extensive shock, moderate weathering.

Type specimens: A total of 2.4 kg is on deposit at *UAb*. The remainder of the known material is held by the anonymous finders.

United States

Arivaca

31° 35' 38.09"N, 111° 22' 12.84" W

Arizona

Find: January 1999

Achondrite (eucrite)

History: Found by Carl Esparza on the historic Wilbur Cruce Ranch near Arivaca, Arizona, in January 1999.

Physical characteristics: A single 30.1 g naturally broken stone, about half coated by dark brown fusion crust. The weathered former interior surfaces are gray and white in color. Sparse small grains of metal are visible on a freshly cut surface.

Petrography: (A. Irving and S. Kuehner, *UWS*) The

specimen is a breccia composed of fragments of ophitic-textured basaltic eucrites and related mineral fragments (possibly from more than one precursor lithology) plus small grains of Ni-poor metal. The major minerals are low-Ca pyroxene (mostly orthopyroxene with sparse exsolved blades of clinopyroxene, but also some homogeneous pigeonite) and calcic plagioclase, with accessory clinopyroxene, silica polymorph, ilmenite, chromite, and troilite (some finely intergrown with clinopyroxene and silica). Orthopyroxene host ($\text{Fs}_{55.3-55.7}\text{Wo}_{2.6-2.9}$, $\text{FeO/MnO} = 30.5-34.6$), plagioclase ($\text{An}_{82.5-83.7}\text{Or}_{2.1-1.9}$)

Classification: Achondrite (basaltic eucrite). This brecciated specimen contains more metal than most eucrites. Specimens: A total of 6.4 g and one polished thin section are on deposit at *UWS*. The main mass is held by *C. Esparza*. [Carl Esparza, 4941 E. Placita Alisa, Tucson, AZ 85718].

Berthoud **40°18'21.0"N, 105°1'23.7"W**

Weld County, Colorado, USA.

Fall: 5 October 2004, ~13:30 local daylight time (UT-6)

Achondrite (eucrite)

History: A meteorite fell ~4 km east of Berthoud, Colorado. According to information from those who visited the site, Megan and Andy Clifford "had just walked out of their house when they were distracted by whistling noise and a thump. Megan observed some dust kicked up in a horse pen about 100 feet away. After a short search, they recovered the object." (<http://www.cloudbait.com/science/bermet.html>). The meteorite embedded itself a few inches below the surface.

Physical characteristics: A single stone, 120 mm across, ~960 g was recovered soon after the fall. Fresh, glossy, black fusion crust covered the stone except for a small broken corner. The interior is medium gray in color.

Petrography: (D. H. Hill, *UAz*) Overall, texture is ophitic to subophitic with evidence of brecciation and recrystallization. The meteorite is shocked with occurrences of dislocated grains; fine melt veins run through the sample. Exsolution is observed in pyroxenes; several exhibit finely spaced fractures. Plagioclase contains many blebby inclusions. Accessory minerals include chromite, phosphates, iron sulfides, ilmenite, and silica.

Mineral compositions and geochemistry: (M. Killgore, *UAz*) Opx ($\text{Fs}_{54.03}\text{En}_{42.82}\text{Wo}_{3.15}$); Cpx ($\text{Fs}_{31.21}\text{En}_{35.80}\text{Wo}_{33.00}$); Plag ($\text{An}_{82.72}\text{Ab}_{16.04}\text{Or}_{1.24}$); pyroxene molar $\text{Fe/Mn} = 31$. Oxygen isotopes (R. Greenwood, I. Franchi, *OU*) $\delta^{17}\text{O} = 1.58\text{‰}$; $\delta^{18}\text{O} = 3.46\text{‰}$; $\Delta^{17}\text{O} = -0.227\text{‰}$.

Classification: Achondrite (eucrite)

Type specimens: A total sample mass of 24.3 g and one thin section are on deposit at UA; owners hold the main mass; several thin sections with anonymous persons.

Dumont **33°49'N, 100°31'W**

Dumont, King County, Texas USA

Find: 1994

Iron (IVB)

History: Found by a rancher who kept it in his garage. Identified by McCartney Taylor in 2005.

Physical characteristics: Weathered and pitted iron with a weight of 27.42 kg. Single mass found, broken end.

Petrography: (J. Wasson, *UCLA*) Ataxite, schlieren lines, no kamacite.

Mineral compositions and geochemistry (J. Wasson, *UCLA*): Ni = 16.2% Ir = 29 mg/g.

Classification: Ataxite iron (IVB).

Type specimens: A total of 70.6 g is on deposit at *UCLA*. McCartney Taylor holds the main mass.

San Joaquin **32°9.994'N, 111°7.031'W**

Pima County, Arizona, USA

Find: May 1, 2005

Ordinary chondrite (L5/6)

History: Mr. Bill Braggs found the sample May 1, 2005, while looking at cacti blooms ~¼ mile NW of Snyder Hill during a visit to a friend. The stone was found on the surface with no other rocks nearby.

Physical characteristics: The meteorite is one complete stone weighing 31.8 g. It exhibits an irregular, angular shape with dimensions of 4 × 3 × 2 cm; >90% weathered, black fusion crust with rusty-orange patches.

Petrography: (D. H. Hill, *UAz*) Chondrules range in size from 0.2 to 1.5 mm. They are mostly porphyritic and granular chondrules. Fragments of BO chondrules and a few RP chondrules are also observed. Chondrule outlines are visible but not well delineated. At least 30% of the matrix is recrystallized with chondrule boundaries not discernible. Metal and sulfide grains are ~1:1 in abundance and range from ~20–500 μm, except for one 1.3 mm metal grain. Many irregular melt pockets <40 μm across contain metal globules usually adjacent to metal grains. There is orange staining of silicates especially near metal grains. A clast, whitish in hand specimen, is composed of recrystallized material with no easily discernible chondrules and smaller metal grains than the main meteorite.

Mineral compositions and geochemistry: Olivine (Fa 24.79% ± 0.57), pyroxene (Fs 21.15% ± 1.01), and kamacite (Co 0.79% ± 0.17) (EMPA).

Classification: Ordinary chondrite (L5/6); W2, S4.

Type specimens: Mass of 5.5 g and two thin sections are on deposit at *UAz*. B. Braggs holds 26 g (5731 N. 3rd Street, Phoenix AZ 85012). Main mass is on loan to the *UAz* Mineral Museum at *UAz* Flandrau Science Center.

Willow Wash **35°22'24.88"N, 115°20'37.95"W**

San Bernardino County, CA, USA

Find: 14 September 2006

Ordinary chondrite (H3.5, breccia)

History: The stone was found by Steve Humeston in an area covered with sand, scattered rocks and sparse native vegetation.

Physical characteristics: A single stone of 552 g was recovered. It was completely covered with fusion crust.

Petrography: (A. Rubin, *UCLA*) Chondrule outlines are well defined; there has been little integration between chondrules and matrix. Some chondrules contain glassy mesostases. The rock has been shocked; olivine grains exhibit undulose extinction under crossed polarizers in the petrographic microscope; the olivine grains contain planar fractures in their crystal structure caused by shock. The rock is moderately weathered; between 20% and 60% of the metal grains have been at least somewhat oxidized. The rock is also a breccia. It contains a clast that has experienced more significant shock than the host; much of the metal and sulfide in the clast was melted and mobilized by shock. The boundary between the clast and the host is sharp.

Mineral compositions and geochemistry: The rock is unequilibrated with a large range in olivine composition (Fa 12.8–30.9 mol%, n=13). The mean Fa content is 20.9 ± 4.7 mol% and it has a percent mean deviation (PMD for Fa) of 17.2.

Classification: Ordinary chondrite (H3.5 breccia), S3, W2.

Type specimens: A total sample mass of 30 g is on deposit at *UCLA*. The remaining mass of 472 g is in the possession of the finder.

Table 3 lists all newly approved meteorites (and their data) from Americas.

ANTARCTICA

ANSMET

Table 4 lists 806 meteorites recovered from Antarctica by ANSMET. These meteorites appear in Antarctic Meteorite Newsletters 30 no. 2 (2007) and 31 no. 1 (2008). For further information on these meteorites visit the Antarctic Meteorite Newsletter, NASA, webpage at <http://curator.jsc.nasa.gov/antmet/amn/amn.cfm>.

ASIA

India

Jodiya 22°40'48"N 70°18'48"E

Jodiya, Jamnagar District, Gujarat, India

Fall: 31 July 2006, 21:28 h. Indian Standard Time (IST) (UT+5 h)

Ordinary chondrite (L5)

History: A meteorite shower was witnessed on July 31, 2006, at 21:28 h. IST, in the regions of Jodiya, Jamnagar district, and Vandy, Kuchchh district, Gujarat. Many pieces fell in marshland and rain filled agricultural lands and could not be recovered. A search team from Geological Survey of India (GSI) has collected several fragments.

Physical characteristics: The samples collected have fallen on rooftops of houses and/or courtyards. The largest sample collected is $\sim 4 \times 2$ cm and is partly fusion crusted. An ~ 4 g

sample, partly covered with fusion crust has been given to PRL, Ahmedabad, for analysis.

Petrography: (Z. G. Ghevaria, GSI, Gandhinagar, Gujarat, India and S. V. S. Murty, *PRL*) The general texture of the Jodiya meteorite is brecciated with porphyritic chondrules of olivine and low Ca pyroxene and low amount of metal. Chondrule sizes range from 0.92 to 1.46 with an average of 1.23 mm. The average olivine composition is Fa_{25.1}, low Ca pyroxene is Fs_{21.2} and compositions are uniform within 1–2% suggesting that the metamorphic grade is 5–6, but trapped noble gas amounts fall in the range of 4–5. Thus, Jodiya is classified as L5. $\Delta^{17}\text{O}$ is 1.16‰.

Classification: Ordinary chondrite (L5)

Type specimens: All collected fragments (~ 100 g) are in the possession of *GSI*, Calcutta. A thick section and a small, fusion crusted chip (~ 2 g) with FC are at *PRL*, Ahmedabad.

Kaprada 20°20'20.96"N, 73°13'23.86"E

Kaprada, Valsad, Gujarat, India

Fall: 28 October 2004 and 16:30 (Indian Standard Time [UT+5 h])

Ordinary chondrite (L5/6)

History: A stone fell in the farm of Kashiram Bhikabhai Diva in Nandgam village of Kaprada Taluka of Valsad district in South Gujarat, India at about 16:30 h. IST on 28th October, 2004. The meteorite was promptly brought to Physical Research Laboratory, Ahmedabad by Manoj Pai, an amateur astronomer of Ahmedabad.

Physical characteristics: The single recovered stone weighed about 1.6 kg. The stone is mostly crusted and has an approximately conical shape, the convex face containing the apex having been smoothed due to ablation whereas the concave base appears rough.

Petrography: (N. Bhandari, S. V. S. Murty, R. R. Mahajan, P. N. Shukla, A. D. Shukla, *PRL*; M. S. Sisodia, *J. N. V. University, Jodhpur*; G. Parthasarathy, *PNGRI*; an V. K. Rai; Department of Chemistry, University of California, San Diego, CA, USA [*UCSD*]) The major minerals in the meteorite are olivine, clino- and orthopyroxene, and metal and sulfide. Some glass is also present. The meteorite shows a melt crystallization texture and veins. A variety of chondrule types is present, the commonest being granular olivine and olivine-pyroxene and radiating fine-grained pyroxene. The chondrule margins are diffuse, tending to merge with the granular groundmass, which consists of olivine and pyroxene with minor sub equal amounts of nickel-iron and troilite.

Mineral compositions and geochemistry: The olivine is Fa_{23.7} and pyroxene is Wo_{39.92}En_{43.3}Fs_{16.79}. The chemical composition is Fe = 21.5%, Mg = 15.3%, Al = 1.2%, Ni = 1.27%, Ca = 1.33% by weight as determined by X-ray fluorescence.

Classification: The meteorite is an ordinary chondrite, (L 5/6).

Type specimens: The main mass is with Geological Survey of India at Calcutta. Thin sections are available at J. N. V.

University, Jodhpur, National Geophysical Research Institute, Hyderabad and Physical Research laboratory, Ahmedabad.

Kavarpura **25°8'36"N 75°48'48"E**

Kavarpura, near Rawatbhata village, Rajasthan, India
Fall: 29 August 2006; 13:37 h Indian Standard Time (IST)
Iron meteorite (IIE-Anom.)

History: Two shepherds witnessed the fall of a single piece (6.8 kg) in bright day light, and reported to the local police. It is an iron mass with regmaglyphs on the surface. A cut piece of ~20 g has been given to PRL, Ahmedabad for analysis.

Physical and chemical characteristics (Z. G. Ghevaria, GSI, Gandhinagar, Gujarat, India, and S. V. S. Murty, PRL, Ahmedabad, India): Polished and etched surface shows Widmanstätten pattern with fine kamacite bandwidths. Optical microscopic observation revealed inclusions ranging in size from few tens of microns to few hundred micrometers across on the polished surface. Qualitative EPMA studies show that some of the inclusions are C rich and some are rich in Si, Cr and P, in addition to Fe, Ni. Preliminary data on siderophiles (Ni 9.5%, Co 0.39%, Ir 1.6 ppm, Ga 6.8 ppm and Ge 5.8 ppm) by ICP-MS and the presence of non-metallic inclusions suggest that Kavarpura can be classified as IIE-Anom. A very interesting feature of this meteorite is the presence of solar noble gases.

Classification: Iron meteorite (IIE-Anom.)

Type specimen: ~10 g piece in PRL, Ahmedabad; the main mass is with GSI, Calcutta.

Mahadevpur **27°40'N, 95°47'E**

Mahadevpur, Near Namsai Town, Arunachal Pradesh, India
Fall: 21 February 2007, 9:10 Indian Standard Time (IST)
Ordinary chondrite (H4/5)

History: The fall was witnessed by many people. The meteoroid broke up mid air and fell as several pieces. At least 4 large fragments were collected; the largest is ~60 kg and is in private hands. A 3.4 kg piece fell through the roof of a house and into the living room, in Mahadevpur, Arunachal Pradesh, and was collected by Guwahati University, Assam.

Physical and chemical characteristics: (A. C. Mazumdar, Guwahati University, Assam, India and S. V. S. Murty, PRL, Ahmedabad) The meteorite is a heterogeneous aggregate of chondrules of varying types (dominantly porphyritic) and the matrix made up of mostly chondrules fragments. Chondrule sizes range from 250 to 1300 μm . The various mineral phases are olivine (Fa_{19}), orthopyroxene (En_{82} Fs_{17} Wo_1), clinopyroxene (En_{57} Fs_8 Wo_{35}), albitic plagioclase (Ab_{87} Or_3 An_{10}), kamacite, taenite, apatite and rare chromite. Olivine grains both in chondrules and matrix are homogeneous. Chemical composition and $\Delta^{17}\text{O}$ (0.857‰) match with H chondrites. Low amounts of trapped noble gases suggest that Mahadevpur belongs to metamorphic grade 4/5. Shock stage is S1.

Classification: Ordinary chondrite (H4/5)

Type specimen: The main mass (~3.2 kg) and thin sections are with Guwahati University (*GauU*); A small mass is with PRL, on loan from *GauU*. Total known weight is 70.5 kg

TURKEY

Didim **37°21'6.2"N 27°19'47.9"E**

Didim, Aydin province, Turkey
Fall: 1 February 2007 at 5.30 p.m. local time
Ordinary Chondrite (H 3–5 regolith breccia)

History: Many persons from Bodrum, Milas and Didim cities heard an enormous explosion followed by dozens of sounds like gunshots, several in a short interval. Other people as far as 200 km from Didim saw a fireball indicating that the meteorite fell in a southerly direction in the vicinity of the southwestern coastline on the Aegean Sea. Many rocks probably fell into the sea. One (D1) weighing about 500 g fell about ten meters from Mr Abdullah Aritürk at Yesilkent, a small district of Didim. He kept about half of it and gave 210 g to Prof. Mehmet Emin Özel of Çanakkale Onsekiz Mart University, Physics Department. Two other samples (D2 = 846 g and D3 = 2340 g) were found one after the other by Mr Hayati Ertugrul and collected by Ms Özlem Kocahan, PhD student, and Prof. Özel. Two small pieces of D1 and D2 were brought to the MNHN in Paris by Mr Mesut Kasikci, the only Turkish collector, living in France, who first informed academic research institutions of the recent fall.

Physical characteristics: All three samples (total mass: 3396 g) were totally covered by a thin black fusion crust.

Petrography: (Catherine Caillet Komorowski, *MNHNP*) Breccia showing a mixture of sub-millimeter to centimeter size H5 white clasts in a dark H3 host. D1 sample exhibits exclusively the H5 texture with little matrix and poorly defined chondrules. Opaque phases represent about 9.5 vol% and rare copper occurs in Ni-rich metal at the interface with sulfide in the H5 part. D2 sample exhibits both H5 (observed in D1 sample) and H3 lithologies. In the unequilibrated H3 part, opaque phases represent 12 vol%. Metal is much more abundant than sulfide and is located in and around the chondrules. Chondrules are small, in some cases less than 0.2 mm. Many olivine porphyritic chondrules and some large olivine crystals (0.5 mm) are present in a fine-grained matrix. Numerous chondrules contain luminescent forsterite. Silica-bearing, spinel-rich, chromite and glassy chondrules were found in addition to banded clasts and broken chondrules which both can contain pure enstatite associated with fine-grained metal. No CAIs were found.

Mineral compositions: EMPA of olivine and pyroxene crystals indicate a rather homogeneous composition in the white lithology (Fa_{19-20} , Fs_{17-19}) and a quite variable composition in the darker lithology of the meteorite where about one third of the chondrules and clasts contain almost pure forsterite and enstatite compositions. In this type 3 lithology Fo ranges from 67 to 100% and En ranges from 70 to 99%.

Classification: Ordinary chondrite (H3-5); S2, W0.

Type specimens: Two samples (total mass of 31,6 grams), one polished thin section of D1 and one polished section of D2 are on deposit at *MNHNP*. Another sample of D3 will soon be deposited at *MNHNP*. Main masses are kept at Çanakkale University, Turkey (*CanaU*). A sample of D3 belongs to a private collector, Mesut Kasikçi.

Table 5 lists all newly approved meteorites (and their data) from Asia.

AUSTRALIA

Georgetown

Queensland, Australia

Found 1988

Iron (IAB complex)

This meteorite was analyzed by Choi et al. (1995) and subsequently listed in the *Catalogue of meteorites* (Grady 2000) as an anomalous IIICD iron with silicate inclusions. It was later analyzed by Wasson and Kallemeyn (2002), who classified it as a “solo iron related to IAB.” The name “Georgetown (iron)” is now recognized as official by the Meteorite Nomenclature Committee. J. T. Wasson (personal communication 2007) reports that Georgetown (iron) was found an unknown distance from Georgetown, Queensland, Australia, by a gold prospector with a metal detector. A 1.3 kg specimen was received by Robert Haag in 1991. *UCLA* now holds pieces weighing 645 g (possibly part of the Haag piece), 420 g, and 461 g.

Prospector Pool

29° 21'S, 121° 46'E

Eastern Goldfields, Western Australia, Australia

Find: November 2003

Iron (ungrouped, fine octahedrite; possibly an ungrouped member of the IAB complex)

History: A single mass was found by J. Harrop while he was prospecting.

Physical characteristics: The irregular, weathered mass weighing 2.768 kg when found, lacks fusion crust and has a deeply pitted surface. A rust line around the mass indicates partial burial in the soil to a depth of 8 cm.

Petrography: (A. W. R. Bevan *WAM*) The meteorite is troilite-rich comprising metal to troilite in the approximate volume ratio 4:1. Accessory minerals include schreibersite and a trace of copper. Metal displays a fine octahedrite (bandwidth 0.4 mm) structure.

Geochemistry: (J. T. Wasson *UCLA*) The composition (by INAA, average of two replicate analyses) of the metal is Ni = 89.4, Co = 4.35 (both mg/g), Cr = 331, Cu = 397, Ga = 22.7, Ge = 130 ± 32, As = 12.2, W = 0.97, Ir = 4.45, Pt = 9.2, Au 1.227 (all µg/g), Sb = 180, Re = 517 (both ng/g).

Classification: Iron (ungrouped, fine octahedrite; possibly an ungrouped member of the IAB complex).

Type specimens: Main mass, now 2.437 kg, and slices, 135.1 and 42 g, at *WAM*. Analyzed sample 35.9 g at *UCLA*.

Table 6 lists all newly approved meteorites (and their data) from Australia.

EUROPE

Święcany

49°47'29" N, 21°15'28" E

Jasło, Poland

Find: September 2004

Ordinary chondrite (L/LL5)

History: A girl of age 12, Katarzyna Dępczyńska, found the stone in gravel on a road about 100 m from the house no. 73 in the village of Święcany, Jasło district, Podkarpackie province, Poland. The gravel was probably brought from a quarry near Skołyszyn in 2003. The stone was then given to Mr. Marcin Mazur from the town of Jasło, who gave it for examination to Mr. Łukasz Bandur, student of geology, who found it was a chondrite. Then the stone was given for classification to Dr. Łukasz Karwowski *USil*.

Physical characteristics: It is an 8 g rusty stone with tiny grains of quartz and argillaceous slate stuck to its surface and rare fragments of fusion crust.

Petrography: (Ł. Karwowski *USil*) Metallic Fe-Ni is replaced by iron oxide except a few tiny taenite grains. Troilite is largely weathered. Iron hydroxides and the remaining metal and troilite comprise 5–6 vol%. No alteration of silicates. There are few well-delineated chondrules and many chondrule fragments. Matrix is composed of olivine and pyroxene grains, some of which are quite large, comparable with chondrules in size (up to 1.5 mm). The stone is brecciated.

Mineral compositions: Olivine (Fa_{25.3–26.4}), low-Ca pyroxene (Fs_{22.0–22.8}), high-Ca pyroxene (Fs_{7.0–7.0} Wo_{46.5–46.5}), feldspar (An_{10.4–13.9} Or_{4.4–6.3}).

Classification: Ordinary chondrite (L/LL5); S2, W3.

Type specimens: One thin section and the main mass, 6.62 g, are on deposit at *USil*.

Table 7 lists all newly approved meteorites (and their data) from Europe.

ERRATA

Errata to previous editions of the Meteoritical Bulletin.

The Meteoritical Bulletin 85

In Table 1, for SaU 094, the correct coordinates are 20°59.469'N, 57°20.326'E. The find date is 08 Feb. 2001.

The Meteoritical Bulletin 87

The classification of Saint Aubin is in error. It is a high-Ni, high-Au, low-Ir member of the IIIAB group.

The Meteoritical Bulletin 88

For Shalim 005, the correct shock stage is S2.

Twannberg (The Meteoritical Bulletin 64/91)
Twannberg total mass is $15910 + 2246 + 2533 = 20689$ g/
20.889 kg
(This is published information from MB 64 and 91.)
Three small masses have turned up in 2007, bringing the total
known mass to 20.771 kg.

Dhofar 658 was listed as an L4/5 chondrite. More recently
A. Bischoff (*Mun*) and J. Grossman (*USGS*) studied this
sample and found that the classification was incorrect. Dhofar
658 is an H chondrite with $Fa_{19.1}$ and $Fs_{17.0}$ $Wo_{1.2}$.

Meteoritical Bulletin 91

For Shigr 100, the correct mass is 579.1 g.

The Meteoritical Bulletin 93

On page 587, For the CHINARE meteorites listed, all type
specimens and main masses are on deposit at the Polar
Research Institute of China (*PRIC*).

GRV 052049 should be deleted from MB 93.

The correct classification for MET 00557 is LL6.

MET 00546, H5, 75.87 g, weathering A/B, Fa_{18} and Fs_{16} .

MET 00456, LL5, 575.5 g, weathering B.

For NWA 4724, the correct find year is 2001.

The following are corrected oxygen isotopic compositions for
three meteorites:

NWA 4663, $\delta^{17}O = 1.144, 1.202$; $\delta^{18}O = 4.125, 4.015$;
 $\Delta^{17}O = -1.025, -0.910$

NWA 4872, $\delta^{17}O = 2.061, 2.012$; $\delta^{18}O = .354, 4.308$; $\Delta^{17}O =$
 $-0.229, -0.254$

NWA 4882, $\delta^{17}O = 2.095, 2.064$; $\delta^{18}O = 4.455, 4.368$; $\Delta^{17}O =$
 $-0.248, -0.234$

In Table 3, the meteorite name Desaguadero is incorrect. The
correct name is Carancas.

On page 594, under Errata, the name Adam Thalha should be
Adam Talha.

On page 592, the correct latitude for Ramlat as Sahmah 221 is
 $20^{\circ}31.912'N$.

In Table 2, the entry for NWA 4796 is repeated.

In Table 6, entries for GRV 052082, 052085, 052104, and
052116 are repeated.

For JaH 122, the correct find date is 12-Dec-2002.

The following 4 meteorites have wrong coordinates:
The correct ones are listed below:

JaH 335	$19^{\circ}37.423'N$	$55^{\circ}43.695'E$
JaH 336	$19^{\circ}54.159'N$	$55^{\circ}39.323'E$
JaH 337	$20^{\circ}00.293'N$	$55^{\circ}42.916'E$
JaH 339	$19^{\circ}55.731'N$	$55^{\circ}40.133'E$

In Table 8, for Mughsayl, the correct find year is 2005 with no
exact date. The correct shock level is S4 and the weathering
degree: W2. The correct fayalite content of olivine: $Fa_{24.2}$.
The correct weight deposited at *NMBE*: 6.4 g. The mass at
SQU is to be considered type specimen as mentioned in the
write-up submitted.

Reclassification and correction: Y-86332 was incorrectly
listed by Ninagawa et al. (1998) as an L3.6 chondrite. The
meteorite that they actually analyzed was Y-86632, which is
hereby reclassified as L3.6. The real Y-86332 has now been
classified as H4 by Kojima and Yamaguchi (2008).

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complex: A group, five subgroups, numerous grouplets, closely
related, mainly formed by crystal segregation in rapidly cooling
melts. *Geochimica et Cosmochimica Acta* 66:2445–2473.

ABBREVIATIONS

Classifiers, Type Specimen Locations, Finders, and Holders of Main Masses

A key to abbreviations for addresses used in the Meteoritical

Bulletin is found at our web site, <http://tin.er.usgs.gov/meteor/MetBullAddresses.php>.

Listed throughout most of the tables within the “Info” column are relevant data on who classified the samples, where the type specimen is located, etc. Below is a key to the abbreviations used within this edition.

CanaU = Çanakkale University, Turkey

DuPont = James M. DuPont Meteorite Collection, Planetary Studies Foundation, 10 Winterwood Lane, Unit B., Galena, Illinois 61036-9283 USA

GMAIbeda = Geological Museum, Omar El-Mokhtar University, Al Beda (Libya)

PDAlBeda = Physics Department, Omar El-Mokhtar University, Al Beda (Libya)

PNGRI = National Geophysical Research Institute, Uppal Road, Hyderabad, India

TantaU = Tanta University, Faculty of Science, 31527 Tanta, Egypt, mmanbar@yahoo.com

UTWroc = Wrocław University of Technology, Faculty of Geoengineering Mining and Geology, Institute of Minings, Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland, tadeusz.przylibski@pwr.wroc.pl

WrocU = Wrocław University, Institute of Geological Sciences, ul. Cybulskiego 30, 50-205 Wrocław, Poland, ryszard.kryza@ing.uni.wroc.pl

ABBREVIATIONS USED WITHIN THE TEXT

For chondrule textural types: BO = barred olivine, GO = granular olivine, PO = porphyritic olivine, POP = porphyritic olivine pyroxene, PP = porphyritic pyroxene.

cr# = Cr / (Cr + Al).

EMPA = electron microprobe analysis.

SEM = scanning electron microscope.

Abbreviations for the locations of Antarctic meteorites recovered by ANSMET: ALH = Allan Hills, CRS = Mount Cranfield, CMS = Cumulus Hills; DOM = Dominion Range; GRO = Grosvenor Mountains; LAP = LaPaz Ice Field; LAR = Larkman Nunatak; MAC = MacAlpine Hills; MCY = MacKay Glacier; MIL = Miller Range; PRA = Mount Pratt, RBT = Roberts Massif, SAN = Sandford Cliff, and TYR = Taylor Glacier.

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Table 1. Meteorites from Africa.

Name	Location of recovery	Date of recovery (dd-m-yyyy)	Find/Fall	Latitude	Longitude	Mass (g)	Number pieces	Class	Type specimen mass (g)	Shock stage	Weather grade	Fa mol%	Fs mol%	Wo mol%	Magn. sus log ₁₀ (10 ⁻⁹ m ³ /kg)	Location of specimen and classifier(s)	Location of main mass	Comments, additional data
Acfer 370	Algeria	Nov-2002	Find	27°40.35' N	4°21.40' E	129	1	Ungrouped Chondrite	67	S3	W2	5.6	6.9–22.6		MSP1	MSP	δ ¹⁷ O = 2.673‰, δ ¹⁸ O = 4.172‰, Δ ¹⁷ O = 0.504‰	
Bouri	Middle Awash, Ethiopia	Fall-1996	Find	10°16' N	40°34' E	9.1	>30	H4	9000	S4	W4	20.1	14.8	4.68	CEREGE/NMIE1	NME		
Chergach	Timbouctou district, Mali	2-Jul-07	Fall	23°41'47" N	5°00'53" W	100000	Many	H5	115	S3	W0	18.2	15.5	1.4	NMBE1	DGtheesling		
Dar al Gani 1049	Libya	21-Oct-07	Find	27°15.98' N	16°21.47' E	88	4	H5	88	S2	W3	17.2	15.6	1.5	OAMI	OAM	found by Monica Basolo	
Dar al Gani 1050	Libya	23-Oct-07	Find	28°12.85' N	15°33.05' E	265	2	H6	265	S3	W4	18	15.4	0.9	OAMI	OAM	found by Monica Basolo	
NoktatAddagmar	Mauritania	0ct-2006	Find	25°42'09" N	10°46'54" W	779	2	LI.5	22.4	S2	W0	27.7	23.1	1.6	NMBE1	SBUhl, Hamburg, Germany		
Toufassour, Tada, Morocco	Toufassour, Tada, Morocco	16-Nov-07	Find	29°39.135' N	7°44.958' W	73300	>5	Mesosiderite	89.6				26 to 33	3 to 8	IZU/UPVII	anonymous		
Werdama	Libya	21-May-06	Fall	32°47.839' N	21°47.228' E	2552	3	H5	2300	S1	W0	19.8	17.7	1.3	UTWroc/GMAIBeda1	GMAIBeda		

MSP1-Type specimen at MSP classified by V. Mogggi Cecchi, G. Pratesi, Museo di Scienze Planetarie, CEREGE/NMIE1-Type specimens at CEREGE and NME, classified by J. Gattacceca (CEREGE) and M. Bourlot-Denise (MNF). NMBE1-Type specimen at MMBE, E. Gnoss, MINGE; B. Hofmann, NMBE, M. Eggemann, UBE/NMBE, OAMI-Type specimen at OAMI, classified by L. Folco (MNA-SI), IZU/UPVII-A, Ibbi and H. Nacht (IZU), and A. Jambon, O. Boudouma and D. Badia (UPVI), UTWroc/GMAIBeda1-Kryza, T. Przylibski (UTWroc).

Magn sus = magnetic susceptibility; given values given as log₁₀ (mg/g).

Weather grade = weathering grade.

Table 2. Meteorites from Morocco and other Northwest Africa regions.

Meteorite name	Location of recovery or purchase	Date of recovery or purchase	Mass (g)	Number of pieces	Class	Type specimen mass (g)	Shock stage	Weathering grade	Weathering	Fa mol%	Fs mol%	Wo mol%	Magnetic sus log ₁₀ (10 ⁻⁹ m ³ /kg)	Location of specimens and classifiers	Location of main mass	Comments, additional data	
NWA 1709	Northwest Africa	Mar-02	9	1	H3.8	1.7	S2	W3		1.2–21.2	4.8–16.9	0.2–0.8		MSP1	Anonymous	δ ¹⁷ O = 2.840‰, δ ¹⁸ O = 4.448‰, Δ ¹⁷ O = 0.527‰.	
NWA 2218	Tucson	Jan-2006	6,050	1	Ureilite	26				19.1	16.9	6.5		UWS	Gregory		
NWA 2219	Tucson	Jan-2006	260	1	Diogenite	20.6				27.9–28.6	24.6–26.3	3.3–3.9		UWS	Gregory	Plagioclase An _{83.7–84.0} Or _{0.5}	
NWA 3211	Northwest Africa	2005	89.2	1	Eucrite	17.9					43.9–55.6	2–21.5		MSP1	Chin	δ ¹⁷ O = 1.71‰, δ ¹⁸ O = 3.85‰, Δ ¹⁷ O = -0.25‰.	
NWA 3212	Northwest Africa	2005	176.6	1	Eucrite	20					35.6–54.1	2–29.2		MSP1	Chin	δ ¹⁷ O = 1.74‰, δ ¹⁸ O = 3.84‰, Δ ¹⁷ O = -0.26‰.	
NWA 3333	Morocco	May-05	33	1	Lunar basalt fragmental breccia	6.55				40–96	17–65	12.–29.		WUSL1	DuPont		
NWA 4222	Northwest Africa	2006	16.5	1	Shergottite	3.5				31.3–41.1	24.1–32.6	8.9–10.3		MSP1	Chin	δ ¹⁷ O = 2.85‰, δ ¹⁸ O = 4.91‰, Δ ¹⁷ O = 0.30‰ (mean on 2 analyses)	
NWA 4224	Tagounite	Dec-2005	10.8	1	Eucrite	2.2				12.7–14.1	50.2–50.3	12.8–13.7		UWS	GHupé	Plagioclase An _{83.1–89.6} Or _{0.6}	
NWA 4225	Erifoud	Dec-2005	1,609	1	Ureilite	20.8					46.9–47.9	4.8–11.2		UWS	GHupé	Cr ₂ O ₃ in olivine = 0.64 wt%	
NWA 4227	Tagounite	Dec-2005	17.6	1	Eucrite	3.6				17.0	13.5–13.7	4.8–5.0		UWS	GHupé	Plagioclase An _{84.25} Or _{0.6,0.3}	
NWA 4228	Tagounite	Dec-2005	181	1	Ureilite	20.8				22.7	18.7	9.4		UWS	GHupé	Cr ₂ O ₃ in olivine = 0.57 wt%	
NWA 4231	Erifoud	Dec-2005	269	1	Ureilite	21.7					21.4–53.6	44.2–2.3		UWS	GHupé	Cr ₂ O ₃ in olivine = 0.60 wt%	
NWA 4291	Denver	Sep-2005	23	1	Eucrite	4.6				19.8	17.1	1.4		UWS	AHupé	FeO/MnO in px = 32.0	
NWA 4297	Denver	Sep-2005	127	2	H4	25.7	S1	W1/2		19.6–19.9	17.2	1.5		UWS	AHupé	Mean of two replicates	
NWA 4299	Erifoud	Mar-2006	240	1	H4	20.1	S2	W2/3		30.5	30.5	2.7		MNB1	Ralew	δ ¹⁷ O = 2.09‰, δ ¹⁸ O = 4.39‰, Δ ¹⁷ O = -0.19‰.	
NWA 4395	Morocco	2004	240	1	Diogenite	20.1											δ ¹⁸ O = 3.340‰, δ ¹⁷ O = 6.388‰, Δ ¹⁷ O = -0.007‰.
NWA 4415	Northwest Africa	2006	10	1	EL6	2					1.5	1.5		MSP1	Anonymous		

Table 2. *Continued. Meteorites from Morocco and other Northwest Africa regions.*

Meteorite name	Location of recovery or purchase	Date of recovery or purchase	Mass (g)	Number of pieces	Class	Type specimen mass (g)	Shock stage	Weathering grade	Fa mol%	Fs mol%	Wo mol%	Magnetic sus $\log \chi$ (10^{-9} m ³ /kg)	Location of type specimens and classifiers	Location of main mass	Comments, additional data
NWA 4416	Northwest Africa	2006	259.1	1	EL6	22				1.1	1.1		MSP1	Anonymous	Probably paired with NWA 4415
NWA 4418	Northwest Africa	2006	103.8	1	Mesosiderite	20.1				29.6, 14.4	3.1, 42.0		MSP1	Chin	$\delta^{17}\text{O} = 2.145\%$, $\delta^{18}\text{O} = 4.524\%$, $\Delta^{17}\text{O} = -0.207\%$.
NWA 4419	Northwest Africa	2006	103.1	1	R4	20.8			39.8	13.9–29.1			MSP1	Anonymous	$\delta^{17}\text{O} = 5.469\%$, $\delta^{18}\text{O} = 6.031\%$, $\Delta^{17}\text{O} = +2.333\%$.
NWA 4435	Algeria, Purchased in Morocco	2006; 2-2006	42.6	1	CV3	9.4	S1	W1	1.3–5.6	2.4–31.5			NAU, T. Bunch	MCimata	
NWA 4439	Algeria, Purchased in Erifound, Morocco	2005; 3-2006	484	1	CO3.3	20.4	S2	W4	33.8–42.2				NAU, T. Bunch	GHupé	Olivine $\text{Cl}_2\text{O}_3 = 0.02\text{--}0.18$ wt%
NWA 4441	Algeria, Purchased in Erifound, Morocco	2005; 3-2006	124	3	CO3.2	20	S2	W2	28.3–36.3				NAU, T. Bunch	GHupé	Olivine $\text{Cl}_2\text{O}_3 = 0.06\text{--}0.24$; FeO/MnO = 56 to 100
NWA 4442	Algeria, Purchased in Erifound, Morocco	2005; 3-2006	1528	4	CV3	20.7	S1	W1	3.8–6.2				NAU, T. Bunch	GHupé	Many cm-sized dark inclusions
NWA 4444	Algeria, Purchased in Erifound, Morocco	2005; 3-2006	145	1	L3.2	20.8	S2	W2	9.8–32.1				NAU, T. Bunch	GHupé	Olivine $\text{Cl}_2\text{O}_3 = 0.05\text{--}0.46$ wt%
NWA 4446	Algeria, Purchased in Erifound, Morocco	2005; 3-2006	4386	3	CV3	20	S2	W2	3.1–44.7	0.9–27			NAU, T. Bunch	GHupé	
NWA 4459	Algerian-Moroccan border	2006	60.07	1	L3	14.4	S2	W3	0.5–39.6	1.1–26.1		$\log \chi = 4.32$ (10^{-5} m ³ /kg)	MNHNP1	PThomas	
NWA 4469	Tagounite	Jun-2006	1,823	1	Ureilite	20.4			19.2	17.0	9.4		UWS	GHupé	Cr_2O_3 in olivine = 0.56 wt%
NWA 4471	Tagounite	Jun-2006	881	1	Ureilite	20.4			22.4	17.4	12.0		UWS	GHupé	
NWA 4474	Rissani	Jun-2006	2,374	1	Ureilite	25.3			19.2	15.2	4.0		UWS	GHupé	Cr_2O_3 in olivine = 0.65 wt%
NWA 4481	Tagounite	Sep-2006	112	1	Ureilite	20.8			20.4	17.9	5.1		UWS	GHupé	
NWA 4483	Algeria	2006	208	12	Lunar breccia fragments	20			30.9–60.8	14.3, 36.4–75.1	2, 6.3–13.5		UWS	Ralew	Possibly paired with Northwest Africa 3163
NWA 4529	Algeria	Sep-06	60	1	lodranite	20				63	2		UWS1	Chupé	
NWA 4536	Morocco	2006	283.1	1	Eucrite	20			63, 30	63, 30	2, 40		UPVII	PThomas	
NWA 4537	Morocco	2005	261	1	Aubrite	136			1.5	1.5	1.5		MSP	MSP	$\delta^{18}\text{O} = 5.021\%$, $\delta^{17}\text{O} = -2.650\%$, $\Delta^{17}\text{O} = +0.039\%$.
NWA 4538	Erifound, Morocco	2006	206	1	H3	20.8	S3-5	W2	15.8–18.6	15.0–16.5	2.1		NAU	Srape	Shock melt
NWA 4539	Erifound, Morocco	2006	483	1	CV3	21	Mod	Mod	0.8–58.1	1.1–32	2.5		NAU	Srape	olivine with 0.0 to 0.33 wt% NiO
NWA 4540	Erifound, Morocco	2006	1310	1	CO3.5	22	Mod	Mod	38.3				NAU	Turecki	FeO/MnO = 121
NWA 4542	Erifound, Morocco	2006		1	CO3.6		Mod	Min	36.7				NAU	Turecki	FeO/MnO = 110
NWA 4543	Morocco	2006	339	1	CV3	23	Min	Min	50.1 (± 1.7)				NAU, Bunch/Connolly	Srape	Matrix obv listed; numerous AOAs.
NWA 4544	Erifound, Morocco	2006	>200 kg	Many	EL3	24	Mod	Ext	1–2.1				NAU	Farmer	Paired with NWA 2965; Si = 0.6–0.95 wt%
NWA 4551	Erifound, Morocco	2006	104	1	CO3.5	21	Mod	Mod	37.7–38.7				NAU	Aaronson	
NWA 4556	Erifound, Morocco	2006	313	1	EL3	28.6	Mod	Ext		<2			NAU	MCimata	$\text{Al}_{17}\text{SiOr}_{4.4}$; paired with NWA 2965; Si = 0.6–0.95 wt%
NWA 4561	Erifound, Morocco	2006	> 200 kg	Many	EL3	27	Mod	Ext		<2			NAU	MCimata	An16.8Or 4.2; paired with NWA 2828; Si = 0.6–0.95 wt%
NWA 4566	Erifound, Morocco	2005	74	1	L3.7	15.1	S2	W2	18.7–29	14.7–24.5	1.4		NAU	Hall	
NWA 4568	"	2005	123	1	Ureilite	23	Mod	Min	17.6 (cores)	15	7.6		NAU	Hall	
NWA 4569	Erifound	2005	484	Many	Angrite	24.3	Mod	Mod	40.3	10.8	53		NAU	GHupé	An100; paired with NWA 2999
NWA 4589	Tagounite	Sep-2006	6,504.0	1	Ureilite	20.2			19.5	5.7	11.9		UWS, A. Hupé	GHupé	Dunite with <5 vol% pyroxene

Table 2. *Continued. Meteorites from Morocco and other Northwest Africa regions.*

Meteorite name	Location of recovery or purchase	Date of recovery or purchase	Mass (g)	Number of pieces	Class	Type specimen mass (g)	Shock stage	Weathering grade	Fa mol%	Fs mol%	Wo mol%	Magnetic sus $\log \chi$ (10^{-9} m ² /kg)	Location of type specimens and classifiers	Location of main mass	Comments, additional data
NWA 4642	Morocco	2006	483.2	1	Enstatite achondrite	22.6				0-1.2			MNB1	FSSH	$\delta^{17}\text{O} = 2.975\%$, $\delta^{18}\text{O} = 5.614\%$, $\Delta^{17}\text{O} = 0.056\%$
NWA 4651	Erfoud, Morocco	2005	1052	1	LL3.2	22	S2	W2	17.2-30.1	13.4-25.2	1.8		NAU, T. Bunch	Aaronson	Ol/Cr ₂ O ₃ = 0.12-0.35 wt%
NWA 4655	Rissani	2006	37	1	Eucrite	8	Mod	Low	51.3-58.7	3.4-45.7			NAU, T. Bunch	Boswell	Recrystallized shock melt breccia
NWA 4660	Erfoud, Morocco	2006	226	1	LL3.8	21	S2	W2	26-35.2	26	2		NAU, T. Bunch	Webb	
NWA 4662	Erfoud	2006	60	1	Angrite	13.1	Mod	Mod	40.1	10.1	53		NAU, T. Bunch	Aaronson	Ah ₀₁₀₅ paired with NWA 2999
NWA 4722	Morocco	2006	294	48	LL3	24.3	S1	W3	0.8-36.5	1.1-27.7		3.23	MNHNP1	Giessler	
NWA 4735	Morocco	2003	64	1	Acapulcoite/lodranite	12.2			10	8	1		UPV11	MI4	
NWA 4742	Morocco	2007	376.0	1	Ureilite	32			21	16	1		UPV11	MI4	
NWA 4748	Northwest Africa	2005	80	1	Polymict eucrite	17			33.6	44.5, 26.6	2.3, 2.3		Hamb1	Huthenau	
NWA 4799	Algeria	May-07	365	86	Aubrite	20.1				0.1	0.4		UWS1	Chupé	Kamacite (Fe 92.1 wt%, Ni 4.5 wt%, Si 3.4 wt%)
NWA 4801	Erfoud	May-2007	252	1	Angrite	20			45.5 (Ln2.4)	11.8	56.9		UWS1	GHupé	Oxygen isotopes (D. Rumble, CIM): $\delta^{18}\text{O} = 3.59\%$, 3.54% , $\delta^{17}\text{O} = 1.809\%$, 1.823% , $\Delta^{17}\text{O} = -0.082\%$, -0.041% per mil. Paired with NWA 4473
NWA 4808	Erfoud	2006	69	3	Diogenite	14.1	Mod	Low	24	22	2.6		NAU1	Ralew	Chromite cr# = 88
NWA 4812	"	"	68	1	CK	13.2	Mod-Ext	See separate entry					NAU1	Ralew	
NWA 4814	"	"	1120	1	R4	20.6	Mod	Mod	38.7				NAU1	Ralew	
NWA 4816	"	"	63	1	Acapulcoite	12.1	Mod	See separate entry					NAU1	Ralew	
NWA 4820	Erfoud	2006	168	1	CK5	20.5	Min-Mod	Min-Mod	39.1	core = 16.8	2.4		NAU1	Burkhard	2.34 wt% Cr ₂ O ₃ in magnetite
NWA 4821	"	2006	117	1	CK4	22	Min-Mod	Min-Mod	38.4				NAU1	Burkhard	3.3 wt% Cr ₂ O ₃ in magnetite
NWA 4824	"	2007	97	1	Eucrite	19.7	mod						NAU1	Farrell	
NWA 4825	"	2007	226	1	Howardite	23.8	mod						NAU1	Farrell	
NWA 4826	"	2007	344	1	Howardite	21.3	mod						NAU1	Farrell	
NWA 4827	"	2007	327	1	Ureilite	23.4	low	Moderate	Core = 22.7				NAU1	Hermann	
NWA 4830	"	2006	78	1	Eucrite	16	Ext						NAU1	Boswell	
NWA 4831	Northwest Africa	2006	154	1	Eucrite	22	Mod						NAU1	Boswell	
NWA 4832	"	2007	8.3	1	Aubrite	2.2	Min-Mod						NAU1	Anonymous	
NWA 4833	"	2007	60	1	Lodranite	12.7	Min-Mod						NAU1	Anonymous	
NWA 4858	Erfoud	2004	329.0	1	Howardite	42				21-39, 36-35	0.7-5, 5-15		Cascadia 1	Thompson	
NWA 4864	Northwest Africa	2007	94.0	10	shergottite	19				50	13		Mun1	Anonymous	
NWA 4868	Erfoud	July 2007	953	1	CO3.3	21	Min-Mod	W2	3-40; FeO/MnO = 128	2-30.4			NAU1	Aaronson	Cr ₂ O ₃ in ol = 0.06-0.28
NWA 4869	"	"	96	1	Howardite	20.1	Mod	Low	separate entry				NAU11	Aaronson	
NWA 4870	"	"	330	1	LL3.7	21	S2	W2	16-33; FeO/MnO = 58	23-26			NAU1	Aaronson	Many large chondrules
NWA 4871	"	"	115	1	Aubrite	20.3	Min-Mod	Mod	separate entry				NAU1	Aaronson	
NWA 4873	"	"	609	1	LL3.6	21.2	S1	W2	15.3-30.8	13.4-25	1.6-2.3		NAU1	Aaronson	
NWA 4875	"	"	900	1	Lodranite	22	Min-Mod	Mod	separate entry				NAU1	Aaronson	
NWA 4877	"	"	1000	1	Angrite	21.7	Mod	Mod	40.8; FeO/MnO = 88	10.3	53.5		NAU1	Aaronson	Paired with NWA 2999
NWA 4878	"	"	130	1	Martian	20.2	Min-Mod	Min		Fig. 36.1-55.4	12-16.3		NAU1	Aaronson	Paired with NWA 2975
NWA 4880	Erfoud	Jul-2007	81.6	34	Shergottite	16.4				38.5	29.3		UWS1	AHupé	Paired with NWA 2975
NWA 4925	Erfoud	2007	282.3	1	Shergottite	20.1			27.6-46.8	20.0-37.7	3-14.8		MNB1	Ralew	

Table 2. Continued. Meteorites from Morocco and other Northwest Africa regions.

Meteorite name	Location of recovery or purchase	Date of recovery or purchase	Mass (g)	Number of pieces	Class	Type specimen mass (g)	Shock stage	Weathering grade	Fa mol%	Fs mol%	Wo mol%	Magnetic sus log χ (10 ⁻⁹ m ³ /kg)	Location of type specimens and classifiers	Location of main mass	Comments, additional data
NWA 4930	Ensisheim	Jun-2007	117.5	76	Shergottite	20.1			39.3-39.5	23.4-59.6	33.6, 16.7		UWS1	GHupé	Paired with NWA 2975
NWA 4931	Tagounite	Oct-2007	2,140	2	Angrite	28.2			27.2-36.9	10.1-10.4	53.9-52.3		UWS1	GHupé	Paired with NWA 2999
NWA 4932	Algeria	Oct-2007	93	1	Lunar feldspathic breccia	18.7				22.3-22.8	5.9-5.3		UWS1	GHupé	
NWA 4933	Tagounite	Oct-2007	2,529	2	Lodranite	20.2			10.6-10.7	3.6-9.2	44.3, 1.3		UWS1	GHupé	Paired with NWA 4478
NWA 4935	Erfoud	Mar-2007	73	1	Eucrite	14.6			7.0	35.8; 55.8	38.9; 12.8		UWS1	MIA	FeO/MnO in pigeonite = 24.6
NWA 4937	Morocco	May-2007	212	1	Winnonaite	20.3				7.4-7.9	2.4-2.7		UWS1	Anonymous	Oxygen isotopes: $\delta^{18}\text{O} = 4.370$, 4.206 ; $\delta^{17}\text{O} = 1.763$, 1.738 ; $\Delta^{17}\text{O} = -0.535$, -0.474 (all‰)
NWA 5151	Algeria	2007	289	1	Lunar feldspathic breccia	20.3	Low		34.1	24.4, 27.9	3.8, 9.2		NAU1	Anonymous	
NWA 5152	Morocco	2006	38	1	Lunar feldspathic breccia	7.7			27.6	25.5	3.8		NAU1	Anonymous	
NWA 5153	Morocco	2006	50	1	Lunar feldspathic breccia	5			31.7, 22.3, 36.7	25.7, 22.1, 7.1	9.3, 17, 13.3		NAU1	DPitt	
NWA 5191	Northwest Africa	2006	27	1	Brachinite	26.5	S1	Mod	32.5	10	45		LPMM1	LPMM	
NWA 5207	Morocco	2007	101	1	Lunar feldspathic breccia	20	Low		30, 56.9	28.5-62.7	16.8-34.7		NAU1	Anonymous	
NWA 5217	Morocco	2007	39.1	1	Aubrite	8.5			0.2	0.2	0.4		NAU1	Anonymous	$\delta^{18}\text{O} = 1.54\%$; $\delta^{17}\text{O} = -2.89\%$; $\Delta^{17}\text{O} = -3.69\%$.
NWA 5247	Morocco	2005	15.2	1	CO3	3.7			0.3-4.9	0.9	1.1		Vernad	Anonymous	$\text{Co} = 0.404$, $\text{Ni} = 9.02$ (both in wt%), $\text{Cu} = 111$, $\text{Ga} = 2.0$, $\text{Ce} < 1$, $\text{As} = 12.0$, $\text{W} = 0.36$, $\text{Re} = 0.08$, $\text{Ir} = 0.80$, $\text{Pt} = 3.76$, $\text{Au} = 2.33$ (all in ppm).
NWA 5289	Northwest Africa	2007	296	1	Iron IVA	31.6							DST-PI	Graul	
NWA 5298	Morocco	Mar-2008	445.0	1	Shergottite	20				23.8-30.2	28.4-11.7		UWS1	Anonymous	

NWA 5298: MSPII-Type specimen at MSP, classified by V. Mogggi Cecchi, G. Pratesi, *Museo di Scienze Planetarie*. WUSL1-Type specimen at *Dupont* and *WUSL*, classified by R. Zeigler and R. Korony. *WUSL*, MNB1-Type specimen at *MVB*, classified by A. Greshake, *MVB*. MNB1-Type specimen at *MVB*, classified by M. Bouron-Donise, *MVB/FP*. UPV11-Type specimen at *UPV1*, classified by A. Jambon, O. Boudouma and D. Badia, *UPV1*. UWS1-Type specimen at *UWS*, classified by A. Irving and S. Kuehner, *MIA*. Moroccan Imports, Asnières, France. HAMB1-Type specimen at *HAMB*, classified by J. Schlieter, *HAMB*. NAU1-Type specimen at *NAU1*, T. Burch and J. Wittke, *NAU1*. Cascadai-Type specimen at *Thompson*, classified by A. Ruzicka and T. J. Schepker, *Cascadia*. Mun1-Type specimen at Mun, classified by A. Bischoff, *Mun*. LPMM1-Type specimen at Laboratory of Petrology, Mineralogy and Materials, Faculty of Sciences, Agadir (LPMM), classified by A. Ibbi, *LPMM*. Verdai1-Type specimen at *Verdad*, classified by M. A. Ivanova, *Ivanova*. DST-PI1-Type specimen at *DST-PI*, classified by M. D'Orazio, *DST-PI*.

Table 3. Meteorites from the Americas.

Name	Location of recovery (description of county, state, province, country, etc.)	Date of recovery or purchase (d-m-yyyy)	Find/fall	Latitude	Longitude	Mass (g)	Number of pieces	Class	Type specimen mass (g)	Shock stage	Weathering grade	Fa mol%	Fs mol%	Wo mol%	Location of type specimen and classifier(s)	Location of main mass	Comments, additional data
Arivaca	Arivaca, Arizona	Jan-1999	Find	31°35'38.09"N	111°22'12.84"W	30.1	1	Monomict eucrite	6.4				55.3-55.7	2.6-2.9	UWS1	CEsparza	plag (An _{65.5} Sr _{3.7} Or _{2.1}) ₁₋₁₉
Berthoud	Weld County, Colorado	05-Oct-2004	Fall	40°18'21.0"N	105°1'23.7"W	960	1	Eucrite (monomict breccia)	24.3				54.03	3.15	UAZ1	Anonymous	
Dumont	Dumont, King County, Texas	1994	Find	33°49'N	100°31'W	27420	1	Iron (VIB)	70.6						UCLA1	MTaylor	Ni = 16.2% Ir = 29 mg/g
San Joaquin	Prima County, Arizona	01-Mar-2005	Find	32°9'994"N	111°9'031'W	31.8	1	Ordinary chondrite (L5/6)	26	S4	W2	24	21.1	UAZ1	UAZ		
Whitecourt	Alberta, Canada	1-July-2007	Find	53°59.95'N	115°35.85'W	5372	74	IIIAB	2400						UAB1	Anonymous	Ni = 8.11 ± 0.13 wt%, Co = 4950 ± 100 mg/g, Ir = 10.3 ± 0.5 mg/g, Ge = 4.40 mg/g
Willow Wash	San Bernardino County, CA	14-Sept-2006	Find	35° 22'24.88"N	115° 20' 37.95"W	552	1	H3.5	30	S3	W2	12.8-30.9		UCLA	SHumston		

UAB1-Type specimen at University of Alberta (*Uab*), classified by C. Herd, *Uab*. UAZ1-Type specimen at UAZ, classified by D. H. Hill, *UAZ*. UCLA1-Type specimen at UCLA, classified by J. Wasson, *UCLA*. UCLA2-Type specimen at UCLA, classified by A. Rubin, *UCLA*.

Table 4. Continued. Antarctic Meteorites collected and classified by the ANSMET program.

Table with columns: Name, Type, Mass (g), Weath, %Fa -min, %Fa -max, %Fs -min, %Fs -max, AMN ref. Rows include meteorites MAC 041069 to MAC 06185 and GRO 06050.

Table 4. Continued. Antarctic Meteorites collected and classified by the ANSMET program.

Table with columns: Name, Type, Mass (g), Weath, %Fa -min, %Fa -max, %Fs -min, %Fs -max, AMN ref. Rows include meteorites GRA 06186 to GRO 06083.

Table 4. *Continued.* Antarctic Meteorites collected and classified by the ANSMET program.

Name	Type	Mass (g)	Weath ^a	%Fa -min	%Fa -max	%Fs -min	%Fs -max	AMN ref
GRO 06084	L6	50.7	C					31(1)
GRO 06085	L5	49	C					31(1)
GRO 06086	LL6	29.4	A/B					31(1)
GRO 06087	H6	33.2	C					31(1)
GRO 06088	H5	23.5	C					31(1)
GRO 06089	H5	23.4	C					31(1)
GRO 06090	L6	16.3	B/C					31(1)
GRO 06091	LL5	27.7	A					31(1)
GRO 06092	H6	15	C					31(1)
GRO 06093	LL5	3.4	A					31(1)
GRO 06094	L5	3.7	B					31(1)
GRO 06096	LL5	10.3	A					31(1)
GRO 06097	L6	2.3	B					31(1)
GRO 06098	L5	3.3	B/C					31(1)
LAR 06253	H6	7595	B/C					31(1)
LAR 06317	CV3	167.2	B	0	34	1	3	31(1)
LAR 06318	CM2	25	A/B	0	54	1	4	31(1)
LAR 06867	CV3	6.5	B	1	4	1	1	31(1)
LAR 06868	CK5	15.4	C	31	31	26	26	31(1)
LAR 06869	CK6	18.4	C	34	34			31(1)
LAR 06871	CK5	25.7	B	29	29	26	26	31(1)
LAR 06872	CK6	31	C	34	34			31(1)

Table 4. *Continued.* Antarctic Meteorites collected and classified by the ANSMET program.

Name	Type	Mass (g)	Weath ^a	%Fa -min	%Fa -max	%Fs -min	%Fs -max	AMN ref
LAR 06873	CK6	15.5	C		34	34		31(1)
LAR 06874	CK5	42.2	A/B	29	29	25	25	31(1)
SCO 06012	CM2	14.3	B/C	0	39			31(1)
SCO 06013	CM2	20.7	B/C	1	30			31(1)
SCO 06014	CM2	48.2	B/C	1	35			31(1)
SCO 06015	L5	205.1	A					31(1)
SCO 06016	L5	204.2	A					31(1)
SCO 06017	L5	64.1	A					31(1)
SCO 06018	L5	32.7	A					31(1)
SCO 06019	L5	65.4	A					31(1)
SCO 06020	L5	13.4	A/B					31(1)
SCO 06021	L5	17	A/B					31(1)
SCO 06022	L5	3.5	A/B					31(1)
SCO 06023	L5	6.1	A/B					31(1)
SCO 06024	H6	9.5	C					31(1)
SCO 06025	L5	5.7	A/B					31(1)
SCO 06026	L5	14.4	C					31(1)
SCO 06027	L5	22.4	A/B					31(1)
SCO 06028	L5	39.1	A/B					31(1)
SCO 06029	L5	16.8	A/B					31(1)
SCO 06042	CM2	6.4	C	0	36			31(1)
SCO 06043	CM1	27.6	B/CE					31(1)

^aWeath = weathering grade.

Table 5. Meteorites from Asia.

Name	Location of recovery (Description of county, state, province, country, etc.)	Date of recovery (dd-m-yyyy)	Find/fall	Latitude	Longitude	Mass (g)	Number of pieces	Class	Type specimen mass (g)	Fa mol%	Fs mol%	Wo mol%	Location of type specimen and classifier(s)	Location of main mass	Comments, additional data
Didim	Didim, Aydin province, Turkey	1-Feb-07	Fall	37°21'6.2"N	27°19'47.9"E	500	Many	H3-5	31.6	19-20	17-19		MNHNP1	CanAU	
Jodiya	Jamnagar District, Gujarat, India	31-Jul-06	Fall	22°40'48"N	70°18'48"E	~100	Many	L5	~100	25.1	21.2		PRL1	GSI and PRL	
Kaprada	Valsad, Gujarat and India	28-Oct-04	Fall	20°20'20.96"N	73°13'23.86"E	1600	1	L5/6	Main mass	23.7	16.8	39.9	GSI	GSI	
Kavapura	Kavapura (Near Rawalbhatta village, Rajashtan, India)	29-Aug-06	Fall	25°8'36"N	75°48'48"E	6800	1	IIE-Anom	10				PRL2	GSI	Ni 9.5%, Co 0.39%, Ir 1.6 ppm, Ga 6.8 ppm and Ge 5.8 ppm
Mahadevpur	Near Namsai Town, Arunachal Pradesh, India	21-Feb-07	Fall	27°40'N	95°47'E	~70500	4	H4/5	3200+	19	17	1	GauU	GauU	

PRL1-Type specimen at GSI and PRL, classified by N. Bhandari, S. V. S. Murty, R. R. Mahajan, P. N. Shukla, A. D. Shukla, PRL.

GSI1-Type specimen at GSI, classified by N. Bhandari, S. V. S. Murty, R. R. Mahajan, P. N. Shukla, A. D. Shukla, PRL; M. S. Sisodia, J. N. V. University, Jodhpur; G. Parthasarathy, National Geophysical Research Institute, Uppal Road, Hyderabad, India, PNGRL.

PRL2-Type specimen at PRL, classified by Z. G. Ghevaria, GSI, Gandhinagar, Gujarat, India, and S. V. S. Murty, PRL.

MNHNP1-Type specimen at MNHNP, classified by Catherine Caillat Komorowski, MNHNP.

CanAU-Çanakkale University, Turkey.

Table 6. Meteorites from Australia.

Name	Location of recovery	Date of recovery	Find/Fall	Latitude	Longitude	Mass (g)	Number of pieces	Class	Type specimen mass (g)	Location of type specimen and classifier(s)	Location of main mass	Comments, additional data
Prospector Pool	Eastern Goldfields, Western Australia	Nov-2003	Find	29°21'S	121°46'E	2678	1	Ungrouped member of IAB complex	2678	UCLA1	WAM	*

UCLA1-Type specimen at WAM, classified by A. W. R. Bevan WAM, J. T. Wasson, UCLA.

*Ni = 89.4, Co = 4.35 (both mg/g), Cr = 331, Cu = 397, Ga = 22.7, Ge = 130 ± 32, As = 12.2, W = 0.97, Ir = 4.45, Pt = 9.2, Au = 1.227 (all µg/g), Sb = 180, Re = 517 (both ng/g).

Table 7. Meteorites from Europe.

Name	Location of recovery	Date of recovery	Find/fall	Latitude	Longitude	Total known mass (g)	Number of pieces	Class	Type specimen mass (g)	Shock stage	Weathering grade	Fa mol%	Fs mol%	Wo mol%	Magnetic sus.	Location of type specimens and classifiers	Location of main mass	Comments, additional data
Święcany	Jasio, Poland	Sept-2004	Find	49°47'29"N	21°15'28"E	8	1	L/LL5	6.62	S2	W3	25.5-26.4	22-22.8	3.15		USII	USII	

USII-Type specimen at Usii, classified by L. Karwowski Usii.

GUIDELINES FOR METEORITIC NOMENCLATURE

Committee on Meteorite Nomenclature, The Meteoritical Society.

Created: February 1980. Revised: October 2000; October 2004; April 2005; October 2006.

Introduction

Objectives

These Guidelines are designed to provide a rational system of nomenclature to be adopted by the discoverers of new meteorites which will avoid confusion and ambiguity in published reports on existing meteorites. The Guidelines should also be acceptable for common-place usage in the field or laboratory and will assist the prompt announcement of new meteorites. In addition, the Guidelines are intended to ensure that type specimens of all new meteorites are preserved in collections that make material available for research.

Scope

- a) These Guidelines provide a framework for naming objects that are commonly recognized to be meteorites. Meteorites to be named under the Guidelines include objects found on the Earth as well as on other solar system bodies during the course of space exploration.
- b) The following types of materials are NOT to be named under these Guidelines: micrometeorites and interplanetary dust particles; xenolithic clasts in other meteorites; artificial meteorites; pseudometeorites; impact craters, tektites, and other impact-produced materials; and, meteoroids or other small bodies in space.
- c) Special provisions are made in these Guidelines for highly altered materials that may have a meteoritic origin, designated relict meteorites, which are dominantly (>95%) composed of secondary minerals formed on the body on which the object was found. Examples of such material may include some types of "meteorite shale," "fossil meteorites," and fusion crust.

Application and Requirements of a Meteorite Name

Unique Names

A unique name shall apply to:

- a) the set of all individual bodies recovered from a single observed meteorite fall or meteorite shower. Each individual shall carry the same name as the set;
- b) a meteorite find that cannot be related with certainty to other falls or finds recovered from the same vicinity;
- c) several meteorite finds, or a fall and one or more subsequent finds, whose geographical relationship and inherent characteristics establish, after careful evaluation

of all evidence available, that they belong to a single occurrence (with the exception stated in §4.2 for finds in dense collection areas).

Distinctive Names

A meteorite name must clearly distinguish the occurrence to which it refers from other meteorite names, and should convey the geographical location of the fall or find. Names should be as brief as possible, but abbreviations (e.g., St. and Mt.) should be spelled out unless special circumstances warrant their usage in the name.

Precedents

An established meteorite name shall remain unchanged, whether the spelling or name of its locality is subsequently altered or was originally assigned in error, or whether it becomes obsolete with respect to current conventions of transliteration or transcription. Earlier meteorite names that do not conform to these Guidelines will not be changed unless the Committee for Meteorite Nomenclature (hereafter called The Committee) rules that this is necessary to avoid confusion. Changes to the names of meteorite falls or important meteorite finds (e.g., Canyon Diablo; Leoville) should be avoided except under extraordinary circumstances (e.g., §3.3a).

International Usage

Meteorite names should be rendered according to local spelling at the time, but in Roman script, including diacritical marks where appropriate. New Chinese meteorite names will be transcribed according to the Pinyin system.

New Meteorite Names

Geographic Features

A new meteorite shall be named after a nearby geographical locality. Every effort should be made to avoid unnecessary duplication or ambiguity, and to select a permanent feature such as a town, village, river, bay, cape, mountain or island which appears on widely used maps and is sufficiently close to the recovery site to convey meaningful locality information. In sparsely populated areas with few place names, less permanent features such as ranches or stations or, in extreme cases, local unofficial names of distinctive quality may be used, provided the latitude and longitude of the recovery site are well determined. The names of large geographic features such as continents, countries, provinces, states, and large counties should be avoided if names that are more specific are available, except as specified in §3.3 and §3.4. In general, the selected feature should be the closest such feature to the site of the recovery. If, for example, the name of the nearest town is already used, the meteorite should not be named for the next nearest town. In such a case, a different geographic feature (e.g., a stream) should be selected, if available (if not, §3.3 applies)."

Duplicate Place Names

Duplication of a place name previously used for a meteorite from another country, state or province should be avoided. If it cannot be avoided, both names may be amplified as in Edmonton (Kentucky) and Edmonton (Canada).

Sparse Place Names

The following rules apply to cases involving insufficient numbers of unique place-names:

- a) Coincidental falls. In the event that a meteorite falls near the same locality as an existing named meteorite, the new fall should not be assigned a letter designation as in §3.3b, or a numeric designation as in §3.3c. If an appropriate, unique name cannot be found for the new fall, then it should receive the suffix (year), as was done for Wethersfield (1982) and Monahans (1998). If there is only one pre-existing meteorite from this location, then the older one should also be given a (year) suffix, e.g., Wethersfield (1971) and Monahans (1938). This is one of the rare situations wherein an existing meteorite fall or an important find may be renamed. If there are multiple existing meteorites with the same name followed by numeric or lettered suffixes, then the fall should still get the year suffix, but the older meteorites do not need to be renamed.
- b) Coincidental finds. Where several meteorites are found near the same locality and alternative place names are not available, each separate meteorite shall bear the name of the locality followed by a parenthesized lower-case letter, e.g. Kress (a) and Kress (b). Letters shall be assigned alphabetically in order of recognition. If an earlier meteorite from the same locality already exists, e.g. Kress, its name does not need to be changed to Kress (a) (although this can be designated as a synonym). In this case, the first new name should be Kress (b).
- c) Dense collection areas. If particularly numerous recoveries are made in one region, as for instance in Antarctica and the Sahara, a generic prefix (conveying geographic information) and a suitable series of numeric suffixes should be applied. New meteorites found within the designated region will be named by combining the prefix with the next available suffix.

Meteorites of Unknown or Poorly Known Provenance

- a) Withheld information. Where the source of a new meteorite cannot be determined due to the withholding of geographic information by a collector or other party, the name should be chosen to reflect the smallest geographic feature identifying the collection location with certainty. If the location information is too vague, or is uncertain or disputed, the name Nova followed by the next available three-digit number should be adopted as the permanent name.

- b) Transported meteorites. When the provenance of a new meteorite cannot be determined due to a lack of sufficient historical information, it should be named after the locality where it was first recognized. For meteorites found in institutions such as universities and museums, the name may be either that of the institution, the collection, or the city in which the institution is located. In accordance with §3.6, the names of people, even if part of the official name of the collection, should be avoided.
- c) Meteorites found in large numbers. In cases where many meteorites are found and distributed or sold without careful documentation of provenance, a numbered sequence of generic names should be used as in §3.3c, wherein the prefix reflects the geographic area in which the meteorites were most likely recovered (e.g., Northwest Africa, for meteorites coming from marketplaces in Morocco).

Meteorites from Morocco and Surrounding Areas

All meteorites found, reported to be found, or purchased in Morocco and adjacent parts of the surrounding countries shall be named according to the following special rules:

- a) Falls. Observed falls will be named the same way as they are in other areas (§3.1–3.3).
- b) Finds and purchased meteorites. These meteorites will all be numbered in a “Northwest Africa” (NWA) series unless they are accompanied by documentation including the date of find, name and address of finder, and reasonable proof of the find location (e.g., a single photograph showing the meteorite in situ, a length-scale, and an active GPS unit displaying the geographic coordinates). If so documented, the meteorites may be given locality-specific names as in §3.1–3.3. If a meteorite bearing a provisional NWA number is later given a formal locality-specific name, the NWA number will become a synonym for the new name.

Prohibited Terms

Neither a person’s name, the classification, nor an unofficial directional term (for example North Haig) should be used in a meteorite name. However, the Committee may rule that such practices are permissible in exceptional situations. Names given under this section should not be changed retroactively, even given the eventual resolution of the true provenance.

Paired and Separated Meteorites*Sparse Collection Areas*

- a) Level of scrutiny. A reasonable effort should be made to ensure that a new recovery does not belong to a previously named meteorite (see also §2.1).
- b) Paired meteorites. If two meteorites previously thought to be separate are subsequently found to be paired after

- comprehensive studies (preferably of the main masses), one name should be abolished and one retained.
- c) Separation of meteorites. If several individuals previously regarded as a single meteorite prove to be distinct, with no reasonable expectation of genetic affinity, then one or all should be renamed in accordance with the provisions of §3. If the original name designates a fall, then every attempt should be made to preserve that name without change.

Dense Collection Areas

In areas of dense meteorite concentrations such as those covered under §3.3 c and §3.4 c, the following guidelines apply:

- a) Level of scrutiny. Sequential names comprising a prefix and numeric suffix will be given to new meteorites without checking for possible pairings, although a single (collective) name may be given in cases where fragments fit together or similar-looking fragments are found within a few meters of each other.
- b) Pairing groups. Two or more newly discovered meteorites in dense collection areas may be considered paired with each other or with another formally named meteorite if there is overwhelming evidence, including geographic data, that is consistent with the meteorites being part of a single fall. The evidence must be evaluated by the Committee. All approved members of a pairing group will be named with a geographic prefix plus a number in the same way as are unpaired meteorites; special type-specimen requirements will apply to newly paired meteorites (section 7.1f). If two or more numbered meteorites with formal names are subsequently determined to be paired, their names should not be changed. Pairing groups may be referred to collectively by the lowest specimen number, the most widely studied mass number or the largest mass number (e.g., the EET 87711 pairing group).
- c) Separation of meteorites. If several individuals previously regarded as a single meteorite prove to be distinct, with no reasonable expectation of genetic affinity, then lettered suffixes in parentheses may be applied, as in section 3.3 b (e.g., Place 95035 (b)).

Synonyms and Discredited Meteorite Names

Synonyms

Synonyms are unofficial names of meteorites, and their use is discouraged. They may be created when:

- a) Popular usage or existing publications have caused confusion through the introduction of alternate names or alternate spellings of the names of approved meteorites.

- b) A meteorite name is abolished after a determination of pairing with a second meteorite, or a meteorite name is modified through the addition of a suffix.

Discredited Names

Meteorite names that are abolished or discredited, or that have been modified through the later addition of a suffix shall not be reused for the naming of subsequent falls or finds.

Meteorite Abbreviations

Abbreviations for meteorite names with numeric suffixes (i.e., those named under §3.3 c and §3.4 c; e.g., ALH = Allan Hills) should be unique and different from all unabbreviated meteorite names (disregarding case). Such abbreviations should be used with a space separating the abbreviated prefix and the numeric suffix (e.g., ALH 84001); the exception to this is certain Antarctic meteorites with names approved prior to 1981, which should have an "A" in place of the space (ALHA, BTNA, DRPA, EETA, MBRA, META, OTTA, PGPA, and RKPA; e.g., ALHA77005). Authors should avoid the use of abbreviated meteorite names in titles and abstracts of publications, and should introduce them in text as they would any other abbreviation. A complete list of abbreviations approved by the Nomenclature Committee, demonstrating proper usage, will be maintained by the editor of the Meteoritical Bulletin.

Approval, Revision, and Announcement of Meteorite Names

New Meteorites

All new meteorite names must be approved by the Committee. The minimum information required to name a meteorite, which the Committee should only modify under special circumstances, is: The location, preferably as geographic coordinates, of the fall or find; The circumstances of the fall or find (narrative); The total known mass and number of pieces recovered; An authoritative classification; The location of the main mass; The location of a type specimen. Type specimens must be deposited in institutions that have well-curated meteorite collections and long-standing commitments to such curation. The minimum mass of a type specimen should be 20% of the total mass or 20 g, whichever is the lesser amount. For newly paired meteorites from dense collection areas (§4.2 b), the minimum required mass shall be whatever is needed to bring the aggregate mass of existing type specimens (if any) to 20% of the aggregate mass of the entire pairing group or 20 g, whichever is less.

Numbering Systems

The Committee must approve all new prefixes, abbreviations,

and proposed numbering schemes for meteorites in dense collection areas.

Pairing Issues

Proposals to pair or separate meteorites that would result in the abolition or creation of meteorite names under §4 must be reviewed and approved by the Committee.

Announcements

Information about all new meteorites, paired and separated meteorites, name changes to existing meteorites, synonyms, and abbreviations will be published at least once per year in the Meteoritical Bulletin in *Meteoritics & Planetary Science*.

Authoritative Information

The authority for existing meteorite names shall be the current edition of the *Catalogue of meteorites* of the Natural History Museum, London, supplemented by published appendices to the Catalogue and by ensuing numbers of the Meteoritical Bulletin. However, the Committee may overrule priority for a particular name if strict application of this or other sections contradicts the general objectives of these Guidelines.

Provisional Names

New numbers may be assigned to meteorites in dense collection areas with approved numbering systems prior to analysis and classification. Allocation of numbers will be coordinated by the Editor of the Meteoritical Bulletin. Names assigned in this way will be considered provisional until the Committee grants formal approval.

In the special case of meteorites found in large numbers and for which accurate geographic information is lacking (e.g., many Northwest Africa meteorites and others covered by §3.4c), provisional names may be assigned with the following minimum information:

The mass of the specimen;

A physical description (e.g., crusted stone, broken fragment, etc.);

An approximate (visual) classification (e.g., stone, iron, chondrite, achondrite, etc.);

An account of how the specimen was obtained (e.g., place and date of sale);

The location where the specimen is believed to have been found (if known).

A list of provisional names will be maintained by the Editor of the Meteoritical Bulletin. The names of meteorites on this list remain provisional even if printed as an appendix in future editions of the *Catalogue of meteorites*, and should not be used in publications.

Relict Meteorite Names

A special type of name should be assigned to relict meteorites (see §1.2 c for definition). The documentation required for these names must include a description of the material, the location and date of the find, the approximate mass or size, the location of the main mass, and the type of meteoritic material it is suspected to represent. The name must conform to all applicable parts of §2–§6 above, and must be approved by the Nomenclature Committee prior to publication. Relict meteorite names may be converted to formal meteorite names by a second vote of the Committee, subject to the requirements of §7.1.

Use of Catalogue Numbers

Acknowledgments—Although application of these Guidelines should in the future decrease the risk of confusion, authors are nevertheless encouraged to cite catalogue numbers from established collections in their publications on meteorites, and curators are urged to catalogue individual masses separately.