



The meteorite collection at Museo di Storia Naturale, Pisa University, Italy

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Abstract—The historical meteorite collection of Museo di Storia Naturale, Pisa University, is presented in this catalog. Dating back to at least 1860, the collection currently (as of June 2003) contains 30 specimens of 26 individual meteorites, representing about 50 kg of extraterrestrial material. The collection includes 2 carbonaceous chondrites, 12 ordinary chondrites, 1 achondrite, 4 stony-iron meteorites, and 7 iron meteorites, including three remarkable specimens: the main mass of Bagnone (48 kg), the fourth largest mass of Quenggouk (717.5 g), and a large (nearly) complete individual of the Siena showerfall (318.8 g).

INTRODUCTION

Pisa University's Museo di Storia Naturale currently maintains the meteorite collection of the former Museo di Mineralogia. Most meteorites were acquired through the interest and effort of Antonio D'Achiardi, who worked for the Museo di Mineralogia from 1860 to 1903, first as an assistant curator and starting in 1880 as the director. Thirty meteorite specimens are reported in his catalogue, including the fourth largest mass of Quenggouk (717.5 g; Fig. 1), and a large (nearly) complete individual of the Siena showerfall (318.8 g; Fig. 2). With the exception of a Bur Gheluai specimen recovered in Somalia in 1919, no meteorites were acquired until the second World War, during which Museo di Mineralogia was bombed and the collections were severely damaged. In the 1970s, Pisa University's natural history museum collection was gathered and reorganized within the newly established Museo di Storia Naturale at the Certosa di Pisa in Calci, 10 km east of Pisa. Since then, two more meteorites have been acquired: Bagnone, the largest Italian iron meteorite found in northern Tuscany in 1904 (or 1905) and recognized in 1967 (Bonatti et al. 1970; D'Orazio et al. 2004), and a specimen of Beni M'hira, which fell in southern Tunisia in 2001 (Laridhi Ouazaa et al. 2004).

The meteorite collection of Museo di Storia Naturale has been recently revised and documented in the work by Perchiazzi and Mellini (1995), published in an Italian journal which is not widely distributed. Perchiazzi and Mellini (1995) reported on 26 specimens belonging to 25 individual

meteorites, pointing out that four specimens from D'Achiardi's inventory were missing: specimen #159, Macerata, (now officially named Monte Milone); specimen #218, Renazzo; specimen #227, Pegu (now officially named Quenggouk); specimen #233, Bitburg. Furthermore, they reported five unlabeled specimens of uncertain name and provenance. Specimens and labels were probably lost during the World War II bombings.

To address an international audience, we decided to report on the valuable meteorite collection of Museo di Storia Naturale in *Meteoritics & Planetary Science*. Table 1 documents the 30 specimens of 26 individual meteorites present to date (June 2003), by providing weight, macroscopic description, and inventory number. Additional information about specimens (i.e., the means of acquisition, treatments, etc.) is available from the corresponding author and from the museum archive. Further details regarding the circumstances of the fall or find, literature, and distribution of each meteorite can be found in Grady (2000) or in *The Meteoritical Bulletin*. Samples are available for study.

We conducted petrographic and geochemical analyses on some of the specimens of uncertain name and origin. These analyses, along with the sparse information available from the Museum's archives, allowed us to tentatively identify three of the specimens (#16362, #10060, #14697) that were either missing or of uncertain provenance.

Specimen #16362 is a fresh, ~75% fusion-crust fragment of 47.5 g. It was found in a box labelled Cosona, a synonym for Siena (possibly explaining why it was

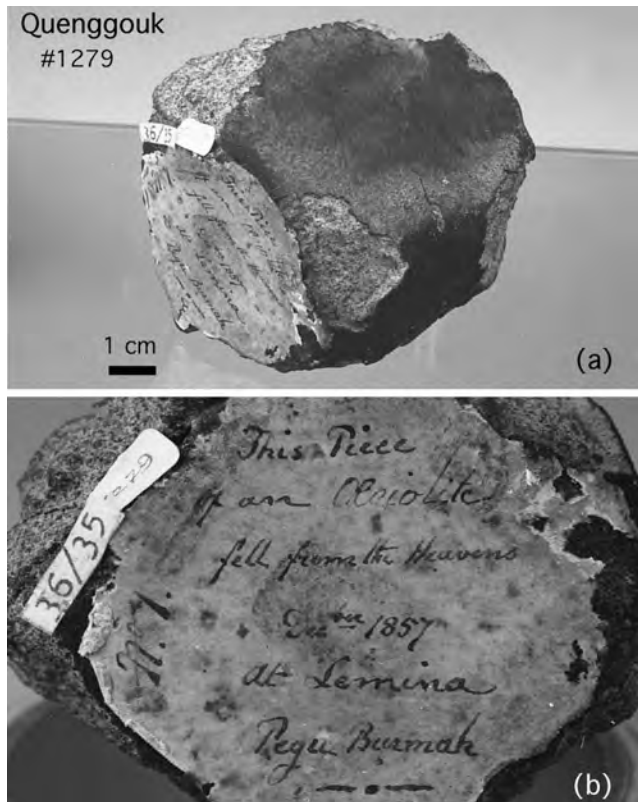


Fig. 1. a) The fourth largest mass of Quenggouk (717.5 g) held at Museo di Storia Naturale, Pisa University; b) the original label of the specimen reporting: “This piece of an aeriolite fell from the Heavens December 1857 at Zemina Pegu Burmah.”



Fig. 2. The almost complete, large (318.8 g) individual of the Siena showerfall held at Museo di Storia Naturale, Pisa University.

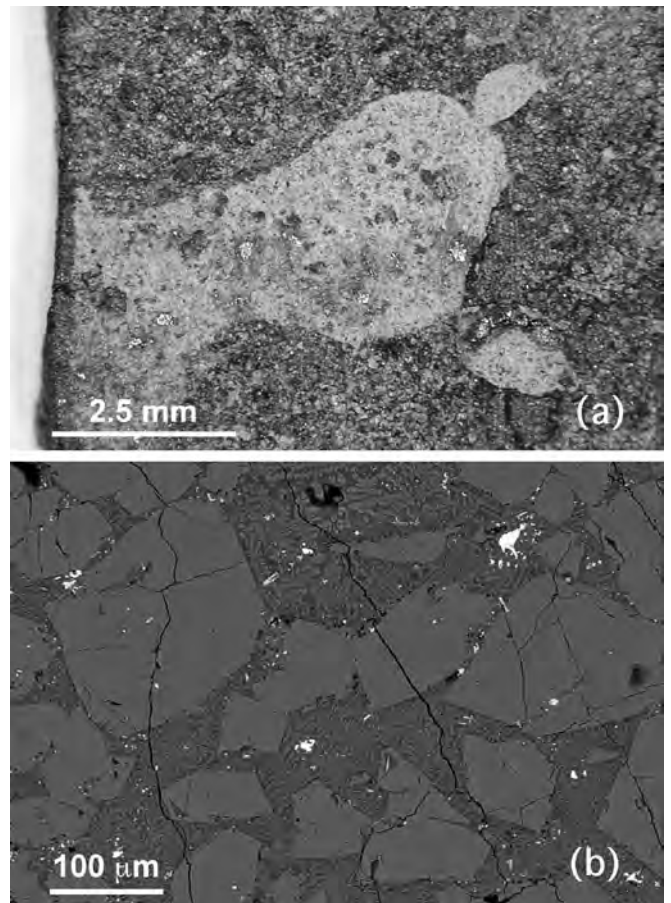


Fig. 3. a) A slice of specimen #16362 held at Museo di Storia Naturale, Pisa University, showing a mm-sized, corroded lithic fragment of L-chondritic material (light grey) set in impact melt (dark grey); b) a backscattered electron image of the impact melt, showing microporphyritic texture given by olivine crystals (100 μm average grain size; Fo_{75}) set in a quench groundmass of Si-rich glass plus microlites of clinopyroxene. Specimen #16362 is classified as an L chondrite impact melt and it is identified as a piece of the Monte Milone showerfall.

mistakenly reported as a Siena piece in Perchiazzi and Mellini 1995). Obvious differences emerging from the direct comparison with the Siena specimen present in the collection, including the shiny fusion crust and lack of chondritic structure, prompted us to check its identity. Based on optical microscopic and microanalytical scanning electron microscopic studies conducted on polished thin sections, specimen #16362 can be classified as an L chondrite, clast-poor, impact melt breccia. The rock has microporphyritic texture (Fig. 3) and consists of nearly equant (100 μm average grain size) olivine crystals ($\text{Fa}_{25.2}$) set in a Si-rich ($\text{SiO}_2 = 68 \text{ wt}\%$) glassy mesostasis plus quench microlites of clinopyroxene ($\text{En}_{39} \text{Wo}_{31}$). Rare corroded relics of L chondritic material, including individual grains of enstatite ($\text{Fs}_{21.5} \text{Wo}_1$), chromite, troilite, and Fe,Ni-metal, are interspersed within the glassy mesostasis. A corroded lithic fragment up to some mm in size (Fig. 3b) was observed at the

Table 1. Meteorite collection of the Museo di Storia Naturale, Pisa University.

Meteorite name	Specimen ^a
<i>Carbonaceous chondrites</i>	
Cold Bokkeveld	
Cape Province, South Africa Fall 1838, October 13, 09:00 hrs Stone. Chondrite. Carbonaceous (CM2)	15.0 g; many small, irregular fragments in vial. #10070 (226)
Renazzo	
Ferrara, Emilia-Romagna, Italy Fall 1824, January 15, 20:30 hrs Stone. Chondrite. Carbonaceous (CR2)	3.5 g; ~20% fusion-crust fragment; mm-sized chondrules and CAIs visible on broken surfaces. #10067 (217)
<i>Ordinary Chondrites</i>	
Alessandria	
Piemonte, Italy Fall 1860, February 2, 11:45 hrs Stone. Chondrite. Ordinary (H5)	3.7 g; two adjoining, angular, inner fragments (2.1 and 1.6 g) crosscut by thin, dark, shock veins; metal grains partially oxidized. #10072 (216)
Ausson	
Haute Garonne, France Fall 1858, December 9, 07:30 hrs Stone. Chondrite. Ordinary (L5)	2.9 g; nearly prismatic, inner fragment; metal grains partially oxidized. #10061 (219)
Beni M'hira	
Foum Tataouine, Tunisia Fall 2001, January 8, 15:00 hrs Stone. Chondrite. Ordinary (L6)	34.0 g; tetrahedral shape, ~40% fusion crusted, 50 × 33 × 21 mm, fresh fragment; veined structure; some mm-sized chondrules and one mm-sized, pink-brown glassy inclusions visible on broken surface; #18313
Bur-Ghelai	
Bur-Hagaba district, Somalia Fall 1919, October 16, 08:00 hrs Stone. Chondrite. Ordinary (H5)	92.1 g; two fragments; the largest is a ~60% crusted (fusion crust partially oxidized), 74.2 g piece showing brecciated structure and partially oxidized metal grains on broken surfaces; the smallest is a 17.9 g partially crusted piece. #10058
Château-Renard	
Montargis, Loiret, France Fall 1841, June 12, 13:30 hrs Stone. Chondrite. Ordinary (L6)	15.1 g; irregular, inner fragment, crosscut by thin, dark, shock veins; metal grains partially oxidized. #10071 (220)
Knyahinya	
Nagybereszna, Ungvár, Ukraine Fall 1866, June 9 Stone. Chondrite. Ordinary (L5), brecciated	146.6 g; ~80% fusion crusted fragment; shallow regmaglypts up to 1 cm across, shiny fusion crust with frozen ablative streamlets in places; broken surface oxidized. #10063 (224) 26.7 g; almost complete, button-shaped, ~85% fusion crusted stone; some oxide haloes around metal grains on broken surfaces. #10068 (229)
Marion (Iowa)	
Linn County Fall 1847, February 25, 14:45 hrs Stone. Chondrite. Ordinary (L6)	3.5 g; irregular inner fragment, crosscut by thin, dark, shock veins; metal grains partially oxidized. #10074 (228)
Monte Milone	
Macerata, Marche, Italy Fall 1846, May 8, 09:15 hrs Stone. Chondrite. Ordinary (L). Impact melt breccia	47.5 g; ~75% fusion crusted, nearly tetrahedral-shaped fragment with one corner broken off; shiny fusion crust with sub-centimeter sized regmaglypts and frozen ablative streamlets; dark-gray interior; one mm-sized, chondritic clast seen on one sawn-cut surface; fresh, except few oxide haloes; plus many tiny inner fragments in vial; this specimen was cataloged as Siena in Perchiazzi and Mellini (1995). #16362
New Concord	
Muskingum County, Ohio, USA Fall 1860, May 1, 12:45 hrs Stone. Chondrite. Ordinary (L6)	38.8 g, irregular, flat fragment; some metal grains partially oxidized. #10073 (231)
Pultusk	
Warsaw, Poland Fall 1868, January 30, 19:00 hrs Stone. Chondrite. Ordinary (H5)	64.7 g; ~80% fusion crusted fragment; round shape in origin; broken surface slightly oxidized. #10066 (223)
Quenggouk	
Bassein district, Burma Fall 1857, December 27, 02:30 hrs Stone. Chondrite. Ordinary (H4)	717.5 g; two, nearly equant fragments glued to recombine a ~50% crusted stone; rather fresh with few patches of oxides; chondrules up to some millimeters in size visible on broken surfaces; #1279 (160)
Siena	
Tuscany, Italy Fall 1794, June 16, 19:00 hrs Stone. Chondrite. Ordinary (LL5)	318.8 g; ~85% fusion crusted, nearly complete, almost prismatic, 45 × 70 × 68 mm, fresh stone; one broken and partially sawn-cut surface with dark shock veinlets and very few metal grains partially oxidized; matt black, fusion crust with polygonal fracturing, spalled off in few places. #14700 (158)

Table 1. Meteorite collection of the Museo di Storia Naturale, Pisa University. *Continued.*

Meteorite name	Specimen ^a
<i>Achondrites</i>	
Stannern	
Iglau, Jihomoravsky Region, Moravia, Czech Republic Fall 1808, May 22, 06:00 hrs Stone. Achondrite. Eucrite	19.8 g; ~60% fusion crusted, irregular fragment with one corner chipped off and one broken surface; fresh; shiny fusion crust with frozen ablative streamlets. #10069 (222)
<i>Stony-iron meteorites</i>	
Imilac	
Atacama Desert, Atacama, Chile Find 1822 Stony-iron. Pallasite	67.9 g; irregular part slab, 11 mm thick; two polished surfaces; weathered olivine crystals >1 cm in size (80% by volume). #14698 (239)
Krasnojarsk	
Yeniseisk, Krasnoyarsk Territory, Russia Find 1749 Stony-iron. Pallasite	8.6 g; irregular weathered fragment; one large, nearly complete, cm-sized, olivine crystal still in place. #10075 (232)
Name uncertain	
Stony-iron. Pallasite	103.9 g; irregular, weathered fragment; olivine crystals spalled off. #16363
Name uncertain	
Stony-iron. Pallasite	170.1 g; irregular, roughly oblate shaped, oxidized fragment; few olivine crystals weathered, others spalled off. #14699 (234)
<i>Iron Meteorites</i>	
Bagnone	
Tuscany, Italy Find 1904 or 1905 Iron. (IIIAB) Medium octahedrite	48000 g; complete individual roughly ovoidal (prolate lense) shape and approximate dimensions of 40 × 21 × 17 cm; shallow regmaglypts; external surface partially oxidized; one corner sawn-cut; cut-surface polished and etched. #14704
Cosby's Creek	
Cocke County, Tennessee, USA Find 1837 Iron. (IAB) Coarse octahedrite	9.1 g; many small, irregular, oxidized, fragments in vial. #10059 (230)
La Caille	
Grasse, Alpes Maritimes, France Find 1828 Iron. (UNGR) Medium Octahedrite	14.8 g; ~6 mm thick, part slab; five surfaces polished and etched; original external surface oxidized. #10054 (236)
Magura	
Arva, Tatry, Slovakia Find 1840 Iron. (IAB) Coarse octahedrite	1.5 g; dark-brown, irregular fragment. #10055 (238)
Ruff's Mountain	
Lexington County, South Carolina, USA Find 1844 Iron. (IIIAB) Medium octahedrite	18.1 g; sawn-cut prism, with one original outer surface oxidized. #10051 (240)
Toluca	
Xiquipilco, Mexico D.F., Mexico Find 1776 Iron. (IAB) Coarse octahedrite	184.9 g; sawn-cut, oxidized, ear-shaped, weathered fragment. #10056 153.9 g; part end-cut; one polished and etched surface; oxidized external surface; this specimen was cataloged as an iron meteorite of uncertain name and origin in Perchiazzi and Mellini (1995). #10060. 71.8 g; four weathered irregular fragments each weighing 23.7, 38.6, 14.1, 8.8 g. #12870 37.8 g; sawn-cut prism with etched and polished surfaces; rust patches in places. #10052
Name uncertain	
Iron. (IIIAB) Medium octahedrite	102.4 g; bent part slice; 3 mm average thickness; two polished and etched surfaces. #14697

^aThe specimen descriptions are followed by the current and, in parentheses, former (D'Achiardi's) catalogue numbers.

very edge of the specimen. The specimen is a breccia of L chondrite composition (olivine, Fa₂₆; enstatite, Fs₂₂) with clasts up to a few mm in size of highly recrystallized material set in a fine-grained fragmental matrix. Shock stage recorded in the impact melt is S1; stronger shock deformation is recorded in the L chondrite relics (Stöffler et al. 1991). Weathering grade, W0 (Wlotzka 1993), typical of fresh falls.

Based on its classification and the fact that a highly shocked L5 breccia from D'Achiardi's inventory is missing, i.e., specimen #159, Macerata (synonym for Monte Milone; Grady 2000), we suggest that specimen #16362 is actually a piece of this meteorite. The petrographic description of the Monte Milone showerfall available from literature (Maras et al. 1979) reports a light and dark structure typical of impact



Fig. 4. Polished and etched surfaces of a IIIAB medium octahedrite (specimen #14697, 102.4 g) and a IAB coarse octahedrite (specimen #10060, 152.1 g) at Museo di Storia Naturale, Pisa University, previously reported as an unclassified iron meteorite of uncertain origin (Perchiazzi and Mellini 1995). Specimen #10060 is now identified as Toluca.

Table 2. Inductively coupled plasma mass spectrometry (ICP-MS) analyses of two previously unclassified iron meteorites in the collection of the Museo di Storia Naturale, Pisa University.

	Unit	Specimen #10060, Group IAB	Specimen #14697, Group IIIAB
Co	mgg ⁻¹	5.1	5.2
Ni	mgg ⁻¹	82.3	83.8
Cu	μgg ⁻¹	149	150
Ga	μgg ⁻¹	71	21.3
Ge	μgg ⁻¹	238	35.2
As	μgg ⁻¹	17.6	6.0
Mo	μgg ⁻¹	6.2	7.4
Ru	μgg ⁻¹	4.2	10.4
Rh	μgg ⁻¹	1.1	1.7
Pd	μgg ⁻¹	4.3	2.8
Sn	μgg ⁻¹	4.3	0.10
Sb	ngg ⁻¹	416	38
W	μgg ⁻¹	0.83	1.20
Re	ngg ⁻¹	225	681
Ir	μgg ⁻¹	2.3	7.0
Pt	μgg ⁻¹	5.6	14.4
Au	ngg ⁻¹	1524	688

melt chondrites and homogeneous compositions for olivine, $\text{Fa}_{25.5}$, and enstatite, $\text{Fs}_{21.4}$.

Specimen #10060 is an end-cut weighing 152.1 g (Fig. 4). It is a coarse octahedrite with a bandwidth of 1.1 ± 0.3 mm. Trace element concentrations reveal that it belongs to the IAB group (Table 2). On the basis of its structure and chemical composition, specimen #10060 is identified as Toluca.

Specimen #14697 is a partial slice of 102.4 g (Fig. 4). It has the structure of a medium octahedrite with a bandwidth of 0.9 ± 0.2 mm. The chemical composition places this iron in the IIIAB chemical group (IIIA). A number of IIIA irons are compositionally similar to #14697, including Cape York, Uegit, Augusta County, Sacramento Mountains, Casas Grandes, Wabar, Boxhole, etc. Available data do not allow a precise identification of specimen #14697.

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