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Buddha from space—An ancient object of art made of a Chinga iron meteorite fragment*

Elmar BUCHNER[1,2*], Martin SCHMIEDER[1,3], Gero KURAT[4], Franz BRANDSTÄTTER[4], Utz KRAMAR[5], Theo NTAFLOS[6], and Jörg KRÖCHERT[1,7]

[1]Institut für Planetologie, Universität Stuttgart, Herdweg 51, Stuttgart D-70174, Germany
[2]Hochschule Neu-Ulm, University of Applied Sciences, Wileystraße 1, 89231 Neu-Ulm, Germany
[3]University of Western Australia (UWA), School of Earth and Environment (M004), 35 Stirling Highway Crawley, 6009 WA – Perth, Australia
[4]Naturhistorisches Museum, Burgring 7, Wien 1010, Austria
[5]Institut für Mineralogie und Geochemie, Karlsruher Institut für Technologie (KIT), Adenauerring 20b, D-76131 Karlsruhe, Germany
[6]Department for Lithospheric Research, University of Vienna, Althanstrasse 14, Vienna A-1090, Austria
[7]Ingenieurbüro CDM-Stuttgart, Motorstraße 5, Stuttgart 70499, Germany
*Corresponding author. E-mail: elmar.buchner@hs-neu-ulm.de

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Abstract–The fall of meteorites has been interpreted as divine messages by multitudinous cultures since prehistoric times, and meteorites are still adored as heavenly bodies. Stony meteorites were used to carve birds and other works of art; jewelry and knifes were produced of meteoritic iron for instance by the Inuit society. We here present an approximately 10.6 kg Buddhist sculpture (the "iron man") made of an iron meteorite, which represents a particularity in religious art and meteorite science. The specific contents of the crucial main (Fe, Ni, Co) and trace (Cr, Ga, Ge) elements indicate an ataxitic iron meteorite with high Ni contents (approximately 16 wt%) and Co (approximately 0.6 wt%) that was used to produce the artifact. In addition, the platinum group elements (PGEs), as well as the internal PGE ratios, exhibit a meteoritic signature. The geochemical data of the meteorite generally match the element values known from fragments of the Chinga ataxite (ungrouped iron) meteorite strewn field discovered in 1913. The provenance of the meteorite as well as of the piece of art strongly points to the border region of eastern Siberia and Mongolia, accordingly. The sculpture possibly portrays the Buddhist god Vaiśravana and might originate in the Bon culture of the eleventh century. However, the ethnological and art historical details of the "iron man" sculpture, as well as the timing of the sculpturing, currently remain speculative.

INTRODUCTION

Meteorites have been regarded as devotional and ritual objects by multitudinous cultures since prehistoric times. The worship of meteorites was practiced by the ancient Greeks and Romans in Europe and the Near East; the "Stone of Delphi" was most probably of extraterrestrial origin and of particular importance in this famous ancient sanctuary (e.g., McBeath and Gheorghe 2005). The holy rock of "Hadschar al Aswad" in the Kaaba in Mecca (Saudi Arabia) is thought to be a meteorite and is adored to date (e.g., Farrington 1900; Antoniadi 1939; Mardon et al. 1992). The 15 ton Willamette iron meteorite was one of the most important sainthoods of the North American natives venerated as a holy rock (Iijima 1995). Fragments of the Canyon Diablo iron meteorite (e.g., Blau et al. 1973), that formed an approximately 50,000 yr Barringer crater in Arizona, have for a long time been adored by a number of North American Indian tribes. Native people throughout the world practiced the worship of meteorites, for instance the Inuit in Greenland, the Aborigines in Australia, as well as different cultures all over Asia, e.g., in India, China, Tibet, and also in Mongolia (e.g., Farrington 1900).

Meteoritic iron was used in knife and dagger production by various ancient civilizations. Artifacts

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*This work is dedicated to the memory of Gero Kurat († 27.11.2009).

Table 1. Concentrations of the crucial major, minor, and trace elements from the "iron man" fragments and the Chinga iron meteorite for comparison; column #1: data analyzed (EDX) at the Institut für Planetologie, Universität Stuttgart in 2007; columns #2–5: analyses (XRF) carried out at the Institut für Mineralogie und Geochemie, Universität Karlsruhe in 2007; columns #7–10: analyses (EPMA) carried out at the Department of Lithospheric Research, University of Vienna in 2009.

	"Iron man"											
Elements	#1	#2	#3	#4	#5	#6 (Average of #2–5)	#7	#8	#9	#10	#11 (Average of #7–10)	#12 Chinga
Fe (%)	84.98	85.02	84.98	84.99	84.99	84.99	83.50	83.49	83.33	83.33	83.41	83.1
Ni (%)	15.02	14.98	15.02	15.01	15.01	15.01	15.90	16.02	16.00	16.02	15.98	16.38
Co (%)	–	–	–	–	–	–	0.60	0.49	0.67	0.65	0.60	0.55
Cr (ppm)	–	1830	–	–	–	1830	876	916	–	–	896	810
Ga ppm)	–	0.25	–	–	–	0.25	0.22	0.21	–	–	0.22	0.181
Ge (ppm)*	–	3.75	–	–	–	3.75	2.96	3.28	–	–	3.12	0.082
Mo(ppm)	–	–	–	–	–	–	6.91	6.78	–	–	6.85	7.42
Ag (ppm)	–	–	–	–	–	–	0.09	0.08	–	–	0.09	–
Cu (ppm)	–	–	–	–	–	–	14.1	14.0	–	–	14.0	–
P (ppm)	–	–	–	–	–	–	440.4	46.6	–	–	443.5	–
W (ppm)	–	–	–	–	–	–	0.58	0.65	–	–	0.61	0.569
V (ppm)	–	–	–	–	–	–	7.88	8.33	–	–	8.11	–

*Due to low concentration levels, Ge data presented here and in the literature must be regarded as potentially imprecise.

Values for Chinga (column #12) are compiled from Wasson and Kimberlin (1967), Schaudy et al. (1972), Buchwald (1977), Rasmussen (1989), Shimamura et al. (1993), and Petaev and Jacobsen (2004).

probably made of meteoritic iron were found in old Egyptian king tombs and in Mesopotamian sanctuaries. In addition, metallic meteorites were once the major source of iron for the Eskimo society (e.g., Mardon et al. 1992). Kotowiecki (2004) reported an axe and some bracelets made up of meteoritic iron from Poland. Accordingly, objects of art and utility made of meteorites are well known in diverse cultures. Eagles and other birds carved in the famous "Aeroliths" (stony meteorites) of Emesa in Syria as a symbol of the celestial origin were considered as a faithful attendant of the Deity itself (Antoniadi 1939). In Tibet, meteoritic iron (regionally referred to as *namchag* meaning "sky iron" in Tibetan language) used to be carved, but that tradition died out a long time ago, and only ancient artifacts are known (Berzin, personal communication). However, figurative illustrations or religious sculptures of gods carved or chased in meteorites are not mentioned in the literature. In this study, we present a sculpture made of a meteorite (approximately 10.6 kg in weight and approximately 24 × 13 × 10 cm in size; Buchner et al. 2009) that represents a potentially unique particularity in both religious art and meteorite science.

MINERALOGICAL AND CHEMICAL PROPERTIES OF THE OBJECT

Sample Preparation and Analytical Methods

In an early stage of the study in the year 2007, the "iron man" was neither in possession of, nor available to any of the authors. The owner provided the statue for geochemical analyses to a very limited degree (i.e., essentially nondestructive analysis). Accordingly, we had to use microsampling methods. Nevertheless, we managed to obtain some small samples for analysis of the elements, indicative for iron meteorites (e.g., Wasson et al. 1998) Fe, Ni, Cr, Ga, Ge (Table 1, columns #1–5), as well as the platinum group elements (PGEs; e.g., Kramar et al. 2001) Ir, Rh, Ru, Pd, and Pt (see Table 2, column #1).

For this first set of analyses, we took five samples (200–500 mg) extracted from the surface of the dorsal part of the sculpture by the use of a steel drilling bit. From these samples, a first analysis on major elements (iron and nickel; see Table 1, column #1) was carried out in the year 2007 by EDX method using a CamScan™ SC44 scanning electron microscope (SEM)—EDAX™ PV 9723/10 energy dispersive X-Ray (EDX) system (Institut für Planetologie, Universität Stuttgart). A screening of major and minor elements (see Table 1, columns #2 to #5) was performed by nondestructive energy dispersive X-ray fluorescence methods (XRF) on a 230 mg chip of the object at the Institut für Mineralogie und Geochemie, Universität Karlsruhe in 2007. The iron-man samples were measured at a SPECTRACE 5000 X-ray affiliation equipped with Rh tube operated at 50 kV/0.05 mÅ using a Pd primary beam filter to optimize the excitation of elements; further details of the procedure are explained by Kramar (1997). Except for Fe, Ni, and Cr, all elements analyzed are below the detection limits of approximately 10 μg g^{-1} in

Table 2. Columns #1–3: platinum group element (PGE) contents of the "iron man"; column #1 analyzed from small splinters taken from the statue in the year 2007; columns #2 and #3: PGEs analyzed from bigger samples taken from the inner part of the statue (socket plate) in the year 2009. All analyses on PGEs (HR-ICPMS) were carried out at the Institut für Mineralogie und Geochemie, Universität Karlsruhe. Column #4: PGE contents of the Chinga meteorite. The PGE contents of the Chinga iron meteorite (column #5) are compiled from Wasson and Kimberlin (1967), Schaudy et al. (1972), Buchwald (1977), Rasmussen (1989), and Shimamura et al. (1993). Column #5: newer PGE data for the Chinga meteorite by Petaev and Jacobsen (2004).

Platinum group elements	#1 "Iron man"	#2 "Iron man"	#3 "Iron man"	#4 Chinga	#5 Chinga
Ir (ppm)	3.31 ± 0.5	3.31 ± 0.5	3.31 ± 0.5	3.60	4.13
Ru (ppm)	7.59 ± 0.7	6.33 ± 0.7	6.53 ± 0.7	6.10	7.86
Rh (ppm)	1.78 ± 0.1	1.75 ± 0.1	1.77 ± 0.1	2.00	2.464
Pt (ppm)	7.59 ± 0.5	7.99 ± 0.5	8.24 ± 0.5	11.00	9.56
Pd (ppm)	6.73 ± 0.2	6.51 ± 0.2	6.67 ± 0.2	9.00	7.89

the Fe-Ni-rich main phase. Fe, Ni, and Cr were quantified by fundamental parameters. A first set of analyses on Cr, Ga, and Ge (see Table 1, column #2), as well as of the PGEs (see Table 2, column #1) were also performed at the Institut für Mineralogie und Geochemie, Universität Karlsruhe in 2007, using a High Resolution Inductively Coupled Plasma Mass Spectrometer (HR-ICPMS) system (AXIOM from VG Elemental, UK). For PGE determinations, the whole chip was digested in 10 mL aqua regia and diluted to 50 ml. No preconcentration procedures for the PGEs were possible due to the small amount of sample material available. Element contents were calculated from the PGE isotopes ^{191}Ir, ^{193}Ir, ^{103}Rh, ^{101}Ru, ^{102}Ru, ^{104}Pd, ^{106}Pd, ^{108}Pd, ^{194}Pt, ^{195}Pt, and ^{196}Pt. Detection limits mainly depend on blanks of the chemicals used and were estimated at 3 ppb for Ru, 40 ppb for Rh, 50 ppb for Pd, 4 ppb for Ir, and 300 ppb for Pt. The PGE concentrations were determined at a level of 30- to 3000-fold the detection limit.

Since the year 2009, the statue has been in the possession of one of the authors and we were able to cut a plate (that was very lightly nital-etched) from the socket of the statue in Vienna (for a picture of the socket plate, see Fig. 1); the slice of the socle is stored at the Naturhistorische Museum, Wien. The socket plate is approximately 1.5 cm thick and approximately 15 cm wide. We were now able to take more fresh samples from the inner part of the object. Two further analyses on the PGEs (Table 2, columns #2 and #3) were carried out on these fresher samples (each 320 mg in weight) in Karlsruhe in the year 2009. For analytical procedure, see description of PGE analyses in Karlsruhe in the text above.

For internal control, we carried out further geochemical analyses of major and trace elements (Table 1, columns #6 to #10) at the Department of Lithospheric Research, University of Vienna in 2009, using a Cameca SX100 electron probe microanalyzer equipped with four WDS and one EDS. In addition, a high-resolution inductively coupled mass spectrometer was utilized. Operating conditions for EPMA were 20 kV accelerating voltage and 10 nÅ beam current. A 5 μm defocused beam was used and the counting times at the peak position were 30 sec. Pure metals were used for calibration and the ZAF method for matrix correction procedures. The relative analytical error was below 5%. PGEs, Ga, and Ge data obtained are reported in Tables 1 and 2. In 2012, we carried out further analyses (EPMA) at the University of Vienna on the minerals kamacite, taenite, troilite, and daubreelite (Table 3) by using the equipment described above.

We decided to rely mainly on the geochemical data achieved (at the Universities of Vienna and Karlsruhe) from the fresher samples from the inner part of the object taken in 2009 and to compare this data to the values of known iron meteorites mentioned in the literature. The material from the surface of the statue taken in 2007 and analyzed in Stuttgart and Karlsruhe might possibly be affected by weathering and/or forging.

Geochemical and Mineralogical Description

The metallic groundmass of the object does not exhibit Neumann bands or Widmanstätten figures. There was no indication of macroscopic features on the sculpture surface nor in the widely structure-less metal of the socket plate (compare to Fig. 1A). However, the metal shows dominant bands of oriented sheen, some straight, others curved (Fig. 1A). Thin long streaks are dense bands of single orientation of microcrystals ("deformation bands"). The metal of the socket plate embeds a few large crystals of daubreelite/troilite (troilite has approximately 1–2 wt% Cr; Figs. 1B and 1C; Table 3) as well as some rare kamacite crystals (approximately 7 wt% Ni; Fig. 1D; Table 3). Furthermore, the metal slice shows rust veins that are orientated toward the outer face of the meteorite and that contain brecciated and partly oxidized daubreelites/troilites, embedded in variable rust

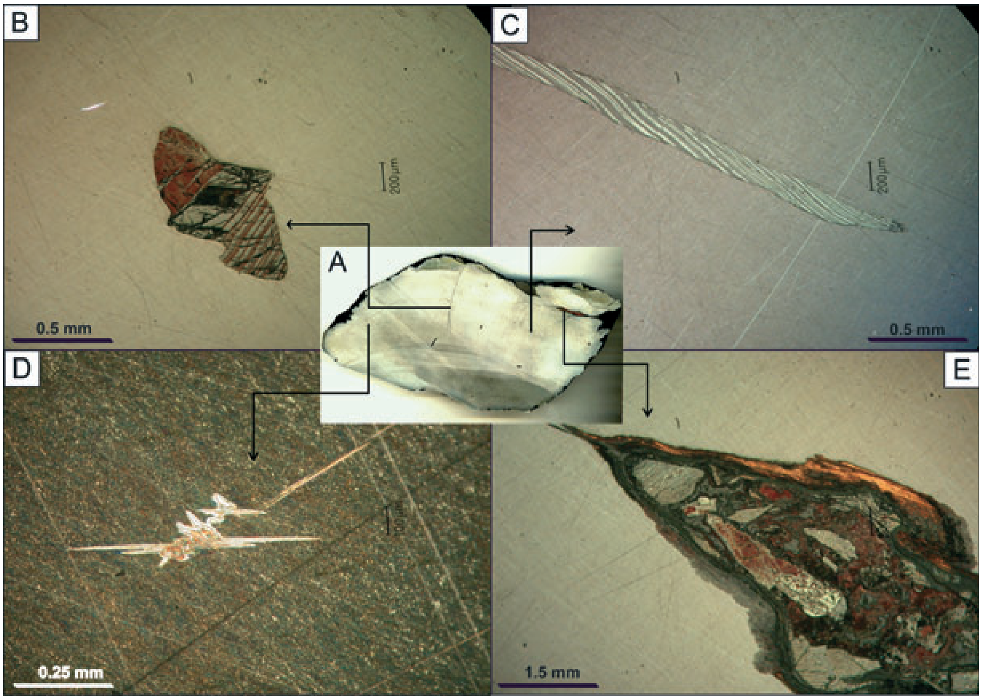

Fig. 1. A) Slice of the socle of the statue (very lightly natal-etched, 15 cm in length); arrows mark position of inclusions and rust veins embedded in the structureless metallic groundmass that are depicted in the four photographs (B–E). B) Inclusion of daubreelite/Cr-troilite intergrowth; troilite has 1–2 wt% Cr; black center is hole. C) Large spindle of daubreelite/Cr-troilite intergrowth with curved lamellae. D) Detail of rare kamacite crystals (approximately 7 wt% Ni) in very fine-grained metal matrix (approximately 15 wt% Ni). E) Rust vein with fragments of large daubreelite/Cr-troilite intergrowths, partly brecciated, and a few Cr-troilites and variable rust generations.

Table 3. Electron microprobe analyses of metal and sulfides from a slice of the socle of the "iron man"; standard deviation (in parentheses) in units of the last digit; n/a: not available; b/d: below detection limit.

Minerals	Kamacite	Taenite	Troilite	Daubreelite
Number of analyses	$n = 9$	$n = 8$	$n = 30$	$n = 26$
Fe (wt%)	91.49 (44)	83.36 (44)	60.80 (21)	18.65 (24)
Ni (wt%)	7.15 (22)	15.85 (20)	0.07 (03)	b/d
Co (wt%)	0.67 (05)	0.50 (02)	b/d	b/d
Cr (wt%)	0.03 (01)	0.07 (02)	1.33 (12)	36.23 (21)
V (wt%)	b/d	b/d	0.83 (09)	0.02 (01)
S (wt%)	n/a	n/a	36.49 (24)	43.80 (24)
Total (wt%)	99.34	99.79	99.52	98.70

generations (Fig. 1E; Table 3). In places, the rust also contains angular grains of quartz, and clasts of K- and Na-feldspar.

The Fe and Ni content turned out to be largely homogenous within a range of approximately 85 wt% for Fe and approximately 15 wt% for Ni (geochemical analyses of metal splinters in 2007) and of 83.4 wt% for Fe and approximately 16 wt% for Ni (analyses from metal of the socket plate in 2009), respectively (Table 1). The elements Ga, Ge, and Cr, as well as the PGEs (compare Tables 1 and 2) were measured (in the year 2007) using a single metal sample extracted from the dorsal part of the sculpture, which we alleged to be unaffected by forging. We were able to reanalyze all crucial elements by the use of adequate amounts of fresh samples (Tables 1 and 2) from the socle plate in the year 2009. The (certainly more reliable) analyses in the year 2009 yielded partly differing element values; this holds notably true for the Cr value (compare Table 1). Tables 1 and 2 clearly show that the element values of Co, Cr, Ga, and Ge, as well as of the PGEs are significantly enriched and in a range typical for iron meteorites (e.g., Pernicka and Wasson 1987).

THE CHINGA METEORITE

The Chinga meteorite fall took place in the area of Tanna-Tuva, the border district between southern Siberia and Mongolia along the Chinga (or Chinge) stream. The approximately 250 Chinga meteorite fragments of individual weights from 85g to 20.5 kg

Fig. 2. Photographs of two fragments of the Chinga ungrouped iron meteorite. Left: untreated Chinga meteorite fragment that exhibits an oxidized melt crust and indistinct regmaglypts. Right: sawn and polished Chinga fragment; the structureless ataxitic metallic mass offers some very small metallic inclusions and some rust veins (compare to Fig. 1).

(Buchwald 1975) and a total known weight of 209.4 kg were first discovered in 1913; just two pieces are heavier than 10 kg. The fall of the Chinga meteorite is estimated to an age of 10–20 ka by glaziofluvial considerations on the postglacial development of the Chinga valley (Buchwald 1975). By the absence of structural features (Figs. 1A and 2) and the high Ni content (approximately 16 wt%), the ataxite of the Chinga meteorite represents an ungrouped iron meteorite. According to Grokhovsky et al. (2000), the microstructure of the Chinga meteorite is a plessite-like kamacite-taenite intergrowth, displaying separated kamacite spindels and rare crystals of troilite, daubreelite, and schreibersite. Schlieren bands in the metallic groundmass of the Chinga meteorite were described by Grokhovsky et al. (2008). The geochemical analyses of the major (Fe, Ni, Co) and the trace elements (Cr, Ga, Ge) as well as of the PGEs were carried out by Wasson and Kimberlin (1967), Schaudy et al. (1972), Buchwald (1977), Rasmussen (1989), Shimamura et al. (1993), and Petaev and Jacobsen (2004) and compiled from these papers in the present study (compare to Tables 1–2).

ETHNOLOGICAL ASPECTS

The origin and age of the ‘‘iron man’’ meteorite is still a matter of speculation. To our knowledge, the statue was brought to Germany by a Tibet expedition in the years 1938–1939 guided by Ernst Schäfer (zoologist and ethnologist) by order of the German National Socialist government (e.g., Mierau 2003). The aim of this expedition was to find the roots of the Aryan religion and the Aryan origin (e.g., Hale 2003; Engelhardt 2007). The swastika on the cuirass of the statue (Fig. 3) is a minimum 3000-yr-old Indian sun symbol and is still used as an allegory of fortune (Beer 2003). This symbol decorates many Buddhist and Hindu statues; one prominent example is the big golden Buddha on Lantau Island near Hong Kong. The swastika was modified into a mirror-inverted form (as a symbol of the National Socialist movement) during the reign of the National Socialists in Germany in the years 1933–1945. One can speculate whether the swastika symbol on the statue was a potential motivation to displace the ‘‘iron man’’ meteorite artifact to Germany.

The sculpture possibly portrays the Buddhist god Vaiśravana (Michel, personal communication) which is also called Jambhala or Namthöse (in Tibet), and which can be either a God of fortune and wealthiness or a God of war (e.g., Lalou 1946). Vaiśravana is also known as the guardian of the northern direction (‘‘the King of the North’’). The character is founded upon the Hindu deity Kubera; the Buddhist and Hindu deities share some characteristics and epithets. In the Buddhist pantheon, Vaiśravana is also known as Jambhala, probably derived from the denomination of the jambhara (lemon) he carries in his hand in some cases. Apart from the regionally variable denominations for Vaiśravana, the portrayal of this deity, as well as the diagnostic features, are extremely variable (Lalou 1946; Fisher 1997) depending on the epoch of art and the provenance of the artifact (India, China, Tibet, or Japan).

Characteristic features of Vaiśravana in Buddhist artwork are (i) In the majority of Buddhist figurative illustrations (statues and pictures), the legs of the sculptures are tucked up or crossed, whereas the right leg of Vaiśravana is generally in a pendant position (Lalou 1946; Snellgrove 2002; compare to Figs. 3 and 4); (ii) In accordance to the ‘‘iron man’’ (compare to Fig. 3), Vaiśravana as the god of war and army is mostly pictured wearing a scale armor made of gilded leather (Lalou 1946; their plates I–IV); (iii) A further attribute of the god of war is a flaming trident clamped in the left crook of the arm (e.g., Fisher 1997, Fig. 4). It remains

Fig. 3. Front and rear side of the "iron man." The sculpture was chiseled from the iron meteorite, forged at the edges and the basis, and shows the Buddhist god Kubera (Vaiśravana); the scale armor was formerly gilded.

uncertain whether the "iron man" was originally equipped with a flaming trident that got lost in the course of time; (iv) Vaiśravana as the god of wealthiness usually holds a symbol of richness in the left hand, which can be represented by a little moneybag, a cup for alms, or the jambhara-lemon, respectively (Figs. 3 and 4). The item in the left hand of the "iron man" is not unequivocally identifiable; it seems to be a small money bag (Fig. 3). Alternatively, the object can be identified as some type of stupa, which would also tend toward the god Vaiśravana.

The Swastika prominently displayed on the cuirass of the sculpture (Fig. 3) was a symbol frequently used by the nature-based pre-Buddhist Bon (Bön) religion rooted in the western parts of Tibet (e.g., Fisher 1997). The Bon religion had its own literature and art that was continuously absorbed into the Tibetan Buddhism (Fisher 1997) that propagated into the entire area of Buddhist influence. Accordingly, the "iron man" could represent a Bon/Buddhist hybrid showing some recognition features of Kubera (the early Vaiśravana).

DISCUSSION

Geochemical Aspects

According to Buchwald (1977), the Ni contents of iron meteorites usually range from approximately 5 to approximately 20 wt%. Campbell and Humayun (2005) and Walker et al. (2008) compiled Ni concentrations for IVB irons (all of which are ataxites) ranging from 15.8 to 18.4 wt%. Thus, the Ni content (Table 1) of the "iron man" meteorite (approximately 16.4% on average) is within the range reported for ataxites.

The elements Ga and Ge are commonly used to classify iron meteorites into one of the established groups (e.g., Lovering et al. 1957; Scott and Wasson 1976; Buchwald 1977; Wasson et al. 1998). Scott and Wasson

Fig. 4. Stylized picture showing the characteristic features of the god Vaiśravana according to Lalou (1946) and Snellgrove (2002): a double halo, the characteristic seating position with the right leg in a pendant position, a flaming trident, and a symbol of wealthiness (e.g., money bag, cup for alms, jambhara-lemon) in the left hand (image source: the Visible Mantra resource for visualizing and calligraphy of Buddhist mantras and seed syllables; available online at http://visiblemantra.org).

(1976) analyzed the concentrations of Ga and Ge of 106 iron meteorites (Groups IC, IIE, IIF together with 97 other irons); Wasson et al. (1998) presented geochemical data including Ga and Ge values for 30 iron meteorites of different types. The considerably variable values range from 6.3 to 54 ppm for Ga and from 0.7 to 250 ppm for Ge (Scott and Wasson 1976), as well as from 1.82 to 61.2 ppm for Ga and ≤176 ppm for Ge (Wasson et al. 1998), respectively. Compared with the element composition of iron meteorites mentioned in the literature (e.g., Scott and Wasson 1976; Wasson et al. 1998), the Ga (0.22 ppm) and Ge (3.12 ppm) values are comparatively low (Table 1). However, Malvin et al. (1984) reported 15 ungrouped iron meteorites that exhibit very low Ga (< 3 ppm) and Ge (< 0.7 ppm) contents.

The Cr contents of eight different types of iron meteorites analyzed by Shimamura et al. (1993) ranged from 0.42 to 810 ppm. According to Choi et al. (1995), the values of the element Cr in 126 iron meteorites (lAB and IIICD irons) ranged between 9 and 2790 ppm. Hence, the Cr value of the "iron man" meteorite (896 ppm) is high, but in the range of known iron meteorites. Shimamura et al. (1993) pointed out that Cr can be enriched particularly in ataxites (e.g., the Chinga iron meteorite; compare Table 1).

Pernicka and Wasson (1987) analyzed the concentration of Ir, Pt, and Ru in 41 iron meteorites. The values range from < 0.1–59 ppm for Ir, 0.1–38.3 ppm for Pt, and < 0.1–26.1 ppm for Ru. The PGE values of the "iron man" (see Table 2, columns #1–3) are clearly within the range of PGE contents analyzed by Pernicka and Wasson (1987), Sun and McDonough (1989), and McDonough and Sun (1995).

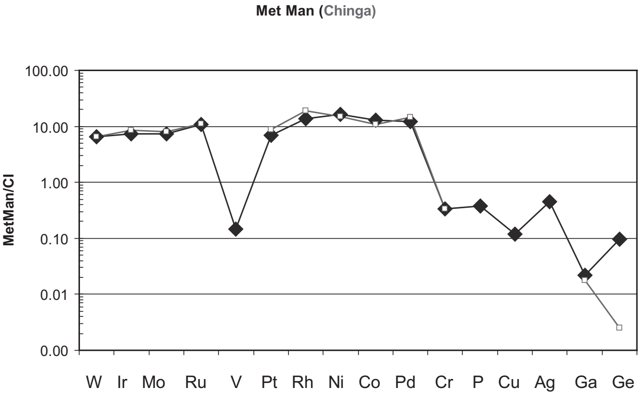

Fig. 5. CI normalized data of the main and trace elements of the "iron man" meteorite (Met Man; black squares) and of the Chinga iron meteorite (small open squares).

In summary, Fe, Ni, Cr, Ga, Ge, and PGE contents (Fig. 5) measured in this study are in the typical range known from iron meteorites reported in the literature. The absence of Neumann bands or Widmannstätten figures, as well as the high values of Ni, suggests that the "iron man" meteorite can be characterized as an "ataxitic" iron meteorite. The element plots of Ga versus Ni (Fig. 6A), and Ir versus Ni (Fig. 6B) show that the composition of the "iron man" meteorite do not match the composition of other known grouped and ungrouped Ni-rich iron meteorites, and the "iron man" meteorite is an ungrouped ataxitic iron meteorite, accordingly.

With respect to the geochemical composition, the Chinga ataxite (ungrouped iron) resembles the "iron man" meteorite. Whereas the geochemical data determined in the year 2007 slightly differ from the geochemical data for the Chinga meteorite mentioned in the literature, the certainly more exact geochemical data ascertained in the year 2009 (compare columns #1–5 with columns #6–10 in Table 1) strongly resembles the geochemical data of the Chinga ataxite. It must be kept in mind that the first analyses in Karlsruhe have been carried out on small splinters of the marginal object. It can be speculated whether the slightly lower Ni values (but higher Fe and Cr values) are due to weathering or if they are the result of Ni expulsion during atmospheric flight (compare Rochette et al. 2009). The element values for Fe, Ni, Co, Cr, as well as for Ga analyzed from the inner part of meteorite exactly matches the Chinga element values known from the literature (Fig. 5). The content of the element Ge in the ungrouped Chinga meteorite (Ge: 0.082 ppm; Rasmussen 1989) is distinctively lower than the values measured for the

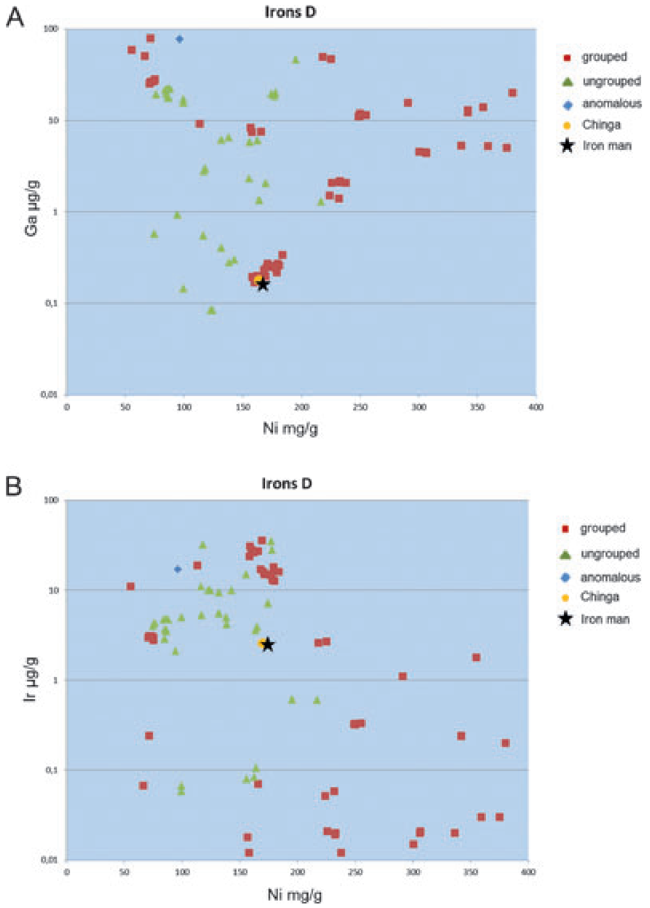

Fig. 6. Plots of Ga versus Ni (A) and Ir versus Ni (B) showing the composition of the "iron man" meteorite relative to other known grouped, ungrouped, and anomalous Ni-rich iron meteorites. The Ni, Ir, and Ga data are compiled from Wasson (1969, 1970, 2000), Schaudy and Wasson (1971), Wasson and Schaudy (1971), Schaudy et al. (1972), Scott et al. (1973), Scott and Wasson (1976), Scott (1977), Kracher et al. (1980), Wasson et al. (1980, 1989), Malvin et al. (1984), Rasmussen et al. (1984), Nagata et al. (1986), Wasson and Wang (1986), Grossman (1994, 1999), Choi et al. (1995), Grossman and Zipfel (2001), and Wasson and Kallemeyn (2002).

"iron man" meteorite 3.12 ppm (Table 2). However, Ge values of such low levels are potentially imprecise (Wasson, personal communication), and both the Ge values for the Chinga meteorite listed in the literature as well as our own measurements must be regarded as highly questionable.

The microstructure of the Chinga meteorite (kamacite–taenite intergrowing, separated kamacite spindels and rare crystals of troilite, and daubreelite) as well as the occurrence of schlieren bands in the metallic groundmass of the Chinga meteorite (Grokhovsky et al. 2000, 2008) were also observed in the metallic groundmass of the socle plate of the "iron man." The angular quartz and feldspar grains in veins of the "iron man" meteorite certainly stem from fluvial Chinga Valley deposits that were incorporated into the rust veins of the "iron man" meteorite and are doubtless of terrestrial origin.

As a result, the geochemical as well as the petrologic data of the "iron man" meteorite widely match the element values known from fragments of the ungrouped iron meteorite of the Chinga strewn field. Thus, the "iron man" was most probably made of the apparent third largest mass of the Chinga meteorite strewn field.

Ethnologic Aspects

Within the scope of our studies, we were not able to clarify the definite identity and age of the "iron man" meteorite sculpture. The statue fulfills some fundamental criteria that argue for the identity of Vaiśravana. However, we are aware of the fact that many figurative illustrations of Vaiśravana significantly differ from the "iron man." Younger illustrations of this deity (particularly in the timespan after approximately 1000 AD) portray Vaiśravana (or Jambhala) as a corpulent figure that holds a mongoose, which spews jewels from its mouth (e.g., Fisher 1997). Subsequently, the illustrations of Vaiśravana became increasingly corpulent and opulently decorated by jewelry and accompanying ghosts and demons. According to Schiffer (1940), statues of ghosts at the feet of Vaiśravana appear from the second half of the eight century onward. From our preliminary ethnological-art historical findings, we assume that the "iron man" is an early portrait of Vaiśravana. However, the statue might as well represent a religious dignitary or another person of high standing that was portrayed with the regalia and in the posture of Vaiśravana. As a further possibility, the "iron man" could be a stylistic cross-over between Bon and the subsequent Buddhist art, exhibiting elements of both. According to this interpretation, the possible provenance of the "iron man" is western Tibet or anywhere in the area of Buddhist influence and the age can be tentatively dated at the eighth to tenth century (compare to Fisher 1997, pp. 12–13). The ancient tradition of meteoritic artwork in Tibet (Berzin, personal communication) and the entire Buddhist area is in good agreement with these age estimations. The provenance of the meteorite used for the statue strongly points to the Tanna-Tuva region in the border area of eastern Siberia and Mongolia. We must speculate whether the piece of art was produced either in Tibet or in Mongolia, and subsequently brought to Tibet. We hereby would like to encourage our colleagues (in particular archeologists and ethnologists) to communicate any cognitions or ideas to us with respect to the identity, age, provenance, and religious role of the "iron man" sculpture.

CONCLUSIONS

1. Concentrations of the crucial major, minor, and trace elements Fe, Ni, Co, Cr, Ga, Ge, as well as PGE concentrations of the "iron man" meteorite are in the range of the values known from iron meteorites. The PGE normalized abundances clearly exhibit a meteoritic signature. It is, therefore, obvious that the "iron man" is made out of an iron meteorite.
2. By the absence of structural features (e.g., Widmannstätten figures) and the high Ni content, the "iron man" can be classified as an ataxitic iron meteorite. However, the meteorite cannot be classified into one of the established iron meteorite groups and, consequently, must be regarded as an ungrouped iron meteorite.
3. The geochemical data of the "iron man" meteorite exactly match the element values known from fragments of the ungrouped iron meteorite of the Chinga strewn field. The "iron man" was most probably made of the apparent third largest mass of the Chinga meteorite strewn field, accordingly.
4. The provenance of the meteoritic "raw material" strongly points to the Tanna-Tuva region in the border area of eastern Siberia and Mongolia. The provenance of the piece of art remains unclear.
5. The figurative illustration possibly portrays the Buddhist god Vaiśravana (also called Jambhala or Namthöse in Tibet, or Hindu Kubera), but the figure represents a stylistic hybrid that might originate in the Bon culture of the eleventh century. However, the ethnological and art historical details of the "iron man" sculpture, as well as the timing of the sculpturing, currently remain speculative.
6. If the correlation of the sculpture with the Bon culture is correct, one can speculate whether this individual meteorite fragment was found much earlier than the discovery of the Chinga strewn field in 1913.
7. Iron meteorites are basically an inappropriate material for producing sculptures. The challenging use of the "iron man" meteorite as well as the (at least) partial gilding of the statue implies that the artist was certainly aware of the outstanding (extraterrestrial) nature of the object carved.

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