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The extraterrestrial matter falls in west-central Poland (Great Poland Lowland); historical and geological data

WOJCIECH T.J. STANKOWSKI

Institute of Geology, Adam Mickiewicz University, Maków Polnych 16 Str., PL-61-606 Poznań, Poland.
E-mail: stawgeo@amu.edu.pl

ABSTRACT:

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Direct and indirect evidence of falls of extraterrestrial matter in west-central Poland (Great Poland Lowland) is proved historically and environmentally. The chronological list of such events has historical (documents, medieval paintings, newspaper reports), geological and morphological documentation. The most important are the environmental sites of Morasko/Oborniki, Przełazy and Jankowo Dolne, where metallic meteorites were recognized. These meteorite falls represent a series of cosmic events: the Morasko fall was c. 5000 years BP, the Przełazy fall was c. 10000 years BP, and the age of the Jankowo Dolne fall is not fully documented.

Key words: Meteorite chronology; Great Poland Lowland.

INTRODUCTION

West-central Poland (Great Poland Lowland) and the adjacent areas to the northwest are characterized by the presence of cosmic material represented by a series of localities with fully documented meteorites, micro-meteorites and cosmic dust (see synthesis by Hurnik 1976; Stankowski 2010 and Muszyński *et al.* 2012). The other available data are newspaper reports of meteorite falls and flights and indirect information from iconography, heraldry, numismatics and architecture (see Czajka 2013, 2013a).

A summary of direct and indirect data on cosmic material falls in west-central Poland (Great Poland Lowland) is presented in Text-fig. 1. The oldest records are from the early fourteenth century (1305 AD). Over a large area of west-central Poland (northwestern Great Poland Lowland and southwestern West Pomerania), there is evidence of an extensive cosmic event (Brzustowicz 2001; Czajka 2013). It seems hardly possible that this event is connected in any way with the Morasko or the Przełazy meteorite showers, as these events took place a few thousand years earlier.

Unequivocal meteorite falls in different parts of the region recorded in newspaper reports date from the mid-nineteenth century. Some of them have analytical documentation.

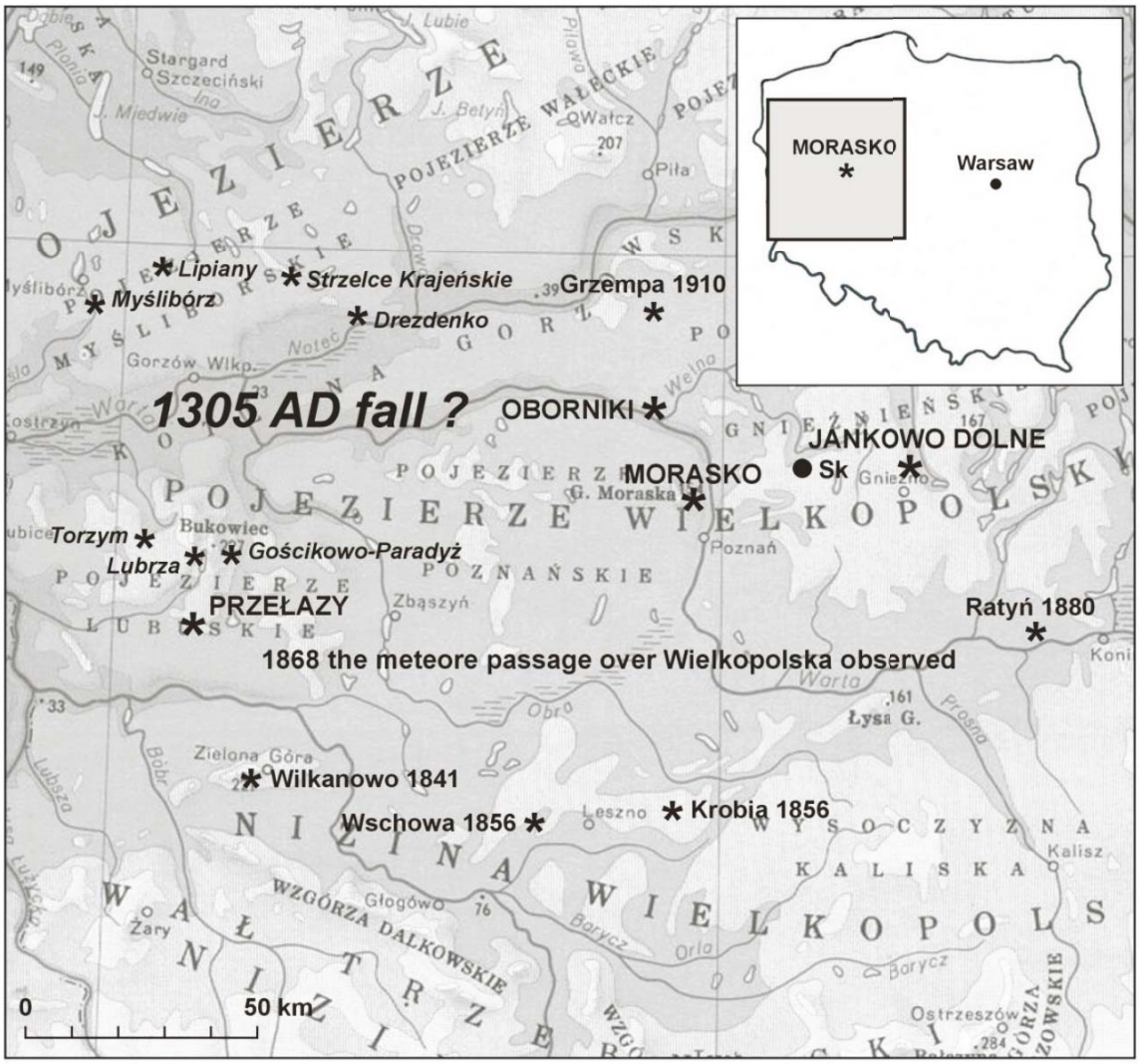
The iron meteorite from Przełazy (of unknown impact time and without precise location), was proved analytically at the end of the 1840s. In 1914 the first specimens of the Morasko metallic meteorites were found, launching the ongoing successful exploration and research of cosmic material. Before World War II two lumps of metallic material were found in the vicinity of Oborniki (not proved analytically) but unfortunately both have since been lost. In the early years of the twenty-first century a metallic meteorite was found in Jankowo Dolne, which is currently under investigation (Text-fig. 1). These four locations (Przełazy, Morasko, Oborniki, and Jankowo Dolne) with iron meteorites of

almost identical chemical composition in the case of Przełazy, Morasko and Jankowo Dolne, have been interpreted as coming from one fall of the wide sequenced falls (Bartoschewitz and Szettel 2001; Karwowski 2004). This interpretation is not followed herein, as is explained later in the text.

Any finds of metallic specimens from the last decades of the twentieth century require special research because, apart from actual meteorites, fragments of artificial satellites have also been found (Nowak and Muszyński 2012; Nowak *et al.* 2013).

Historical documents of the meteorite falls

In west-central Poland (Great Poland Lowland), there is direct and indirect evidence of falls or flights of meteorites. A chronological list of the events is presented in Table 1. The oldest event is the so-called 'Great Poland Bolide' (see Czajka 2013, 2013a), which is documented by iconographic, heraldic, numismatic and architectural evidence. This is the probable impact event in Strzelce Krajeńskie at the beginning of the fourteenth century (Brzustowicz 2001; Karwowski and Brzustowicz 2009), based on fragments of medieval paintings of falling stars in the temple of Paradyż near Gościkowo and the frieze in the northern portal, as well as brick architectural elements from the fourteenth-century parish church in Rzepin and, finally, the supposition of medieval provenance of star motifs on the coats of arms of several cities in western Poland (Great Poland Lowland and Western Pomerania). Most of the events listed in Table 1 are observed meteorites falls or flights recorded in newspaper



Text-fig. 1. Direct and indirect evidence of cosmic material in the Great Poland Lowland (after Stankowski 2010; Czajka 2013, 2013a) (base map with names of lakelands/pojezierza and morphogenetic units in Polish). a) sites of documented metallic meteorites – capital letters, b) newspaper reports of an impact or passage of a meteorite – locality and date in small letters, c) the area of the iconographic, heraldic and architectural indications of the cosmic event called 'The Great Poland Bolide' – localities in italics, d) potential position with the meteorite/s and the crater – marked by a dot and a symbol Sk

Year	Recorded impacts and flights	comments
2012	Wargowo near Oborniki Wlkp. – impact	Metallic part of the structure of an artificial satellite, probably Chinese
1910	Grzempa (between Poznań and Piła) – impact	The observed fall of the stone meteorite
1880	Ratyń near Konin – impact	It was observed by several reapers
1868	Observation of meteorite/s flight over Great Poland by a number of people	Flight without impact
1856	Krobia and Góra Świdnica – impacts (piece found in 1857)	Direct observation of the fall and analytical data of the metallic extraterrestrial material
1841	Wilkanówka near Zielona Góra – impact	The fall was observed and two stone pieces were found
1715	Skalin near Stargard Szczeciński – impact (NW corner of the map, close to Lake Miedwie; see Fig. 1)	Two stone meteorites, one the size of a human head, the second the size of a goose egg
1305	Flight connected to the intense meteorite shower, the so-called 'Great Poland Bolide'	The event estimation based on various indirect considerations

Table. 1. Impacts, flights and kinds of extraterrestrial material in Great Poland Lowland

reports. The most recent event is the fall of a metallic lump in Wargowo, near Oborniki in April 2012 (Nowak and Muszyński 2012; Nowak *et al*. 2013). This is an important example of an impact of anthropogenic material.

MORASKO – SPECIAL POSITION WITHIN IRON METEORITES AND IMPACT CRATERS

The first metallic meteorite discovery in Morasko was over 100 years ago. In 1914, during military exercises, a 77.5 kg lump and three more, with weights of 4.2, 3.5 and 3.5 kg, were found. In the years 1919–1939, and then in 1947–1960, many additional meteorites were discovered (Pokrzywnicki 1956, 1957, 1964; Hurnik 1967; Pilski and Walton 1999), with the largest of them reaching a mass of approximately 80 kg. In the 1990s, extensive new researches were started by the Institute of Geology of the Adam Mickiewicz University, in collaboration with researchers from both national and international research centres (see Stankowski 2010; Muszyński *et al*. 2012). New discoveries were soon made, with the two largest meteorites weighing 164 kg (in 2006) and 261 kg (in 2012) respectively.

Studies aimed at determining the impact time were carried out using dosimetric dating (TL – thermal stimulated luminescence; OSL – optically stimulated luminescence). The analyses were performed on: (a) thin melting films, generated during the final phases of flight through the earth's atmosphere, together with its influence on the material of the impact site (up to 2–3 mm); and b) sintered coatings (ranging in thickness up to c. 10 cm), developed after the fall of a hot object on the mineral surface. It should be noted that diagenetic weathering changes occurred later in the cases of both the "a" and "b" meteorite coatings – hence these are defined as melt-weathering crust and sinter/coating-weathering crust respectively. From both the thin melting films and the thicker sintered coatings TL ages were obtained: 4.6 to 4.9 ka for the melting films of three of the meteorites (Stankowski *et al.* in press), and 4.7 to 6.1 ka for the sinter coatings of four other meteorites (Stankowski 2010). The material from above and beneath the immediate vicinity of one small meteorite was dated as ~5.4 ka, which indicated zeroing of the luminescence in the vicinity the of impact site as well.

OSL dosimetric dating was also performed on mineral material from the bottoms and slopes of the Morasko depressions developed in glacitectonically deformed sediments of Neogene and Quaternary age (not less than 18–17 ka in age, but most of them probably older than 150 ka). The very young zeroing time of luminescence documented in 101 OSL measurements of quartz grains ranged from 4 to ~350 ka (Stankowski and Bluszcz 2012). The data show that ~43% of the grains were zeroed less than 10, 000 years ago (~ 13% <5 ka and ~30% in the 5–10 ka range) and 19% in the range 10–15 ka. Thus in total, 62% of the dosimetric dating data indicates zeroing of the luminescence at a much later date than the real date of origin of the sediments

analysed. The data also indicate incomplete zeroing (>10 ka up to 350 ka) of the some of the analysed material. Nevertheless, the OSL data seem to be an important argument in favour of a young date of zeroing. This additionally proves the impact origin of the Morasko depressions, which contradicts Karczewski's (1976) conception of their glacigenic development.

THE AREA OF OBORNIKI AND ITS REFLECTION OF THE MORASKO IMPACT

Two metallic lumps discovered before World War II in the vicinity of Oborniki, and referred to as meteorites (unfortunately lost during the war), led the author to search for a meteorite fall in this area. Such an event was suggested by data from the analysis of the contents of the small magnetic fraction in the surface layers of the Morasko area, showing the trajectory of the fall from the north (compare Hurnik 1976) or, more probably, from the east-northeast (Muszyński *et al*. 2012). The time of the Morasko event can be estimated by study of the enrichment of peat profiles in fine-grained magnetic material (in this part of the Great Poland Lowland sedimentation has occurred for several thousand years – Ołtuszewski 1957; Tobolski 1991). Such a layer was found in a few peat profiles from the vicinity of Oborniki. Its radiocarbon ages range between 5.07 and 4.75±40 (cal. 5.72–5.32) years BP. The convergence of the above radiocarbon dates and the dosimetric datings from the Morasko meteorite fall, seems to be an important proof for Morasko impact time of the presumed meteorites from Oborniki, as well as for impact craters that originated at the same time.

RADIOCARBON AGES OF THE EARLY FILLING OF THE MORASKO CRATERS WITH ORGANIC SEDIMENT

The first dating of organic sediments from the Morasko craters was based on palynology (Tobolski 1976), and the results obtained ranged between 5.6 and 5.0 ka. Material collected from a small crater filled mainly with mineral deposits containing thin organic layers (manual coring by the author in crater E, in the northeastern part of the Morasko Meteorite Reserve) gave a radiocarbon date of ~3.4 ka for the deepest organic layer. It indirectly proved the young date of origin of this depression. Thanks to later cooperation with the GeoForschungsZentrum in Potsdam, Germany, cores from the two largest Morasko craters were obtained using professional equipment. Samples of organic material derived from the infilling (3–5 cm above the mineral bottom) provided the following dates: 4.49 ka (cal. 4.98–5.30) in the largest crater and 4.76 ka (cal. 5.32–5.60) in the second largest crater. These dates are consistent not only with those of Tobolski (1976), but also with the dosimetric dating of film age and peat enriched in metallic spherules from Oborniki.

It worth mentioning here the astonishing radiocarbon date for wood charcoal from the shell of a small, highly weathered meteorite, found in the immediate vicinity of the Morasko Meteorite Reserve. From the wood charcoal fragments a radiocarbon date of 1.94 ka was obtained (compare Stankowski 2010). This date is much younger than the date of the main Morasko meteorite shower, which suggests that there was more than one fall of iron meteorites in Morasko.

THE PRZEŁAZY METEORITE, INDIRECT FALL DATING

Some time before 1847, a meteorite weighing ~102 kg, was found near Przełazy in a location that was not clearly identified. An attempt to determine the impact site and to date the impact of the Przełazy meteorite was made by the author using indirect evidence, such as the content of metallic spherules in the peat profiles, as well as in the surface mineral deposits in the Przełazy area (Stankowski and Uścinowicz 2011). According to these data, the Przełazy meteorite fall trajectory was not from west to east as previously suggested (Bartoschewitz and Szettel 2001; Karwowski 2004), but from northwest to southeast. The most likely impact site was in the present-day peat area directly southwest of Przełazy. Based on spherule content in peat profiles and in the mineral bottom of the peat, the impact should be dated between the Late Glacial and the Holocene, probably the early Holocene (11,000–9,000 years BP).

Another theoretically possible, albeit doubtful, time of the event could be the time interval 3–2 ka, or least likely 0.5–0.8 ka. Both are very unlikely. The dating results of the Przełazy meteorite fall clearly differ from that of the Morasko main fall event. Morasko and Przełazy should be considered as independent falls of extraterrestrial material, albeit their mineralogical and geochemical features, as well as those of the Jankowo Dolne meteorite, are very similar (Karwowski 2004).

It should be added that the existing concept of a gradual descent trajectory of metallic fragments over a huge area – Przełazy, Morasko, Jankowo Dolne, even including Tabarz in Germany (Bartoschewitz and Szettel 2001; Muszyński *et al.* 2012; Czajka 2013) is impossible to accept .

Time	Spherule content in the peat profiles	Particular sites of meteorite fall
last 300 years	very intensive and widespread increase of spherule content – anthropogenic and potential extraterrestrial ones	
~700 years BP	weak and not widespread increase in spherule content	equivalent of the so-called 'Great Poland Bolide'
3000–2000 years BP	distinct increase in spherule content in the peat profiles and in superficial mineral sediments	potential second Morasko meteorite fall (?)
~5000 years BP	increase in spherule content in the peat profiles, very distinct in the Szlaban site (N of Oborniki Wlkp.)	the main Morasko meteorite fall
Late Glacial/Holocene boundary	distinct increase in spherule content in the peat profile near Przełazy and in the superficial mineral sediments in its neighbourhood	Przełazy meteorite fall (?)

Table 2. Metallic spherules in the peat profiles as an indicator of meteorite falls and flights

METALLIC SPHERULE CONTENT IN THE PEAT PROFILES – POTENTIAL INDICATOR OF METEORITE FALLS

The peat profiles in the Great Poland Lowland that date from ~ 13,000 BP (13 ka) contain individual spherules throughout the profile. However, some particular layers are enriched in metallic dust. Peat layers with an increased amount of spherules may be treated as indicators of extraterrestrial material accompanying meteorite falls or flights. A synthetic summary of this phenomenon is shown in Table 2, with the interpretation of events in the Great Poland Lowland

SUMMARY

In west-central Poland (Great Poland Lowland) several meteorite falls have been reported. Some of them are reflected in historical documents or iconography and could have been incorporated in heraldry and even in architecture. However, the most important is the presence of well-documented metallic extraterrestrial material in Morasko/Oborniki, Przełazy and Jankowo Dolne. Iron meteorites in Morasko have been discovered for over 100 years but in the last decade many iron meteorites of different sizes have been found there, including large specimens with weights of 164 and 261 kg; all of these meteorites have comprehensive mineralogical and geochemical records (compare Muszyński *et.al.* 2012). Morasko is one of only a few places on the Earth where, in addition to the extraterrestrial material, the impact effects exist in the form of craters. The meteorite shower in Morasko occurred approximately 5 ka ago. The Przełazy meteorite appears to come from another fall, a few thousands of years older than Morasko, and most likely left no effect in the form of craters. Further detailed research is necessary to substantiate an alleged fall of possible metallic meteorites in Morasko in the time interval ~3–2 ka.

Interpretations of a huge meteor scatter belonging to one cosmic event (from Tabarz in Germany to Jankowo Dolne, and even from Przełazy to Jankowo Dolne) seem unlikely in the light of the spatial extent of the known extensive falls, for example, Pułtusk (1868), Łowicz (1935), or Sikhote-Alin (1947), Goa-Guen (Górna Wolta 1960), Julin in China (1979), and finally the last event in Chelyabinsk (2013).

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