in press: Documenta naturae (München) (5)

Meteorite Fall at Mbale, Eastern Uganda, 14-8-1992, a preliminary report ← Fettest

by Erasmus BARIFAJO, Craig HAMPTON, Thomas ~~Schlueter~~ SCHLUETER ← fett

Department of Geology, Makerere University, Kampala ← fett

~~&~~ and

Hans BETLEM ← fett

Dutch Meteor Society and Leiden Observatory, Leiden, The Netherlands ← fett

Abstract: ..

see page 9!

## 1 Introduction

On August 14th, 1992, at approximately 15.40 hours East African time, the residents of Mbale town and its outskirts were thrown into panic when they heard several loud explosions in the sky. These explosions preceded the fall of meteoritic material around the town. As much of the material fell on the township (where due to international scientific agreement for the naming of a meteorite also the next postoffice is based) it seems appropriate to call this the Mbale meteorite. This work reports on preliminary fieldwork and research carried out in the first few weeks following the fall. in name after the nearest post office

It has been estimated that some 500 tons of rock debris enter the earth's atmosphere each day (SHORT 1975), but of this perhaps only 150 meteorites larger than 10 cm reach continental land masses each year. Of these perhaps only 5-10 are recovered annually. The proportion recovered in Africa is less than elsewhere comprising only approximately 5% of the total of recovered meteorites. SASSOON (1967) put the number at 104 African meteorites comprising of 65 stones, 3 stoney-irons and 35 irons. Considering that many of these are finds (not seen to fall) rather than falls, this shows the fall of the Mbale meteorite is extremely significant.

There are two well documented meteorites from Uganda (ROBERTS 1947). The first fell at Maziba, near Kabale, SW Uganda in September 1942. It has been analysed and classified as a group L chondritre. The second fell on Soroti, E Uganda (approximately 100 km NE of Mbale) in September 1945. This fall was observed and well documented. The Soroti meteorite is an iron rich type but anomalous so falls in no category (WASSON 1974). The lack of other meteorite data for Uganda emphasizes the great value of the Mbale meteorite to indigenous research.

## 2 Location

Mbale town is located in the E of Uganda between latitudes 01$^{0}$04'00" and 01$^{0}$06'30" N and longitudes 34~~0~~09'45" and 34~~0~~12'30" E, about 250 km E of Kampala. It stands on the W flank of Mount Elgon at an elevation of 1100-1250 m. Much of the area around the town is under agriculture but other areas to the 34°09'45" 34°12'30"

Abstand der Zeilen möglichst eng (1)

SW are swampy and the slopes of Mt. Elgon are wooded making the recovery of meteorite fragments difficult.

## 3 The Fall of the Mbale Meteorite

A survey of the area a few days after the meteorite fell included locating meteorite fragments, inspecting crater sites and interviewing local people to obtain eye witness accounts. The general concensus of opinion was that there were three loud explosions in the sky, followed by several smaller ones. The explosions were followed by a whistling sound which gave way to a cracking noise just prior to stones falling in various parts of the town. The loud explosions were presumably supersonic shock-wave bangs caused by the compression of air around the meteorite. Other explosions and cracking noises are caused by the meteorite breaking up in mid-air. The break up is caused by air pressure stress forces and by the differential heating between the outer layers and the interior. The outer layers are extremely hot due to frictional heating which in the case of the Mbale meteorite forms a black glassy ablation crust. The interiors remain at the very cold temperatures the meteorite experienced in outer space. A policeman who touched a sample soon after impact described the rock as feeling cold.

In addition to the noises, eye-witnesses saw a trail of smoke. most of them said that it moved approximately from N to S. One recalled the trail being in the opposite direction. The discrepancy may be in part due to fragments moving out in all directions after explosions as the meteorite breaks up in mid-air. In fact the people of Doko claimed one explosion occurred directly overhead and observed smaller trails scattering in all directions from the main N-S trail.

No eye witnesses claimed to have seen a fireball (meteor) which usually accompanies such a fall, however this is often easier to observe further away from the impact. But it was not yet possible to gather reports from further N (e. g. Soroti, Gulu) where a fireball may have been observed.

## 4 Strewn Field of the Mbale Meteorite

Fig. 1 shows the distribution of fragments of the meteorite that were collected or reported. Unfortunuately some people thought the stones had economic value or were useful in the treatment of AIDS, and hence removed them. Thus many of the larger fragments were subsequently artificially broken up for distribution and transportation. For these fragments estimates for their weight were made combining eye witness reports and measurements of the craters produced. In all ~~about 45~~ impact localities were found, almost 50 the majority without fragments. Fortunuately nobody was injured, although one small boy claimed to have been hit by a tiny fragment. Not much damage to property occurred but one fragment broke through the factory roof at the African Textile Mill in the industrial estate, forming a small hole in the cement floor (Plate 1, Fig. 3) and another broke through the roof of the Mbale Railway Station respectively (Plate 1, Fig. 4).

The smallest particles (3-100 g) were collected between Kamonkoli and Mugiti to the ENE of Mbale. Intermediate size fragments (0.1-3.5 kg) were collected from Doko, Namatala, the industrial area, near the railway station and the N part of the prison. The heaviest (3-20 kg) of the falls were found to the S of the town from the prison through Malukhu to Shibinikho village. Other areas to the N (Nakaloke, Kolonyi and Namunsi) and to the E (Gangama) were visited but reported no falls. Most craters range from a few cm to about 1 m in diameter and from 3-50 cm in depth.

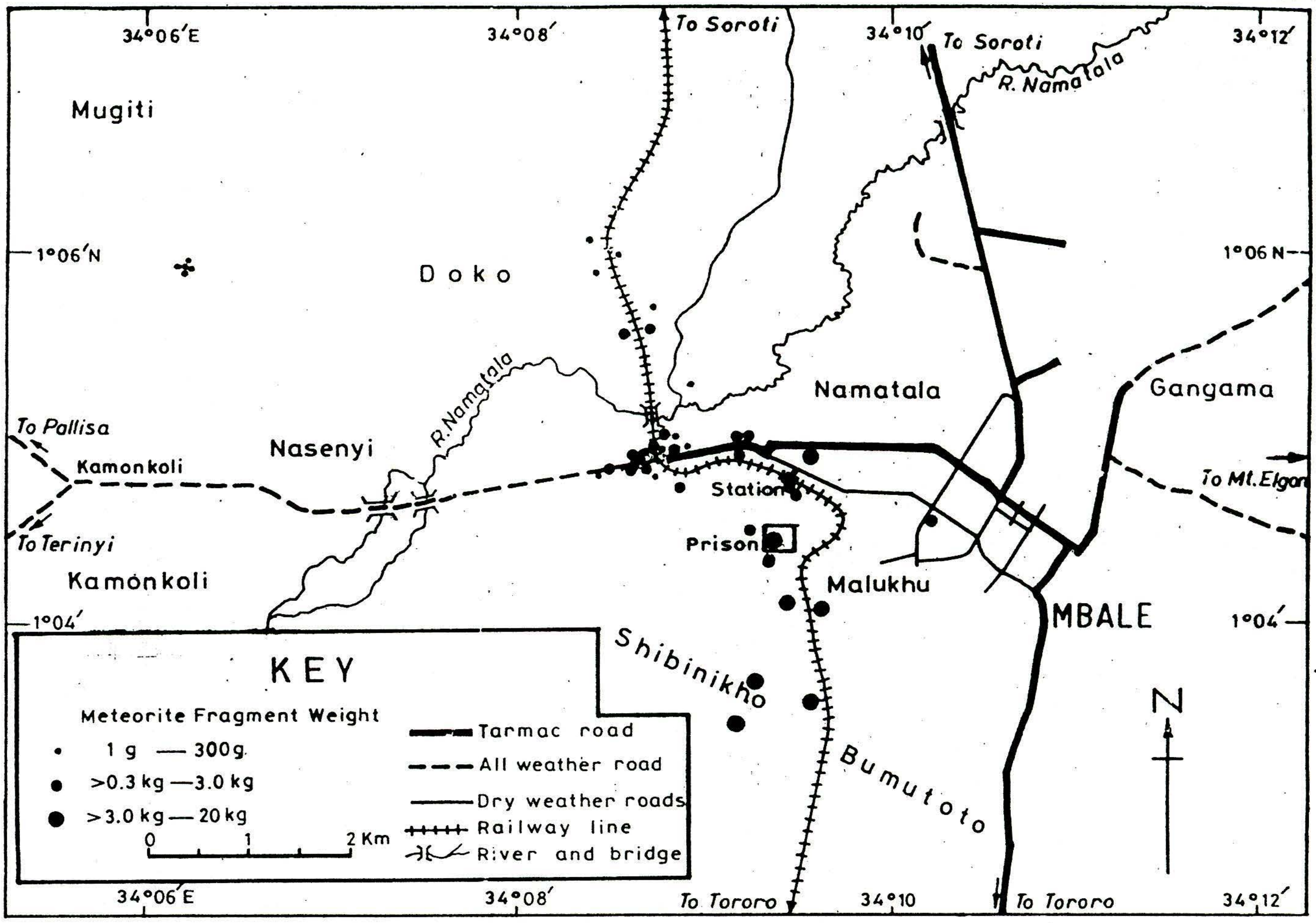


Fig. 1: Map of Mbale and surrounding areas, showing the strewn field. The meteorite was moving from the NW to the SW where the largest gragments fell. /f

The strewn field covers an area from Mugiti to Shibinikho-Bumutoto villages of total area of about 20 $km^2$. During a meteorite fall the small stones fall first followed by the heavier ones. This means the trajectory of the meteorite wasfrom the NW to the the SE. Obviously some areas of the stream field were inaccessible or covered by dense vegetation. However, about 100 kg of material was recovered. We estimate that accounts possibly for around 20 % of the material that fell around Mbale. /w

But the original size of the meteorite was much larger and a lot burnt up as it entered the atmosphere at around 80 km. It would have travelled at about 15-20 km/sec. Over Doko the altitude was 5-10 km, by then the velocity and mass would be much less just prior to the explosion that caused disintegration.

## 5 Morphology of the Meteorite

### 5.1 Macroscopic Aspects

Many of the fragments have angular glassy black ~~interiors~~ exteriors (Fig. 2, Plate 1, Fig. 5 and 6). The black crust is thin (1-2 mm thick), has ridges and furrows, and this represents the melting or ablation crust. Inside the samples are fresh with a pale grey-green colour. The rock is fine grained (grain size <0.5 mm), however silvery metallic grains can easily be seen. These metallic grains turn red-brown on exposure to moisture indicating the presence of iron. The presence of iron was further indicated by using a magnet which could attract cm size chips. Application of HCl caused the liberation of $H_2S$. This is probably due to the presence of troilite (FeS). As troilite is non-magnetic and bronze in colour, it seems likely that iron also exists in another phase, most likely a Fe-Ni alloy. Black glassy veins about 1 mm thick, similar to the ablation crust dissect some samples. Such veins are common in meteorites (KRINOV 1960). The density of the Mbale meteorite was found to be 3.53 $g/cm^3$. KRINOV (1960) found most chondrites having an average density of 3.54 $g/cm^3$ and in a table compiled by WASSON (1974) the density of the Mbale meteorite would lie in group L or E.

## 5.2 Thin Section Study

In thin section the main mineral is olivine, probably forsterite (colourless, 2V, around $90^0$ (+ve)). Some of the larger olivine grains (around 0.25 mm) are subhedral, but all grains are cracked and fragmented. Much of the groundmass is olivine. There are also a few chondrules (around 1 mm diameter). They are composed principally of either radiating grated prismatic crystals of orthopyroxene. The orthopyroxene is colourless and lacks pleochroism, but the 2V around $70^0$ (-ve) indicates bronzite or possibly hypersthene. A few isolated phenocrysts of orthopyroxene occur outside the chondrules. The remaining 15-20 % of the rock is made up from opaques assumed to be Fe-Ni alloy and troilite. The opaque phase sometimes has olivine inclusions and shows iron staining in surrounding grains.

## 5.3 Classification

On the basis of the morphology, mineralogy, density and the presence of chondrules, the Mbale meteorite should be placed in group L using WASSON's (1974) classification system. The petrological type corresponds best to type 6 (namely, presence of orthopyroxene, absence of igneous glass, poorly defined chondrule, crystalline matrix). Despite the fact that not all the criteria relevant to classification have been determined so far, we would tentatively classify the Mbale meteorite as a group L6 chondrite. This is the most common type of meteorite.

## 6 Acknowledgements

We would like to thank Mr. J. BETLEM of Mt. Elgon Conservation Project who acted quickly to acquire samples and provided logistical support. We are also grateful to the local authorities (District Administration, Police, Army, Railways, Prisons and others) who allowed us to collect samples in the district. We should not forget the many residents of Mbale town and district who aided our investigations. Finally, thanks to the staff of Makerere University Geology Department, who aided us with advice, logistics, thin section preparation and map preparation.

## 7 References

KRINOV, E. L., 1960: Principles of meteoritics.-- 1-535, Pergamon Press, London, New York (tramslated from Russian).

ROBERTS, R. C., 1947: Meteorites in Uganda.-- Uganda J. 11 (1), 43-46.

SASSOON, H., 1967: Guide to Mbozi meteorite.-- Edit. by Dept. of Antiquities, Dar es Salaam, 1-7.

SHORT, N. M., 1975: Planetary Geology.-- 1-361, Prentice-Hall Inc.

WASSON, J. T., 1974: Meteorites.-- 1-316, Springer Verlag, Berlin.