Temporal and spatial distribution of meteorites falls in Africa

Fouad Khiri[1,2], Abderrahmane Ibhi[1] and Lahcen Ouknine[1]

[1] **Geoheritage and Geomaterials Laboratory, University of Ibn Zohr, Agadir, Morocco**
a.ibhi@uiz.ac.ma

[2] **Regional Center of Trades of Education and Training, Inzegane, Agadir, Morocco**
Fkhiri2009@gmail.com

158 meteorites falls were recorded during the period 1801–2014 in Africa. Their mass ranges from 150 g to 175 kg. The number of meteorites' falls is variable in time and in space. It continues to grow since 1801. More, this number seems to be cyclic since 1940. The average rate of falls is low in Africa with only 0.024 per million km^2 per year. This rate is high in countries, which exhibit croplands and sparse grasslands. Other factors are also involved in the spatial variation of those meteorites falls' recuperation: the population, the percentage of forest. Moreover, the African meteorites' falls as in the worldwide falls are dominated by chondrites (78%).

1 Introduction

Meteorites constitute a great source of information about the history of the solar system. For this, their collection is important for scientific study, especially the observed meteorites falls, which offer fresh material. However, many of these extraterrestrial rocks finish in difficult explorable areas (sea, forest, etc.), others are not observed during their fall. These may explain the low recovery rate of meteorite falls compared to the meteorite finds. In this note, we try by a statistical study, to characterize meteorite falls (that are meteorites seen when they fell from the sky and were collected) and to check their link with some geographic factors, namely population, population density, superficies, forest cover, in order to detect favorable conditions for their observation and collection. We chose the African continent that covers 20% of the emerged lands' surface with more than 30 million km² (FAO, 2002). This large area is supposed to host a large part of the flow of meteorites falls on Earth.

2 Temporal distribution

1800 is the date when meteorites were recognized as objects falling from the sky. Since this date, 158 observed meteorites falls were recorded. They are totaling a mass of 2145.4 kg. The oldest meteorite fall (L6) was in 1801 in Mauritius[1]. The most recent is an Eucrite fragment collected in 2014 at the Tighert region in southeastern Morocco (Ibhi, 2014). Almost all the classes are represented in the collection of meteorites falls in Africa during the study period (*Table 1*).

They include 123 chondrites dominated by the ordinary, 17 achondrites, 8 irons but no stony-iron. 10 of these meteorites' falls are not classified or uncertain. However, three Martian meteorites are present in this collection

Table 1 – Types, numbers and percentages of meteorites falls in Africa.

Types			Number	%
Chondrites 78%	Carbonaceous		6	4
	Ordinary	H	46	29
		L	50	32
		LL	16	10
	Rumuruti		1	1
	Enstatite		4	3
Achondrites 11%	Martian		3	2
	Aubrites		2	1
	Urelites		1	1
	Angrites		0	0
	HED		11	7
	Lunary		0	0
Stony-Iron			0	0
Iron			8	5
Unclassified			10	6
			158	100

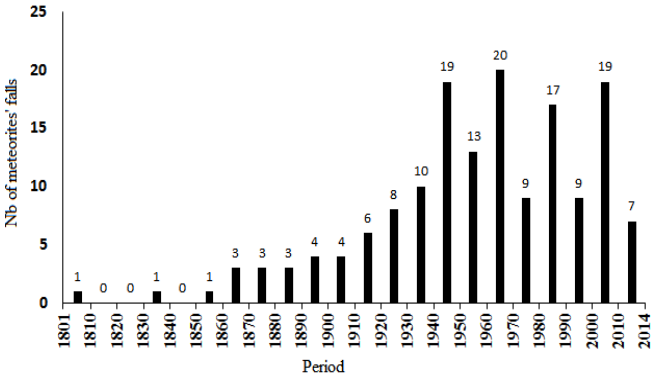

Figure 1 – Evolution of meteorites falls' number in Africa between 1801 and 2014.

[1] Meteoritical bulletin database (2014). The meteoritical society. http://www.lpi.usra.edu/meteor.

(Nakhla of Egypt, Tissint of Morocco and Zagami of Nigeria), but no lunar meteorite (Khiri and Ibhi, 2015).

Furthermore, the quantitative study of meteorites falls in Africa reveals varied temporal distribution. The falls spreading rate has increased from 0.017 meteorites / 10^6 km^2 every 10 years (3 falls only in the continent) during the period 1800–1860, to 0.17 falls / 10^6 km^2 every 10 years (41 falls) between 1860 and 1940. This rate is timed into 3 (0.50 falls / 10^6 km^2 / 10 years) during the period 1940–2014 which recorded 113 falls. That is, 71% of collection in the study period (*Figure 1*). Moreover, distribution over a period of 10 years has identified a certain periodicity of these falls.

3 Spatial distribution

The projection of African meteorites' falls coordinates (using ArcGIS application) shows an heterogeneous distribution. These seem to be concentrated outside of deserts and rainforest precisely in countries with large and well distributed population (*Figure 2*).

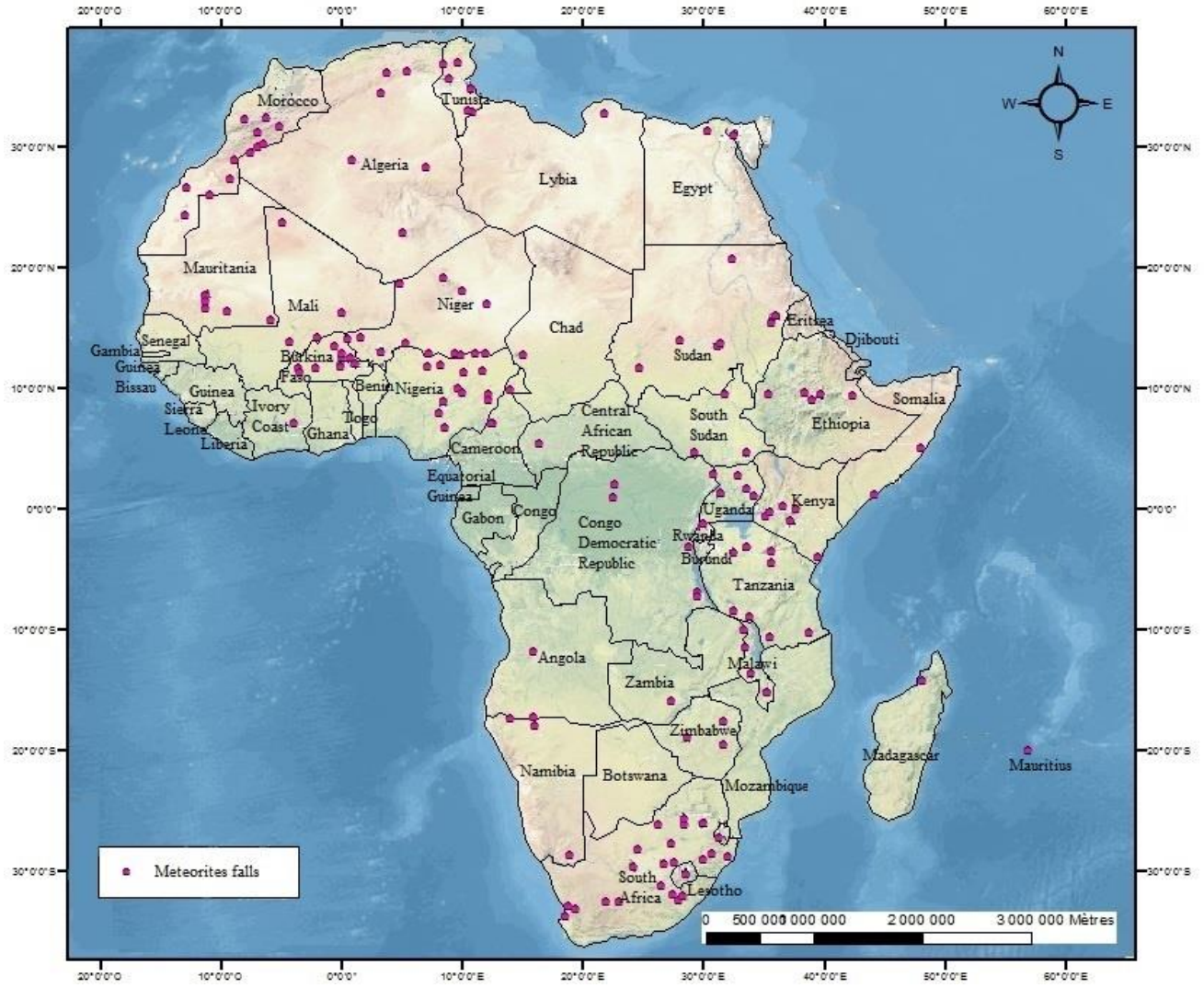

Figure 2 – The distribution of meteorites' falls in Africa.

The principal components' analysis applied on 6 geographic variables and the 57 African countries shows that the meteorites falls number in many of these countries, like Nigeria and South Africa, increases with population and superficies; but it is opposed to the percentage of forest cover. More, there is no clear correlation between the recovery of falls and the population density.

4 Discussion and conclusion

The abundance of chondritic falls in Africa (78%) is similar to that observed worldwide representing 86.2% of falls (Bevan, 1992). The rate of meteorites' falls in Africa ($0.024/10^6$ km^2/year) is twice higher than that known in Australia ($0.011/10^6$ km^2/year). Yet, it is still low. This may be due to the lack of culture and education about meteorites. Almost all the countries with considerable area and well distributed population have a relatively large spreading rate of meteorites falls. But, their rate is low or null in many of African countries, for example in Egypt, Libya, and Chad despite their large superficies. Egypt presents only 2 falls with population condensed on the banks of the Nile. This confirms that the spreading rate of meteorites falls is linked to an uniformed distribution of the inhabitants (Rasmussen, 1991). Moreover, the countries hosting dense rainforest over a large area have seen little or no recuperated falls. Therefore, the uneven distribution of the population and the forest cover make it difficult for the falls to be observed or discovered.

References

Bevan A. W. R. (1992). "Australian meteorites". *Records of the Australian Museum Supplement*, **15**, 1–27.

FAO (2002). Evaluation des ressources forestières mondiales 2000. Etude FAO forêts, 140. Rome.

Ibhi A. (2014). "Tighert: A New Eucrite Meteorite Fall from Morocco". In Rault J.-L. and Roggemans P., editors, *Proceedings of the International Meteor Conference*, Giron, France, 18–21 September 2014. IMO, pages 173–175.

Khiri F. and Ibhi A. (2015). "African meteorites falls: some statistics". *European Planetary Science Congress 2015*. Vol. **10** # 80.

Rasmussen K. L. (1991). "Historical accretionary events from 700 BC to AD 1850 – A 1050 year periodicity". *Quarterly Journal of the Royal Astronomical Society*, **31**, 95–108.

Abderrahmane Ibhi (at right) in discussion with *Paul Roggemans* (left) and *Kerem Çubuk* (middle) during a coffee break on 28 August 2015 (Photo by *Axel Haas*).