THE IMPACT CRATERING RECORD OF AFRICA: AN UPDATED INVENTORY OF PROVEN, PROBABLE, POSSIBLE, AND DISCREDITED IMPACT STRUCTURES ON THE AFRICAN CONTINENT. S. Master[1] & W. U. Reimold[1]. [1]Impact Cratering Research Group, Dept. of Geology, University of the Witwatersrand, P. Bag 3, Wits 2050, Johannesburg, Republic of South Africa. (065sha@cosmos.wits.ac.za, 065wur@cosmos.wits.ac.)

Introduction: The last inventory of African impact craters, by Koeberl (1994) [1], showed 15 proven impact structures on the continent. Since then, a number of new proven and probable impact structures have been discovered in Africa. Several new possible impact structures, which are still awaiting investigation, have been found using remote sensing techniques (Landsat imagery, aerial photography, airborne and satellite radar, and airborne geophysics). Some of the new discoveries include large impact structures that may have a bearing on the terrestrial record of mass extinctions. New studies have shown that some structures, previously suggested to be of impact origin, must now be discounted as impact structures. We have compiled an updated inventory (to the year 2000) of confirmed, probable, possible and discredited impact structures in Africa (Table 1).

Confirmed Impact Structures: In addition to the 15 impact structures known in 1995 [1], three new structures (Gweni-Fada [2], Morokweng [5] and Kgagodi [4]) have been proven on the basis of the occurrence of shock metamorphic effects diagnostic of impact processes. The 70-80 km-diameter Morokweng structure [5] is dated at 145 Ma, which coincides with the terminal Jurassic mass extinction and the Jurassic-Cretaceous boundary.

Probable Impact Structures: In addition to the well-known 750 m Temimichat Ghallaman crater in Mauritania [1], two newly discovered structures, Sinamwenda [6-8] and Velingara [9], are strong contenders as probable impact structures (which have many attributes of impact structures, but in which diagnostic shock features have not yet been recognised). Sinamwenda, in Zimbabwe, is only 220 m in diameter [7], and although the overturned crater rim shows multiply-striated joint surfaces and microbrecciation, TEM examination of the few examples of possible planar deformation features (PDF's) reported [7] show that they are deformation bands [25]. A possible iron meteorite with Widmanstätten lamellae was reported from near the crater [8], but this has not yet been confirmed. The 48 km-diameter multiring Velingara structure in Senegal and Gambia [9] is probably a buried complex impact structure, formed on Mid-Eocene carbonate rocks, and buried by Neogene continental sediments, in which a central uplift of metamorphic Neoproterozoic/ Paleozoic basement schists has been delineated by drilling and geophysical studies. This structure may be related to other Late Eocene impact structures (Chesapeake Bay, Popigai), or to the terminal Eocene mass extinction [9].

Possible Impact Structures: Numerous possible impact structures found with remote sensing techniques have not yet been investigated on the ground. The main reasons for this are remoteness and inaccessibility in deserts (El-Baz [12], Ntwetwe [18], Aorounga 2,3,4 [10]) or in dense tropical jungles (Kogo [13], Minkebe, Mekambo [17]). Some structures, though less remote, are inaccessible because of ongoing wars (Luizi [15]), or lack of infrastructure such as roads. Lack of funding is probably the main constraint in the investigation of possible impact structures in Africa. Other factors include restrictive policies imposed by governments and by private mining companies, and the legacies from past conflicts, such as minefields.

Discredited Structures: Several circular structures in the Sahara (Richat, Semisiyat, El Mouilah, Aflou, Foum Teguentour, Mazoula) have been discounted as impact structures [1]. The Bangui anomaly of the Central African Republic [19] is part of a continental-scale magnetic anomaly, and is not of impact origin [14,20]. No macroscopic or microscopic evidence of shock metamorphism has been found in the Bushveld Complex of South Africa [21]. The "Nyika Plateau structure" [22] was rediscovered, and shown to have formed by a mudslide, not a meteorite impact [23]. The "Meteor Strike" of Maputaland, South Africa, has also been discredited [24].

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Table 1: List of confirmed, probable and possible impact craters in Africa.

Name	Country	Latitude	Longitude	Diameter (km)	Age (Ma)	Ref.
Confirmed Impact Structures						
Amguid	Algeria	26°05'N	04°23'E	0.45	≤0.1	[1]
Aorounga	Chad	19°06'N	19°15'E	12.6	0.01	[1]
Aouelloul	Mauritania	20°15'N	12°41'W	0.36	3.1±0.3	[1]
B.P. Structure	Libya	25°19'N	24°20'E	2.8	<120	[1]
Bosumtwi	Ghana	06°32'N	01°25'W	10.5	1.1±0.2	[1]
Gweni-Fada	Chad	17°25'N	21°45'E	14	<345	[2]
Highbury	Zimbabwe	17°04'S	30°07'E	20	1034±13*	[3]
Kalkkop	South Africa	32°43'S	24°26'E	0.64	<1.8	[1]
Kgagodi	Botswana	22°29'S	27°35'E	3.5	<2000	[4]
Morokweng	South Africa	26°28'S	23°32'E	70-80	145±0.8	[5]
Oasis	Libya	24°35'N	24°24'E	11.5	<120	[1]
Ouarkziz	Algeria	29°00'N	07°33'W	3.5	<70	[1]
Roter Kamm	Namibia	27°46'S	16°18'E	2.5	3.7±0.3	[1]
Talemzane	Algeria	33°19'N	04°02'E	1.75	<3	[1]
Tenoumer	Mauritania	22°55'N	10°24'W	1.9	2.5±0.5	[1]
Tin Bider	Algeria	27°36'N	05°07'E	6	<70	[1]
Tswaing**	South Africa	25°24'S	28°05'E	1.13	0.2	[1]
Vredefort	South Africa	27°00'S	27°30'E	250->300	2023±4	[5]
Probable Impact Structures						
Sinamwenda	Zimbabwe	17°11.7'S	27°47.5'E	0.22	<220	[6-8]
Temimichat-Ghallaman	Mauritania	24°15'N	09°39'W	0.75		[1]
Velingara	Senegal/Gambia	13°0.2.2'N	14°07.7'W	48	>24, <42	[9]
Possible Structures, not yet fully investigated						
Aorounga 2,3,4	Chad	19°15'-19°30'N	19°15'-19°30'E	11.6,12,11.7		[10]
Bangweulu	Zambia	11°32.3'S	30°08.3'E	150	<620	[11]
El-Baz	Egypt	24°12'N	26°24'E	4		[12]
Kogo	Equat. Guinea	01°11'N	10°01'E	4.67	>145	[13,14]
Luizi	D.R. Congo	10°10'S	27°55'E	12.6	<620	[15]
Lukanga Swamp	Zambia	14°24'S	27°45'E	52	<450	[16]
Mekambo	Gabon/Congo	00°55.7'N	13°40.4'E	50	>2100, <2800	[17]
Minkebe	Gabon	01°21.2'N	12°24.5'E	90	>2100, <2800	[17]
Ntwetwe	Botswana	20°55'S	24°50'E	7	<200	[18]

* to be confirmed **formerly known as Pretoria Saltpan