SEARCHING FOR THE ALH84001 "SMOKING GUN" (PARENT CRATER). J. W. Rice, Jr., Department of Geography, Arizona State University, Box 870104, Tempe, AZ, 85287-0104, USA, (asjwr@asuvm.inre.asu.edu).

Martian Meteorite ALH84001 is an ancient, coarse-grained, igneous rock, namely a cumulate orthopyroxenite, with a crystallization age of 4.56 Ga [Mittlefehldt, 1994]. Treiman [1995] states that ALH84001is plutonic not volcanic, unlike the other Martian meteorites. This sample records evidence of two shock metamorphic events (impacts), separated by thermal metamorphism and low temperature chemical alteration events [Treiman, 1995]. The first impact event shattered the basement rock where ALH84001 was located. Following the initial impact event, ALH84001 underwent alteration and endured a second shock event, possibly from the meteorite impact that eventually ejected the rock from Mars.

The cosmic ray exposure age of ALH84001 is 16 Ma, this date records the meteorite's time spent in space before impacting upon Earth. ALH84001 landed in the icefields of Antarctica 13,000 years ago and was subsequently collected in 1984 at the Allan Hills, Far Western Icefield.

Therefore, based on ALH84001's significant age (4.5 Ga) and history of multiple shock events (crater impacts) it seems quite reasonable to assume that the rock formed in an ancient region (Noachian Age) of the Martian surface, namely the cratered highlands. The focus of this paper is to locate candidate parent craters for the Martian meteorite ALH84001 based upon extensive photogeologic analysis of 1:2,000,000 scale photomosaic base maps MC-3 through MC-30 (consisting of 91 quadrangles) and individual Viking Orbiter images which cover the appropriate geologic terrains.

The following geomorphic and geologic criteria were established to locate potential parent craters for ALH84001. The impact crater that ejected this meteorite was formed 16 million years ago, based on the cosmic ray exposure age. This would result in a very fresh and young crater. Young craters on Mars are defined as having sharp, complete, well preserved rims, steep walls, deep and rough floors, and extensive well preserved ejecta blankets superposed on surrounding materials. Candidate parent craters of this young age (16 Ma) should have no impacts superposed on their crater and/or ejecta materials and should have experienced litttle or no modification (eolian erosion, crater wall slumping). The parent source crater should preferably be emplaced upon Noachian Age geologic materials.

The following criteria were established to locate candidate parent craters for ALH84001:

1.Identification of a young, pristine crater defined by sharp, well preserved rims, steep walls, deep and rough floors, and extensive well preserved ejecta blankets. The crater is 16 Ma old based on the cosmic ray exposure age of ALH84001. This would result in a very fresh crater. Therefore, there should be no impacts superposed on crater and ejecta materials of the parent crater.

2.Crater emplacement upon Noachian Age geologic materials.

3.Crater diameters range from 10 - 30 km; no larger craters fit the morphologic criteria of young craters.

The leading candidate source crater, positioned at 5°S; 146°W, is located in the Memnonia Region of Mars near the planet's equator. The crater is 10 km (6.2 miles) in diameter and displays an oblique ejecta blanket, which indicates that the impact occurred at an angle to the surface. This oblique impact would have facilitated the ejection of material off the Martian surface and into space. This region of Mars contains numerous valleys and canyons where water once flowed from the southern cratered highlands, of Terra Sirenum, to the lowland volcanic plains, of Amazonis Planitia, billions of years ago. The largest channel (65 km long, 2.5 km wide, and 300 meters deep) in the region is named Abus Vallis.

REFERENCES:

Mittlefehldt,Meteoritics, 29, 214-21, 1994.
Treiman, Meteoritics, 30, 294-302, 1995.

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Source Crater	Latitude degrees	Longitude degrees	Diameter (km)	Resolution m/pixel	VO Frame Number	Geologic Unit(s)
1	5 S	146 W	10 km	48 m/p	455S13	Nplr
2	37 S	74 W	25 X 9 km	254 m/p	606A47	Npl_2
3	19 N	349 W	12 km	241 m/p	831A27	Npl_2
4	51 S	2 W	30 km	242 m/p	093A25	Npl_1
5	37 S	19.5 W	20 km	231 m/p	084A05	Nplr; Npl_1
6	19 N	338 W	20 km	161 m/p	868A07	Npl_2; Hr
7	53 S	8 W	20 km	242 m/p	093A23	Npl_1
8	65 S	186 W	15 X 5 km	152 m/p	479B51	Npl_1
9	24 S	165 W	20 km	270 m/p	635A94	Npl_1
10	31 S	158 W	20 X 14 km	245 m/p	637A37	Npl_1
11	58 S	81 W	17 X 11 km	132 m/p	521B71	Npld; Npl_2
12	25 S	319 W	18 X 10 km	179 m/p	547A13	Npl_1
13	20 S	315 W	15 km	223 m/p	620A06	Npld
14	32 S	110 W	17 km	214 m/p	603A10	Npl_1
15	10 S	357 W	17 km	239 m/p	615A55	Npld
16	6.5 S	3 W	12 km	333 m/p	689A07	Npl_2
17	64 S	148 W	30 km	145 m/p	516B31	Hpl_3
18	25 S	164 W	20 km	267 m/p	635A92	Npl_1, Hr
19	8 S	321 W	30 km	249 m/p	618A35	Npld