



The Space Congress® Proceedings

2001 (38th) A Space Odyssey - The Next 50 Years

May 2nd, 2:00 PM

Paper Session II-B - Lunar and Martian Paleontology

Doug D. Shull

Follow this and additional works at: <http://commons.erau.edu/space-congress-proceedings>

Scholarly Commons Citation

Doug D. Shull, "Paper Session II-B - Lunar and Martian Paleontology" (May 2, 2001). *The Space Congress® Proceedings*. Paper 15.
<http://commons.erau.edu/space-congress-proceedings/proceedings-2001-38th/may-2-2001/15>

This Event is brought to you for free and open access by the Conferences at ERAU Scholarly Commons. It has been accepted for inclusion in The Space Congress® Proceedings by an authorized administrator of ERAU Scholarly Commons. For more information, please contact commons@erau.edu.

EMBRY-RIDDLE
Aeronautical University™
SCHOLARLY COMMONS

Lunar and Martian Paleontology

by

Douglas D. Shull

20 Feb 2001

for

2001 Space Congress

Introduction

The discovery of organic material imbedded in the Martian Meteorite Alan Hills (AH) 84001 in 1996 changed science. Many people now consider the possibility that microbial life existed on or may still exist on the planet Mars. NASA, The Jet Propulsion Laboratory (JPL), and the European Space Agency (ESA) are considering packages and experiments for future Mars robotic missions to detect the presence of microbial life near the surface of Mars. We should pursue these worthy efforts. However, the surfaces of Mars and the Moon may very well hold evidence of life, both microbial and macroscopic, from Earth's past. I will discuss how past meteor strikes causing large extinction events can positively affect today's science.

Understanding Meteors and Meteor Impacts

The history of knowledge about meteors has undergone quite a change in the last few decades. Almost all scientists once thought asteroids from the asteroid belt never became Earth crossers, and that the craters on the moon were of volcanic origin. We now know of hundreds of Earth crossing asteroids, and almost every crater on the Moon is from an impact. Many scientists thought some craters on the Earth, now known to be impact craters due to telltale signs of shocked quartz, iridium, etc., were of volcanic origin. *1* The discovery of meteorites originating from Mars has changed a lot of thinking.

Meteors from Mars

A meteor impact on Mars sent AH84001 into solar orbit, and eventually to the Antarctic. Due to the lower gravity and reduced or nonexistent atmosphere on Mars and the Moon, meteors striking these bodies with sufficient force will eject some debris into solar orbit or Earth orbit, respectively.

Scientists once thought meteor impacts pulverized any ejecta to dust. In the mid-1980s, two University of Arizona scientists, Jay Melosh and Ann Vickery, developed a new theory of crater formation based on painstaking mathematical analysis of the behavior of shock waves near the surface of a target planet. The pair proposed the existence of a relatively shallow zone around the edges of the impact site in which surface rocks would be shielded from the crushing force of the shock waves and instead would be kicked upward at great speed; the larger the impact, the larger the ejected fragments. In fact, the scientists suggested, the shielding at the surface would be so effective that microorganisms in the Martian soil, if they exist, might be hurled uninjured into space. 2

Due to the Earth's higher gravity and relatively thick atmosphere, large stony iron or metallic meteors are required to eject material from the Earth into Earth orbit, where it may end up on the Moon, or into solar orbit, where it may end up on Mars. Cratering and ejecta are acted on differently by the violent forces of formation.

In principle, some aspects of the cratering process itself can also be constrained. High-speed, lightly shocked ejecta may be launched by shock wave interference or by vapor-plume entrainment. The cratering physics that launches ejecta at speeds above the escape velocity may differ greatly from the physics of the excavation flow that creates the impact crater. 3

Meteors from Earth

The possibility of material ejected from Venus or Earth is seriously entertained. Certainly, if it is at all possible to eject material out and away from the atmosphere of Venus,

which is 90 times thicker than Earth's, then the ejection of material away from Earth is much more likely.

The identification of meteorites from the moon and Mars has allowed scientists to consider more seriously the possibility of finding meteorites from Venus or Earth. The larger escape velocities of these planets will only be overcome by a tiny fraction of the ejecta, and then only in larger and rarer impact events. The difficulty of successful ejections is heightened by the presence of the massive atmospheres of Earth and Venus, because such atmospheres effectively screen out all crater-producing impactors below a certain threshold size, and launched fragments have to plow back through the atmosphere. It is conceivable that ejecta could escape out through the atmospheric 'tunnel' left by the impactor's entry. 4

Before Shoemaker-Levy (S-L) 9 impacted Jupiter some scientists felt its atmosphere would simply swallow up the pieces. Any doubt that meteors or comets striking the Earth would do cataclysmic destruction were erased starting on 16 Jul 1994 when the first of 21 pieces of the Shoemaker-Levy 9 began to strike Jupiter. Before leaving scars nearly the size of the Earth, the medium size pieces blasted plumes of Jupiter's atmosphere thousands of miles above its cloud tops. 5

Mass Extinctions

We know the Earth's geologic past is punctuated by with periods of mass extinction, and the latest evidence in the geologic record shows large meteor impacts were responsible. These mass extinctions occurred 590, 360, 160, 90, 65, 38, 10, and 2 million years ago. 6 Although no solid evidence exists at this time, I intend to work in the future with a few scientists and engineers to model the effects of a meteor strike, to see if the possibility exists that significant amounts of plant and animal matter were blasted into space during these events.

The Effects of a Massive Impact

Clark Chapman of the University of Arizona mentioned that some meteors impact at 42 km/sec (26 mi/sec). The meteor that created Meteor Crater in Arizona impacted at 16 km/sec (10 mi/sec). It was 30 to 50 meters (100 to 150 ft) in diameter and weighed nearly 300,000 tons. It cut through the Earth's atmosphere like a baseball flying through cobwebs. 7 This meteor left a crater 200 meters (600 feet) deep and 1200 meters (4000 feet) across. If something that size left a hole like that, imagine the power of a meteor impact similar to the K-T Meteor of 65 million years ago.

The thin veil of Earth's atmosphere would offer little resistance to a six-mile-wide, trillion-ton asteroid: Diving toward the ocean at 55,000 miles per hour—seventy times the speed of sound—the massive object would blast the air aside, heating the surrounding atmosphere to about 50,000 degrees Fahrenheit. Ionized oxygen and nitrogen would form nitrogen oxide compounds, progenitors of acid rain. All of this would happen in a fraction of a second.

As the front edge of the huge projectile struck the ocean, impact shocks would instantaneously raise the temperature of the seawater to 100,000 degrees, flash boiling eight trillion tons of brine. Vast jets of vapor would rocket skyward while the asteroid, only three-quarters of a second from seabed impact, would begin a kind of death rattle as rebounding shocks raced through its core.

When the monster made contact with the ocean bed, 100 million megatons of energy would be released, eventually shaking the entire planet. With a stupendous crack of thunder and a blinding flash of light, 100 trillion tons of ocean bedrock and vaporized meteorite and 130 billion trillion gallons of seawater would shoot outward from the impact site at 25,000 miles per hour. In the passage of only three minutes, an expanding fireball of steam and molten ejecta

would level any city within a distance of 1,200 miles, scouring the terrain down to bedrock. ⁸ Traveling 1200 miles in three minutes works out to an average speed of about 6.5 mi/sec (10.4 km/sec), allowing ejecta angling out of the atmosphere to go into a long orbit.

Conclusion

Though out Earth's long history, large meteors causing extinction events have struck our planet. Each one of these events has blasted large amounts of ejecta around the globe. The projected speeds of ejecta and atmospheric shock waves are certainly stupendous. The observed effects of the pieces of Comet SL-9 creating massive explosive plumes above Jupiter, where the atmosphere and gravity are far more expansive than Earth's, proved that small objects at high speeds can have cataclysmic effects on a target world. Many no longer doubt the destructive effects of a large meteor to our civilization and our lives.

I am not attempting to merely repeat what we know about past large meteor impacts and what effects future large meteor strikes could have on our world. Certainly, far more intelligent and educated individuals have already done extensive work on these subjects. I have drawn on their works for this paper.

Many have heard the reason we explore the solar system is to better understand the Earth. I wish to add an additional positive to the reasons for traveling to Mars and returning to the Moon. The possibility that freeze dried biological material, blasted from the Earth in the past, is now intermingled with regolith and polar ice deposits on the Moon and Mars. Although subjected to micro-meteors, cosmic rays, and solar radiation, none of this material has undergone fossilization or biologic decomposition.

The future discovery of this material would revolutionize biology, especially paleontology. Scientists could have in their hands the preserved biochemistry of life from many of the past extinction events on Earth. The value of prehistoric plant and animal fragments (especially chunks of dinosaur bones) would certainly exceed that of the rarest meteorites.

Again, what I can calculate or discover is far exceeded by the many fine minds here in the U. S. and around the world. If these people think the possibility exists, we should work on how to detect this sparse material on the vastness of Mars and the Moon. Some might say this material has spent countless millions of years on these worlds, so what is the hurry? To that I would say, "What are we waiting for!?"

Endnotes

1. National Geographic Video, "ASTEROIDS, DEADLY IMPACT", NGT, Inc. c 1997. ISBN 0-7922-5206-3
2. Fallow, Alan (ed.). *Comets, Asteroids, and Meteorites*. Time-Life Books, 1992. Pgs 112 & 113.
3. Gladman, Brett J., et al. "The Exchange of Impact Ejecta Between Terrestrial Planets." *Science*, 8 March 1996, page 1387.
4. Gladman, Brett J., et al. "The Exchange of Impact Ejecta Between Terrestrial Planets." *Science*, 8 March 1996, page 1391.
5. Same as 1.
6. Same as 2. Pages 118 & 119.
7. (The Cosmic Travelers Series, Sudden Impact: Meteors, Vol. II, c 1997 Paradise Productions, Inc.)
8. Same as 2. Pages 125 & 127.

Contributor

A special thanks to Dan Berlinut of Suntree for helping me understand the science of modeling meteor impacts.