METEORS AS THE CAUSE OF OUR GLACIER PERIODS

By JAMES F. PORTER, '95

THE planetesimal theory of the origin of our solar system presupposes that the sun at one time, before the existence of the planets, expanded or shot out waves of its substance as far as the orbit of Neptune, the outermost planet. This expansion was caused either by the great tidal action induced by a passing star that just missed hitting the sun or by an atomic explosion of some kind similar to what seems to occur about a dozen times each year among the stars of our universe, that is, our spiral nebula, producing what is known as a new star or nova. All this stray sun matter is next supposed to consolidate, first into small balls, and then through collision and attraction into larger and larger masses until finally a few of the largest masses will have gathered to themselves most of the smaller masses that lay in their paths or orbits. The final outcome is the present status of our solar system, that is, eight planets and their moons and a thousand or more asteroids all of which are still growing very slowly by sweeping up the small left-over meteoritic material that comes from time to time within their gravitational influence. It has been estimated that as many as one hundred million minute meteorites enter our atmosphere every day.

Our moon, of course, is one of the masses that was built up in this way and it has been cited by some of the advocates of this theory as an exceptional example displaying visibly on its face the truth of this hypothesis, but strange to say, most astronomers, until recently, have rejected the moon as offering any such proof and have maintained that its surface markings could be explained only as the result of vulcanism in one form or another.

However, now that the meteoritic or bolide origin of the moon is at last accepted by many astronomers, the revolutionary implications that seem to follow the adoption of this theory when applied to the earth become pertinent subjects for careful consideration. It may possibly develop that a few of these are so fundamental and far-reaching in their nature, that a complete rearrangement of the data of geology will be found necessary before all the facts can be brought again into a harmonious whole. It is not the object of this paper, however, to do more than outline a few of these implications, stressing especially those that may have a bearing on the cause of the many ice sheets that have left their traces in the geologic record.

Upon the shoulders of some early astronomer must probably be placed the responsibility of having decided too hastily that the scarred face of the moon represented a multitude of extinct volcanoes. Evidently the association of ring-shaped mountains with extensive lava beds was considered by him and his followers all sufficient and conclusive evidence which need not be again disturbed. What an interesting commentary on the resistance of the human mind to new and revolutionary ideas if it finally develops that this faulty deduction is largely responsible, not only for the credence given in the past to such complicated and involved hypotheses advanced to account for the various glacier periods, as the changing axis of the spinning earth or the periodic accumulation of carbon dioxide in the atmosphere, but also for the misinterpretation of much geological data.

Other things being equal it would seem to be the most reasonable, as well as the most conservative policy, to adopt the simpler explanation in every case where we have a choice. It is therefore one of my objects here to try and place the bolide theory, with all that it implies, in the class of the least complicated of the various hypotheses.

Granting the meteoritic origin of the moon, it would almost seem to be a corollary that the earth originated in the same way.

The objection raised by the opponents of the bolide theory that the surface of the earth shows none of the characteristic scars seen on the moon may, I believe, be modified on further investigation. So much of the surface of the earth is covered by water and the land has been so altered by weathering and by vegetation that a duplication of the surface of the moon can hardly be expected here. Nevertheless, with good contour maps, a pair of compasses, and a friendly eye on the lookout for fragments of circular scars, such evidence is not lacking.

The best example perhaps is the circle suggested by the island of Porto Rico, the Lesser Antilles and the coast of Venezuela. Here some eighteen or twenty islands are found to fall on the circumference of a circle of about five hundred and thirty miles in diameter. If these islands were stretched out in a straight line extending over a thousand miles, the fact would certainly be considered remarkable, but is not the extremely delicate arrangement of a perfect arc of this length even more significant? How then can we disregard this interesting phenomenon or attribute it to a slowly shrinking earth?

By using the compasses to outline and continue the suggestion of curves along our coasts, many arcs of circles are to be found which cannot be wholly explained on the theory of chance.

Fragments of arcs may be traced in this way on our Pacific and Atlantic coasts, in the Mediterranean and along the coasts of Africa and Asia.

It has been suggested that the Red Sea represents the furrow of a great bolide that struck the earth tangentially and finally after having also scooped out the Adriatic, came to rest under northern Italy where it piled up the Alps by pushing the stratified rock back horizontally some 70 miles.

It does not seem to me merely accidental that the arc established by the curve of part of the western coast of Portugal and Spain when continued should touch the Azores or that the curved deep water line of our coast north and east from Cape Hatteras and extending east of Cape Cod, should, on being continued, strike the Bermuda Islands, and that the geology of the Atlantic States is more or less consistent with the catastrophic requirements of a bolide striking the earth somewhere in this region at the end of the Carboniferous Age. Dana in describing the geologic turmoil of this region says, "It was due to a lateral pressure, the folding having taken place under a lateral or pushing movement. It was accompanied by great heat, which melted and consolidated the rocks, changed their condition, drove the volatile gases out of the bituminous coal and changed it into anthracite, in some places altered it to graphite, as if it had been passed through a furnace. . . . The extermination of life which took place at this time was one of the most extensive in all geological history." . . . To explain all this, as produced by the slow shrinkage of a cooling earth, as is generally done, surely does not seem quite adequate. On the other hand if it is explained as due to a short period of great diastrophic change the bolide theory supplies the cause. According to the bolide theory the earth is growing more than it is shrinking. This is shown by the great overflows of granite and basalt such as cover much of New England and eastern Canada, by dykes, which are filled cracks, and by such a great open crack as the Grand Canyon of the Colorado River. Here the land does not slope towards the Canyon as would be expected if it were excavated by the river but away from the rims showing that the river probably made use of a crack and only helped in cutting the deep channel.

The immediate effect of a bolide hundreds of miles in diameter crashing into the earth would be the conversion of hundreds of thousands of square miles, where it sank below the surface, into a caldron of melted rock. Whenever water from the ocean entered this caldron

it would at once be transformed into immense clouds of steam. These clouds would rise quickly and drift away in a northeasterly direction. They would be swept to the north to take the place of the cold air rushing south towards the rising column of hot air over the caldron and they would then be carried to the east because of the greater speed of revolution of the atmosphere in equatorial than in more northern latitudes. Just as the Gulf Stream is now carried in a northeasterly direction to Europe and may possibly indicate both by its temperature [1] and its color, the final stages of a cooling caldron in the Caribbean Sea, the blue color like that of glacier lakes being due to pulverized limestone, so the supersaturated air would be carried in the same general direction and would eventually be precipitated as rain or snow depending upon the amount of cold air encountered. The rising hot air over the caldron would necessarily have to be balanced by an increase in the returning cold air, thus causing a precipitation of much of this moisture as snow rather than as rain. This process continuing let us say between Portugal and the Azores until the caldron was cooled would cause a perpetual snowstorm for an extended period over what is now northwestern Europe and would amply account for the formation there of a great glacier. In like manner an asteroid landing to the west of California might be responsible for the glacier of the last ice age and incidentally for the recent elevation of southwestern United States.

In this way, I believe, the more or less restricted area involved in each period of glaciation is explained, since the phenomenal snowfall would occur in northern latitudes only in a northeasterly direction from the caldron, while in the southern hemisphere the direction would be to the southeast. The recent expeditions of the American Museum of National History to the Gobi Desert and Mongolia discovered no evidence of glaciation there which seems to indicate that there was no extensive glaciation in northern Asia. This might be accounted for by the great extent of intervening land in a southwesterly direction before reaching the Atlantic Ocean.

If the number of large scars on the face of the moon visible to us is used as a criterion of the frequency of collisions here, then the bolide theory also accounts for the repeated waves of glaciers increasing in number as we retreat in time. It further accounts for the necessarily great and continued supply of moisture in the air and for the sudden

[1] As the Gulf Stream emerges from the Gulf of Mexico it has a temperature of 84 degrees in summer, higher than that of the ocean at the Equator.

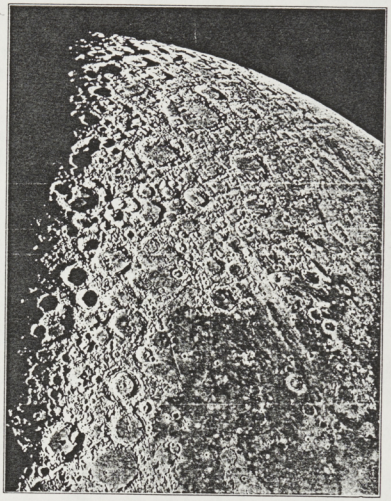


FIGURE I

Photograph of southern portion of the moon taken by the largest telescope in the world at the Mt. Wilson Observatory, California. Tycho is the scar a little above the center of the photograph with terraced inside walls and a small central mountain, the remnant of the meteor that made it.

The sides of the central mountains are never terraced, showing that they floated on and settled with the receding lava that once filled the cups and therefore are not volcanic cones.

arrival of the snow in such overwhelming quantities as to trap and bury animals like the mammoth far removed from any subsequent feeding ground.

A bolide striking the earth near enough to the poles to produce warm currents in the ocean would explain the former tropical polar climate as evidenced by the Arctic and Antarctic coal measures. In like manner the humidity of the Carboniferous Age and the catastrophic changes in the fauna and flora of succeeding geological ages may be attributed directly to great meteors.

Presumably on striking the earth an asteroid would throw up a circle of mountains with their broken strata sloping away from the caldron. Beyond the ring of mountains there might be an extensive region elevated by the heavy molten bolide flowing under, lifting and floating the lighter sedimentary rock. Eventually this raised plateau would be changed into secondary mountain ranges by the cooling and shrinking of the supporting underlying basalt. Thus accounting for the frequently limited area of shrinkage.

Against these conclusions the opponents of the bolide theory quote the physicists who have calculated that the energy produced by our collision with an asteroid of the size indicated would be sufficient to liquify, if not to vaporize, the entire earth. Nevertheless scars of great size are to be seen on the moon and there is no evidence of its ever having been wholly reduced to a liquid state. The old scars around Tycho, a lunar mountain (Fig. 1), seem to be covered deeply with dust, and the radiations from many other lunar scars, besides those from Tycho, only faintly seen in this photograph, can be adequately accounted for only as dust streaks. In calculations of this kind it is necessary to make use of a certain number of assumptions, any one of which may have been given undue weight. There can of course be no exact knowledge as to what takes place in so great a cataclysm involving perhaps even the transmutation of elements.

Because of the existence of sedimentary rock on the earth and its absence on the moon, for sedimentary rock is only formed under water, scars here cannot be expected to be entirely like those of the moon. On the earth the striking meteor would force its way under the ighter stratified rock, the calcium carbonate of this rock perhaps assisting in the complete reduction of the meteor by acting as a fusing agent or flux, while on the moon, the terraces, sometimes to be seen on the inside of the scars, indicate that many of the cups were once filled to their brims with melted rock, while the central cone-shaped

mountains, frequently seen, may represent the unreduced remnants of the denser or overtaken meteors.

For various reasons some geologists have advanced the theory that all the continents were at one time connected. It seems probable for example that the dinosaurs roamed freely over the entire earth. Prof. Wegener has suggested that the American continents broke off from Europe and Africa due to the continual tidal action in the surface rock, and floating on the heavy underlying glassy basalt, migrated to their present positions. This westerly drift of the continents is supposed to be still in progress. Professor Daly, in "Our Mobile Earth," gives the cause of this movement as a sliding down hill of the "domed" continental blocks. According to the bolide theory, on the other hand, the oceans mark the coalesced scars of the larger asteroids, all the connecting land having been blotted out. The absence of sedimentary rock under the oceans and the presence there of basalt is explained in this way. A drift of the continents, however, would perhaps help to account for the evident obliteration or distortion of the larger scars.

Another possible confirmation of the bolide theory is to be found in the surface coating of red clay occurring so frequently in unglaciated country where it has not been scraped off by the glaciers. We know that the yellow clays turn red when baked to make brick. In like manner ferruginous rock, pulverized and heated by a meteor would be scattered as red dust, like the dust streaks on the moon, and thus form the irregular beds of red clay. Red clay is found in large areas under the ocean showing that its color cannot be explained as due to slow oxidation.

Whenever a bolide struck the moon undoubtedly great quantities of gas were generated but since it has no atmosphere or water it is supposed not to have been able to hold gases against the very great attraction of the earth. It would seem to be a reasonable inference then that in acquiring all the lunar atmosphere and water, the earth may have suffered some serious climatic disturbances. At any rate we have here a sufficient explanation of the origin of our deep atmosphere and of our over supply of water, for these are the combined products of all the gases generated by bolide collisions both here and on the moon.

One of the serious obstacles confronting the bolide theory may be seen by comparing it with the carefully worked out theory of Sir George Darwin explaining the moon as born from the earth by the centrifugal force of a too rapidly spinning liquid sphere. This is accepted quite generally in England although supported by not a single example in nature, while the bolide theory which has substantiating evidence is given only meager encouragement from astronomers and none at all from geologists.

In conclusion, I think it will be seen that the bolide theory as applied to the earth at least offers simplified explanations for the following mooted questions:

The cause of periods of glaciation.

The frequent advance and retreat of ice sheets.

The sudden change of climate evidenced by the frozen bodies of the mammoth.

The cause of the termination of each geological age.

The tropical climate at the poles.

The isolation of the American continents.

The presence of basalt instead of sedimentary rock under the oceans.

The blue color of the gulf stream and of the Mediterranean.

The origin and distribution of the red clays.

The origin of our atmosphere and of our hydrosphere.

In the May 11, 1928, number of *Science*, there appears a letter from George P. Merrill, of the United States National Museum, giving translations from Russian newspapers concerning the Siberian Meteorite of June 30, 1908. The following are a few extracts from this letter:

> The appearance at 7 o'clock in the morning on June 30, 1908, of a "fiery body" of unusual brightness, rolling across the sky out of the north east and falling down in the "taiga" between the Yenissei and Lena Rivers, north of the Railroad line, was observed by a great number of people, mostly the native inhabitants, living in the basins of these rivers.
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> The fall of the meteorite was instantly followed by a column of fire rising skyward, by the formation of the heavy black clouds, and by a most deafening, resounding noise far surpassing in its magnitude any thunderstorm or artillery cannonade. This was heard for hundreds of kilometers within a radius of the cities of Yenisseisk, Krasnoyarsk, Kansk, Nijneudinsk, and Kirensk on Lena.
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> A terrific air-wave was formed which pushed ahead everything that it met in its way. The water in all rivers, lakes and streams was raised up; people and animals were lifted by it and carried along.
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> . . . . . .
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> The immediate area is surrounded by high naked hills, deforested by the falling meteorite. All trees are still on the ground, their tops are spread out in fan-like fashion away from the central zone of the fall. Exceptions are noted only in the ravines or in the gorges and deep perpendicular valleys and also in a zone which can be considered as the "interference" zone. And even in

these places the trees, in most cases, are scorched and, though still in upright position, they are all leafless and dead.

The zone where the heat effect of the meteorite is evident is considered by L. Kulik to be thirty kilometers in diameter and the area of the air-wave breaking the trees is fifty kilometers in diameter.