Jupiter - Gaseous or Solid?

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Abstract

Jupiter and Saturn are assumed to be 'gas giants' because of their low average densities, but this model is fraught with problems - the perminance of the Great Red Spot, the multiple zonal wind bands and their asymmetery relative to the equator, its temperature excess, not to mention the magnitude of the delayed 'main events' resulting from the larger Shoemaker-Levy 9 comet fragments. I propose a very simple solution to all of these in adequately explained mysteries - that all four giant planets comprise primarily methane gas hydrates - the natural form of water in the presence of abundant methane at high pressures and low temperatures. The vast amount of hydrogen in the giant planets is that which combined with heavier elements, primarily oxygen (H_2O), carbon (CH_4) and nitrogen (NH_3). Only this hydrogen remained in the solar nebula long enough to be accreted. The gas hydrate (clathrate) structure encapsulates all the heavy elements originally in the solar system. The giant planets accreted from ices over hundreds of millions of years, and are therefore very cold. Their frozen nature is obscured by the effects of relatively recent high-energy impacts. Hot gases still being released by slowly diminishing nuclear conflagrations in the impact craters produce their spots, rings, and multiple wind bands, which distribute the heat throughout their atmospheres. The ubiquitous water in the satellites and rings of the giant planets, point directly to their gas hydrate makeup.

The Failed Gas-Giant Hypothesis

The notion that Jupiter is a gaseous hydrogen planet originated with the work of Rupert Wildt at Gottengen in 1930, based on spectral 'combination bands' involving methane and ammonia. Because both compounds are easily broken down by sunlight, he suggested that the only way to restore them was through equilibrium with large amounts of hydrogen at high pressures. This hypothesis was bolstered by the *assumption* that any ice or rock at its core would be crushed to such high densities that the calculated average density and moment of inertia could not be satisfied (Stevenson 1981). A quantum mechanical model of a pure hydrogen planet proved unsuccessful, in that it required the ad hoc introduction of a ten to twenty earth-mass rocky-iron core in order to satisfy the measured gravitational moments. Although never stated, the addition of this core violated the assumption that core materials would be super-compressed. However, the notion that such a core would have been necessary in order to capture the hydrogen, has helped to justify its addition. The modified hydrogen model still predicts that the bulk of the interior outside the rocky-iron core comprises a liquid conductive state of hydrogen, which has never been reproduced in the laboratory. As a result, its equation of state, and thus the interior of Jupiter remains unknown to this day. In essence the theory of Jupiter has not evolved since Rupert Wildt's time.

Because Jupiter radiates 2.3 times the energy it receives from the Sun, its interior is assumed hot (25,000 K) (which is inconsistent with the presence of a rocky-iron core), in hydrodynamic equilibrium and its atmosphere adiabatic. These assumptions resulted in the prediction of three cloud layers, ammonia, ammonium sulfide, and water, touted in every textbook, but were not found by the Galileo atmospheric probe. Planetary scientists dismissed this non-observation, suggesting that the probe entered the atmosphere in a 'non-typical' region. The absence of a water cloud layer was consistent with the unexpectedly low proportion of water measured by the mass spectrometer. In an adiabatic atmosphere water could not remain in the hot interior when carbon-containing gases such as methane, are ubiquitous in the upper atmosphere. The paucity of water is all the more incomprehensible in light of the fact that Jupiter is surrounded with three giant water-ice bodies and some sixty smaller ones, as is Saturn, plus its vast rings of water. The fact that the giant planets have abundances of heavy elements much greater than in the Sun has been attributed to the influx of many solid planetesimals (Owen, T. et al.).

The hydrogen hypothesis is also inconsistent with the total amount of gaseous hydrogen in our solar system - now only a few percent of that needed to make all the giant planets, and with observations of young Sun-like stars, which reveal very little H_2 in their nebula (Zuckerman et al. 1995). The implied loss of hydrogen gas from the disks of young, sun-like stars, in only a few million years - long before the massive cores of the giant planets would have had time to form, has prompted a rash of models, attempting to force the rapid creation of giant planets by introducing unrealistic 'instabilities' (Boss, A.P. 2004).

The temperature excesses of Jupiter and Saturn, hypothesized to be due to the 'raining' of He through their putative conductive hydrogen interiors, are not consistent with the same He/H phase diagram (Fortney and Hubbard 2003). Jupiter's *multiple* zonal jets are inconsistent with a gaseous planet - requiring a frictional boundary layer beneath the atmosphere (Jones et al. 2003). Moreover, their latitudinal asymmetry precludes both solar and primordial driving sources. Also unexplained are the longevity of the GRS, and the fact that this 'storm' is an atmospheric high, which has remained at the same latitude for about 350 years, in spite of an enormous Coriolis 'force' resulting from the rapid rotation rate of Jupiter. Attempts to determine Jupiter's tidal Q (a measure of its tidal influence on its satellites), based on the energy dissipation of Io, resulted in a $Q_J = 4. X10^4$ and $Q_{Io} = 1$, both impossible values. The canonical Q for a gas giant is infinity and for a solid earth-like planet is 100. This has led Hubbard to suggest that Io must have an additional internal energy source. Indeed, others have proposed that the entire interior of Io might still be molten rock (Keszthelyi et al. 1999).

The Accretion of the Giant Planets

Since the 'gas giant' hypothesis is obviously incorrect, I propose a completely new explanation of the makeup and features of all four giant planets. That they comprise solid gas hydrate and their temperature excesses, spots, zonal winds, satellites and rings are due to recent impacts.

In the proposed scenario, all elements were driven from the inner solar system to the current orbit of Jupiter and beyond due to blow-offs or jets in the early solar nebula. The only hydrogen retained in the nascent solar system was that which combined chemically with heavier elements. Because oxygen is the third most plentiful element, most hydrogen was captured in the form of water but also with large concentrations of methane and ammonium. The heavy elements, in the form of dust particles, acted as catalysts on which primordial atomic hydrogen, H, became molecular hydrogen H_2, and subsequently water and ice. Thus each dust grain became the nucleus of a crystal which became incorporated into a `snowflake,' ensuring the complete incorporation of the heavy elements into the giant planets. The tendency of snowflakes to stick to one another made it possible for accretion to begin at the smallest scale - something that dust particles alone could never do. Thus there was a beautiful symbiotic relationship between the dust particles and the atomic hydrogen and oxygen that made possible the accretion of the giant planets, particularly Jupiter.

This process formed larger and larger fluffy, low density snowballs which coalesced until their gravity became a factor in the accretion process. Four massive proto-planets eventually dominated at the orbital radii of each current giant planet. They eventually formed rocky-iron cores from the refractory elements as the internal pressure and heat increased. But, due to their great orbital radii, the process of sweeping up the icy planetesimals from the entire orbit, moving at the same speed, slowed the accretion and minimized heat accumulation. Once the proto-giant-planets attained the size of the Earth, the accretion became primarily that of low density planetesimals approaching at less than escape velocity, melting in their primal atmospheres and falling as snow. Thus the bulk of the accretion was a slow, cold process. In the freezing, high pressure interior of the proto-giant-planets the water and methane molecules took on their natural form of gas hydrates or clathrates - cage-like structures of water molecules that are known to encapsulate many other atoms and molecules, the most common of which, on Earth, is methane.

Natural gas hydrates are solids that form from a combination of water and one or more hydrocarbon or non-hydrocarbon gases. In physical appearance, gas hydrates resemble packed snow or ice. But in a gas hydrate, the gas molecules are 'caged' within a crystal structure composed of water molecules. Sometimes gas hydrates are called "gas clathrates". Clathrates are substances in which molecules of one compound are completely "caged" within the crystal structure of another. Therefore, gas hydrates are one type of clathrate.

Per unit volume, gas hydrates contain a tremendous amount of gas. For example on Earth, 1 cubic meter of hydrate disassociates at atmospheric temperature and pressure to form 164 cubic meters of natural gas + 0.8 cubic meters of water (Kvenvolden, 1993). The natural gas component of gas hydrates is typically dominated by methane, but other natural gas components can also be incorporated into a hydrate.

Gas hydrates require high pressure and low temperatures, exactly the conditions within the giant planets. The 'foreign' molecules, such as methane, are essential for their formation. But the evidence suggests that this property also allowed the giant planets, particularly Jupiter, to capture most of the heavy elements in the nascent solar system in its interior. The presence of heavy elements is implied by early human observations of proto-Venus condensing from an enormous plasma cloud which rebounded from a highly energetic impact on Jupiter 6000 years ago. Recently, a wide range of heavy element spectra were observed some six minutes after the larger fragments of comet Shoemaker-Levy 9 impacted Jupiter's solid surface. The delay was due to the time required for the towering mushroom clouds to rise above the cloud-tops and become visible.

The density of Jupiter would only be 0.80 gm/cm^3 if it comprised pure gas hydrate, but assuming most of the heavy elements became incorporated in it, plus a small degree of compression in the deep interior, its actual average density, 1.3 gm/cm^3 makes complete sense. The fact that the average density of Saturn is 0.80 implies that it is almost pure methane clathrate - that is, Jupiter `grabbed' most of the heavy elements. This implies that in the nascent solar system, most of the elements were blown out to the radius of Jupiter and some of the less heavy elements beyond.

The ubiquitous presence of water in the satellites and rings associated with the giant planets is, in itself, convincing evidence of the gas hydrate composition of the primaries, as is the continuing presence of methane. The satellites and rings are produced by high energy impacts on the solid giants, vaporizing the gas hydrates, which freeze as water-ice in the rings or, if beyond the Roche limit, become incorporated into satellites. Each impact also releases a lesser mass of refractory material that has been encapsulated for billions of years in the gas hydrates. This explains the fact that the Galilean satellites are mixtures of rock and ice, as are the rings of Saturn. Dr. Linda Spilker, of NASA's Jet Propulsion Laboratory, Pasadena, CA, deputy project scientist for the Cassini-Huygens mission states. "What puzzles us is that the A and B rings are so clean and the Cassini Division between them appears so dirty. Some scientists have already proposed that the larger of the giant planet moons comprise gas hydrates (Kargel 2001), but they fail to recognize the same nature in the primaries.

The slow accretion of the giant planets is consistent with infrared observations of young sun-like stars, which indicate that their 'dust' discs last as long as 400 million years (Habing et al. 1999). This time scale is consistent with Hoyle's calculations of the accretion time of Neptune equal to 300 million years (Hoyle 1979, p.52). The 'dust' discs surrounding young Sun-like stars are primarily water ice but because of their low temperatures and consequently low vapor pressure of water, no characteristic infrared spectrum is present to identify it as such. High water concentration in dust disks of young stars is consistent with recent studies of Herbig Ae/Be stars, showing the inner portions of the discs are evaporated out to larger radii than expected (Monnier et al. 2005). In 2001, an amount of water 10,000 times all the oceans on Earth, was detected surrounding CW Leonis, a red giant, the temperature and radius of which is increasing (Melnick et al. 2001). I maintain that this is the result of melting the gas hydrate giants in orbit around it and the vaporization of their water.

Jupiter's Torch

Archaic texts from a number of cultures imply that a high energy ($>10^{40}$ ergs) impact occurred on Jupiter 6,000 years ago. This was the same impact from which proto-Venus was born, implying that Jupiter comprises a vast supply of heavy elements. The impact also ejected the mass from which the *cores* of the Galilean moons formed. They formed in their current spin-orbit relationships. The impact also initiated a long-lived nuclear conflagration in the crater which shot a jet of hot gases more than two million kilometers into space from the crater, gradually adding to the outer layers of the proto-Galilean moons with each rotation of Jupiter. The decreasing temperature and spreading of the jet with distance from Jupiter and its slowly declining intensity over six millennia are the reasons for the great differences in their compositions. Being more distant, Ganymede and Callisto cooled most rapidly and as a result comprise a mixture of water and refractory compounds, with the closer Ganymede the more differentiated. The temperature of Europa remained too high for any water to condense in the first few millennia after the impact. When the rocky core finally cooled, an entire ocean condensed onto it, much of which still remains liquid due to the residual heat in the core. Due to the intensity and longer exposure to the jet and the radiation field from Jupiter's hot *atmosphere*, Io has never cooled to the point that water could condense. Indeed, the residual heat of Io and Europa remain much greater than can be explained by tidal processes.

As the hot gases of the jet expanded and cooled, they condensed and froze, forming porous, low density hydrated bodies in the weightlessness of space. Their impacts on the warmer Ganymede produced craters with no relief, and slightly more relief on Callisto. But millions of these bodies, which were not captured by the Galilean moons, formed the main belt asteroids, many each day, throughout five millennia. Because they formed in the vicinity of Jupiter, their small proportions of iron and nickel retained remnant magnetic fields, which would not be the case if they were 'rubble piles.' Amalthea, has recently been found to be just such a porous body, with a density less than water (Anderson et al. 2005). Millions more such bodies remain unrecognized in the inner and outer solar system. Their orbits depend on the orientation of the impact crater (the jet), at 20 south latitude, relative to Jupiter's orbital velocity vector. Those given the highest velocities formed the Kuiper belt objects. Those with the lowest velocities went into highly eccentric orbits which eventually decay until they hit the surface of the Sun, and are the cause of sunspots and the resulting CMEs, which effect the climate of the Earth to this day. This is the reason that sunspots occur in eleven years cycles - close to the orbital period of Jupiter. Such high energy impacts and the resulting jets also provide a more pragmatic explanation of the finite inclinations and eccentricities of the giant planets (Tsiganis et al. 2005). Incidentally, the higher density composition of the Near Earth

Asteroids shows that they were ejected from a terrestrial planet and are not related to the main belt asteroids.

Jupiter's Slowing Rotation

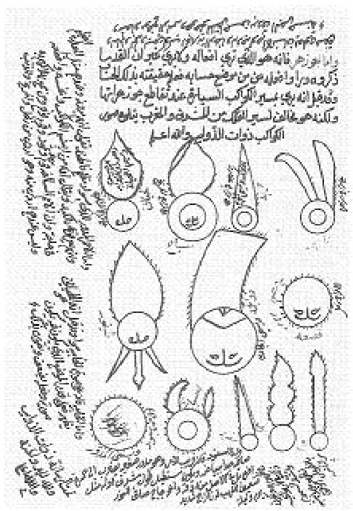

Figure 1 9th century AD draw-ing of jet extending from upper left body "having the nature of Jupiter"

Based on the estimated impact date at 6000 BP, the longevity of the jet is illustrated in a 9th century A.D. Arab document (Fig. 1), which shows it still extending more than a planetary diameter from Jupiter. Its current visible manifestation at Jupiter's cloud tops is the Great Red Spot (GRS). This southern latitude, clockwise rotation and temperature lower than the general cloud-cover, proves it is an atmospheric high, not a low as would be true if it were a 'storm.' The fact that it has remained at the same latitude over the 350 years it has been observed from Earth, proves it originates on a solid planet. The enormous total mass expelled by the jet in the last 6,000 years is implied in Fig. 2. This is a century-long record of what is thought to be a 'longitudinal drift' of the GRS, relative to an *assumed* constant rotation rate of Jupiter determined by the current periodicity of its magnetic field. This apparent drift is usually cited to show that the GRS is a storm. But I suggest, based on its monotonic nature from 1910 to 1938, that *this is a record of the 'tail end of the slowing of Jupiter's rotation due to the ejection of mass (angular momentum) by the jet*. After 1938 there followed a period of apparent acceleration, probably due to the sweeping up of mass left in its orbit and the settling of the atmosphere toward the surface. It has now settled at the rotation rate determined by magnetic field monitoring, about ten hours. Hoyle calculated a primordial rotation period of Jupiter of about one hour (Hoyle 1979 p.45-52). Assuming the slowing was due to the jet over the last 6,000 years, implies an energy dissipation of 10^{43} ergs, but earlier impacts are likely, out of which other terrestrial bodies, such as Mars, Earth and the Moon were born. The great longevity of the jet is the result of a gradually diminishing nuclear conflagration in the impact crater, the deuterium fuel for which is continuously being released from the methane gas hydrate surrounding the crater.

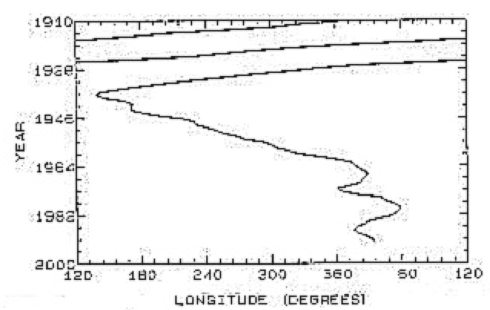

Figure 2 Longitudinal 'drift' of the GRS in

Evidence that the rotation of a giant planet could be slowing significantly has been provided by Voyager and Cassini measurements, which document a recent slowing of Saturn's rotation. This may be due to the mass ejected as the result of the impact which created the Great White Spot in 1990. Also, the 'spokes' photographed superimposed on Saturn's ring system by both Voyager probes and Cassini may have been material actually being ejected from the planet at the time as a result of an earlier impact.

Fast Dust Streams

Recent corroboration of the dying jet has been discovered by several research teams, in the form of fast dust streams from Jupiter. The earliest evidence of these was provided by the Ulysses probe in 1992. More recently, Galileo measured counts as large as 20,000 per/day. Cassini confirmed Jovian streams with velocities >200 km/s, *with a periodicity equal to Jupiter's rotation*. The source of these dust streams is indirectly linked to the GRS by a study of the NASA Galileo NIMS data, which reported 'a swirling jet' of 'water' being ejected from the center of the GRS (Taylor et al. 1998). This suggests that molecules still being ejected from the very center of the GRS form the fast dust streams, while the outward 'swirling' molecules maintain the unexpecyedly high temperature and density above the cloud tops and Jupiter's tenuous rings. The most convincing evidence for the crater is the GRS itself, an atmospheric high rising above the cloud tops, which has remained at the same latitude for over 350 years. The refractory material being released from the crater crystallizes and colors the GRS and the entire atmosphere, forming a thermal blanket, which distributes the heat throughout the atmosphere, while the body of Jupiter remains frozen.

Multiple Zonal Jets

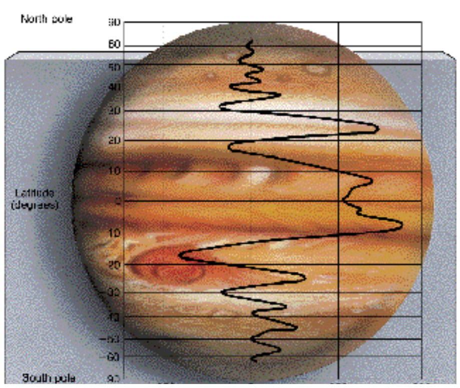

Figure 3 Jupiter wind velocity versus latitude showing asymmetry at GRS

The velocities of the zonal wind bands, which circle the planet in alternating directions, are plotted, superimposed on the image of Jupiter in Fig. 3. As with the trade winds on Earth, the presence of multiple jets *requires* a boundary layer at the bottom of the atmosphere to create 'Reynolds stresses' (friction), which is nonexistent in a gaseous or liquid planet (Jones et al. 2003). Their presence implies a solid planet a few thousand km below the cloud tops

The strong vorticity of the GRS arises from the powerful Coriolis 'force' of the rapidly rotating planet acting on the fast-rising gas from the crater. The rising column of hot gases is driven westward due to the rapid easterly rotation of Jupiter, providing a horizontal component to its motion, which imparts opposite vorticities to the adjacent zonal bands. These bands spawn secondary and tertiary bands further to the north and south. By this mechanism, heat is propagated throughout the atmosphere, creating the apparent temperature excess, disguising the source of the heat. The effect of the rising column accounts for the depth of the winds measured by the Galileo atmospheric probe. As can be seen in Fig. 3, the strongest westerly wind corresponds to the northern extreme of the GRS, which is rotating counter-clockwise. The asymmetry of the zonal wind bands relative to the equator and their depth in the atmosphere are not consistent with either a primordial or solar energy source.

The fact that 'spots' drive the winds to their north and south in opposite directions, was demonstrated on Saturn in 1990 (Beebe et al. 1992). See Fig. 4.

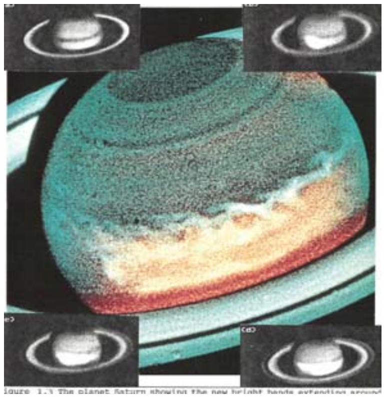

Figure 4. Wind bands north and south of Saturn's white spot propagate in opposite directions.

An earth-sized white spot suddenly appeared and over a period of days spawned a belt and a zone of white material moving in opposite directions to its north and south. Scientists were amazed that a 'storm' could develop so quickly. Because of their insistence on the 'gas giant' hypothesis, they cannot imagine that this was the result of an impact. The cause and effect of the impact and the resulting zonal jets is unquestionable. Although text books invariably allude to the protection from asteroids afforded by the giant planets, these very events are still not recognized.

Jupiter's putative three cloud layers are absent because the water, ammonia and sulfur are frozen in the body of Jupiter, precluding normal convection. The only oxygen in the atmosphere is that being released from the gas hydrates in the crater, some of which is consumed by the burning of methane and hydrogen. Over the last 6,000 years, the primordial atmosphere has been completely entrained in the jet and expelled into space. It has been replaced by gases and crystals, formed from material long frozen in the gas hydrate interior, which are being released from the burning crater. This is the source of the many heavy elements, including neon, argon, krypton, xenon and radiogenic argon 40 that has been accumulating for billions of years. Many heavy compounds crystallize as they rise and cool and are not detectable by infrared spectroscopy or the mass spectrometer.

Comet Shoemaker-Levy 9

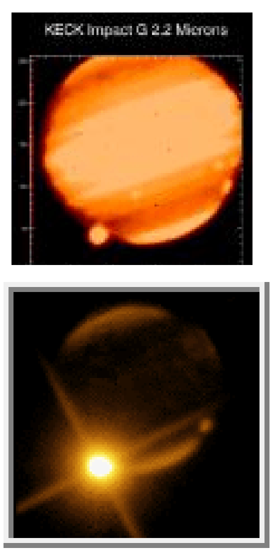

Figure 5. Fireball (top) Main Event (bottom)

Comet Shoemaker-Levy 9 provided a sequence of Jovian probes more powerful than any that mankind could produce. Comet fragments with diameters between a tenth and three kilometers impacted Jupiter within one Earth day and were observed by hundreds of Earth and space-based instruments. All the impacts produced fireballs, which rose 2,000 to 3,200 kilometers above the atmosphere (upper figure). The consensus is that they comprised super-heated atmospheric gases and some comet material, which was blown back out through the atmospheric tunnel 'bored' by the incoming bodies. But the more massive fragments, A, G, L, and K, produced intense infrared emissions and flares that lasted typically from 300 to 2,000 seconds after impact. These were many orders of magnitude more powerful than the fireballs - a fact reflected in the term 'main events.' Infrared images in Figs. 5 contrast the energies released by the fireball and main event from fragment G relative to the intensity of the normal radiation from the planet. The G fragment main event at its peak brightness radiated an energy equalling 15 percent of the total light from Jupiter and saturated the infrared instruments on Earth! It released approximately $4X10^{30}$ ergs.

To explain the delayed main events, scientist Mac Low proposed that they were caused by the atoms in the fireballs falling ballistically back onto the top of the atmosphere, even though they had cooled completely before they reentered. In order to reproduce the large delayed main events, mathematical models had to assume the mass of the fireball material to be some 0.3 times the mass of the impacting body and that it heated a mass of atmosphere equal to *80 times the mass of the impacting body.* This outlandish hypothesis was dismissed by Eugene Shoemaker, "Its nonsense," arguing that the returning material would not impart nearly enough energy to cause the main events.' The Mac Low hypothesis was quickly accepted by most planetary scientists because it saved the 'gas giant' hypothesis. These values, which were arbitrarily set to obtain the desired results, exceed the limits of credulity.

Spectroscopic observations of the larger S-L 9 comet impacts revealed the presence of a number of metallic elements never before observed on Jupiter. CS, Mg I, Mg II, Si I, Fe I, and Fe II, where I and II indicate singly and doubly ionized radicles. All had estimated masses in the range 3.6 to $8.1 \text{ X } 10^{13}$ grams, calculated from emission lines at the G impact site three hours after impact (Noll et al. 1995). Some observers measured no H_2O at all, but G. L. Bjoraker claimed he detected the equivalent of a one kilometer ball of ice. The estimated mass of S_2 alone was $2.5 \text{ X } 10^{13}$ grams, but based on its lifetime for photodissociation of a few hours, there could have been many orders of magnitude more. Some have suggested that the sulfur was ejected from the ammonium sulfide cloud layer predicted in the gas giant hypothesis, a claim that completely ignores the fact that this cloud layer was not found by the Galileo atmospheric probe. Observations of emission lines of the L and Q_1 sites at the time of the impact and one hour later revealed the spectra of multiple transitions of Na I, Fe I, Ca I, Li I, and K I (Roos-Serote et al. 1995).

Figure 6. The shock wave which propagated from the S-L 9 fragment G impact site.

Figure 6 shows the black G impact site with a gray crescent on the cloudtops in the 'blowback' direction. In addition a circle was observed by MacGregor et al that expanded from the time of impact at a velocity of about 4 km/sec, but appeared to be centered downrange of the impact point by 3,600 km (Deming & Harrington, 2001). This was a shock wave from the impact of the G fragment on the solid surface of Jupiter. The vertical impact angle of 45 degrees, the comet velocity of 60 km/sec plus a delay of one or two minutes for the appearance of the fireballs, suggests that the G fragment traversed an atmosphere some 2,500 km deep. Given the current hypothesis that Jupiter is a gaseous planet, there is no explanation for the expanding ring. Others have suggested that the ring is the result of the explosion of the comet fragment high in the atmosphere reflecting from the "thick water cloud" layer deeper in the atmosphere. This is yet another case illustrating the refusal to accept the absence of these putative cloud layers, revealed by the Galileo atmospheric probe.

The Shoemaker-Levy 9 data supports the hypothesis that the larger comet fragments penetrated the atmosphere and struck the solid gas hydrate surface of Jupiter, exploding with mega-megaton forces. Some of the impact energy and the heavy elements trapped in the frozen body of the planet managed to exit through the tunnel bored by the incoming bodies, thereby producing the dark crescents. In fact, the outer crescent edge for the G impact is ~13,000 km from the impact site, more than twice as far as a ballistic object can fly under gravity based on the estimated 3100 km altitude of its fireball (Harrington and Deming 2001). But most of the surface impact energy rose as a large mushroom cloud until it appeared near the surface impact site, some ten to twenty minutes later and included several flares, due to roiling clouds that momentarily exceeded the brightness of the entire planet (Shoemaker et al.). The expanding circles, also exclusive to the higher mass impact sites, were shock waves expanding from the surface impacts, providing further evidence that Jupiter has a solid surface perhaps as deep as 2500 km below the cloud tops.

Considerable discussion has focused on the origin of the different elements detected in emission. In the solid gas hydrate hypothesis these questions are mute because Jupiter comprises all the elements in the primordial solar system. Its atmosphere contains the same elements as the body of the planet because the nuclear conflagration in the crater from which the Great Red Spot originates, is continually carrying all these materials into the atmosphere, while the original atmosphere was completely entrained in the great jet and ejected from the planet in the last 6,000 years. The impacting bodies comprise the same material because they were ejected by impacts or comprise jet material that has condensed in space. The greatest mass of material was that ejected from the surface of the planet by the impacts of the larger bodies. They rose in gigantic mushroom clouds and were not observed until six or more minutes after the impacts when they finally reached the cloud tops and became visible to the observing instruments

Discussion

The evidence overwhelmingly favors the hypothesis that the 'gas giants' are cold, solid, methane gas hydrate bodies, comprised primarily of water, with Jupiter incorporating the bulk of the heavy elements originally in the solar nebula. Papers written decades ago, before most of the currently available data on Jupiter and Saturn was available, which argue that the giant planets cannot comprise water, were based on a lack of knowledge of high pressure physio-chemical changes, such as the formation of methane gas hydrates (Stevenson 1981), which is now available.

The effects of a recent impact (6000 BP) on Jupiter still disguise the origin of its temperature excess, the GRS and the multiple zonal wind bands, all of which are due to a continuing nuclear conflagration in the impact crater. Fed by the hydrogen (deuterium) being released from the gas hydrates surrounding the crater. The proposed paradigm implies that all four giant planets are basically the same composition, that is, water ice in the form of gas hydrates. This greatly simplifies the cosmogony of the solar system and explains all the features of the giant planets and the origin of their satellites.

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