Short communication
Validation of the Protoplanetary Theory of Solar System Formation

ABSTRACT

Kant's 1755 hypothesis on the origin of the sun and planets, as modified by Laplace, foreshadowed the modern protoplanetary theory of planet formation in which planets were thought to form at very high pressures from within giant gaseous protoplanets. The protoplanetary theory was popular in the 1940s and 1950s, but was abandoned and ignored by phenomenological model-makers in the early 1960s who favored the planetesimal theory, the idea that planets formed by the progressive accumulation of dust that had condensed at very low pressures. Here, I validated the protoplanetary theory by:

- Thermodynamic considerations;
- Observations of internal magnetic field generation;
- Observations of Mercury; and,
- Observations of Earth's behavior.

Although the planetesimal theory did not account for solar system formation, some of its elements added a veneer of oxidized material to the outer portions of Earth, especially oxidized iron which is critical for the development of life.

Keywords: georeactor, Mercury, planetary magnetic fields, Protoplanetary, Whole-Earth Decompression Dynamics.

1. INTRODUCTION

In 1755, Kant [1] set forth a hypothesis on the origin of the sun and planets that was modified by Laplace [2] four decades later. Laplace's nebula hypothesis was the forerunner of the modern protoplanetary theory of solar system formation in which planets were thought to form at very high pressures from within giant gaseous protoplanets. The protoplanetary theory attracted scientific attention in the 1940s and 1950s [3-5], but was abandoned and ignored by phenomenological model-makers in the early 1960s who favored the planetesimal theory [6-9], the idea that planets formed by the progressive accumulation of dust that had condensed at very low pressures.

The primordial matter from which planets and other objects in the solar system formed, as compelling evidence indicates [10-17], had a well-defined composition that is yet manifest in the solar photosphere. Figure 1 shows the similarity in relative abundance of less-volatile elements in the solar photosphere and in two chondrite meteorites that possess strikingly different states of oxidation.

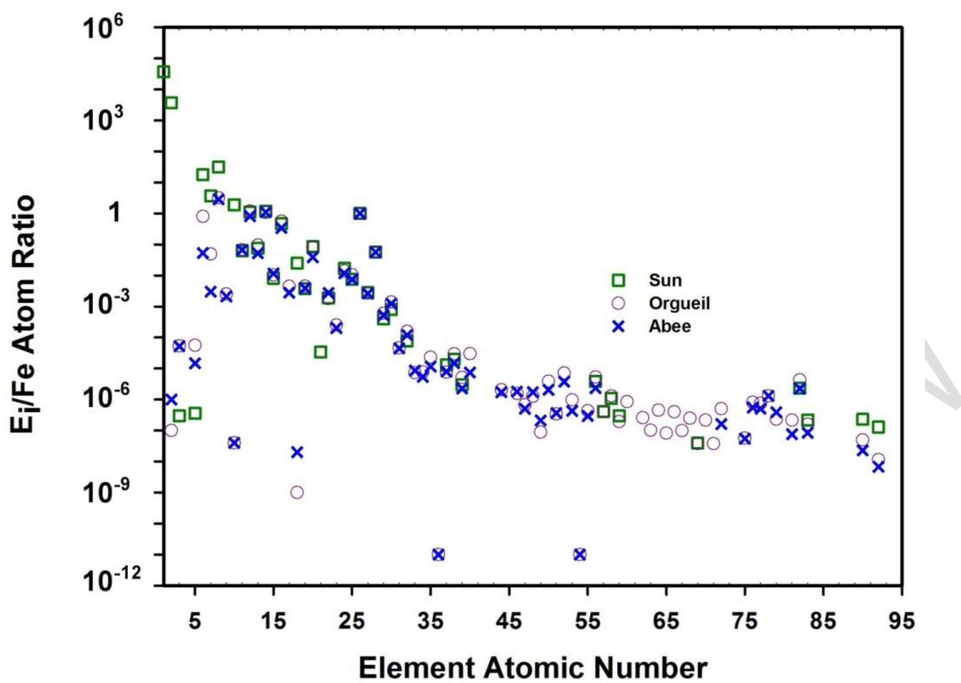

Figure 1. Comparison of relative element atom-abundances, normalized to iron, in the sun and in the Orgueil carbonaceous chondrite and in the Abee enstatite chondrite. From [10].

Thermodynamic considerations which involve the intensive variables X-T-P, i.e. composition-temperature-pressure, are independent of the size of the system or the amount of matter present [18]. As the solar system formed from well-defined primordial matter, thermodynamic considerations of the protoplanetary theory and of the planetesimal theory must differ solely in their respective T-P domain. Early considerations of the protoplanetary theory invoked high-pressures >1 atm whereas models based upon planetesimal theory invoked low-pressures <0.001 atm.

The purpose of this brief communication is to show that the composition of Earth's interior is directly related to high-pressure condensation of matter from a gas the composition of the sun's photosphere, concomitantly justifying and validating the theoretical protoplanetary origin of the solar system. Further supporting evidence is presented, specifically related to planet Mercury, the occurrence of internally generated magnetic fields in planets and large moons, and the geological and geodynamic behavior of Earth.

2. VALIDATION OF THE PROTOPLANETARY THEORY BY THERMODYNAMIC CONSIDERATIONS

In 1944, Eucken [3] published a scientific article entitled "Physikalisch-chemische Betrachtungen ueber die frueheste Entwicklungsgeschichte der Erde" which translates as "Physico-Chemical Considerations about the Earliest Development History of the Earth". From thermodynamic considerations, Eucken investigated condensation from primordial matter, namely, a gas of the composition of the sun's photosphere at pressures from 1 to 10^4 atm. Eucken showed that the first primordial condensate from a cooling gas of solar composition at high-pressures would be molten iron at high temperatures, followed at lower temperatures by silicate minerals, and, if the condensation was complete, at still lower temperatures, by gases and ices as evident in Jupiter.

From these thermodynamic considerations, Eucken [3] proposed Earth's formation from within a giant gaseous protoplanet that began with liquid iron metal raining out forming its core, followed by the condensation of minerals that formed its mantle. Here, I validated the protoplanetary origin of Earth in the following ways:

- By thermodynamic considerations I connected high-pressure primordial condensation with the oxidation state and minerals of the enstatite chondrites [19], and
- By ratios of mass I connected the minerals of the Abee enstatite chondrite to the components of Earth's interior [20-23], as shown in Table 1. For details, see [23].

Table 1. Comparison of fundamental Earth mass ratios with corresponding ratios for the Abee enstatite chondrite

Fundamental Earth Ratio	Earth Ratio Value	Abee e.c. Ratio Value
Lower Mantle Mass to Total Core Mass	1.49	1.43
Inner Core Mass to Total Core Mass	0.052	theoretical 0.052 if Ni_3Si 0.057 if Ni_2Si
Inner Core Mass to Lower Mantle + Total Core Mass	0.021	0.021
D'' CaS + MgS Mass to Total Core Mass	0.09	.011
ULVZ of D'' CaS Mass to Total Core Mass	0.012	0.012

3. VALIDATION OF THE PROTOPLANETARY THEORY BY INTERNAL MAGNETIC FIELD GENERATION

Uranium in the Abee enstatite chondrite resides in the iron-alloy component that corresponds to Earth's core [24]. Planetocentric nuclear fission (georeactor) formation is a natural consequence of density layering in oxygen-starved (highly-reduced) planetary matter [25-27]. The two-component, self-regulated [28] nuclear fission georeactor assembly is capable of sustained thermal convection in its charged-particle-rich sub-shell, and is ideally suited for geomagnetic field generation [29-31].

Two independent lines of evidence support georeactor existence:

- Calculated georeactor nuclear fission production of $^3He/^4He$ ratios are in precisely the range of ratios observed in oceanic basalts [32].
- Geoneutrino (antineutrino) measurements, at a 95% confidence level, at Kamioka, Japan [33] and Grans Sasso, Italy [34], indicate georeactor nuclear fission output energy of 3.7 and 2.4 terawatts, respectively. These fissionogenic energy values

are similar to the 3-6 terawatt range employed in Oak Ridge National Laboratory georeactor simulations [32, 35].

The commonality of internally-generated magnetic fields at the surface of numerous planets and large moons (Table 2, adapted from [36]) further validates the theoretical protoplanetary origin of the solar system.

Table 2. Planetary Surface Magnetic Field

Object	Intensity in Tesla
Mercury	2×10^{-7}
Venus	$< 10^{-8}$
Earth	5×10^{-5}
Moon	Ancient
Mars	Ancient
Jupiter	4.2×10^{-4}
Io	$< 10^{-6}$
Europa	10^{-7}
Ganymede	2×10^{-6}
Callisto	4×10^{-9}
Saturn	2×10^{-5}
Titan	$< 10^{-7}$
Uranus	2×10^{-5}
Neptune	2×10^{-5}

4. VALIDATION OF THE PROTOPLANETARY THEORY BY OBSERVATIONS OF MERCURY

Thermodynamic considerations have shown that enstatite ($MgSiO_3$) is the primary silicate to condense from solar matter at high pressures (>1 atm) [3, 19]. Enstatite is the major silicate of the Abee enstatite chondrite [37, 38] and, by the mass ratio identity shown in Table 1, enstatite is the major silicate of the Earth [20-23]. Moreover, enstatite is a significant component of the surface of planet Mercury [39, 40].

In 2011, NASA's MESSENGER orbiting spacecraft produced important images of features unique to planet Mercury that were inexplicable to NASA scientists. Many of the images revealed *"… an unusual landform on Mercury, characterized by irregular shaped, shallow, rimless depressions, commonly in clusters and in association with high-reflectance material …. and suggests it indicates activity*" [41]. Figure 2 shows examples of the Mercury's surface pits with their associated highly reflecting material.

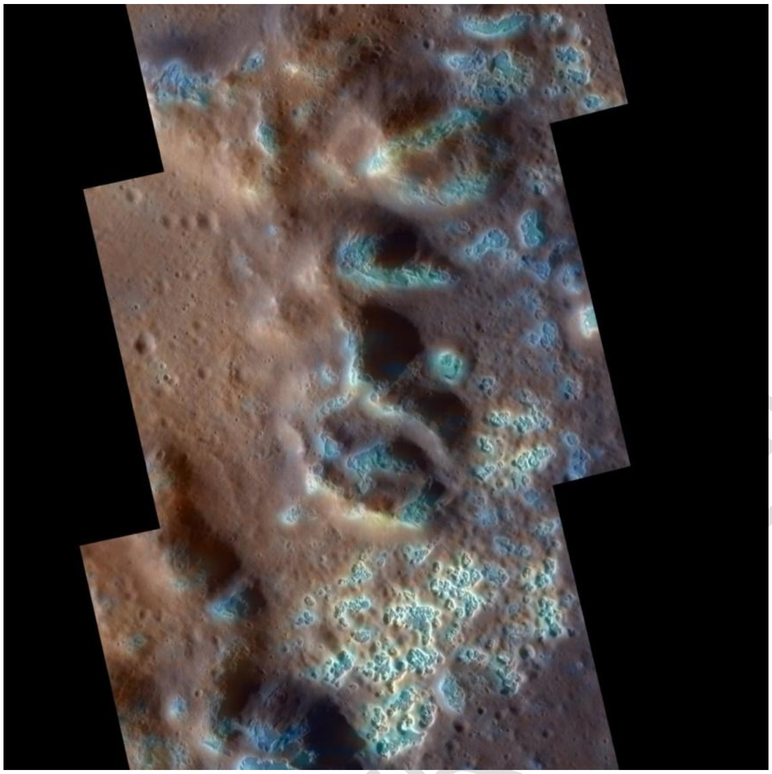

Figure 2. NASA MESSENGER image showing Mercury's pits surrounded by shiny material. These bright shallow depressions appear to have been formed by disgorged volatile matter from within the planet.

In 2012, I published the following scientific explanation for the anomalies observed on Mercury's surface [42]: "*During formation, Mercury's iron core, in condensing and raining-out as a liquid at high pressures and high temperatures from within what was a giant gaseous protoplanet, dissolved a considerable amount of hydrogen, as hydrogen is quite soluble in liquid iron. As Mercury's core solidified, the hydrogen was dispelled and erupted from the surface like hydrogen geysers, forming the surrounding shiny iron metal by turning relatively low reflecting iron sulfide into highly reflecting iron metal*."

Figure 3 shows the relationship between condensation and dissolved hydrogen. For the indicated hydrogen gas pressures (left vertical axis) and temperatures, the red curve shows the boundary between liquid iron and gaseous iron in an atmosphere like the outer part of the sun. For each temperature/pressure point along the red curve, the amount of hydrogen dissolved in the molten iron, indicated by the blue curve, can be read from the right vertical axis. For reference, the green lines tie together these corresponding points. The hydrogen volume units, at STP (standard temperature and pressure), are equal to the volume of planet Mercury. (STD is defined as 273°K and 1 atm.)

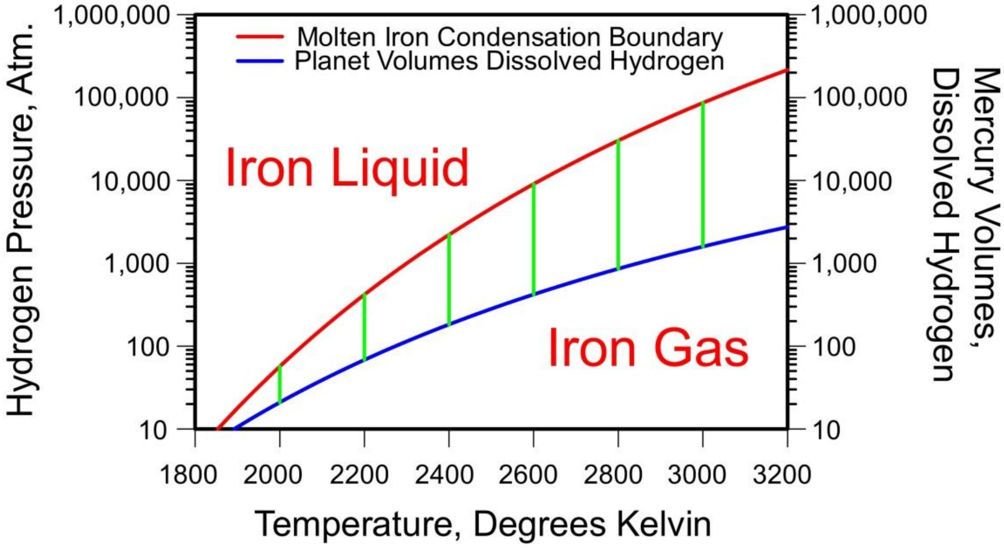

Figure 3. By condensing from a giant gaseous protoplanet at pressures above 10 atm, Mercury's core initially was liquid and contained copious amounts of dissolved hydrogen. For details see [42].

Verifying my assertion [42] that the shiny material surrounding the pits on Mercury's surface is indeed iron metal will further validate the protoplanetary theory of solar system formation.

5. VALIDATION OF THE PROTOPLANETARY THEORY BY OBSERVATIONS OF EARTH'S BEHAVIOR

Eucken [3] recognized from thermodynamic considerations that complete condensation from within a giant gaseous protoplanet would yield a gas-giant planet like Jupiter. I posited a similar formation for Earth, initially fully condensed with a 300 Earth-mass outer shell of condensed ices and gases [29, 43-45]. Subsequently, violent T-Tauri phase solar winds stripped the ices and gases away leaving, at the beginning of the Hadean eon, a rocky planet that had been compressed to about two-thirds of present-day Earth-diameter, and containing within itself the great stored energy of protoplanetary compression.

Earth's subsequent decompression, described by my *Whole-Earth Decompression Dynamics*, in logically and causally related ways, accounts for virtually all of Earth's surface geology and geodynamics.

As whole-Earth decompression progresses and as Earth's volume increases, its surface area increases by the formation of decompression cracks. Primary decompression cracks with underlying heat sources extrude basalt-rock, which flows by gravitational creep until it falls into and infills secondary decompression cracks that lack heat sources. This accounts for the separation of the continents and for the topography of Earth's ocean basins.

As whole-Earth decompression progresses and as Earth's volume increases, its surface curvature must change. The manner by which surface curvature adjusts to changes in volume explains, in logical, causally related ways, the formation of mountain chains characterized by folding, fjords, and submarine canyons [46].

Whole-Earth Decompression Dynamics explains more completely and more correctly the observations previously attributed to plate tectonics, without requiring physically-impossible mantle convection [23] or fictitious super-continent cycles [47]. In addition, *Whole-Earth Decompression Dynamics* explains geological observations that are inexplicable by plate tectonics, including the geothermal gradient [48], origin of petroleum and natural gas deposits [49], oceanic troughs [43], and more.

6. COUNTER ARGUMENTS

In 1974, when I earned the Ph.D. degree in nuclear chemistry, there was wide-spread belief that the planets and other objects in the solar system originated by condensing from a very low pressure gas, <0.001 atm, with a composition similar to that of the sun's photosphere. Then the dust was assumed to gather into progressively larger masses, ultimately becoming planetisimals, then planets.

These ideas stemmed from assumption-based computational models of Cameron [6], and were followed up by other models [7-9]. Not only were the model calculations incorrect [50], but they led to geophysically impossible concepts. For example, core formation reputedly required whole planet melting and a magma ocean. Geomagnetic field production supposedly required physically impossible [23] core convection and continent displacement reputedly required physically impossible [23] mantle convection. There were paleomagnetic errors in latitudes [51], and fictitious supercontinent cycles were said [47] to exist to account for multiple periods of mountain formation by assumed continent collisions.

Clearly, the planetisimal theory does not account for solar system formation. However, elements of the planetisimal theory, for example, low-pressure condensation in the outer regions of the solar system or in interstellar space, added a veneer of oxidized material to the outer portions of Earth, especially oxidized iron which is critical for the development of life.

7. CONCLUSIONS

Kant's 1755 hypothesis on the origin of the sun and planets, as modified by Laplace, was the forerunner of the modern protoplanetary theory of planet formation in which planets are thought to form within giant gaseous protoplanets. The protoplanetary theory was popular in the 1940s and 1950s, but was abandoned and ignored by phenomenological model-makers in the early 1960s who favored the planetesimal theory. I validated the protoplanetary theory by:

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COMPETING INTERESTS

The author declares that no competing interests exist.

AUTHORS' CONTRIBUTIONS

This is the sole and original work of the author.

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Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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