Origin of mountains and primary initiation of submarine canyons: the consequences of Earth's early formation as a Jupiter-like gas giant

Wegener[1] has stated that: '…all Earth sciences must contribute evidence towards unveiling the state of our planet in earlier times, and that the truth of the matter can only be reached by combining all of this evidence'. Equally important is the necessity to discover mistaken understanding and to rethink considerations that were based upon erroneous beliefs. Mantle convection is one such erroneous belief that for 80 years has critically distorted geodynamic considerations. Mantle convection, like Earth-core convection, is physically impossible[1–7]. For 70 years, the Earth's interior erroneously has been thought to resemble an ordinary chondrite meteorite, when only enstatite chondrites have the sufficiently high relative proportion of iron alloy to account for such a massive planetary core, and mass ratios of an enstatite chondrite match precisely corresponding mass ratios for the interior parts of the Earth below a depth of 660 km (refs 7–9).

Earth sciences have indeed contributed abundant evidence about the state of our planet in earlier times. Wegener and those who followed, in attempting to understand the Earth's history, have proceeded empirically 'combining all this evidence' from a host of disciplines, including astronomy, biology, climatology, geochemistry, geodetics, geology, geomagnetism and geophysics, instead of progressing from knowledge of the origin of these processes. As noted by Wegener, 'that is the inductive method'. I have described an indivisible geoscience paradigm that begins with and is the consequence of our planet's early formation as a Jupiter-like gas giant[6,7,10], and which permits deduction of: (i) The Earth's internal composition and highly reduced oxidation state; (ii) powerful new internal energy sources, protoplanetary energy of compression and georeactor nuclear fission energy; (3) georeactor geomagnetic field generation and (4) decompression-driven geodynamics that accounts for the myriad of observations attributed to plate tectonics without requiring mantle convection[2,3,6,11,12]. Here I deduce a novel concept that explains in a logical, causally related manner, the origin of fold-mountains and the primary initiation of submarine canyons.

Since the first hypothesis about the origin of the Sun and the planets was advanced in the latter half of the 18th Century by Immanuel Kant and modified later by Pierre-Simon de Laplace, various ideas have been put forward. Generally, concepts of planetary formation fall into one of two categories that involve either (1) condensation at high-pressures, hundreds to thousands times the pressure of our atmosphere at Earth's surface; or (2) condensation at very, very low-pressures.

Since the early 1960s, the scientific community almost unanimously concurred that Earth formed from primordial matter that condensed at a very low-pressure, about one ten-thousandth of an
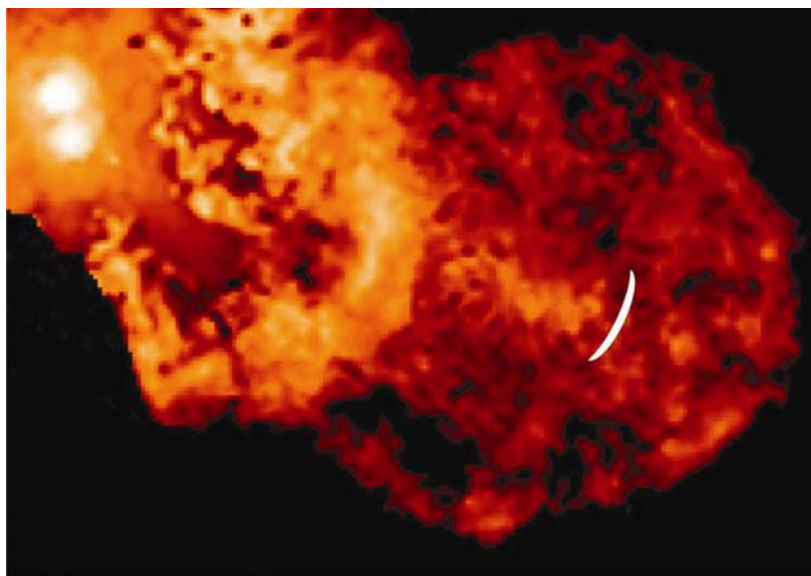

Figure 1. Hubble Space Telescope image of binary star XZ-Tauri in 2000 showing a T-Tauri phase outburst. The white crescent label shows the position of the leading edge of that plume in 1995, indicating a leading-edge advance of 130 AU in five years. T-Tauri eruptions are observed in newly formed stars. Such eruptions from out nearly-formed Sun, I submit, stripped the primordial gases from the inner four planets of our Solar System.

Figure 2. NASA Landsat view of the Teton Range of the Rocky Mountains with no vertical enhancement.

atmosphere. The 'planetesimal hypothesis' was accepted as the 'standard model of solar system formation'. The idea was that dust would condense from the gas at this very low pressure. Dust grains would collide with other grains, sticking together to become progressively larger grains, then pebbles, then rocks, then planetesimals and finally planets. As I have shown from thermodynamic calculations[10], the problem with this model is that low-pressure, low-temperature condensation would lead to oxidized condensate; there would be insufficient iron metal to account for the massive-core terrestrial planets.

Thermodynamic considerations led Eucken[13] to conceive of Earth formation from within a giant, gaseous protoplanet when molten-iron first rained out to form the core, followed by the condensation of the silicate-rock mantle. By similar, extended calculations I verified Eucken's results and deduced that oxygen-starved, highly-reduced matter characteristic of enstatite chondrites and, by inference, also the Earth's interior condensed at high temperatures and high pressures from primordial Solar System gas under circumstances that isolated the condensate from further reaction with the gas at low temperatures[10,14].

The gaseous portion of primordial Solar System matter, as is the Sun's photosphere today, was about 300 times as massive as all of its rock-plus-metal forming elements. Earth's complete condensation formed a gas-giant planet virtually identical in mass to Jupiter. Giant gaseous planets of Jupiter size are observed in extrasolar systems closer to their star than Earth is to the Sun[15]. So, for the Earth what happened to the gases?

A brief period of violent activity, the T-Tauri phase, occurs during the early stages of star formation with grand eruptions and super-intense 'solar-wind'. The Hubble Space Telescope image of an erupting binary T-Tauri star is seen here in Figure 1. The white crescent shows the leading edge of the plume from a five-years earlier observation. The plume edge moved 130 AU, a distance 130 times that from the Sun to Earth, in just five years. A T-Tauri outburst by our young Sun, I posit, stripped gas from the inner four planets. A rocky Earth, compressed by the weight of primordial gases, remained. Previously, I described the consequences of Earth's early formation as a Jupiter-like gas giant[2,3,6,11,12].

Now, I add to those the consequence of mountain formation and primary initiation of submarine canyons.

Mountain systems characterized by folding, such as the Teton Range of the Rocky Mountains shown in Figure 2, have been the intensively studied and debated since the 19th Century. The age-old problem of fold-mountain formation reduces to this question: How can one account for the 'extra' surface area, contained within the continental boundaries, that observations reveal folded atop other layers? Presently, two conflicting views prevail. In the plate tectonic view, mountain-building is thought to be caused exclusively by plate collision, which is thought to 'elongate' the continent, whereas in the Earth-expansionist view, it is uplift from beneath with gravity sliding and gravity spreading[16]. Although in some instances each of these mechanisms may come into play, I deduce a more fundamental, general consideration from Earth's early formation as a Jupiter-like gas giant, with concomitant compression of the rock-plus-alloy portion to about 64% of present radius, and its subsequent decompression following primordial-gas removal[7,12,17].

As illustrated in Figure 3, consider a hypothetical 4000 km 'ancient' continent cross-section (great circle arc ABC) at a

radius of 64% of the Earth's present radius, OB, and the same 'present' continent cross-section (great circle arc DEF) at the present Earth radius, OE. Consider the line OR as a fixed reference, indicating that no 'continental drift' has occurred, as the reference line OR bisects both the ancient and present continents. Observe that the ancient continent subtends an angle, <AOC, that is considerably greater than the angle the present continent subtends, <DOF: 56.3° versus 36.0°. Note that although the length of both the ancient and present surface continent great circle cross-section arcs are the same, 4000 km, the chord lengths, indicated by dotted lines, differ: 3841.3 versus 3934.5 km respectively. Whole-Earth decompression causes changes in surface curvature that, I posit, are responsible for fold-mountain formation and are responsible for initiating the formation of submarine canyons and major drainage systems.

Suppose that the coastline of the hypothetical continent, shown in Figure 3, is circular. Then the perimeter of that circular coastline is simply π times its chord length. The area of that spherical section is 2π times the radius times the maximum rise above the chord. Whole-Earth decompression, in the example above, necessitates an increase in peri-continental
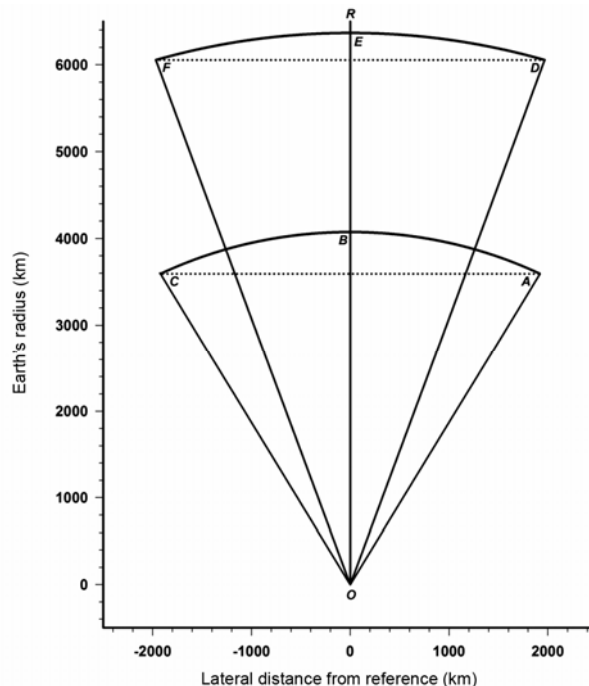

Figure 3. Hypothetical 4000 km 'ancient' continent cross-section at a radius of 64% of the Earth's present radius and the same 4000 km 'present' continent cross-section at present-day Earth radius, taken as 6366 km.
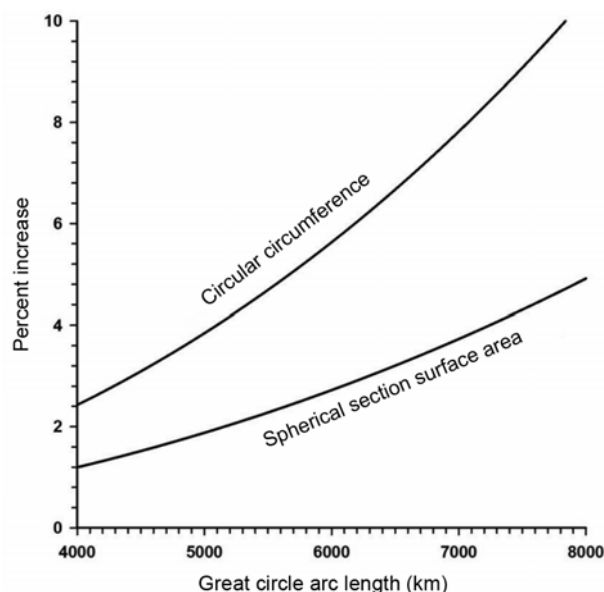
Figure 4. Percentage increase in peri-continental circumference and spherical section surface area due to decompression for the hypothetical circular continent, shown in Figure 3, as a function of great circle cross-section arc-length.

Figure 5. Demonstration illustrating the formation of fold-mountains as a consequence of Earth's early formation as a Jupiter-like gas giant. On the left, two balls representing the relative proportions of 'present' Earth (pink), and 'ancient' Earth (blue) before decompression. In the center, a spherical section, representing a continent, cut from 'ancient' Earth and placed on the 'present' Earth, showing: (1) the curvature of the 'ancient continent' does not match the curvature of the 'present' Earth and (2) the 'ancient continent' has 'extra' surface area confined within its fixed perimeter. On the right, tucks remove 'extra' surface area and illustrate the process of fold-mountain formation that is necessary for the 'ancient' continent to conform to the curvature of the 'present' Earth. Unlike the ball-material, rock is brittle so tucks in the Earth's crust would break and fall over upon themselves producing fold-mountains.

circumference of about 2.4% and an increase in surface area of about 1.2%. The circumference increase and surface area increase for other hypothetical great circle continental arc-lengths of a spherical segment are shown in Figure 4.

The two curves shown in Figure 4 illustrate the consequences of whole-Earth decompression on 'sial' continental masses which must adjust to 'flattening' changes in curvature. Whereas rocks can undergo considerable compression, their brittle nature and low tensile strength precludes adjusting to the requisite increase in continent circumference caused by whole-Earth decompression without tension fractures occurring. Such decompression-generated, peri-continental

tension fractures could have initiated the formation of submarine canyons and drainage channels; later, erosion-processes did the rest. But, to adjust to changes in surface area as a consequence of decompression-generated changes in curvature by the tension fractures alone, the fractures would have to extend from continent edge to centre and open an area equal to the increase in surface area shown in Figure 4, which appears less energetically favourable than the alternative. Alternatively, if decompression-generated increases in 'sial' surface area cannot be achieved solely by tension fractures, the decompressing 'sial' continent will act to 'flatten' itself, to reduce the need for increased surface area by

buckling breaking and falling over upon itself. Thus, this buckling, breaking and falling over upon itself, I deduce from the Earth's early formation as a Jupiter-like gas giant, is the principal agent involved in the formation of fold-mountains.

The mathematical relationships described above may be dramatically illustrated by the demonstration shown in Figure 5.

It is no longer necessary to assume continent collisions to explain mountain ranges characterized by folding, particularly those that occur in the middle of continents. In fact, one might say, the existence of such mountains is evidence of Earth's early formation as a Jupiter-like gas giant.

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