Asteroids, TNOs, and Olivine: The Petrological Problem with Hydroplate Theory's Astronomical Submodel

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Abstract

The origin of small Solar System bodies (SSSBs) such as asteroids, Trans-Neptunian Objects (TNOs), comets, and meteoroids remains an elusive question in secular and creation cosmogonies. The Hydroplate Theory (HPT) proposes a terrestrial origin, explaining these features as fragments of the crustal debris launched by the fountains of the great deep during the earlier stages of the Flood. However, HPT faces a challenge: SSSBs are predominantly olivine in composition, yet olivine is absent in the granite crust and rare in its predicted basalt subterranean floor. Despite assertions that olivine would be common, the compositions of granite and basalt simply do not lend credence to this idea. Hydrothermal alteration in the subterranean chamber also contradicts HPT predictions, as quartz is a chemically resistant mineral. Rather than dissolving quartz, hydrothermal alteration would replace feldspars, micas, pyroxenes, and olivine with clay, phyllosilicates, and additional quartz. Consequently, the crustal debris launched by the fountains of the great deep should be dominantly granite and quartz, with olivine being extremely rare if present at all. This is precisely the opposite of what we commonly observe in the composition of SSSBs. This represents a significant flaw in the HPT astronomical submodel.

Simple Summary

The article discusses a major problem with the Hydroplate Theory (HPT), which suggests that small Solar System bodies (SSSBs) like asteroids and Trans-Neptunian Objects (TNOs) were formed from pieces of Earth's crust launched into space during the Global Flood. A significant issue is that SSSBs are mostly made of a mineral called olivine. However, HPT describes the source of SSSBs as the Earth's granite crust, which contains no olivine, and a layer below the crust made of basalt, which has very little olivine. The article explains that the high temperatures and water described by HPT would not help create or preserve olivine; instead, these conditions would cause granite and basalt to change, resulting in more quartz and clays, while destroying any existing olivine. Therefore, the debris launched by the HPT's fountains of the great deep should be mostly granite, clays, and quartz, with very little or no olivine, which is the opposite of what is observed in SSSBs.

Introduction

Small Solar System bodies (SSSBs) such as asteroids and Trans-Neptunian Objects (TNOs) remain an intriguing frontier of the planetary sciences. Debate over their origin and development abound within both the secular and creation cosmogonies. One such model is the Hydroplate Theory (HPT) as proposed by Walter T. Brown (2019). This model relates asteroids and TNOs to the activities fueled by the fountains of the great deep during the earlier stages of the Genesis Flood. Specifically, asteroids and TNOs are explained by the erosion of the pre-Flood crust and subcrustal rocks that were then carried beyond Earth's orbit where they

agglomerated into the SSSBs we see today. This proposal has been challenged on the basis of an insufficient energy supply in the pre-Flood Earth's energy budget to propel crustal debris beyond Earth's orbit (Carter and Isaacs, 2022) and the inability of solar-driven processes to significantly aid in pushing TNOs beyond Mars' orbit (Isaacs, 2023). However, HPT's explanation suffers from an even more fundamental challenge that comes from over a century of pioneering experiments and laboratory data from the field of empirical petrology, the study of rock-forming processes active in the production and progression of rocks and their minerals through time. Specifically, HPT must explain how asteroids and TNOs became dominantly composed of olivine when derived from a primarily granitic and, to a lesser extent, a basaltic source. This note will briefly review the impossibility of HPT's explanation in light of fundamental igneous petrology.

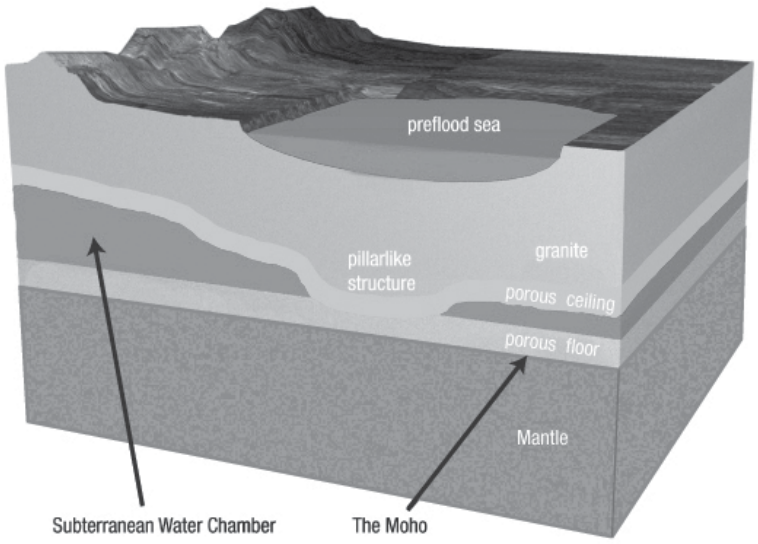

Figure 1. The HPT pre-Flood Earth system consists of a granite crustal shell approximately 100 km thick, which sits atop a solid basaltic mantle. Portions of the granite crust seep downward to act as pillars to support the granite crust. Between this granite crust and basalt mantle is a subterranean water chamber which averages 1.6 km thick. Hydrothermal alteration by the supercritical water within this chamber makes the granite crust and basalt chamber floor porous. Image from Brown (2019, p. 124, Figure 42)

Hydroplate Theory: A Brief Overview

Brown (2019) established several characteristics that define the HPT pre-Flood Earth system. First, Earth's crust was a continuous shell of granite approximately 100 km thick that lay atop a basalt mantle. Between this granite shell and basalt mantle was an interconnected network of subterranean water passages which averaged 1.6 km thick (Figure 1). The granite shell supported itself by pillar structures which settled to the chamber floor (Brown, 2019, p. 343). However, at the onset of the Flood, an initial crack released this highly pressurized water as the fountains of the great deep described in Genesis 7:11:

> "As flood waters escaped from the subterranean chambers, pillars were crushed, because they were forced to carry more and more of the weight of the overlying crust. Also, the almost 60-mile-high walls of the rupture were unstable because rock is not strong enough to support a cliff more than 5 miles high. As lower portions of the walls crumbled, blocks—some a staggering 200 meters in diameter—were swept up and launched by the jetting fountains." (Brown, 2019, p. 340)

This ejected crustal debris, as Brown explains over the course of two chapters, gradually agglomerated to become the comets, meteoroids, asteroids, and TNOs we now see across our solar system.

Asteroids and TNOs: What Are the Potential Sources of Olivine?

The composition of SSSBs has generated considerable excitement over the years due to interests in planetary evolution and, more recently, the possibility of mining asteroids (e.g., Martínez-Jiménez et al., 2016; Cannon et al., 2023; Ríos Muñoz et al., 2024). From observing hand samples of meteorites to spectral measurements of cometary debris tails or asteroids, it is believed that the vast majority of SSSBs are composed dominantly of olivine (e.g., Binzel et al., 2009; Hamilton et al., 2021; Soens et al. 2022), a mafic (magnesium- and iron-rich) silicate mineral which comprises much of the Earth's upper mantle. Brown himself readily recognized this and makes several mentions of it throughout his book (e.g., Brown, 2019, pp. 122, 310, 316), often giving the impression that olivine is readily available to serve as debris to form asteroids and other SSSBs. However, these statements are often misleading and require some

clarification before proceeding. For instance, Brown claimed that, "Olivine may be the most abundant of the more than 2,500 known minerals in Earth's crust and mantle" (Brown, 2019, p. 122). This is true of the upper mantle, which is about 55% olivine, but it is not true of the crust. Instead, the crust is almost exclusively granitic in composition, which by its very definition has no olivine in its overall makeup (as later discussed). Elsewhere, he said again that "Olivine is a class of minerals that includes perhaps half the minerals in the Earth's crust and upper mantle" (Brown, 2019, p. 369, endnote 32). Again, this statement is specifically wrong in reference to the crust's composition, unless Brown meant that olivine is *included* in a class of minerals called silicates, which do dominate the crust and mantle, but include a wide variety of minerals other than olivine. Consequently, we distinguish between the mantle, which is olivine-rich, and the crust, which is olivine-poor.

It is important to recognize, however, that HPT's upper mantle is not the same as what most petrologists would define as the upper mantle. To most petrologists, the upper mantle is composed of peridotite, which is about 55% olivine, 35% pyroxene, and 10% other minerals (Best and Christiansen, 2001, p. 438). In contrast, Brown claimed that the subterranean water chamber rested between the granite crust and an uppermost part of the mantle comprised of solid basalt (Brown, 2019, p. 124). This is because the basaltic Atlantic floor is believed to be the original created chamber floor (Brown, 2019, pp. 130–131), which is in contrast to the Pacific floor, which is from outpourings of basalt over a submerged hydroplate (Brown, 2019, pp. 158–162; see also critical review by Isaacs, 2018). Consequently, in terms of the HPT Earth system, the uppermost mantle was not peridotite but instead basalt. This is an important distinction because the material available to be swept up by the fountains of the great deep is 1) the granite crust, and 2) the solid basalt chamber floor. Consequently, the peridotite mantle cannot be considered an accessible source of olivine, as that would be below the basalt comprising the chamber floor.

Now that we have defined granite and basalt of Atlantic seafloor composition as the source for nascent SSSB debris, the question naturally arises: from where is this olivine derived? As defined in the literature, granite comprises, by volume, 20–60% quartz and 35–90% alkali and/or plagioclase feldspar (Streckeisen, 1976). This is not to be confused with the more general term "granitic rock," which refers to texturally similar rocks that contain proportions of quartz, alkali feldspar, and plagioclase that fall outside of the previous definition (Shellnut et al., 2021). Basalt has widely varying compositions but is dominantly plagioclase and pyroxene (Best and Christiansen, 2001, p. 37). In many cases, basalt is completely devoid of olivine, depending on the location and composition of that basalt. On the scale of basalts, the Atlantic seafloor is probably among the richest in olivine yet generally has less than 10% olivine by weight (e.g., Bryan and Moore, 1997; Zhong et al., 2019).

Hydroplate Theory's Petrological Gymnastics

The composition of the granite and the Atlantic seafloor basalt poses a significant barrier to HPT's explanation for SSSBs. With the vast majority of debris being derived from the granite crust and only lesser amounts from the basalt chamber floor, then olivine should be found in minor quantities at best. This is directly contradictory to Brown's claim that much of the eroded material was comprised of magnesium-rich olivine (Brown, 2019, p. 316). Besides the misleading claims on the distribution of olivine throughout the crust, Brown did not directly address how SSSBs became enriched to the point of becoming dominantly olivine despite their derivation from an olivine-poor source. However, Brown did attempt to answer the question of why quartz is so rare:

> "Pillarlike structures formed in the subterranean chamber when the thicker, denser portions of the crust settled through the subterranean water onto the chamber floor.… Twice daily, during the centuries before the [F]lood, tides in the subterranean water stretched and compressed these pillars. This powerful heating process steadily raised pillar and subterranean water temperatures, dissolved quartz, and made pillars porous (spongelike).…these temperatures exceeded 1,300°F, enough to do all this and allow iron and nickel to settle downward and concentrate in the pillar tips." (Brown, 2019, pp. 343–344)

Elsewhere, Brown explains that "Temperatures [in the subterranean chamber] probably reached 3,000°F (1,650°C).…If so, as temperatures steadily rose, quartz would have been the first major mineral in granite to melt. Much of it would have dissolved in the hot, subterranean water" (Brown, 2019, p. 368, endnote 25).

These elevated temperatures, then, are believed to have removed the quartz from the granite and concentrated it into the subterranean water so that the quartz was no longer available to form SSSBs. This explanation, of course, is incomplete, as tremendous volumes of quartz would have to be dissolved while only a severely limited amount of water exists in which it can dissolve. Note that the thickness of the HPT subterranean water layer is only one mile or 1.6 km. Solubilities measured for quartz in supercritical water are typically well less than 1 g/kg of water,

that is, less than 0.1 percent (Rendel and Mountain, 2023). This implies that the maximum thickness, on average, of dissolved quartz is no greater than 1.6 m, which is only a tiny fraction of the 100 km thickness of the granite crust.

However, these concerns are predicated on the faulty assumption that it was the quartz that would dissolve under these HPT conditions. Quartz may have a relatively low melting temperature, but it is far more chemically resistant than many of its companion minerals. This is why the end result of granite weathering is commonly clay and sand grains; the feldspars and mica chemically alter into clays while the quartz resists alteration, remaining instead as quartz sand grains (e.g., Table 1 of Chiu and Ng, 2014). This matches the well-documented progression of alteration observed from hydrothermal activity (Savage et al., 1987; Meller et al., 2014; Yuguchi et al., 2021; Fries et al., 2025).

For instance, Nishimoto and Yoshida (2010) employed microscopic observation and chemical investigations to identify the order of hydrothermal alteration phases in deep-fractured granite, analogous to Brown's proposed alteration of the granite crust. As seen in Figure 2, they observed three primary phases of alteration:

1. Phyllic zone alteration with the dissolution of K-feldspar and precipitation of the clay mineral illite and quartz.
2. Propylitic zone alteration with dissolution of biotite and precipitation of a clay-like Fe-phyllosilicate.
3. Outer zone alteration with dissolution of plagioclase and partial chloritization of biotite.

In short, alteration involved the dissolution of original feldspars and micas and the precipitation of clay (illite), clay-like minerals (chlorite and Fe-phyllosilicate), and quartz. Note that no quartz was dissolved; instead, the silica tetrahedra in the feldspars and mica were precipitated as additional quartz and the aluminum, potassium, and any remaining silica were precipitated as illite ($K_{0.65}Al_{2.0}[Al_{0.65}Si_{3.35}O_{10}](OH)_2$). The result of this alteration serves to *increase*, not decrease, the modal amount of quartz within the altered granite. This demonstrates that any alteration of the granite crust would lead to the replacement of feldspars and micas with illite, phyllosilicates, and quartz. More pervasive alteration would only continue to eradicate the primary texture of the host granite and replace it with clay minerals and quartz, as observed in advanced argillic and silicic alteration (Hedenquist and Arribas, 2022). Consequently, quartz and clay would dominate the material swept out by the escaping fountains of the great deep, exacerbating the composition discrepancy between HPT expectations and observed SSSBs.

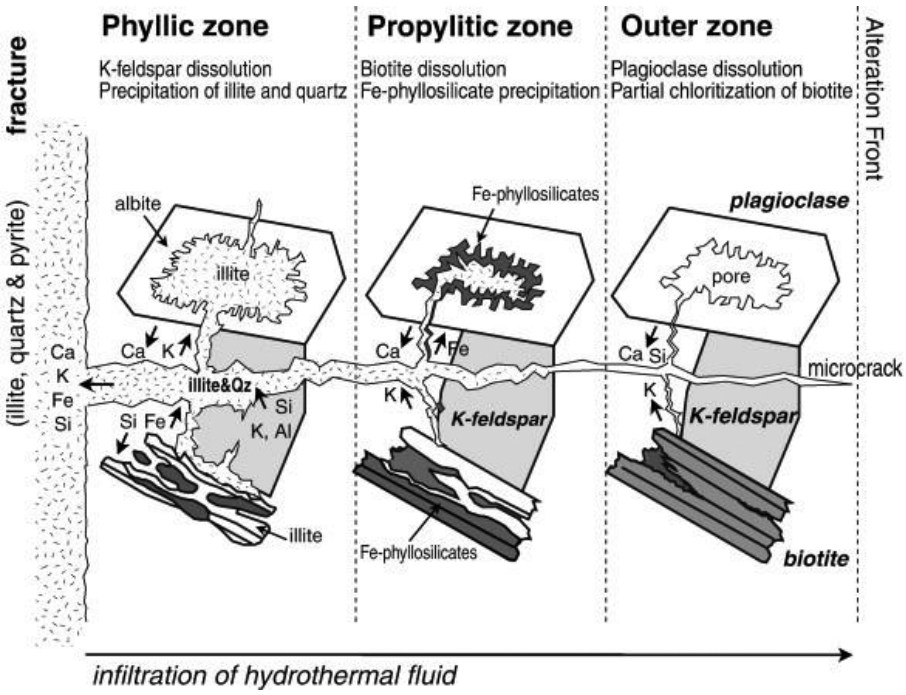

Figure 2. Order of hydrothermal alteration of mineral phases in fractured granite. Alteration radiates outward from the fracture on the left, creating an alteration halo in three zones. The Phyllic zone involves the dissolution of K-feldspar and the precipitation of quartz and the clay mineral illite. The Propylitic zone involves biotite dissolution and precipitation of a Fe-phyllosilicate, while the Outer Zone involves plagioclase dissolution and partial replacement of biotite into the phyllosilicate chlorite. Note that quartz is not dissolved due to its chemical resistance compared to feldspars and micas. Continued alteration would continue to replace the original texture with clay (advanced argillic) and precipitate more quartz (silicify). Image from Nishimoto and Yoshida (2010, Figure 8).

Sourcing Ni: A Two-Edge Sword

HPT also wrestles with how to source Ni from the granite crust to explain

Fe-Ni meteoroids. As referenced earlier, Brown explains this as partial melting of Fe- and Ni-rich minerals in the granite crust, which seep downward and concentrate in the pillar-like structures. This is a desperate attempt, as granite has no major minerals rich in Ni. Instead, Ni-rich minerals are far more common in mafic igneous rocks such as gabbro and to a lesser extent basalt. This is why Ni mining companies explore for weathered gabbro (Ni-laterites) rather than weathered granite (Al-bauxites).

This raises the question: could HPT source the Ni from the basalt chamber floor rather than the granite? Basalt has high variability in Ni composition that correlates with MgO; many basalts consequently have only between 100–300 ppm Ni (Hedge, 1971). The mineral sources of Ni, however, are olivine and pyroxene (Dong et al., 2024). This is contradictory for HPT: olivine and pyroxene must be destroyed in order to liberate Ni, yet olivine must be preserved in SSSBs. In his explanation of pallasites, which are meteoroids where magnesium-rich olivine (forsterite) and nickel-iron alloys are found together, Brown specifically claimed that *only* the nickel-iron source minerals melted while the olivine remained unmelted:

> "In pallasites, the olivine is strictly the magnesium variety, a mineral called forsterite. At atmospheric pressure, forsterite melts at almost 1900°F, one of the highest melting temperatures of all minerals.... An iron-nickel mixture melts at about 1300°F....The fluttering hydroplates and pounding pillars crushed rock and generated frictional heat along the sliding surfaces. Near those surfaces, minerals that had low melting temperatures, including minerals containing iron and nickel, melted quickly. The dense iron and nickel drained down cracks and displaced upward melted material that was less dense....Before forsterite could melt, the molten iron-nickel steadily froze while forsterite crystals were suspended in a weightless environment within the melt." (Brown, 2019, p. 369, endnote 32)

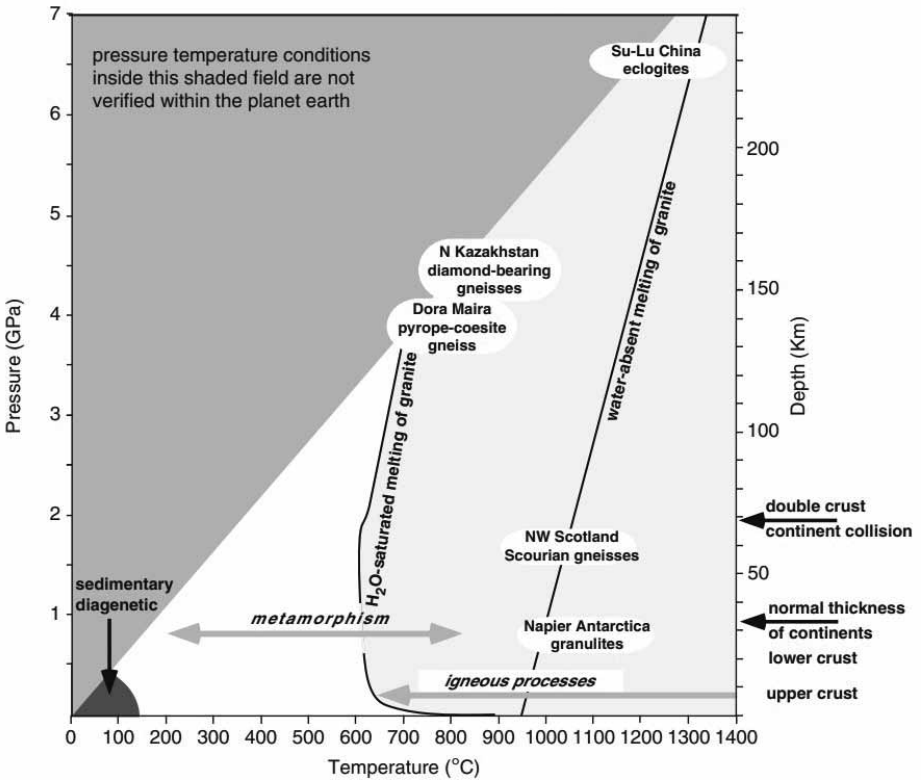

Figure 3. A phase diagram illustrating processes at differing pressure-temperature regimes across crustal depths and beyond. Note the diagonal solid black line, "water-absent melting of granite" is the solidus, where the region to the right of the line is a field of pressure-temperature conditions resulting in melt. This diagram does not even extend as high as HPT's predicted temperature condition of 1650°C. Clearly, the conditions in HPT's predicted subterranean chamber are most conducive to pervasive melting of the granite crust. Diagram from Bucher and Grapes (2011, p. 6, Figure 1.2).

However, forsterite (magnesium-rich olivine) is the Ni-rich mineral that would have to be broken down to liberate Ni. In this scenario, HPT cannot have both liberated Ni and preserved olivine.

Deep Hydrothermal Alteration of Basalt Destroys Olivine

The hydrothermal alteration fueled by the subterranean chamber also poses a problem for preserving olivine in the basalt chamber floor. Much like what happens in granite, hydrothermal alteration of basalt only serves to destroy the original texture and replace it with clays, phyllosilicates, and quartz. Hydrothermal alteration of olivine specifically leads to its breakdown to the phyllosilicate chlorite

(Humphris and Thompson, 1977). In the temperature range of 150–400°C, alteration generally leads towards the greenschist facies where the basalt is broken down into quartz, chlorite, epidote, and other common alteration minerals (Teagle and Alt, 2004). Much as with granite, alteration destroys olivine while increasing the amount of quartz and phyllosilicates like chlorite to be swept up in the subterranean waters. Alteration would be even more pervasive at the postulated pressures and temperatures of the HPT system.

Could Olivine Be Derived from Other Silicates?

As illustrated in the preceding sections, granite is devoid of olivine while any olivine that may occur in basalt is liable to be altered to chlorite rather than being preserved. This leaves no olivine for forming SSSBs. This results in one final question: could olivine be derived from other silicates? Only two mechanisms exist for generating new minerals:

1. Alteration of existing minerals
2. Melting

As discussed with the first option, alteration would destroy minerals like olivine and the feldspars and transform them into clays and phyllosilicates. On the other hand, melting would cause a greater problem for HPT. At a temperature of 1650°C and at crustal depths in the presence of water, rocks melt to form granite magmas at >650°C (Bucher and Frey, 2001, p. 5, Figure 1.1). By 1400°C, partial melting is thermally unpreventable in the deep crust (Best, 2003, p. 313). In the HPT subterranean chambers with water at 1650°C, the granite crust would at the very least partially melt, if not totally melt (Figure 3). As described before, supercritical water cannot hold much quartz in solution. However, magmas readily hold water in solution. Given the extent of melting that would accompany HPT's speculated pressure-temperature regime, the subterranean chamber would be dominated by melted granite with dissolved water, rather than water with dissolved quartz. The resulting magma would be silica-rich (like quartz) rather than silica-poor (like olivine).

Norman Bowen was among the first petrologists to exhaustively study the geochemical processes at work with the crystallization of silicate melts, demonstrating in what is now known as Bowen's Reaction Series that melts become more silica-rich over time in an irreversible sequence (Bowen, 1928). This involves a process known as fractional crystallization (Best and Christiansen, 2001, pp. 95–97). This involves only part of the melt crystallizing, and the available Mg and Fe becoming locked up in those crystals. The remaining melt is now depleted in Mg and Fe and enriched in silica. It is now believed that this process must be repeated multiple times to transform a peridotite to a granitic composition, where as much as 70% of the original mass has been removed by the time that a granitic composition has been achieved (Christiansen et al., 2022). This is where the problem lies: melts only become more silica-rich and more Mg- and Fe-poor in an irreversible progression. A melt from a granite composition simply lacks the necessary Mg and Fe to create stable olivine crystals. Likewise, a basalt melt also cannot create any more olivine than already exists in the original basalt. Mixing a basalt melt with a granite melt would furthermore make a hybrid between the basalt and granite that is also too silica-rich to create olivine.

Conclusions

The composition of the small Solar System bodies (SSSBs) remains a serious objection to Hydroplate Theory (HPT). Olivine, contrary to some statements from Brown, is simply not common in the HPT granite crust. Even in the HPT basalt chamber floor, olivine is only a secondary mineral if present at all. The hypothesized dissolution of quartz from the granite crust is likewise contrary to many observations of granite alteration. Quartz is a chemically resistant mineral in comparison to its companion minerals like potassium feldspar and biotite mica. Hydrothermal alteration by the subterranean waters would replace feldspars and mica in the granite, and olivine and pyroxene in the basalt, with clays, phyllosilicates (e.g., chlorite), and quartz. Consequently, the debris launched by the fountains of the great deep should be, in decreasing order of prominence, 1) granite, 2) illite and other clays, 3) quartz, and 4) chlorite, with olivine and pyroxene only appearing as minor (0.1 – 1 wt.%) or trace (< 0.1 wt.%) quantities if found at all. This is far from what we observe of SSSB compositions. The HPT astronomical submodel simply fails to explain the petrological data, which calls into question the HPT system as a whole (Isaacs, 2023).

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