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Volcanism, "Fountains of the Great Deep," and Forty Days of Rain

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Abstract

The Bible references the fountains of the deep and forty days of rain as contributors to the global Flood. Magmas are ideal candidates for fountains of the deep since water is the primary gas released during virtually all volcanic eruptions. The geologic record preserves volcanism on a level not observed today, especially with the existence of large igneous provinces. Gravimetric analysis of large igneous provinces indicates the liberation of water from their magmas could have contributed at least 58 cm of rain worldwide every day for forty days. Diatremes could be signature structures for volatiles launched into suborbital trajectories. The possible cause of the volcanism, Flood, and forty days of rain could have been concentrated, global decompression due to multiple bolide impacts. Under the scenario of global decompression from bolide impacts, the forty days of rain came from four potential sources: (1) liberation from volcanism, (2) destruction of vapor canopy, (3) vaporization of existing liquid water upon bolide impact, and (4) vaporization of bolides.

Introduction

The phrase "fountains of the great deep" is frequently used by creation scientists to refer to the source for water within the earth used to flood its surface. The phrase originates in the Bible, where it or a similar phrase appears three times: once in Genesis 7:11, once in Genesis 8:2, and once in Proverbs 8:28.

> In the six hundredth year of Noah's life, in the second month, the seventeenth day of the month, the same day were all the *fountains of the great deep* broken up, and the windows of heaven were opened. And the rain was upon the earth forty days and forty nights (Gen. 7:11–12 KJV, emphasis added).
>
> The *fountains also of the deep* and the windows of heaven were stopped, and the rain from heaven was restrained (Gen. 8:2 KJV, emphasis added).
>
> When he established the clouds above: when he strengthened the *fountains of the deep* (Prov. 8:28 KJV, emphasis added).

These verses share a common theme. All three associate moisture in the air with the fountains in the earth. Genesis specifically associates the fountains of the great deep with rain. Genesis 7:11–12 reads "…were all the fountains…broken up,…And the rain was upon the earth forty days and forty nights" (KJV). In the next chapter, in Genesis 8:2, the

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same order is repeated; the fountains were "stopped" and then the rain was "restrained." If so, the Bible could be describing a cause-and-effect relationship observed today. The Hebrew text historically has been interpreted as indicating a causal relationship between the "windows" and "fountains" (Brown, 2008, p. 120; Dillow, 1981; Fouts and Wise, 1998; Whitcomb and Morris, 1961). Moreover, the atmospheric effects of volcanism (ozone depletion, tropospheric cooling, acidification, and cirrus modification) are well documented (Buchwald, 2007; Dasch, 1996a; Fischer, 1994; Gerlach et al., 1989; McGee et al., 1997; Rampino and Self, 1982; Self, 2006; Sigurdsson, 1982; Sigurdsson, 2000a; Sutton et al., 1997; Whitcomb and Morris, 1961). Volcanism is one example of how swiftly and severely geologic episodes can affect climate. The "cause" of the Flood may have been the eruption of crustal and subcrustal magmas, which the Bible calls "fountains of the deep" (Dickens and Snelling, 2008; Dillow, 1981; Hunter, 1996; Rehwinkel, 1951; Whitcomb and Morris, 1961). The "effect" would have been large releases of lava onto Earth's surface, as well as volatiles and ash into the atmosphere.

Volatiles are an element or compound that forms a gas at relatively low pressure and magmatic temperature (Wallace and Anderson, 2000). Carbon dioxide, sulfur, chlorine, and fluorine are common, but water vapor is the most abundant volatile (Johnson et al., 1994). If water vapor released during an eruption is forced high into the atmosphere, it will cool and condense. The liquid water can precipitate or revaporize (Fetter, 1988). Therefore, rainfall can be sustained indefinitely by sufficient volcanism.

Volcanism and the Flood Waters

Although the Bible does not specify the exact amount of rainfall for forty days and forty nights (Gen. 7:12), past investigators have traditionally interpreted the "violent shower" meaning of the word "rain" used in Genesis 7:12 and 8:2 as referring to a "torrential downpour" (Brown, 2008, p. 120; Rehwinkel, 1951; Strong, 2001; Whitcomb and Morris, 1961). Presently there is approximately 1.27 x 10^{19} grams of water in the atmosphere (Trenberth and Smith, 2005), which is enough to provide approximately 2.5 cm of rain simultaneously across the entire Earth's surface (Dillow, 1981; Fox, 1952; Whitcomb and Morris, 1961; Appendix A). This modest amount of water would be insufficient to generate either global torrential rainfall or a global flood. Therefore, magmas would have had to liberate considerably more than the 10^{19} grams of water in order to sustain forty days of rain.

Experiments have shown that magmas can conceivably liberate vast amounts of water because the solubility of water in magmas increases with pressure. Snelling (2008) quoted previous investigators who determined granites could dissolve 24 weight percent water (wt % H_20) at 100 km. Rhyolite melts can contain up to 21 wt % H_20 at 1,000°–1,200° C at 10 kbars (Sood, 1981), which is the pressure at approximately 36 km depth (Blatt et al., 2006). Andesitic melts can dissolve 10 wt % H_20, and basaltic melts can dissolve 14 wt % H_20 under similar conditions (Middlemost, 1985; Annen et al., 2006). Mitchell (1986) discusses but discounts how kimberlites could have contained about 40% H_20 at a depth of 200 km. Magmas degassing these large volumes of water vapor at Earth's surface could have contributed significant amounts of precipitation for the Flood.

Rainfall during the Flood

There has been much debate as to exactly how much rainfall occurred during the forty days of rain. Determining the precise amount of precipitation during the Flood is a formidable task, but could begin with a quantification of water liberated from magmas erupted during the Flood.

Basalt is the most common type of igneous rock (Smith, 1999a), and more than half of all volcanoes consist wholly or largely of basalt (Walker, 2000). The largest known volcanic emplacements on Earth consist almost exclusively of basalt and are called *large igneous provinces* (LIPs) (Figure 1). LIPs are defined by Coffin and Eldholm (1994) as a continuum of voluminous iron and magnesium rock emplacements that include continental and ocean basin flood basalts, volcanic passive margins, oceanic (submarine) plateaus, submarine ridges, and seamount groups. The largest known LIP is the Ontong Java LIP, a submarine emplacement located in the western Pacific Ocean (ONTO in Figure 1) with an area and volume estimated at 1,900,000 km^2 and 44,000,000 km^3 respectively (Large Igneous Provinces Commission, 1993).

The immense size of LIPs suggests their magmas may have contributed significant amounts of water to the Flood (Froede, 2007). The volume of some LIPs are known, and six are considered and included in Table I. The original water contents by mass for six LIPs also have been calculated and included in Table I. The density and original water contents of many continental LIPs are difficult to quantify due to alterations after initial emplacement (metamorphism, weathering, etc.). Furthermore, the actual volume of the Siberian Traps in Table I is much larger, but only the portion with a volume and water content available for estimation are considered in this study.

Using a gravimetric analysis procedure (Chang, 1984) for each LIP in Table I, where

$$\text{mass } H_20 \text{ in LIP} = (\text{mass of total LIP}) \times (\% \ H_20 \text{ by mass in LIP})$$

and assuming the density for basalt is 2.9 g/cc (Best, 2003), it can be determined that the magmas from these six LIPs

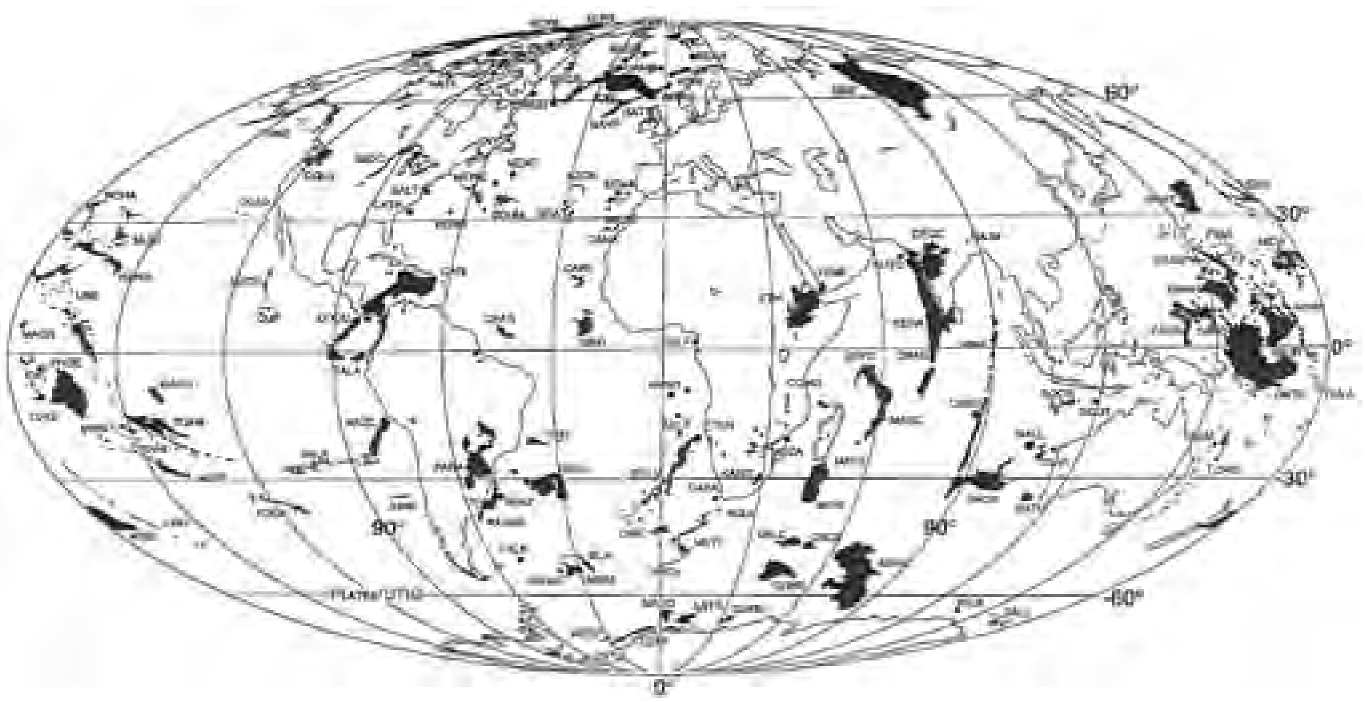

Figure 1. Distribution of known large igneous provinces (after *Reviews of Geophysics*, by Coffin and Eldholm, 1994)

alone could have liberated a volume of water equivalent to approximately 4.4 cm of rain across Earth's surface every day for forty days.

Note that the calculated water contents from direct sampling in Table I are much lower than the empirical values referenced earlier for previous investigators. Since the Bible makes it clear that Earth was made out of water (Genesis 1, 2 Peter 3), the empirical values indicating high water contents should align with the water contents calculated from sampling. Why are calculated values lower than the empirical values? One possible reason could be the magmas from LIPs originated from shallow sources, where the lower pressures allow only limited amounts of dissolved water within magmas. However, most investigators suspect magmas for

Table I. Name and volume of LIPs along with the reported original water content.

LIP name	Vol. km^3	Reference	$H_2$0 wt %	Reference	Mass $H_2$0 g
Deccan	8,600,000	LIPC, 1994*	0.6	Sano et al., 2001	1.496×10^{20}
Iceland	6,600,000	Hooper, 2000	0.15	Nichols et al., 2002	2.871×10^{19}
Kerguelen-Broken Ridge	9,100,000	LIPC, 1994*	0.63	Scoates et al., 2008; Yang et al., 1998	1.666×10^{20}
Naura Plateau	900,000	LIPC, 1994*	1.17	Floyd, 2007	3.054×10^{19}
Ontong Java Plateau	44,000,000	LIPC, 1994*	0.29	Michael, 1999	3.700×10^{20}
Siberian Traps	280,000º	Carlson et al., 2006	(1.75*0.6)+(0.625*0.4)	Ivanov, 2007; Elkins-Tanton et al., 2006	1.903×10^{18} + 8.881×10^{18}
TOTAL	**69,480,000**				**7.563×10^{20}**

* LIPC — Large Igneous Provinces Commission
º Although the entire volume of the Siberian Traps exceeds 2,000,000 km^3 (LIPC, 1994) only the geologic portion as defined by Carson et al., 2006 has data sufficient for reliably estimating initial water contents using a gravimetric procedure.

LIPs as originating within the mantle (Coffin and Eldholm, 1994; Duncan and Richards, 1991; Jones et al., 2002, Klevberg, 2007; Smith, 1999b), where the higher pressures permit much higher water contents in the magmas. Another possibility is that the magmas from the LIPs underwent degassing before solidification (Carlson et al., 2006; Jambon, 1994).

Before the acronym "LIP" was coined, Schubert and Sandwell (1989) published a paper estimating the volumes of continental submarine plateaus, oceanic plateaus, and thermal swells, much of what is now known as LIPs (continental flood basalts are absent in Schubert and Sandwell's estimating). Schubert and Sandwell, using the Airy compensating model, estimated the individual volumes of continental submarine plateaus, oceanic plateaus, and thermal swells to have a combined volume of 621,820,000 km^3. This total volume calculation included Madagascar and the surface volume of the Caribbean plate, along with its compensation root. These volumes should be removed from analysis due to the abundance of nonvolcanic rocks (Boast and Nairn, 1982; Donovan and Jackson, 1994). When these volumes are removed, the adjusted total volume is 605,603,000 km^3.

Another interesting paper was written by Kovalenko et al. (2007) about the analysis of melt inclusions and quenched glasses from various geodynamic settings. Quenched glasses are frequently analyzed for the original volatile contents of the parent magma, but since degassing before solidification is almost always a concern (Carlson et al., 2006; Jambon, 1994), the measured H_2O contents in quenched volcanic glasses should be interpreted as minimum values. Nevertheless, Kovalenko et al. (2007) reported mean volatile values for mid-ocean ridge basalts, oceanic islands, and continental settings that take from the analysis of quenched glasses. The classification system used by Kovalenko et al. (2007) varies from Schubert and Sandwell (1989), but Table II unifies the two classification schemes.

Table II provides the mean for the H_2O values reported by Kovalenko et al. (2007) for the corresponding volcanic setting. Kovalenko et al. (2007) used the geometric mean for the H_2O content of the continental intraplate volatile data and the arithmetic mean for the H_2O content of oceanic island and mid-ocean ridge settings. When gravimetric analysis is applied to the information in Table II, a volume of 605,603,000 km^3 of basaltic magma would have yielded a total of 1.174×10^{23} grams H_20. Additionally, the total water calculated from both the continental Deccan and Siberian Traps from Table I is 1.604×10^{20} grams H_20 and can be added to the 1.174×10^{23} grams H_20 calculated for oceanic volcanism, yielding a total value of 1.190×10^{23} grams H_20. If 1.190×10^{23} grams of water were released into the atmosphere during the forty days of rain, then approximately 58.3 cm of rain would have fallen across Earth's surface every day for forty days. Although it is more desirable to individually quantify each LIP geochemically, as done in Table I (Froede, 2007), this estimate gives a "rough idea" for a minimum value of global precipitation during the Flood. Continental LIPs and other forms of volcanism are underrepresented in this study, but future research may quantify their hydrologic contribution to the Flood.

High Velocity Volcanism

Basaltic magma is capable of spectacular eruptions. A rapid ascent (> 1m/s, Wolff and Sumner, 2000) of a low viscosity mafic (basaltic) magma would create a lava fountain comprised of a central jet of gas (Austin et al., 1994; Gonnerman and Manga, 2007; Wolff and Sumner, 2000). Degassing by this method could have sent volatiles to extraordinary heights. Morgan et al. (2004) describe volatile-driven explosions that would have fractured cratonic rock and launched jets of volatiles high into the atmosphere. Diatremes, described by Morgan et al. (2004) as "verneshots," are funnel-shaped breccia pipes formed as a result of rapidly ascending, degassing basaltic magma. Kimberlites, famous for their association with diamonds, are examples of rocks found in diatremes (Evans, 1987; Heinrich, 1966; Milashev, 1984; Mitchell, 1986; Morgan et al., 2004; Smith, 1999c) and comprise approximately 30% of all diatremes (Milashev, 1984). The formation of kimberlites, along with their ascent rates, is debated. McGetchen and Ullrich (1973) have modeled ascent rates ranging from 25 m/s at 90 km deep to 334 m/s at the surface. Best (2003) reports ascent rates of 10–30 m/s and a surface exit velocity approaching 600 m/s. Velocities up to 1,200 m/s are discussed and discounted by Milashev (1984), but he concurs with exit velocities of 500 m/s. Any of these launch velocities would have sent volatiles several kilometers high into the atmosphere.

Best (2003) estimates that there are more than 5,000 kimberlite diatremes worldwide with an estimated volume exceeding 5,000 km^3. However, the original water content and density of kimberlitic magmas is uncertain. Shkodzinskii and Zol'nikov (1995) tested kimberlite melts with water contents between 10–20 wt %. O'Brien and Tyni (1999) report the water content of several kimberlite samples averaging 9.69 wt % H_20. The density of the original kimberlitic magma varies, with Katsube et al. (1999) reporting an average of 2.4 g/cc and McCallum and Eggler (1971) reporting a range from 2.66–2.72 g/cc. Therefore, if the values of 10 wt % H_20 and a specific gravity of 2.60 g/cc are chosen, then 5,000 kimberlite diatremes with a volume of 5,000 km^3 would have contributed approximately 0.25 cm of water across the entire earth's surface for one day. This modest volume of water from diatremes may conceal a disproportionately large

Table II. Compilation of the work of Schubert and Sandwell (1989) and Kovalenko et al. (2007).

Name	Setting Schubert and Sandwell (1989)	Setting Kovalenko et al., (2007)	Volume (10^6 km^3) Schubert and Sandwell (1989)	H_20 wt % Kovalenko et al. (2007)	Mass H_20 g
Broken Ridge	Oceanic Plateau	Mid-Ocean Ridge	12.4	0.29	1.043E+20
Caribbean	Oceanic Plateau	Ocean Island	34.964	0.43	4.360E+20
Caroline	Oceanic Plateau	Ocean Island	5.595	0.43	6.978E+19
Chagos Ridge	Oceanic Plateau	Mid-Ocean Ridge	24.991	0.29	2.1024E+20
Crozet	Oceanic Plateau	Con. Intraplate	9.449	1.66	4.549E+20
Emperor	Oceanic Plateau	Mid-Ocean Ridge	13.423	0.29	1.129E+20
Hess Rise	Oceanic Plateau	Ocean Island	9.081	0.43	1.132E+20
Iceland	Oceanic Plateau	Mid-Ocean Ridge	14.151	0.29	1.190E+20
Kerguelen	Oceanic Plateau	Con. Intraplate	44.655	1.66	2.150E+21
Magellan	Oceanic Plateau	Con. Intraplate	5.335	1.66	2.568E+20
Manihiki	Oceanic Plateau	Oceanic Island	13.092	0.43	1.633E+20
Marcus Wake	Oceanic Plateau	Oceanic Island	15.427	0.43	1.924E+20
Maud Rise	Oceanic Plateau	Oceanic Island	2.353	0.43	2.934E+19
Mid Pacific	Oceanic Plateau	Oceanic Island	21.469	0.43	2.678E+20
Mozambique	Oceanic Plateau	Oceanic Island	9.819	0.43	1.224E+20
Nazca Ridge	Oceanic Plateau	Mid-Ocean Ridge	9.165	0.29	7.708E+19
Ninetyeast	Oceanic Plateau	Mid-Ocean Ridge	23.738	0.29	1.996E+20
Ontong Java	Oceanic Plateau	Oceanic Island	50.677	0.43	6.319E+20
Shasky	Oceanic Plateau	Oceanic Island	13.007	0.43	1.622E+20
Wallaby	Oceanic Plateau	Oceanic Island	4.185	0.43	5.219E+19
Walvis	Oceanic Plateau	Mid-Ocean Ridge	16.224	0.29	1.364E+20
Agulhas	Con. Plateau	Oceanic Island	6.821	0.43	8.506E+19
Artic Ridges	Con. Plateau	Mid-Ocean Ridge	22.057	0.29	1.855E+20
Campbell	Con. Plateau	Oceanic Island	24.950	0.43	3.111E+20
Chatham	Con. Plateau	Oceanic Island	18.885	0.43	2.355E+20
Cuvier	Con. Plateau	Oceanic Island	2.351	0.43	2.932E+19
Exmouth	Con. Plateau	Oceanic Island	9.273	0.43	1.156E+20

(table continues on next page)

Table II (continued). Compilation of the work of Schubert and Sandwell (1989) and Kovalenko et al. (2007).

Name	Setting Schubert and Sandwell (1989)	Setting Kovalenko et al., (2007)	Volume (10^6 km^3) Schubert and Sandwell (1989)	H_20 wt % Kovalenko et al. (2007)	Mass H_20 g
Faeroe	Con. Plateau	Mid-Ocean Ridge	6.257	0.29	5.262E+19
Falkland	Con. Plateau	Oceanic Island	47.815	0.43	5.963E+20
Flemish Cap	Con. Plateau	Oceanic Island	3.570	0.43	4.452E+19
Galicia	Con. Plateau	Oceanic Island	3.624	0.43	4.519E+19
Lord Howe	Con. Plateau	Con. Intraplate	47.163	1.66	2.270E+21
Mascarene	Con. Plateau	Con. Intraplate	19.861	1.66	9.561E+20
Naturaliste	Con. Plateau	Oceanic Island	3.230	0.43	4.028E+19
Porcupine	Con. Plateau	Oceanic Island	3.689	0.43	4.600E+19
Queensland	Con. Plateau	Oceanic Island	8.325	0.43	1.038E+20
Rockall	Con. Plateau	Oceanic Island	9.668	0.43	1.206E+20
Shirshov	Con. Plateau	Oceanic Island	1.767	0.43	2.203E+19
Voring	Con. Plateau	Oceanic Island	2.518	0.43	3.140E+19
Austral	Thermal Swell	Con. Intraplate	0.290	1.66	1.396E+19
Bermuda	Thermal Swell	Con. Intraplate	0.286	1.66	1.377E+19
Canary	Thermal Swell	Con. Intraplate	0.719	1.66	3.461E+19
Cape Verde	Thermal Swell	Con. Intraplate	0.818	1.66	3.938E+19
Conrad	Thermal Swell	Mid-Ocean Ridge	0.276	0.29	2.321E+18
Hawaiian	Thermal Swell	Con. Intraplate	2.220	1.66	1.069E+20
Line Swell	Thermal Swell	Oceanic Island	1.657	0.43	2.066E+19
Marquesas	Thermal Swell	Con. Intraplate	0.401	1.66	1.930E+19
Midway	Thermal Swell	Con. Intraplate	0.272	1.66	1.309E+19
Rio Grande	Thermal Swell	Con. Intraplate	1.427	1.66	6.870E+19
Sierra Leone	Thermal Swell	Oceanic Island	0.496	0.43	6.185E+18
S Tasman	Thermal Swell	Con. Intraplate	0.439	1.66	2.113E+19
Tahiti	Thermal Swell	Con. Intraplate	0.303	1.66	1.459E+19
Tuamotu	Thermal Swell	Oceanic Island	0.975	0.43	1.216E+19
TOTAL			**605.603**		**1.174E+22**

contribution to the Flood due to high velocity launchings into the atmosphere (Dickens and Snelling, 2008). The suborbital presence of volatiles would have collapsed any existing vapor canopy and contributed additional precipitation to the Flood (Dillow, 1981; Hunter, 1996; Jorgensen, 1990; Whitcomb and Morris, 1961).

Not all hydrological contributions to the Flood would have necessarily been explosive and terrestrial. Comparatively uneventful submarine eruptions are currently the most common form of volcanic activity on earth (Fisher and Schmincke, 1984). Water condensed directly into seawater from LIP magmas would have increased eustatic sea levels during the Flood. Moreover, the sheer volume of the LIPs, coupled with their rapid emplacement, would have raised eustatic sea levels. Coffin and Eldholm (1994) estimate the volume of displaced water from the Ontong Java LIP alone would have elevated sea level by approximately 10 m. Moreover Austin et al. (1994) noted that newly emplaced magmas would also raise sea level by increasing crustal volume and note the MOR mountain range is believed to have displaced eustatic sea levels by more than 1,000 m.

Two existing creation science theories that explain rainfall during the Flood, the hydroplate and the catastrophic plate tectonics (CPT) theories, describe a wall of high velocity linear geysers at the Mid-Oceanic Ridge (MOR) (Austin et al., 1994; Brown, 2008). Although there are geological differences between deep-rooted, volcanic diatremes and subterranean linear geysers, both provide roles for volatiles changing Earth's atmosphere during the Flood.

Cause of Concentrated, Global Volcanism

Most geologists date LIPs within their uniformitarian framework rather than that of the Bible. As noted earlier, the one great geologic catastrophe in Biblical history was the Flood. Therefore, it is reasonable to assign LIP and diatreme formations to that event. Moreover, many of the LIPs are associated with active volcanism (hot spots) and are believed to have been formed quickly (Austin et al., 1994; Best, 2003; Coffin and Eldholm, 1994; Self et al., 2005; Sigurdsson, 2000b), thereby rendering present-day eruption rates inadequate for LIP formation.

Although the Bible tells us "why" God flooded Earth, it does not provide many details about "how" God flooded Earth. One vital clue appears in Genesis 7:11 (KJV, emphasis added): "*The same day* were all the fountains of the great deep broken up, and the windows of heaven were opened." If the fountains of the deep were magmas that erupted when they were "broken up," what could cause concentrated, global volcanic eruptions on the same day?

The ultimate source of magma is the mantle, where rocks exist as mainly crystalline and partially molten (Jeanloz, 2000). Mantle rock can be further melted in three ways: increasing heat, changing chemical composition, or decreasing pressure (Asimow, 2000). Decompression melting is considered the most common form of melting in the crust and mantle, and it is believed to occur with rock upwelling at the MOR (Asimow, 2000), while Hunter (2000) has proposed that rocks were decompressed globally by a miraculous change in the gravitational constant. Another alternative is that bolide impacts could have created areas of concentrated decompression worldwide and initiated the Flood.

Bolides are meteors, meteorites, or comets (Jackson, 1997; Smith, 1999d), and they frequently strike Earth. If bolides with sufficient size and velocity were to strike Earth, the impacts would cause decompression of the upper mantle through the creation of a cavity and lithospheric updoming (Fischer, 1994; Rampino and Self, 2000). Cavity formation would quickly remove substantial amounts of material at the impact sites, thus decompressing and melting the underlying rock (Jones et al., 2002; Smith 1999e). The new buoyant, less viscous magma would rise and add stress against the lower lithosphere, generating updoming, while fractured rock near the impact zone would provide conduits for magmas to extrude onto the surface (Faulkner, 1999).

Many investigators believe Earth was bombarded by bolides in the past (Gilmour and Koeberl, 2000; Glikson, 2001; Norman et al., 1977; Oard, 2009; Spencer, 1998a; Unfred, 1984; Whitcomb and Morris, 1961). In the shorter Biblical timescale, the impact events would have been catastrophic and probably associated with the Flood (Aldaney, 1992; Froede and DeYoung, 1996; Glikson, 2001; Oard, 2009; Parks, 1990; Unfred, 1984; Whitcomb and Morris, 1961). A rapid, global bombardment could have led to extensive fracturing, segmental upper mantle decompression, LIP emplacement (Jones, 2005; Jones et al., 2002), and diatreme emplacement (Oard, 2009). The modeled ascent speeds of kimberlite and basaltic magmas attest to the accuracy of the Bible's recording how the fountains of the great deep were "broken up" on the same day.

Bolides may have contributed to the Flood in other ways. If they struck water, the impact would have vaporized water near the impact area (Ingle and Coffin, 2004; Spencer, 1998b), which could have been carried into the upper atmosphere and returned to the surface as precipitation (Spencer, 1998b). Additionally, comets are comprised mainly of water (Campins et al., 2004; Dasch, 1996b; Hartmann, 1989); and if comets struck Earth, they would have been vaporized upon impact. The vaporized water could have been dispersed, condensed, and returned to Earth's surface as precipitation during the Flood (Spencer, 1998b). Therefore, under the scenario of global decompression from bolide impacts, the forty days of rain came from four potential sources: (1) liberation from volcanism, (2) destruction of vapor canopy, (3) vaporization of existing liquid water upon bolide impact, and (4) vaporization of bolides.

Some investigators have suggested that water vapor may not have significantly contributed to the Flood. This suggestion seems to be directed at water vapor condensing into liquid because life-threatening amounts of heat would have been released to convert enormous amounts of water vapor to liquid water (Baumgardner, 2002; Brown, 2008, p. 120; Dillow, 1981). The concentration of diatremes and LIPs in distinct regions across Earth's surface, along with the launching volatiles at various heights within the atmosphere, may have localized heat. Additionally, the global cooling effects from sulfur dioxide (Fischer, 1994; Jorgensen, 1990; Rampino and Self, 2000) and dust ejected from bolide impacts (Smith, 1999e; Spencer, 1998b) also could have helped to offset any atmospheric temperature increases from condensation (Dasch, 1996a). Dillow (1981) and Sibley (2004) reference volcanism, dust, and other cooling mechanisms.

Conclusion

The conjunction of the "fountains of the great deep" and "windows of heaven" at the beginning of the Flood suggests a causal relationship. This is reinforced by the impossibility of today's atmosphere providing sufficient rain for forty days. However, past voluminous magmatic emplacements with water contents measured today could have provided at least 58 cm of rain worldwide everyday for forty days. This calculated rainfall value is commensurate with our understanding of how diatremes, LIPs, and volcanism transformed Earth during the Flood.

Since the fountains of the deep were broken up on the same day the windows of heaven were opened, an abrupt catastrophic event must have triggered these phenomena. A global bolide impact event could have triggered tremendous crustal volcanism through decompression of the mantle and fracturing of the lithosphere. Moreover, bolide impacts may have initiated LIP emplacements and the launching of volatiles including water vapor through diatremes. LIPs and diatremes have ramifications for the hydroplate, CPT and vapor canopy models and offer a plausible explanation for globally dispersed, torrential rainfall during the Flood. Additional research is needed to more precisely quantify the water liberated from volcanic activity during the Flood.

There are over 40,000 volcanoes on Earth, with 1,500 of them active (Dasch, 1996b). If a singular global event gave rise to the Flood via global volcanism, the resulting volcanic activity would absolutely dwarf modern volcanic activity. A world where 40,000 volcanoes simultaneously erupt would be extremely dreadful and may very well be the world referred to in Genesis 7 and 8.

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CRSQ: Creation Research Society Quarterly

JOC: Journal of Creation

CENTJ: Creation Ex Nihilo Technical Journal (now Journal of Creation)

EPSL: Earth and Planetary Science Letters

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Appendix A

Total amount of water in the atmosphere (Trenberth and Smith, 2005): 1.27×10^{16} kg

Total amount of water in the atmosphere in gm: 1.27×10^{19} g

Total surface area of Earth (Dutch, 2007): 5.1×10^{8} km^2

Total surface area in cm^2: 5.1×10^{18} cm^2

Density of water: 1 g/cm^3 (Lindeburg, 2001).

Total volume of water in atmosphere: 1.27×10^{19} cm^3

Dividing the volume of total moisture by the total surface area yields the total water height over the total surface area of the earth:

$$(1.27 \times 10^{19}\ \text{cm}^3) \div (5.1 \times 10^{18}\ \text{cm}^2) = 2.49\ \text{cm}$$