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North American Precambrian Geology: A Proposed Young Earth Biblical Model

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NORTH AMERICAN PRECAMBRIAN GEOLOGY— A PROPOSED YOUNG EARTH BIBLICAL MODEL

Harry Dickens, Australia.

ABSTRACT

Precambrian geology, especially of the crystalline basement rocks, is complex. Consequently, understanding what appears to be its long and involved history is a challenge. This paper not only aims to help address this challenge, but also to interpret this history within a Young Earth biblical model. An overview of North America's Precambrian province geology is described and a geological history model for the whole continent is developed that aims to be consistent with both mapped regional geology and the Biblical record.

Correlation of Precambrian geological history with the sequence of acts chronicled in the Bible is based on interpreting key subjects such as mapped stratigraphy, the relative order of radiometric "ages", the role of water and regional heating events. Interpretation of radiometric date clusters, and thus thermal-tectonic events, was used to infer correlation with the biblical record. It is proposed that God instigated heating events and that with the heat of each event, radiometric "ages" were systematically reset to lower values. These "ages," or isotopic ratios, provide information on the history of crystallization and cooling of rocks.

On the basis of these date clusters, the principal thermal-tectonic events in North America are as follows:

1. Kenoran (late Archean) – associated with simultaneous cooling and convective heat dissipation of earlier hotter crust within individual Archean provinces, and the beginning of stable cratons.
2. Hudsonian (late Paleoproterozoic) - associated with internal deformation and further metamorphism of Archean provinces, as well as metasomatism.
3. Grenvillian (late Mesoproterozoic) - associated with huge thickening of continental crust and high mountain building.
4. Pan-African (late Neoproterozoic) – associated with massive rifting on the Cordilleran and Appalachian margins, as well as immense continental erosion and enormous water flows.

Biblical descriptions of Day One (initial global ocean and hovering over the waters), Day Two (the waters above and below), Day Three (dry land appears) and the early Noahic Flood (fountains bursting forth and rain) were respectively correlated with North America's Archean, Paleoproterozoic, Mesoproterozoic and Neoproterozoic geology (including Kenoran, Hudsonian, Grenvillian and Pan-African thermal-tectonic events) respectively. Some specific locations of pre-Flood geography were inferred in relation to today's Precambrian areas.

KEY WORDS

Creation days, Flood, thermal-tectonic event, North America, Precambrian provinces, Archean, Paleoproterozoic, Mesoproterozoic, Neoproterozoic.

INTRODUCTION

An earlier paper (Dickens and Snelling 2008) reviewed Precambrian geology on a global scale, but did not refer to individual mapped Precambrian provinces, together with their temporal and spatial relationships. To address this, the North American continent was chosen as a case study. It is a well-studied region of the Earth and provides among the most complete geological, geophysical, and isotopic data sets of any continent (Whitmeyer and Karlstrom 2007). The geology of successive Archean to Mesoproterozoic basement provinces, as well as the overlying Neoproterozoic sedimentary cover is outlined.

Due to the relative paucity of suitable fossils in Precambrian successions, and particularly their absence in crystalline basement rocks (including granite), radiometric dating is routinely used to indicate the "age" of Precambrian rocks. I consider that these "ages" are useful in a relative rather than absolute time sense. Resetting of "ages" due to heating events has global significance. Heating events are related in this paper not only to regional geology, but also to the biblical record.

METHODS

A search of scripture identified key verses considered to be relevant to geological history, along with their possible time sequence. This paper has a Young Earth biblical perspective of scripture: literal 24-hour six-day framework for Creation Week and the global Noahic Flood some centuries later. Dickens and Snelling 2008 provided a useful starting point for the concept and approach of this paper.

Through a search of the geological literature, I became aware of various aspects of North American regional geology and associated interpretations of geological history. A generalized geological map (Fig. 1) provides necessary basic data for the proposed geological history model as it shows major geological provinces, their principal rock types and relative ages. In this paper I use the terms

Archean, Paleoproterozoic, Mesoproterozoic and Neoproterozoic not as deep-time "Eons" or "Eras" but as mappable stratigraphic units having characteristic features. Relevant Bible verses, mapped regional stratigraphy and radiometric dates provided key data for the proposed time sequence model.

REGIONAL GEOLOGY

1. Radiometric "age" dates and heating events

Zircon is a commonly found as a trace constituent of most granitoid rocks. Zircons are resilient and contain high concentrations of important trace elements that include radiogenic isotope systems of geochronological importance, namely U-Pb and Th-Pb (Hawkesworth et al. 2010). A profound episodicity exists in the Precambrian geological record (O'Neill et al. 2013). Both igneous and detrital zircon populations show that major age peaks are global in extent (Condie and Aster 2010; Condie et al. 2017) (Fig. 2). The deformation age distribution of greenstone belts (most abundant at 2.70, 1.85, 1.05 and 0.60 Ga) is broadly similar to the age distribution of Precambrian granites and detrital zircons (Bradley 2011). Due to its hardness, durability and chemical inertness, zircon is a common constituent in detrital form in most sedimentary deposits (Fedo et al . 2003). Detrital zircon grains can be used for sedimentary sequence provenance studies (Rainbird et al. 2012).

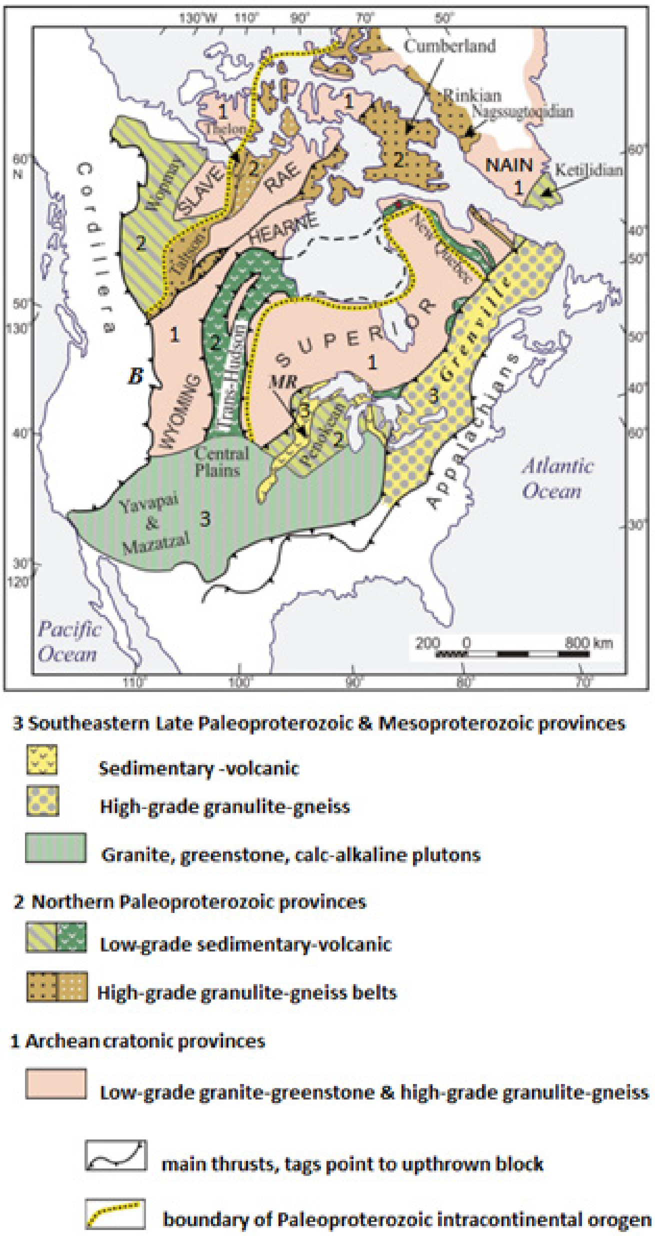

Figure 1. Generalized map showing North America and Greenland's major Precambrian provinces (with platform cover removed) and their principal rock types (after Mints, 2015). MR = Midcontinent Rift. B = approximate location of Belt-Purcell Basin. In this paper's proposed model, it is inferred that Archean to Mesoproterozoic geology formed during early Creation Week, and specifically that the 1, 2, and 3 numbering in this figure's legend respectively refers to provinces formation in Creation Days One, Two, and Three.

On the basis of clusters of radiometric dates (U-Pb, K-Ar, Rb-Sr) which occur in well-defined areas (provinces), the three principal thermal-tectonic events in the Canadian Shield have been named the Kenoran, Hudsonian and Grenvillian (King 1976; Stockwell 1964) (Fig. 2). Reworking of earlier provinces (and overprinting of earlier events) is indicated on the Tectonic Map of North America (King 1976). Regional patterns of radiometric ages are correlatable with field relationships mapped on a province scale (Fig. 2).

2. Archean provinces geology

The Earth's radiometrically oldest continental crust is exposed in Archean cratons (Zientek and Orris 2005). Archean provinces display intense deformation over their entire area and show no stable areas at all. In contrast, for most terranes other than the Archean, crustal deformation is restricted to narrow belts (Frazier and Schwimmer 1987). Archean metamorphism is distinctively a low-pressure/high temperature variety (Anhaeusser 1975). North America's Archean provinces include the Superior, Wyoming, Slave, Rae, Hearne, and Nain provinces (Fig. 1). The Superior Province is the world's largest Archean province. These provinces essentially consist of high metamorphic grade granulite-gneiss terranes and low-grade granite-greenstone terranes. The Archean contains the oldest rocks, including the Acasta Gneiss Complex in the westernmost Slave Province (Iizuka et al. 2007). Only Archean megacrystic anorthosites have a highly calcic composition (Ashwal 2010). Sedimentary rocks and pillow lavas occur in greenstone belts such as the Isua greenstone belt of southwestern Greenland (Sharkov and Bogatikov 2010).

Early Archean gneisses mainly consist of hydrous tonalite, trondhjemite and granodiorite (TTG) (Hamilton 2003). Greenstone belts are large and complexly-deformed belts which consist of thick and deeply infolded sequences of mainly mafic volcanics and associated sediments. Commonly granitic and gneissic rocks surround and locally intrude the greenstone belts. Greenstone belt sequences have been subjected to relatively low-grade metamorphism and contain komatiite (a high magnesium basalt) which has a high melting point, and which is characteristic of the Archean.

Archean greenstone belts commonly contain banded iron formations (BIFs) and are called Algoma-type after a location in Canada. These deposits are mined in the Superior Province's Abitibi greenstone belt and are rich in magnetite (Taner and

Chemam 2015). Banded iron formations (BIFs) consist of bands of iron oxide and chert.

Archean sedimentation in the Canadian Shield was dominated by the resedimented (turbidite) facies association of submarine fans—greywacke, mudstone-siltstone, and conglomerate. Archean sedimentary rocks consist largely of greywacke—an immature sandstone containing abundant mafic minerals like hornblende and biotite (Dickens and Snelling 2008).

Archean stromatolites are found in sedimentary carbonate rocks, almost always associated with extensive volcanic sequences (Hofmann 2000). Millimeter -scale layers of fine ash at regular intervals attest to periodic explosive volcanic eruptions during deposition of microbial mats in the Back River volcanic complex of the Slave Province (Lambert 2011). Stromatolites are more abundant in Paleoproterozoic and Mesoproterozoic sediments (Hofmann 1998) along with extensive carbonates (Lucas and St-Onge 1998). North American carbonates and quartz arenites are much less well developed in Archean strata (Okajangas 1985).

Archean greenstone belts have economically significant gold and other metals deposits (Rey at al. 2013). Most major lode gold deposits have a late Archean "age" (Cameron 1988). The Abitibi greenstone belt of the Superior Province, for example, contains world-class copper-zinc massive sulphide orebodies as well as banded iron formation (Pirajno 1992; Taner and Chemam 2015). There is a large zircon "age" peak in the late Archean geology of North America and all continents (Bradley 2011; Condie 2018; O'Neill et al. 2013; Voice et al. 2011) (Fig. 2).

3. Northern Paleoproterozoic provinces geology

There is a remarkable change in tectonic style going from Archean granite-greenstone terrane and high-grade granulite-gneiss metamorphic terrane to the adjacent linear Proterozoic belts (Frazier and Schwimmer 1987). Proterozoic tectonic style was indeed different from the permobile style of the Archean, but it also differed from that of the Phanerozoic in that intracontinental deformation and igneous activity were much more extensive than they have been since (Frazier and Schwimmer 1987).

North America's Paleoproterozoic provinces (Fig. 1) largely consist of two types (Mints 2007):

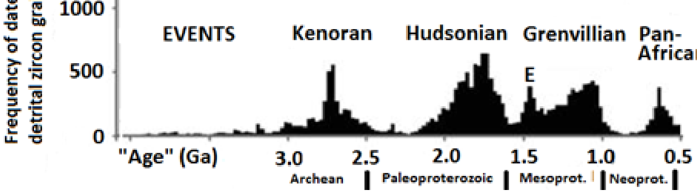

Figure 2. Age frequency distribution of detrital zircon U-Pb radiometric "ages" from North America, with corresponding significant thermal-tectonic Events and proposed correlation with the Biblical record. E = Elsonian Event (figure modified from Voice et al., 2011). The presence of four dominant "age" peaks globally on each individual continent, in all major tectonic settings, and in modern sediments implies the episodic nature of crustal processes (Voice et al. 2011). These four global peaks correspond to North America's Kenoran, Hudsonian, Grenvillian and Pan-African Event peaks.

Low metamorphic grade sedimentary-volcanic belts (greenschist to low-temperature amphibolite facies metamorphism) and granulite-gneiss belts (with a predominance of high-temperature amphibolite to ultrahigh-temperature granulite facies). Northern Paleoproterozoic provinces include the low metamorphic grade Trans-Hudson, New Quebec, Penokean, Wopmay and Ketilidian belts, together with the high metamorphic grade Talston-Thelon belt, as well as the Cumberland, Rinkian and Nagssugtoqidian provinces (Fig. 1).

The Trans-Hudson Province is the largest and best exposed Paleoproterozoic belt in North America (Zhao et al. 2002). This belt has Archean provinces on both sides. Deep seismic reflection lines (Nelson et al. 1993) indicate that the Trans-Hudson province has a complex structure that dips to the west in the west and to the east in the east. The North American Central Plains (NACP) conductivity anomaly, a very large electrical conductor delineated by electromagnetic induction studies, is colinear with the Trans-Hudson province (Alabi et al. 1975). In the Trans-Hudson Province of northern Saskatchewan, uranium-thorium-hosted granitic pegmatites have an intrusive relationship to Early Paleoproterozoic metasedimentary rocks and interfolded granitoids that unconformably overly Late Archean gneisses.

Economic sources of unconformity-related uranium occur in association with Paleoproterozoic basins such as Canada's Athabasca Basin that contains the highest-grade and largest deposits of this type in the world (Hanly et al. 2006). Early Paleoproterozoic gold-uranium conglomerates are found at Elliot Lake and the Huronian Supergroup of Canada (Pirajno 1992). Supposedly "glacial" diamictite is found in locations such as the Huronian Supergroup (Bekker et al. 2005). Paleoproterozoic basins, such as the Athabasca and Thelon of northern Canada, contain detrital zircons of similar "age" to the Trans-Hudson Province. (Rainbird et al. 2012). Paleoproterozoic sediments of Arctic Canada contain sedimentary structures indicative of incised valleys and sheet-braided rivers (Ielpi and Rainbird 2016).

Worldwide, by far the most important type of banded iron formations are located in relatively undeformed Paleoproterozoic sedimentary basins that have unconformable contacts on granite-greenstone terrains (Lascelles 2013). These Superior-type deposits are large in dimensions (more than 100 meters in thickness and over 100 km in lateral extent) (Evans et al. 2013). Superior-type BIFs contain most of the world's hematite-goethite ore deposits (Douglas 1970). The Marquette Lake deposit is an example of a Superior-type deposit in the Penokean Province (Schmidt 1980).

Sediment-hosted copper deposits first appear in the Paleoproterozoic. Precambrian chemical sediments are said to have changed from mainly sulphide facies before 1.85 Ga to predominantly oxide facies (Slack and Cannon 2009). Metamorphic microdiamonds have been found to contain high concentrations of nitrogen within Paleoproterozoic magmatic rocks at Nunavut, Canada (Cartigny et al. 2004).

There is a large zircon "age" peak in the late Paleoproterozoic geology of North America and all continents (Bradley 2011; Condie 2018; O'Neill et al. 2013; Voice et al. 2011) (Fig. 2).

4. Southeastern Proterozoic provinces geology

In striking contrast to most of North America's older Proterozoic provinces, the lithosphere of southeastern North America has an overall northeast-southwest regional trend. This includes the Late Paleoproterozoic Yavapai and Mazatzal provinces, as well as the Mesoproterozoic Grenville Province (Fig. 1). These northeast-trending provinces are characterised by voluminous granitoid plutonism (Mints 2015; Whitmeyer and Karlstrom 2007). The principal Mesoproterozoic province of North America is the Grenville Province. In addition, there are significant Mesoproterozoic rift basins. These include the Midcontinent Rift Basin (also known as the Keweenawan Rift) which is largely basaltic, and the Belt-Purcell Basin which is mainly sedimentary (Fig. 1).

The Grenville Province is characterized by extremely high grades of metamorphism (amphibolite and granulite facies) in both basement terranes and supracrustal rocks of the Grenville Supergroup. Rock types are ensialic with quartzofeldspathic gneisses and metasediments including marble (Davidson 1998). Regions of similar isotopic signatures and geochemistry have been found in other parts of the world, including Western Australia, and have been correlated with the Grenville Province (Van Kraendonk and Kirkland 2013).

The Midcontinent Rift Basin contains thick Mesoproterozoic basalt lavas (15 to 20 km) and an overlying Neoproterozoic terrigenous sedimentary sequence (Allen et al. 2015; Hoffman, 1989) and has been extrapolated southwestward beneath Phanerozoic cover on the basis of gravity and magnetic anomalies (Davidson 1998). The basalts are tholeiitic and host world-class copper deposits (Presnell 2004).

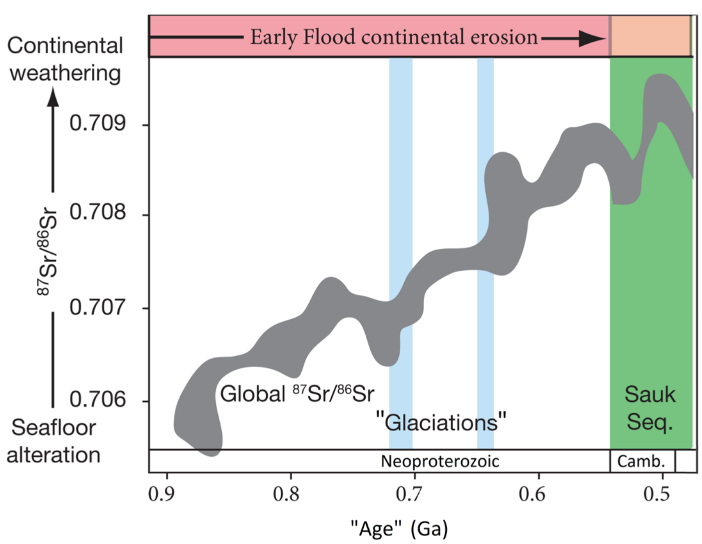

Figure 3. Summary of major geochemical and sedimentary patterns derived from Neoproterozoic to Cambrian strata (modified from Peters and Gaines 2012). I infer that: 1) The observed increase in Neoproterozoic strontium isotope ratios $^{87}Sr/^{86}Sr$ can be explained by accelerated rates of erosion due to the impact of the early Flood's rain on the supercontinent and to associated Pan-African Event tectonism., and 2) The subsequent decline in $^{87}Sr/^{86}Sr$ ratio in post-Cambrian strata may be due to the globe being totally covered with ocean so that the Flood's rain no longer directly impacted the land.

The Belt-Purcell Basin is found on the western margin of North America but is considered here along with the southeastern Proterozoic provinces because it has a similar "age". It outcrops over an area of about 200,000 km^2 (Lydon 2007). This sedimentary basin is enormously thick, ranging from about 6 km in thickness along its eastern margin to a probable maximum of 20 km in the centre of the Belt Basin (King 1976). Rock types include clastics, carbonates and volcanics (Lydon 2007). Throughout much of their extent, these rocks have been subjected only to lower grades of metamorphism and still retain their primary sedimentary structures (Frazier and Schwimmer 1987). Belt-Purcell rocks are overlain across a slight unconformity by the Neoproterozoic Windermere Group – a westward-thickening group of mainly detrital sediments up to 6 km thick (Frazier and Schwimmer 1987). The Belt-Purcell Basin hosts the world-class Sullivan sedimentary-exhalative (SEDEX) stratiform lead-zinc deposit (Presnell 2004).

Grenville-age detrital zircon comprises a significant proportion of most sedimentary successions in western and southeastern North America (Rainbird et al. 2012). In western North America this includes northwest Canada (Rainbird and Young 2009) and the central Cordillera of California and Nevada (Fedo et al. 2003). There is a large zircon "age" peak in the late Mesoproterozoic geology of North America and all continents (Bradley 2011; Condie 2018; O'Neill et al. 2013; Voice et al. 2011) (Fig. 2).

5. Neoproterozoic sedimentary cover geology

Neoproterozoic sedimentary cover is found in areas such as the Appalachians, and the Cordillera (Fig. 1), as well as cratonic sequences (Frazier and Schwimmer 1987; Schermerhorn 1974). There is a significant $^{87}Sr/^{86}Sr$ ratio increase in Neoproterozoic successions in North America of "age" between 0.9 Ga and 0.5 Ga (Peters and Gaines 2012) (Fig. 3). The Neoproterozoic to Lower Paleozoic geology of North America is characterized by thick sedimentary successions in rift basins and extensional-margin sedimentary wedges (Miall 2008). In the Grand Canyon, the 'Great Unconformity' is the contact between underlying either Paleoproterozoic crystalline basement or tilted Neoproterozoic Chuar Group sediments, and overlying Paleozoic layered sediments. This unconformity is traceable across North America (Peters and Gaines 2012; Timmons et al. 1999).

Lower Neoproterozoic sequences in North America contain braided-type well-sorted sheet sandstones. These sequences contain Grenville-age detrital zircons in regions such as northwestern Canada, southeastern North America and overlying basaltic rocks in the Midcontinent Rift Basin (Krabbendam et al. 2017; Rainbird et al. 1997). In contrast, mid-Neoproterozoic deposits are mainly poorly sorted immature clastic sediments, with lesser volcanic rocks, and are characterized by deposits commonly interpreted to be "glacial" (Hoffman 1989). The geochemistry of Neoproterozoic cap carbonates, which overlie "glacials", carries a strong hydrothermal signal (Young 2013). The Rapitan Group of the lower Windermere Supergroup in Canada consists of mixtite, siltstone, shale, sandstone (including arkosic sandstone), volcanic ash and tuff, as well as banded iron formation (Baldwin et al. 2012; Frazier and Schwimmer 1987).

High-pressure metamorphic/orogenic belts are restricted to rocks

of "age" < 0.6 Ga (Brown 2007). It has been claimed that there are no ophiolites or blueschists in rocks older than Neoproterozoic (Hamilton 2011). There is a large zircon "age" peak in the late Neoproterozoic geology of North America and all continents (Bradley 2011; Condie 2018; O'Neill et al. 2013; Voice et al. 2011) (Fig. 2).

DISCUSSION

1. Radiometric "age" dates and heating events

There are regional patterns in radiometric dates that can be systematically related to different Precambrian geological provinces (Fig. 1). A relative time sequence of geological formations can be deduced from Precambrian rocks using observable measurable data such as field relationships and isotopic ratios. However, interpretation of the absolute age of formations is debatable, based on uniformitarian assumptions on matters such as process rates. Granitoid rocks are key targets for radiometric dating as they commonly contain zircon. Deep-time is not necessary for the generation of granitic magmas and their subsequent intrusion, crystallization, and cooling. Crystallization and cooling would be facilitated by hydrothermal convective circulation (Snelling 2008). The growth of large crystals from magmas within hours has now been experimentally determined (London 1992).

Zircon ages do not usually correspond to peak metamorphism but instead provide information on the history of cooling from high temperatures, including the timing and rates of exhumation of the deep hot roots (foundations) of mountain chains (Harley et al. 2007). "Age" peaks are associated with major tectonic and magmatic events, including inferred addition of new continental crust, orogeny (mountain building), voluminous high temperature volcanism, massive mantle depletion, and mineralization (O'Neill et al. 2013). Continental crust has been said to be the archive of the "deep-time" geological history of the Earth (Hawkesworth et al. 2010; Roberts and Spencer 2015).

> *"For a fire is kindled by my anger, and it burns to the depths of Sheol, devours the earth and its increase, and sets on fire the foundations of the mountains*" (Deuteronomy 32:22 ESV).

God is said to have set on fire the foundations of the mountains. Whether this particular verse is literal or poetic, God is certainly capable of literally setting on fire the foundations of the mountains. Consistent with this, mineral assemblages provide evidence of ultrahigh-temperature metamorphism (900^{0}C-1100^{0}C) during mountain building (Harley et al. 2007). In addition, the day of the Lord described in 2 Peter 3 has repeated references to the effect of heat.

Four heating events (Kenoran, Hudsonian, Grenvillian and Pan-African) (Fig. 2) are believed to be key to the creation of Precambrian stratigraphy in North America. I propose that God supernaturally instigated heating episodes (thermal-tectonic events) which drove cataclysmic geological processes around the globe. That is, I propose that the geological work which took place on each of Day One, Day Two and the earlier part of Day Three was the result of divine actions involving three global heating episodes. Each heating event would have reset the "ages" to lower values. Thus, Precambrian crystalline basement rocks, with their radiogenic "age" clusters, are considered to be geoscientific evidence of the Creator's actions in early Creation Week. In addition, Noah's Flood is considered to have been initiated by God causing the mantle to heat in a fourth global heating episode and so drive out water to the Earth's surface. The subsequent rain eroded the land, the resulting detritus was entrained in flowing water and sedimentary cover sequences were then deposited over crystalline basement.

> *For by him [Jesus] all things were created, in heaven and on earth, visible and invisible, whether thrones or dominions or rulers or authorities—all things were created through him and for him. And he is before all things, and in him all things hold together.* (Colossians 1:16-17 ESV).

"All" includes atoms. Therefore, Jesus (by whom the universe was created) could also allow atoms to transform or transmute, for both creative purposes (such as growth of continental crust in the early Creation Week) and destructive purposes (such as flooding the whole Earth in Noah's time). It is suggested that episodes of accelerated radioactive decay may have provided the heat source for thermal-tectonic events which drove cataclysmic geological processes around the globe. This decay acceleration would also give the appearance of enormous age, since radiometric "clocks" would have ticked faster (Vardiman et al. 2003). However, the original radiometric "age" for the Earth (ca 4.6 Ga) is based on meteorites and may actually be an artefact of isotopic ratios from the beginning of Creation (Snelling 2015). In either case, subsequent heating events would have reset the "ages" to lower values. Such thermal resetting of radiometric ages is described in the literature (e.g., Harley et al. 2007; Nyquist et al. 1991). Regional patterns of radiometric ages are correlatable with field relationships mapped on a province scale (Fig. 2).

It has been estimated that the early Earth had a greater quantity of radionuclides, resulting in greater amounts of interior heat and that radiogenic heat production declined at a geometric rate throughout the Archean so that lithosphere thickness probably increased with time as the actual amount of heat decreased (Frazier and Schwimmer 1987). Higher temperature conditions are indicated by the presence of komatiite in Archean provinces. An overall cooling Earth would have influenced the depths and hence the geochemical signatures at which melt generation takes place, as well as the rheology of the crust and lithosphere which in turn would have influenced tectonic processes. In addition, the lithosphere is believed to have thickened and crustal reworking increased, resulting in higher erosion fluxes and changes in ocean chemistry (Hawkesworth et al. 2016).

It is suggested that heating events drove cataclysmic geologic processes during the early part of the Creation Week Days One to Three, fashioning the land to be inhabited (Isaiah 45:18) while avoiding damage to life created on Days Five and Six. This fits the model proposed, with radioisotope ages indicating relative order and rocks being rapidly 'aged' during the early Creation week through the Archean-Mesoproterozoic (Dickens and Snelling 2008).

2. Archean provinces history

A.. Watery early world

> *The earth was without form and void, and darkness was over the face of the deep. And the Spirit of God was hovering over the face of the waters*. (Genesis 1:2 ESV).
>
> *For they deliberately overlook this fact, that the heavens existed long ago, and the earth was formed out of water and through water by the word of God* (2 Peter 3:5 ESV).

The Earth's continental crust appears to be unique compared with crusts on other planets and satellites in the solar system, as a result of the Earth's abundant free water (Taylor and McLennan 1995). "Water is essential for the formation of granites, and granite, in turn, is essential for the formation of stable continents. The Earth is the only planet with granite and continents because it is the only planet with abundant water." (Campbell and Taylor 1983). It has been claimed that for the major part of the Earth's fluid history, fluid transport was mostly one way, from the outer core to the surface and that the rifting of continents during orogenic events delivered mantle water to the surface (Santosh et al. 2010).

Before Day Three there is no mention of land, but there is mention of the "deep" or ocean, so one can infer that there was a global ocean which from space appeared to be without topographic relief and empty (Dickens and Snelling 2008). The description of water on Day One (in the beginning) is proposed to relate to the role of water in the Archean. The Spirit of God hovering upon the waters (Genesis 1:2b) may imply shaking or vibrating, with convection cells operating in the waters and in the hot crustal rocks below. There may have been submarine volcanic mountains and turbidite facies associated with submarine fans, but no shelf deposits (Dickens and Snelling 2008). The Archean is said to have had a permobile tectonic regime whereby there were no stable areas (Burke et al. 1976). This is believed to relate to the idea of convective dissipation of heat generated in the early Earth (Burke et al. 1976).

It has been inferred that water was important for early Archean granitoid (tonalite-trondhjemite-granodiorite)(TTG) petrology, with hydrous basaltic melts as parental liquids, undergoing extensive fractional crystallisation (Hamilton 2003; Kleinhanns et al. 2003). Indeed, there is evidence for granitoid formation processes in the presence of liquid water oceans on the early Earth (Iizuka et al. 2007). The high water content of parental melts may explain the highly calcic composition only found in megacrystic anorthosites of the Archean (Ashwal 2010). The occurrence of sedimentary rocks and pillow lavas (products of submarine eruption) in the Isua greenstone belt of southwestern Greenland indicates that water basins existed in the early Archean (Sharkov and Bogatikov 2010). Archean banded iron formations have been interpreted as formed in deep water below wave base (Pirajno 1992). The minimal development of Archean carbonates and quartz arenites in North America implies a lack of stable shelf areas (Okajangas 1985). From the observation that most Archean continental flood basalts were emplaced on flooded continents, a theory was proposed for the hypsometry of the early Earth showing that most Archean continental crust was flooded and the Earth was largely a water world. (Rey et al. 2013).

B. Tectonism

Most models for the generation of new continental crust involve differentiation of basalt, by fractional crystallization to higher silica compositions (Hawkesworth et al. 2010). In other words, melting of mafic rock may produce a surface crust composed mainly of less dense, more buoyant rocks of granitoid composition. Crust formation is related to heat generation (stern et al. 2007). Thus there are believed to be links between granite magmatism, high-grade metamorphic events and crustal growth (Hawkesworth et al. 2010). The formation, rise, and emplacement of granitoids via dikes may only take days and so millions of years are not necessary (Snelling 2008).

The paleomagnetic record provides evidence that the Precambrian continental crust was essentially intact from the Archean to the Neoproterozoic (Piper 2015). Mints (2018) has written an alternative to the model of supercontinent cycles. This involves growth of an Archean to Neoproterozoic supercontinent during, and as a result of, high-temperature events accompanied by granulite-facies metamorphism.

For most terranes other than the Archean, crustal deformation is restricted to narrow belts (Frazier and Schwimmer 1987). In contrast, Archean terranes have intense deformation over their entire area. This indicates that rigid lithospheric plates, at least as known today, may not have existed in the early Earth and that modern-style plate tectonic processes may not have been involved. Archean tectonism may have been dominantly intracontinental deformation as the hotter crust would have been far too weak and mobile to behave as rigid plates (Hamilton 2003, Hamilton 2007). Thus with high heat flow, the Kenoran Event would have had tectonism and magmatism, but not necessarily orogeny since the hotter crust may have been too weak to support high mountains. The Archean may only have had subdued topography (< ca. 2000 m) (Rey et al. 2013).

It has been claimed that bedrock mapping and associated geochronology of the Superior Province provides evidence that microcontinental fragments and juvenile oceanic terranes were amalgamated into a composite Superior superterrane in a series of orogenic events at ca. 2.7 Ga (Percival et al. 2004). However, an alternative interpretation to the amalgamation idea, based on the paleomagnetic record, is that the Precambrian continental crust was essentially intact from the Archean to the Neoproterozoic (Piper 2015). This interpretation is more consistent with the idea of the progressive growth of only one supercontinent from Day One to the first part of Day Three. There is no indication of numerous supercontinent cycles in the Bible.

The Kenoran Event or so-called "orogeny" was defined on the basis of ca. 2.5 Ga K-Ar ages from provinces including the Superior, Slave and Nain Provinces (Stockwell 1964). The Kenoran Event is associated with simultaneous tectonism in North American Archean provinces. The Kenoran Event has been described as the last important period of widespread folding, metamorphism and intrusion in the Canadian Shield, with the Superior Province chosen as the type region (Stockwell et al. 1970). The late Archean age peak is thought to represent coincidental cooling within individual provinces (Percival 2004) and the beginning of stable

cratons (Frazier and Schwimmer 1987). This is the first global pulse of crustal generation as reflected by the large late Archean zircon "age" peak (Condie 2018) (Fig. 2).

C. Foundations of the Earth

> *"And I have put my words in your mouth and covered you in the shadow of my hand, establishing the heavens and laying the foundations of the earth, and saying to Zion, 'You are my people.'"* (Isaiah 51:16 ESV)
>
> *"Where were you when I laid the foundation of the earth? Tell me if you have understanding.*" (Job 38:4b ESV)

Archean cratons may have cold mantle roots (Hoffman 1990) that extend twice as deep (to about 200 km) as the lithosphere beneath younger continental crust and thermally mature ocean basins. Evidence in favor of this includes the correlation of these cratons with areas of high shear-wave velocities, low surface heat flow and high lithospheric flexural rigidities (Dickens and Snelling 2008). Mantle roots of Archean cratons may be considered as the foundations of the Earth's crust. Most major lode gold deposits formed in the late Archean, corresponding to the principal time of crustal thickening and stabilization, and was associated with the formation of granulite, the anhydrous, refractory base for the crust (Cameron 1988).

D. Hydrothermal activity

"Archean greenstone belts are richly endowed with gold and other metals deposits. On flooded continents, an infinite fluid reservoir was available to feed crustal-scale hydrothermal circulations promoting the formation of craton-wide metal deposits in the interior of continents, far away from their margins." (Rey et al. 2013). The world-class copper-zinc massive sulfide orebodies of the Abitibi greenstone belt of the Superior Province are considered to have formed as chemical precipitates from submarine hydrothermal volcanic vents (Pirajno 1992). Gold deposits of Archean greenstone belts are also said to have a hydrothermal origin (Pirajno 1992).

The origin of a typical Algoma-type banded iron formation (BIF) in the Abitibi greenstone belt is said to be closely related to regionally extensive submarine hydrothermal activity associated with the emplacement of volcanic and related subvolcanic rocks. (Taner and Chemam 2015). Earlier models of BIF formation referred to the slow deposition of annual micro-laminations over millions of years (for example, Garrels 1987). However, episodic and rapid deposition of turbidity and density currents may have only lasted a few hours to days! (Dickens 2017a; Lascelles 2013). Modern interpretations consider BIFs as deep sea sediments with iron and silica sourced from reactions between circulating sea water and hot mafic to ultramafic rocks as hydrothermal systems vented onto the sea floor. Hot acidic hydrothermal fluids would immediately precipitate colloidal particles of iron hydroxide and iron silicates on quenching by cold neutral seawater (Lascelles 2013). Banded iron formations (BIFs) are concentrated in the later Archean and Paleoproterozoic regions (Groves et al. 2005), with a few small occurrences in the Neoproterozoic (Reddy and Evans 2009).

> "*.. worship him who made heaven and earth, the sea and the springs of water*." (Revelation 14:7b ESV).
>
> "*.. when he established the fountains of the deep."* (Proverbs 8:28b ESV)

Springs and fountains may have included sites in the vicinity of hydrothermal areas where stromatolitic structures formed. The Bible's first mention of the creation of lifeforms is that of seed-bearing land plants on Day Three (Genesis 1:11-12). The Bible does not give a comprehensive listing of lifeforms created. Thus cyanobacteria in the form of stromatolites may have been present even on Day One. Fully-functioning stromatolites and even stromatolite reefs may have been created by God before Day Three along with the carbonate sediments on the floor of the pre-Flood global ocean (Purdom and Snelling 2013; Wise 2003). Death referred to in the Bible applies to "nephesh" organisms. and since stromatolites are not "nephesh" organisms, they could have died during the Creation Week and not violate God's "very good" creation.

In summary, it is proposed that Day One processes be correlated with the development of Archean provinces along with North America's Kenoran Event (Fig. 2).

3. Northern Paleoproterozoic provinces history

A. Movement of waters

> *And God said, "Let there be an expanse in the midst of the waters, and let it separate the waters from the waters." And God made the expanse and separated the waters that were under the expanse from the waters that were above the expanse. And it was so. And God called the expanse Heaven. And there was evening and there was morning, the second day.* (Genesis 1:6-8 ESV).

The Hebrew word râqîyaʿ (רָקִיעַ) is translated as the expanse (ESV) or firmament (KJV) and has Strong's Concordance number H7549, which indicates that this apparently represents the visible arch of the sky. This Hebrew word is also used on Day Five of Creation Week where "birds fly above the earth across the expanse of the heavens." (Genesis 1:20 ESV). The same word is also used on Day Four of Creation Week with "lights in the expanse of the heavens to separate the day from the night". Thus, there is a sense of vertical separation of water. It has been claimed that for the major part of the Earth's fluid history, fluid transport was mostly upwards, from the outer core to the surface and that the rifting of continents during orogenic episodes delivered mantle water upwards (Santosh et al. 2010). I believe that such a process is consistent with the operation of major episodes of proposed fluid flow on Day Two and with Noahic Flood fountains, that can be inferred from some common features of Paleoproterozoic and Neoproterozoic geology.

Provenance analysis using zircon grains has been used to infer that big river systems transported Paleoproterozoic sediments, shed from the Trans-Hudson Province to northern Canada (basins such as the Athabasca and Thelon). (Rainbird et al. 2012). These Paleoproterozoic sediments may have resulted from erosion as continental crust thickened during the Hudsonian Event on Day Two (Dickens 2017b). In addition, sheet-braided rivers and incised paleovalleys have been inferred from Paleoproterozoic sediments of Arctic Canada (Ielpi and Rainbird 2016). I suggest that such deposits also resulted from a great tectonic movement (Hudsonian Event) during Day Two.

B. Paleoproterozoic tectonism

Various North American Archean provinces have commonly been interpreted to have been "welded together" by Paleoproterozoic belts (Hoffman 1989; Hoffman 1998; Presnell 2004). In a global review, North American Archean provinces have been said to have sutured along 1.9–1.8 Ga orogens including the Trans-Hudson, Penokean, Wopmay and Nagssugtoqidian (Fig. 1) (Zhao et al. 2002). However, an alternative view is that as Proterozoic provinces developed, they underwent deformation and thickening but without the major fragmentation, widespread dispersion and collision of continents typical of the post-Permian (Engel and Kelm 1972; Hamilton 2011). Proterozoic magnetostratigraphy provides evidence that the Hudsonian Event is associated with internal deformation and further metamorphism of Archean provinces, rather than with dismemberment and continental drift (Irving et al. 1976). This is consistent with the idea of the progressive formation of only one Precambrian supercontinent (Mints 2018; Piper 2015) by Day Three.

The Trans-Hudson Province is believed to have involved internal rifting rather than collision between two Archean continental blocks (Mints 2015). It is suggested that the region of the North American Central Plains (NACP) conductivity anomaly (the Trans-Hudson province) was a site where hydrothermal fluids burst out, consistent with vertical separation of waters on Day Two. Rock sampling has provided evidence that migration of sulfides during tectonism is responsible for the anomaly (Jones et al. 2005). Subsequent recovery provided compressional thickening (Hamilton 2007).

Apparently ensialic Paleoproterozoic belts were involved in large-scale reworking (remobilization and further metamorphism) of Archean basement (Frazier and Schwimmer 1987). Vertical tectonic motions have been inferred (Anhaeusser 1975). On Day Two, submarine mountains may have formed with North America's Hudsonian Event and prior to the emergence of land on Day Three. The claimed rise in atmospheric oxygen in the Paleoproterozoic (called the "Great Oxygenation Event") has been related to tectonism (Lee et al. 2016; Och and Shields-Zhou 2012).

C. Some common features of Paleoproterozoic and Neoproterozoic geology

1. Lithologies

A review of tectonic settings of late Neoproterozoic "glaciogenic" rocks and Paleoproterozoic (Huronian) "glaciogenic" rocks, found a preponderance of settings interpreted as rift related (Eyles 2008). The geochemistry of Neoproterozoic cap carbonates carries a strong hydrothermal signal and Paleoproterozoic (Huronian) carbonates have been interpreted to have formed in a hydrothermally influenced, restricted rift setting (Young 2013). "Glacials" of Early and Late Proterozoic successions have a close association with sedimentary rocks formed in warm climates (Young 2013). Warm, not cold, weathering conditions have been interpreted from the occurrence of minerals such as kaolinite and diaspore in parts of the Huronian Supergroup (Nesbitt and Young 1982). I infer that these features described for Paleoproterozoic and Neoproterozoic strata are related to effects of the movement of hydrothermal fluids in a rifting environment during Day Two and the early Flood, respectively. The Paleoproterozoic "glacio-epoch", exemplified by the Huronian Supergroup of Ontario, Canada and strata in the U.S., is associated with rifting (Eyles 2008).

Transfer of carbon dioxide to the ocean during rifting may have enabled rapid precipitation of calcium carbonate in warm surface waters. This could have caused the precipitation of cap carbonate rocks over Neoproterozoic mixtites which are observed globally (Shields 2005) and observed in North America's Paleoproterozoic (Bekker et al. 2005). I interpret both the Paleoproterozoic and Neoproterozoic mixtites as mass flow deposits rather than "glacials".

> *"Or who shut in the sea with doors when it burst out from the womb"* (Job 38:8 ESV)

A pouring out of volcanics and associated hydrothermally-formed banded iron formations in the Paleoproterozoic and Neoproterozoic (Barley et al. 1999; Pirajno 1992) is inferred to have occurred catastrophically on Day Two and in early Flood, respectively. The main iron oxide mineral in Superior-type and Rapitan-type BIF is hematite (Fe_2O_3) and this may have appeared blood-colored (Dickens and Snelling 2008).

2. Atmosphere growth

> *…when he made firm the skies above* … (Proverbs 8:28a ESV)

It has been claimed that there were rises in atmospheric oxygen in both the Paleoproterozoic and Neoproterozoic, and that these were related to tectonism (Lee et al. 2016; Och and Shields-Zhou 2012) and magmatism (Ciborowski and Kerr 2016). These inferred episodes of increased atmospheric oxygen are called in the secular literature the "Great Oxygenation Event" (GOE) and the "Neoproterozoic Oxygenation Event" (NOE), respectively. It is suggested that God used the GOE on Day Two to prepare the Earth's atmosphere for life on Earth.

The "Great Oxygenation Event" has been indicated by sulfur isotopes and base metal sulfide deposits. Sediment-hosted copper deposits first appear in the Paleoproterozoic and their formation is ascribed to the reaction of oxidized copper-bearing solutions with sulfide-containing solutions at the site of deposition (Farquhar et al. 2010). Oxygenation associated with volcanism has been described (Gaillard et al. 2011; Lyons et al. 2006; Macouin et al 2015). Metamorphic microdiamonds containing high concentrations of nitrogen within Paleoproterozoic magmatic rocks at Nunavut, Canada (Cartigny et al. 2004) may be evidence for volcanic degassing also enriching the Earth's atmosphere with nitrogen.

3. Radioactive mineral deposits and fluid flow

Uranium deposits related to sodium metasomatism have been described for both the Paleoproterozoic and the Pan-African Event, with thermal events able to circulate large volumes of fluids at high temperatures (550°−350°C) to produce metasomatism along crustal-scale structures (several tens to hundreds of kilometers) (Cuney 2010). Sodic metasomatism has been described from the Huronian Supergroup in particular (Fedo et al. 1997). Economic sources of unconformity-related uranium occur in association with Paleoproterozoic basins such as Canada's Athabasca Basin (Hanly et al. 2006). Such unconformity on Archean basement rocks (Hanly et al. 2006) is consistent with this paper's model framework

- expected erosional action of Day Two water movement on rocks formed on Day One. Early Paleoproterozoic gold-uranium conglomerates of Canada (Pirajno 1992), are inferred to have resulted from great tectonic upheavals of Day Two.

The intrusion of radioactive pegmatites in the Trans-Hudson Province of northern Saskatchewan is described as being associated with high temperature hydrous melts during peak and late-metamorphic events and deformation-induced rapid melting of the Hudsonian Event (McKeogh et al. 2013; Stockwell 1964). Volatile saturation and metasomatic interaction with host rocks during ascent and emplacement of pegmatite is indicated by field relationships, mineralogical and textural evidence (McKeogh et al. 2013). Steep pegmatite structures in fractures would have enabled rapid heat loss and crystallization of the pegmatite (McKeogh et al. 2013; Snelling 2008). It is proposed that Day Two fluid flow processes be correlated with the development of northern Paleoproterozoic provinces along with North America's Hudsonian Event (Fig. 2).

4. Southeastern Proterozoic provinces history

A. Huge crustal growth and high mountain building

> *And God said, "Let the waters under the heavens be gathered together into one place, and let the dry land appear." And it was so. God called the dry land Earth, and the waters that were gathered together he called Seas . And God saw that it was good* (Genesis 1:9-10 ESV).

The northeast-trending Yavapai, Matzatzal and Grenville provinces are considered to represent episodes of huge continental (granitoid) growth and crustal thickening as part a great accretionary orogen (Condie et al. 2009; Spencer et al. 2015; Van Kranendonk and Kirkland 2013). The Grenvillian Event has been described as an orogeny, with the Grenville Province as the type region (Stockwell et al. 1970). The Grenvillian Event was preceded by, and was partly contemporaneous with, extensive rift systems which developed following the Elsonian Event (Fig. 2), which was a phase of dominantly granitoid intrusion (Frazier and Schwimmer 1987; Irving et al. 1976). The western Nain Province of northeast Canada is the type region for the Elsonian Event (Stockwell et al. 1970). Unlike the much larger region of the Grenville Province, the Nain Province was unaffected by later metamorphism (Ashwal 2010) (Fig. 2). During the Grenvillian Event, northwest-directed contraction at the southern margin of North America was accompanied by intracratonic extension and voluminous mafic magmatism including the Midcontinent Rift (Whitmeyer and Karlstrom 2007).

The Grenvillian Event has been described as "Perhaps the greatest orogenic event in Earth's history…" (Rainbird et al. 2012). Huge crustal thickening and mountain building is inferred. The peak in geochemical and isotopic signatures, identified in North America, Western Australia and global data sets, indicates that the Grenvillian Event represents a unique episode in Earth history. Indeed, paleogeographic reconstructions and tectonic analysis reveal that the Grenville orogen was perhaps the longest and widest in Earth history, spanning a quarter of the globe, or a distance of approximately 20,000 km long and as wide as 800 km, including a core zone several hundred kilometers wide (Van Kranendonk and Kirkland 2013).

B. Pre-Flood seas, land, and associated mineralisation

The Belt-Purcell Basin is of Mesoproterozoic age like the Grenville Province. It is considered to be filled by marine and fluviatile sediments (Lydon 2007) and this may be consistent with formation in a pre-Flood sea created on Day Three. The most favourable environment for the formation of SEDEX deposits, such as that at Sullivan, is believed to be intracratonic rifts that have been filled by marine sediments, with the deposits being spatially associated with synsedimentary faults. (Lydon 2007). Thus, such ore deposits are considered to have formed associated with tectonism as the pre-Flood seas gathered on Day Three. Interaction with anoxic, cool, reduced deep seafloor sediments and more alkaline seawater would have enabled rapid precipitation of base metal sulfides on the pre-Flood seafloor (Dickens and Snelling 2015).

> *And the waters prevailed so mightily on the earth that all the high mountains under the whole heaven were covered*. (Genesis 7:19 ESV).

Antediluvian high mountains may have been located at the site of Proterozoic belts adjacent to Archean provinces. The rocks of today's Grenville Province may represent the Flood-eroded roots (Dickens 2017b, Rainbird et al. 2012) of some pre-Flood high mountains (Genesis 7:19) formed on Day Three. The late Paleoproterozoic and Mesoproterozoic is considered to represent a time of growth and huge thickening of continental crust to form high mountains and thus emergent land of a supercontinent. This is prior to the latter part of Day Three when seed-yielding plant life was created.

The voluminous granitoid plutonism of overall northeast-trending late Paleoproterozoic provinces (Yavapai and Mazatzal provinces) (Mints 2007; Whitmeyer and Karlstrom 2007) may be associated with an initial thickening of crust. This then is considered to have led to the emergence of land on Day Three, associated with the mountain-building of the Grenvillian Event. Worldwide, the late Paleoproterozoic had the biggest magmatic processes (Salop 1982). It is proposed that formation of late Paleoproterozoic and Mesoproterozoic provinces of the southeast of the North American craton, along with North America's Grenvillian Event (Fig. 2), be correlated with processes in the earlier part of Day Three.

5. Neoproterozoic sedimentary cover history

A. Supercontinent breakup

> *by his knowledge the deeps broke open…* (Proverbs 3:20a ESV)

> *In the six hundredth year of Noah's life, in the second month, on the seventeenth day of the month, on that day all the fountains of the great deep burst forth, and the windows of the heavens were opened.* (Genesis 7:11 ESV)

'Deeps were divided' and 'springs of the great deep burst forth' imply rifting and fracturing of the Earth's crust. This is inferred to correlate with Neoproterozoic breakup of a supercontinent (Dickens and Snelling 2008). The Pan-African Event is associated with massive Neoproterozoic breakup of a supercontinent, including the Cordilleran and Appalachian margins of North America. In this article the Pan-African Event is inferred to have initiated with the

breaking open of the fountains of the great deep.

It has been postulated that episodic rifting events at the margins of North America between 0.8 and about 0.6 Ga record the fragmentation of a Neoproterozoic supercontinent (Bond et al. 1984; Hoffman 1989). This is consistent with the initial breaking open of the crust with the bursting forth of the fountains of the great deep on a specific day, followed by further extension and then ocean formation. Subsidence histories of passive margins are a key indicator of worldwide continental extension and then ocean formation beginning at 0.6 Ga, and this has been described as the dismemberment of the supercontinent "by the most important single continental breakup event in geological history shortly before the dawn of the Cambrian." (Bond et al. 1984; Piper 2009). During the Pan-African Event, continental rifting cut across all earlier tectonic grain, initiated Cordilleran sedimentation, and gave birth to the EoPacific between North America and Asia (Carey 1976).

B. Enormous water flows and continental erosion

> *and rain fell upon the earth forty days and forty nights.* (Genesis 7: 12 ESV).
>
> *and that by means of these the world that then existed was deluged with water and perished* (2 Peter 3:6 ESV)
>
> *"and they were unaware until the flood came and swept them all away, so will be the coming of the Son of Man."* (Matthew 24:39 ESV).
>
> *he who removes mountains, and they know it not, when he overturns them in his anger* (Job 9:5 ESV)

World-wide simultaneous (commencing in the same day) erupting of springs or fountains (including eruption of volcanic material) was followed by global rainfall. Much of the water for the Noahic Flood may have come from various depths within the Earth. The mantle may be a major water source (Bergeron 1997). The Earth's mantle transition zone, between 410 to 660 km, could be a major repository for water, due to the ability of the higher-pressure polymorphs of olivine-wadsleyite and ringwoodite to host up to ~2.5wt. % H_2O (Pearson et al. 2014).

An anti-creationist geologist said "Sedimentation in the past has often been very rapid indeed and very spasmodic. This may be called the Phenomenon of the Catastrophic Nature of the Stratigraphical Record." (Ager 1973). In North America, braided-type sheet sandstones are found in lower Neoproterozoic sequences whereas poorly sorted "glacial" deposits are found in mid-Neoproterozoic sequences. This is considered consistent with subaerial sheet flow when the Flood rain began and later mass flows on slopes as the marine transgression of the Flood progressed, respectively.

Zircon grains of Grenvillian age were recovered from lower Neoproterozoic sedimentary basins in northwestern Canada, more than 3000 km away from the nearest probable source in the Grenville Province on the other side of the continent. In addition, paleocurrents derived from cross-bedding in thick fluvial deposits in these basins indicates regionally consistent west-northwesterly transport (Rainbird 2008; Rainbird et al. 2012). The presence of mature quartz-arenite sandstone bodies and braided river systems in lower Neoproterozoic successions (Rainbird et al. 2012) is consistent with extremely high energy and relatively short duration (days and weeks) for global early Flood geological processes. Braided rather than meandering river systems are characteristic of Precambrian successions (Eriksson et al. 2013).

This is all evidence for enormous water flow systems as part of a gigantic erosional episode due to the Flood's tectonic activity and the impact of prolonged and geographically extensive rain on the land (Dickens 2017b). The Grenville Province is inferred to contain the roots of a deeply eroded pre-Flood high mountain chain (Dickens 2017b).

Stupendous rain of Noah's Flood would have caused immense continental erosion and would have led to the deposition of Neoproterozoic sediments (Dickens 2016; Dickens and Snelling 2015), including mass flow deposits. The major $^{87}Sr/^{86}Sr$ isotope ratio increase between 0.9 Ga and 0.5 Ga (Fig. 3) is consistent with erosion of highly radiogenic continental crust (Dickens 2016; Dickens 2017b; Dickens and Snelling 2015; Meert and Powell 2001; Peters and Gaines 2012) during the Pan-African Event (Derry et al. 1994). Neoproterozoic mixtites have been interpreted as mass flows rather than as "glacials" (Schermerhorn 1974). The pre-Flood earth surface was destroyed (Genesis 6:13) in the sense of being totally wiped away (eroded). Pre-Flood people were swept away (Matthew 24:39) in the immense water flows. The subsequent decline in $^{87}Sr/^{86}Sr$ ratio in postCambrian strata may then be due to the presence of a globe-covering ocean so that the rain no longer directly impacted the land.

The 'Great Unconformity' (first named for its occurrence in the Grand Canyon, but traceable across North America) provides evidence for the erosion of continental crust as Flood rain impacted the land. Locations where Paleozoic sediments lie directly on basement are considered to be where there was basement erosion only and not deposition of detritus eroded off the land (Dickens 2017b). While the Flood rain was eroding the land (and depositing the Chuar Group sediments), the sea elsewhere continued to rise. The land was then progressively covered by water leading to a global ocean (depositing Paleozoic sediments in the process).

In the Grand Canyon area, the Mesoproterozoic Unkar Group and associated mafic magmatism appears to record the presence of a basin within the continent that formed in response to northwest contraction and northeast extension related to the Grenvillian Event to the south. The overlying Neoproterozoic Chuar Group deposition indicates renewed continental rifting in an east-west sense, probably related to the early stages of supercontinent breakup (Timmons et al. 1999). I infer that along with emergence of land on Day Three, a basin formed into which the Unkar Group was deposited. The Chuar Group formed later from detritus derived from the early Flood's erosion of the land (Dickens 2017b).

C. Mass flows

Mid-Neoproterozoic mixtites of the North American Cordillera have been interpreted as submarine mass flow deposits during Noah's Flood (Sigler and Wingerden 1998; Snelling 2009; Wingerden 2003). The Kingston Peak Formation in California is an example, with debris flows and catastrophic coarse clastic deposits having been interpreted (Sigler and Wingerden 1998).

The final basin-forming episode of Proterozoic rocks involved a series of rift basins that once more preserve evidence of multiple

"glaciations" and contain banded iron formations (Yeo 1981). The Rapitan-type iron formation of northwest Canada is associated with Mid-Neoproterozoic mixtites (so-called "glacial" sediments), debris flow deposits, turbidites and widespread continental flood basalts (Cox et al. 2016). Iron isotope values are consistent with oxidation of ferruginous waters during marine transgression and rift-related hydrothermal activity associated with the breakup of a supercontinent is inferred (Cox et al. 2016). Accommodation space for many mixtites may have been provided by rifting. (Young 2013). Geochemical data indicates that Neoproterozoic iron formations result from mixing between a hydrothermal and detrital component, while rare earth element data indicates substantial interaction with seawater (Cox et al. 2013). The Rapitan's iron formation has been described as an "apparent sudden reappearance of iron formation after a ca. 1 billion year hiatus in the sedimentary record" (Cox et al. 2016). I infer that the Flood's fountains, that rifted the crust open, provided the hydrothermal component (Dickens and Snelling 2015) and that erosion of land caused by the Flood's rain (Dickens 2016) supplied the detrital component, including mass flow deposits (Dickens 2017a).

D. Subduction and plate tectonics

> *Have you … walked in the recesses of the deep?* (Job 38:16b ESV).

A trench marks the position at which a subducting slab begins to descend beneath another lithospheric slab (Stern 2002). High-pressure metamorphic/orogenic belts are restricted to rocks of "age" < 0.6 Ga and it has been concluded that this indicates cold subduction along convergent margins (plate tectonics) (Brown 2007). It has been claimed that there are no proven Archean, Paleoproterozoic or Mesoproterozoic ophiolites or blueschists (Hamilton 2011). Correlation of paleomagnetic poles also provides evidence for the integrity of Precambrian continental crust between Archean and Neoproterozoic times (Piper 2015). Only by very late Neoproterozoic or early Paleozoic time do significant indicators of subduction (and thus "true" plate tectonics) appear, including complete ophiolites and high-pressure, low-temperature metamorphism (Stern 2005). Thus, modern-style plate tectonics may not have existed in the Archean to Mesoproterozoic. This is consistent with the idea of the growth of only one supercontinent by Day Three.

It is proposed that early Noah's Flood be correlated with the development of Neoproterozoic geology along with the Pan-African Event. Processes involved are considered to include supercontinent breakup, enormous waterflows, continental erosion, mass flows and subduction.

CONCLUSIONS

I consider that God instigated heating events which provided the immense energy required for cataclysmic continent-scale geological processes during early Creation Week and in initiating Noah's Flood. I believe that Archean to Mesoproterozoic basement provinces formed as continental crust grew in the early Creation Week. This formed a supercontinent which by Day Three was thick enough to appear above the water. During the early Flood, massive tectonism as well as immense continental erosion and enormous water flows delivered detritus to form the Neoproterozoic sedimentary cover.

North America's Kenoran, Hudsonian, Grenvillian and Pan-African thermal-tectonic events are respectively related to Archean, Paleoproterozoic, Mesoproterozoic and Neoproterozoic provinces geology, along with the biblical record of Day One, Day Two, Day Three and the early Noahic Flood.

I consider that water played a significant role in all the thermal-tectonic events. Day One, Day Two and the Noahic Flood have a global ocean. Initial upward vertical movement of hydrothermal water is believed to have occurred in Day Two and in the early Noahic Flood. Supposed "glacials" in the Paleoproterozoic and Neoproterozoic are then considered to have formed as mass flow deposits associated with downslope water movement on Day Two and early Noahic Flood times respectively. In addition, the banded iron formations of the Archean, Paleoproterozoic and Neoproterozoic are believed to have formed hydrothermally in association with volcanic activity.

Numerous examples have been mentioned where uniformitarianism does not apply in the Precambrian. These include clusters of radiometric "ages", lithologies with restricted ages (such as komatiite, banded iron formation, megacrystic anorthosites, ophiolites, and blueschists), tectonic style (such as permobile Archean versus linear Proterozoic belts, intracontinental deformation versus later plate tectonics, and mountain building) and effects of fluid flow (such as massive river systems, mass flows, and the 'Great Unconformity'). Many geological processes are known to not require deep time. This paper has referred to processes such as those relating to granite, banded iron formation, sedimentation, base metal sulfides and calcium carbonate precipitation.

The Flood drastically altered the world's topography. Nevertheless, inferences have been made regarding some specific locations of the pre-Flood world's geography in relation to today's North American Precambrian rocks:

Pre-Flood land	supercontinent, including North America
High mountains	eroded mountain roots in the Grenville Province
A pre-Flood sea	in the vicinity of the Belt-Purcell Basin
Fountains of the great deep	adjacent to western and eastern continental margins

It is intended that this paper would encourage further work to improve and refine our understanding of geological and geochemical processes in Precambrian provinces within a young Earth biblical framework. A possible application for further investigation is to examine the relevance of continental-scale Phanerozoic tectonic episodes and detrital zircon provenance studies to models of the Flood and post-Flood times.

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