The Belt Supergroup Is Likely from the Early Flood:

Evidence for Precambrian Sedimentary Rocks from the Flood

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Abstract

The Belt Supergroup represents one of the thickest sections of Precambrian sedimentary rocks in world. It contains rare features, such as molar-tooth structures, syneresis cracks, and "stromatolites." The rocks were deposited in an intracratonic basin thought to be at least 25 km deep, which could have originated as an impact crater. It is conventionally dated as Mesoproterozoic, about 1.4 Ga. Correlation of formations across the Belt Basin is difficult. The sediment originated predominantly from the west, but since there is no obvious source to the west today, there is much speculation on the land mass that once existed to the west. The place of the Belt Supergroup within Biblical Earth history points to the Flood, especially given the generally conformable contact between the Belt rocks and the overlying Cambrian Flathead Sandstone, a universally accepted Flood rock. Thus, the Belt rocks likely were deposited very early in the Flood. Some of the Belt rocks imply tremendous catastrophism very early in the Flood.

Key Words: Belt Basin, Belt Supergroup, molar-tooth structures, Noah's Flood, stromatolites, syneresis cracks

Introduction to the Belt Supergroup

Belt sedimentary and metasedimentary rocks outcrop in western Montana, northern and central Idaho, northeast Washington, and adjacent Canada over an area of 197,000 km^2 (Link et al., 2021, p. 294) (Figure 1). They are called the Belt Supergroup in the USA and the Purcell Supergroup in Canada. Researchers often simply call the rocks the Belt-Purcell Supergroup. A *supergroup* in geology is two or more groups, while a group is two or more formations. A *formation* is "A body of rock identified by lithic characteristics and stratigraphic position…" (Neuendorf et al., 2005, p. 250). I will refer to the rocks as sedimentary rocks in the

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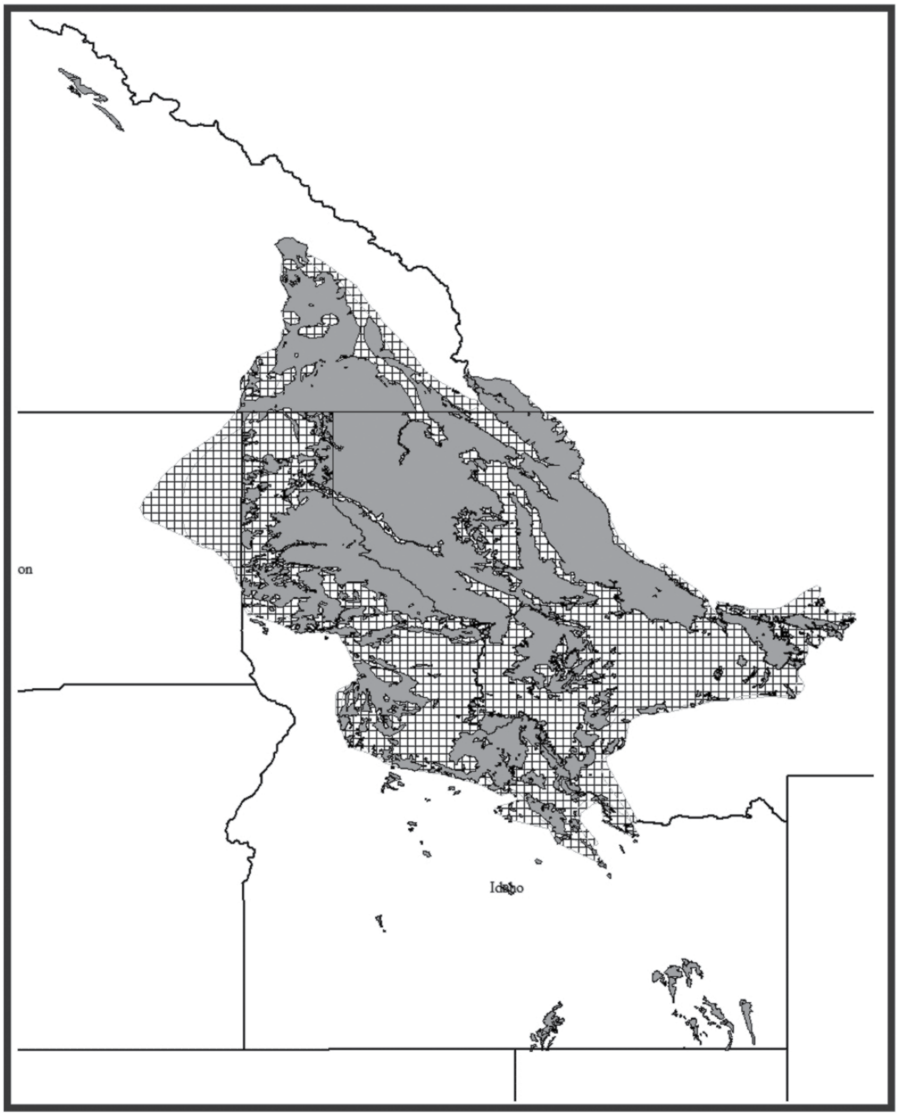

Figure 1. The area of the Belt Supergroup (courtesy of John Reed). The solid gray area is from maps while the hatched area is the total extent. The claimed Belt rocks from southeast Idaho are just rocks correlated to the same age as the Belt Supergroup.

Belt Supergroup, although many experienced a low degree of metamorphism.

The Belt Supergroup occupies what is called the Belt Basin that represents one of the thickest Precambrian sedimentary basin in North America (McFarlane, 2015). The supergroup is thickest in the west and southwest and thins toward the northeast (Duke and Lewis, 2010). The maximum depth of the rocks today is 20 km west of Missoula, Montana (Harrison et al., 1974). However, the bottom of the sedimentary rocks is not seen and the top has been greatly eroded. So, the original thickness was probably on the order of 25 km. However, numerous thrust faults may have caused duplication in the estimated thicknesses as well.

Rocks in the Belt Basin contain several unusual features, such as molar-tooth structures (MTSs) (Figure 2), found only in the Precambrian, abundant syneresis cracks, ripple marks, and classical "stromatolites." Raindrop imprints may also occur in the highest formations (Link et al., 2021, p. 299). It is important to understand the Belt-Purcell Supergroup's place within Biblical Earth history, since it contributes important information to that history.

The Belt Supergroup is composed of four groups and about 25 formations (Hyndman and Thomas, 2020, p. 29). The groups, starting from the lowest to the highest, are: (1) the Lower Belt, (2) Ravalli, (3) Piegan, and (4) Missoula. The Lower Belt is the thickest at about 12 km (González-Álvarez and Kerrich, 2012). Within the groups, different regions have different formations. The formations have been weakly to moderately metamorphosed with the metamorphic grade generally increasing from east to west (Slotznick et al., 2016) and areas of high and low metamorphism within this general trend (Duke and Lewis, 2010). The rocks are composed of argillite, quartzite, siltite, and less than 1% carbonate, conglomerate, and mafic sills and dikes. Argillite is a weakly metamorphosed shale, quartzite is a weak to moderately metamorphosed sandstone, and siltite is a weakly metamorphosed siltstone. There are also diabase sills in the Belt rocks (see below).

The Origin of the Belt Basin

Uniformitarian scientists don't have a consensus explanation for the origin of the Belt Basin: "The origin of the Belt Basin is not well understood, but it formed through crustal stretching, or extension, and was located well within the supercontinent" (Hyndman and Thomas, 2020, p. 25). Sears and Alt (1989) once thought it was a meteorite impact basin, but they later changed their minds and believe it is a rift, (Sears et al., 1998; Sears, 2016). An

Figure 2. Weathered molar tooth structure, Belt Supergroup.

impact basin is still considered one of four possible origins, however (Sears et al., 1998; Elston et al., 2002).

A *rift* is considered a subcontinental, deep crack in the crust (Neuendorf et al., 2005, p. 555), but this does not fit the 500-km-diameter Belt Basin. And the rate of subsidence is debated; some geologists believe the basin subsided rapidly (see below) while others believe it slowly subsided over millions of years. The subsidence rate is claimed to be about the same as the sedimentation rate, a special condition that seems unlikely. Kidder (1988) states: "Most of the Belt Supergroup consists of shallow-water sediments deposited in a basin in which subsidence and sedimentation were closely balanced." The reason researchers believe that deposition was shallow was because the supergroup has numerous "mudcracks" (Figure 3), ripple marks (Figure 4), and "stromatolites."

The paleoenvironment of the Belt Basin is widely debated with some researchers thinking that it was a large lake with braided streams (Retallack et al., 2013; Winston, 2016), while other researchers think it was marine (Harrison, 1972; Pratt, 2001; Adam et al., 2017; Pratt and Ponce, 2019). It is still not resolved (Maliva, 2001). Winston (1990, 2016) further believes the sediments were laid down by sheet floods.

Two Sub-basins

The Belt Basin has been subdivided into two sub-basins: (1) the main Belt basin in the north and (2) the Lemhi sub-basin in east-central Idaho and southwest Montana (Burmester et al., 2016). Doughty and Chamberlain (1996) believed the Lemhi sub-basin sedimentary rocks are equivalent to the Lower Belt Group. They are estimated to be 15 km thick of mostly quartzite (Burmester et al., 2016), but Bookstrom et al. (2016) claim the Lemhi sub-basin is 20 km thick. The divide between the two sub-basins is not distinct.

The Beaverhead Mountains, southwest Montana, are considered the northeast part of the Lemhi sub-basin, but the sedimentary fill is confusing. Lonn et al. (2016) have mapped what seems like a giant 10 km high fold that has been greatly eroded, leaving behind the steeply dipping limbs.

The Belt sediments are very colorful, often alternating green and red (Figure 5). Pratt and Ponce (2019) think the color changes are diagenetic, formed during compaction and lithification, as shown by color changes in the same bed and alternating colors between beds. Slotznick et al. (2016) believe the colors formed by changing redox conditions with the differential presence of reduced and oxidized iron minerals.

Mafic Dikes and Sills

Very few volcanic tuff layers occur in the Belt Supergroup (Moe et al., 1996; Aleinikoff et al., 2015). However, there are abundant mafic dikes and sills in the Lower Belt sedimentary rocks (Doughty and Chamberlain, 1996; Sears et al., 1998; Link et al., 2021, p. 295). These dikes and sills are 5–300 m in thickness and trend generally NW-SE or NNW-SSE (Rogers et al., 2016). Some dikes or sills can be traced up to about 200 km. Either way, the dikes and sills occurred after the sedimentation they intruded into.

Figure 3. Presumed mudcracks that are likely syneresis cracks.

Figure 4. Ripple marks on different bedding planes, Belt Supergroup, Glacier National Park, Montana.

Little Deformation Until Basin Filled

Little deformation occurred within the Belt sedimentary rocks without an appreciable break (Elston et al., 2002). Disconformities and paraconformities are difficult to detect and angular unconformities rare (Harrison, 1972; Pratt, 2001). It is as if the basin subsided and filled quickly: "Although there is little evidence for normal faults growing during deposition, the formation of the main Belt basin was initiated with stunning rapid subsidence" (Link et al., 2021, p. 246). These authors contradict themselves when they later on claim that subsidence occurred at the same rate as sedimentation (Link et al, 2021, p. 295), which is very unlikely, unless both the subsidence and sedimentation were both extremely fast.

After deposition, some of the strata was uplifted forming many structural features, such as folds and faults. In addition, the Lewis and Clark tectonic zone seems to be where much of the faulting was concentrated (White, 2016). This fault zone is about 80 km wide and stretches from northeast Washington, southeast to beyond Helena, Montana (Hyndman and Thomas, 2020, pp. 32–34). The faults are mostly strike-slip with one fault traced a whopping 240 km. No one knows the total horizontal displacement but it is estimated to be over 30 km with the strike-slip offset toward the left looking across the fault (left-lateral fault). Seismic activity still occurs within this fault zone.

Uplifted exposed metamorphic rocks commonly occur at the surface by erosion. Much of the rock is a metaquartzite, a metamorphic sandstone. The broken-up quartzite rocks have been well rounded by the action of water and spread in all directions from the Belt Basin. Quartzite rocks have been spread up to 1200 km east northeast into central Saskatchewan and southwest Manitoba (Oard et al.,

Figure 5. Typical purple (right) and green (left) colors of the Belt strata, sometimes with sharp boundaries.

Figure 6. Well-rounded quartzite boulder with percussion marks from the top of the Gravelly Mountains, Southwest Montana.

2005). They have been found on the tops of mountains in the area (Figure 6).

During the "Sevier Orogeny" in the late Mesozoic, the Belt Supergroup is claimed to have been thrust eastward about 220 km, followed by 26 km of extension during the "Laramide orogeny" (Maclean and Sears, 2016). But Bedrosian and Box (2016) claim the amount of thrusting is questionable. In fact, thrust faults were not recognized in the Belt Supergroup for a long time (Harrison et al., 1980). The faults now labeled as thrust faults were once considered normal faults. The thrust faults include the Lewis Overthrust that put Precambrian dolomite over Cretaceous shale in Glacier National Park. Chief Mountain, standing alone a little east of the Lewis thrust, is an erosional remnant of this overthrusting.

The Uniformitarian Date of the Belt Supergroup

The dating of the Belt Supergroup has varied. Early on, it was dated at 740 Ma (Moe et al., 1996). In 1968, this was increased to ~1450 to 900 Ma and has since been revised to ~1450 to 1200 Ma based on paleomagnetism (Evans et al., 2000). Current dates are 1,470–1,400 Ma, based on U-Pb dating, which puts it in the early Mesoproterozoic, which ranges from 1,600–1,000 Ma. Over the years, there have been various other dates that have been rejected or later classified as the date of a metamorphic event (Evans et al., 2000; Aleinikoff et al., 2015). Some dates were rejected because they were discordant or because of lead loss in zircons (Evans and Zartman, 1990; Sears et al., 1998).

The Belt Supergroup is believed to lie on Paleoproterozoic 2,500–1,600 Ma igneous and metamorphic rocks, but the basement rocks do not outcrop in the Belt Basin, except in the southeast (Doughty and Chamberlain, 1996). It is believed that the Mesoproterozoic Deer Trail Group overlies the Belt Supergroup in northeast Washington (Box et al., 2020). The Neoproterozoic to early Cambrian Windemere Supergroup overlies the Deer Trail Group and deposited in a rift from Utah north well into Canada (Link et al., 2021). It was once believed that the Deer Trail Group overthrust the Belt Supergroup, but their contact is now believed to be depositional. It may be possible that the Dear Trail Group and the Windermere Supergroup are just younger Belt rocks.

Phanerozoic sedimentary rocks lie on top of the Belt Supergroup in many areas but have been eroded in most others. The basal Phanerozoic Flathead Sandstone (Figure 7) is correlative with the Tapeats Sandstone in the Grand Canyon that overlies Precambrian igneous and metamorphic basement and the tilted Precambrian Grand Canyon Supergroup. This sandstone is about 30 to 100 m thick, coarse grained with quartz pebbles, has few interbeds, and has been deposited over about half of North America on basement rocks (Clarey, 2020, p. 196).

What uniformitarian process would deposit such an even thickness of coarse-grained sandstone over half of North America? Such deposition is exactly what we expect in the early Genesis Flood as one type of sediment was deposited over large areas. Furthermore, the formations on top are generally conformable showing little if any erosion, again precisely what we expect during deposition from Noah's Flood—of one type of sediment deposited on another in quick succession.

The Flathead Sandstone is dated around 500 Ma, which is about a billion years younger than the Belt Supergroup. The contact is often a massive erosion surface below the Flathead Sandstone called the Great Unconformity, the origin of which is a major uniformitarian mystery. The Great Unconformity lies near the bottom of Grand Canyon, but is seen at the tops of the mountains in Wyoming. This mysterious surface is found on nearly every continent.

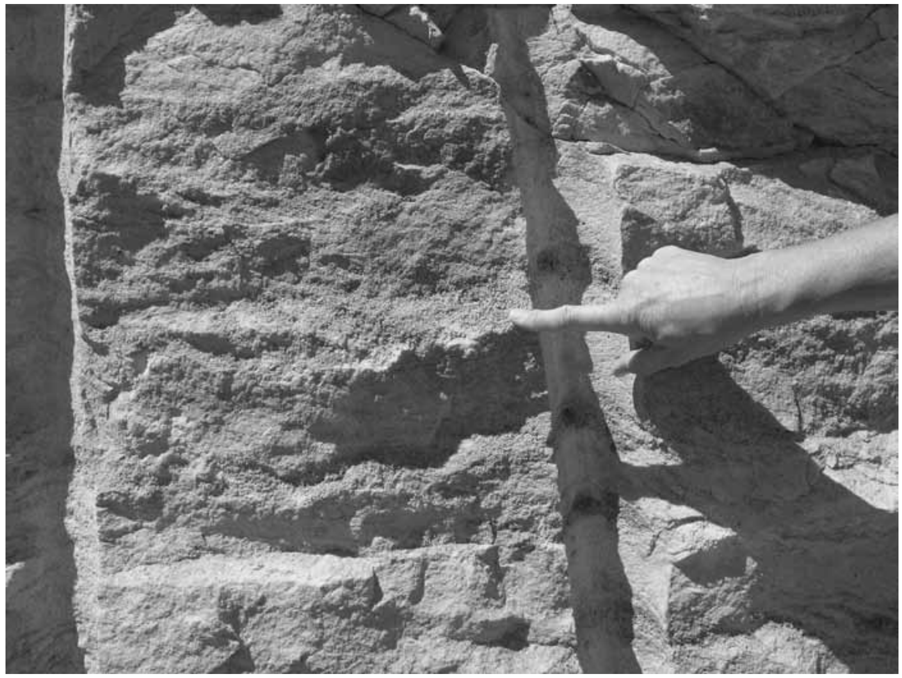

Figure 7. The Flathead Sandstone at Cody, Wyoming.

"Molar-Tooth" Structures

One mysterious feature of the Belt Supergroup is the existence of "molar-tooth structures" (MTSs) (Figure 2), networks of interconnected vertical and horizontal mostly microcrystalline calcite sheets or ribbons and occasional spheroidal objects found in fine-grained clayey carbonate sediments (Smith, 2016). MTSs obtained their name from the Belt-Purcell sedimentary rocks in 1885 for a variably weathered surface of intricately crinkled calcite sheets that reminded the researcher of the corrugated surface of an elephant molar tooth (Smith, 1968). They are about 5 mm to a few cm wide, intricately folded or fragmented by compaction of the sediment and about up to a meter long before compaction. It is possible that MTSs are interconnected in a 3-D network (Bishop and Summer, 2000; Bishop et al., 2006). The calcite is composed of 5–15-micron equant, microspar crystals that are mostly pure and uniform (James et al., 1998). Microspar is re-crystallized micrite, which is fine-grained calcite.

The sediments associated with these structures contain a high amount of carbonate and are cemented by calcite (Bishop and Summer, 2006). Smith (2016, p. 78) states that "MTSs are most abundant within fine-grained, dolomitic cycle tops." Dolomite requires hot water to form (Oard, 2022a, 2022b), which may be a clue as to the origin of MTSs. It is believed that the process that formed MTSs occurred rapidly because the sediment had not yet compacted (Bishop et al., 2006; Pollack et al., 2006). The origin of MTSs is enigmatic with no modern analogs.

Researchers also believe that MTSs formed in shallow water, but within a Biblical model, this need not be the case. MTSs must satisfy three main

Figure 8. Typical domal stromatolites in limestone, Belt Supergroup, Glacier National Park, Monana.

conditions: (1) void space must be created, (2) subsequent precipitation of microspar then takes place, and (3) they are ubiquitous in the Precambrian with very few, if any, reported in the Phanerozoic (Hodgskiss et al., 2018). There is one claim of MTSs in the late Cretaceous of northern Brazil (Rossetti and Góes, 2000).

There are at least 10 processes suggested for their origin. One popular hypothesis is that molar-tooth structures originated by seismic shaking of partially consolidated sediments (Fairchild et al., 1997; Pratt, 2001). Syneresis cracks (see below) would be formed at the same time. They are similar to sediment-filled cracks, except molar-tooth structures taper up and down and are predominantly filled with calcite.

A second popular hypothesis is that molar-tooth structures formed by gas bubbles and expansion cracks in poorly consolidated, shallow carbonate sediments (Furniss et al., 1998; Frank and Lyons, 1998). It is possible that passing waves at the water surface (Bishop et al., 2006) or internal waves (Oard, 2013b) caused expansion cracks. Then the voids were filled with calcite exceedingly fast. The gas likely formed from the decay of organic matter and/or hot temperatures (Boudreau, 2012). Although not completely understood, it appears that researchers are mostly settling on gas expansion that immediately fills with precipitated fine-grained calcite (Pollack et al., 2006; Kuang, 2014; Kriscautzky et al., 2022). However, the gas mechanism satisfies only one of the three main conditions. Organic matter decay can reproduce the gas for the void spaces, but does not account for the precipitation of microspar nor the temporal restriction of MTSs to predominantly the Precambrian (Hodgskiss et al., 2018).

Many conventional researchers claim that molar-tooth structures ended in the mid Neoproterozoic before there were organisms to bioturbate the sediments (Shields, 2002). The origin of MTSs in the Precambrian could be due to changes in ocean chemistry such as a decrease in $CaCO_3$ saturation and/or an increase in the concentration of precipitation inhibitors (Shields, 2002). If the Precambrian sedimentary and metasedimentary rocks are from the Flood (Oard et al., 2023), what is it about the Precambrian in the early Flood that caused such unique features as molar-tooth structures that are rarely, if ever, found in the Phanerozoic or today?

"Mudcracks" Are Syneresis Cracks Formed Under Water

"Mudcracks" are very common in the Belt Supergroup (Figure 3). This is one reason why researchers assume that sediments in the Belt Basin were deposited in shallow water that was occasionally exposed. However, most researchers are leaning away from these features as being true mudcracks. They ascribe them to various underwater processes, collectively called syneresis cracks (Schieber, 1990). *Syneresis cracks* are defined as "…fissures that develop in a suspension where waters are expelled from the clay-water system by internal forces; they may resemble mud cracks in the sediments" (White, 1961, p. 561). Some reserve the definition of syneresis cracks to the sediment/water interface, but this need not be the case, since shrinkage cracks can occur within the sediments (Tanner, 1998). The shrinkage cracks in the Belt are mostly ascribed to syneresis cracks, since there is no supporting evidence of subaerial exposure (Pratt, 1998).

Crinkle cracks are one form of syneresis cracks, although Winston and Smith (2016) do not believe they are syneresis cracks. But that is more of a definition problem. Crinkle cracks are widespread in the rock record, including the Green River Formation. They are about 5 mm wide and 0.5 to 5 cm deep and those in the Belt Supergroup are filled with sandstone. Crinkle cracks are believed to be caused by waves in the water causing cracks to form in mud from a passing wave (Winston and Smith, 2016). They were shown to occur from passing waves in mud along the Louisiana coast (Winston and Smith, 2016).

There are several ways to form syneresis cracks, such as underwater compaction of clay flocs (White, 1961), clay dewatering by increased salinity (Burst, 1965; Harazim et al., 2013), intrastratal compression (Plummer and Gostin, 1981), seismic shaking (Pratt, 1994, 1998, 2002; Pratt and Ponce, 2019), and intrastratal volume reduction (Winston and Smith, 2016). Because of the interplay of many possible factors in forming shrinkage cracks, there does not appear to be any single feature diagnostic of whether cracks are subaerial or underwater by syneresis cracking (Plummer and Gostin, 1981; Tanner, 1998). Many of the cracks in the Belt Supergroup were filled from below (Pratt and Ponce, 2019), evidence against subaerial exposure.

In the Flood, we would expect numerous earthquakes that cause waves on top of the Floodwaters and tens of thousands of internal waves (Oard, 2013). We would also expect rapid sedimentation, compression, and dewatering of sediments. Salinity changes likely were very large. All of these could produce numerous syneresis cracks. There also could be true mudcracks during Briefly Exposed Diluvial Sediments (BEDS) because of oscillations in the height of the Floodwater (Oard, 2011).

"Stromatolites" and Microfossils in the Belt Supergroup

"Stromatolites" are fairly common in the Belt Supergroup, having been

Figure 9. Stromatolites in Figure 8 that have transitioned into carbonate laminations, Belt Supergroup, Glacier National Park, Montana.

Figure 10. Stromatolites in dolomite, Belt Supergroup, Glacier National Park, Montana.

recognized as early as 1906 by Walcott (Rezak, 1957). Stromatolite-rich layers extend laterally up to about 100 km (Pratt, 2001). Domal stromatolite alternate with planar stromatolites in places (White, 1984). At one location, I observed domal stromatolites in limestone (Figure 8) that transitioned laterally into planar laminations (Figure 9). How can planar laminations, claimed to be stromatolites, be distinguished from sedimentological planar laminations?

Furthermore, many stromatolites are in dolomite (Horodyski, 1977; Pratt and Rule, 2021), for instance, as shown in Figure 10. Since it takes hot water to form dolomite, whether primary or secondary dolomite, it is doubtful such stromatolites are biological.

Klevberg and Oard (in preparation) also question whether these claimed stromatolites are truly biological and grew in situ.

Most microfossils in the Belt are in the Helena Embayment in the east-central Belt Basin, for instance the Chamberlain Formation (Adam et al., 2016, 2017) or in Glacier National Park (Horodyski, 1993; Retallack et al., 2013).

Difficult to Correlate Formations

It is difficult to correlate most of the strata across the Belt Basin:

> Despite this well-recognized coarse stratigraphic architecture, more detailed stratigraphic correlations between different parts of the Belt Basin have been challenging, in part due to facies changes and local stratigraphic nomenclature. (Slotznick et al., 2016, p. 224)

Winston (2016) believes the Revett Formation is an exception in that it can be correlated long distances in the basin, but even this formation presents difficulties (see below).

Because of the difficulty of correlating formations, miscorrelation has occurred, for instance in the Lemhi sub-basin (Burmester et al., 2016). Revett Formation quartzite in western Montana grades laterally to argillitic silt-to-clay couplets and coarse quartzite beds. The Burke, Revett, and St. Regis Formations cannot be separated, and the whole section is simply called the Grinnell Formation in Glacier National Park (Winston, 2016, p. 31). The Belt Supergroup rocks in the Highland Mountains south of Butte, Montana, had been assumed to be from the Missoula Group but now are believed to be from the Ravalli Group (McDonald and Lonn, 2014).

Paleocurrent Directions Mainly from the West

Paleocurrent directions are obtained by a variety of methods, including the orientation of scour marks and flute casts, sediment thickness patterns, paleomagnetic properties, cross-beds in sandstone, and imbrication in conglomerate. The paleocurrent directions in the Belt Supergroup indicate flow was predominantly from the southwest and west (Harrison, 1972; González-Álvarez et al., 2006; Sears and MacLean, 2016). This indicates that the source of Belt sediments was to the west of the Belt Basin. This has long presented a major puzzle:

> Some of the main problems puzzling to students of Belt rocks concern the character of the source areas and the conditions of weathering, transport, and deposition that provided such a great thickness of fine-grained sediment, most of which was deposited in shallow water. The sheer monotony of the series implies a remarkable relative stability. (Harrison and Campbell, 1963, p. 1425)

Some believe that a continent lay to the west: "Stratigraphic, sedimentologic, and isotopic evidence strongly suggest that the Belt basin was bordered on the west (present-day coordinates) by a continental mass…" (Evans et al., 2000, p. 1297). What is to the west, but Washington, Oregon, and the Pacific Ocean? Washington and Oregon are supposed to be mostly an amalgamation of exotic terrains plastered onto North America by plate tectonic activity well after the Precambrian (Coney et al., 1980), so researchers do not have a good source for the sediments.

Some paleocurrent directions differ from the general flow from the west. The southwest part of the Belt Basin, the Lemhi sub-basin, has paleocurrent directions generally from the south (Burmester et al., 2016). Paleocurrent directions in the southeast Belt Basin are quite variable, ranging from the north to the east and to the south (Schieber and Ellwood, 1993). The top of the Belt, the Missoula Group, has paleocurrent directions from the south and east (Bedrosian and Box, 2016).

To aid them in their search for a source, geologists mostly use U-Pb dates on zircon crystals in the sand particles within the sandstones (Jones et al., 2015). From this they look upcurrent, hoping to find the source terrain for the sediment. Unfortunately, there is no source for the particular dates on zircon crystals that came from the west and southwest. This has caused much speculation about the continent that was supposed to lie to the west of the Belt Basin during supercontinent formation.

Speculation on the "Missing" Western Half of the Strata

Therefore, uniformitarian scientists have claimed that the western half of the Belt Supergroup is "missing" and once existed on some other continent after the "Columbia supercontinent" broke up (Ross et al., 1992; Duke and Lewis, 2010). After this supercontinent broke up, parts re-amalgamated into the "Rodinia supercontinent." Box et al.

(2020) believe the western part of the Columbia supercontinent is now located in Australia or eastern Antarctica. Based on zircon U-Pb dates on other continents, some researchers believe Antarctica was just west of the Belt Basin (Goodge et al., 2008). However, other geologists think it was Siberia (Sears, 2007, 2012). Some think the missing Belt rocks are in south-central Australia (Ross et al., 1992). Zheng-Xiang et al. (1995) believe the missing strata could be in southeast China.

Based on paleocurrent directions generally from the south in the Lemhi sub-basin, Jones et al. (2015) believe the source terrain is in the southwest United States, mainly the Yavapai province. Ultimately, there is no consensus.

Dolomite in the Belt Supergroup

Not a high percentage of carbonate rock exists within the Belt-Purcell Supergroup, and much of the carbonate is dolomite. For instance, the Piegan Group carbonates are dolomite (Slotznick et al., 2016). Even some "stromatolites" are in dolomite. If the dolomite is primary, precipitated directly from solution, the water requires temperatures greater than 100°C, but probably well over that temperature (Oard, 2022a, 2022b). Burns et al. (2000, p. 53) state: "Only at temperatures over about 100°C, well beyond those expected for synsedimentary dolomite formation, can dolomite be readily precipitated in experiments" Morrow (1982, p. 6) corroborates:

> The absence of a widely accepted theory concerning the chemistry of dolomitization is due primarily to the difficulty in precipitating dolomite from appropriate solutions at temperatures less than 100°C.

It is known that dolomite much more easily precipitates at higher temperatures, higher Mg/Ca ratios, and high Mg supersaturation (Burns et al., 2000). Stoichiometry and ordering increase in hot water.

Just recently, Kim et al. (2023) claimed that dolomite can form at ambient temperatures due to thousands of supersaturation/undersaturation cycles. However, this "solution" has many problems (Oard, in press), one of which the experiment on the micron scale was run at a temperature of 80°C. Moreover, it is an unrealistic mechanism for the huge dolomite formations in the rock record

Since geologists do not think the Belt rocks were deposited in hot water because of their uniformitarian assumption, they simply assume that the dolomite was formed by replacement (dolomitization) from limestone (Tucker, 1982). If the dolomite is widespread, in order for thick dolomite to be formed by replacement, several conditions must be met. Tremendous fluid flow (Warren, 2000) with a "pumping mechanism" and enough available Mg must occur. Not only that, the fluid flow must flush out the extra Ca liberated during dolomitization (Boggs, 2009), and the porosity and permeability must allow the fluid flow. The amount of available magnesium would have to be huge (Jones and Rostron, 2000), and the pump and fluid flow must continue for an extended period of time, since it is estimated that 1,000 units of fluid flow are needed to dolomitize one unit volume (Given and Wilkinson, 1987), and 350 kg of Mg are needed to dolomitize 1 m^3 of limestone with a porosity of 7% (Jones and Rostron, 2000). Of course, the fluid flow of magnesium ions decreases away from a potential source—one of the many problems with dolomitizing a huge limestone formation. Such dolomitization needs to occur in the subsurface where temperatures are higher, but porosity and permeability are often reduced by compaction with depth. This is one reason why it supposedly would take millions of years for dolomite to form, according to uniformitarian reckoning. How reasonable is such a replacement process, even given millions of years?

There is actual evidence that replacement formed some dolomites, but it is limited. For instance, a close analysis of a 1,600 m-thick carbonate in eastern Spain showed massive dolomite near faults (Yao et al., 2020). It is assumed that hot Mg-rich water issued from the faults to dolomitize the limestone, which is reasonable. Further evidence of replacement is provided by observations that certain beds are selectively dolomitized, limestone stringers exist within dolostones, and the dolomite ends abruptly. Such fault-transported dolotimizing fluids would have been hot. Based on fluid inclusions in the affected rock, the temperature of dolomitization for a Cambrian dolomite in the Western Canadian Sedimentary Basin was 124º–181°C (Koeshidayatullah et al., 2020). Based on a dolomite from northern Spain, Lapponi et al. (2014) determined that hydrothermal dolomitization occurred at temperatures of 80–120°C. So, it appears hot water temperatures are also required for replacement dolomite.

When Was the Belt Supergroup Deposited in Biblical Earth History?

How do these unique Belt rocks fit in Biblical Earth history? Many creation scientists place these rocks prior to the Flood, either during Creation Week or between Creation Week and Noah's Flood (Dickens and Snelling, 2008; Humphreys, 2014; Dickens, 2018; Dickens and Hutchison, 2021). This begs the question of how such a large volume of sediment was deposited in a very deep "hole" before the Flood? It implies massive erosion, transport, and deposition over at least a regional scale. One possibility is rapid erosion on Day 3 as the continents or a supercontinent emerged

Figure 11. The Belt LaHood Formation contact with the Flathead Sandstone near the top of the Bridger Mountains (Peter Klevberg is pointing at the contact). The strata are generally dipping about 70° east.

out of the waters below. I do not think this likely because the Creation was one super-miracle, and Genesis 1:9 says that the dry land appeared within the waters under the heavens that were gathered into one place.

However, objective evidence that the Belt rocks were deposited in the early Flood does exist (Oard et al., 2023). The contact between the Belt Supergroup and the Cambrian Flathead Sandstone, a Flood rock, is commonly conformable, indicating no significant break between deposition of the Belt rocks and obvious Flood rocks. The lack of a significant unconformity between the Belt and Phanerozoic rocks imply that the Belt rocks are from Noah's Flood, as well as the erosion, transportation, deposition, and subsidence implied by the basin.

The Flood rocks on top of the Belt could have been very thick before erosion. Elston et al. (2002) claim that a thickness of 8 km of Paleozoic carbonates and Mesozoic clastics accumulated in southeast British Columbia on top of the Belt rocks.

However, some researchers have claimed the contact is disconformable and with a low angular unconformity in spots (Harrison et al., 1974; Harrison and Cressman, 1993). Deiss (1935) claimed that he has found eight locations with angular unconformities, supposedly justifying about a billion years of missing time. But, Deiss (1935) acknowledged that many geologists cannot really see such an unconformity, disconformable or otherwise, between the Belt Supergroup and the Flathead Sandstone because the relationship is rarely angular. Campbell (1960, p. 573) reinforces this lack of an angular unconformity: "The angular discordance between the Precambrian and the Cambrian beds at these locations is so slight that it was not detected." So, the areas with a slight angular discordance are the exceptions and could be due to local erosion or slight movements within the strata.

I have seen a few of these contacts and they look conformable, for instance at the top of the steeply east-dipping Bridger Mountains northeast of Bozeman, Montana, USA (Figure 11). Lonn et al. (2016) report no significant angular unconformity between the Belt Rocks and overlying Paleozoic rocks in the Lemhi Range of central Idaho. Bedrosian and Box (2016, p. 309) summarize:

> We infer that any deformation of Belt strata in the study area prior to Paleozoic deposition was local and minor, as Cambrian strata are only known to depositionally overlie the youngest formation the Belt Supergroup (Harrison et al., 1992), indicating little if any folding and erosion prior to Paleozoic deposition.

The big picture indicates continuous sedimentation from the Belt Supergroup upward into the Paleozoic. This is the main reason I place at least the top of the Belt Supergroup as early Flood.

The catastrophic activity that formed the Belt rocks is characteristic of other features that can be placed in the very early Flood, such as impacts (Oard et al., 2023) and the opening of great rifts in the continental crust that quickly filled with basalt and sediments. One major rift in North America is the Midcontinent Rift (Figure 12), which is about 2200 km long, the width ranging from 40 km in Kansas to 150 km over Lake Superior, and up to 30 km deep (Reed et al., in preparation)! Many other deep basins and rifts occur on the continents, and it is reasonable to include these within very early Flood catastrophism.

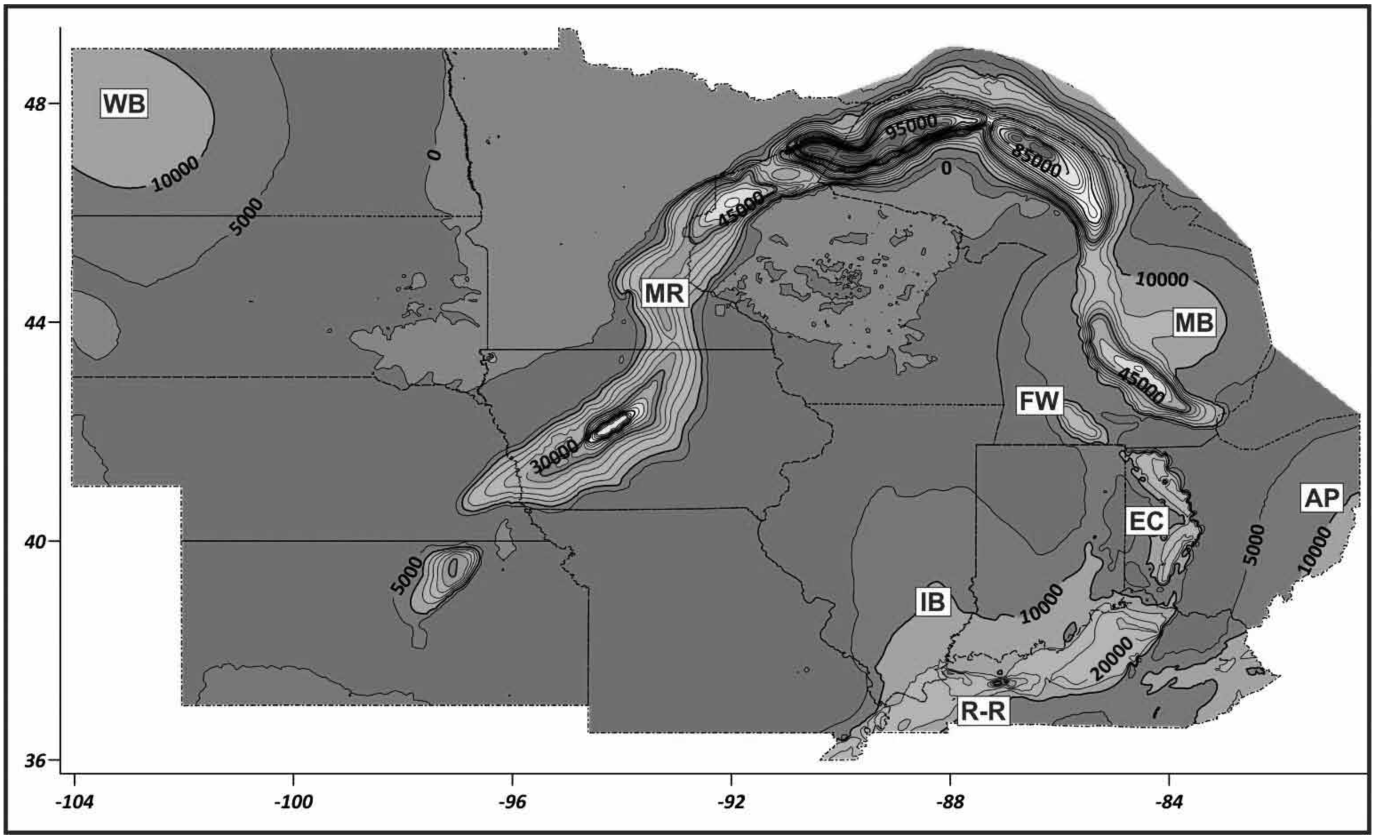

Figure 12. The Midcontinent Rift showing depths greater than 95,000 feet in the Lake Superior area with other rifts south of Michigan (courtesy of John Reed).

Questions Still Remain

Many unusual features of the Belt Supergroup remain to be explained by the Flood. The stromatolites likely are not truly biological (Klevberg and Oard, in preparation), and dolomite is an indication that many of the rocks were laid down in hot water. I currently have no explanation for MTSs and syneresis cracks.

The source of the Belt sediments is also a mystery. The sediments predominantly came from the west and appear to have been deposited rapidly, as indicated by no deformation within the strata. This implies massive erosion and transport. But there is no source to the west. Could it mean that another continent existed before Noah's Flood to the west, being part of a pre-Flood supercontinent? Or, could the erosion come from an uplifted Pacific Ocean basin? What could generate so much sediment so quickly? Since the Belt Basin seems to be a deformed impact crater, could another impact to the west pulverize a great volume of rock and transport it east to quickly fill up the Belt Basin? The Belt rocks present many mysteries, and unfortunately, I do not have many answers. But they also do contain clues to catastrophism in the early Flood.

Conclusions

The Belt sedimentary rocks are mysterious for both uniformitarian and creation scientists. In order to solve these mysteries, we need to first place the Belt Supergroup into Biblical Earth history. The lack of evidence of a significant unconformity at the contact with the Belt rocks and the Flathead Sandstone indicates that some of the Belt rocks are early Flood, possibly even in an impact crater. But, more research needs to be done to test this hypothesis. A further deduction is that some Precambrian sedimentary and metasedimentary rocks, are from the early Flood. This helps us to better understand the catastrophism of the early Flood and will help in formulating a more sophisticated Flood model.

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