Part IV

Quartzite Rocks Transported Long Distances Northwest States and Adjacent Canada

During uplift and erosion of the continents, a wide variety of rocks were eroded by Flood currents rushing off the continents. The softer rocks, like siltstone, sandstone, limestone, basalt, and granite, would be rapidly pulverized during transport. The resistant rocks would be carried down current and quickly rounded. These resistant rocks would became smaller the farther the rocks were transported. If the distance of transport was far enough, however, even resistant rocks would be totally annihilated into fine particles. But before the resistant rocks could be totally pulverized, many of them were deposited on the Earth's surface, leaving a trail left behind that demonstrates the powerful currents sweeping off the continents during the Retreating Stage of the Flood. The finer-grained rocks that were pulverized would sometimes be deposited with the resistant rocks, but much of this sediment would be carried off the continents.

If the resistant rock type is unique to a particular area, one can calculate the distance from the point of erosion to the rounded gravel deposits down current to see how far the unique type of rock was transported. We can compare such distances to the drainage pattern today to see if modern rivers were responsible for the transport, as mostly claimed within the uniformitarian paradigm.

This part will summarize extensive research over about 20 years by Peter Klevberg, John Hergenrather, and myself on the numerous locations where well-rounded quartzite rocks are found on the surface in the northwest states and adjacent Canada. Quartzite is the most resistant rock in the northern Rocky Mountains. We know where the quartzite rocks outcrop as thick sheets. We find the trail of eroded, rounded quartzites at many locations of the northwest states and adjacent Canada. We have discovered that the quartzite rocks have been transported much farther than any river could transport them, even with numerous floods and flash floods over millions of years, if that much time were real. The rounded quartzite rocks provide powerful evidence for the runoff of the Floodwater. I will also analyze the uniformitarian hypotheses that attempt to account for the far-travelled quartzite rocks.

Chapter 13

The Source of Quartzite Rocks

Figure 13.1. Coarse gravel with a high percentage of well-rounded quartzites and a petrified log (just above Dennis Bokovoy) in a road cut on highway 12, east of Bryce Canyon National Park.

Numerous well-rounded, coarse gravel deposits are found on the surface of northwest United States and adjacent Canada (Figure 13.1). Coarse gravel is a general term for rocks of all sizes: gravel (smaller than 2.5 inches (6 cm) in diameter), cobbles (2.5 to 10 inches (6 cm to 25 cm) in diameter), and boulders (greater than 10 inches (25 cm) in diameter). But, to make the terminology simple, I will refer to all transported rocks of any size as gravel.

Transported rock deposits are found in a variety of contexts: on the floor of valleys, carpeting plateaus, filling up deep paleovalleys, or even on mountaintops or ridges. The gravel is well rounded and smoothed by water action. Water is the only agent that can round and smooth rocks. (Weathering sometimes produces rounded rocks, but the surface of the rock is generally rough. Moreover, they are found generally in situ, where they weathered out of surface rock.)

A large proportion of the well-rounded gravels consists of quartzite—a very hard rock that has either been metamorphosed by the heating of sandstone or hard cemented by silica within sandstone (see in depth section at the end of the chapter). The quartzite that is metamorphic sandstone is one of the toughest rocks on earth. During metamorphosis, the sandstone has been recrystallized resulting in a vitreous or glassy texture. Figure 13.2 shows the vitreous texture of a fractured quartzite cobble. The quartzite cobble on the left is iron stained—a common feature of quartzites from the northwestern states and adjacent Canada. I will refer to these vitreous types of high-grade quartzite as simply quartzite, unless otherwise specified as opposed to hard-cemented sandstone that is a low grade quartzite (see in-depth section at the end of the chapter). The source of these quartzites is the Belt-Purcell rocks of the northern Rocky Mountains of the United States and adjacent Canada.

Figure 13.2. Vitreous texture of quartzite (the two fractured rocks to the right of the lens cap). Note the dark iron stain (a patina) and pressure solution marks on the rock with the lens cap.

The Belt-Purcell Rocks

The Rocky Mountains of western Montana, central and northern Idaho, and extreme northeast Washington are composed mostly of a similar type of rock called the Belt rocks (technically, the rocks are called the Belt Supergroup, made up of many formations, which are individual rock units). The Belt rocks extend into Canada where they are called the Purcell rocks. The Belt-Purcell rocks crop out in thick beds over an area of about 500 miles (800 km) north-south by 400 miles (640 km) east-west (Figure 13.3). They were deposited in a deep basin with one estimate of the present-day maximum thickness of about 10 miles (16 km).[1] Another estimated is by Evans et al., who claim the maximum depth is 9.4 to 12.5 miles (15 to 20 km).[2] These figures are minimums for the original thickness of the Belt-Purcell rocks because the bottom has not been found and the top has been greatly eroded, which is the reason we find the resistant quartzite rocks eroded and transported so far away, as we will see in the rest of Part IV.

The Belt-Purcell rocks are dated about 1.5 billion years according to uniformitarian geologists and are given the uniformitarian designation as "Precambrian." These rocks consist of a remarkable uniformity of sediments in both mineralogy and in the fineness of their grain size.[3] The rocks have been metamorphosed but the grade of metamorphism is low, probably caused by temperatures around 390°F (200°C). Most of the rock (over

1 Frank, T.D., T.W. Lyons, and K.C. Lohmann, 1997. Isotopic evidence for the paleoenvironmental evolution of the Mesoproterozoic Helena Formation, Belt Supergroup, Montana, USA. *Geochimica et Cosmochimica Acta* 62(23):5,023–5,041.

2 Evans, K.V., J.N. Aleinikoff, J.D. Obradovich, and C.M. Fanning, 2000. SHRIMP U-PB geochronology of volcanic rocks, Belt Supergroup, western Montana: evidence for rapid deposition of sedimentary strata, *Canadian Journal of Earth Science* 37:1,287–1,300.

3 Harrison, J.E., 1972. Precambrian Belt basin of northwestern United States: its geometry, sedimentation, and copper occurrences. *GSA Bulletin* 83:1,230.

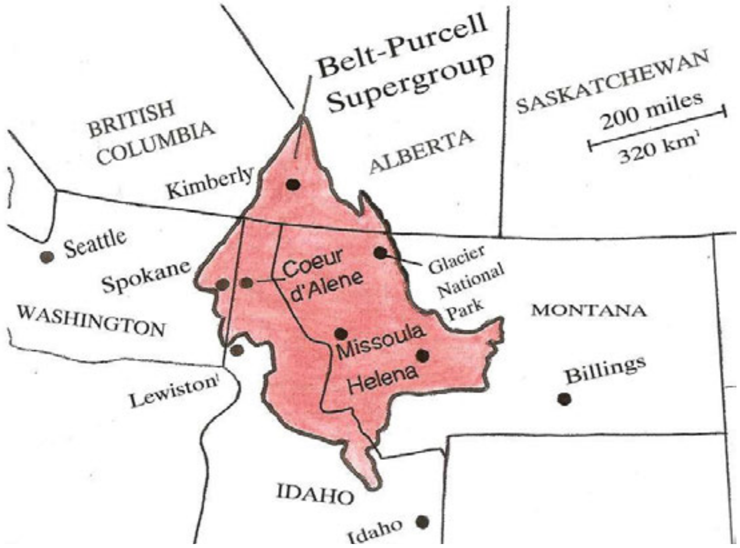

Figure 13.3. Area of the 500 miles (800 km) north-south by 400 miles (640 km) east-west Belt Basin containing the Belt-Purcell Supergroup uplifted and deformed strata (courtesy of Jim Pearl and colored by Mrs. Melanie Richard).

80%) is a metamorphic shale or silt, called argillites and siltite, respectively, which is composed predominantly of quartz.[4] The argillites are often colorful, displaying alternating red and green colors (Figure 13.4a), even at a small scale in a seemingly chaotic pattern (Figure 13.4b). (Uniformitarian scientists believe the red is iron from an oxidizing environment and the green is iron from a reducing environment, but this interpretation is suspect with such chaotic and short distance changes in color as shown in Figure 13.4.) Quartzite makes up to about 10% of the Belt-Purcell rocks, and carbonates and other types of rocks make up the remaining 10%. Figure 13.5 shows a thick outcrop of bedded Belt quartzite about 9 miles (15 km) north of Challis in central Idaho. General paleocurrent directions of the Belt rocks are from the west

Figure 13.4a. Layers of green and red argillite along the Dearborn River at Montana Wilderness School of the Bible. The red argillite is supposed to be oxidized iron and the green color reduced iron.

[4] Campbell, A.B., 1960. Geology and mineral deposits of the St. Regis—Superior area Mineral County, Montana, *Geological Survey Bulletin 1082 – I*, United States Geological Survey, Washington, D.C., p. 440.

Figure 13.4b. A close up of the argillite layers showing the chaotic mix of red and green colors.

and southwest,[5] which can be determined by the dip of cross-bedded sandstones. The grain size is similar throughout the Belt-Purcell rocks, which is fine sand metamorphosed to quartzite and coarse silt metamorphosed to argillite. Such a similar grain size implies rapid deposition in the deep Belt basin from a distant source where the particles were broken down into fine grains of the same size before deposition. There are a few Belt rocks that are conglomerate, for instance the Lahood Formation found in southwest Montana along the southeast edge of the former Belt Basin. The Lahood Formation at one outcrop near the Jefferson River near Whitehall, Montana, has rocks up to 6 feet (2 m) across (Figure 13.6).

Figure 13.5. Thick outcrop of bedded quartzite along Morgan Creek Road, about 4 miles (7 km) from Highway 93, about 40 miles (60 km) southwest of Salmon, Idaho and 9 miles (15 km) north of Challis, Idaho.

The Cambrian Flathead sandstone lies on top of the Belt rocks in many places and the contact is practically always even (Figure 13.7). It appears as if the Flathead Sandstone was deposited without a significant time break on top of the Belt rocks, although there is said to be about 1 billion years missing at the contact.

The Belt-Purcell rocks hold a lot of mysteries for uniformitarian geologists: Some of the main problems puzzling to students of Belt rocks concern the character of the source areas and the conditions of weathering, transport,

[5] Ross, G.M. and M. Villeneuve, 2003. Provenance of the Mesoproterozoic (1.45 Ga) Belt basin (western North America): another piece in the pre-Rodinia paleogeographic puzzle. *GSA Bulletin* 115:1,191–1,217.

Figure 13.6. Lahood Formation with boulder 6 feet (2 m) in diameter (youngest son Nathan for scale).

Figure 13.7. Conformal contact between Middle Cambrian Flathead Sandstone and the Lahood Formation of the Belt Supergroup in the Bridger Mountains, northeast of Bozeman, Montana. The contact represents about one billion years of missing time and shows no erosion in all that time.

and deposition that provided such a great thickness of fine-grained sediment, most of which was deposited in shallow water.[6]

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[6] Harrison, J.E. and A.B. Campbell, 1963. Correlations and problems in Belt series stratigraphy, northern Idaho and western Montana. *GSA Bulletin* 74:1,425.

One contentious conclusion is that all these rocks are believed to be deposited in shallow water, because some of the rocks have ripple marks. This has forced uniformitarian geologists to conclude that more than ten miles (16 km) of subsidence of the Belt-Purcell basin, as the original deep trough is called, occurred at the same rate as the sedimentation. This is very improbable situation. Practically every basin across the Earth, some filled with many miles of sedimentary rocks, are claimed to have been deposited in shallow

Figure 13.8. Picture of Glacier National Park with a U-Shaped valley (view west from St. Mary Ridge).

water. So this is not an unusual explanation for the Belt-Purcell basin. Could it be that all such shallow-water indicators, which assume uniformitarianism, could have been formed in deep water under catastrophic conditions?

After the Belt-Purcell rocks were laid down, they were uplifted and eroded. The sandstone that was once deeply buried and metamorphosed into quartzite was now exposed. The Belt-Purcell rocks form the high mountains of the northern Rockies of the United States and adjacent Canada. They are the rocks that outcrop in Glacier National Park in Montana (Figure 13.8) and in Waterton Lakes National Park just north in Canada. Figure 13.9 show a schematic of the geological history of the Belt Rocks. They have a similar history to many other Precambrian rocks deposited in large basins in the western United States.

Bedded Quartzite Mostly from the Western Rocky Mountains

The metamorphic grade of the Belt-Purcell rocks generally increases toward the west.[7] Most of the high-grade, vitreous quartzite rocks outcrop in sheets in the western part of the northern Rockies, west of the continental divide in extreme western Montana and northern and central Idaho. Figure 13.5 shows a typical example from central Idaho.

Smaller areas of high-grade quartzite are found in the far eastern outcrops of the Belt and Little Belt Mountains in central Montana, but these are small compared to those in

[7] Horodyski, R.J., 1993. Paleontology of Proterozoic shales and mudstones: examples from the Belt Supergroup, Chuar Group and Pahrump Group, western USA. *Precambrian Research* 61:241–278.

the western Rocky Mountains. Low-grade quartzite rocks are found in the eastern Rocky Mountains, which are also found as gravel deposits in some places close to the mountains (see next chapter).

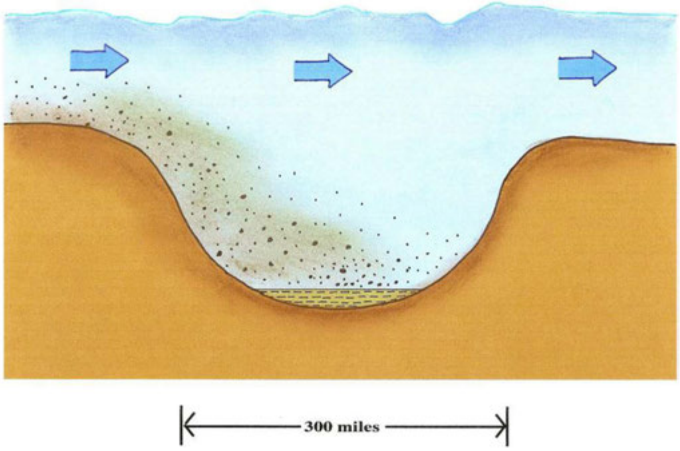
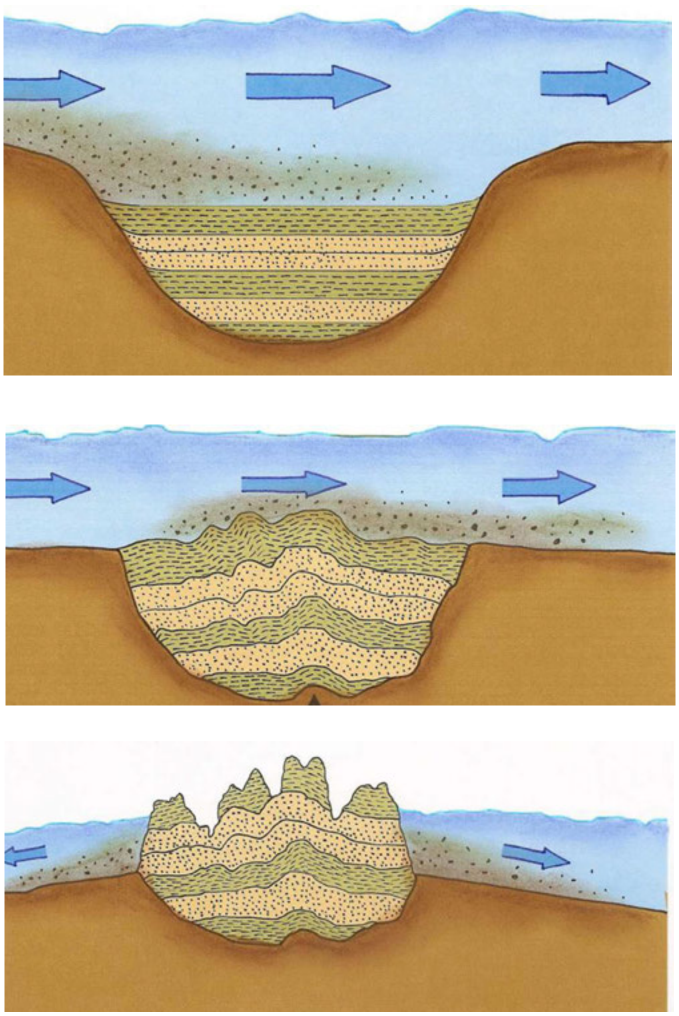


Figure 13.9a-d Schematic of geological history of the Belt Supergroup during the Flood (drawn by Mrs.Melanie Richard). Rapid deposition in a deep, wide basin early in the Flood gives way to uplift of the basin late in the Flood with erosion at the top forming the northern Rocky Mountains.



Quartzites Spread East, Southeast, and West

Quartzite is so tough that a high proportion of the gravel deposits observed in the northwest states and adjacent Canada are commonly quartzite. Argillite and siltite are not as hard as quartzite, so there are only small proportions of these rocks in far-transported gravel deposits.

Other types of rocks are found mixed in with the quartzite rocks. Usually they were eroded from the substrate upon which the currents carrying the quartzites traveled. For example, along the Columbia Gorge, we find a lot of rounded and partly rounded basalt cobbles and boulders, sometimes as much as 90%, with a small percentage of quartzites mixed in (Figure 13.10). Basalt outcrops in the region (see Figures 9.2 and 19.6), so the water currents that spread the quartzite for long distances also eroded the basalt. In the Cypress Hills, we find lozenge-shaped sandstone eroded from the High Plains sedimentary rocks.

We find quartzite rocks hundreds of miles from their source and in locations that defy the action of normal rivers. The next ten chapters will summarize about 20 years of research on quartzites that were spread far from their source.

What Is quartzite? (in-depth section)

Quartzite comes in two varieties. The first is a very resistant metamorphic rock, formed by the recrystallization of sandstone under elevated temperature,[8] which usually results from high pressure during deep burial. The sandstone was once porous; a typical sandstone has about 25% open space between the grains. The grains of the sandstone are mostly quartz. Upon recrystallization, the quartz particles dissolve and fill the voids, forming a dense, vitreous rock (Figure 13.2). The quartzite is so tough that it is very difficult to crack with a rock hammer. Although the original sandstone texture has completely changed, sometimes color bands from the original sandstone remain.

The second type of quartzite is non-metamorphosed sandstone consisting mostly of quartz that has been so completely and solidly cemented by quartz (silica) that it becomes very hard. When cracking a rock with a rock hammer, the crack cuts through the original sand grains as well as the silica cement, satisfying the definition of a quartzite. Figure 13.11 shows a picture of this type of quartzite from the core of the Unita Mountains. But, this type of quartzite is generally considered a very hard sandstone and will be rarely mentioned in this book.

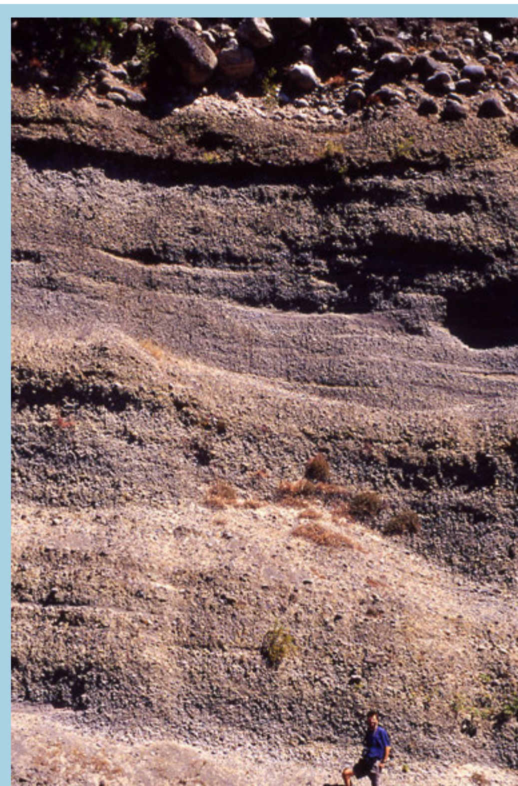


Figure 13.10. Outcrop of rounded basalt coarse gravel with a minor proportion of exotic quartzites along the Columbia River at White Salmon, Washington. It is called the Underwood Gravel (David Anderson for scale)

Figure 13.11. Red quartzite of the Uinta Mountain Group

[8] Neuendorf, K.K.E., J.P. Mehl, Jr., and J.A. Jackson, 2005. *Glossary of Geology*, fifth edition, American Geological Institute, Alexandria, VA, p. 530.