Appendix 9

High Velocity Spread of Quartzite Gravel

Several methods have been used to estimate the minimum speed a current needed to be able to move quartzites from the Rocky Mountains to the Cyprus hills. The methods are based on properties of the gravel, the distance of transport, the slope of transport, the roughness of the surface of transport, and the presence of percussion marks.

The High Plains of northern Montana and southern Canada gradually slope east or northeast and have few topographic obstructions, therefore it is fairly easy to predict current velocities on the High Plains. The mountainous terrain of southern Montana, Wyoming, and west of the continental divide are much more difficult. So, we chose the High Plains for a velocity estimate.[1]

Velocity Derived from Deformation Structures

Peter Klevberg first studied a gravel capped planation surface northwest of Great Falls, Montana, which was being excavated by a gravel company. This planation surface is Alden's Bench Number 3, the lowest east of the Rockies. It lies just below the Fairfield Bench to the north (Alden's Bench Number 2). [2] Figure A9.1 shows Bench Number 3 in the foreground northwest of Great Falls with the Fairfield Bench, Alden's Bench Number 2, in the background.

At the Big Sky Paving Gravel Pit, the gravel deposited on Bench Number 3 is 5 to 20 feet (1.5-6m) thick. It is about 70% quartzite and is clast-supported (the larger rocks are touching each other) with some sand interbeds. A clast is simply another name for a rock. The type of quartzite is low grade and can be found on the Rocky Mountains Front east of the continental divide, a minimum distance of 60 miles (95 km) to the west. The largest rock was a quartzite cobble 9 inches (23 cm) in median diameter.

The gravel sunk partially into the sand, deforming the bedding. These deformation structures are caused by loading of gravel on soft sand and are called load casts. Load casts are common when sand overlies clay, but they are rare when gravel overlies sand. They provide clues to the depositional environment and the rapidity of gravel deposition.

Since channel and bar structures are not observed in the gravel pit, it is not likely the gravel rolled into place. Furthermore, rivers commonly deposit oblong rocks in a pattern that gives the direction of the current. This pattern is called imbrication and is shown in Figure 14.9. The dip of the rocks points downstream. This pattern is rare in the gravel pit. This suggests the gravel was *not* deposited by a normal river. In addition, the sand must have contained an abundant amount of water in the pore spaces for deformation structures to form. This indicates the sand was deposited shortly before the gravel was laid down.

The pattern of the gravel and sand gives evidence they were deposited rapidly and that at times the gravel moved in *suspension*. Based on a relationship between the current

1 Klevberg, P., 1998. The Big Sky Paving gravel deposit, Cascade County, Montana. *Creation Research Society Quarterly* 34:225–235.

2 Alden, W.C. 1932. Physiography and glacial geology of eastern Montana and adjacent areas. *U. S. Geological Survey Professional Paper 174*, Washington, D.C.

Figure A9.1. Alden's Bench Number 3 in foreground with Fairfield Bench, Alden's Bench Number 2, in background (view northwest from near Fort Shaw, Montana).

velocity and other variables that cause rock suspension, Klevberg calculated minimum current speeds to be in excess of 30 mph (50 kph) for spherical rocks with a 4-inch (10 cm) diameter.[1]

Velocity Derived from the Cypress Hills Gravel

Klevberg later analyzed the quartzite rocks atop the Cypress Hills and Flaxville Plateaus.[3] The gravel caps and their source indicated they were transported over 600 miles (1,000 km) on a slope that averaged less than 0.1° (see Chapter 14). He considered a variety of sediment transport mechanisms and environments. The billions of well-rounded quartzite clasts and other gravel features indicated the water transport flowed east from the Rockies.

The big picture is one that has quartzites transported from central Idaho and extreme western Montana by wide, swift currents of water that flowed from there to over the Cypress Hills and Flaxville Plateaus. A typical current profile shows the fastest currents are at the surface, with decreasing current velocity toward the bottom because of bottom friction (see Figure A2.2). A turbulent, high velocity current would drag the largest boulders along the bottom with the small to medium size clasts in suspension. Based on Chezy's

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[3] Klevberg, P. and M.J. Oard, 1998. Paleohydrology of the Cypress Hills Formation and Flaxville gravel. In, Walsh, R.E. (editor), *Proceedings of the Fourth International Conference on Creationism*, technical symposium sessions, Creation Science Fellowship, Pittsburgh, PA, pp. 361–378.

Equation for open-channel flow, Klevberg calculated the minimum current velocities it would take to transport the cobbles and boulders hundreds of miles (more than 500 km). These velocities ranged from 10 to 13 mph (16-22 kph). Remember that these are minimum current velocities; the actual velocity may have been much higher.

Even more revealing was the analysis of the small to medium sized rocks that were temporarily suspended in the water in turbulent flow. These clasts would fall to the bottom and collide with other rocks and form percussion marks. Based on a similar analysis performed on the gravel pit near Great Falls, Klevberg determined the minimum velocities and depths of the water for a 4 inch (10 cm) spherical rock and a bullet-shaped rock that has a width of 6 inches (15 cm). These were considered the maximum size of the clasts that would be briefly suspended in the water. Table A9.1 shows the minimum velocities and depths for these two sizes and shapes of quartzite rocks transported from the top of Flattop Mountain in Glacier National Park to the Cypress Hills. Current velocities are over 68 mph (110 kph).

Rock Size & shape	**Minimum Current Velocity**	**Minimum Current Depth**
4 inch sphere	30 mph	50 feet
6 inch diameter bullet	68 mph	180 feet

Table A9.1. Minimum current velocities and depths for two sizes and shapes of quartzite clasts transported in suspension at times from the top of Flat Top Mountain in Glacier National Park to the Cypress Hills.

These calculated velocities are around two to three times faster than the fastest flash floods on Earth. They approach the velocity of large dam breach floods, as that in the Lake Missoula flood.[4] Additionally, the characteristics of the gravels indicate sheet flow; the width of the current was much greater than the depth.[3] The analysis of the well-rounded quartzites from the Rocky Mountains is consistent with a sheet of water moving at high speed eastward from the Rocky Mountains. This fits with the Retreating Stage of the Genesis Flood.[5] This conclusion is further supported by multiple planation surfaces found east of the Rocky Mountains (see Volume II). At least 3,000 feet (1,000 m) of strata was removed from the area.[6] Erosional remnants give proof of a rapid transition from sheet flow to channelized flow. The waning stages of the biblical Flood would have excavated the narrower valleys where rivers and streams flow today.

[4] Oard, M.J., 2004. *The Missoula Flood Controversy and the Genesis Flood*, Creation Research Society Monograph No. 13, Chino Valley, AZ.

[5] Oard, M.J. and P. Klevberg, 1998. A diluvial interpretation of the Cypress Hills Formation, Flaxville gravels, and related deposits. In, Walsh, R.E. (editor). *Proceedings of the Fourth International Conference on Creationism*, technical symposium sessions, Creation Science Fellowship, Pittsburgh, PA, pp. 421–436.

[6] Oard, M.J., 1996. Where is the Flood/post-Flood boundary in the rock record? *Journal of Creation* 10(2): 258–278.