

Openwork Gravel Deposits in Stream Valleys

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ABSTRACT

Openwork gravel, without interstitial sand, has been found in the valleys of northern Minnesota streams which are reworking glacial debris. It occurs as lenses in what may be called normal gravel. It is in the process of formation on the downstream side of bars and on the surface of the deltas. Sometimes it is the only sizable deposit of a stream. Vortex action may be partly responsible for the absence of sand in some of the deposits, but in other cases the gravels were laid down without any fine material filling the voids.

CHARACTERISTICS OF OPENWORK GRAVEL

Openwork gravel deposits have no sand between the individual particles, hence the particles are in mutual contact and are often well interlocked. In almost every case the gravels are well sorted as to size, and often their long axes parallel each other. The size of the gravel in the openwork deposits varies not only from stream to stream, but from bar to bar along any one stream. In some places the material was about $\frac{1}{4}$ inch in diameter, but along Crow Creek, a very small stream flowing into Lake Superior on its north shore, the gravels were from three to four inches in diameter. This stream is known to people who live near it as a "stream without any water in it," but it has evidently had considerable volumes of water in it during spring flood time for it has heaped up a great deal of gravel, considering its small size, in its lower 200 to 300 feet. It has several bars about 10 feet long, four to five feet high, and about that wide bordering its channel. The bars are composed of clean gravels with no binder. Since the gravels near the mouth of the stream were being trucked away, it was possible to examine them closely. These gravels did not have a clay coating as did those of some other streams.

The thin clay coatings on openwork gravels are secondary deposits which are laid down while the gravels are below water level or which are deposited by waters seeping downward after the deposit is above water level. As the water enters the voids its velocity is slackened for each void acts as a reservoir. Often only the undersides of the gravels are coated with clay.

OCCURENCE

Northern Minnesota streams that flow into Lake Superior have high velocity flow, especially during spring and fall, and they carry a gravel bed load. In many places they flow on bed rock, and in some places they flow on cobble pavement. Because of the relative unimportance of fine material in the load of the streams, openwork gravel may or may not be associated with what may be termed normal gravel deposits.

Openwork gravel has been found on the downstream side of gravel bars on a number of streams. Some of the deposits had been piled up on the banks by floodwaters. In a bend area on Lester River the stream built up three elongate bars which parallel the direction of flow. The upper part of the bars is of openwork gravel. Further upstream the river attempted to cut off a segment of itself when it was in flood. During the flood most of the fine material which had been gathered from the valley sides was carried out into Lake Superior. Some sand was deposited in the woods about 300 feet from the point where the stream tried to batter itself out of its channel and where it had piled up a great mass of rock debris and trees. Along the opposite side of the channel a short distance downstream from this point, an elongate bar of openwork gravel had been deposited. Its surface was covered with a few dozen armoured mud balls. Its downstream

end had several minute streamers of sand appended to it. The gravels in the upper portion of the bar were clean and the voids were not filled, but those three inches or more below the surface had a very thin coating of clay.

Other deposits of openwork gravel were found where the streams debouched into Lake Superior, but the washing of the sand from the gravels was not a beach process. Grabeau¹ mentioned the fact of separation of sand from pebbles as a beach process. Wadel² discussed openwork gravels in connection with the formation of eskers.

ORIGIN OF OPENWORK GRAVELS

Cary³ discussed openwork gravel which he found associated with stream deposits in the Pacific Northwest. He considered that vortex action may be partly responsible for the absence of sand in the interstices in gravel deposits, and he has discussed this in his article.

The streams of northern Minnesota whose load consist primarily of coarse material and whose gradients are steep have a different regime than those of regions where the flow through soft alluviums of plains areas. In many places northern Minnesota streams have cut down into bed rock. In some places their beds are paved with cobbles and boulders which are wedged tightly together. Year after year the fine material is carried away, whereas the heavier material is moved but a short distance during each flood period. As time goes on the load of the stream becomes progressively more coarse. The bed of the stream becomes a boulder pavement. The individual stones become smoothed and eventually flattened where abrasion is especially active. A place for the lodgement of debris becomes less and less easy to find. Subsiding floodwaters leave gravel deposits that are predominantly of the openwork type.

CONCLUSION

Openwork gravels are the deposits of swift flowing streams of glaciated regions. Because the gravels occur as lenses their permeability characteristics are of special interest to engineers and engineering geologists.

REFERENCES

- Cary, Allen S., "The Origin and Significance of Openwork Gravel," American Soc. Civil Engineers, Trans. Vol. 116, 1951, pp. 1296-1318.
 Grabeau, A. W. "Principles of Stratigraphy," A. G. Sellen & Co. New York, 1913, p. 701.
 Wadel, Haakon, "Volume, Shape, and Shape Position of Rock Fragments in Openwork Gravel," *Geografiska Annaler*, 1936-1937, p. 74.

¹ Grabeau, A. W. "Principles of Stratigraphy," A. G. Sellen & Co., New York, 1913, p. 701.

² Wadel, Haakon, "Volume, Shape, and Shape Position of Rock Fragments in Openwork Gravel," *Geografiska Annaler*, 1936-1937, p. 74.

³ Cary, Allen S., "The Origin and Significance of Openwork Gravel," American Soc. Civil Engineers, Trans. Vol. 116, 1951, p. 1296.