Calculating Discharge energies Needed to Transport Largest Boulders within Eskers

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Abstract

One of the methods of sediment transportation within glaciers is the esker which is created melt water carving ice as it flows out of the glacier. During times of rapid melt the amount of sediment that could be transported is at a maximum. It is the water velocity and amount of discharge that determines the maximum grain size that can be transported. The areas of data collection have been the north western portion of Wisconsin and the north eastern portion of Minnesota. Data collection has been done by finding the measurements of the largest material transported through the esker and uses the data to calculate the energy necessary to transport the grains found. The research has been expanded beyond the glacial margin to investigate the change in discharge energy from the esker to the outwash plain.

Introduction

An esker is created by melt water flowing from moulins into cracks and flowed creating a single flow of water that melts out a tunnel to the margin of the glacier. Eskers can be seen as long sinuous ridges filled material in a way very similar to that seen in rivers. Within these eskers there have been infrequent, unusually large boulders. It is the purpose of this research to find the flow velocities needed to transport these unusually large boulders. As a continuation of this experiment, samples from the outwash plain were investigated in order to determine the loss of energy as the melt water left the glacial margin. The discharge of the esker during these maximum flow events will be estimated to gain an outlook into discharge of the glacier

Materials and Methods

Topographic maps were used to find eskers and gravel pits within them to gain adequate access and a cross-sectional view.

Each gravel pits was investigated for the largest sample and measurements, including diameter and circumference, were taken of all.

A rope, measuring tape, and a specially constructed apparatus for finding the diameter of the sample were used to find the general dimensions of the samples.

To get a better picture of what was happening within the esker discharge of the esker was also calculated. It should be noted that since it is difficult to gain the dimensions of the original esker, to get the necessary cross-sectional area a cross-sectional area from a glacier producing similar flow velocities were used so the discharge numbers produced are estimates and should be viewed only as an educational tool and visualization aid.

The following equations were used:

Equations

Flow Velocity: **V = 5.9 (D)^1/2**
V = velocity (m/s)
D = diameter (m)
5.9 = calculated constant

Discharge: **Q = V(A)**
Q = discharge (m^3/s)
V = flow velocity (m/s)
A = cross-sectional area (m^2) *

***Equation used for all sites Cross-Sectional area estimated from related text.**

Example of esker found on topographic map

Results

Measurements of circumference next to flow velocities for comparison

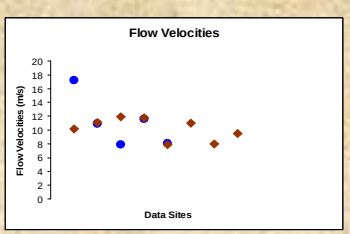
Esker (inches)	**Outwash** (inches)	**Esker** (m/sec)	**Outwash** (m/sec)
Circumference	Circumference	Flow velocities	Flow Velocities
81.5	126.7*	5	8.4
95.5	93	5.4	5.4
109	49	5.8	3.9
157*	104.7*	5.7	5.7
48	50.5	3.8	3.9
50		3.9	
70		4.6	
93.5		5.4	

* Data from unusual sample.

Estimated Discharge

Esker m^3/sec.	Esker gal/sec.	Outwash m^3/sec.	Outwash gal/sec.
43,800	11,600,000	73,600	19,500,000
47,500	12,600,000	47,300	12,500,000
50,800	13,400,000	34,000	9,000,000
50,300	13,300,000	50,000	13,200,000
33,300	8,800,000	34,000	9,000,000
34,100	9,000,000		
40,700	10,700,000		
47,300	12,500,000		

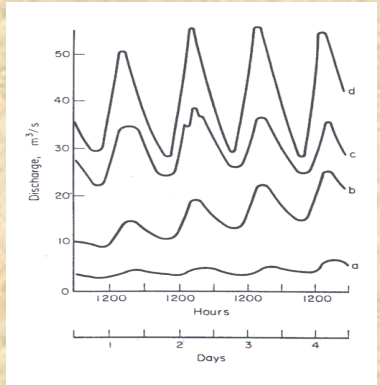
Flow velocities of both esker sites (red) and outwash sites (blue) to show flow of eskers and outwash plain to be similar



Flow Velocities per esker

Frederick Esker (m/s)	Lewis Esker (m/s)	Sawyer Esker (m/s)	Cloquet Esker (m/s)
5	5.8	3.9	5.4
5.4	5.74* 3.8	4.64	

Graph used to show change of discharge within glacier at different times of year



*shows change of discharge at four intervals over one year
The data from this reference is not consistent with my data.

Conclusions/Interpretation

It is believed that there were spiked times of glacial discharge when the glacier was at maximum melt out. It is believed that it was during these times that the unusually large samples were transported.

Ideas have risen suggesting that the infrequency and unusual shape and size of the samples suggest that the samples were deposited to the esker by other means. Possibly by being frozen into the ice and then melted out of the glacier by the esker. To seek the validity of this hypothesis we should go to the samples themselves were we see a large amount of rounding. This suggests that the samples were transported by water and in the process rounded, much like a stone in a river. If the sample had been transported by ice there would be less rounding and we would see a more angular sample which is why some samples have been marked.

It is believed that, although the flow velocities and discharge of a glacier can change depending on the characteristics of the glacier in question, the numbers generated from these eskers are appropriate for the size of the glacier and the dimension of the esker.

The many samples from the outwash plane were as large or larger than the samples studied in the esker. Some were also more angular and irregularly shaped suggesting little to no transport by water. Since the variety of composition suggests that these samples came from sources other than local, this points to other forms of transport such as, for the more angular samples, dragging by the solid ice of the glacier or, for the more rounded samples, supplemental sources of water for transport.

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