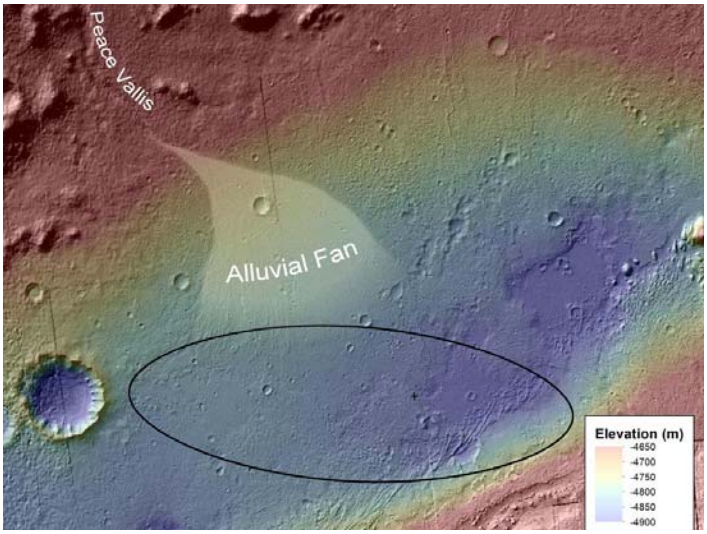
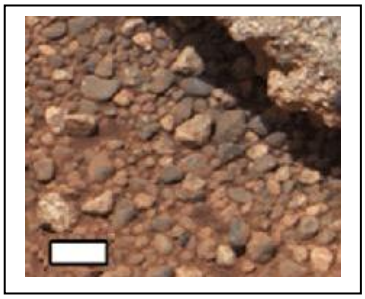


The Curiosity Rover discovered rounded pebbles near its original landing site marked with the 'X' in the figure. The figure also shows the elevation changes in this area. Here is what the pebbles looked like! The white bar is 1 cm long.



Geologists studying the pebbles and the landscape believe that the water flow that moved and rounded the pebbles was at least ankle deep and perhaps waist deep. As on Earth, the pebbles were carried by fast moving water and over time became rounded by the constant scraping and bouncing. How fast was the water moving?

Calculating the stream gradient:

Problem 1 – The landing ellipse is 18 km wide. To the nearest kilometer, how far is the Curiosity 'X' from the apex of the alluvial fan near Peace Vallis?

Problem 2 – What is the change in elevation, h, between the alluvial fan vertex and the 'X'.?

Problem 3 – The stream gradient is defined as the elevation difference divided by the distance traveled. What is the stream gradient, SG, in units of meters/meters, for the water which left Peace Vallis and flowed down the alluvial fan?

ADVANCED) Calculating the stream flow speed:

Problem 4 – On Mars, the stream flow can be approximated by $V = (2gh)^{1/2} \sin(\theta)$ where $\tan(\theta) = SG$, $g = 3.8$ meters/sec^2 is the acceleration of gravity on Mars, and h is the difference in elevation of the top and bottom of the stream. About how fast was the water flowing past the Curiosity landing area to create the pebbles?

Calculating the stream gradient:

Problem 1 – The landing ellipse is 18 km wide. To the nearest kilometer, how far is the Curiosity 'X' from the apex of the alluvial fan near Peace Vallia? Answer: **About 15 km**.

Problem 2 – What is the change in elevation, h, between the alluvial fan vertex and the 'X'.? Answer: -4650 m – (-4900 m) so h = **250 meters.**

Problem 3 – The stream gradient is defined as the elevation difference divided by the distance traveled. What is the stream gradient, SG, in units of meters/meters, for the water which left Peace Vallis and flowed down the alluvial fan? 250 meters / 15 km = **17 meters/kilometer or SG=0.017 meters/meter.**

Calculating the stream flow speed:

Problem 4 – On Mars, the stream flow can be approximated by $V = (2gh)^{1/2} \sin(\theta)$ where $\tan(\theta) = SG$, and $g = 3.8$ meters/sec^2 is the acceleration of gravity on Mars. About how fast was the water flowing past the Curiosity landing area to create the pebbles?

Answer: h = 650 meters, SG=0.017, g = 3.8 meters/sec^2 . Then θ = 1.0 degrees.
$V = (2 \times 3.8 \times 650)^{1/2} \sin(1.0)$
V = 1.2 meters/sec.

This is about as fast as a human walking very slowly (about 0.3 miles/hr or 4.3 km/hr).