Do it yourself: Geological time with a Dam 2008

Motivation: The time for geological processes to occur was a key issue in the 1800s. Scientists did not yet know about radioactive decay. We will do a see-for-yourself method that yields an estimate of the duration of geological events.

Project: The objective is to get the age of the local topographic relief around a dam. You we need a dam pond and a geological map of the drainage upstream from the dam. You will not get the age of the Earth, but 1800s geologists might have interpreted the results as such for a large catchment like an ocean basin. The class will do this project near Jasper Ridge. It is not ideal but is available. We will work in meters.

Activities at the dam.

Step 1: You first need to determine the volume of sediments in the reservoir. First get the thickness of sediments at the dam itself. Lower a fish weight down and measure the distance to the pond floor. We will work in meters.
Record _____ (A).

Go to downstream side of dam and measure distance to base of channel with fish weight.
Record _____ (B).

The maximum sediment thickness is
(B) _____ - (A)_____= (M) _____

You now see that erosion and deposition are real processes and that the dam pond is filling up.

Now use map or simple surveying to estimate the surface area of the pond.

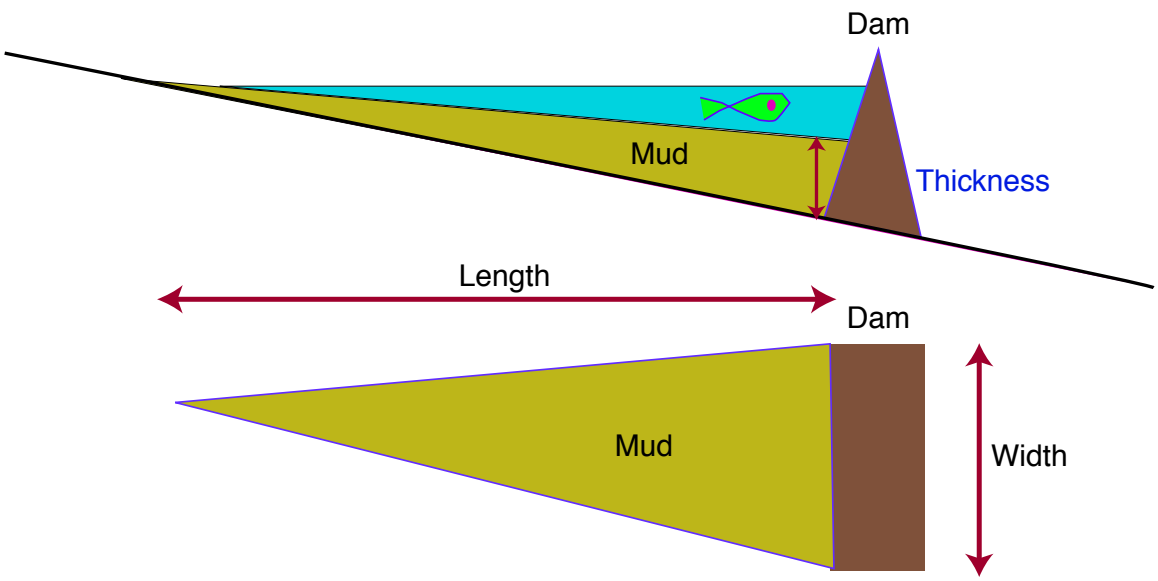
Record (Area)_____

The volume of the sediments is approximately

(M) _____ × (Area) _____ ÷ 3

= (sediment volume) _____

The "3" comes in because the thickness of sediments varies from the maximum to zero at the edges of the reservoir. For those with math, we are treating the sediment body as a cone. We could do this more accurately if we used a map of the pond just before or just after dam was built.



Map activity. The map activity is essentially the same. However, we do not really know what the topography looked like before erosion started so we will be simple. The drainage is complicated and much of the sediment in the pond came from sediments on the valley floor not the hard rock in the hills.

One procedure is analogous to what we did with the dam pond. There are two canyons but we will treat area as one drainage. Canyons are marked on the map. You can use this map. There is hard copy on reserve in the library that may be easy to read. You will get order of magnitude right as long as you keep track that elevations are in feet. Convert to meters by multiplying by 0.3048. This will give you practice reading maps without consuming lots of time.

Find the highest point at the upstream end of the drainage.

Record _____ (H1).

Find the elevation of the lowest point at the foot of the drainage, that is dam pond.

Record _____ (F1).

The maximum erosion is
(H1) _____ - (F1)_____= (E1) _____

We could use map to estimate the surface area of the canyons. This would take time because the drainages are irregular. Instead we will make the calculation quicker. Assume that the affected area is 3000 m by 3000 m or 9,000,000 meters squared. This is a reasonable estimate of the whole watershed. See last page map.

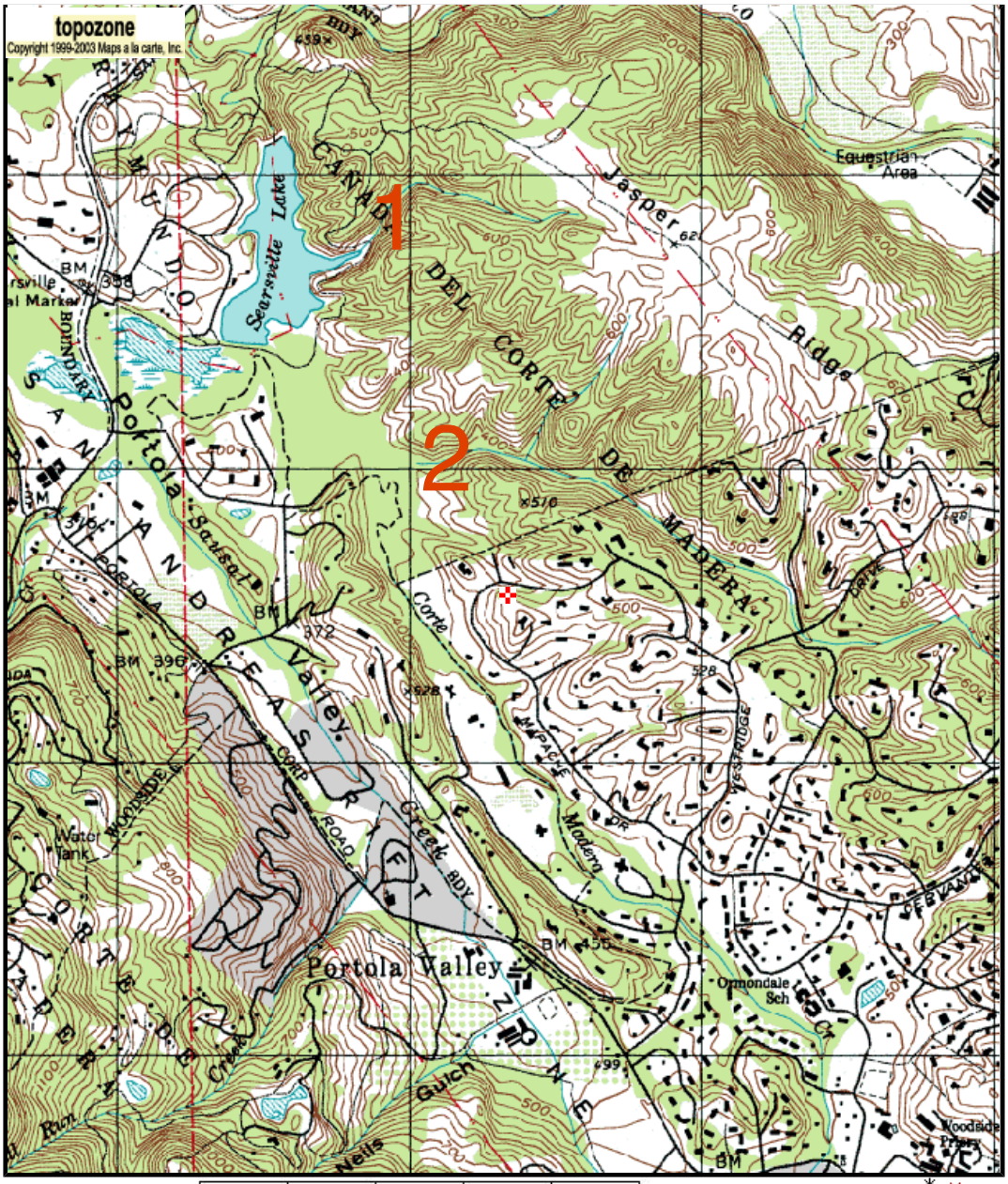
The volume of the eroded material is approximately

(E1) _____ × (9,000,000 meters squared) _____
÷ 3
= (Eroded volume) _____

If we assume that erosion as gone on at a constant long-term rate, we get the age of the topography. This dam is 103 years ago.

(Eroded volume) _____ × (pond age) 103 years
÷ (sediment volume)_____ =
(age of topography) _____

We have assumed that the sediments have the same density as the rock that was eroded. The actual sediments include pore water so we have overestimated the volume solid in them. We have also ignored that some of the rock dissolves and does not end up in the pond. Neither of these effects will change the magnitude of your result.



0 0.3 0.6 0.9 1.2 1.5 km

0 0.2 0.4 0.6 0.8 1 mi

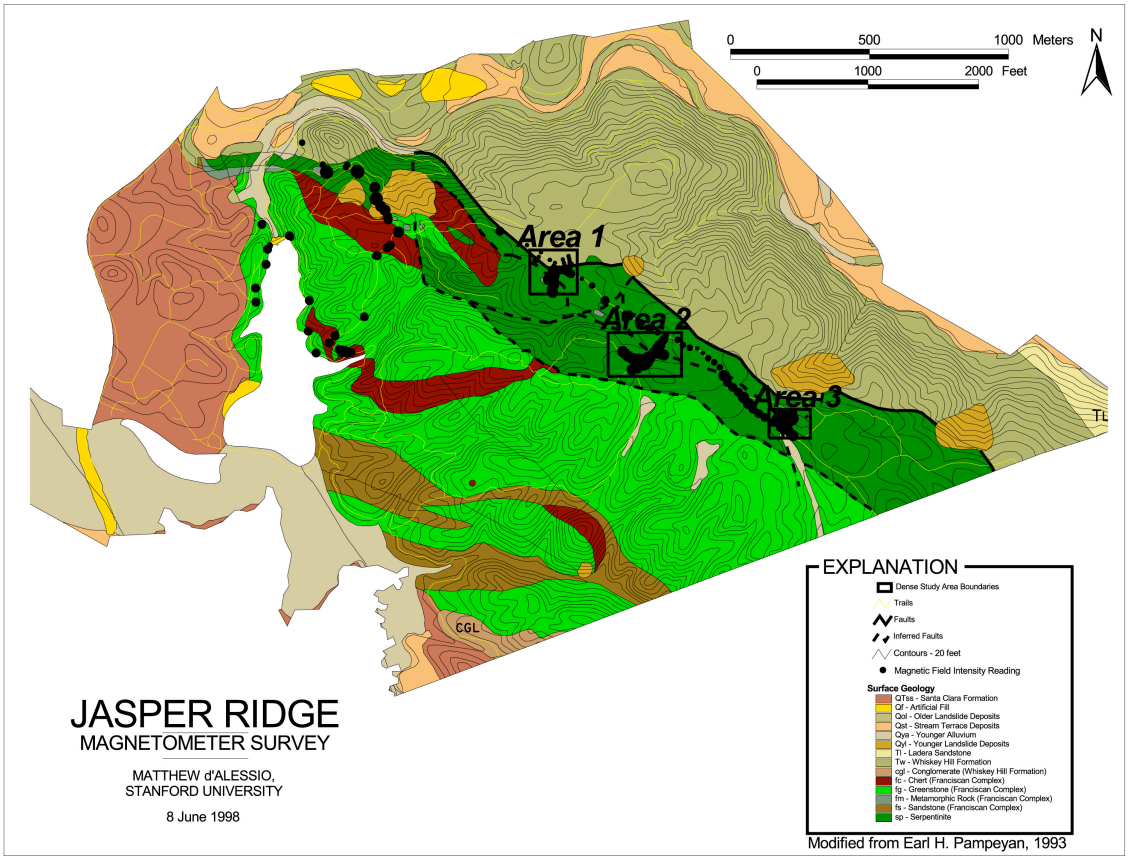
Map center is UTM 10 568230E 4138780N (WGS84/NAD83)

Palo Alto quadrangle

Projection is UTM Zone 10 NAD83 Datum

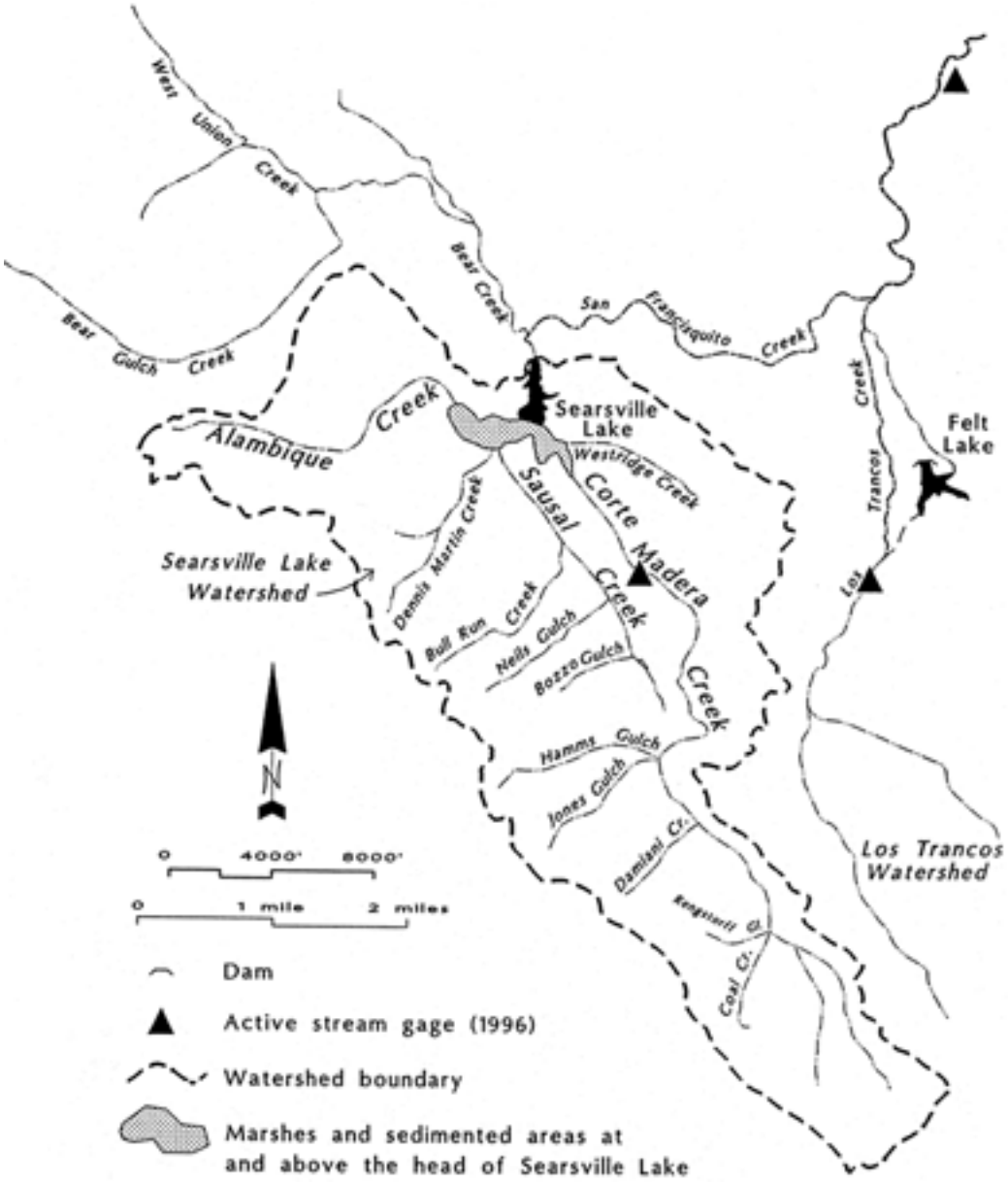
M=15.042

G=0.468



Modified from Earl H. Pampeyan, 1993

It may be easier to measure the area of the pond from this geological map. We will go around the pond clockwise from the dam at the north end. We will see various rock types including greenstone (the black volcanic rock basalt, erupted on an ancient seafloor, buried, and altered by following water at a temperature of a few 100°C) and chert (a chemical sediment made of SiO_2 that precipitated on the seafloor).


West Union Creek
Bear Creek
Bear Gulch Creek
San Francisquito Creek
Alambique Creek
Searsville Lake
Westridge Creek
Felt Lake
Trancos Creek
Los
Sausal Creek
Corte Madera Creek
Searsville Lake Watershed
Dennis Martin Creek
Bull Run Creek
Nells Gulch
Bozzo Gulch
Hamms Gulch
Jones Gulch
Damiani Cr.
Kingstrell Gl.
Coal Cr.
Los Trancos Watershed
N
0 4000' 8000'
0 1 mile 2 miles
Dam
Active stream gage (1996)
Watershed boundary
Marshes and sedimented areas at and above the head of Searsville Lake