ESS103A
Igneous Petrology, Spring 2006

Name__________________________
Due: May 17, 2006

Homework 4
REE DIAGRAMS AND RB-SR ISOTOPES IN THE PENINSULAR RANGES

The purpose of this assignment is to use geochemical tools (Rare-earth elements and isotopic systematics) to better understand the origin of the intrusions of the Peninsular Ranges Batholith.

1. REE Diagrams.

A map of sample sites for this problem is provided in Figure 1A.

A) Describe the REE pattern you observe in each of the three diagrams:

Figure 1B: granitoid rocks (tonalite, monzogranite) in the western part of the batholith.
Figure 1C: hornblende gabbros in the western part of the batholith (like Los Pinos Mountain).
Figure 1D: granitoid rocks in the eastern part of the batholith (like La Posta)

What are the absolute values? Are the rocks relatively LREE enriched or HREE depleted relative to mid-ocean ridge basalts? (Typical REE patterns for mid-ocean ridge basalts are fairly flat or convex (i.e., Figure 16-10A, Low-K) and have REE/chondrite of 5-30). Are there any anomalies?

B) Summarize the major differences and similarities between the three diagrams.

C) Use the partition coefficients given in Table 9-5 of Winter to help explain the origin of these three groups of rocks. In particular:

Remember from Homework 3 that on the western side of the batholith the granitoids can be derived by partial melting of gabbros. Are the REE patterns consistent with this theory? Why or why not?

What mineral is likely in the source region of the eastern part of the batholith?

D) Figure 1E shows the stability fields of Al-rich phases in mantle peridotite rocks. Assume this diagram is approximately correct for mafic oceanic and lower continental crust. What is the implication of this diagram and the REE analyses above for the depth of magma generation and differentiation processes beneath the western versus eastern side of the subduction zone?

2. Age dating and initial Sr ratio.

A) Using the Rb-Sr data below, calculate an age date for the small biotite facies of the La Posta Pluton.

Sample	$^{87}Sr/^{86}Sr$	Sr (ppm)	Rb (ppm)	$^{87}Rb/^{86}Sr$
	Unit: Western Small-Biotite Facies			
Whole rock	0.70555	419	57	0.39
Biotite	0.81490	13	387	84.30
Apatite	0.70483	384	1.1	0.01
Hornblende	0.70410	37.6	7.4	0.65

B) Compare the age of the La Posta Pluton to those reported for other intrusions in the batholith (Figure 2A). What is the general trend of intrusive ages from west to east?

C) Determine the initial $^{87}Sr/^{86}Sr$ ratio ($^{87}Sr/^{86}Sr_o$) for the small biotite facies of the La Posta Pluton. Does the La Posta value fit with the trend in Figure 2B?

The $^{87}Sr/^{86}Sr_o$ for mid-ocean ridge basalts (i.e., rocks that make up the oceanic crust) ranges from 0.7025-0.7035. Island arc volcanics have $^{87}Sr/^{86}Sr_o$ between ~0.703 and 0.708, sediments have $^{87}Sr/^{86}Sr_o$ generally greater than 0.710, and old continental crust can have values anywhere between 0.703 and >0.720.

D) What is the simplest way to explain the $^{87}Sr/^{86}Sr_o$ values observed for the Peninsular Ranges Batholith (Figure 2B)?

E) What is one way to explain the trend of $^{87}Sr/^{86}Sr_o$ values observed from west to east across the batholith (Figure 2B)? $\delta^{18}O$ is a proxy for distance across the arc for the Peninsular Ranges intrusions, but this is not generally true for other batholiths. Hint: where is the old continental craton?

3. Field trip notes.

Turn in the notes you took during the Peninsular Ranges field trip. Make sure your name is on them somewhere!

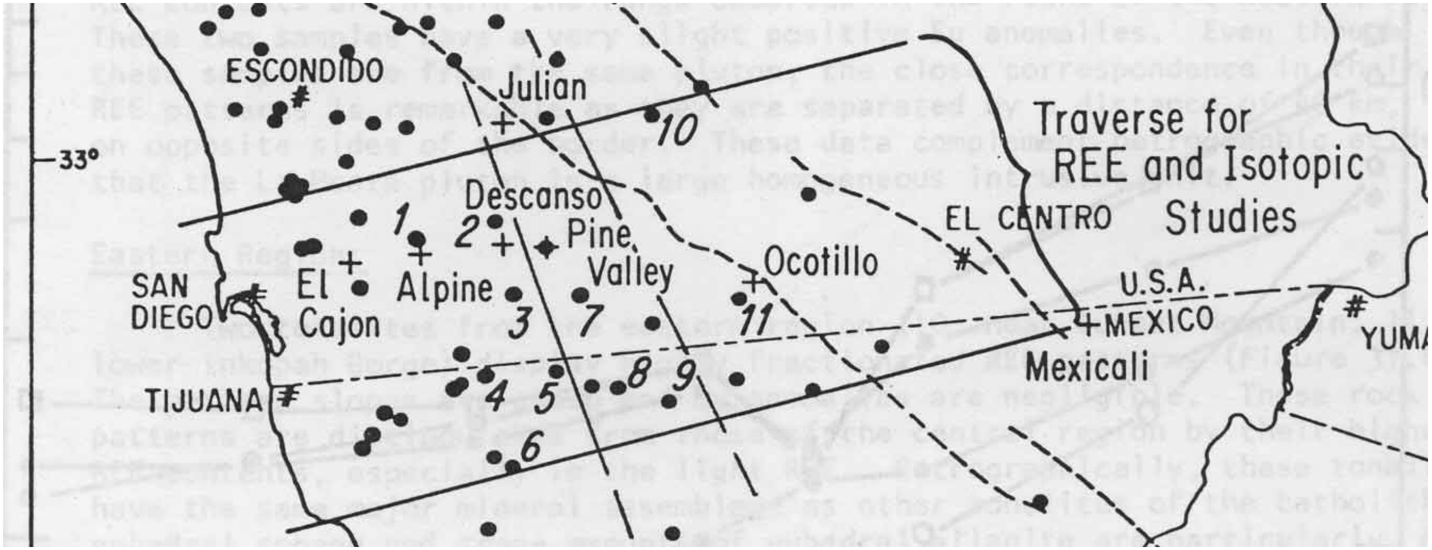


Figure 1A (Gromet and Silver 1979)

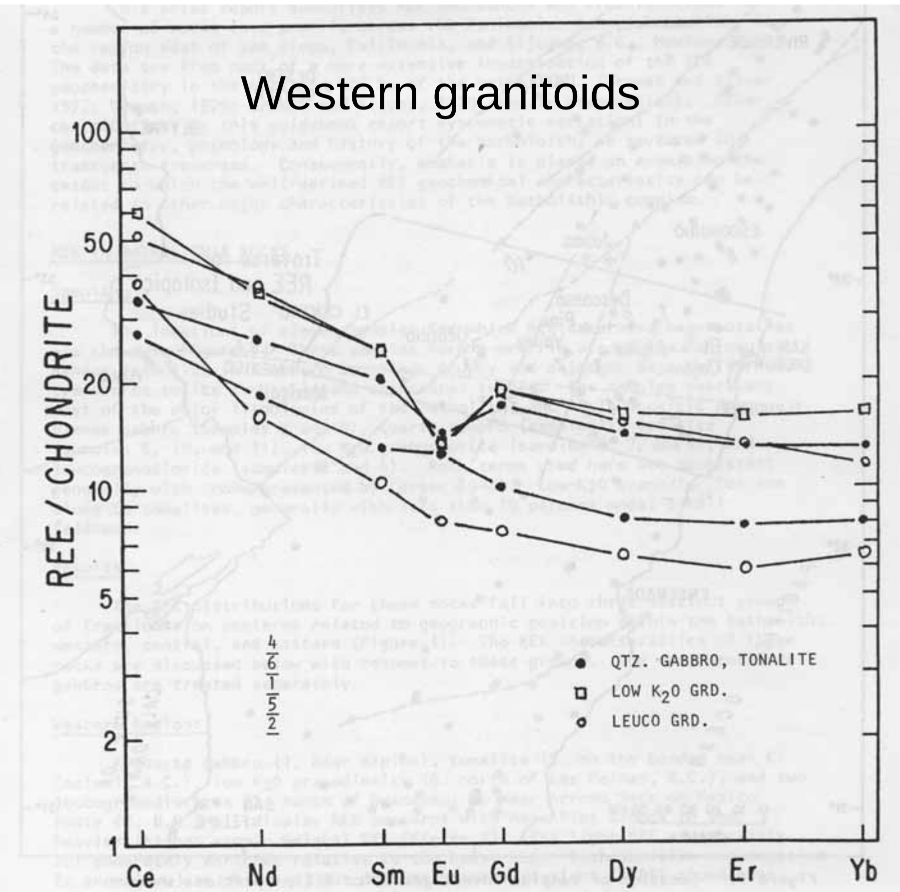


Figure 1B

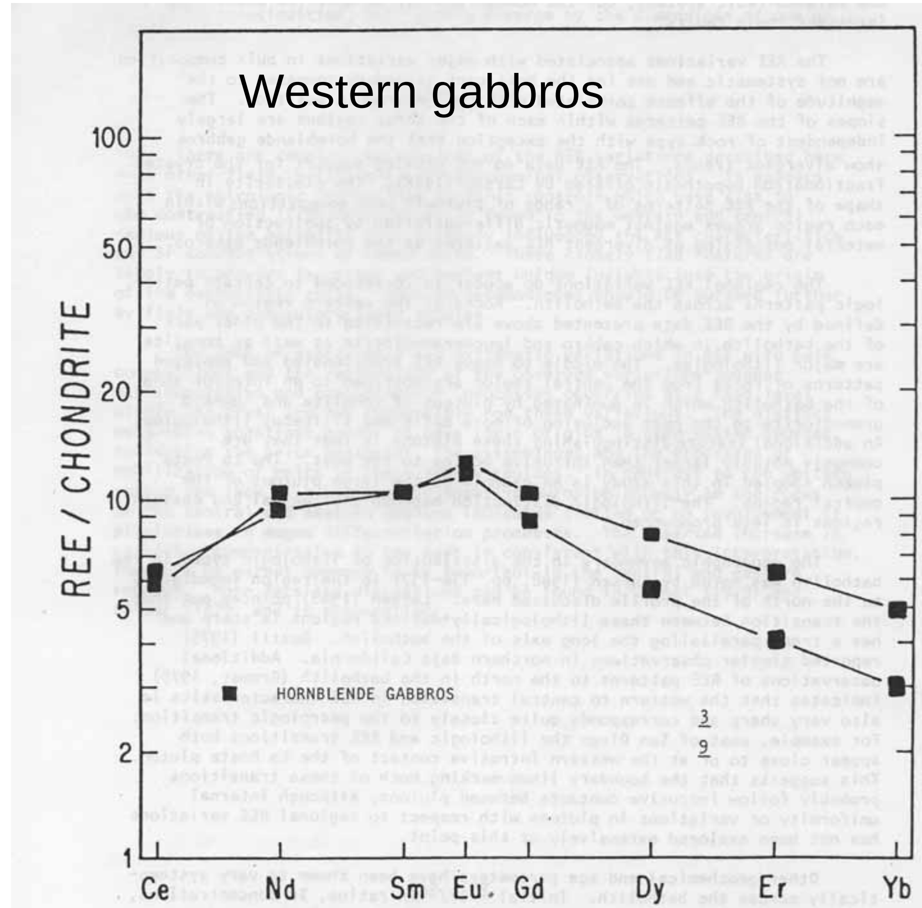


Figure 1C

(Gromet and Silver 1979)

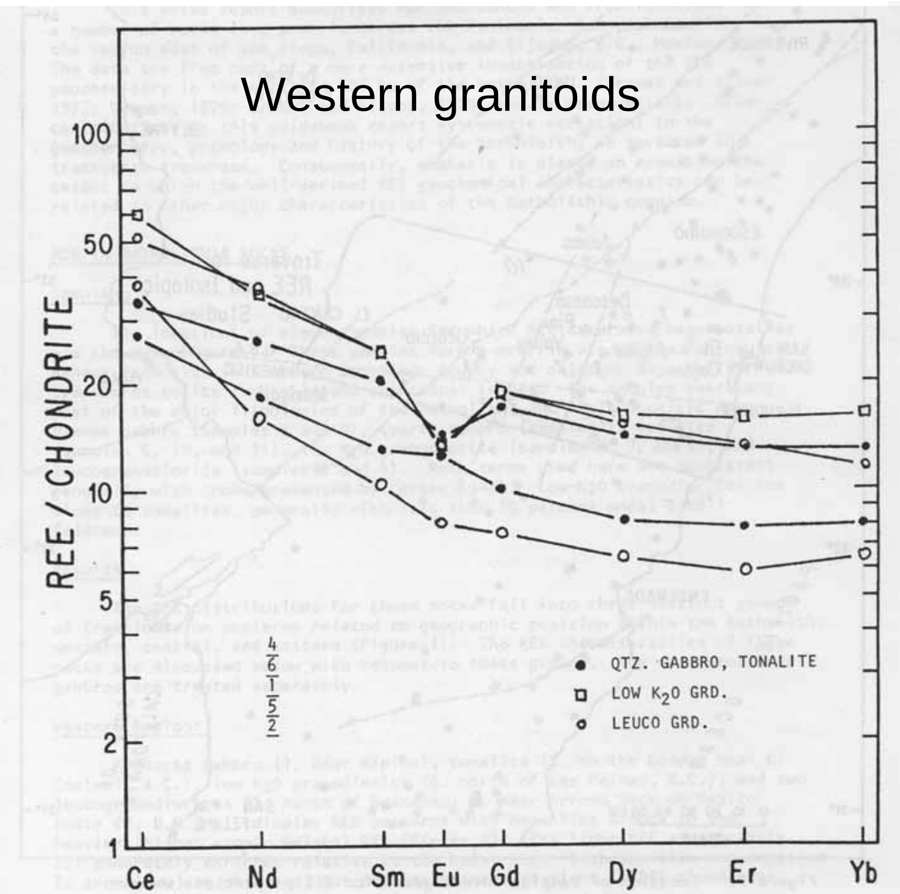


Figure 1B

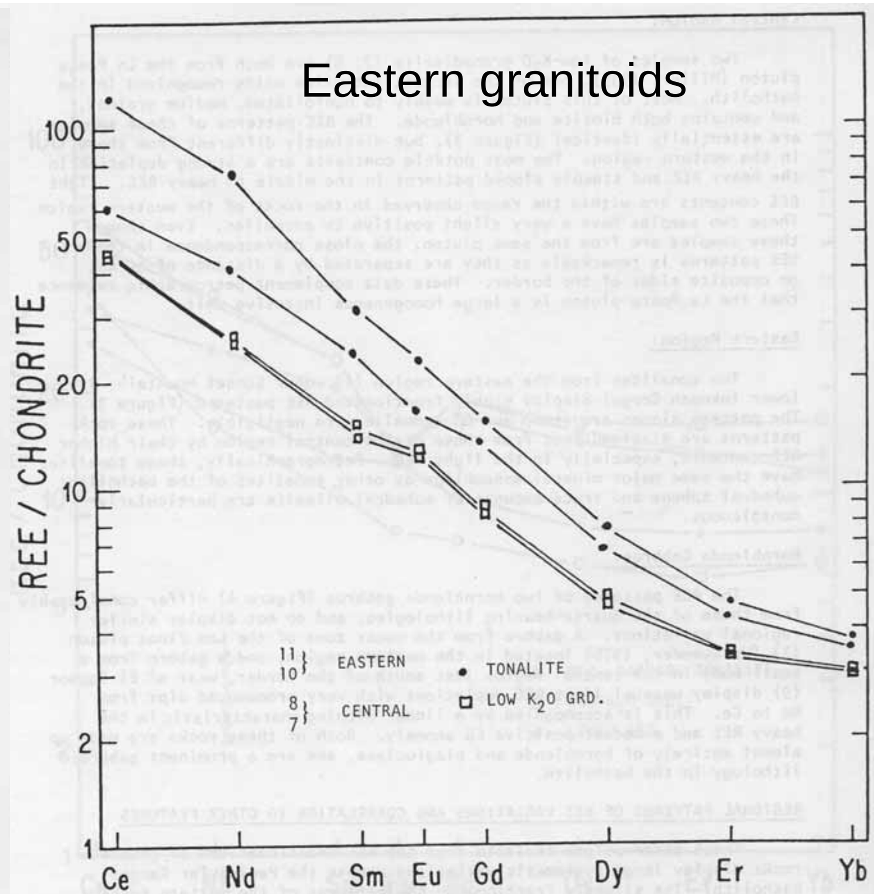


Figure 1D

(Gromet and Silver 1979)

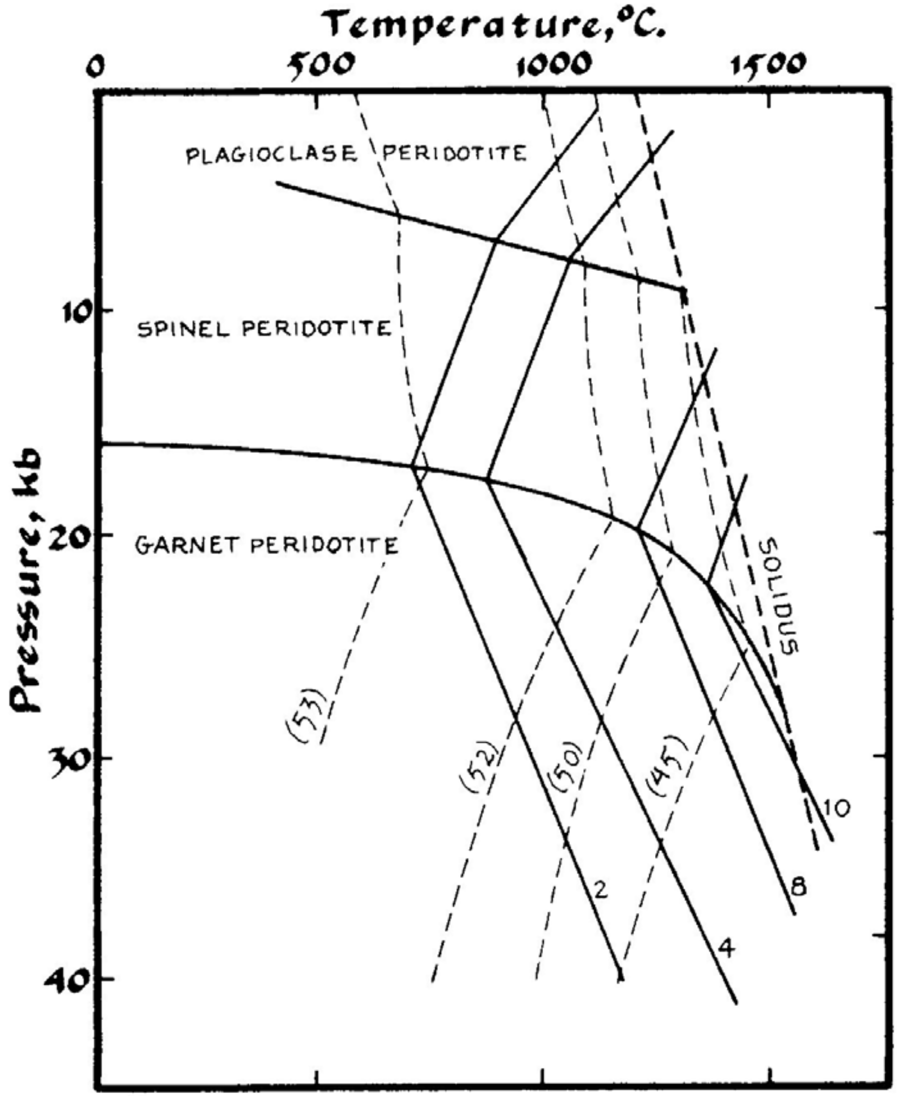


Figure 1E

(McBirney)

La Posta

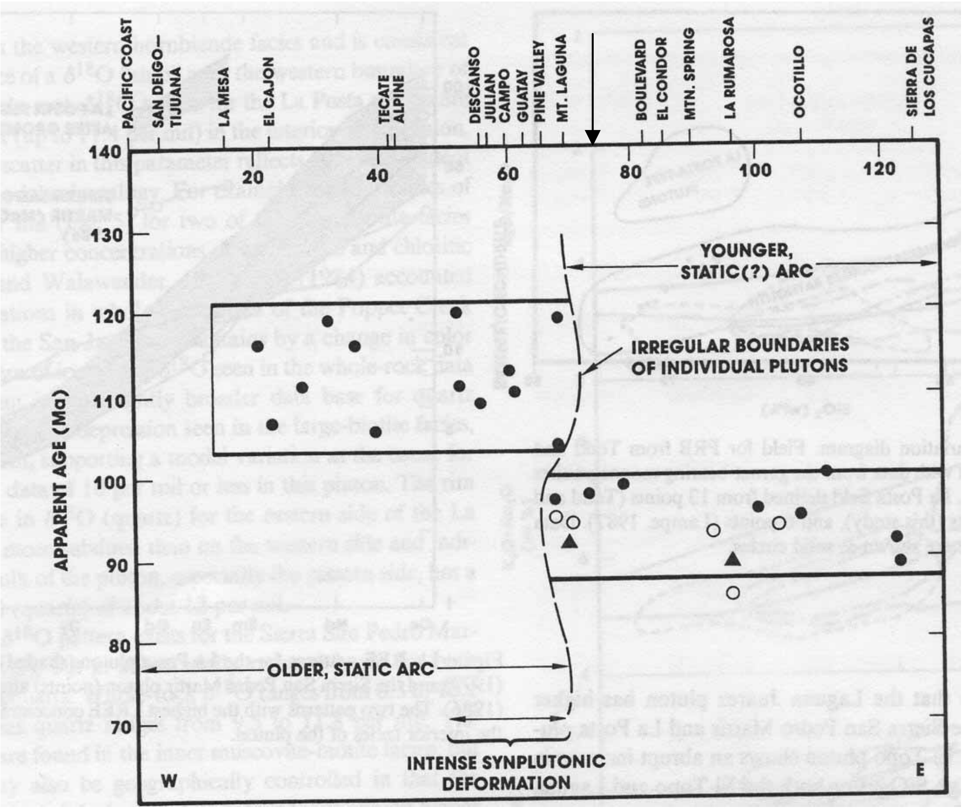
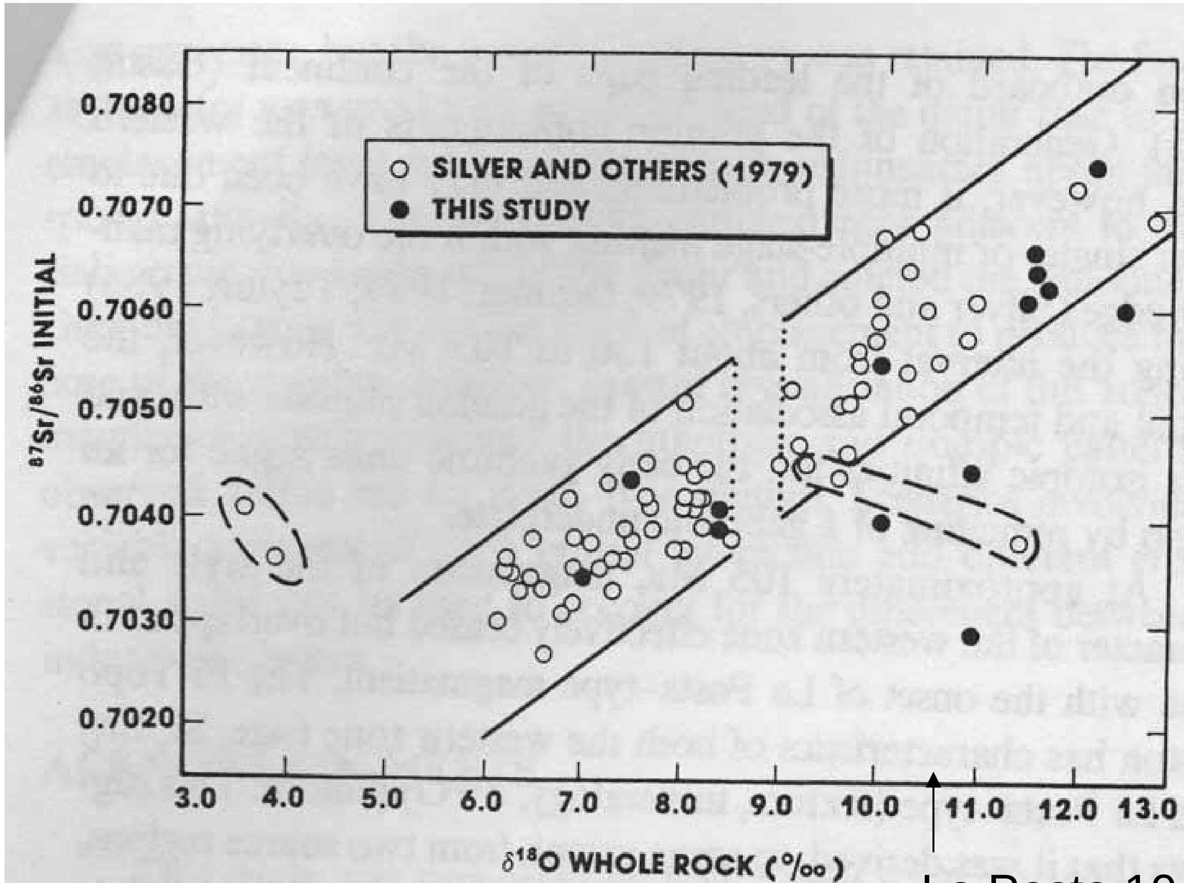


Figure 2A (Walawender et al. 1990)

West

East



La Posta 10.7

$\delta^{18}O$ is a proxy for distance across batholith (longitude)

Figure 2B (Walawender et al. 1990)