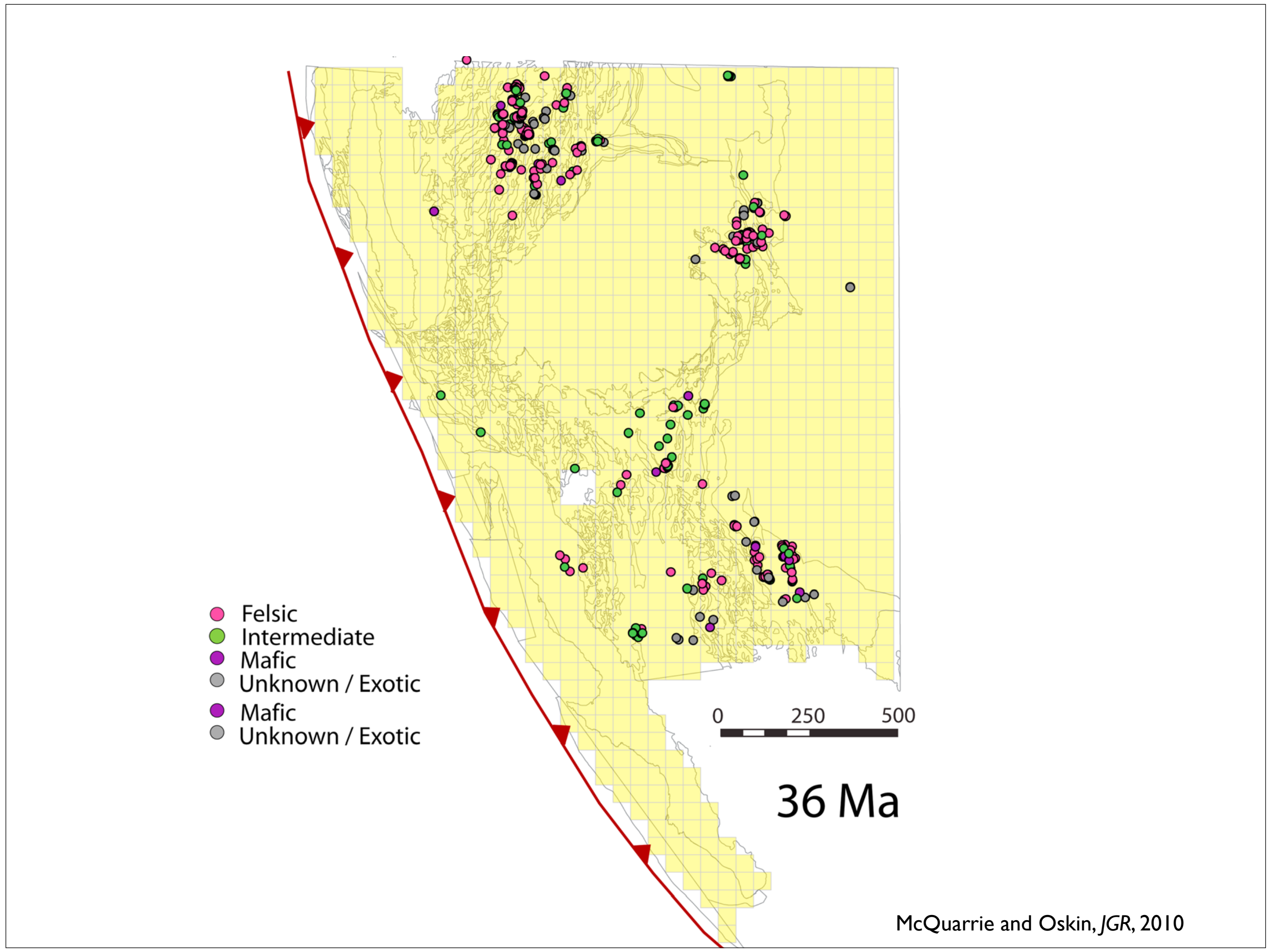
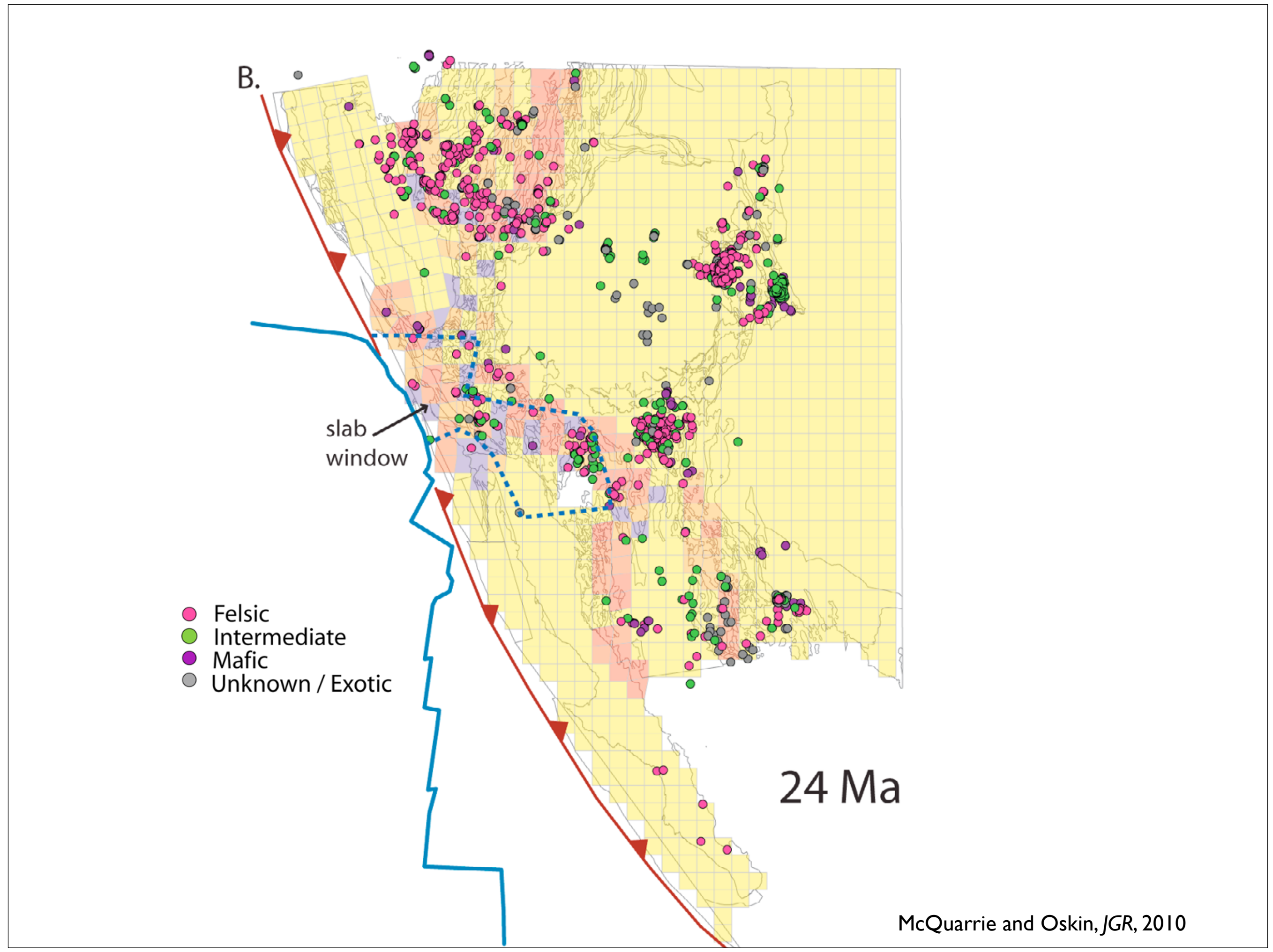
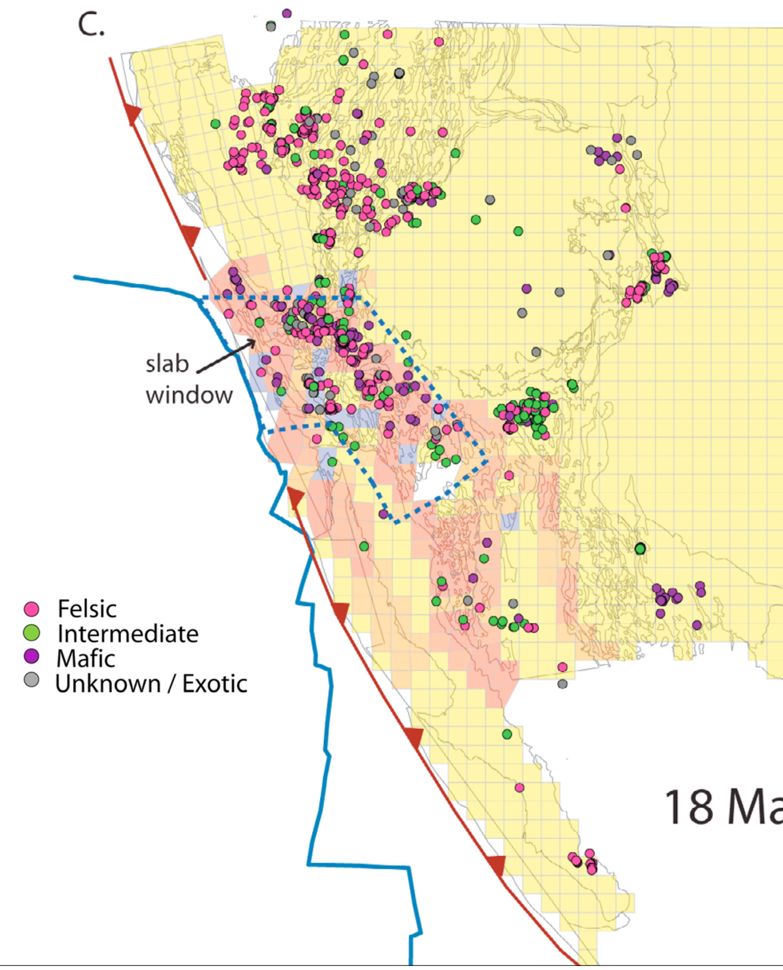
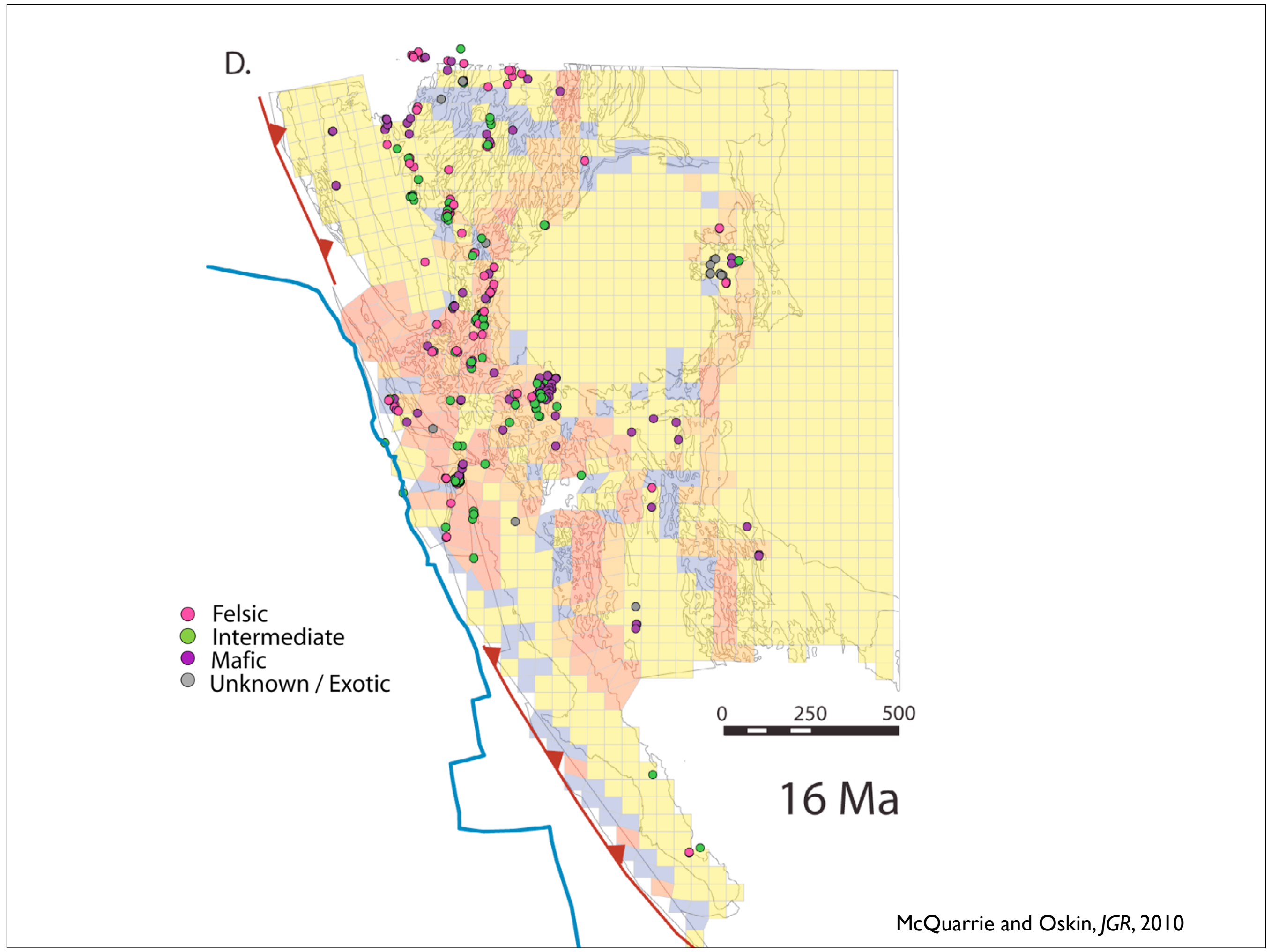


We’re going to do this twice..

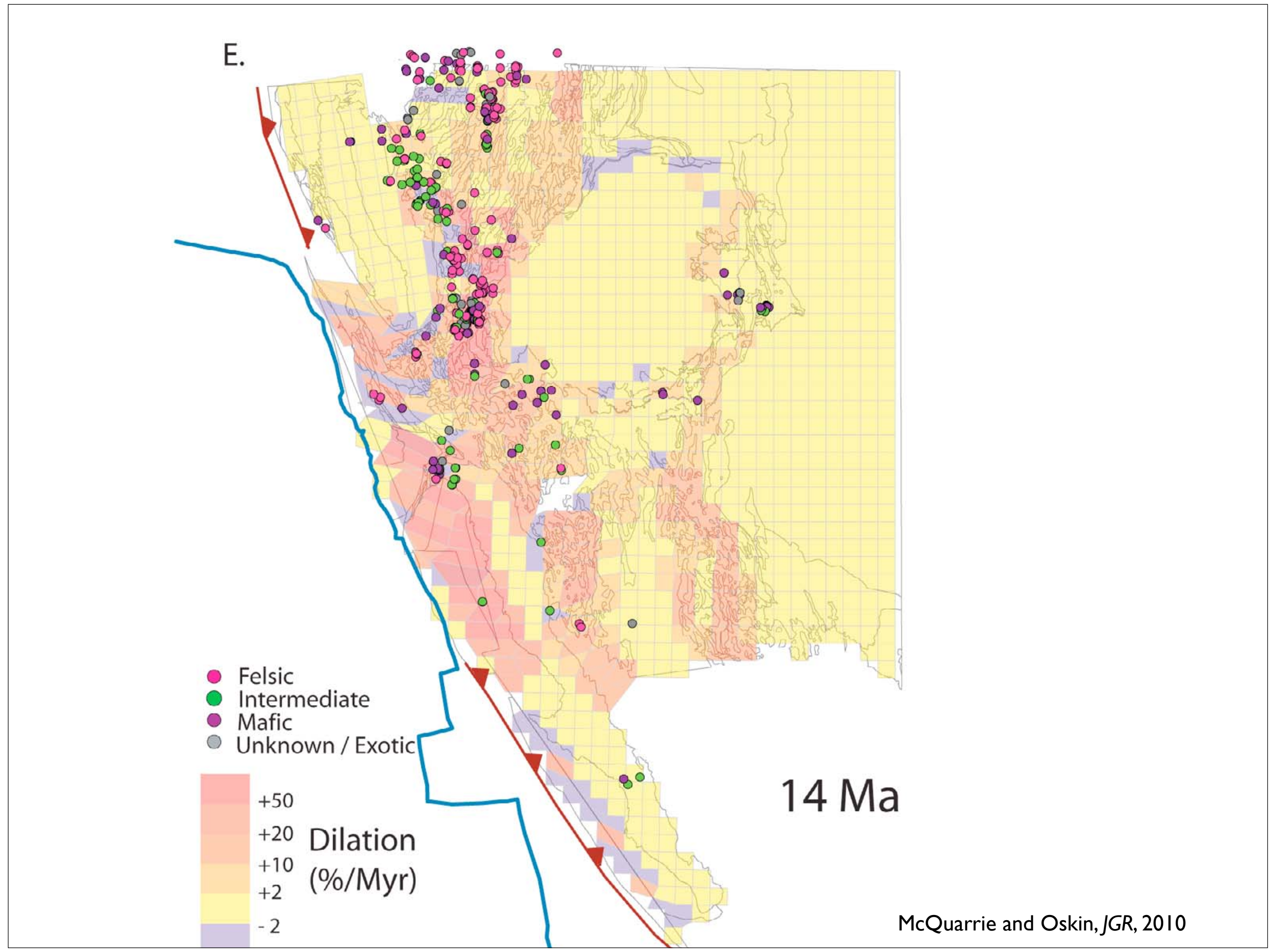

B.
slab
window
Felsic
Intermediate
Mafic
Unknown / Exotic
24 Ma
McQuarrie and Oskin, *JGR*, 2010

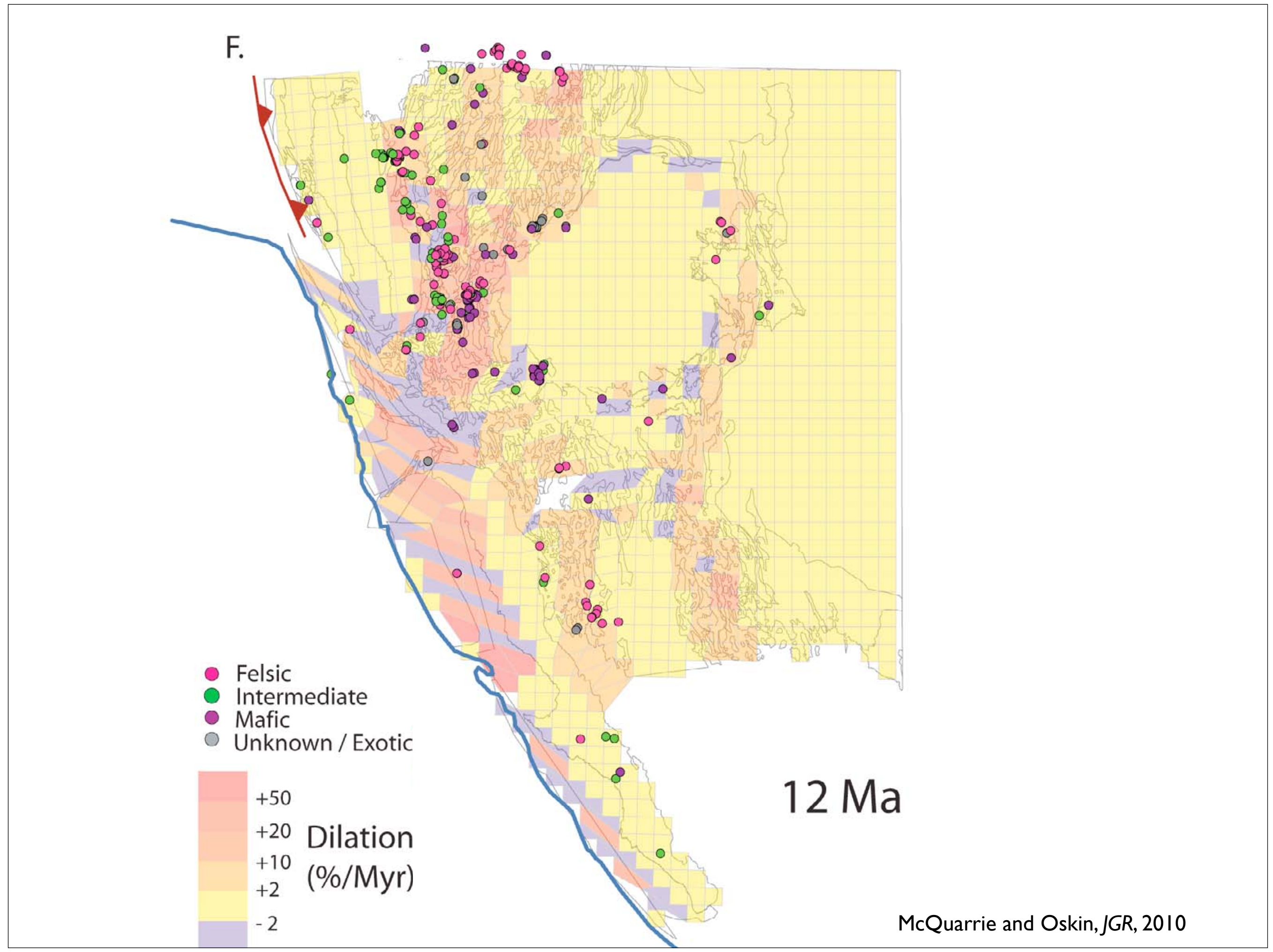


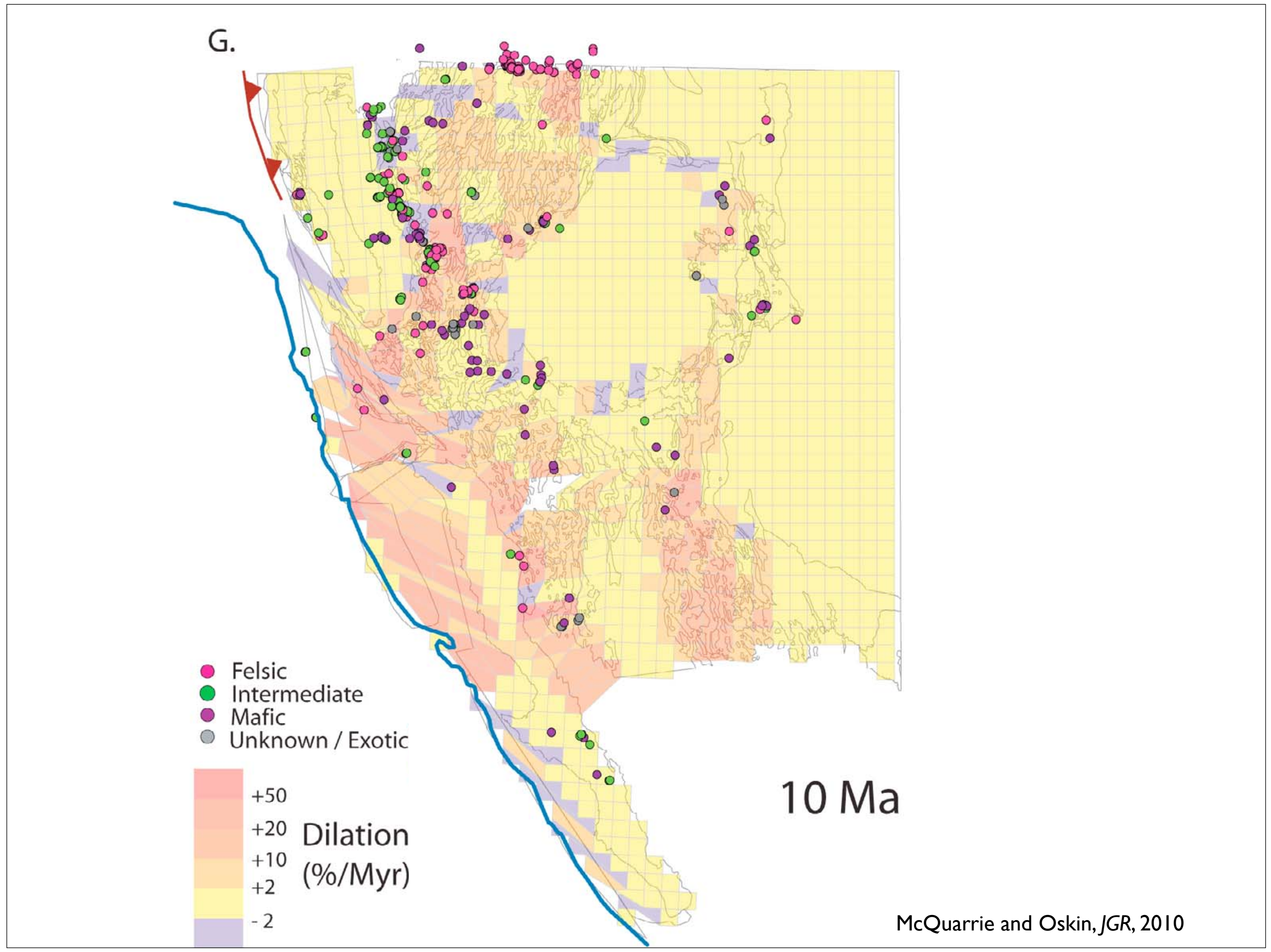
McQuarrie and Oskin, *JGR*, 2010



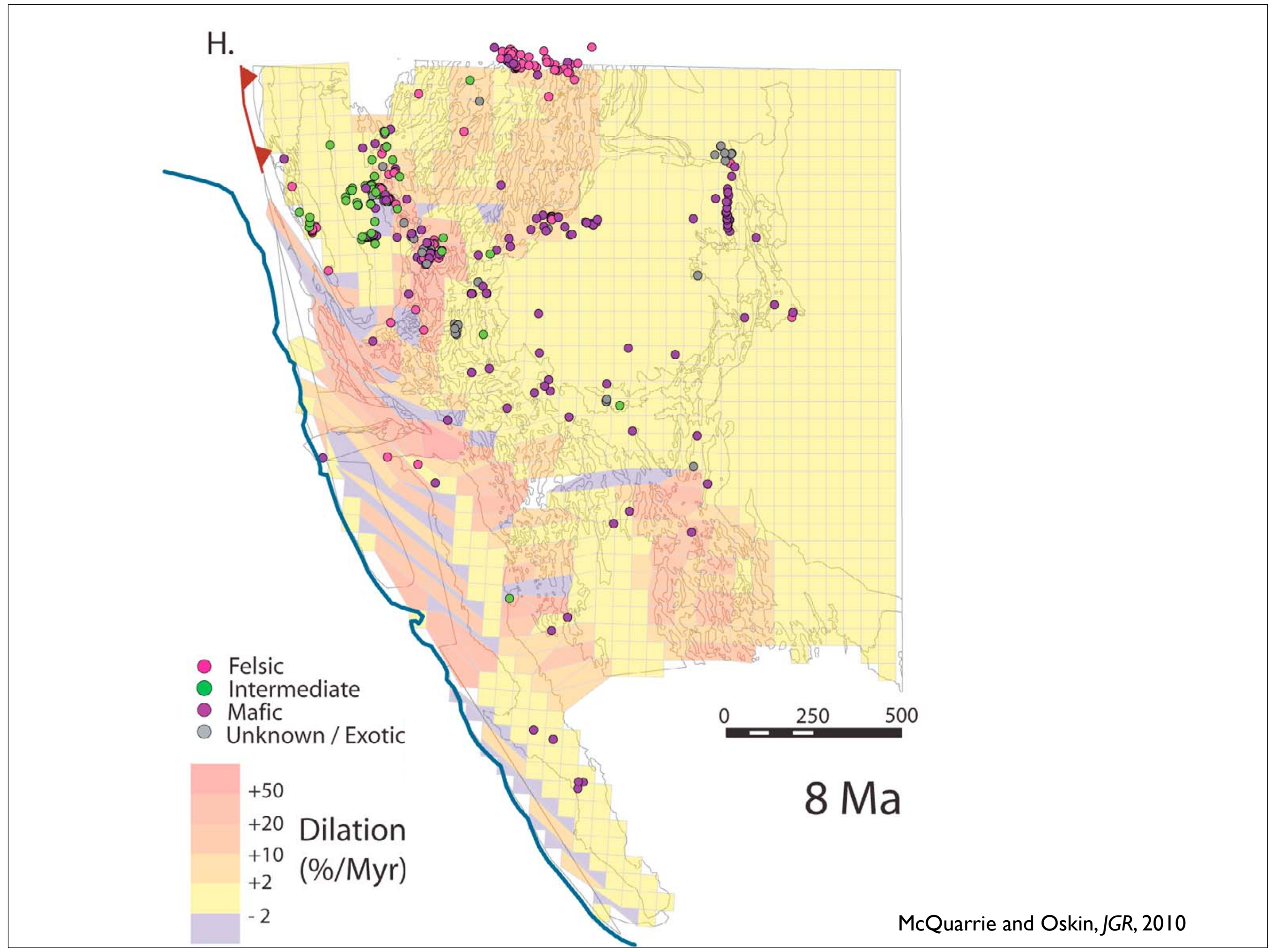
D.
Felsic
Intermediate
Mafic
Unknown / Exotic
0
250
500
16 Ma
McQuarrie and Oskin, *JGR*, 2010

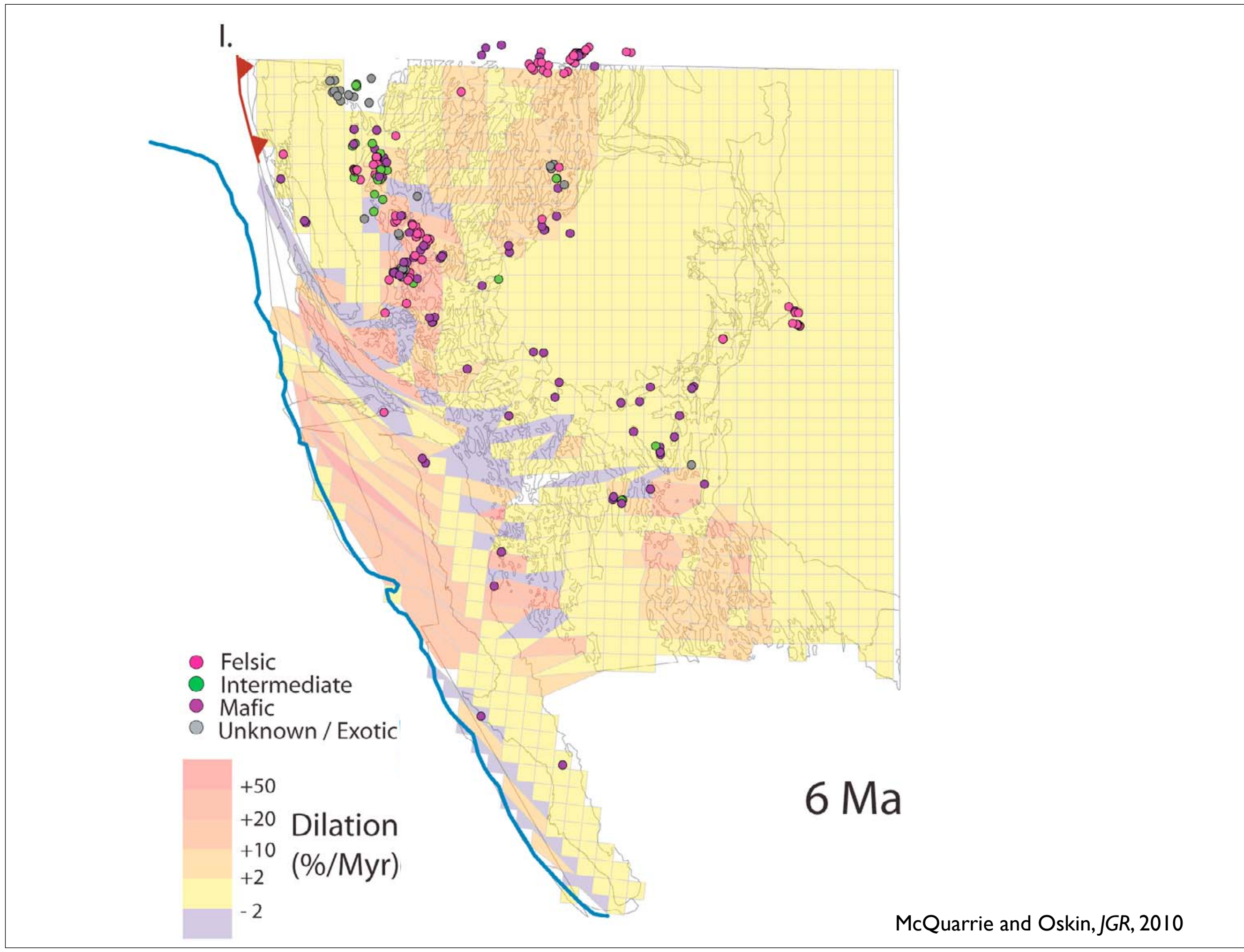

E.
Felsic
Intermediate
Mafic
Unknown / Exotic
+50
+20
+10
+2
- 2
Dilation
(%/Myr)
14 Ma
McQuarrie and Oskin, JGR, 2010


F.
Felsic
Intermediate
Mafic
Unknown / Exotic
+50
+20
+10
+2
- 2
Dilation
(%/Myr)
12 Ma
McQuarrie and Oskin, *JGR*, 2010

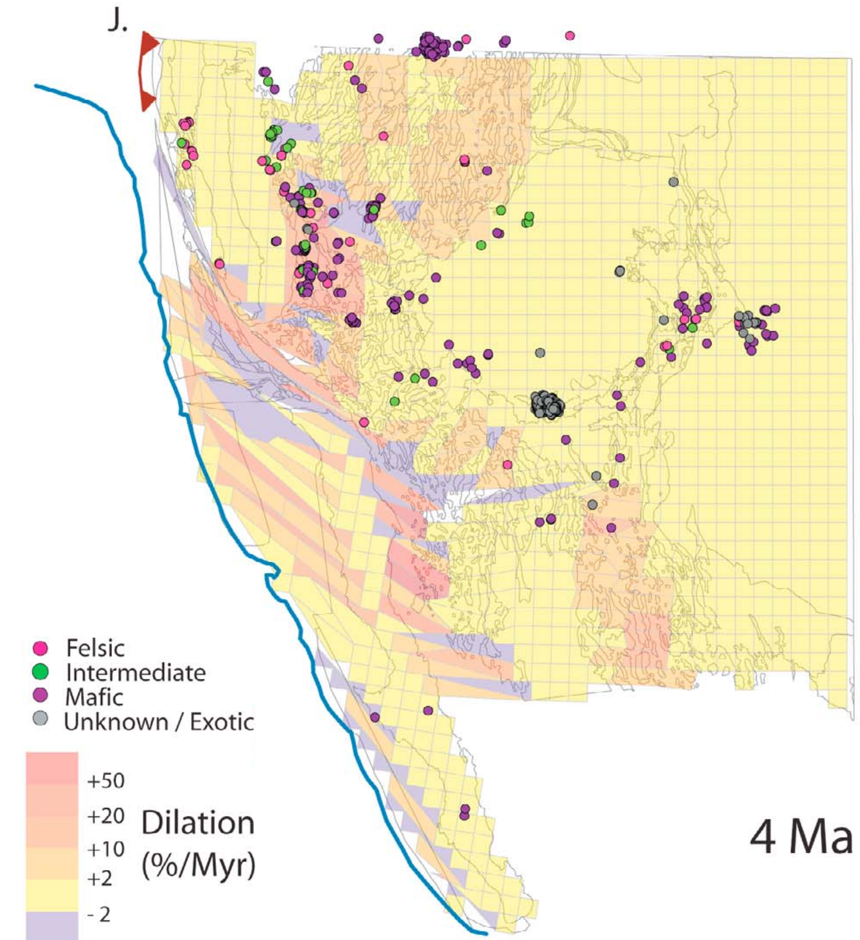


G.
Felsic
Intermediate
Mafic
Unknown / Exotic
+50
+20
+10
+2
- 2
Dilation
(%/Myr)
10 Ma
McQuarrie and Oskin, *JGR*, 2010

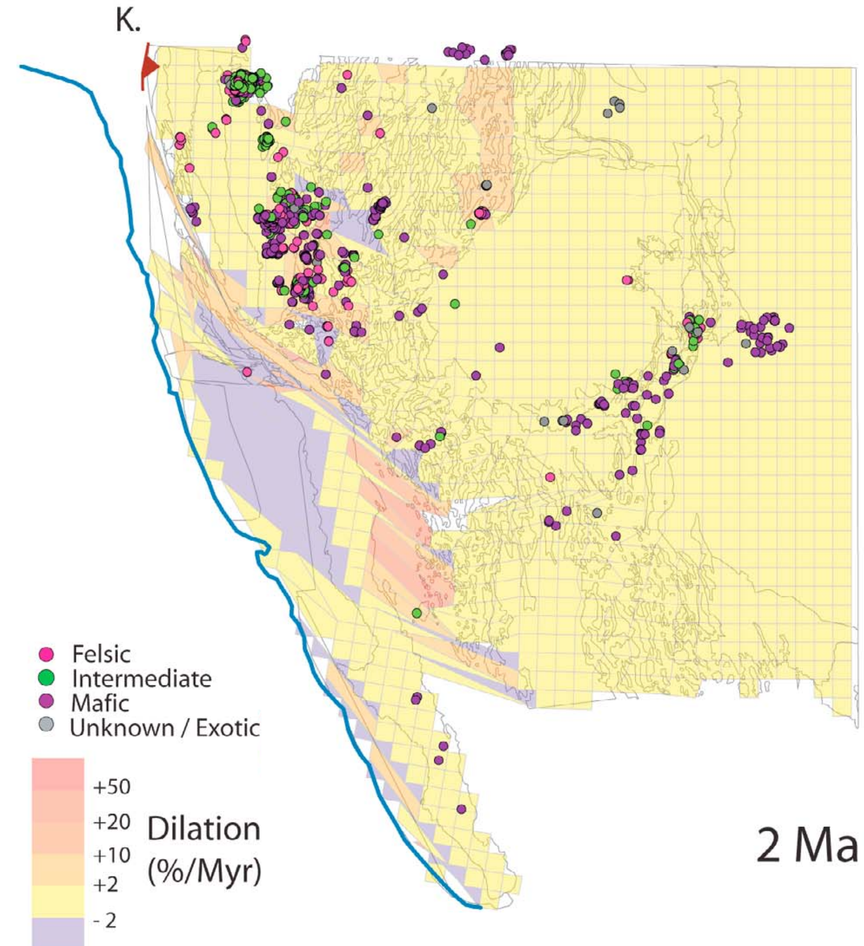

H.
Felsic
Intermediate
Mafic
Unknown / Exotic
+50
+20
+10
+2
- 2
Dilation
(%/Myr)
0
250
500
8 Ma
McQuarrie and Oskin, JGR, 2010



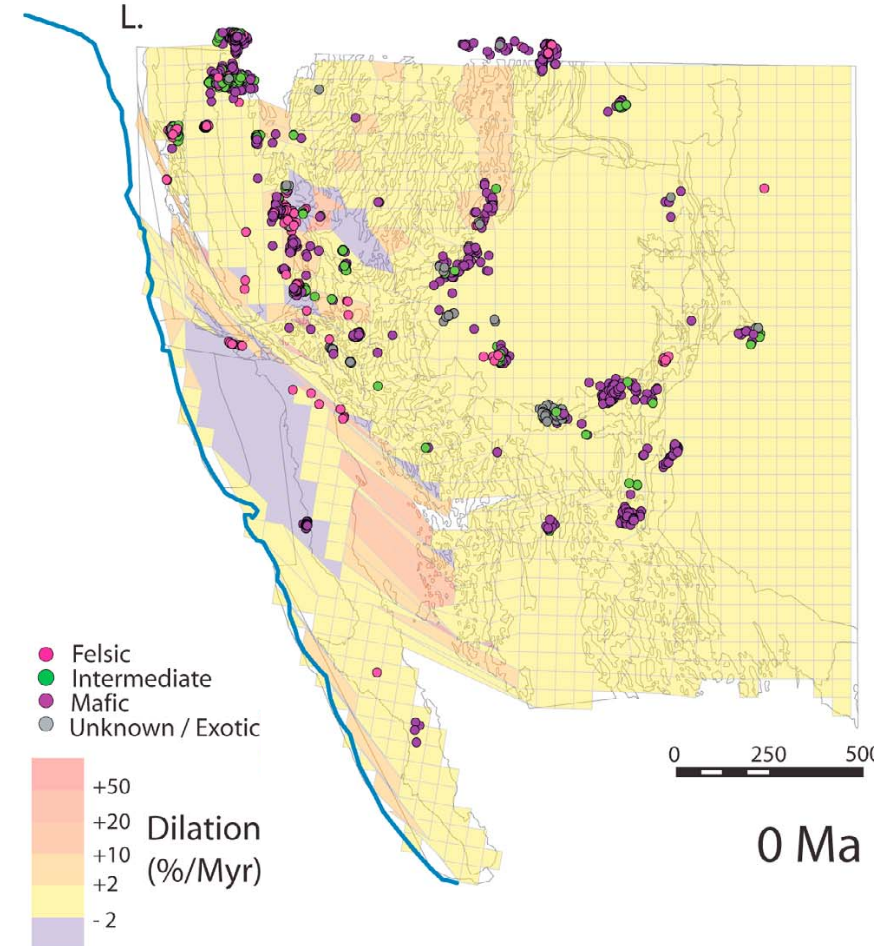
McQuarrie and Oskin, *JGR*, 2010



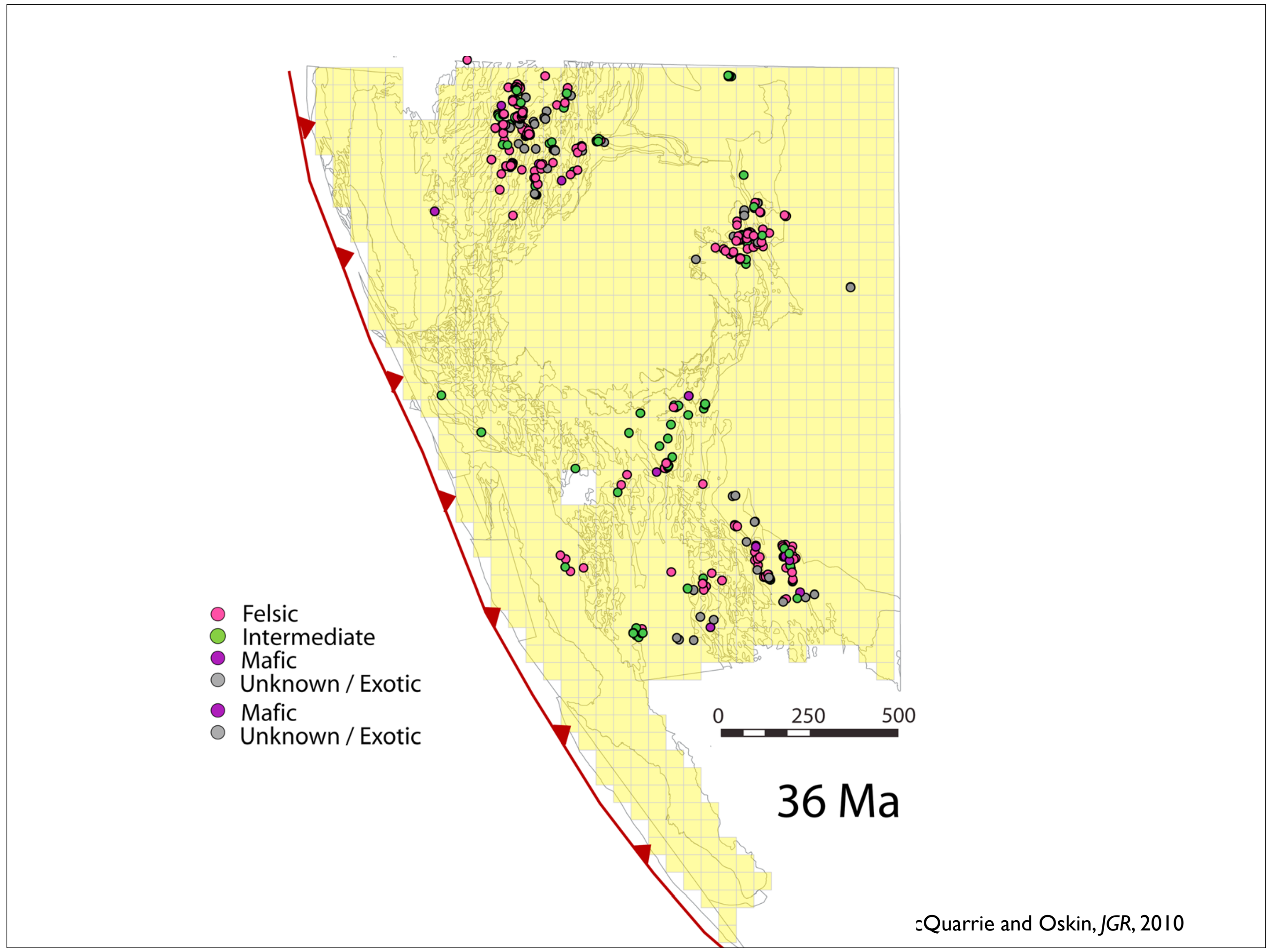
McQuarrie and Oskin, *JGR*, 2010

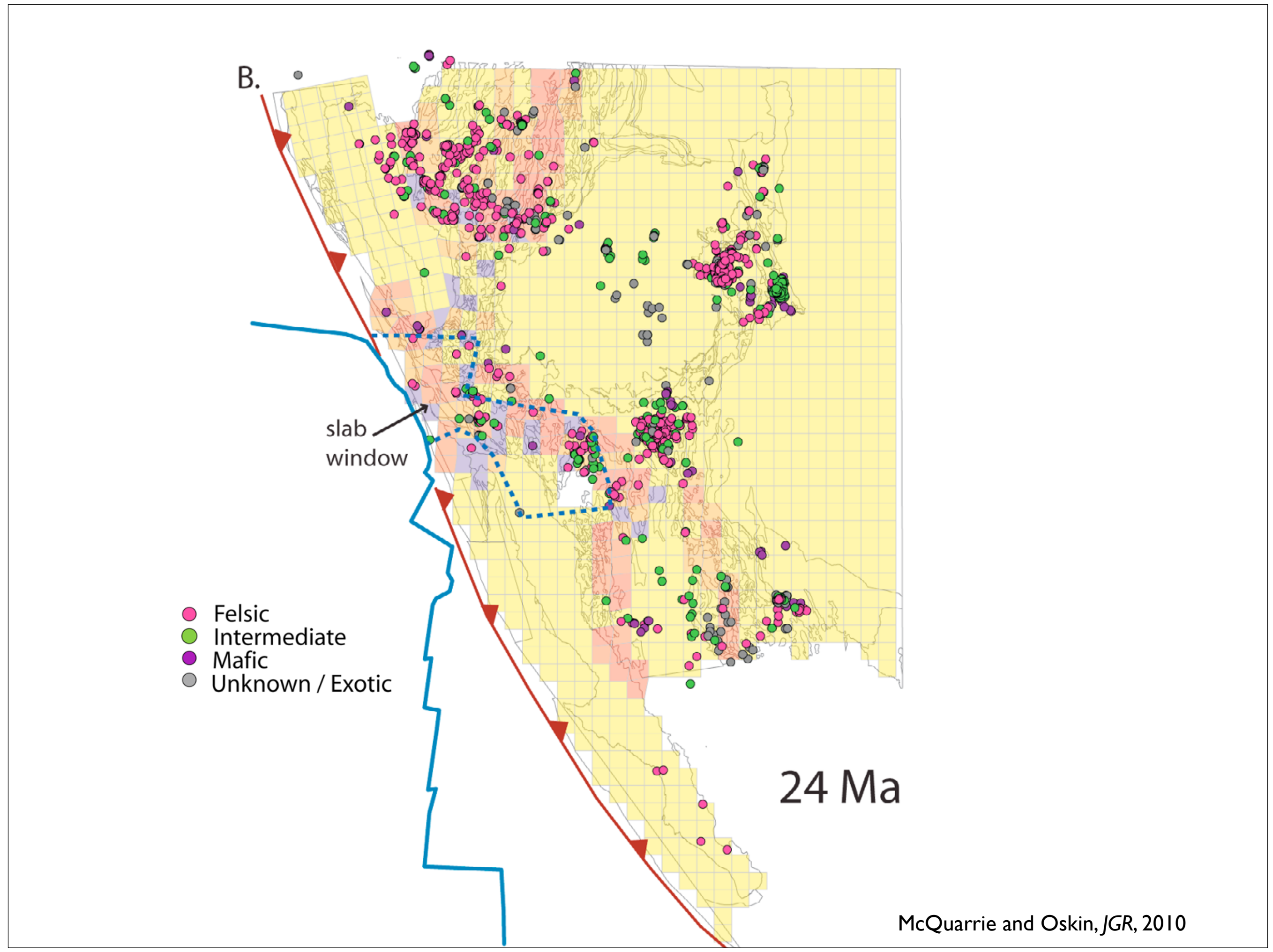


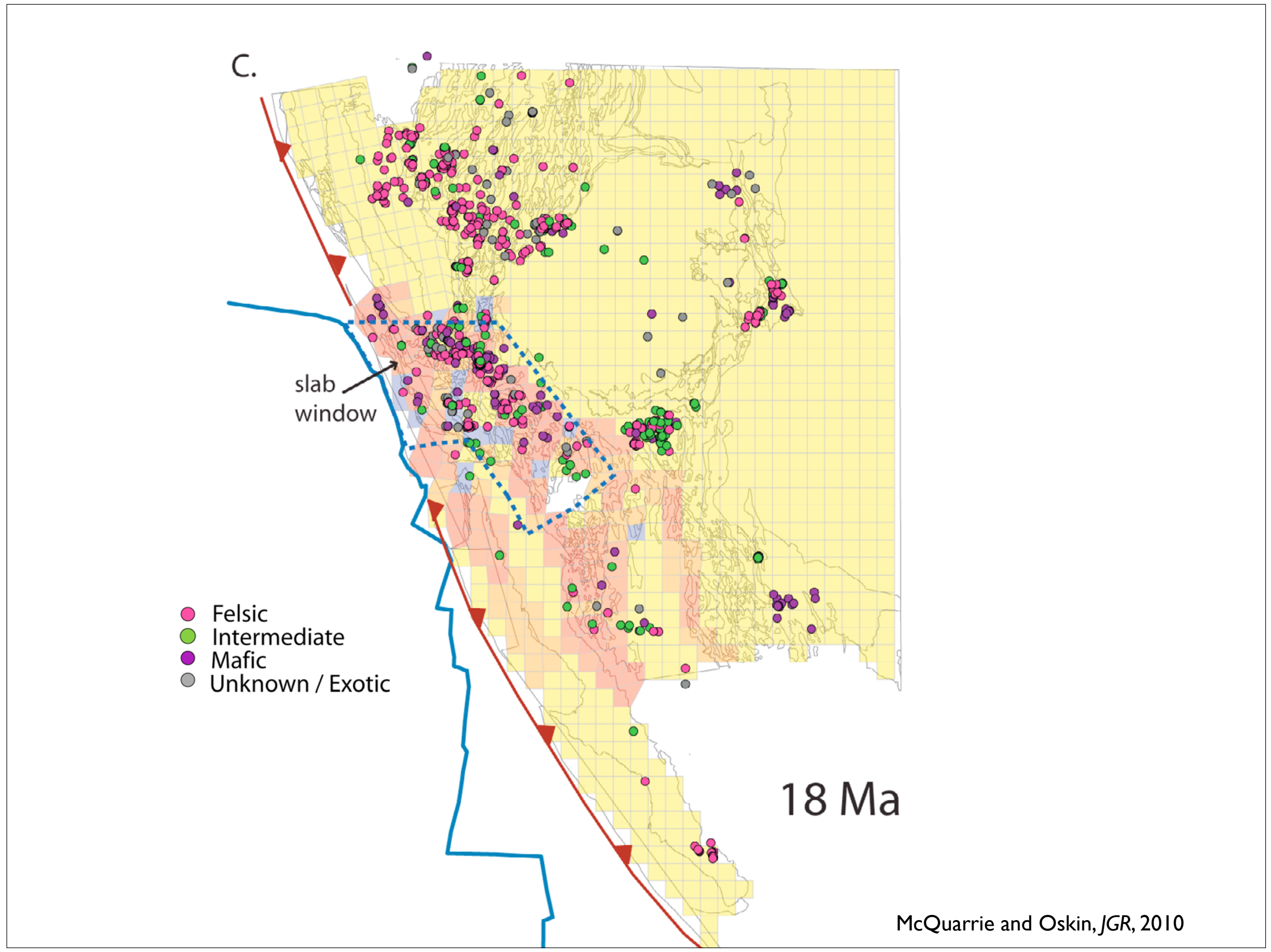
McQuarrie and Oskin, *JGR*, 2010

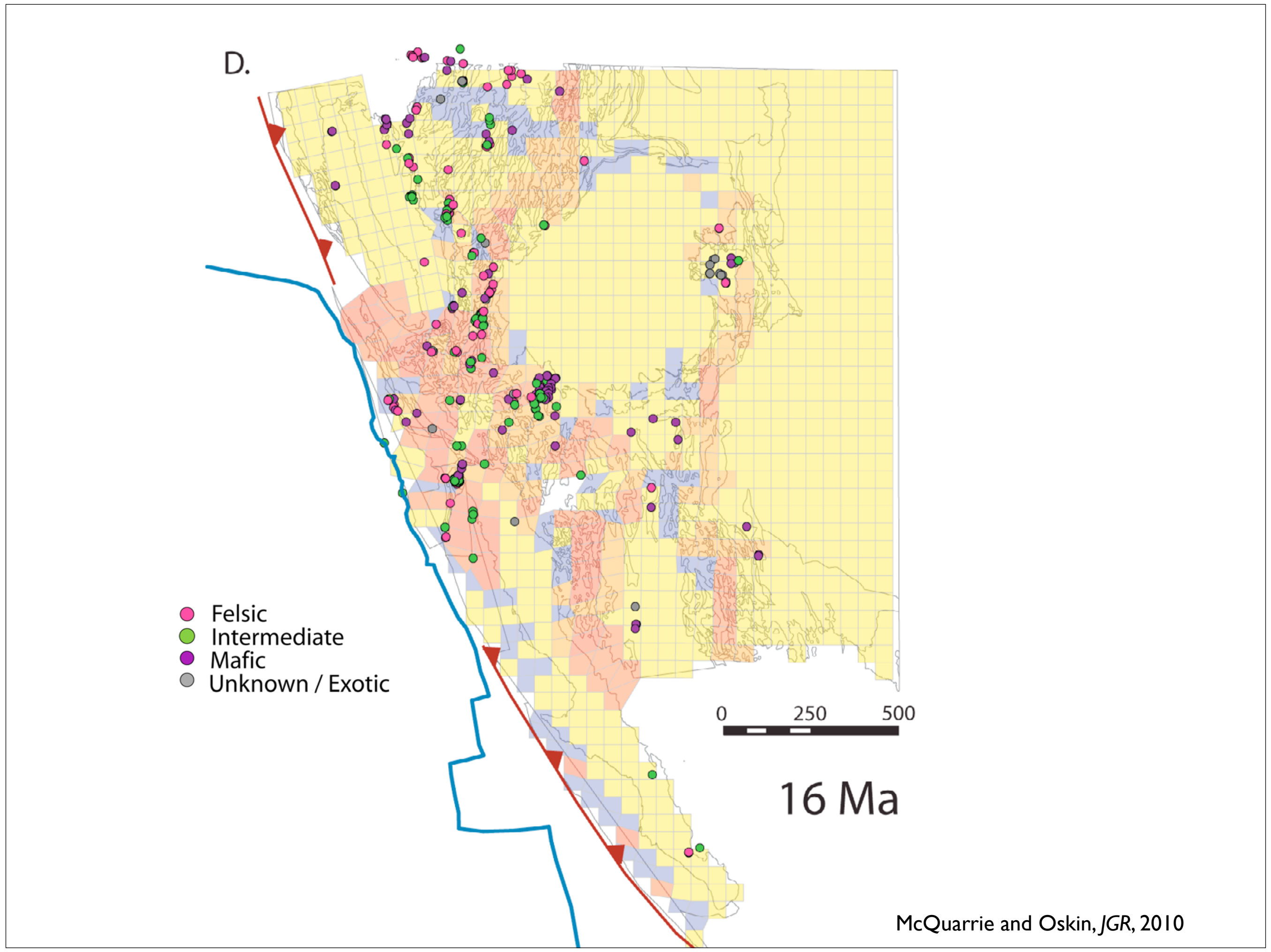


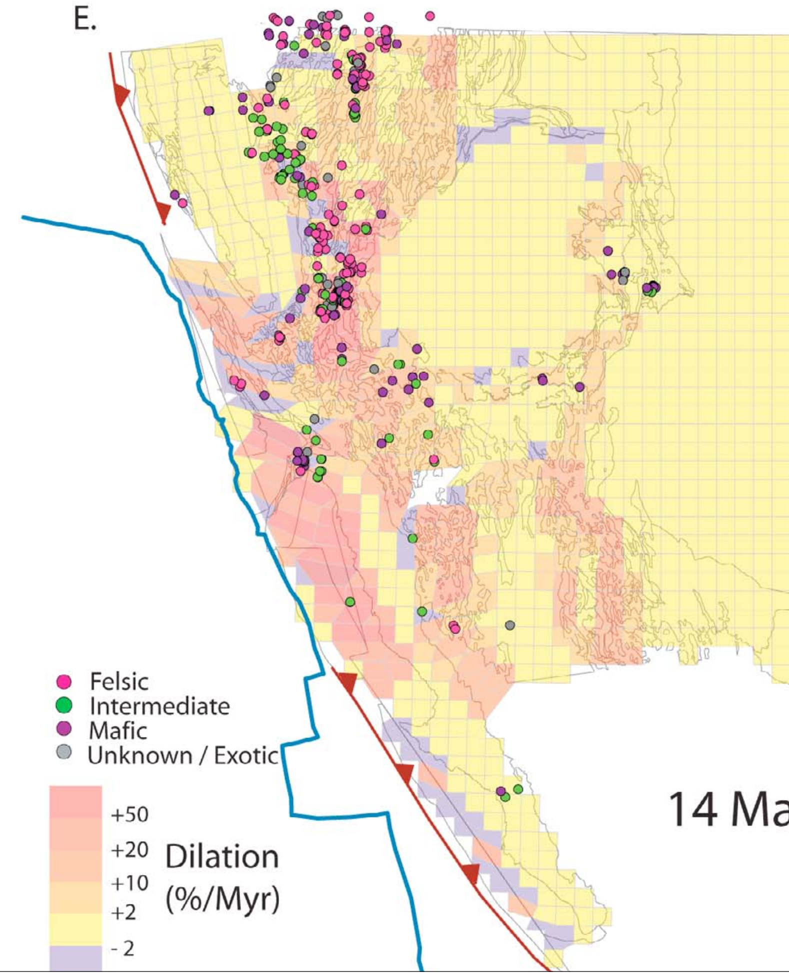
McQuarrie and Oskin, *JGR*, 2010


Felsic
Intermediate
Mafic
Unknown / Exotic
Mafic
Unknown / Exotic
0
250
500
36 Ma
cQuarrie and Oskin, JGR, 2010

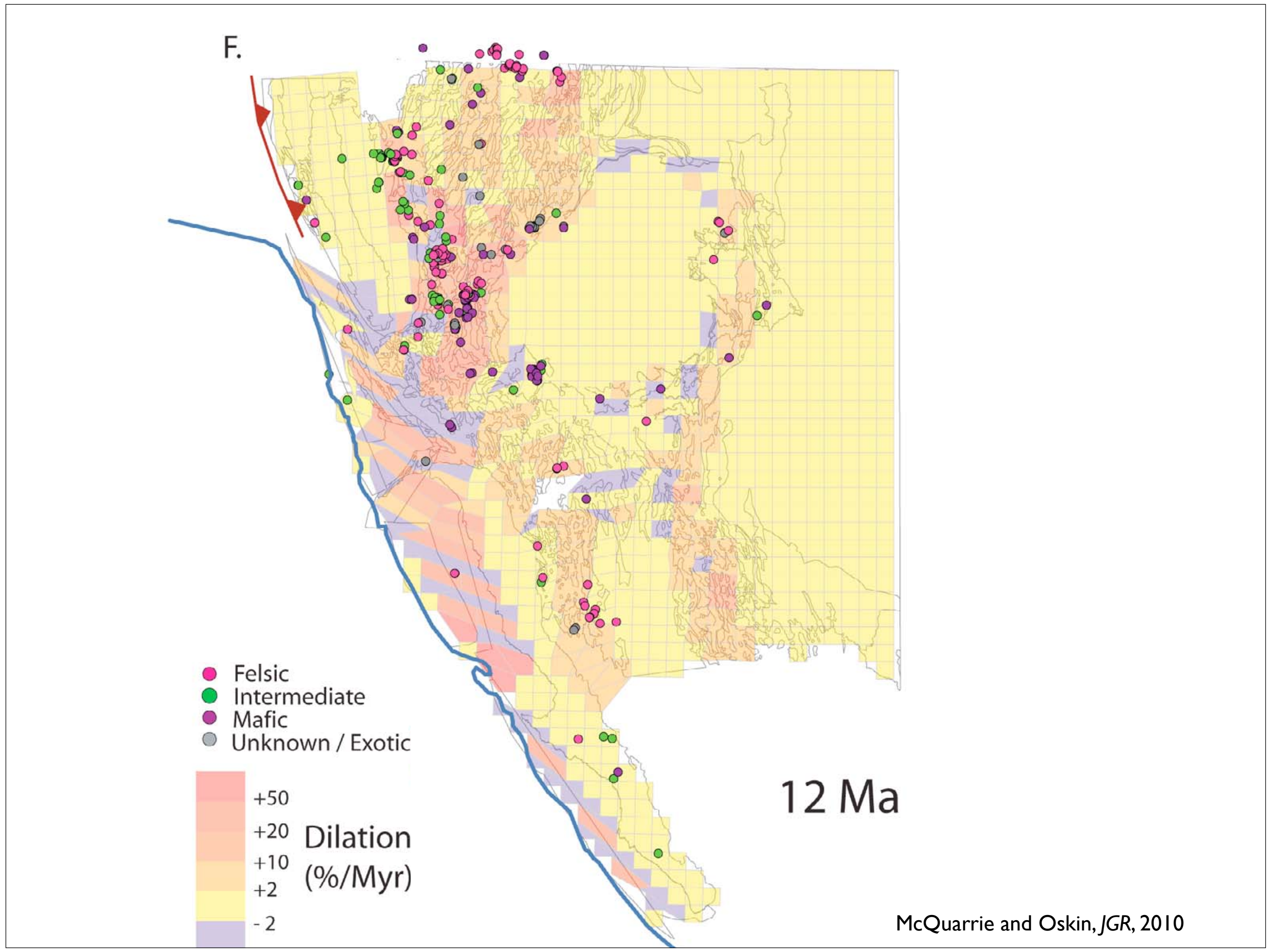

B.
slab
window
Felsic
Intermediate
Mafic
Unknown / Exotic
24 Ma
McQuarrie and Oskin, JGR, 2010


C.
slab
window
Felsic
Intermediate
Mafic
Unknown / Exotic
18 Ma
McQuarrie and Oskin, *JGR*, 2010

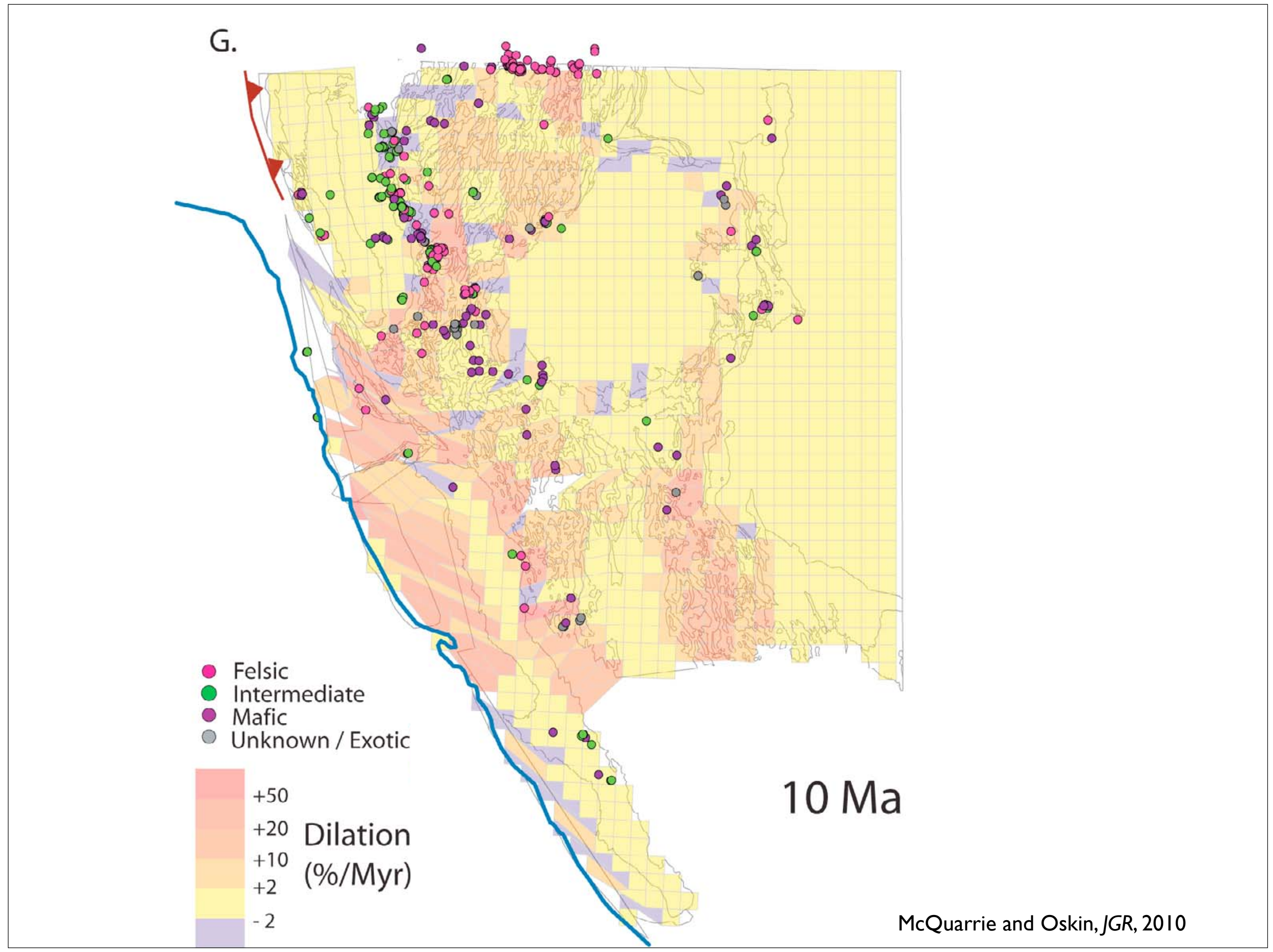

D.
Felsic
Intermediate
Mafic
Unknown / Exotic
0
250
500
16 Ma
McQuarrie and Oskin, JGR, 2010

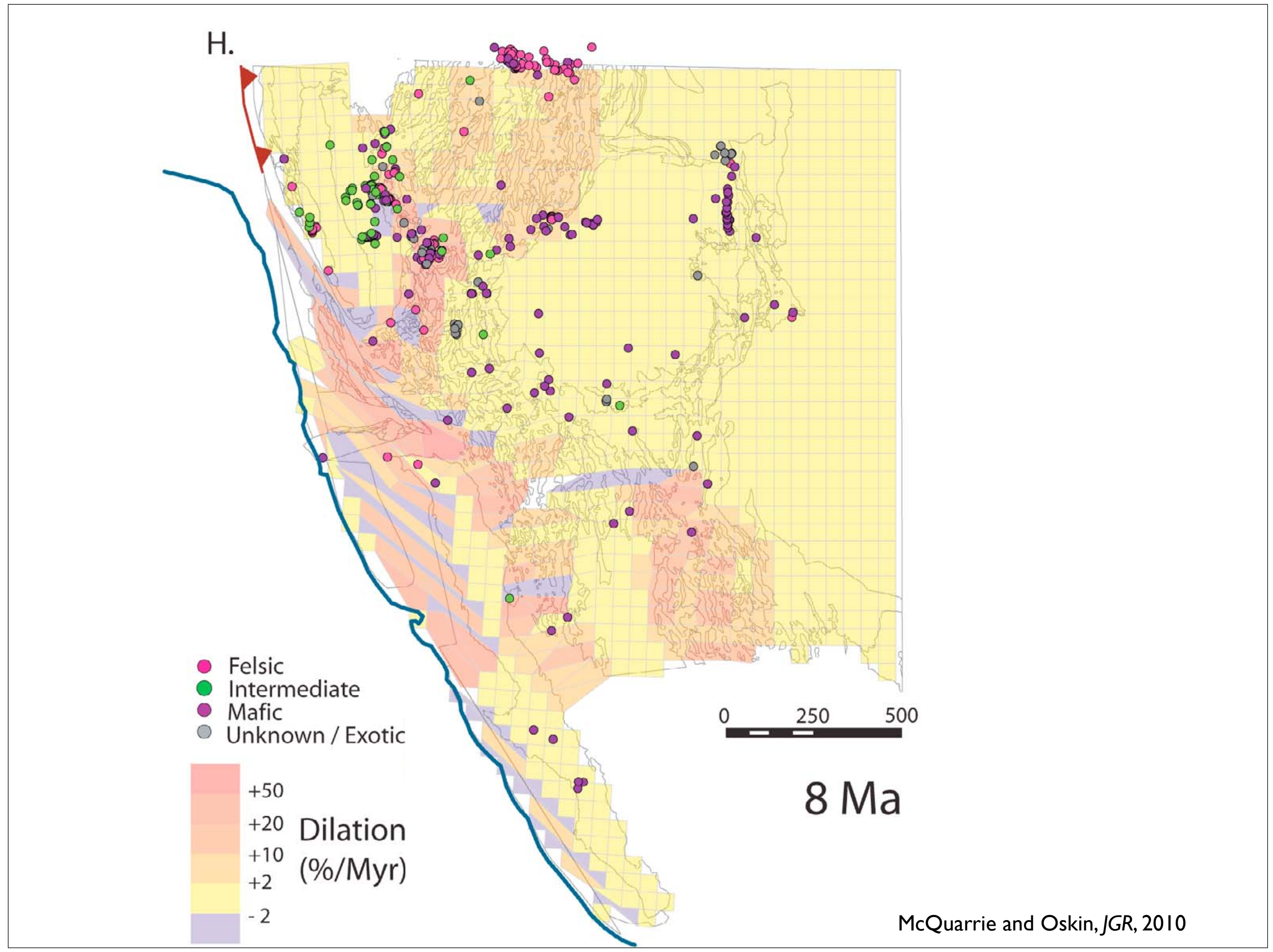


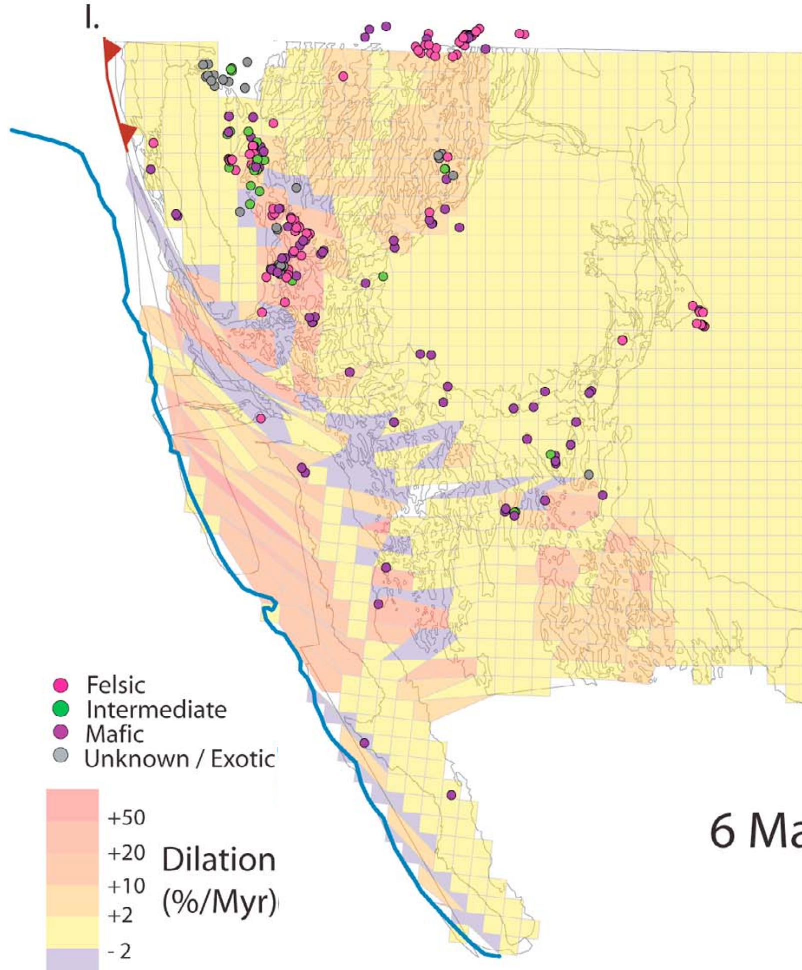
McQuarrie and Oskin, *JGR*, 2010



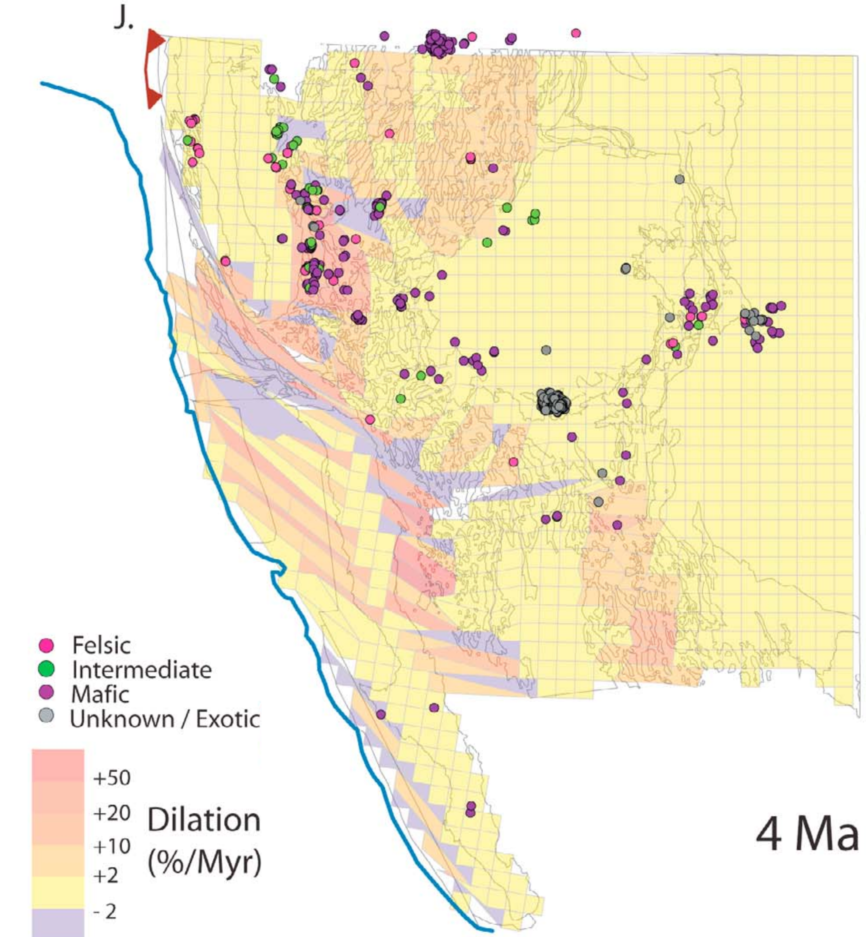
McQuarrie and Oskin, *JGR*, 2010


G.
Felsic
Intermediate
Mafic
Unknown / Exotic
+50
+20
+10
+2
- 2
Dilation
(%/Myr)
10 Ma
McQuarrie and Oskin, *JGR*, 2010

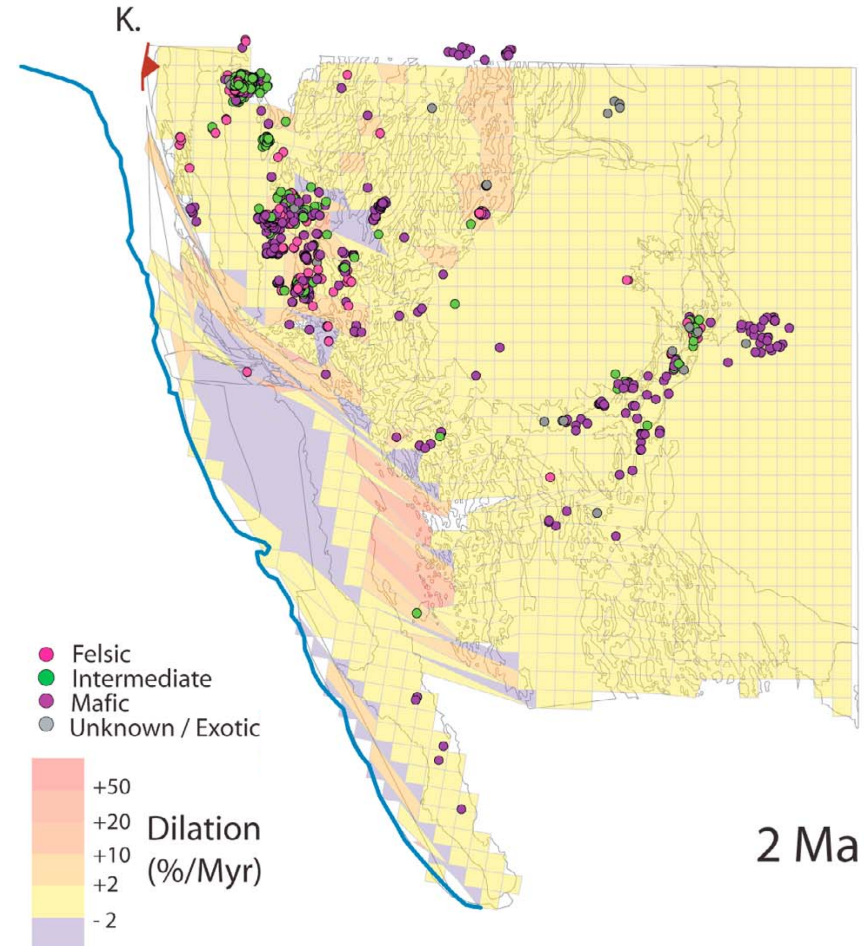

H.
Felsic
Intermediate
Mafic
Unknown / Exotic
+50
+20
+10
+2
- 2
Dilation
(%/Myr)
0
250
500
8 Ma
McQuarrie and Oskin, JGR, 2010



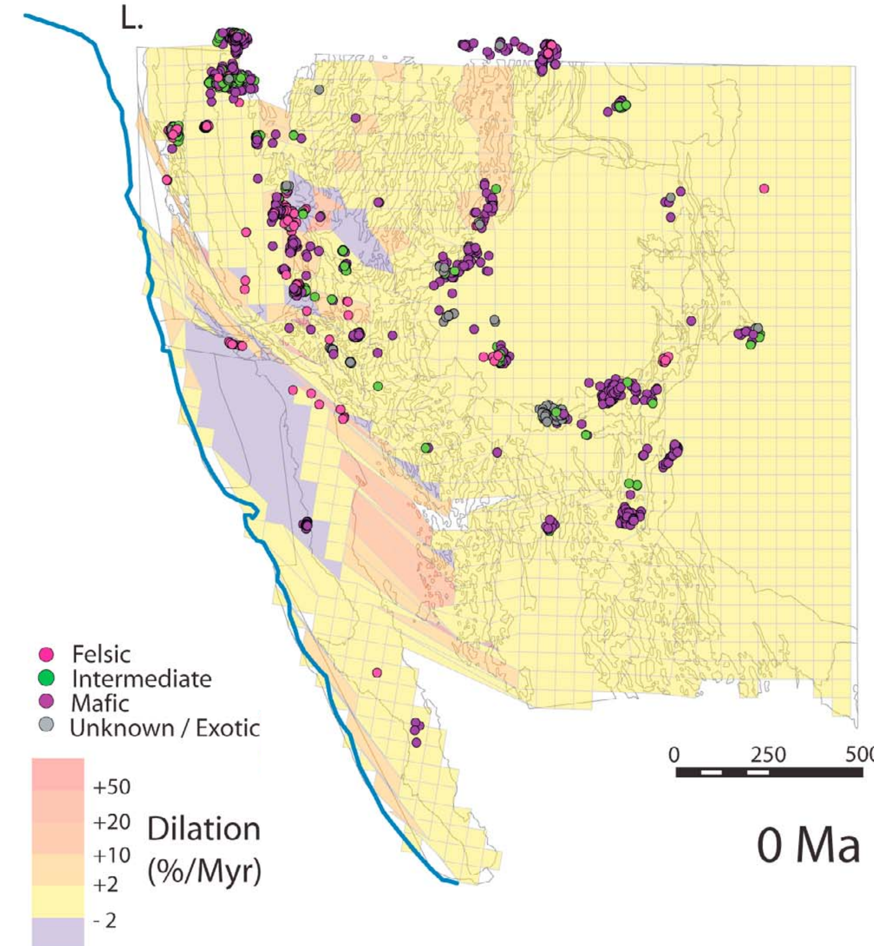
McQuarrie and Oskin, *JGR*, 2010



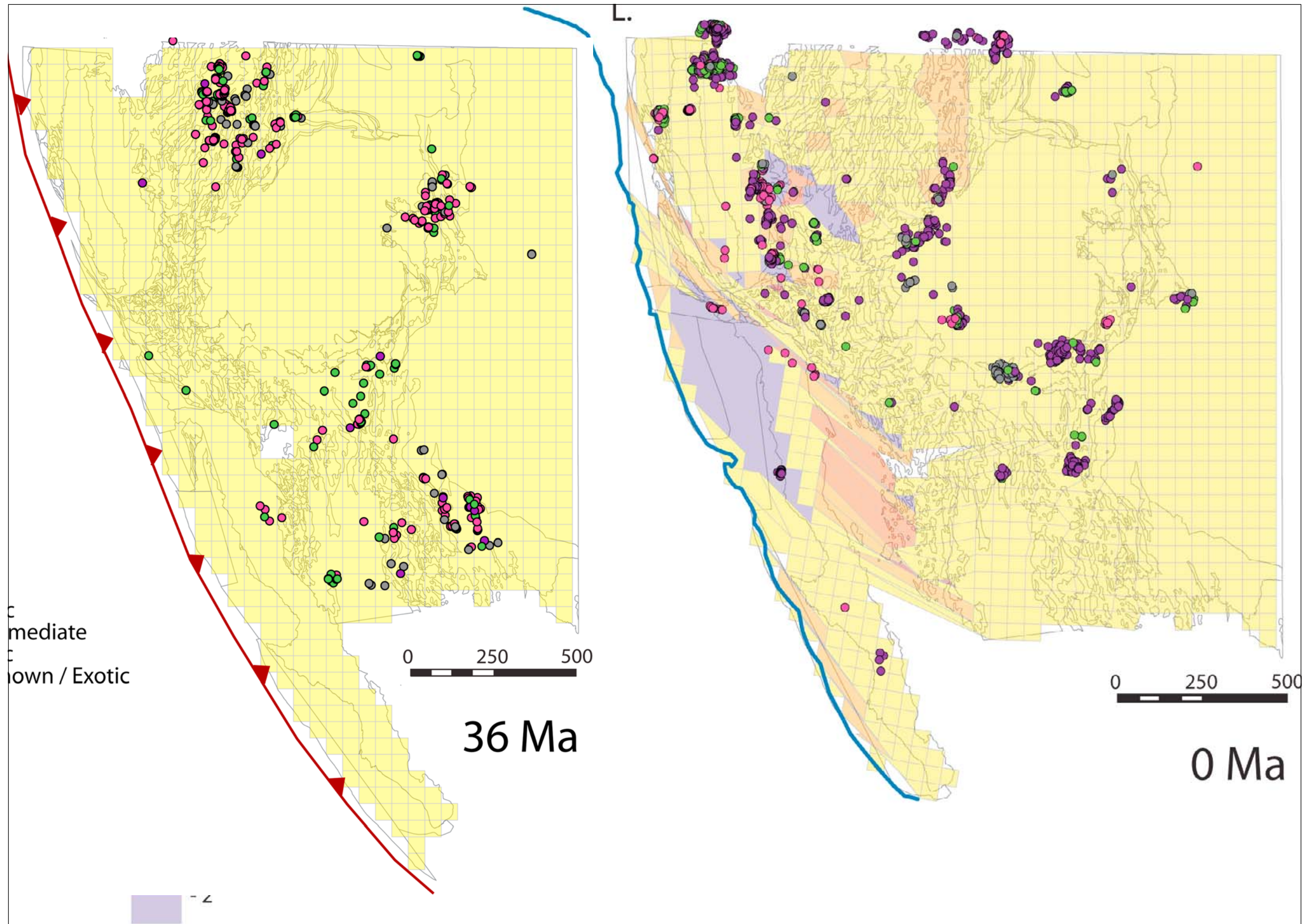
McQuarrie and Oskin, *JGR*, 2010



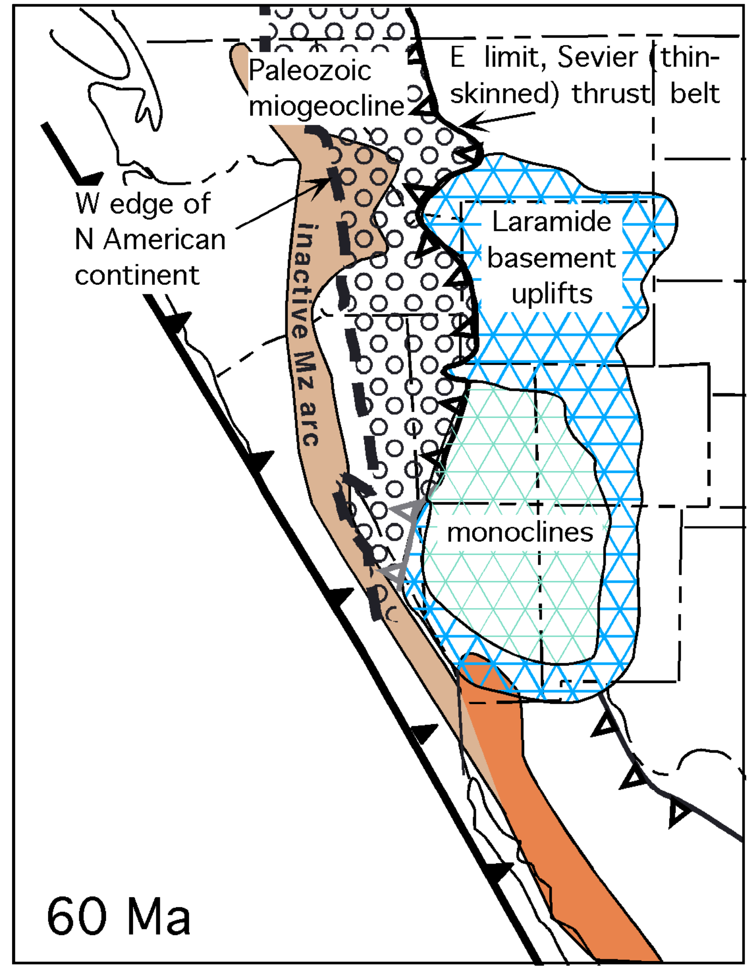
McQuarrie and Oskin, *JGR*, 2010



McQuarrie and Oskin, *JGR*, 2010

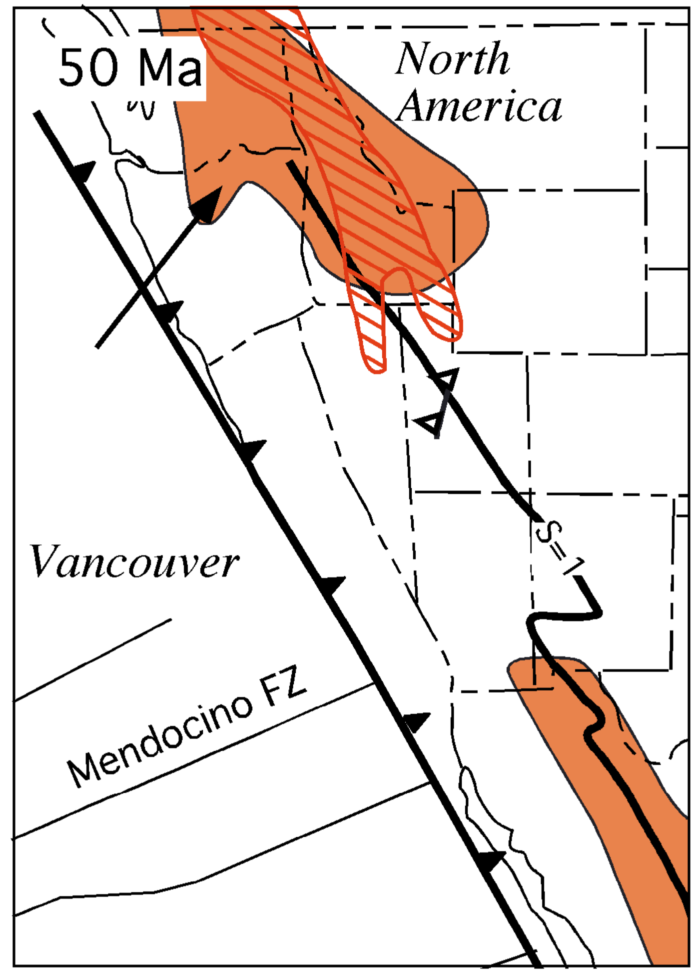


McQuarrie and Oskin, *JGR*, 2010



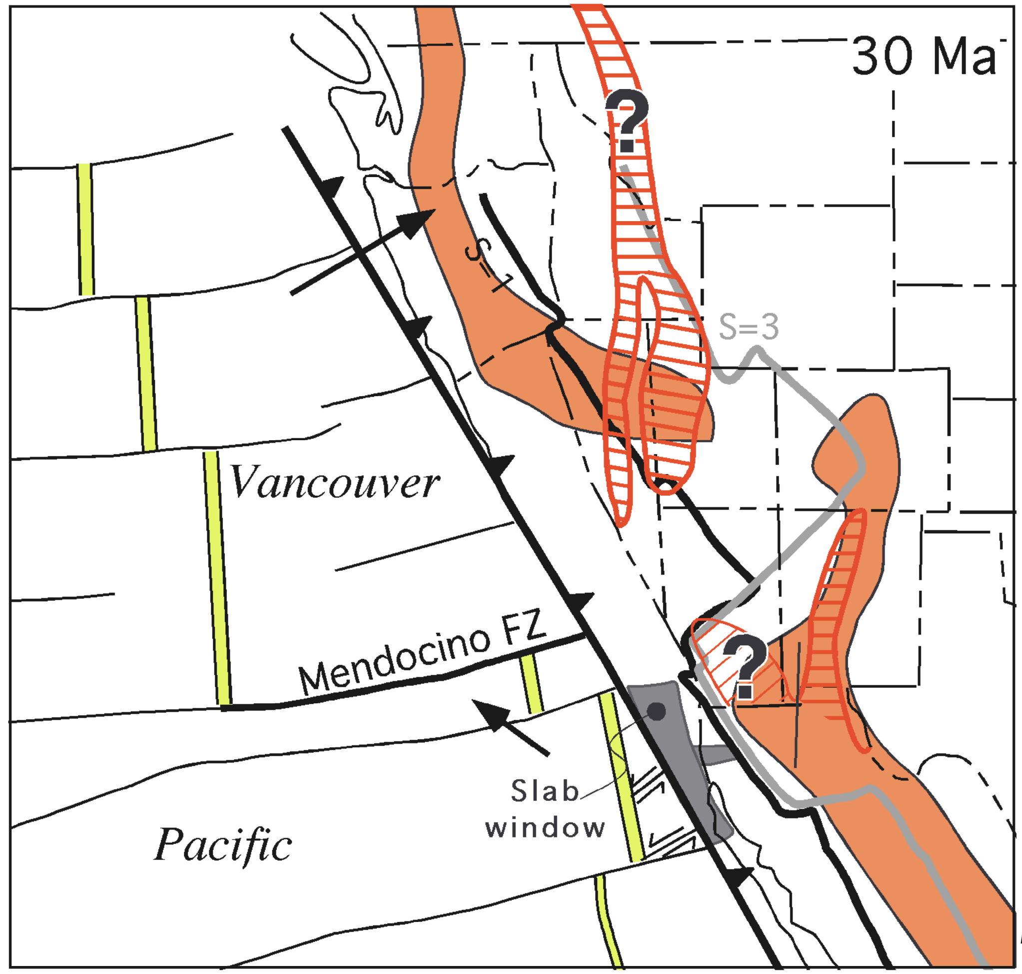
Sonder & Jones, *Ann. Rev Earth Plan. Sci*, 1999

Dark orange is calc-alkaline volcanic areas (some interpret as arc)

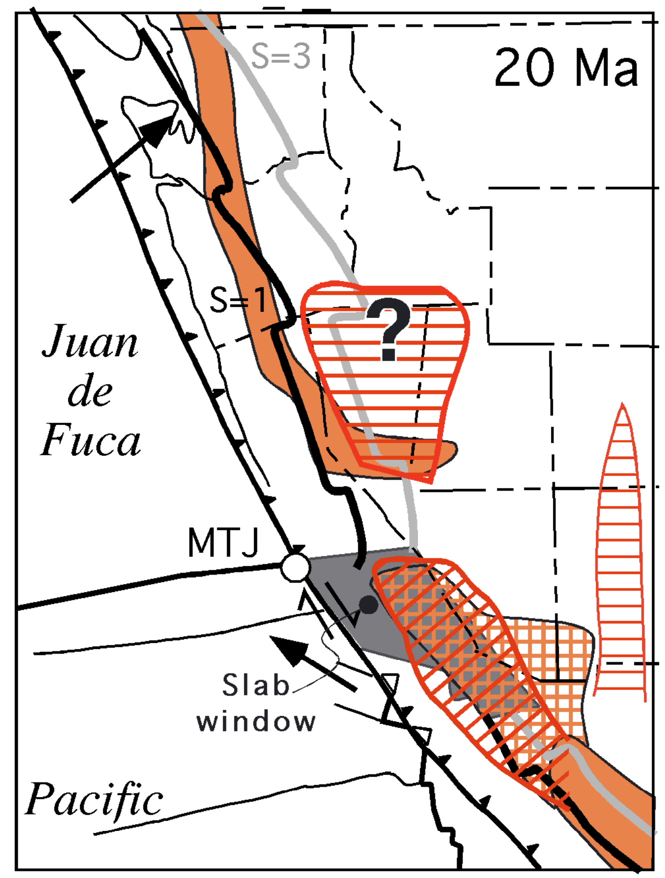


Sonder & Jones, *Ann. Rev Earth Plan. Sci*, 1999

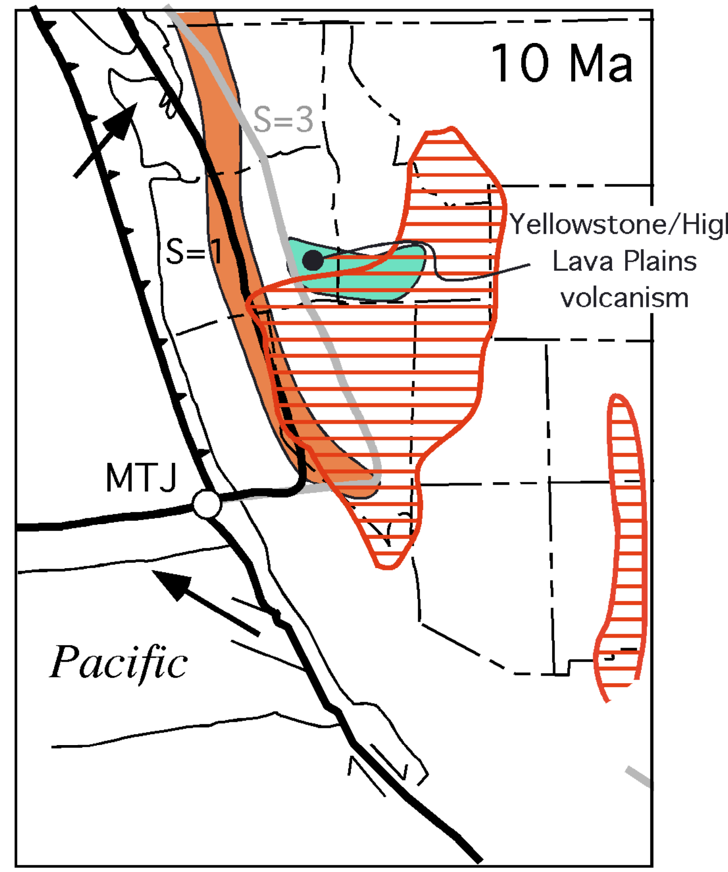
Big arrow is relative plate motion. Large heavy line (S=1) indicates position along which slab has fairly constant thermal state. “At each point on the slab, S equals the time since subduction divided by one-tenth of the age of that point at the time it was subducted.”
S=1 is approximately maximum depth of seismic slab. S = 10T/(A-T-C) where T is time since subduction, A age of magnetic anomaly and C is time of map construction (so A-C is age of slab at subduction.



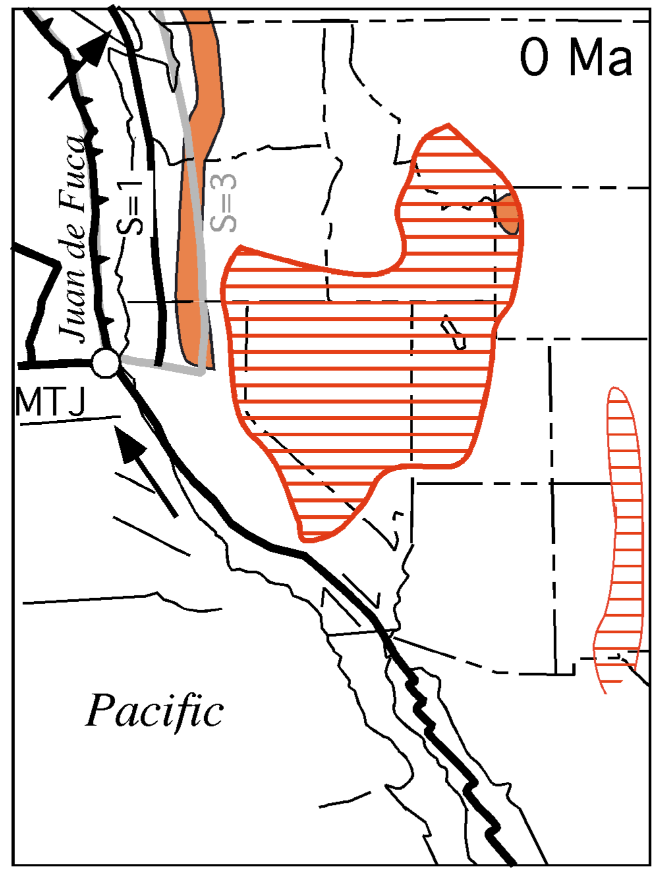
Sonder & Jones, *Ann. Rev Earth Plan. Sci*, 1999



Sonder & Jones, *Ann. Rev Earth Plan. Sci*, 1999

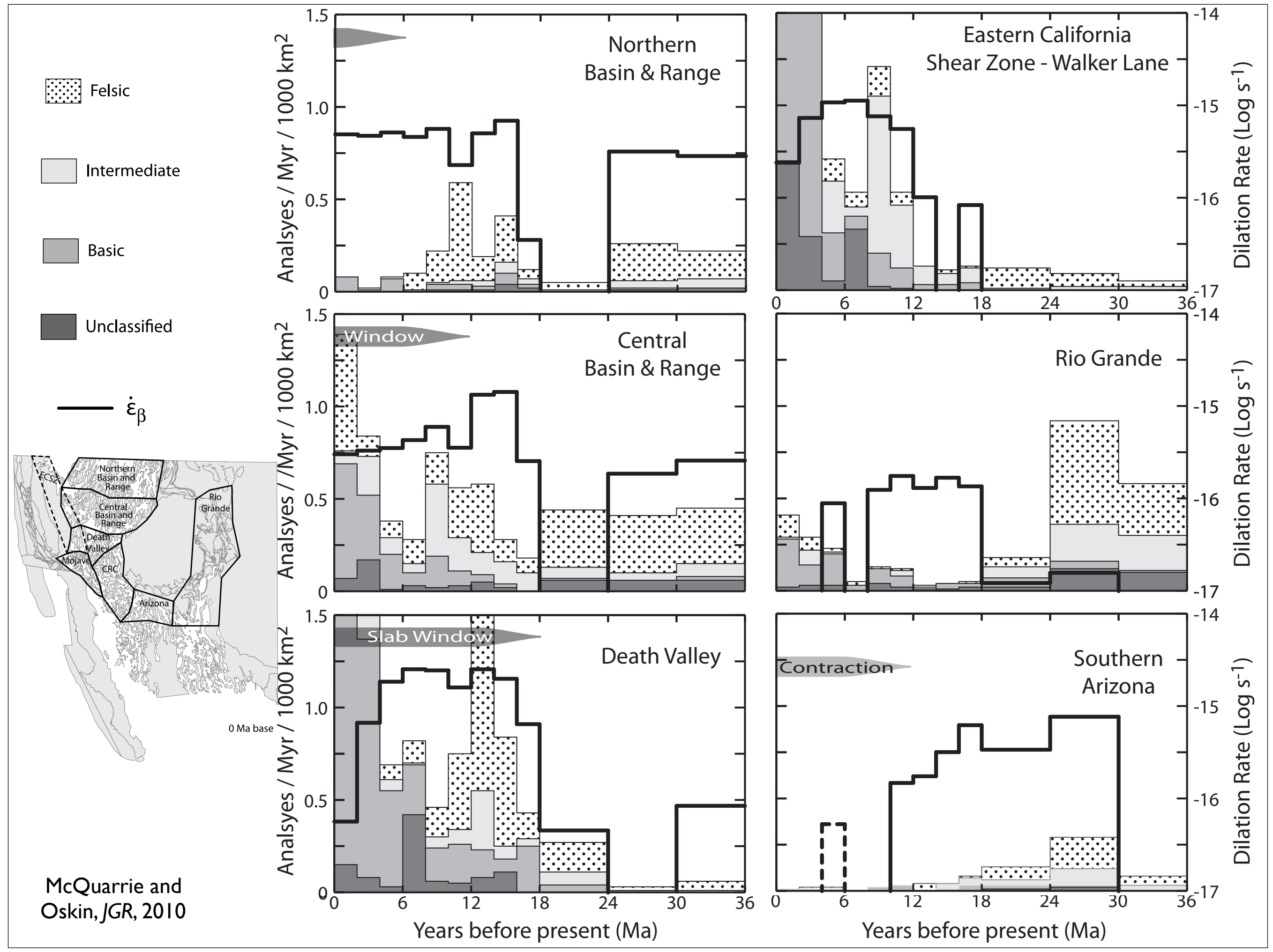


Sonder & Jones, *Ann. Rev Earth Plan. Sci*, 1999



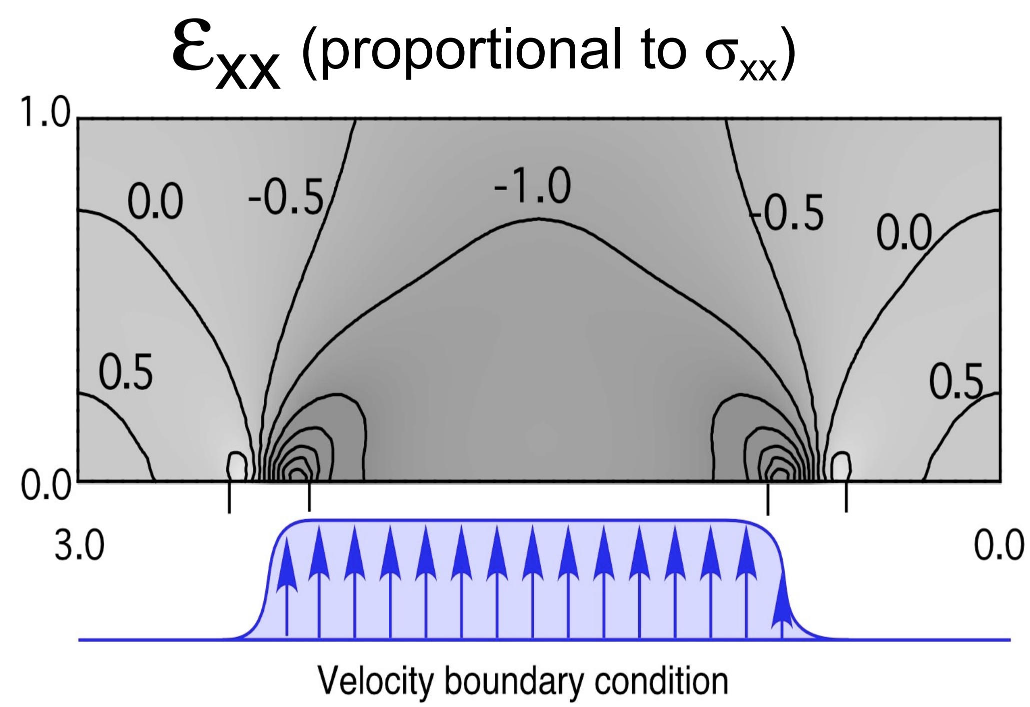
Sonder & Jones, *Ann. Rev Earth Plan. Sci*, 1999

Note that the B&R extent seems unrelated to the triple junction.



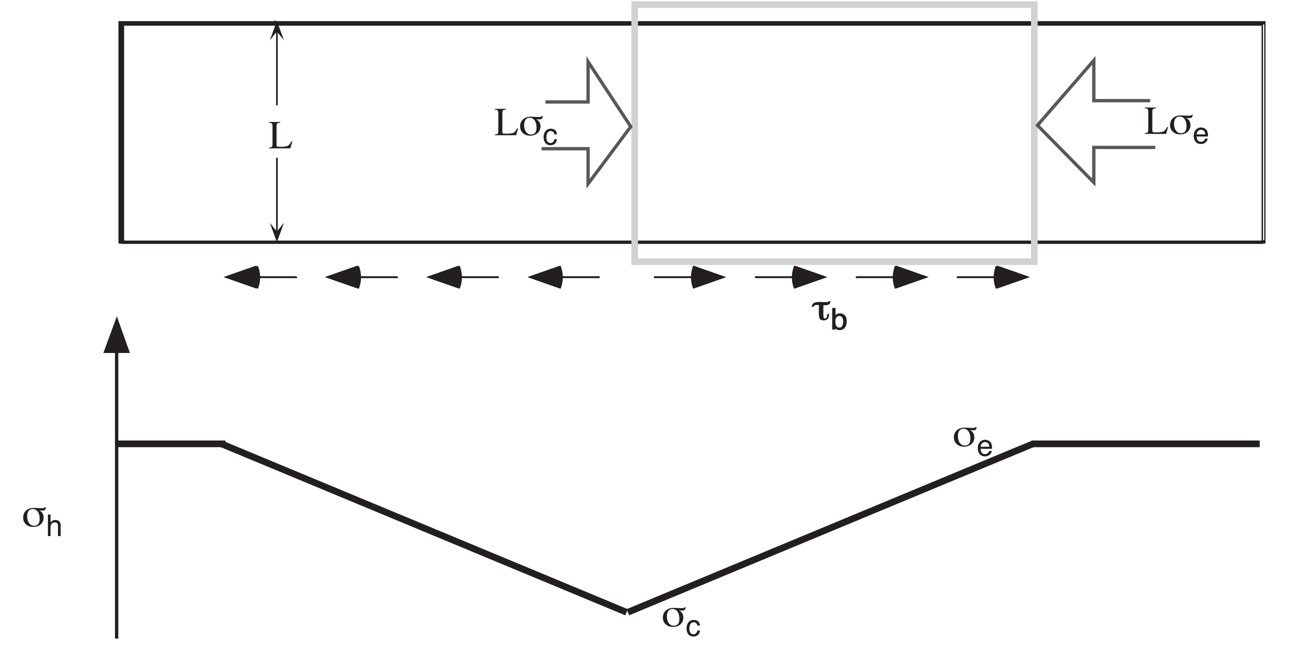
Felsic
Intermediate
Basic
Unclassified
$\dot{\varepsilon}_{\beta}$
McQuarrie and Oskin, JGR, 2010
Northern Basin & Range
Eastern California Shear Zone - Walker Lane
Central Basin & Range
Rio Grande
Death Valley
Southern Arizona
Window
Slab Window
Contraction
Analsyes / Myr / 1000 km²
Dilation Rate (Log s⁻¹)
Years before present (Ma)
0 Ma base

For edge forces, deformation should decrease with distance from edge…



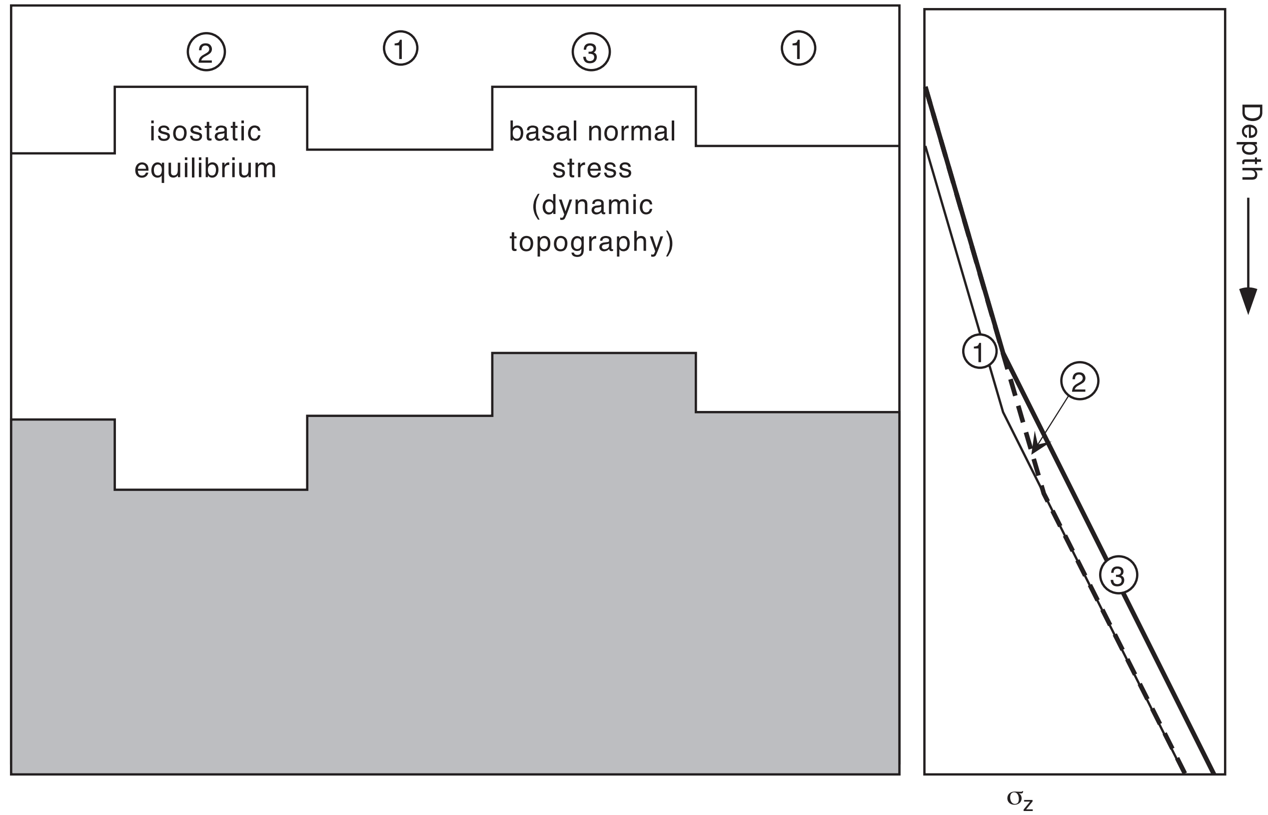
Modified from Sonder and Jones (1999)

Basal shear stress



This might not be such a terrible model for some back-arc situations.

Body forces



2
1
3
1
isostatic equilibrium
basal normal stress (dynamic topography)
Depth
1
2
3
σz

$$\int_{-\varepsilon}^{z_c} \sigma_z(z)\,dz = \int_{-\varepsilon}^{z_c}\int_{-\varepsilon}^{z} g\rho(z')\,dz'dz$$

$$= \left[zg\int \rho\, dz' \right]_{-\varepsilon}^{z_c} - \int_{-\varepsilon}^{z_c} gz\rho(z)\,dz$$

$$= \left[z\sigma_z \right]_{-\varepsilon}^{z_c} - \int_{-\varepsilon}^{z_c} gz\rho(z)\,dz$$

$$= z_c \int_{-\varepsilon}^{z_c} g\rho(z)\,dz - \int_{-\varepsilon}^{z_c} gz\rho(z)\,dz = GPE$$

$$\frac{\partial \bar{\tau}_{ij}}{\partial x_j} + \frac{\partial \bar{\tau}_{zz}}{\partial x_i} = \frac{1}{L}\frac{\partial (PE)}{\partial x_i}$$

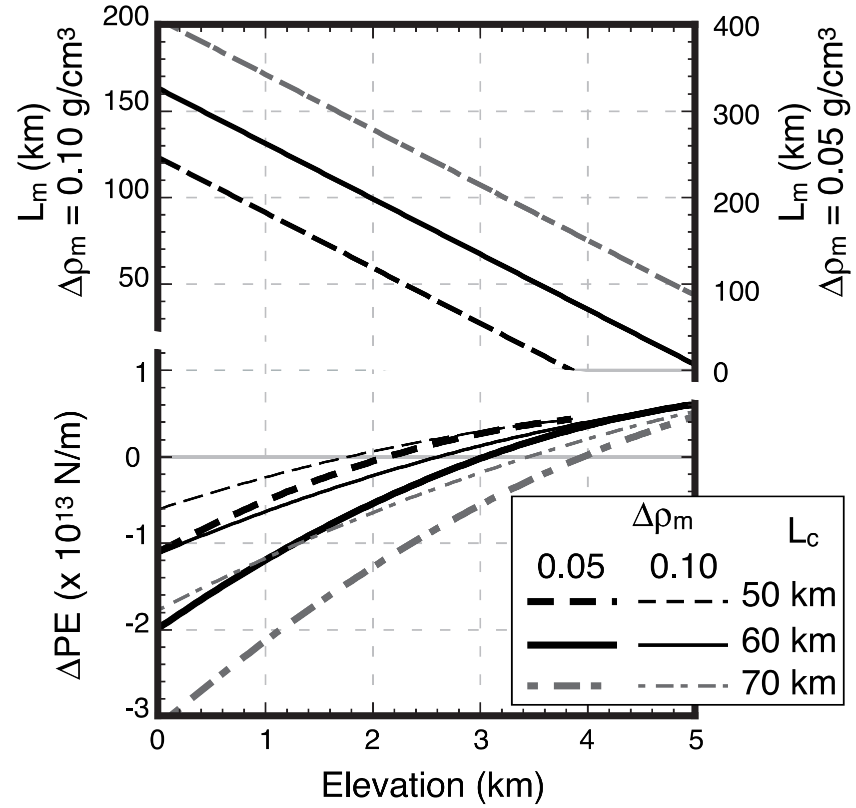
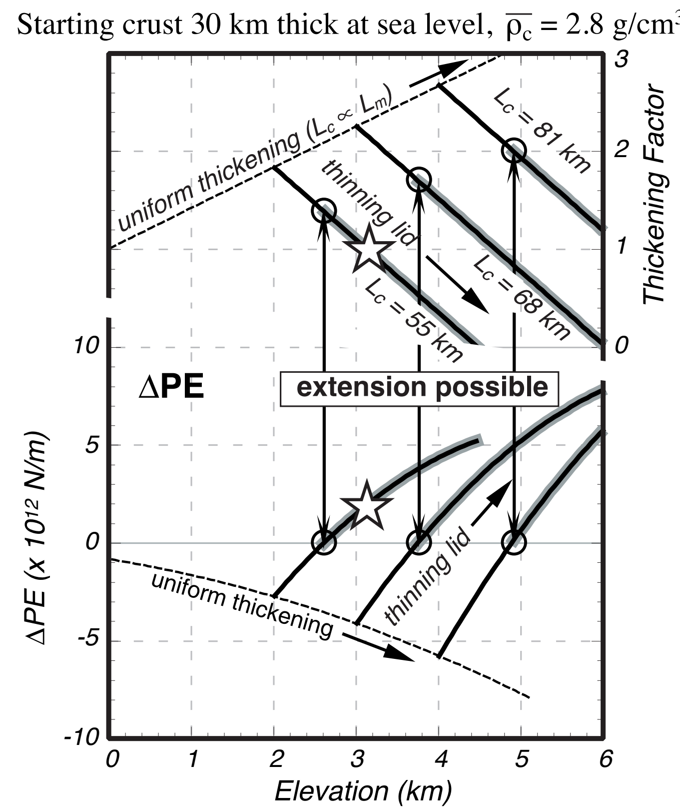


Figure 3. ΔPE for lithospheric columns with different crustal thicknesses (L_c) as a function of elevation. Two mean density contrasts ($\Delta\rho_m$) between mantle lithosphere and asthenosphere are illustrated. Note that low elevations with 50–70-km-thick crust likely for the early Tertiary Great Basin would require very thick or exceptionally dense mantle lithosphere and imply very negative values of ΔPE.

Jones et al., *Geology*, 1998

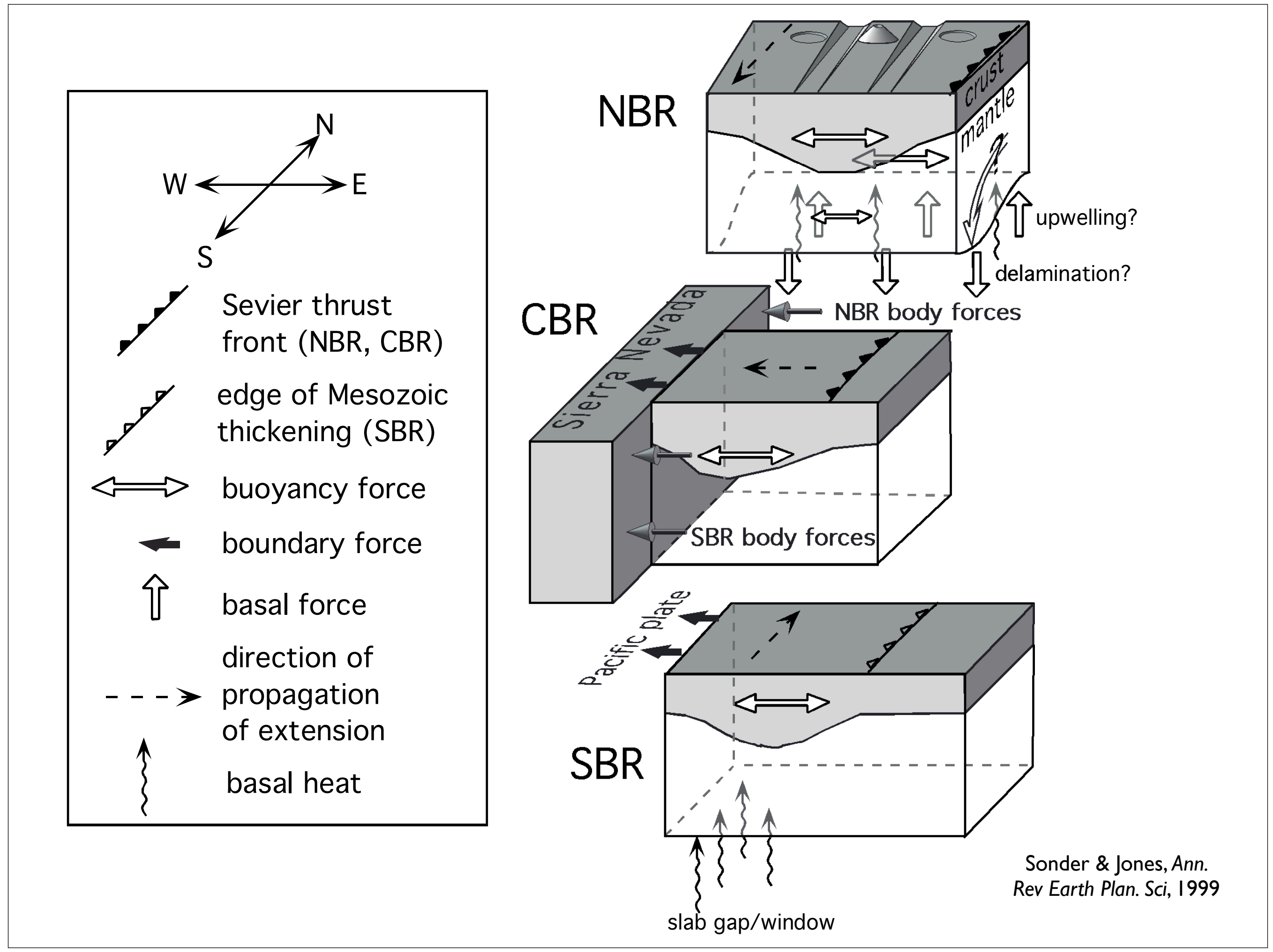
Relation of crustal thickness, elevation, and GPE.

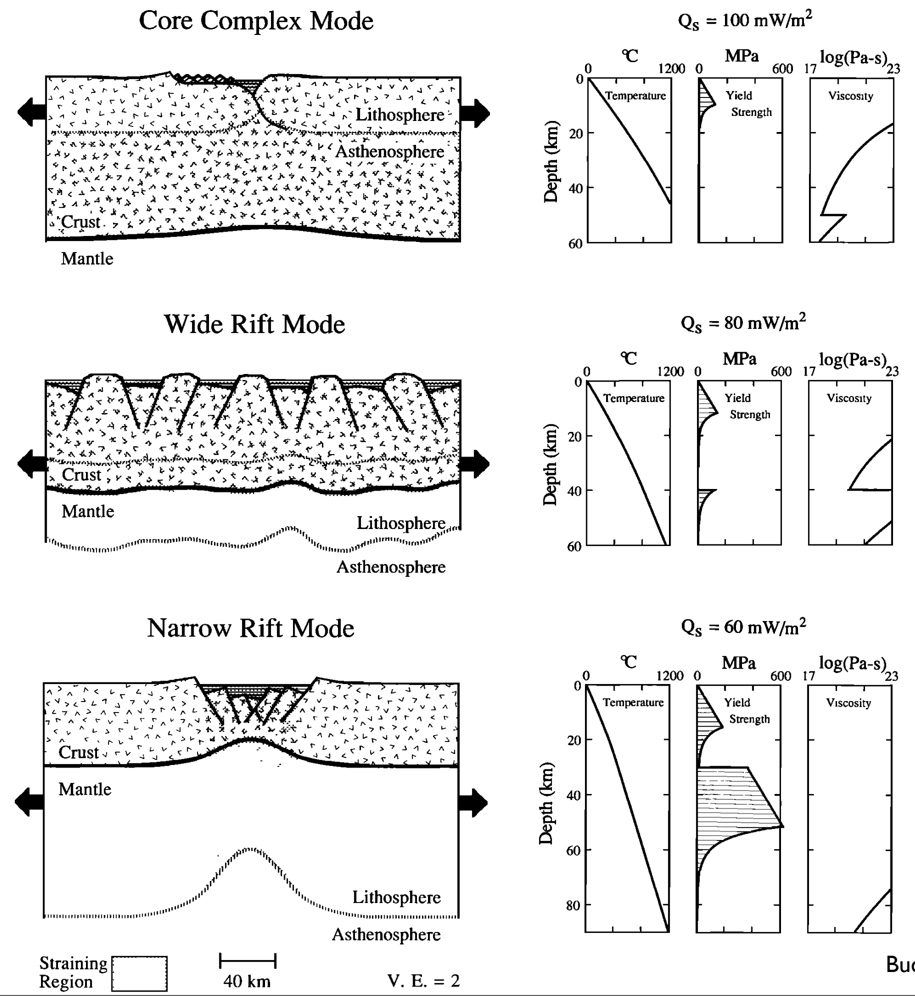
Figure 2. Evolution of orogen with initial phase of uniform lithospheric thickening (dashed lines) followed by thinning of mantle lithosphere once the orogen reaches elevations of 2, 3, or 4 km (solid lines). Note that elevation always increases, but ΔPE reverses once mantle lithosphere begins to be removed. Gray lines indicate conditions under which extension is possible. Crustal thickness L_c = 30 km at outset; L_m = 86 km; ρ_c = 2.8 g/cm^3. An equivalent path in Figure 1 would proceed toward the right from thickening factor = 1 on the solid line, then up toward the dashed curve once thinning of the mantle lithosphere begins.



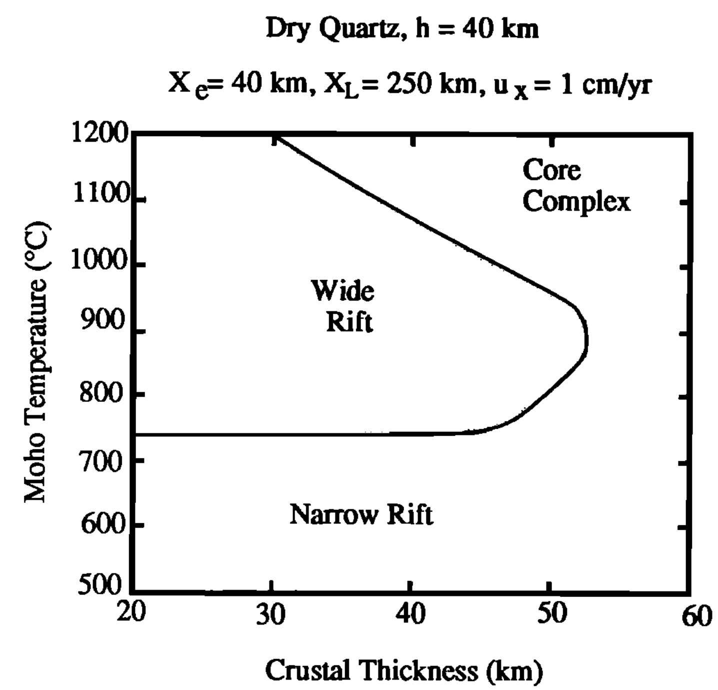
Jones et al., *Geology*, 1998

This is set up to move into paleoelevation studies.

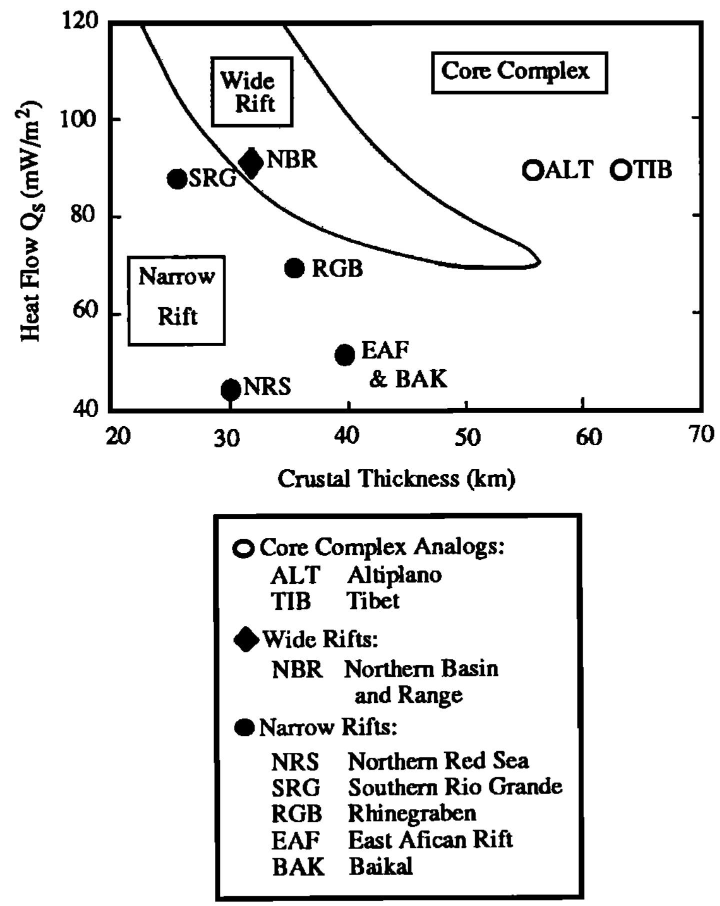

N
W
E
S
Sevier thrust front (NBR, CBR)
edge of Mesozoic thickening (SBR)
buoyancy force
boundary force
basal force
direction of propagation of extension
basal heat
NBR
crust
mantle
upwelling?
delamination?
CBR
NBR body forces
Sierra Nevada
SBR body forces
Pacific plate
SBR
slab gap/window
Sonder & Jones, Ann. Rev Earth Plan. Sci, 1999



Buck, *JGR*, 1991



Buck, *JGR*, 1991



Buck, *JGR*, 1991