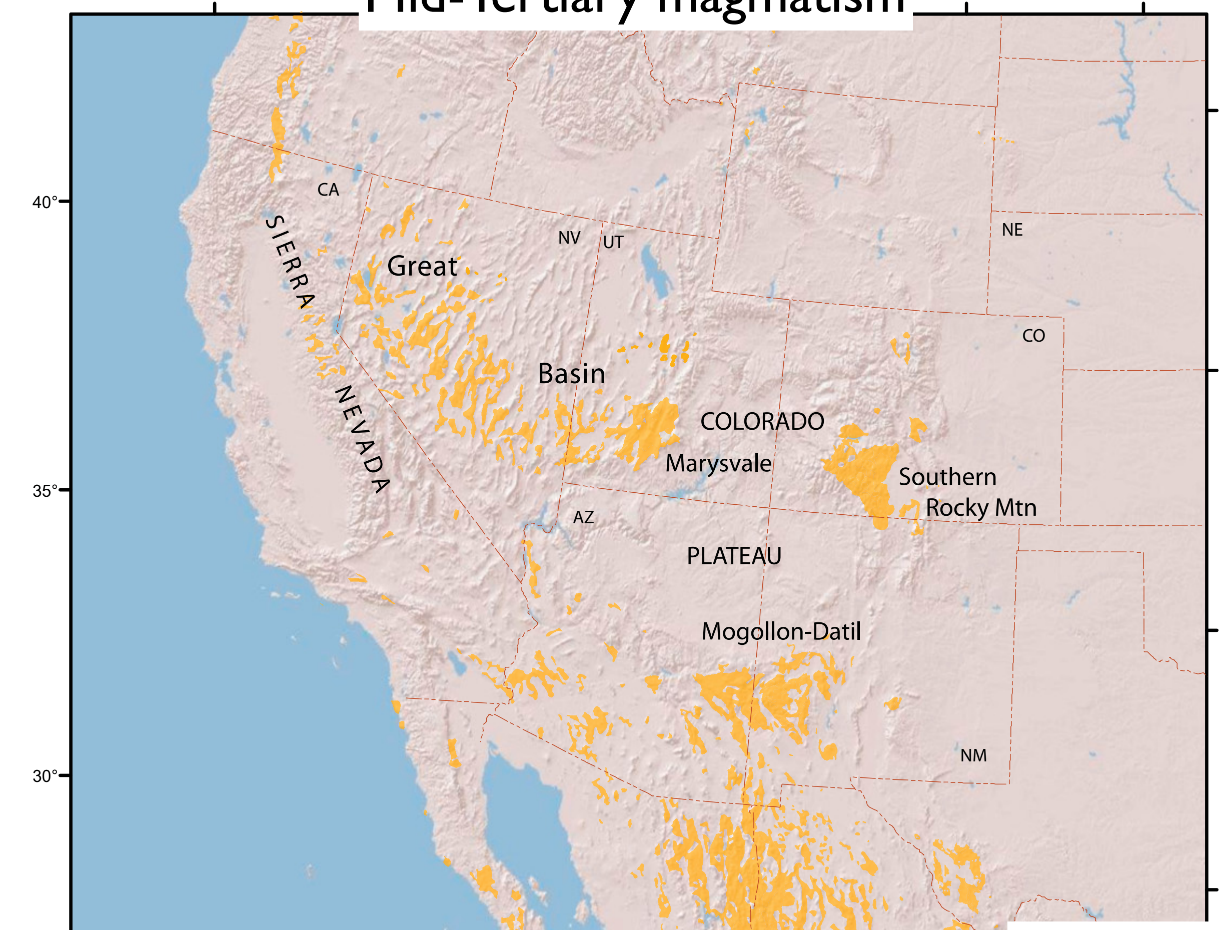
Mid-Tertiary magmatism



Best et al., *Geosphere*, 2013

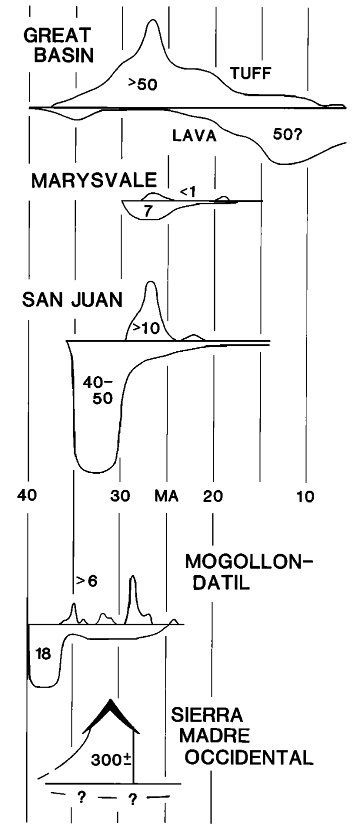
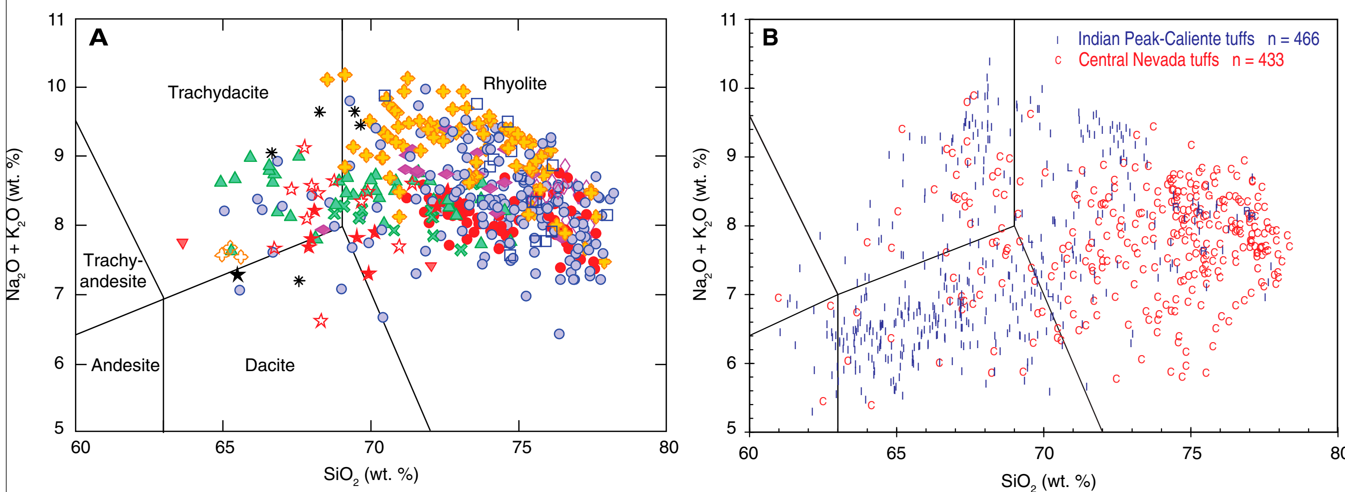


Fig. 4. Highly generalized time-volume relations of lava flow and tuff deposits in volcanic fields of the southwestern United States and Mexico (Sierra Madre Occidental [from *McDowell et al.*, 1990]). Volume estimates are in thousands of cubic kilometers (sources of data are in *Best et al.* [1989*b*, Table 1] and *Ratté et al.* [1989]). Note near coincidence in time of voluminous ash flow activity (ignimbrite flareup) in the five areas [*Noble*, 1972].

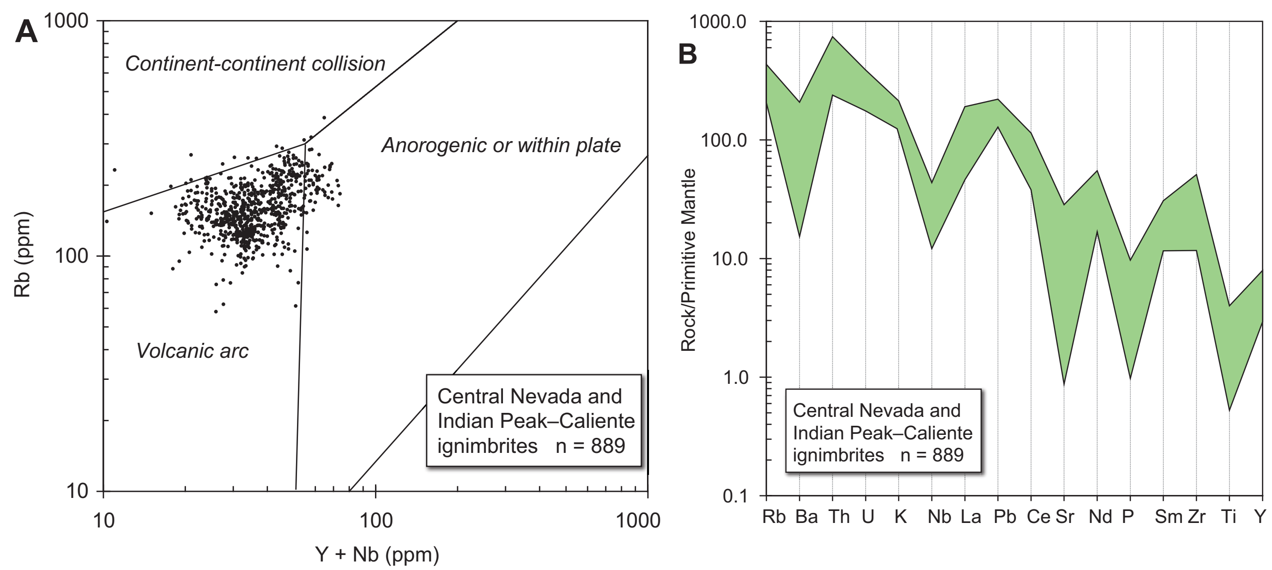
Best and Christiansen, JGR 1991

Best et al., *Geosphere*, 2013



Henry & John, *Geosphere*, 2013

Very silica rich eruptions and very low volumes of andesites



Best et al., *Geosphere*, 2013

Best et al. argue that these are subduction related, noting the Nb depletion.

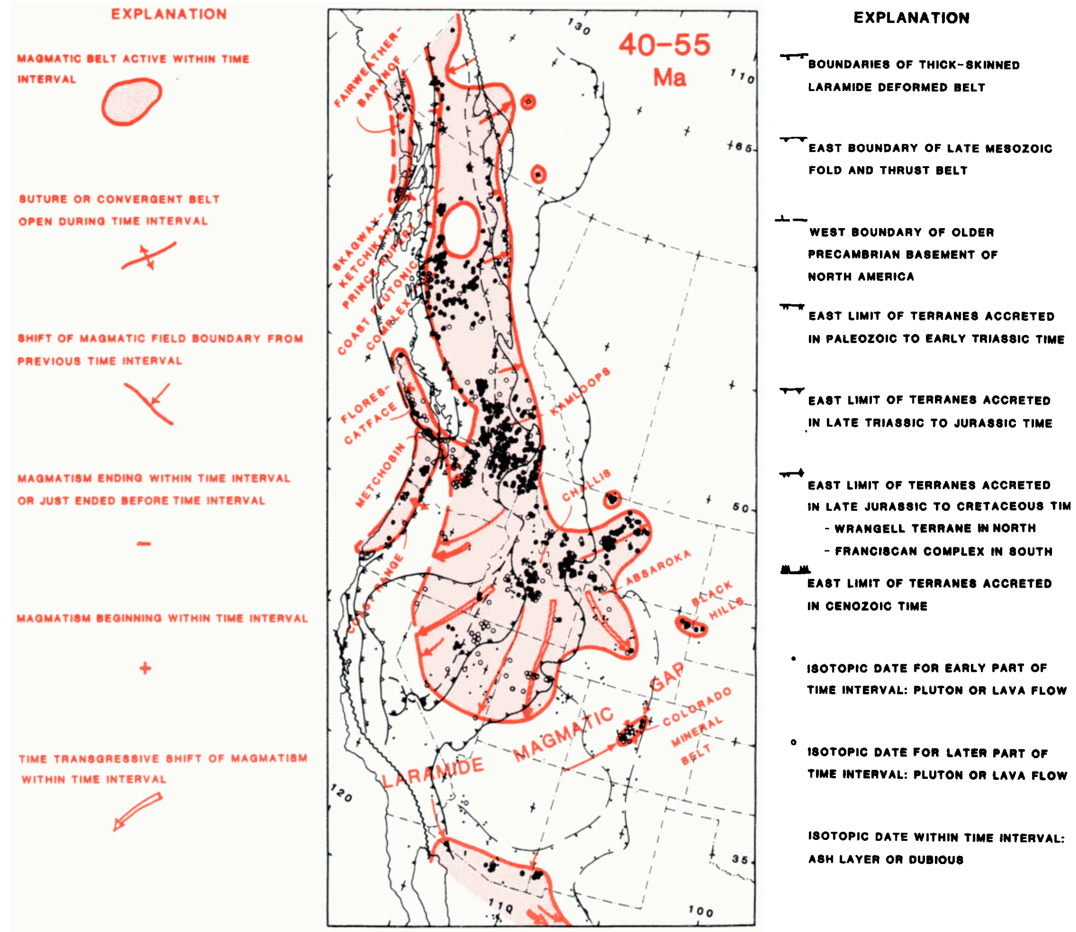
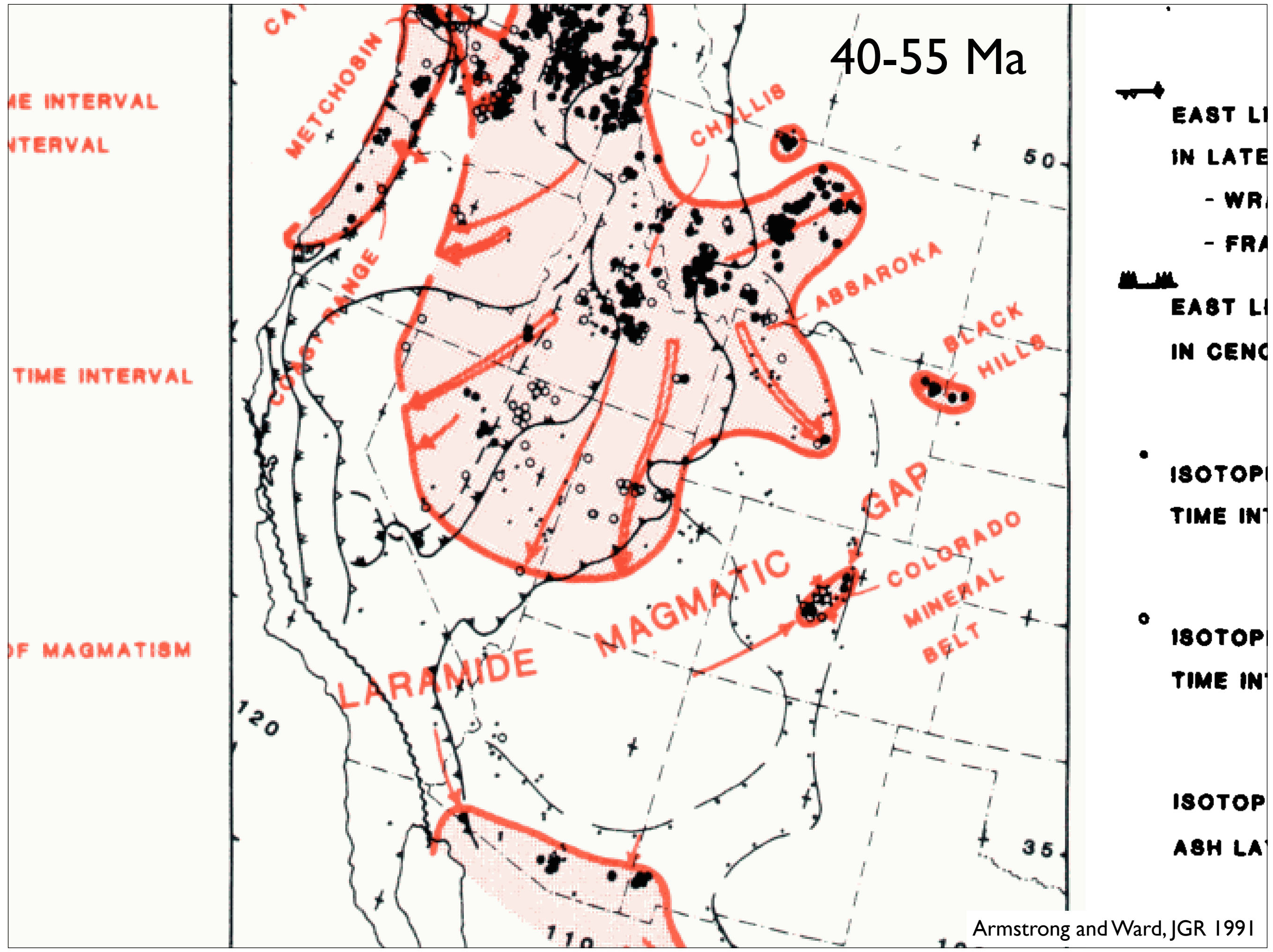
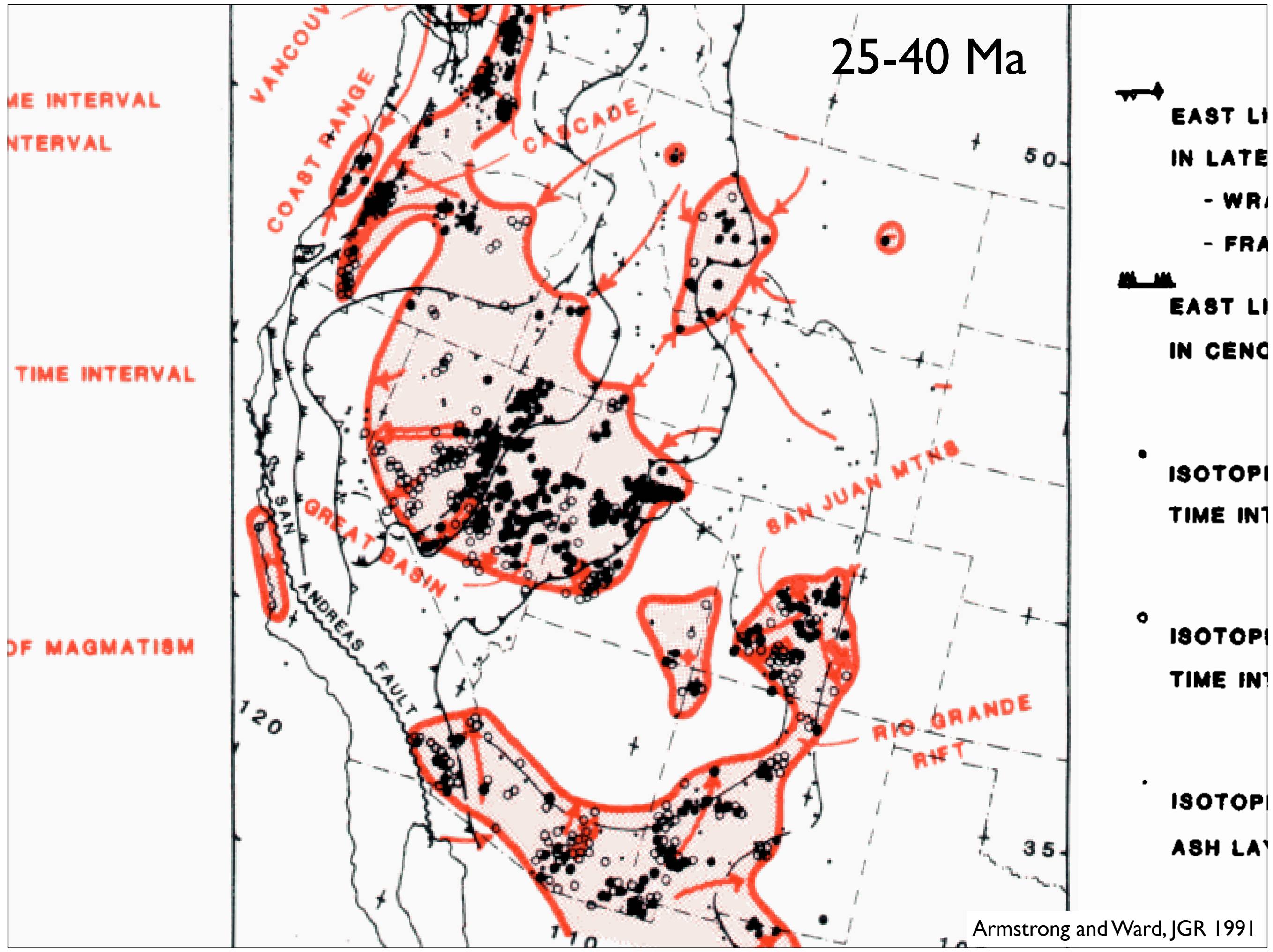


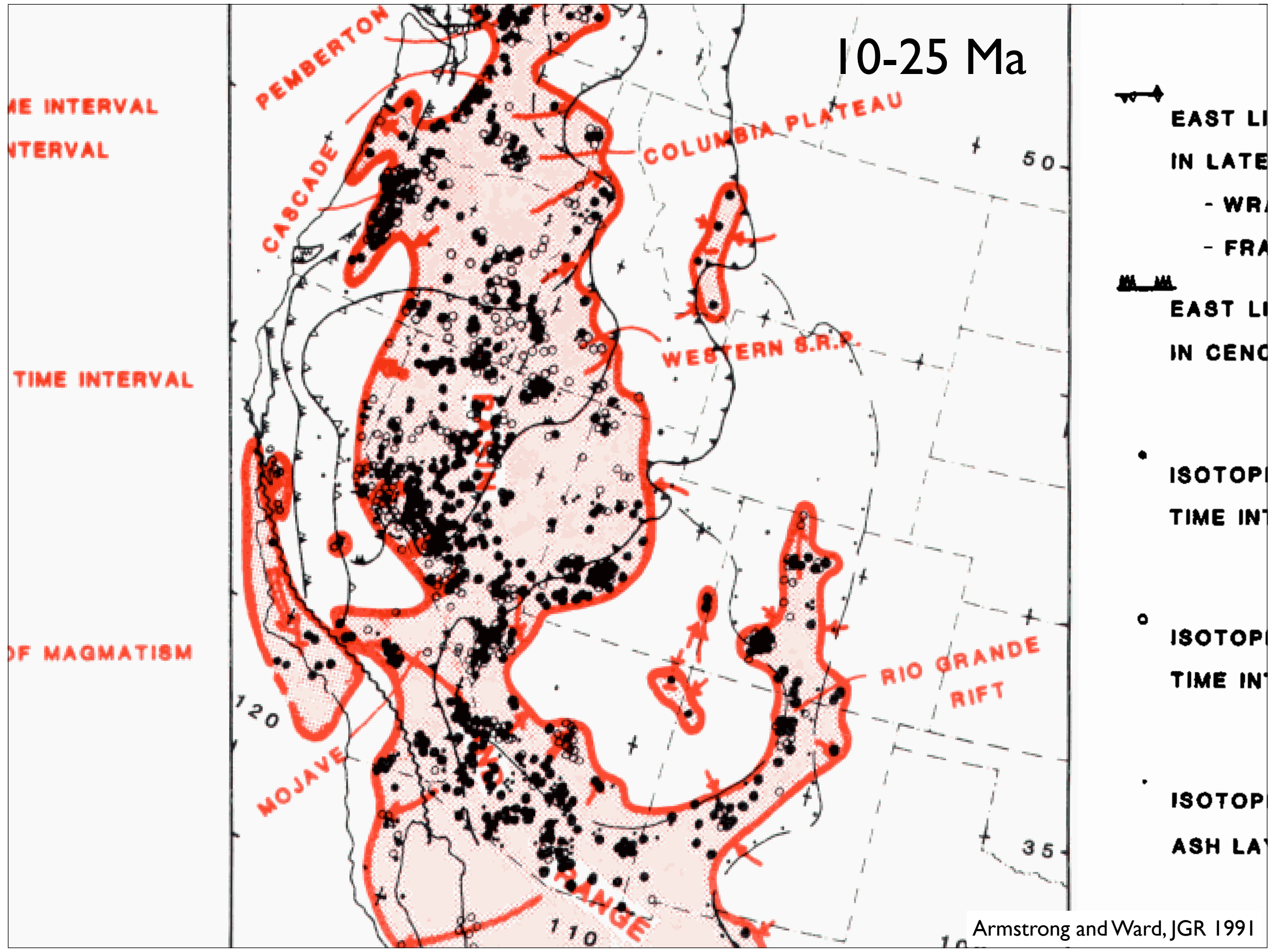
Plate 1. Distribution of isotopic age determinations for the time interval 40-55 Ma ago (early and middle Eocene time). Red indicates extent of magmatic activity for the time interval and time-transgressive trends in the di of magmatic activity.

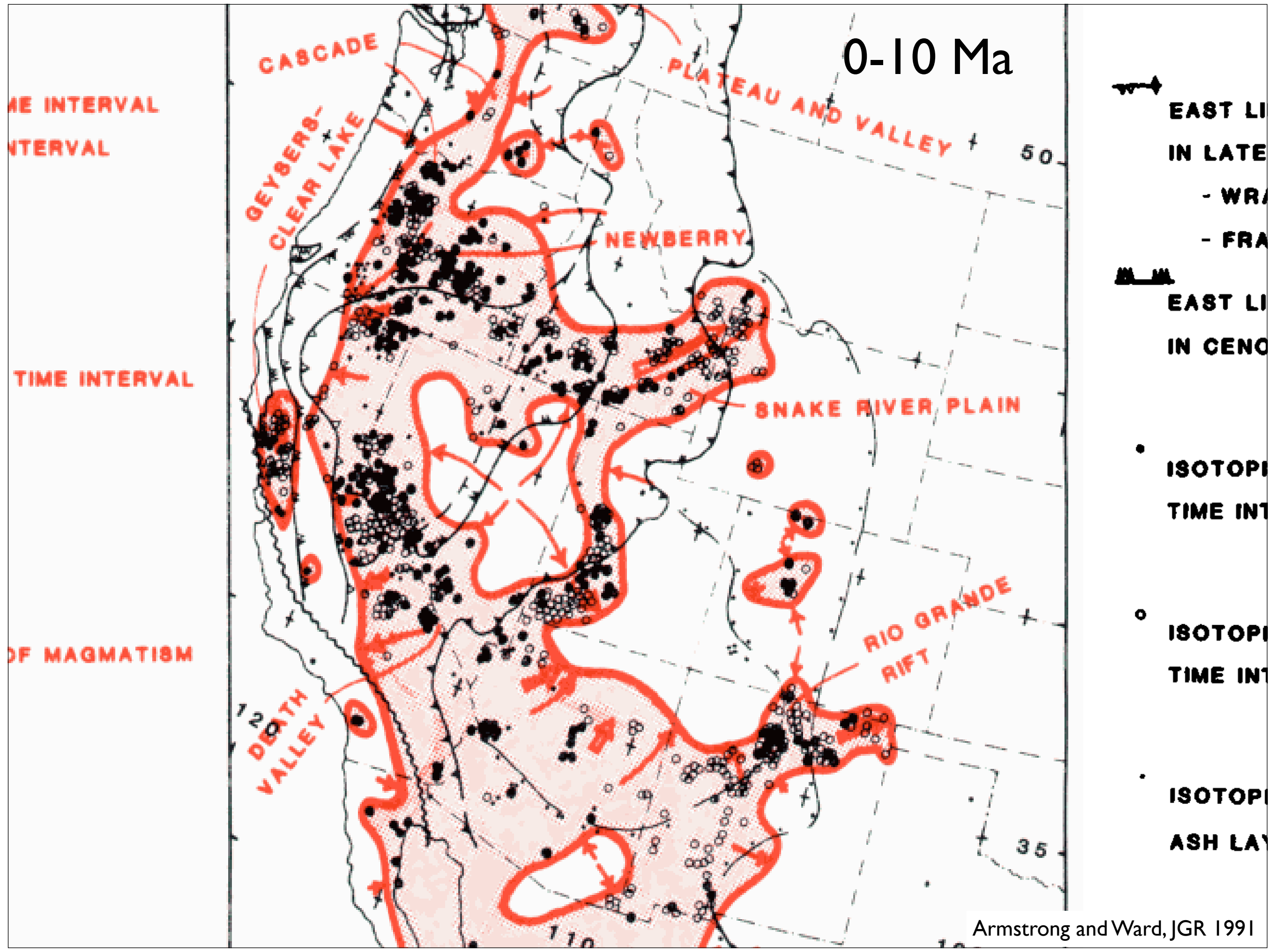
Armstrong and Ward, JGR 1991

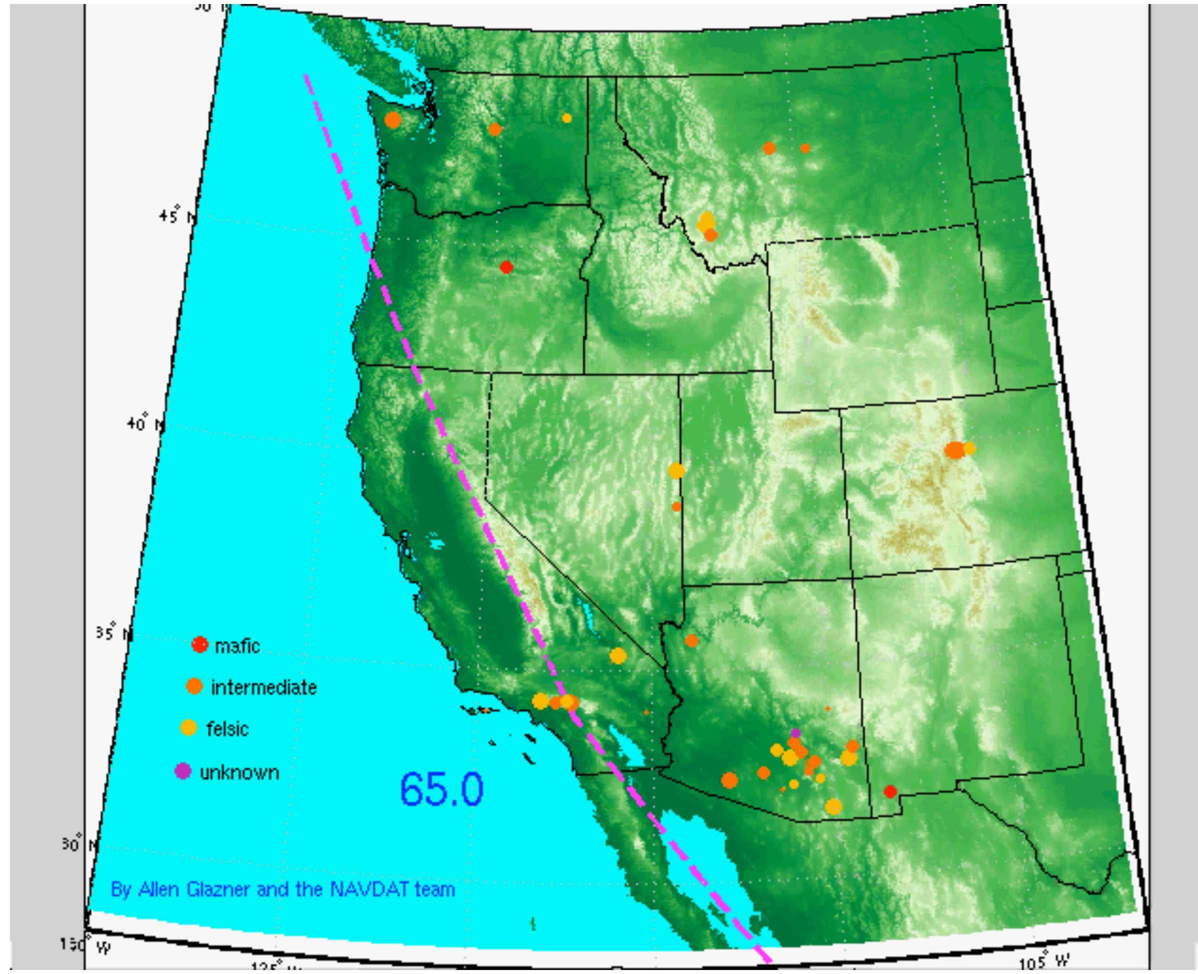

40-55 Ma
METCHOSIN
COAST RANGE
CHALLIS
ABSAROKA
BLACK HILLS
GAP
COLORADO MINERAL BELT
LARAMIDE MAGMATIC
ME INTERVAL
NTERVAL
TIME INTERVAL
OF MAGMATISM
EAST LI
IN LATE
- WR
- FR
EAST LI
IN CENO
ISOTOP
TIME IN
ISOTOP
TIME IN
ISOTOP
ASH LA
50
35
120
110
Armstrong and Ward, JGR 1991

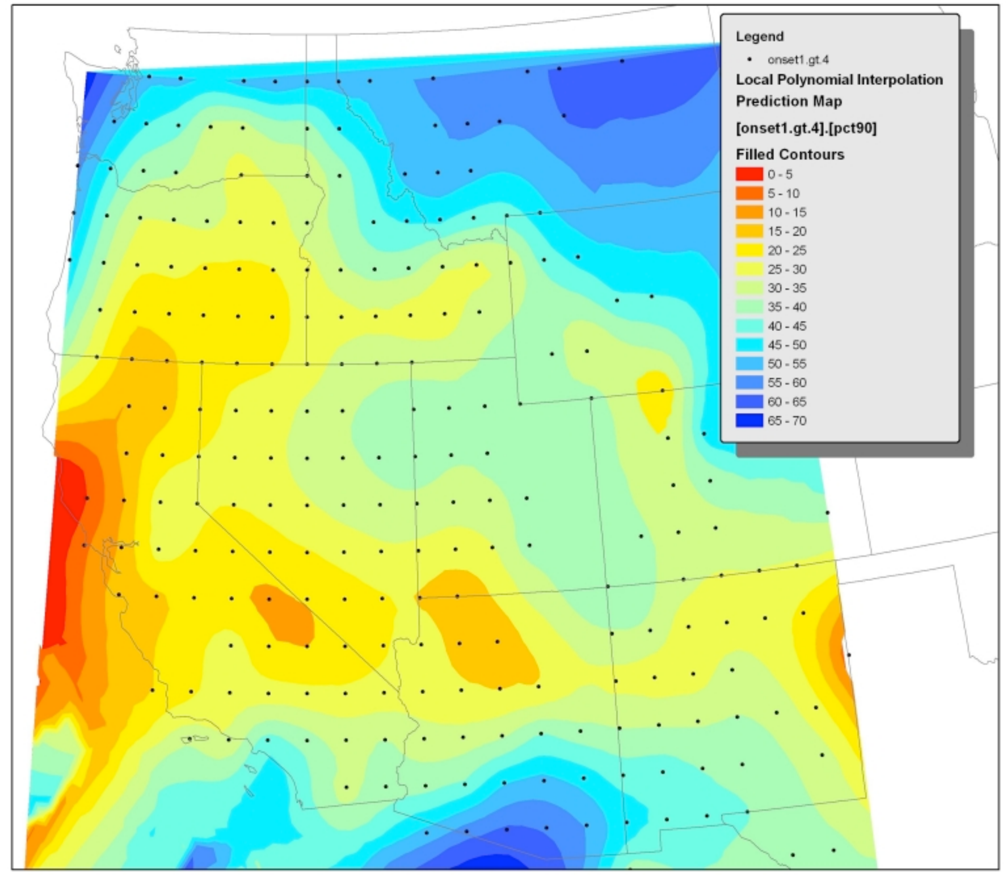


Armstrong and Ward, JGR 1991


10-25 Ma
PEMBERTON
CASCADE
COLUMBIA PLATEAU
WESTERN S.R.P.
RIO GRANDE RIFT
MOJAVE
ME INTERVAL
NTERVAL
TIME INTERVAL
OF MAGMATISM
EAST LI
IN LATE
- WR
- FRA
EAST LI
IN CENO
ISOTOP
TIME INT
ISOTOP
TIME IN
ISOTOP
ASH LA
50
35
120
110
Armstrong and Ward, JGR 1991


0-10 Ma
CASCADE
GEYSERS-CLEAR LAKE
PLATEAU AND VALLEY
NEWBERRY
SNAKE RIVER PLAIN
RIO GRANDE RIFT
DEATH VALLEY
TIME INTERVAL
50
120
35
110
Armstrong and Ward, JGR 1991


mafic
intermediate
felsic
unknown
65.0
By Allen Glazner and the NAVDAT team



http://www.navdat.org/Navweb/pct90.jpg

Plot of onset of magmatism in the western United States, defined by 90th percentile of ages within 1x1 degree blocks. Note the southwestward sweep out of Montana toward California, and the northward sweep out of Mexico. Evidence for an east-to-west sweep is not clear.

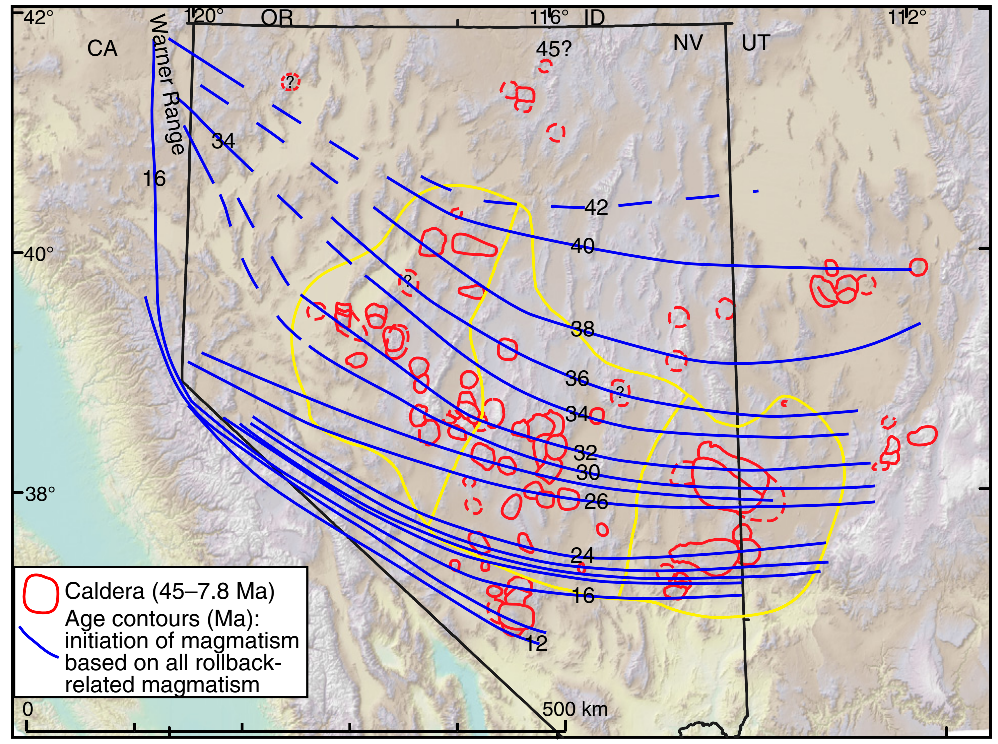
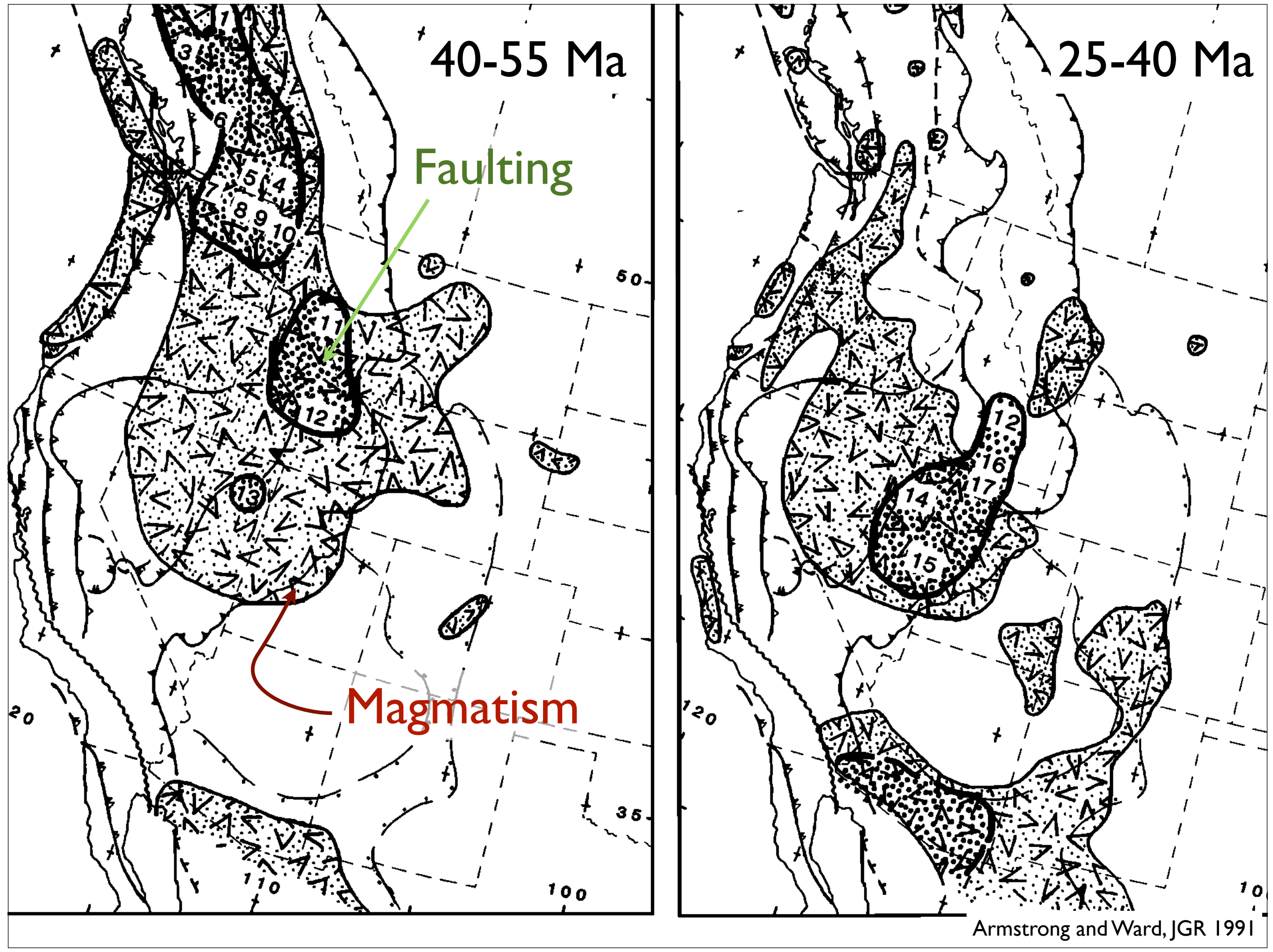
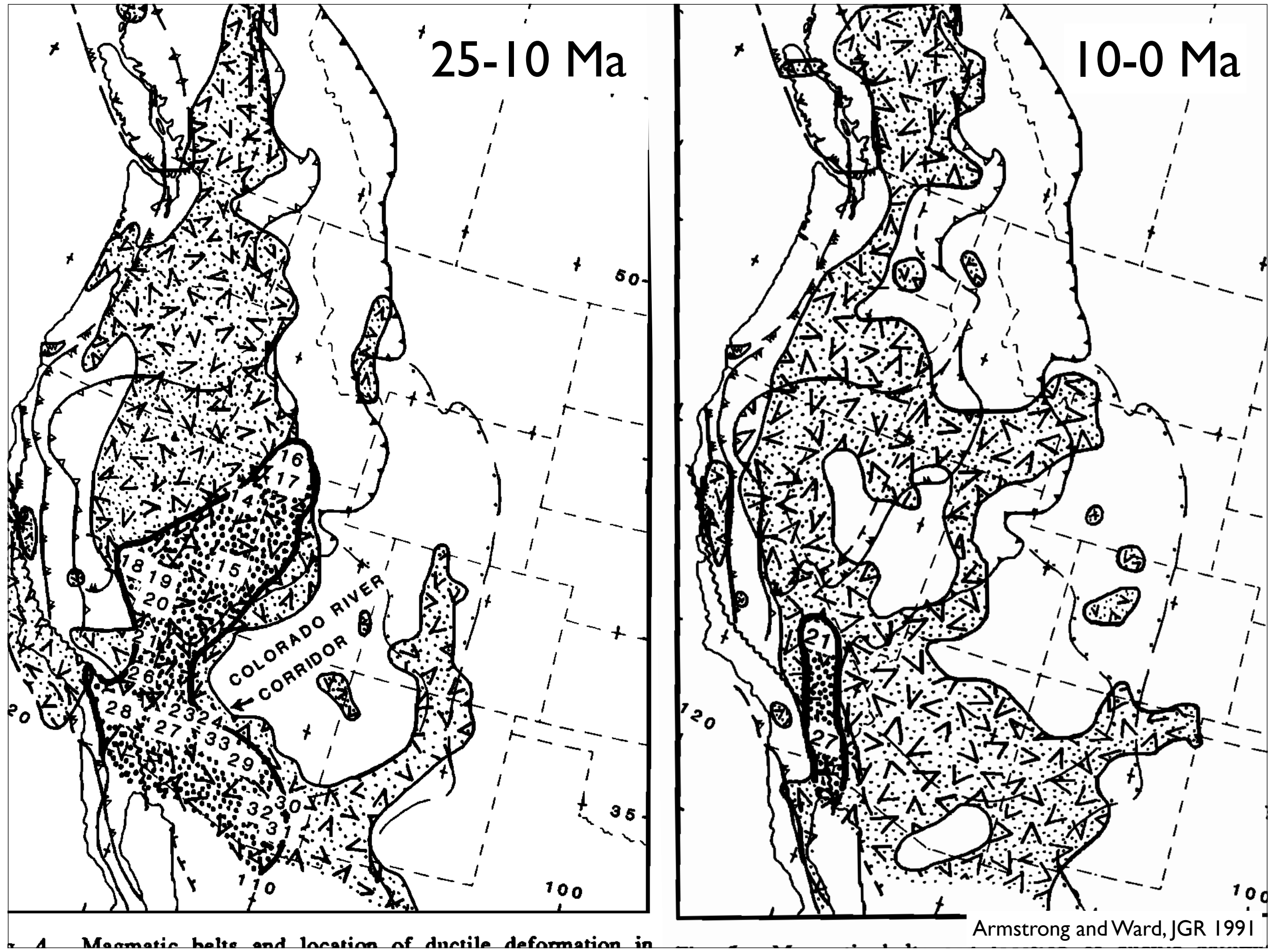


Figure 5. Contours of age of initial, locally sourced magmatism showing southwesterly migration of magmatism. Intermediate to silicic intrusive and effusive activity generally preceded caldera-forming ash-flow eruptions by 2–6 Ma in any area. For example, formation of the 34 Ma Caetano caldera followed ~6 Ma of nearby, semi-continuous andesitic to non-explosive rhyolitic activity (John et al., 2009). Development of the 32.9 Ma Northumberland caldera was preceded by andesitic and rhyolitic intrusions at 35.4 Ma (McKee, 1974, 1976; our unpublished data).

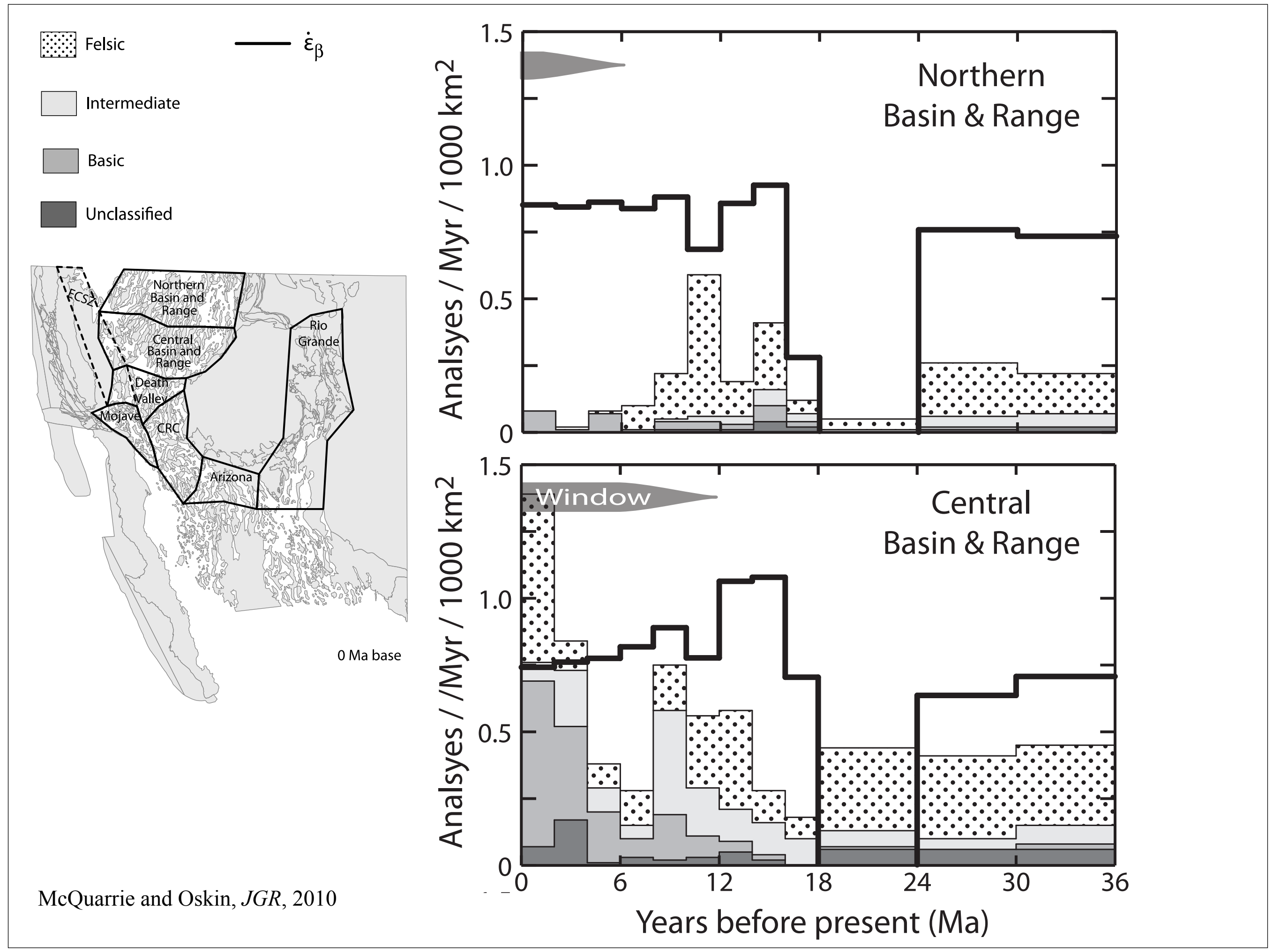
Henry & John, *Geosphere*, 2013



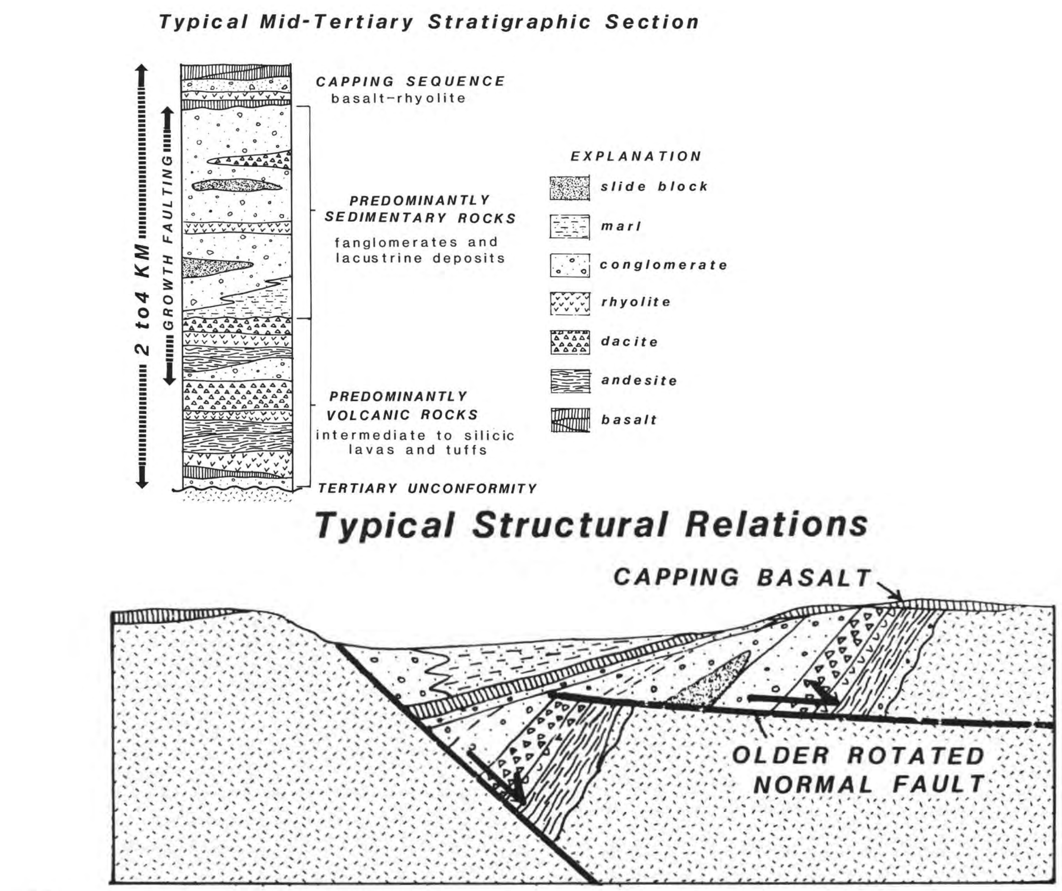
Move into relationship of magmatism to extension…



Armstrong and Ward, JGR 1991

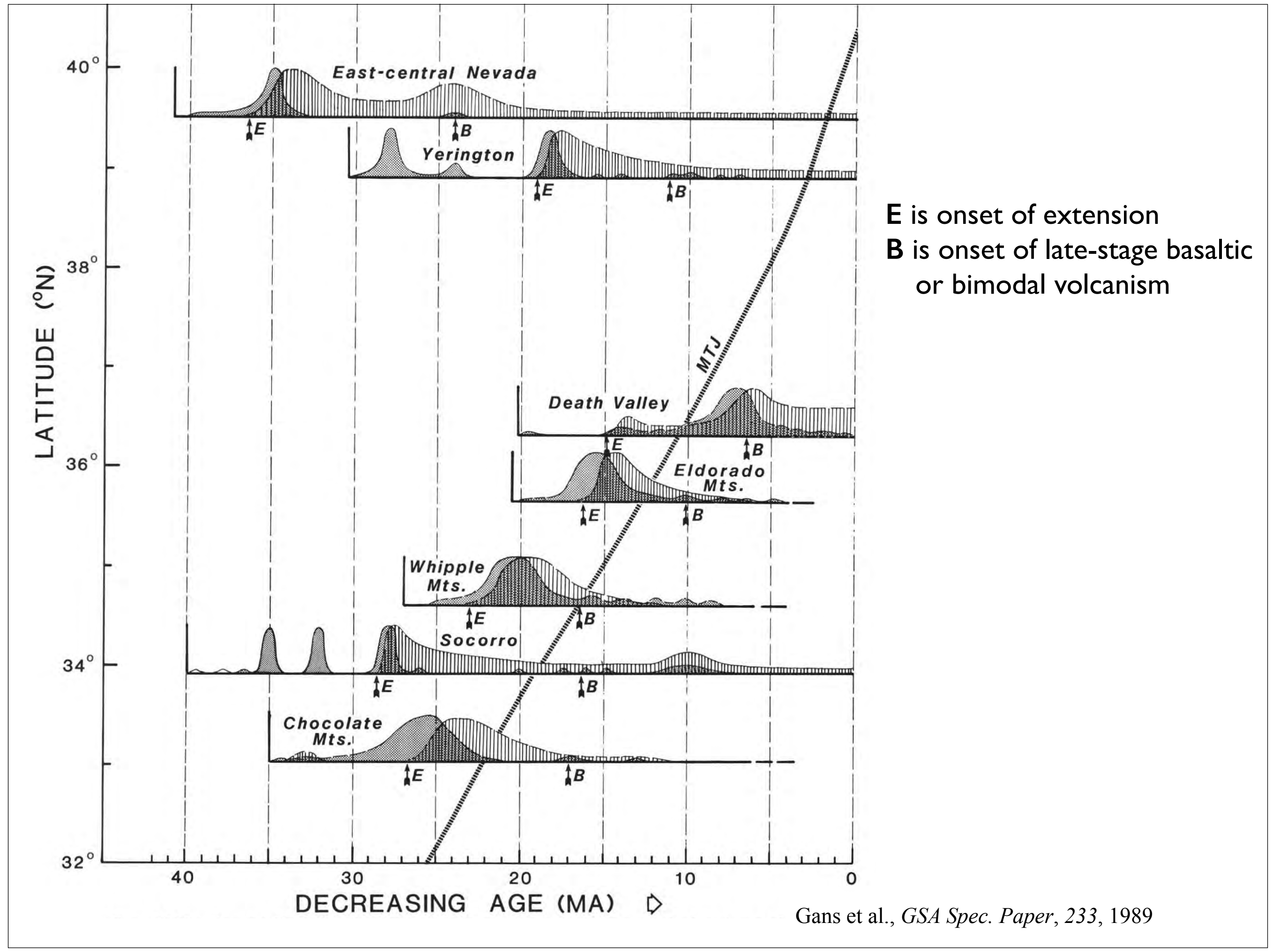


Newer compilation sort of supports but sort of suggests that there is a disconnect in central B&R



Gans et al., *GSA Spec. Paper*, *233*, 1989

Clear evidence for coincidence of magmatism and extension would look like this



Lined areas are extensional magnitude, shaded are volcanic. In this vision, extension and magmatism are tightly related.

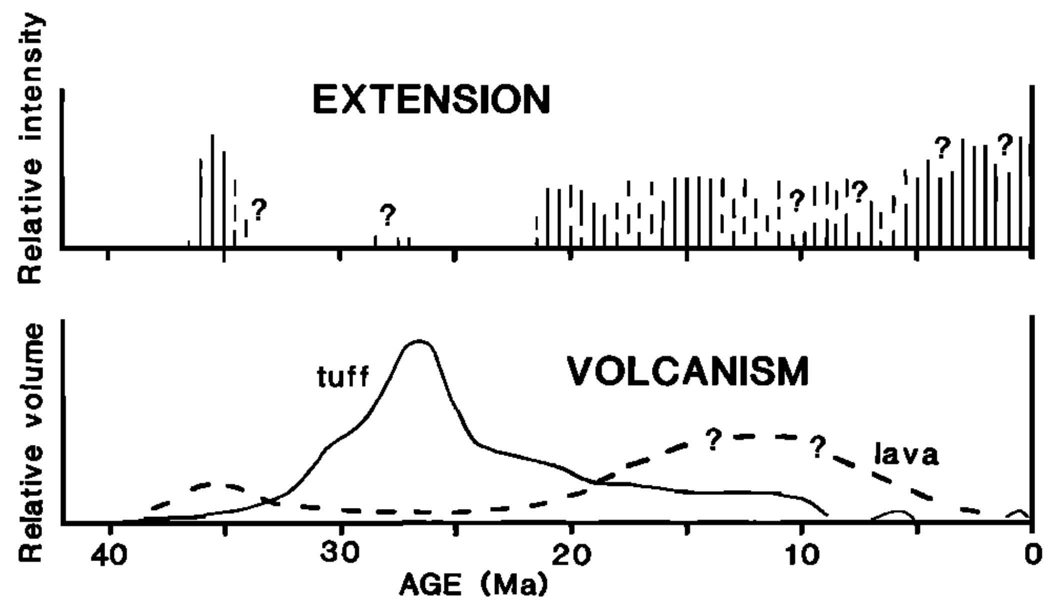


Fig. 10. Schematic timing of diachronous extension and volcanism for the entire Great Basin. Generalized relative volumes of volcanic rocks are based on Figure 3 and essentially represents an integrated picture of volcanism along a north (older) to south (younger) section through the Great Basin.

Best and Christiansen, JGR 1991

A different view has been that they are complementary.

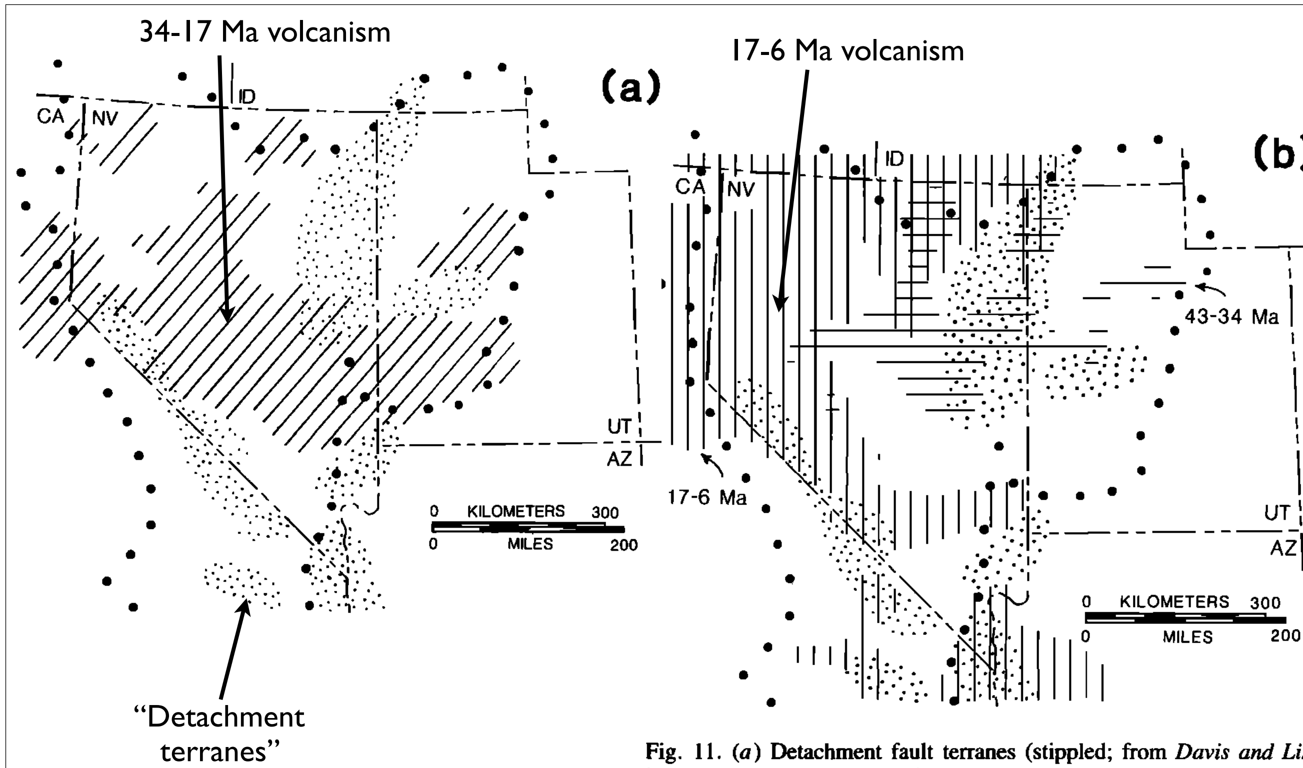


Fig. 11. (*a*) Detachment fault terranes (stippled; from *Davis and Lister* [1988]; see also *Wust* [1986]) and areas of voluminous volcanic rocks deposited 34–17 Ma (diagonal ruling; from *Stewart and Carlson* [1976]; and D.M. Miller (written communication, 1989)). The 34–17 Ma volcanism was chiefly pyroclastic, except in central Utah where lavas dominate. (*b*) Detachment fault terranes correspond poorly to lava-dominant areas formed at 43–34 Ma (horizontal ruling) and 17–6 Ma (vertical ruling).

Best and Christiansen, JGR 1991

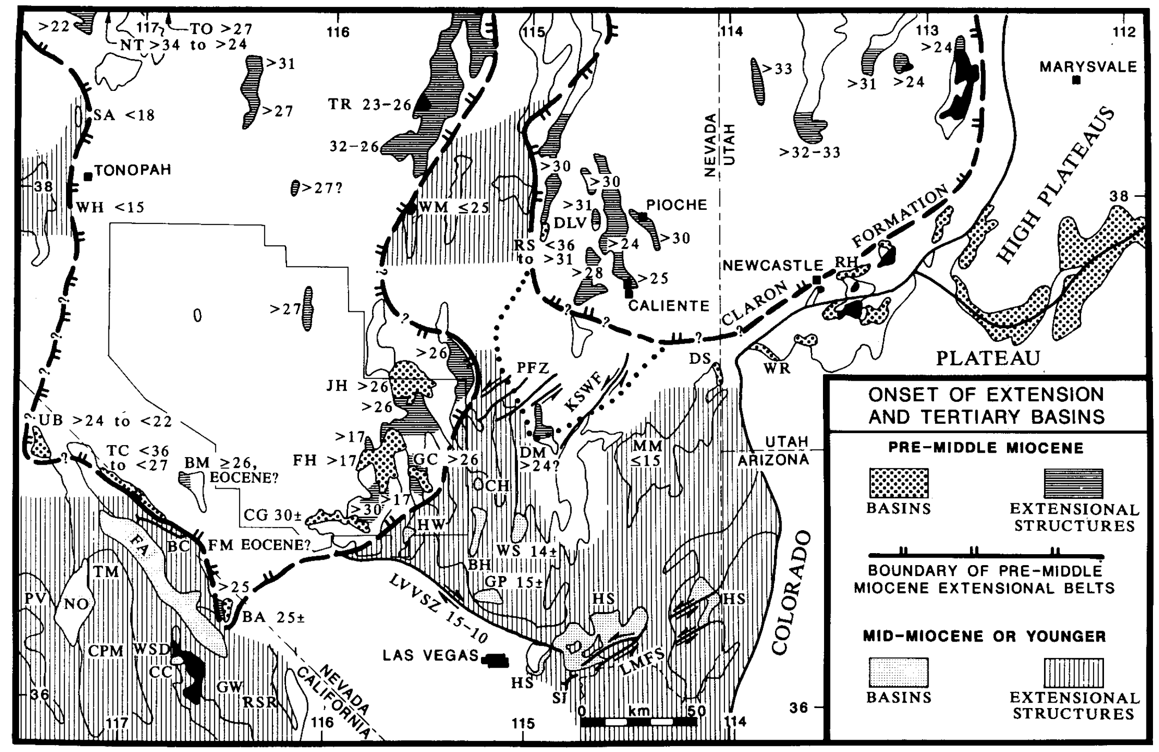


Figure 5. Map of same area as Figure 4, with locations of basins of probable extensional origin and areas where the age of onset of Tertiary extension is known or can be confidently inferred. Numbers refer to the age (Ma) of extensional structures or basins. Heavy dotted line encloses possible extension of eastern belt. See text for discussion of areas inside and near boundaries of extensional belts, and Table 1 for summary of areas where extension began in mid-Miocene or later time. Other localities: BA, Bat Mountain; BM, Bare Mountain; CG, Crossgrain basin; DLV, Dry Lake Valley (see Fig. 3); DM, Delamar Mountains; DS, Dodge Spring; FH, Fallout Hills; FM, Funeral Mountains; GC, Gravel Canyon basin; JH, Jumbled Hills; NT, northern Toiyabe Range (off figure); RH, Red Hills; RS, Rattlesnake Spring basin; TC, Titus Canyon basin; TO, Toquima Range; TR, Troy granite; UB, Ubehebe basin; WR, White Rock Spring.

Axen et al., GSA Bull, 1993

Much of the extension here is the Sheep Pass and equivalents, which are looking to be more pre-middle Eocene. Seems a lot of extension is well south of coeval magmatism

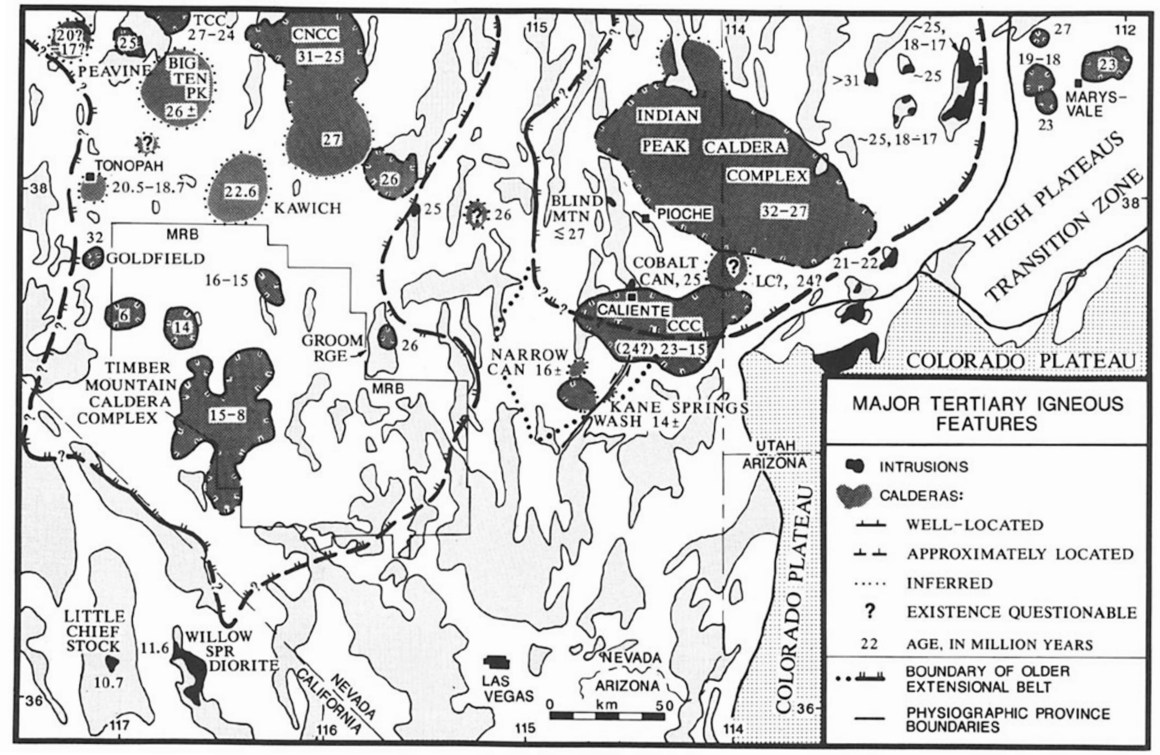
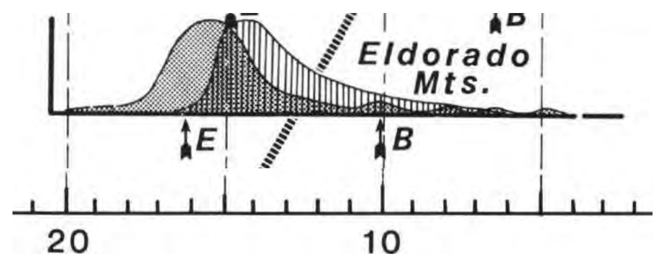
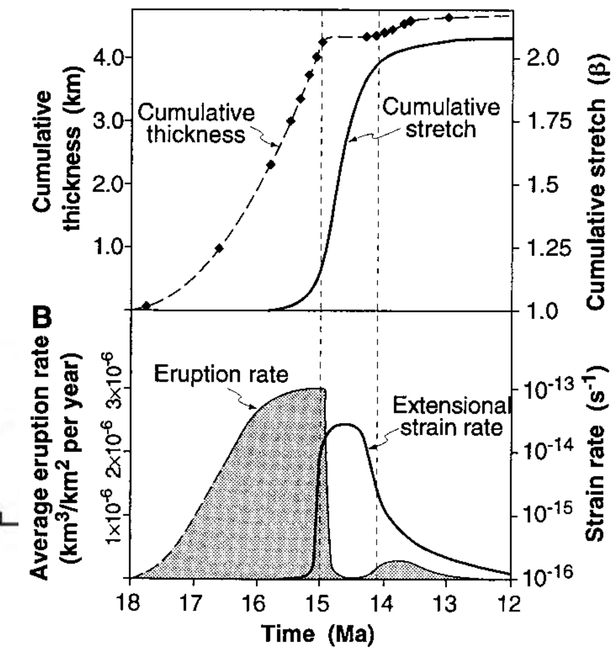


Figure 6. Locations and ages of calderas and Tertiary intrusions on a pre-Tertiary base from Figure 4. Abbreviations: CCC, Caliente caldera complex; CNCC, central Nevada caldera complex; LC, questionable source for the Leach Canyon tuff; TCC, Toquima caldera complex. From Best and others (1989a) and other sources cited in text.

Axen et al., GSA Bull, 1993

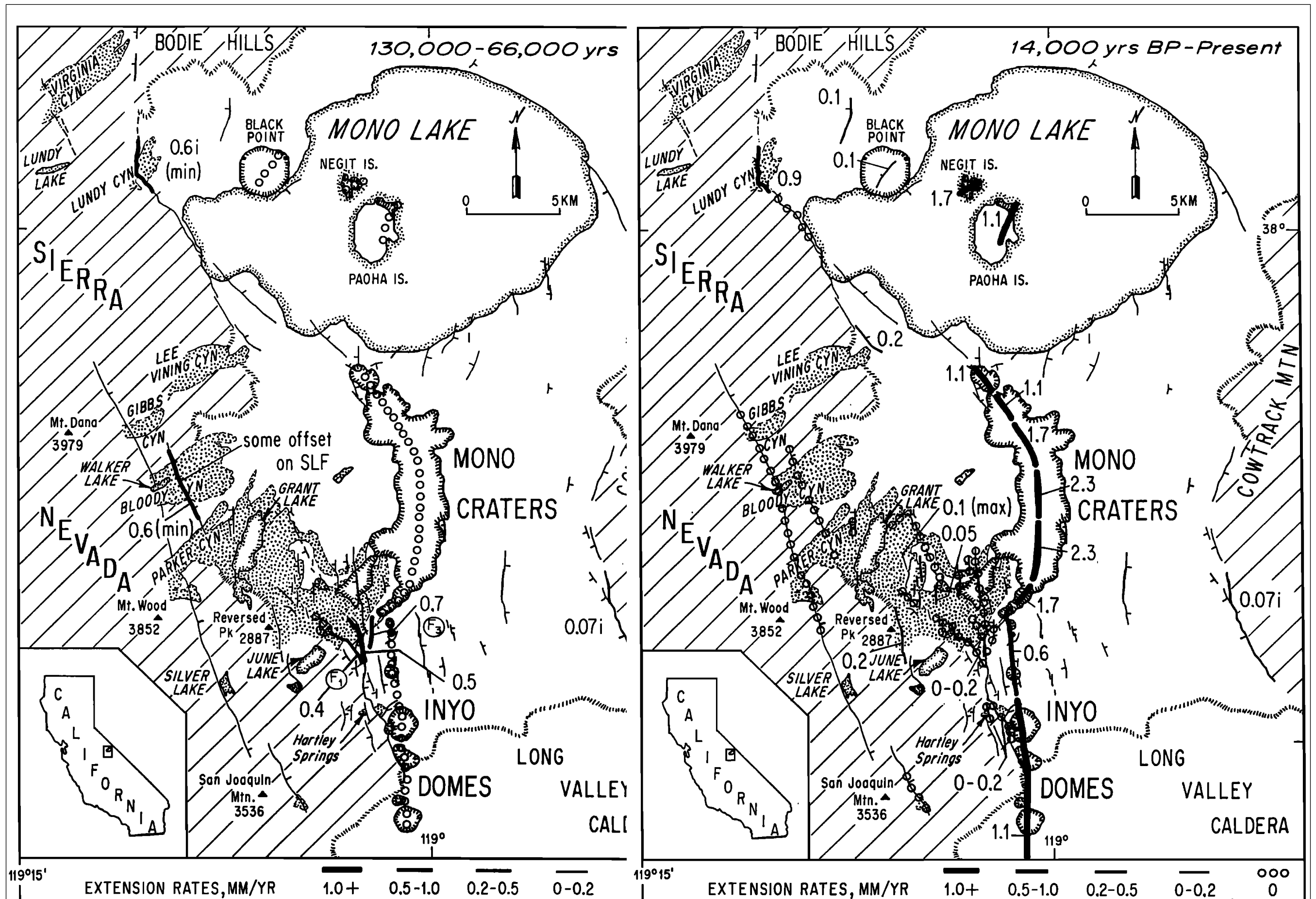


Gans et al., *GSA Spec. Paper*, *233*, 1989



Gans and Bohrson, *Science*, 1997

Closer examination of at least one complex suggests that while tightly related in time, extension and volcanism are not coeval.

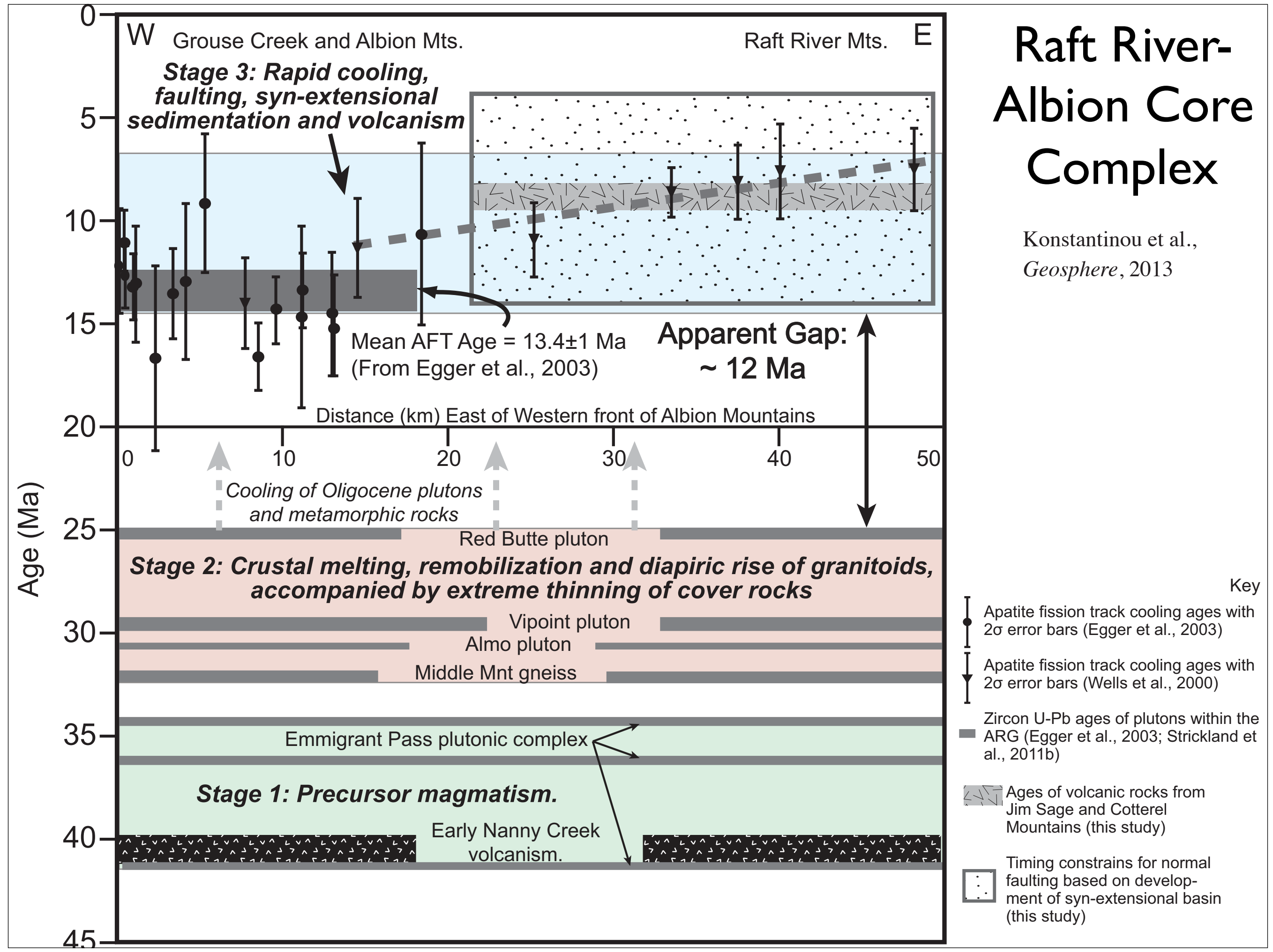


Bursik and Sieh, *JGR*, 1989

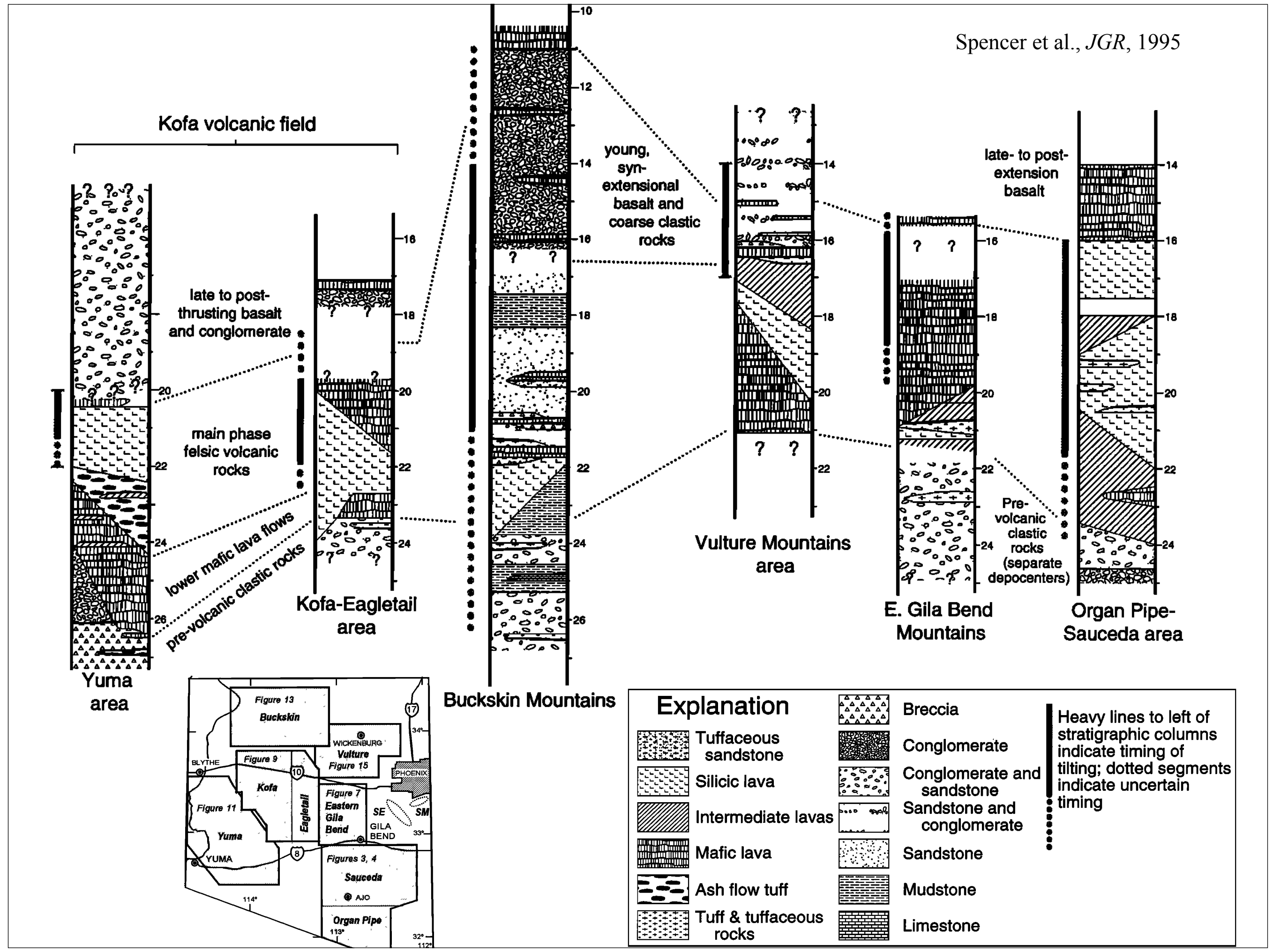
Initiation of volcanism has shifted extension into diking--so volcanism could represent extension.

Raft River-Albion Core Complex

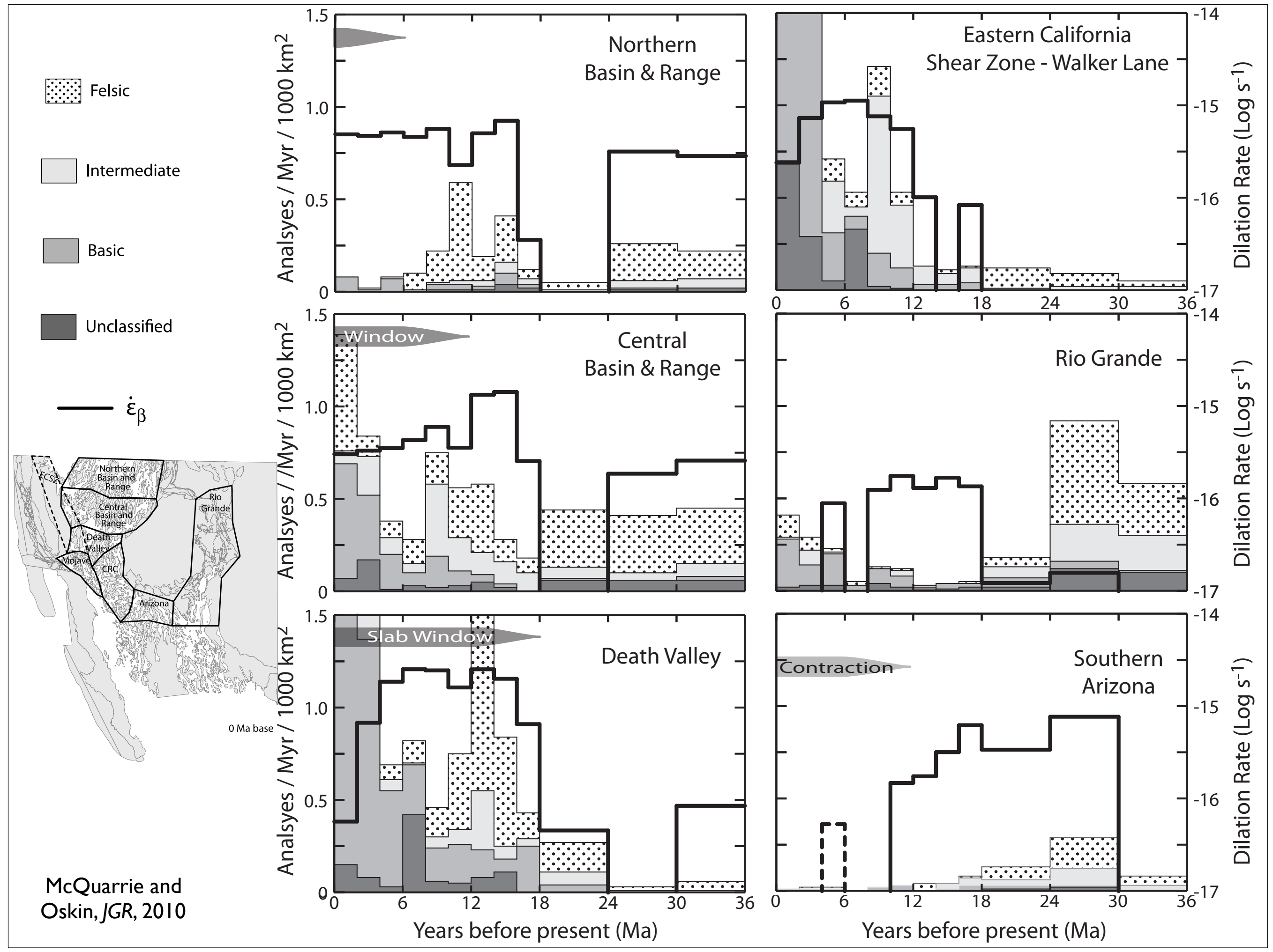
Konstantinou et al., *Geosphere*, 2013



Or, maybe, we have grossly overestimated extension in Paleogene.



Arizona relation of tilting to volcanism. Note too some thick clastic sequences preceding volcanism.



Recall these are not volumes….