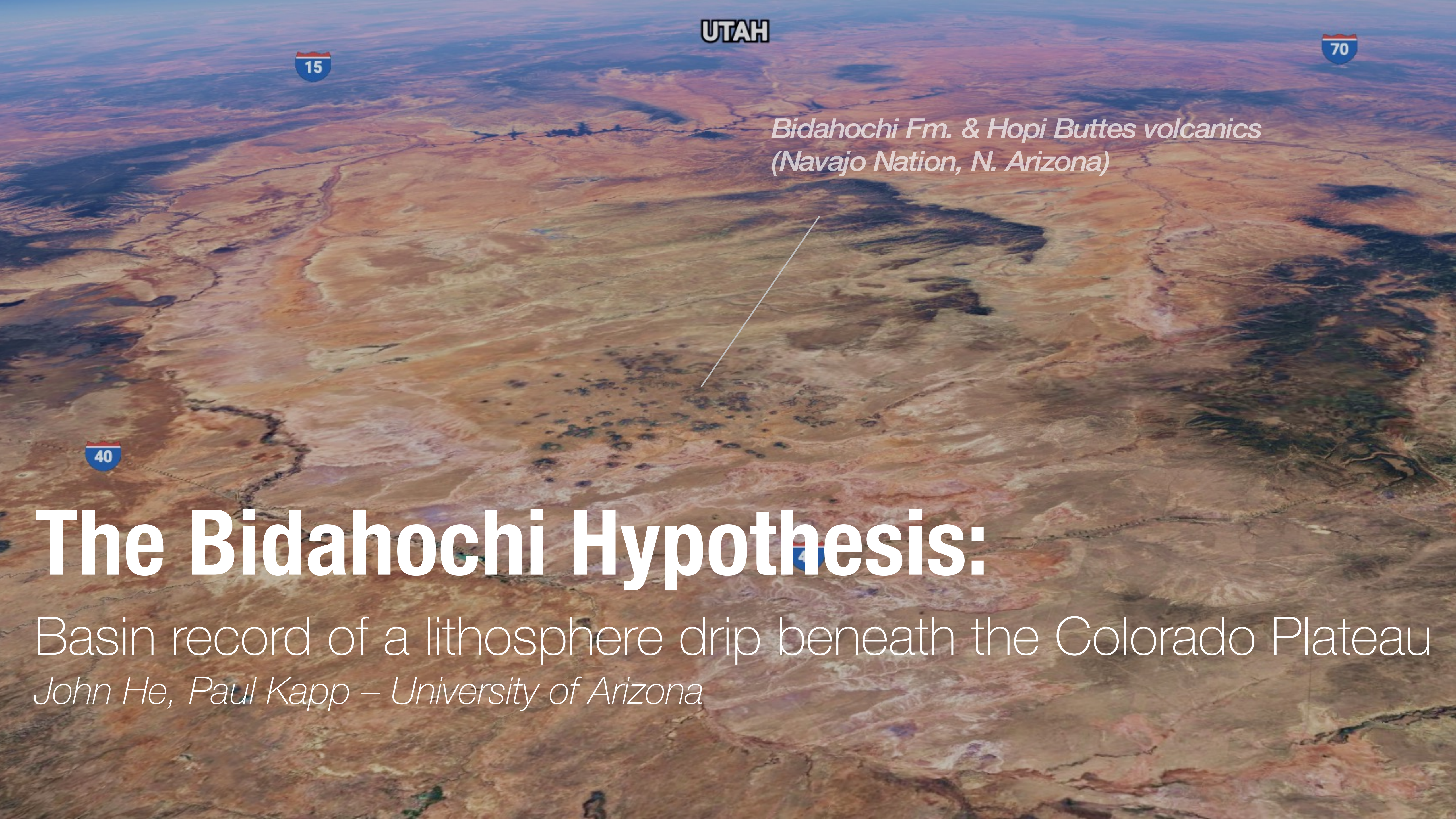
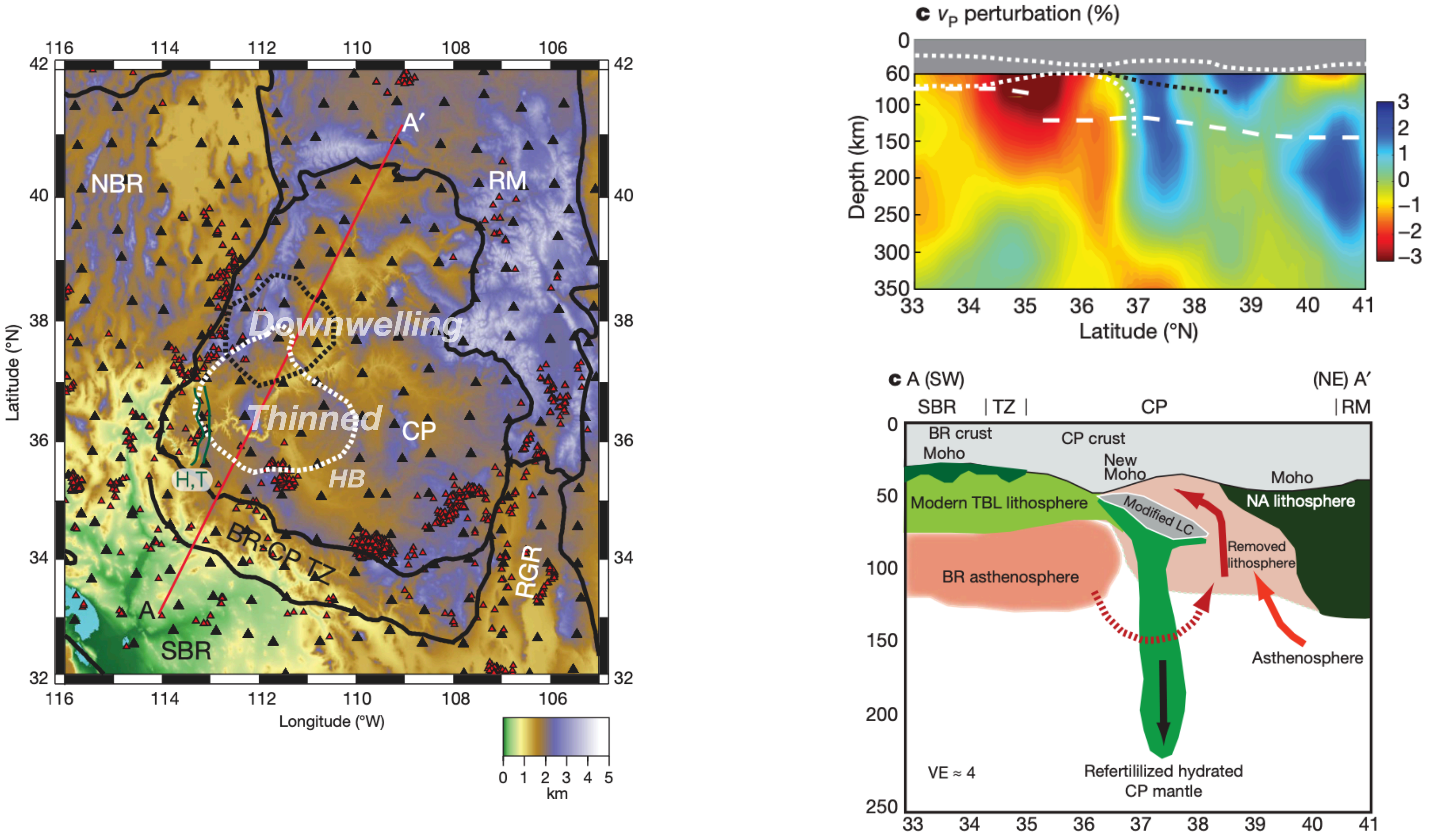


The Bidahochi Hypothesis:

Basin record of a lithosphere drip beneath the Colorado Plateau

John He, Paul Kapp – University of Arizona



Geophysical evidence of recent or ongoing lithosphere foundering beneath the Colorado Plateau

Levander et al. 2011, Nature

C. Alibert, A. Michard and F. Albarède

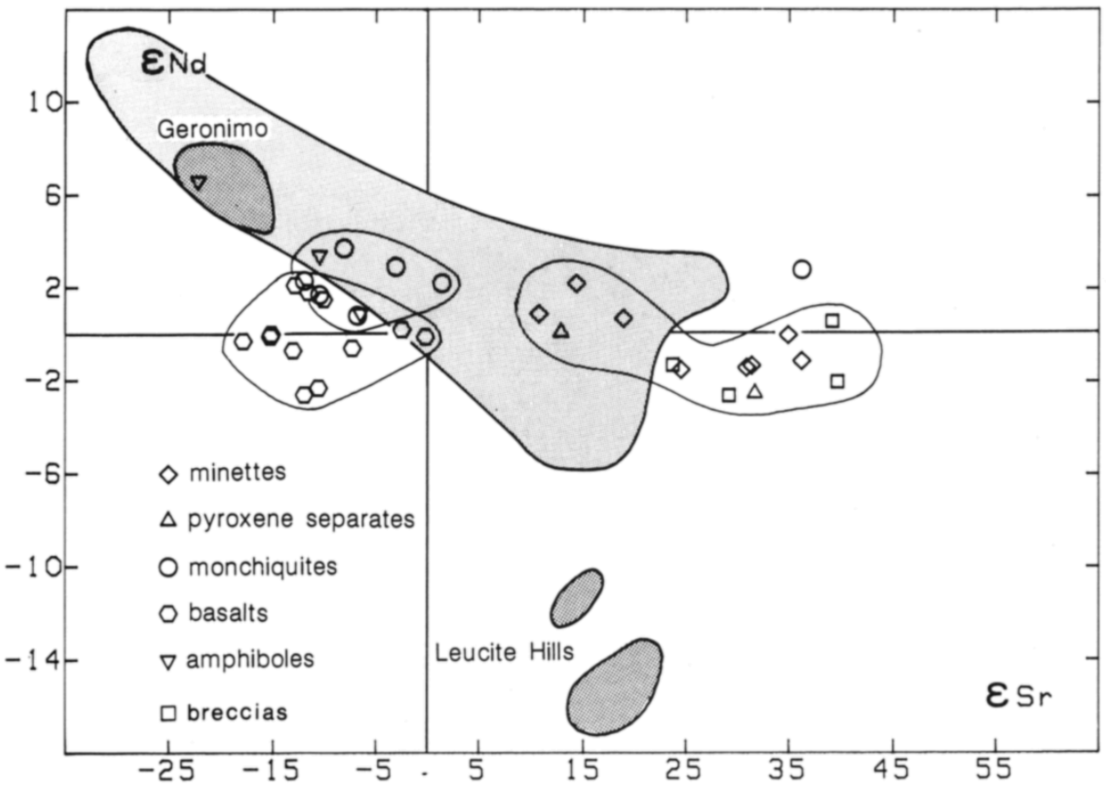
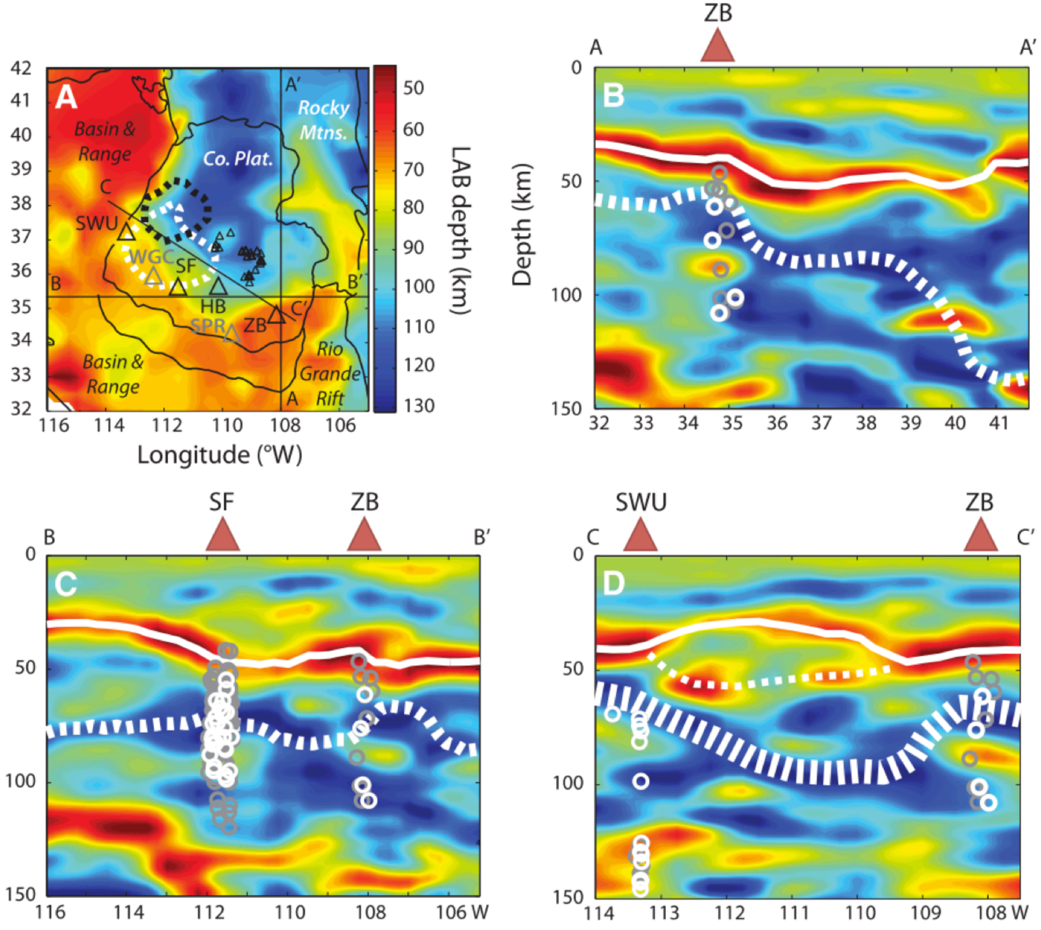


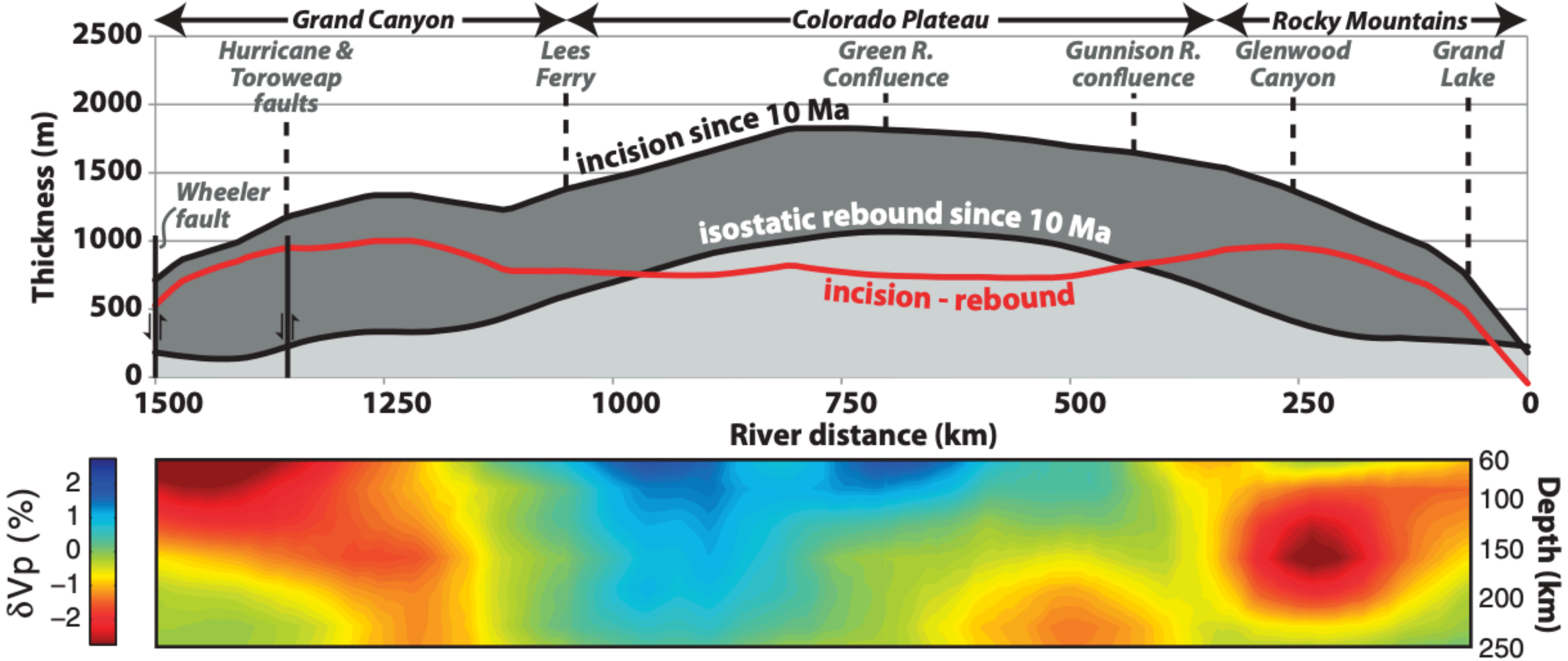
FIG. 4. Nd-Sr isotopic composition of Colorado Plateau volcanics, amphibole megacrysts and breccias. Light shaded area: oceanic basalts. Geronimo data are from MENZIES *et al.*, (1983). Leucite Hills data from VOLLMER *et al.*, (1984).



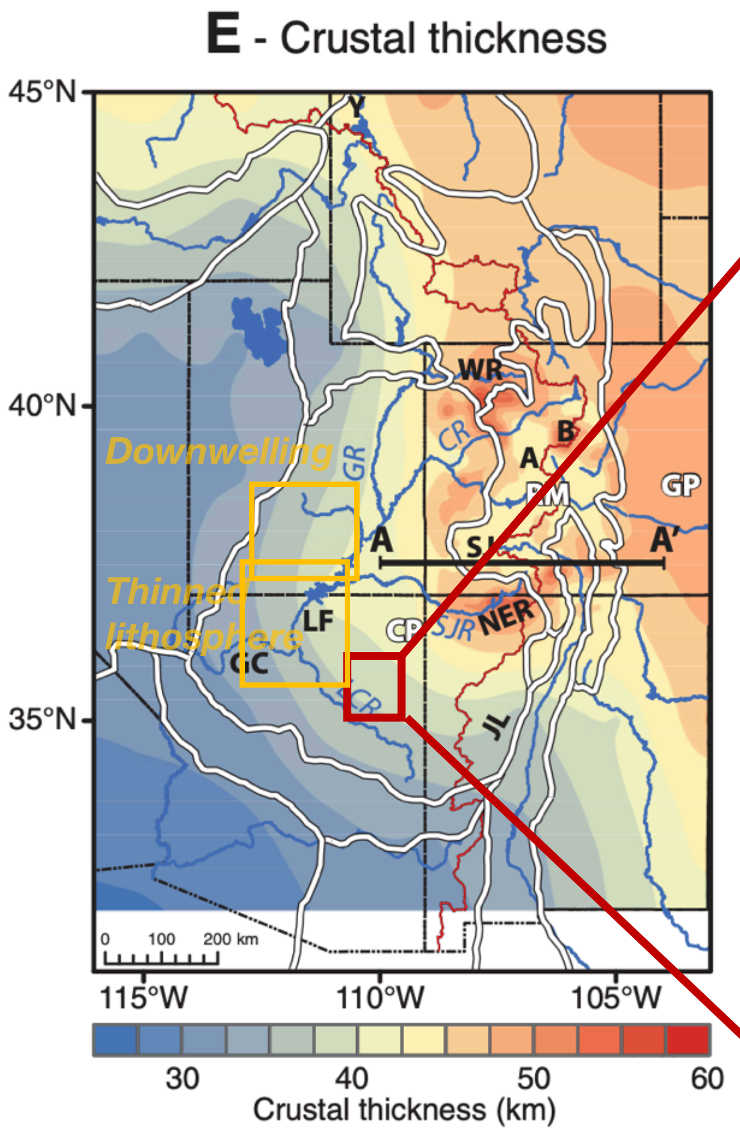
Geochemical evidence of recent or ongoing lithosphere foundering

Alibert et al., 1986, GCA; Reid et al., 2012, Geology

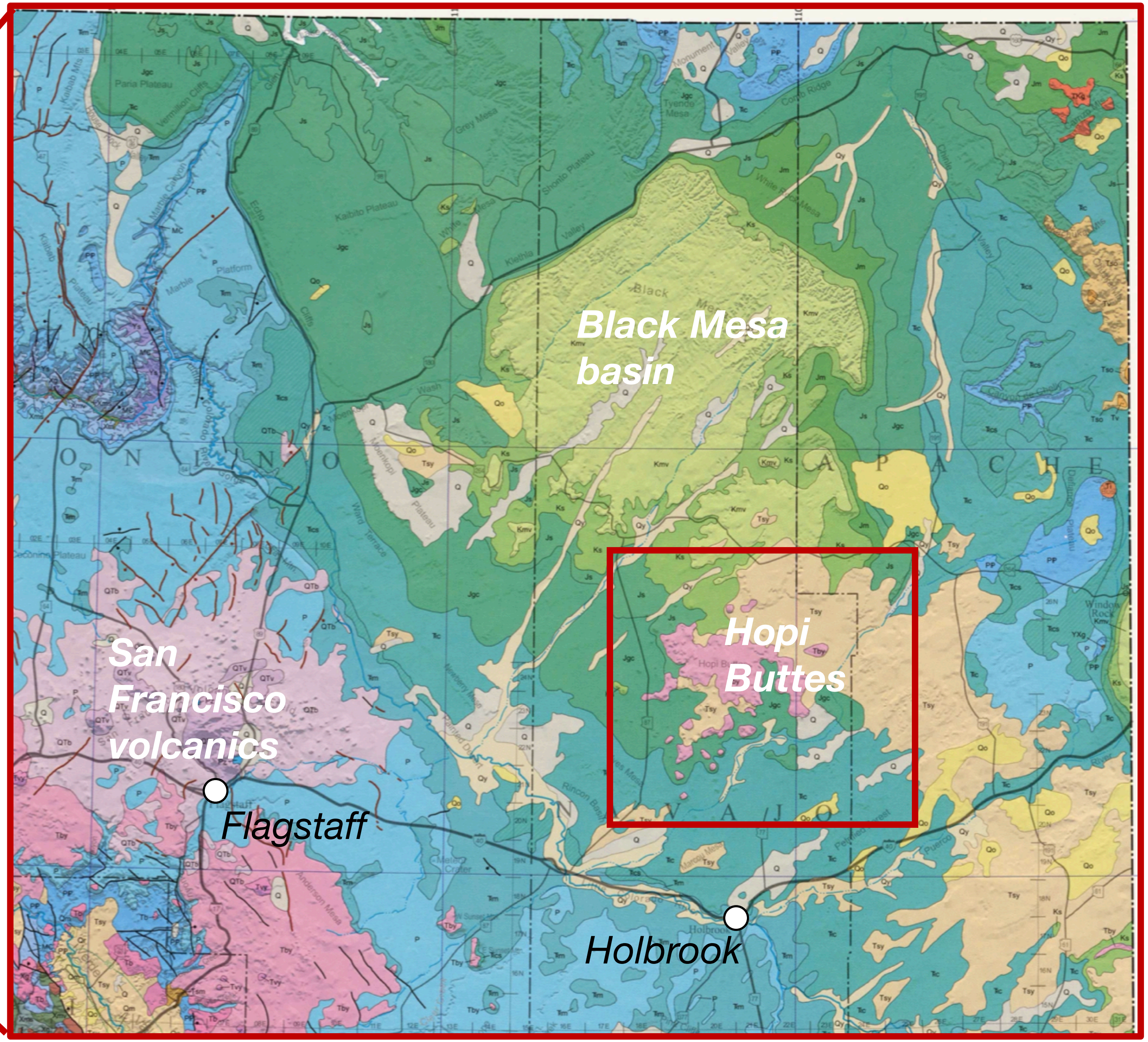
B - River parallel plot showing "residual incision"



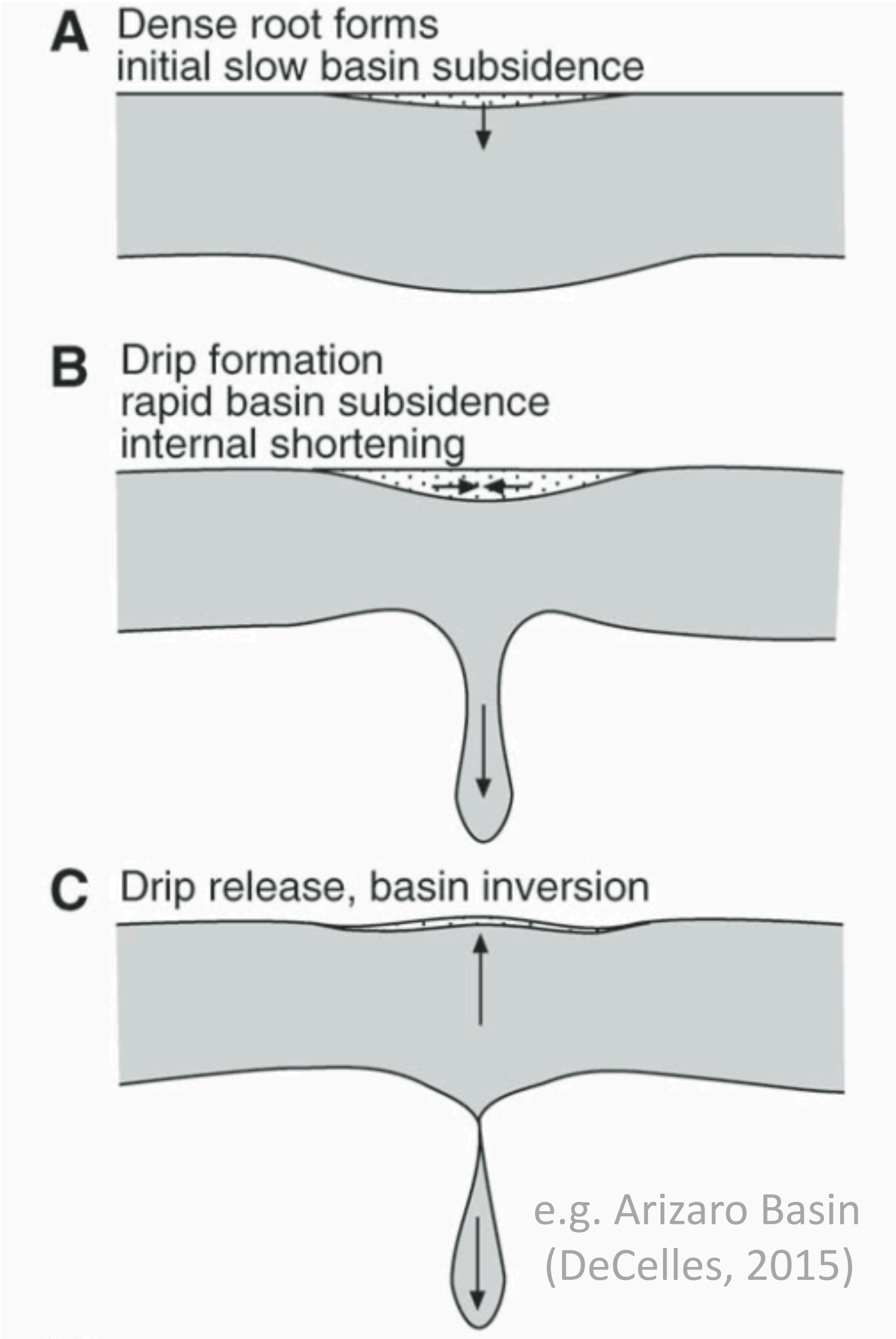
Correspondence of long wavelength topography, crustal thickness, mantle tomography, incision
Karlstrom et al. 2012



Karlstrom et al. 2012 **Figure 1**



AZGS Geologic Map of AZ



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Continental Delamination and the Colorado Plateau

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Probable Geological Consequences

The preceding effects of delamination leave no permanent record and can only be observed where it has happened in the Late Tertiary. This section considers the geological consequences that might mark an ancient event: gas-rich eruptions, basalt extrusion, silicic intrusion, and uplift. Each of these involves an all-or-nothing, nonlinear process like fault slip or a phase change. Therefore lack of one response does not rule out an ancient delamination.

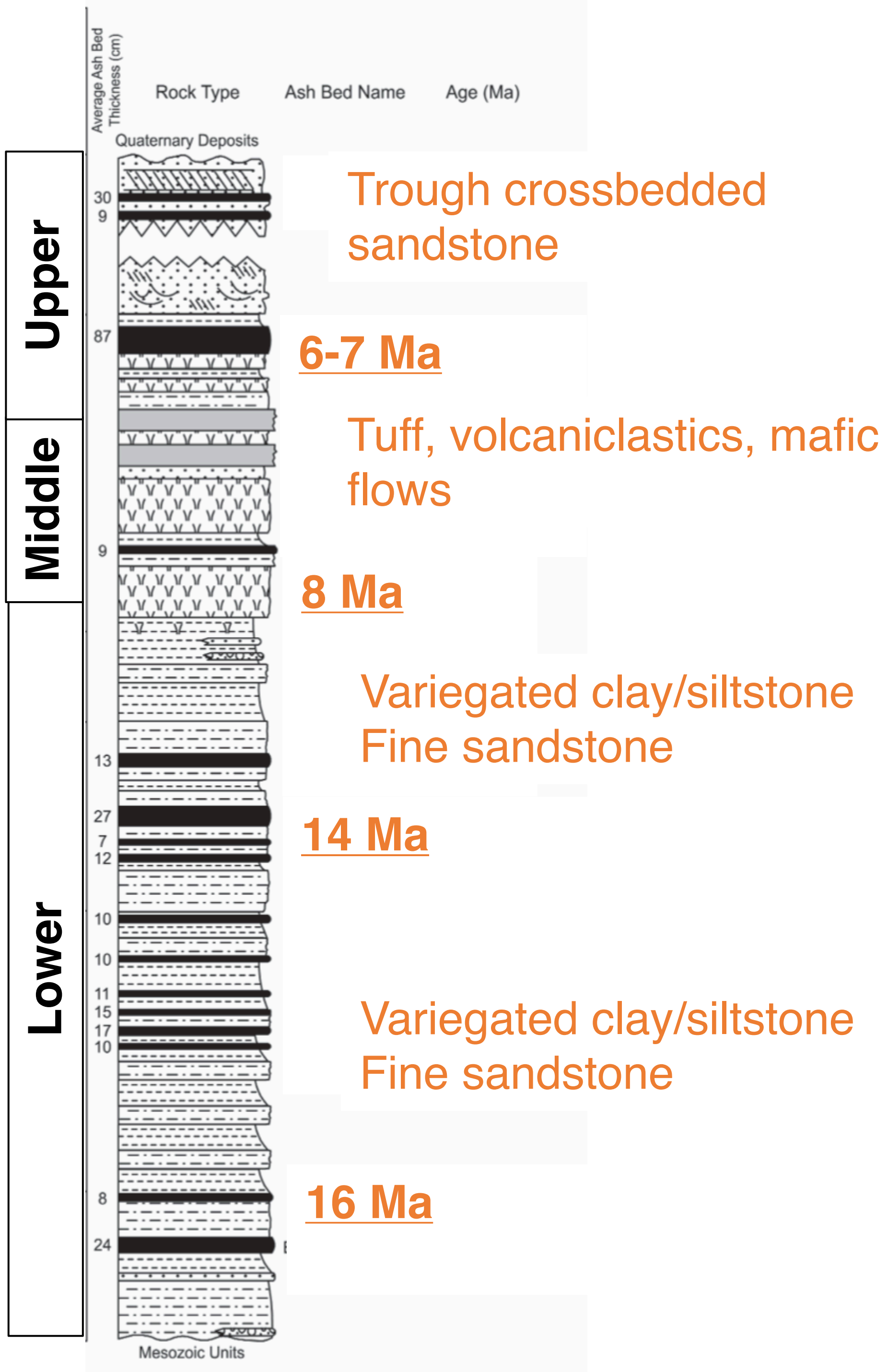
Generalized Bidahochi Formation (Dallegge 1999)

Lower Bidahochi

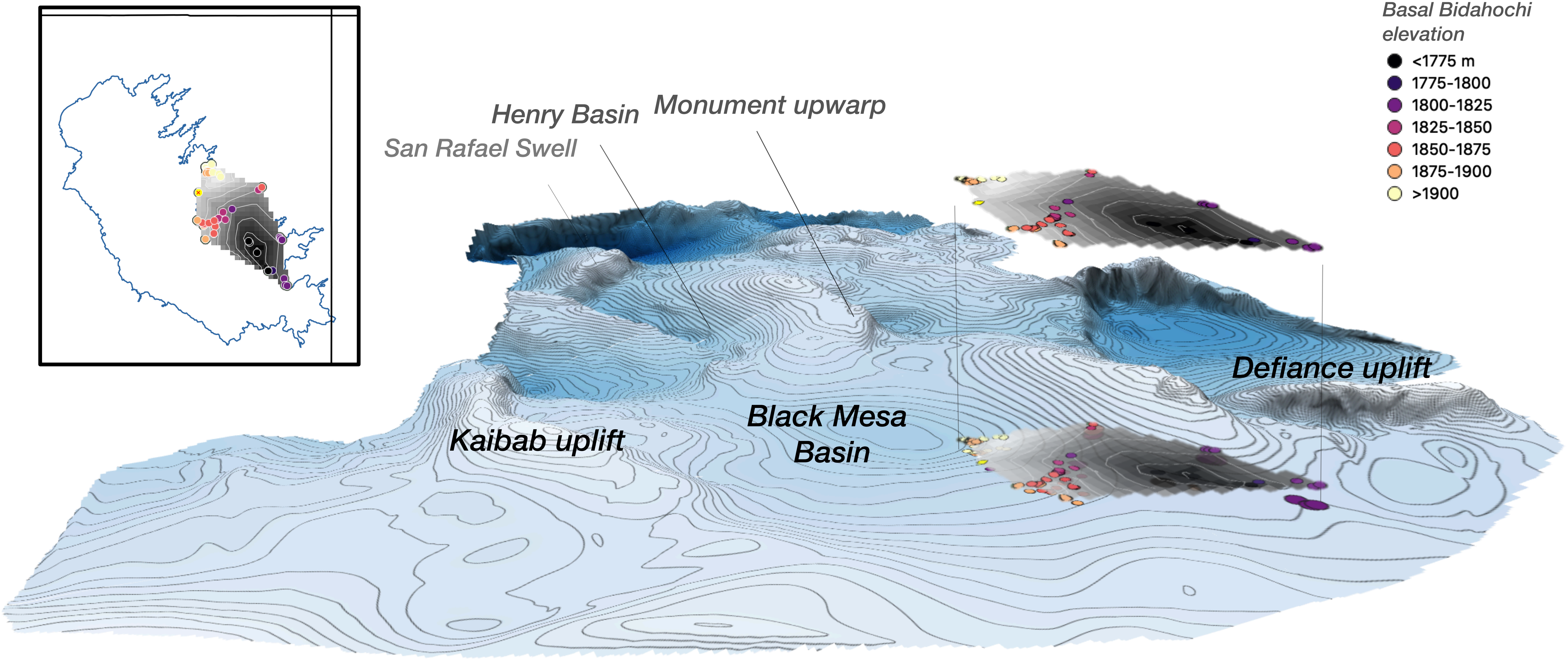
- **<u>16-14 Ma</u>** Fine grained lacustrine sedimentation
- **<u>14-8 Ma</u>** condensed section of slower sedimentation

Middle Bidahochi (Hopi Buttes Volcanic Field)

- **<u>8-6 Ma</u>**
    - nephelinites (~ 10% MgO, silica undersaturated)
    - high-T decompression melting (~ 70 km)
    - Juvenile eNd values (c. +4)
        - At least partial component of melt from an isotopically depleted mantle source
    - (Alibert 1986, Reid et al., 2012)



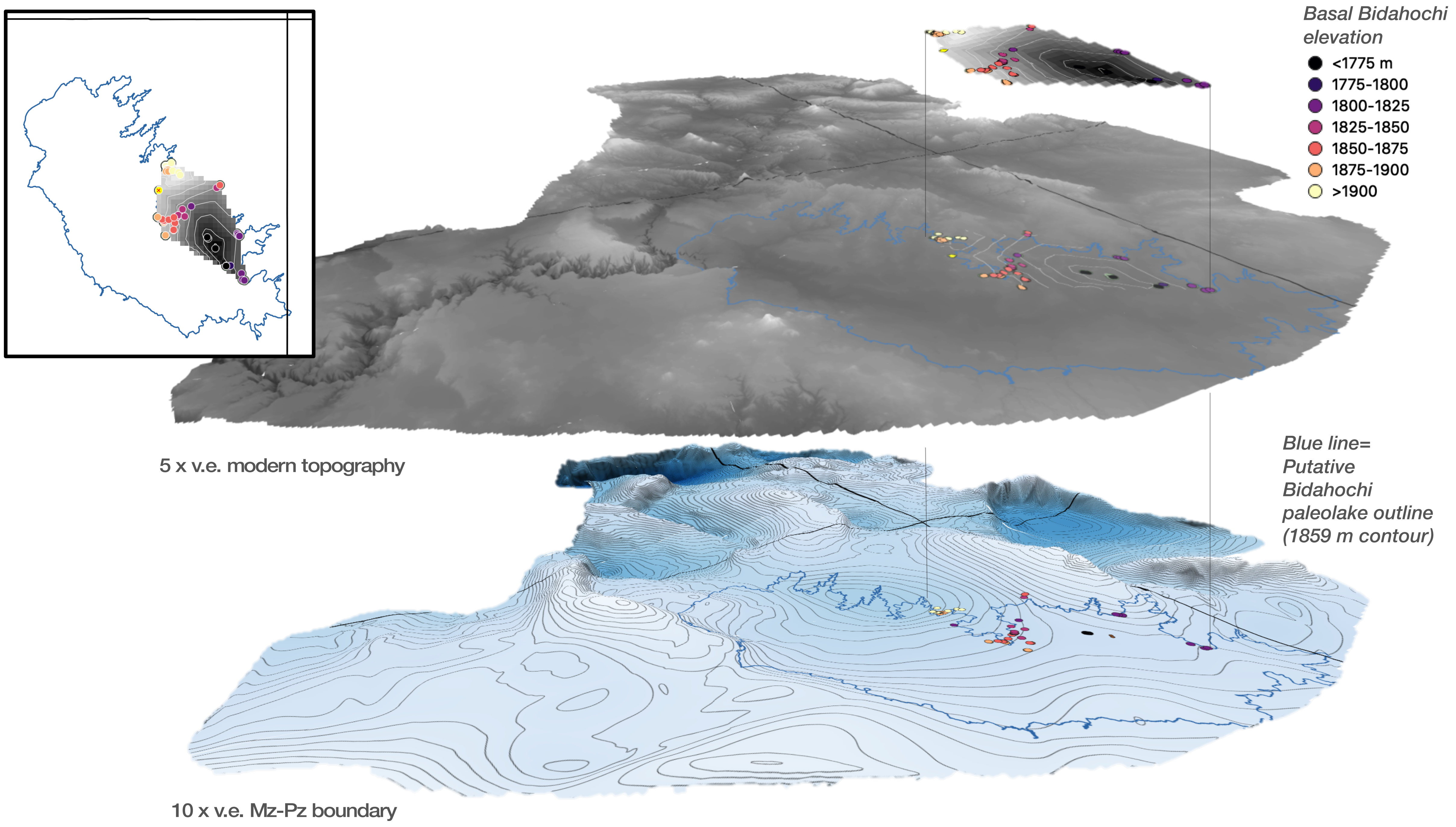

Middle Bidahochi – 6-7 Ma max depo age
Chinle

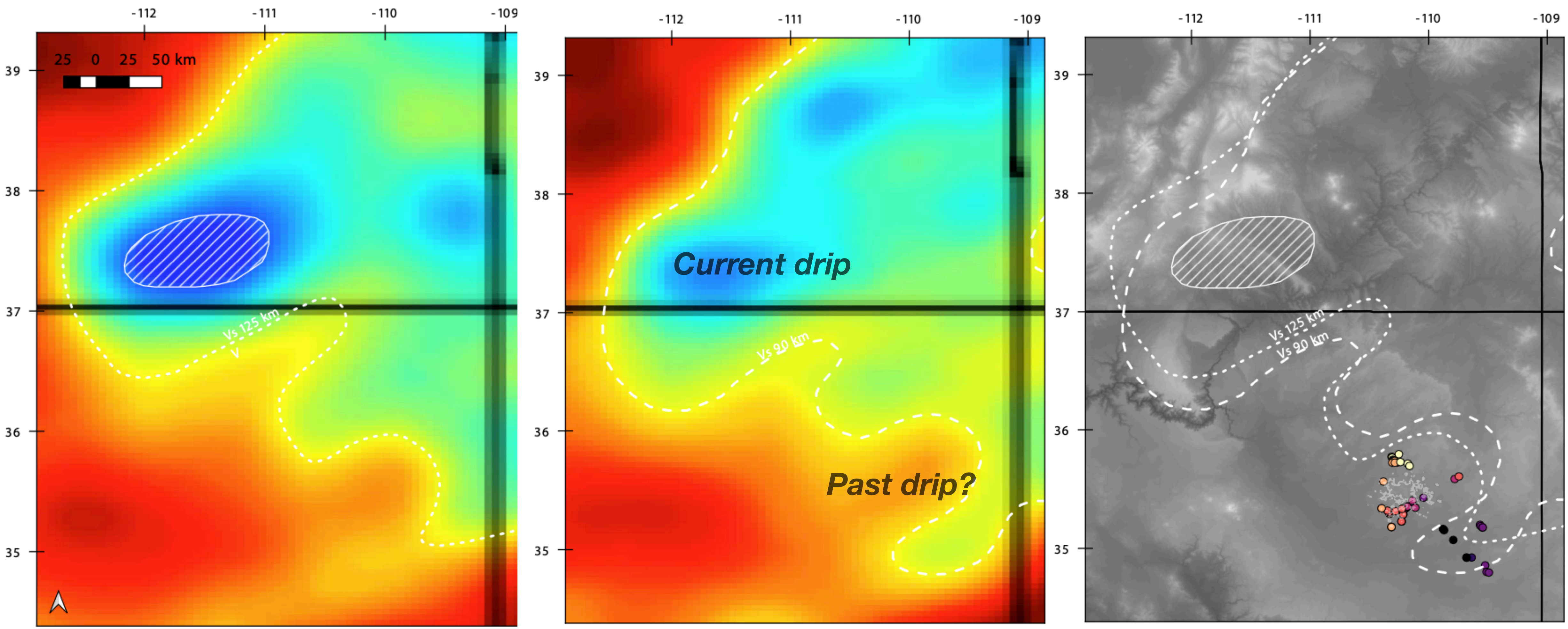


Structure contour of Laramide monoclines and uplifts

(DEM of Pz-Mz boundary/top of Kaibab limestone)

10x vertical exaggeration; data from Flowers et al. (2008); Hunt (1956)


Basal Bidahochi elevation
<1775 m
1775-1800
1800-1825
1825-1850
1850-1875
1875-1900
>1900
5 x v.e. modern topography
Blue line= Putative Bidahochi paleolake outline (1859 m contour)
10 x v.e. Mz-Pz boundary

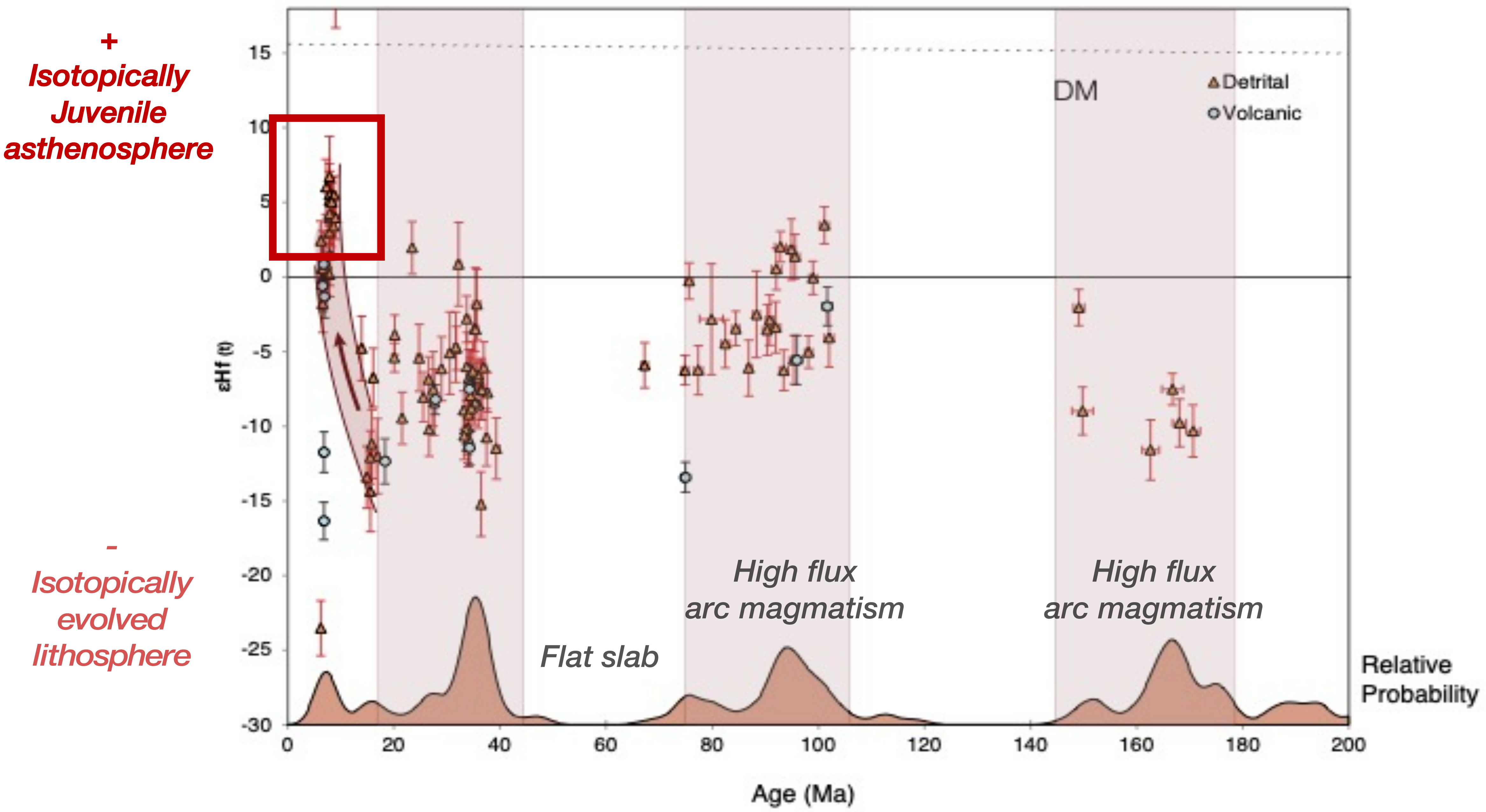


Vs 125 km

Schmandt and Humphrey 2010

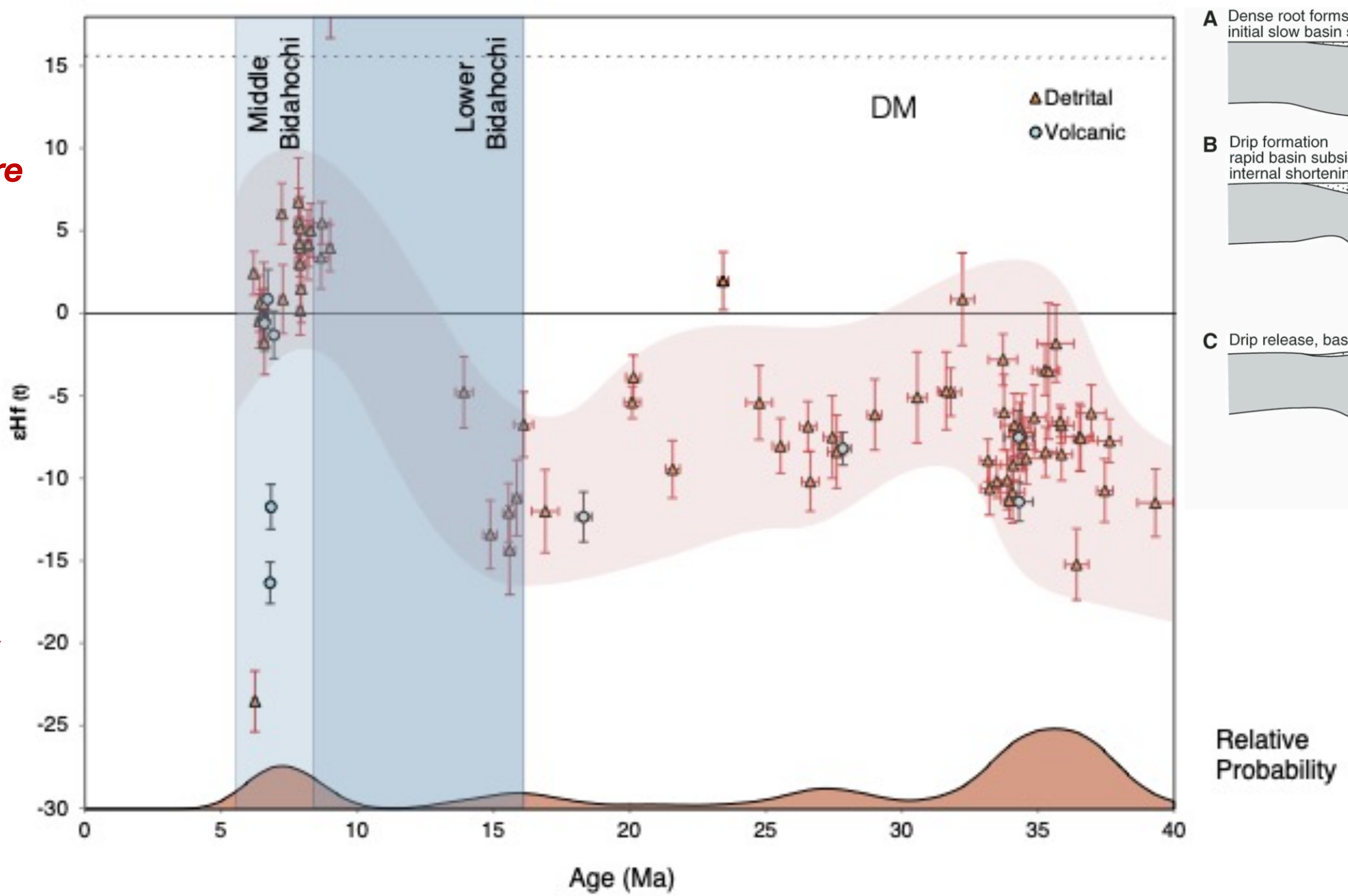
Vs 90 km

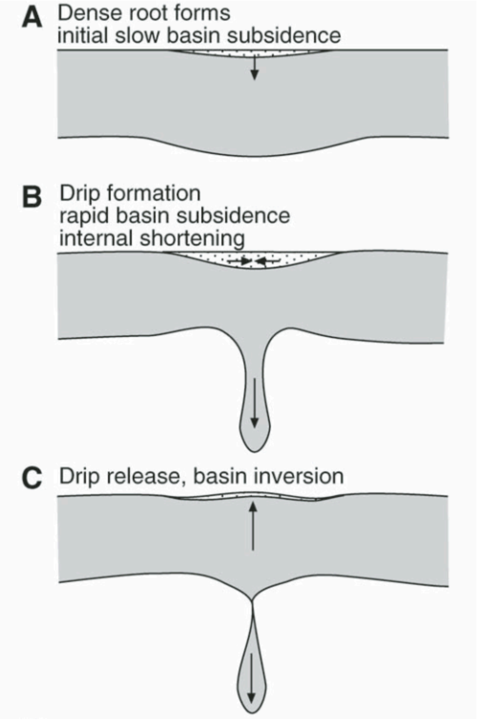
U-Pb/Lu-Hf of detrital zircon grains in the Bidahochi Fm



U-Pb/Lu-Hf of detrital zircon grains in the Bidahochi Fm

+
Isotopically Juvenile asthenosphere





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Isotopically evolved lithosphere

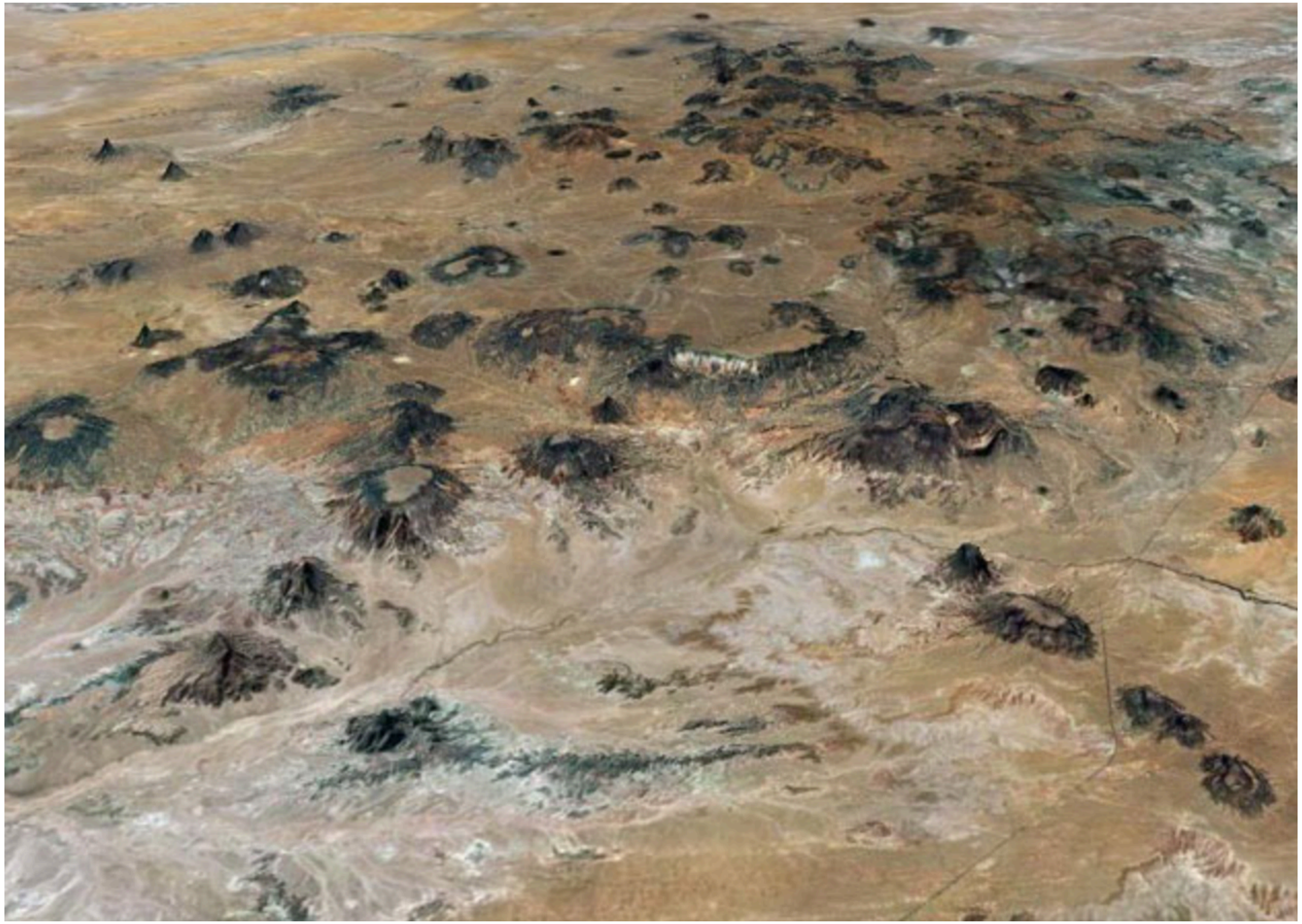
Summary:

1. Localized lacustrine deposition high on the Colorado Plateau

2. Subsequently uplifted and now mostly eroded

3. Spatially coincident with mafic/nephelinitic mantle-derived, decompression melt

4. Temporally coincident with Hf isotopic trend in proximal detrital record



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