"Budding" Positive Flower Structure along the Northern Death Valley Fault Zone, Death Valley, California*

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Abstract

Death Valley is a lazy-Z strike-slip basin developed by slip on the right-lateral Northern Death Valley/Furnace Creek and Southern Death Valley fault zones with the intervening normal-slip Black Mountains fault zone. The Northern Death Valley fault zone (NDVFZ) is a cross-valley fault that is now the locus of Quaternary deformation in lieu of the Furnace Creek fault zone. For most of its trace the NDVFZ is a low-relief, linear fault, with the exception of the 250-m-high Kit Fox Hills (KFH). The KFH consist of Miocene (?) to Quaternary uplifted and tilted lacustrine and alluvial-fan deposits mapped at 1:62500 scale. Mapping at 1:12000 and geochronology, including 17 tephra layers distributed throughout the KFH, indicate that KFH deposits range in age from ~3.5 Ma to <0.76 Ma. Structurally, the KFH are consistent with an emerging positive flower structure that is elongating from south to north. In the south where the greatest relief is found, deposits that include the 3.335 Ma Zabriskie Wash tuff are deformed in an overturned anticline with trend oblique to the NDVFZ. Beds in the central KFH are east-tilted and interrupted by faults with apparent normal, down-to-the-north offset and strikes about 30-45° from the strike of the NDVFZ. In the north, 0.76 Ma deposits that include the 0.76 Ma Bishop Ash bed are folded into a broad syncline that trends parallel to the NDVFZ. In addition, the northern KFH are characterized by down-to-the-northwest normal faults with arcuate strikes. Proximal to the NDVFZ, the strikes of the normal faults are at a 45° angle to the NDVFZ. Distally, these same normal faults strike parallel to the NDVFZ. WeI interpret the older deposits, greater structural complexity and greater relief, in the relative, to the north as south to north growth of the KFH. The secondary faults and folds are consistent with modeled and observed positive flower structures in a simple shear environment.

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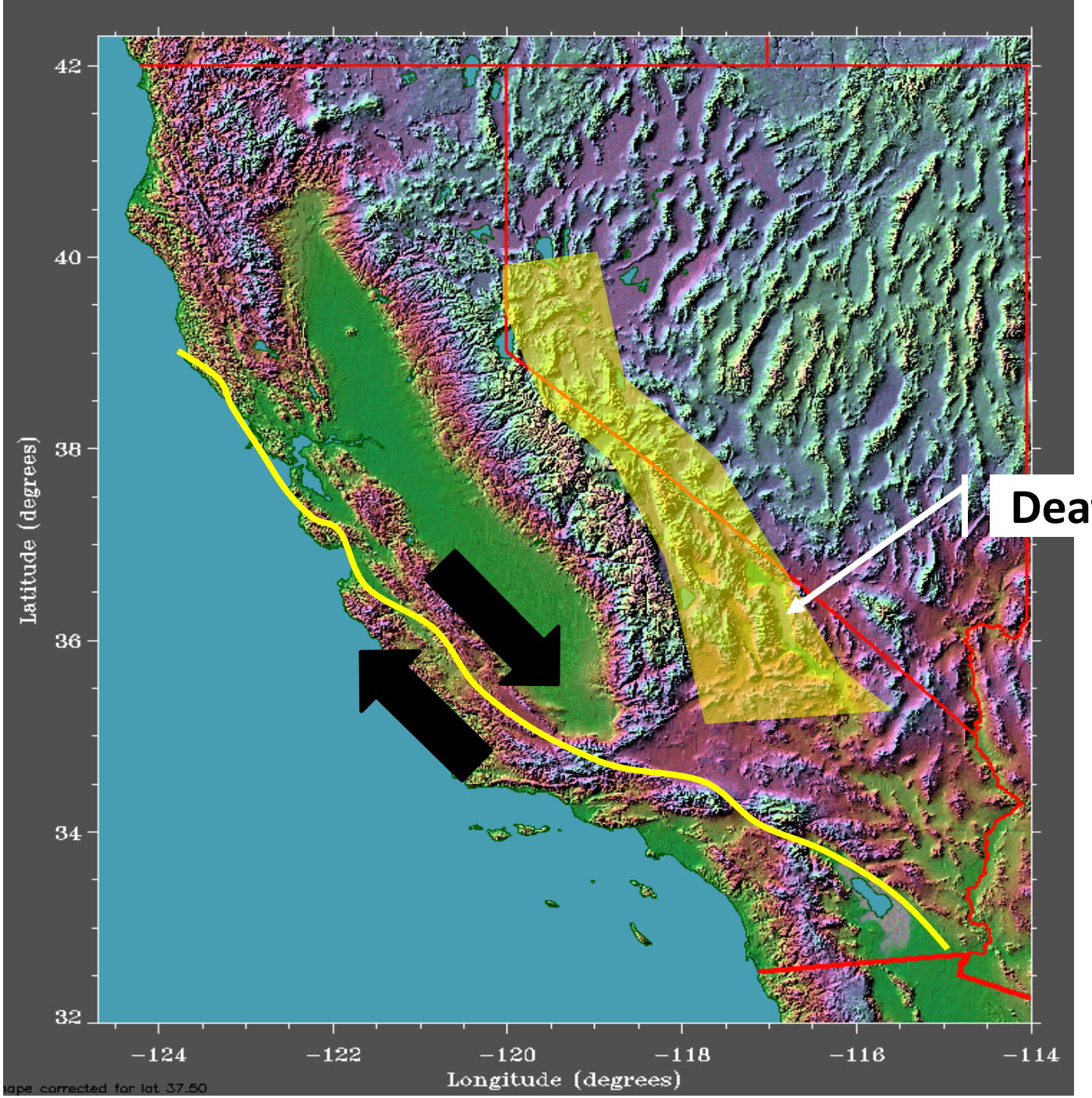
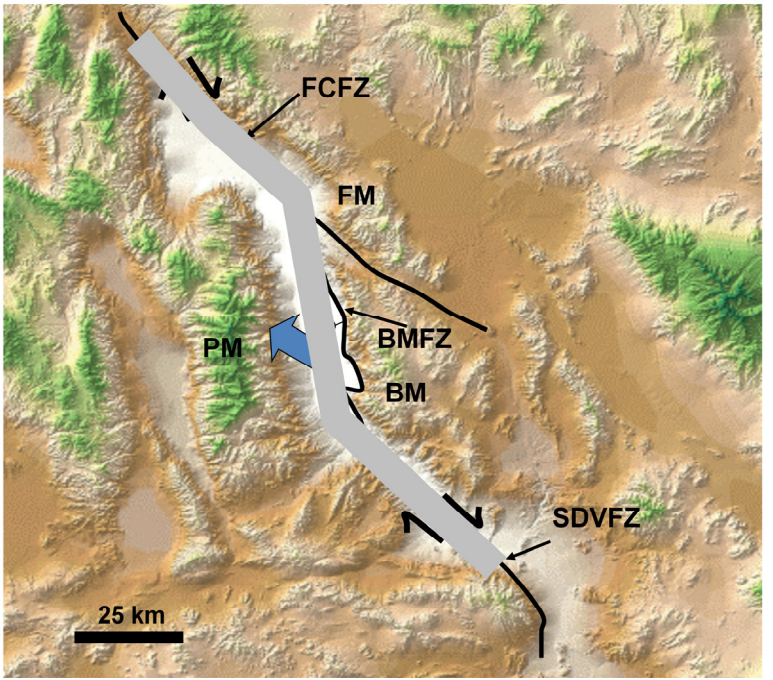
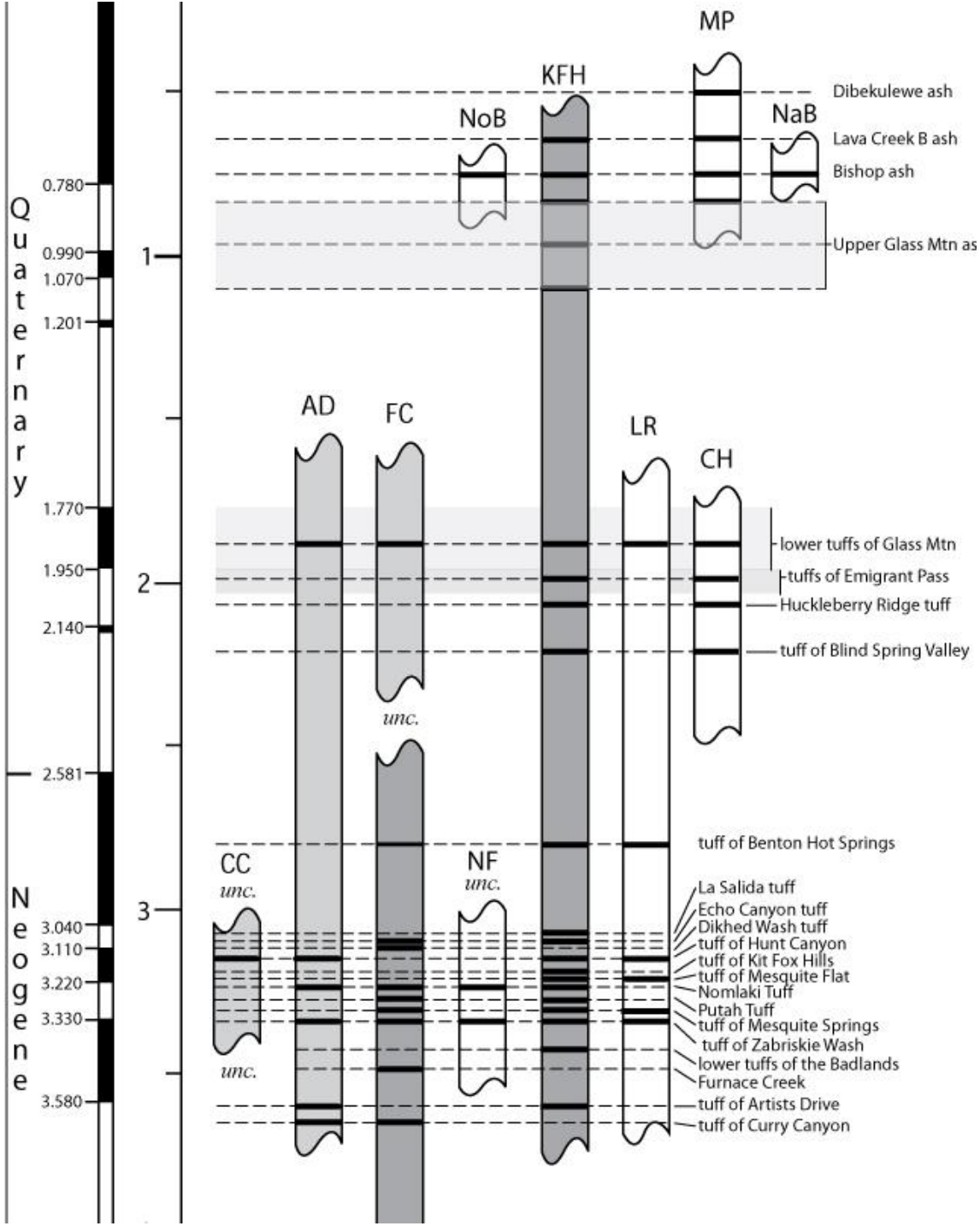

42
40
38
36
34
32
Latitude (degrees)
−124
−122
−120
−118
−116
−114
Longitude (degrees)
Death Valley



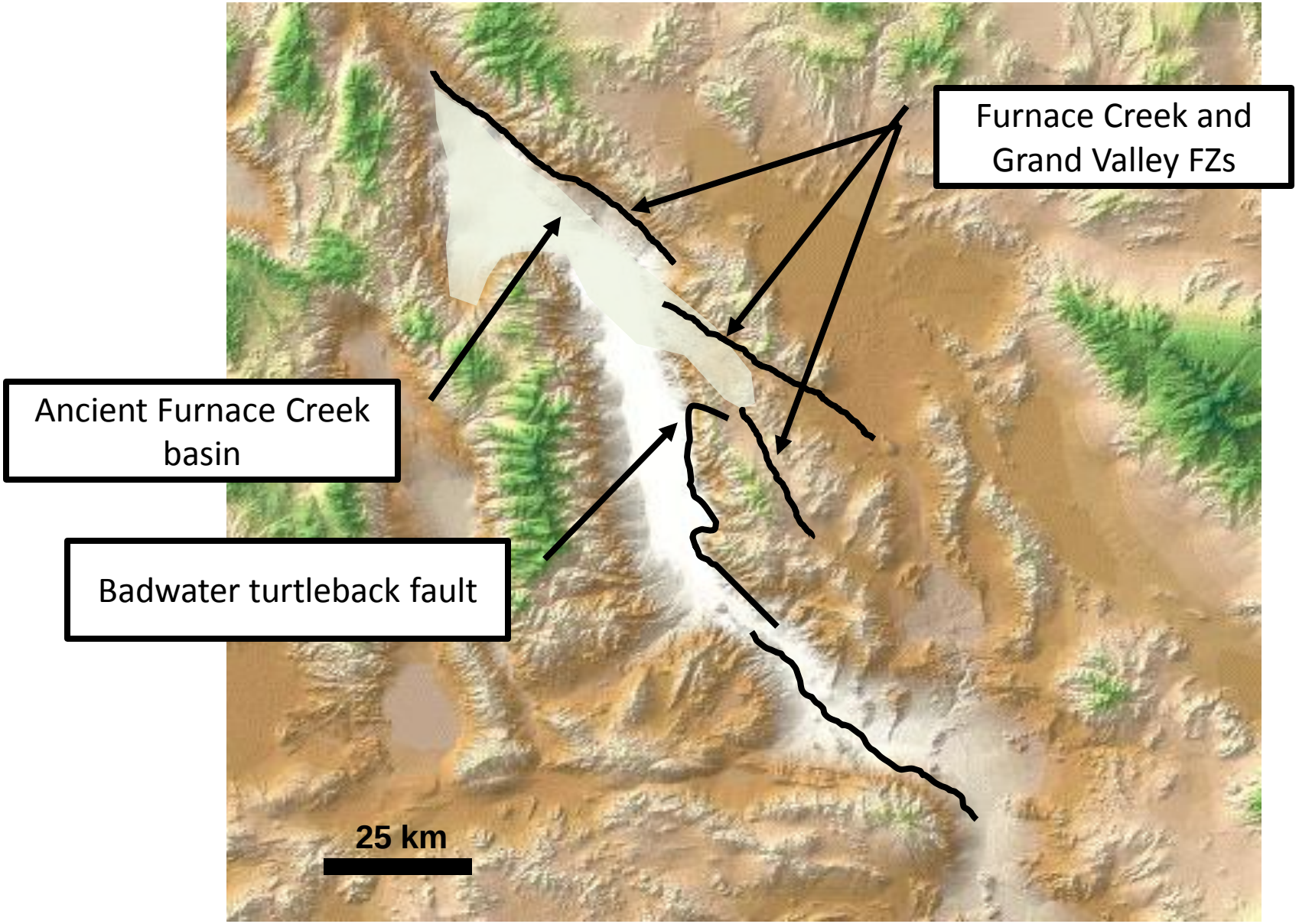
after Burchfiel and Stewart (1966); Mann (1983)

Presenter's notes: Key: FCFZ=Furnace Creek fault zone; FM=Funeral Mountains; BMFZ=Black Mountains fault zone; BM=Black Mountains; SDVFZ=Southern Death Valley fault zone; PM=Panamint Range.



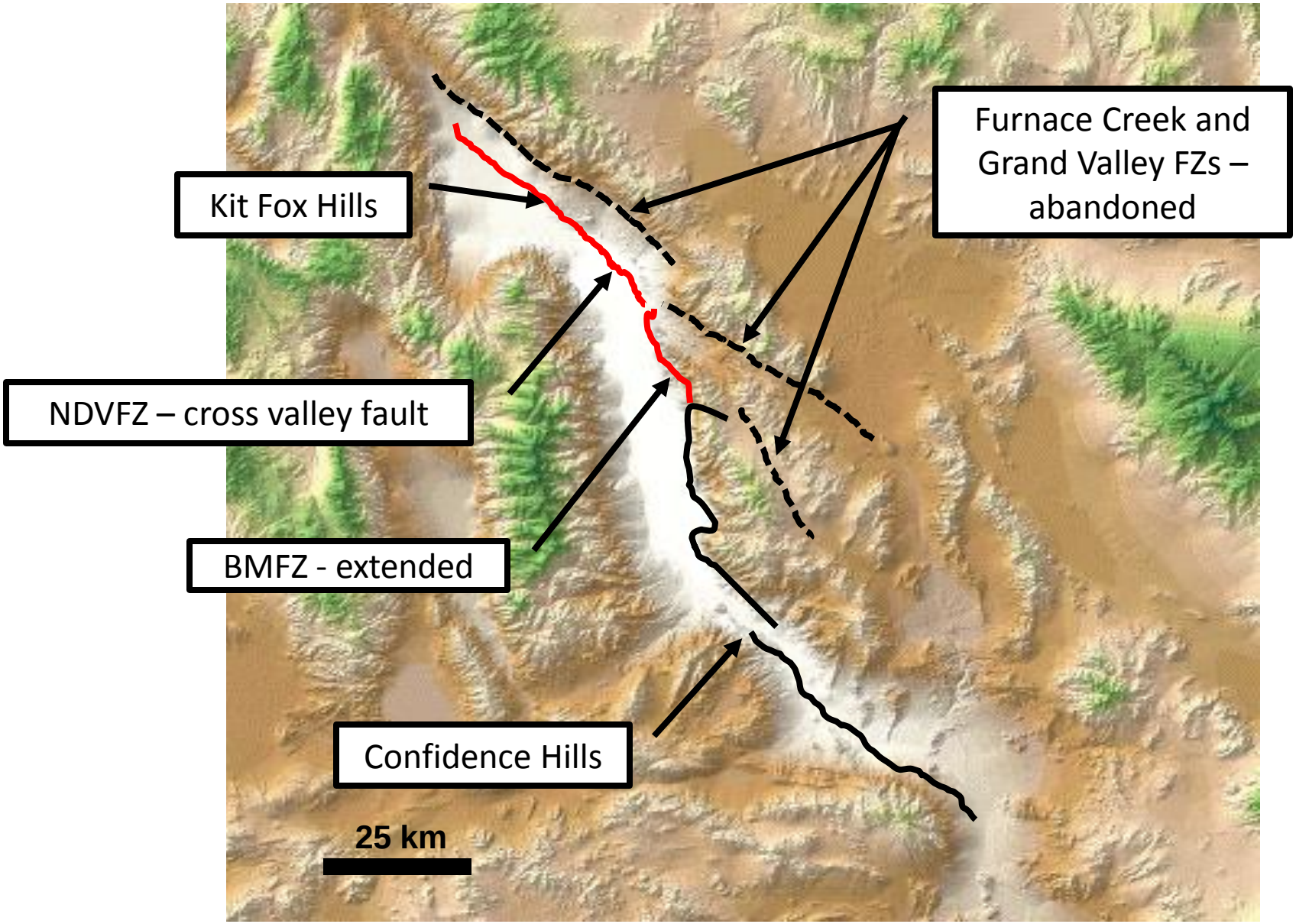
- 25 different tephra layers
  - Long Valley
  - Cascades
  - Yellowstone
  - Sonoma
  - Coso
- 3.58 – 0.5 Ma

~6-~2 Ma



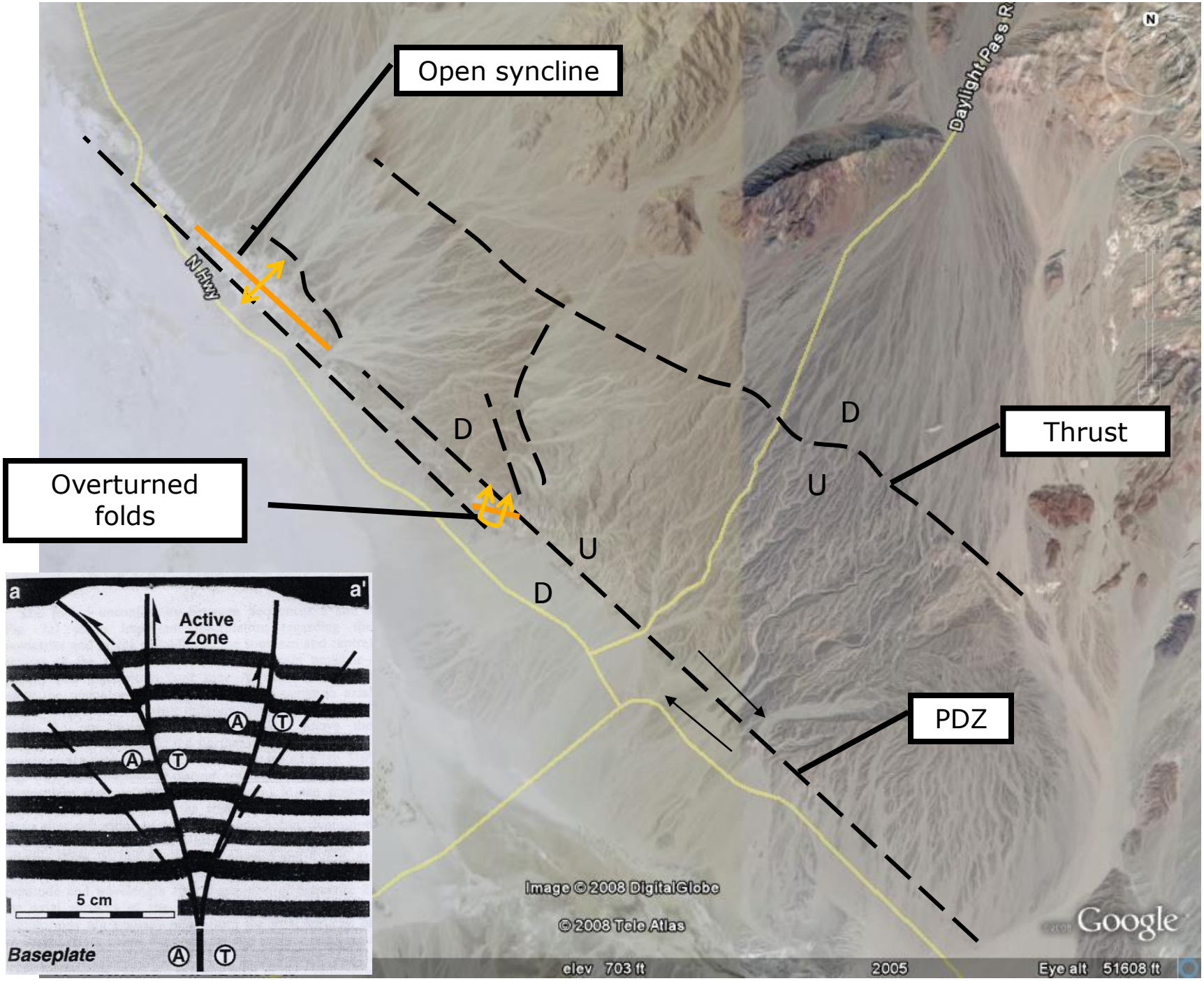
Wright et al. (1999); Machette et al. (2001); Knott et al. (2005)

<2 Ma



Machette et al., 2001; Knott et al. (2005)

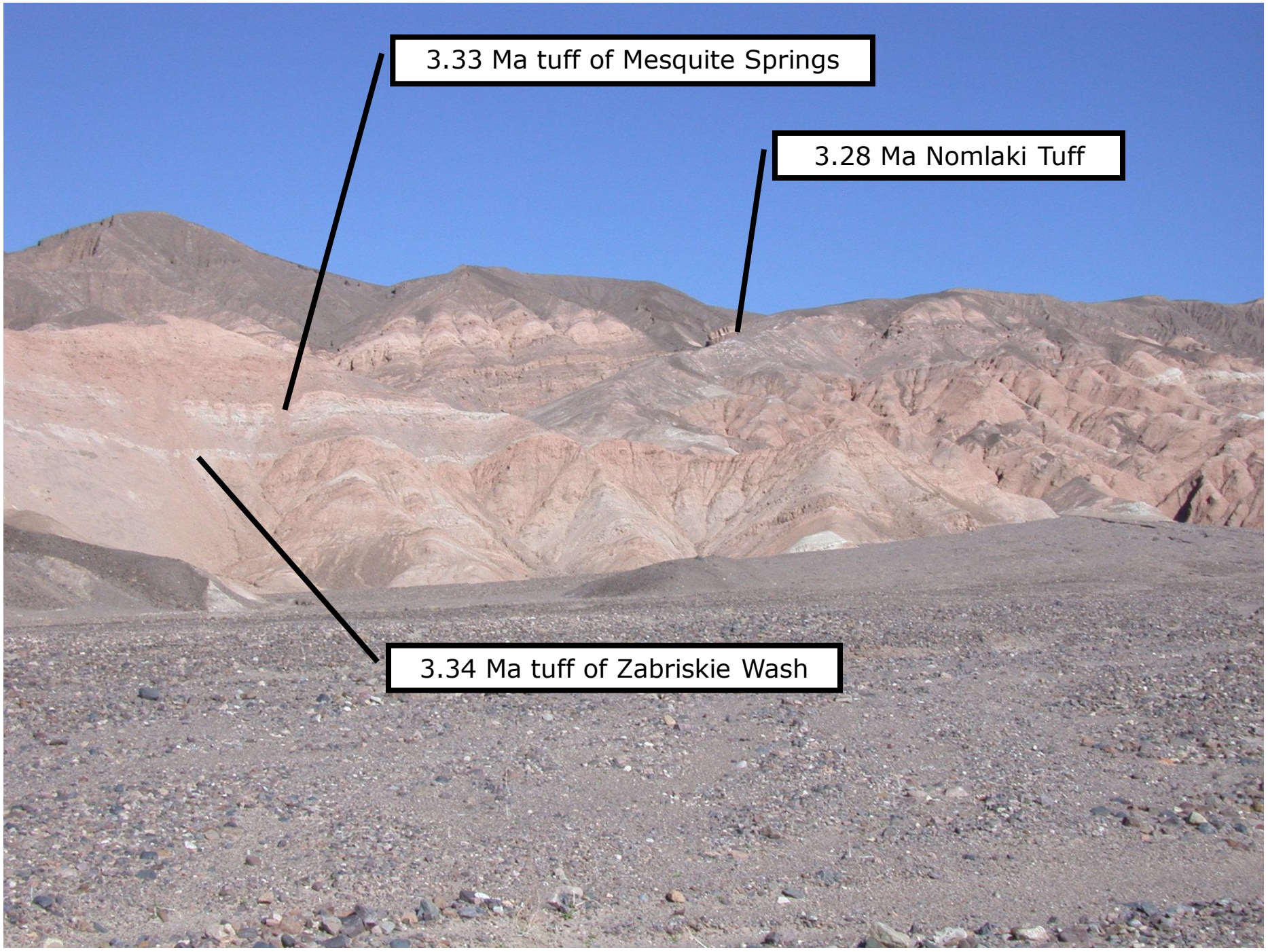
Kit Fox Hills – why a flower structure?


Open syncline
Overturned folds
Thrust
PDZ
NHW
D
U
D
U
D
Daylight Pass R
N
a
a'
Active Zone
A
T
A
T
5 cm
Baseplate
A
T
Image © 2008 DigitalGlobe
© 2008 Tele Atlas
Google
elev 703 ft
2005
Eye alt 51608 ft

Why a “budding” flower structure?

- Growth is from south to north.
  - Relief decreases from south to north.
  - Fold complexity decreases from south to north.
  - Fault offset on thrust decreases from south to north.

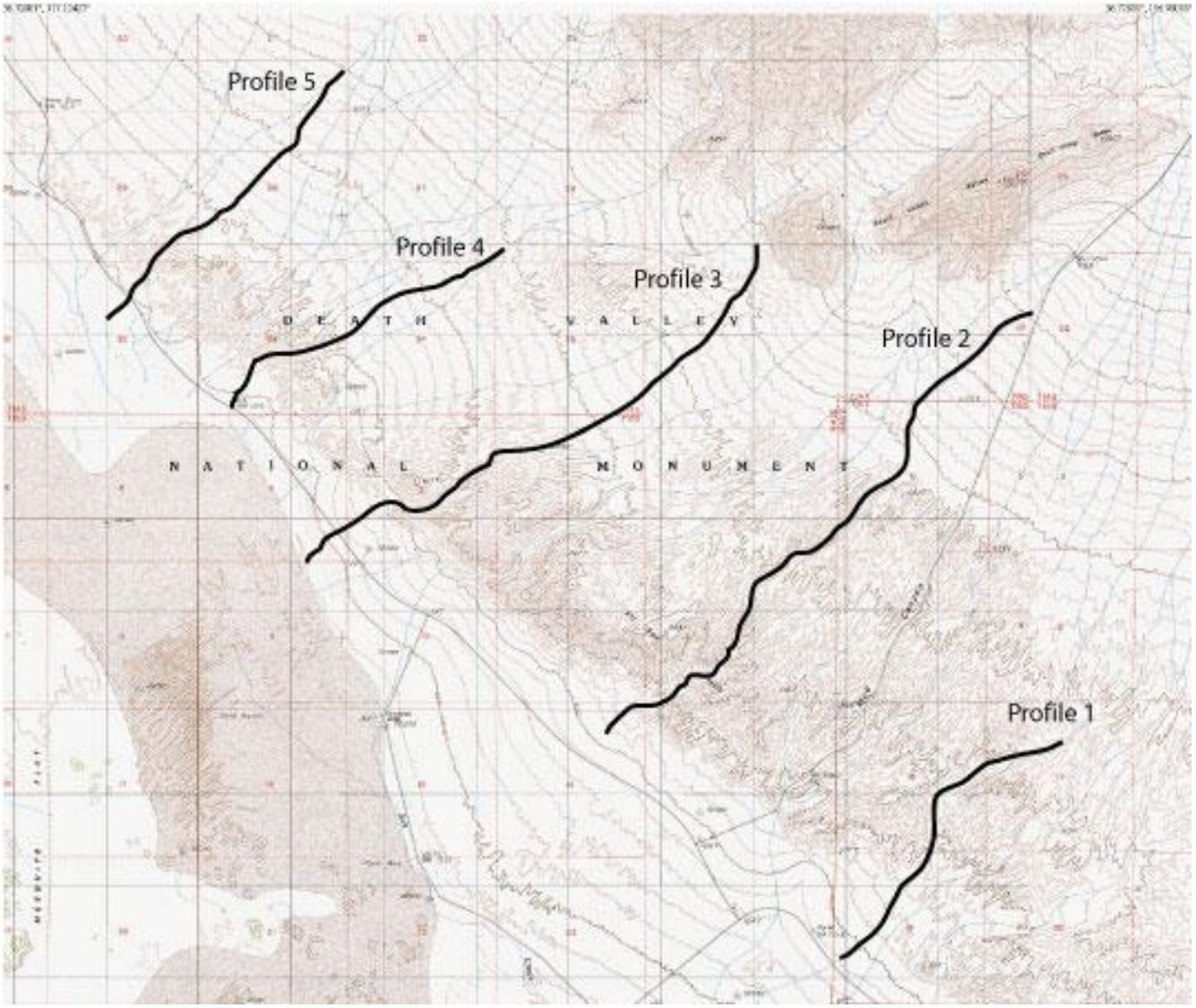
Kit Fox Hills

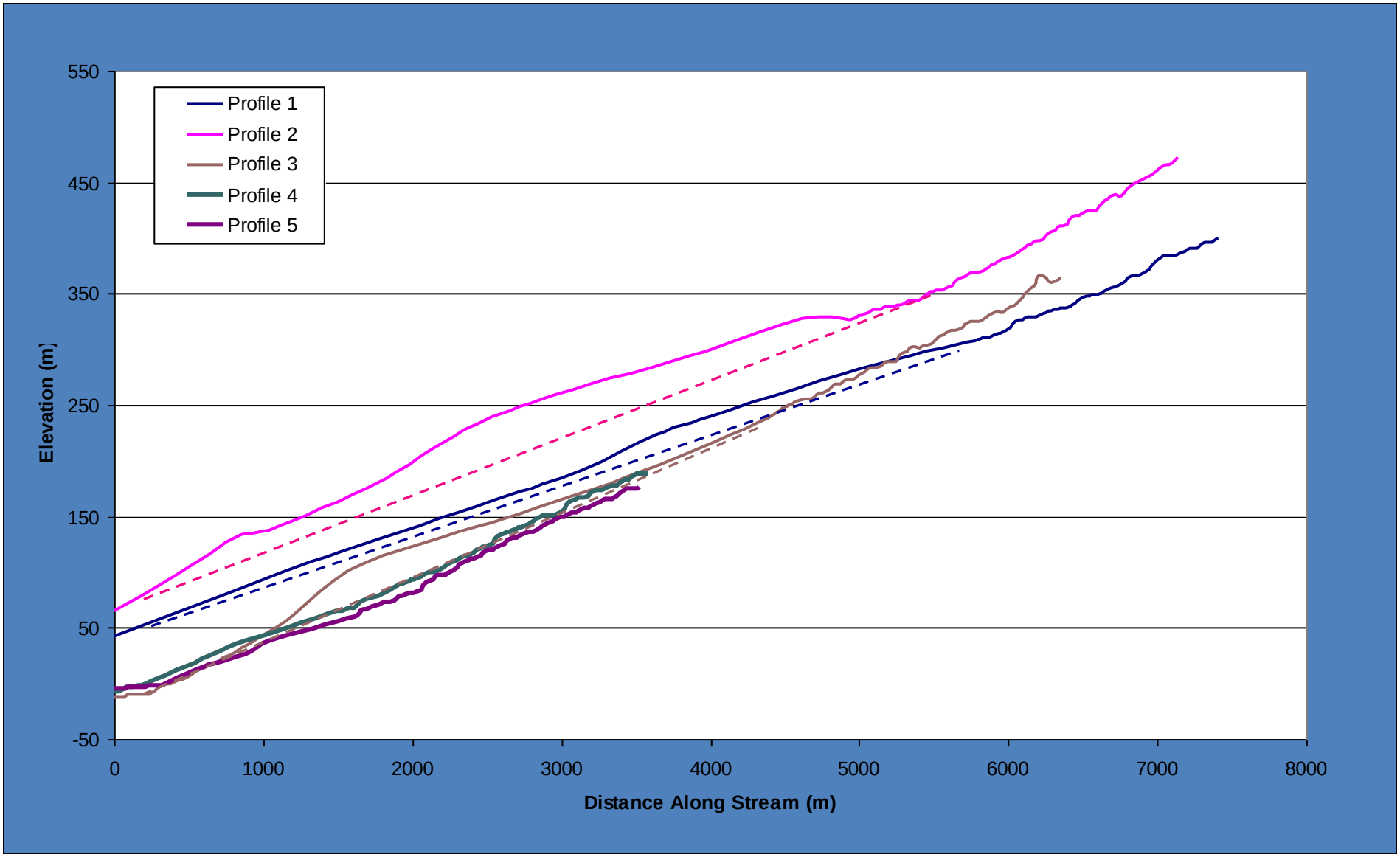

3.33 Ma tuff of Mesquite Springs
3.28 Ma Nomlaki Tuff
3.34 Ma tuff of Zabriskie Wash

0.77 Ma Bishop ash bed

1.7-1.9 Ma lower tuff of Glass Mountain

Streams crossing Kit Fox Hills have varying non-equilibrium profiles.




Profile 1
Profile 2
Profile 3
Profile 4
Profile 5
550
450
350
250
150
50
-50
Elevation (m)
0
1000
2000
3000
4000
5000
6000
7000
8000
Distance Along Stream (m)


D
U
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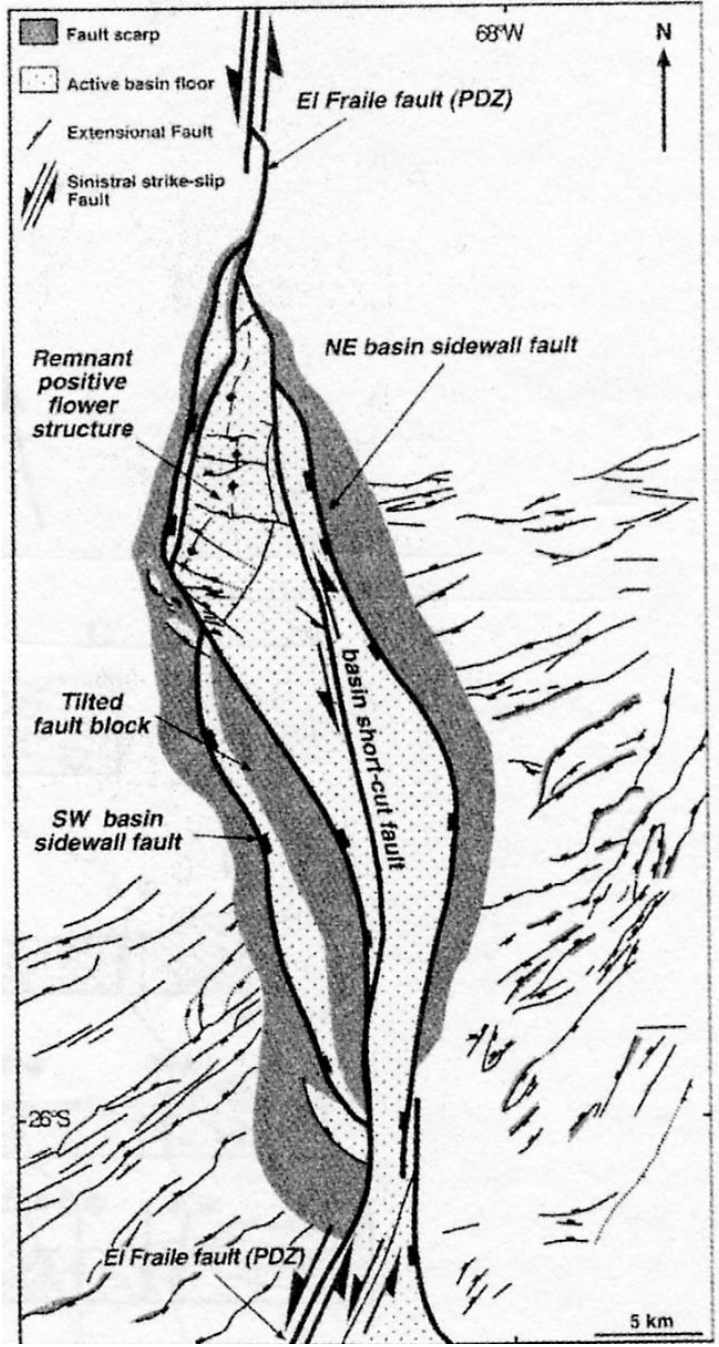

From McClay and Dooley (1995)

- The Kit Fox Hills flower structure is
  - a complex, north-propagating, transtensional/transpressional structure along the NDVFZ.
  - North end uplifted post-0.77 Ma
  - Overlying alluvial fan gravels indicate post-70 ka
- Development of strike-slip, cross-valley faults in extensional basins may
  - Divide reservoir sands
  - Separate source rock from reservoir rock
  - Indicate extinction phase of basin development