Structural Development and Tectonic Role of the Arrowhead Mine Fault, Pahranagat Shear Zone, Nevada*

Michael D. Evans[1] and Wanda J. Taylor[1]

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[1]University of Nevada, Las Vegas, NV, USA (mevansmusic@gmail.com)

Abstract

The boundary between the Northern (NBR) and Central (CBR) Basin and Range sub-provinces is seismically active and a fundamental tectonic element with differences in the timing, magmatism and the onset of extension across it that may be accommodated by strike-slip faults along it. The Pahranagat shear zone (PSZ) in Lincoln County, Nevada is a 20-25 km wide zone of left-lateral faults that lies within the central part of that boundary zone. The Arrowhead Mine Fault (AMF), one of the three major faults in the PSZ, is a Cenozoic, left lateral, strike-slip fault at which more typical Cenozoic normal faults terminate. The purpose of this research is to determine whether the normal and strike-slip faults represent two distinct periods of deformation or, alternatively, a regional transfer zone, with normal faults kinematically linked along the transfer fault. This determination requires geometric data and crosscutting relations, which are best documented through field mapping. Consequently, 1:12,000 scale mapping with emphasis on fault crosscutting, termination, and kinematic relationships of the AMF and normal faults in the western part of the Pahranagat Range was done. Mapped geometries show three fault sets: NNE-striking normal, NW-striking normal and NE-striking left lateral. Two episodes of deformation are apparent from map data, a first set of NW-striking normal faults formed before the AMF due to kinematic incompatibility. Mapped geometries and associated analysis suggests that one NNE-striking normal fault set and the NE-striking left-lateral faults of the AMF formed synchronously based on kinematic compatibility of fault kinematics and orientations from slickenline and geometric data. Both the AMF and the NNE-striking normal faults that end at the AMF cut the 14 Ma Kane Wash Tuff making them both younger than 14 Ma. These age relations and the kinematically compatible geometries of the NNE-normal and NE-strike-slip faults suggest that the fault system is a transfer zone. These findings indicate that transfer faults play a significant role in structural

development of the NBR-CBR boundary. This new kinematic interpretation of the AMF lays the foundation for our understanding of strike-slip faults in the boundary zone. It also indicates that extension in the boundary zone between NBR and CBR was active after 14 Ma and may still be relatively active, which is consistent with modern seismicity near it.

References Cited

Jayko, A.S., 2007, Geologic Map of the Pahranagat Range 30'x60' Quadrangle, Lincoln and Nye Counties, Nevada, Scale 1:100,000.

Taylor, W., and D. Switzer, 2001, Temporal changes in fault strike (to 90°) and extension directions during multiple episodes of extension: An example from eastern Nevada: Geological Society of America Bulletin, v. 113, p.743-759.

Tschanz, C.M., and E.H. Pampeyan, 1970, Geology and mineral deposits of Lincoln County, Nevada: Nevada Bureau of Mines and Geology Bulletin 73, 188 p.

Wernicke, B., 1992, Cenozoic extensional tectonics of the U.S. Cordillera: The Geology of North America, The Cordilleran Orogen: Conterminous U.S., p. 553-581.

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Michael Evans
Dr. Wanda Taylor
University of Nevada, Las Vegas

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Pahranagat Range, NV

Significance

-What role do strike-slip faults play in Basin and Range extension?

-How does the AMF fit into the regional tectonic setting?

-The Pahranagat Shear Zone (PSZ) marks the transition between Northern Basin and Range and Central Basin and Range

-The PSZ connects active seismic belts

-Seismic hazard?

-Understanding the development of strike-slip fault systems and extenstion may aid in hydrocarbon play analysis

What is the Arrowhead Mine Fault?

What is the Arrowhead Mine Fault?

The Arrowhead Mine Fault (AMF)

-Quaternary age

-Strike-Slip

-Left-Lateral

-3 miles (4.8 km) offset (Jayko, 2007)

Tectonic Setting

-Basin and Range

-Transition zone between CBR and NBR (Wernicke, 1992)

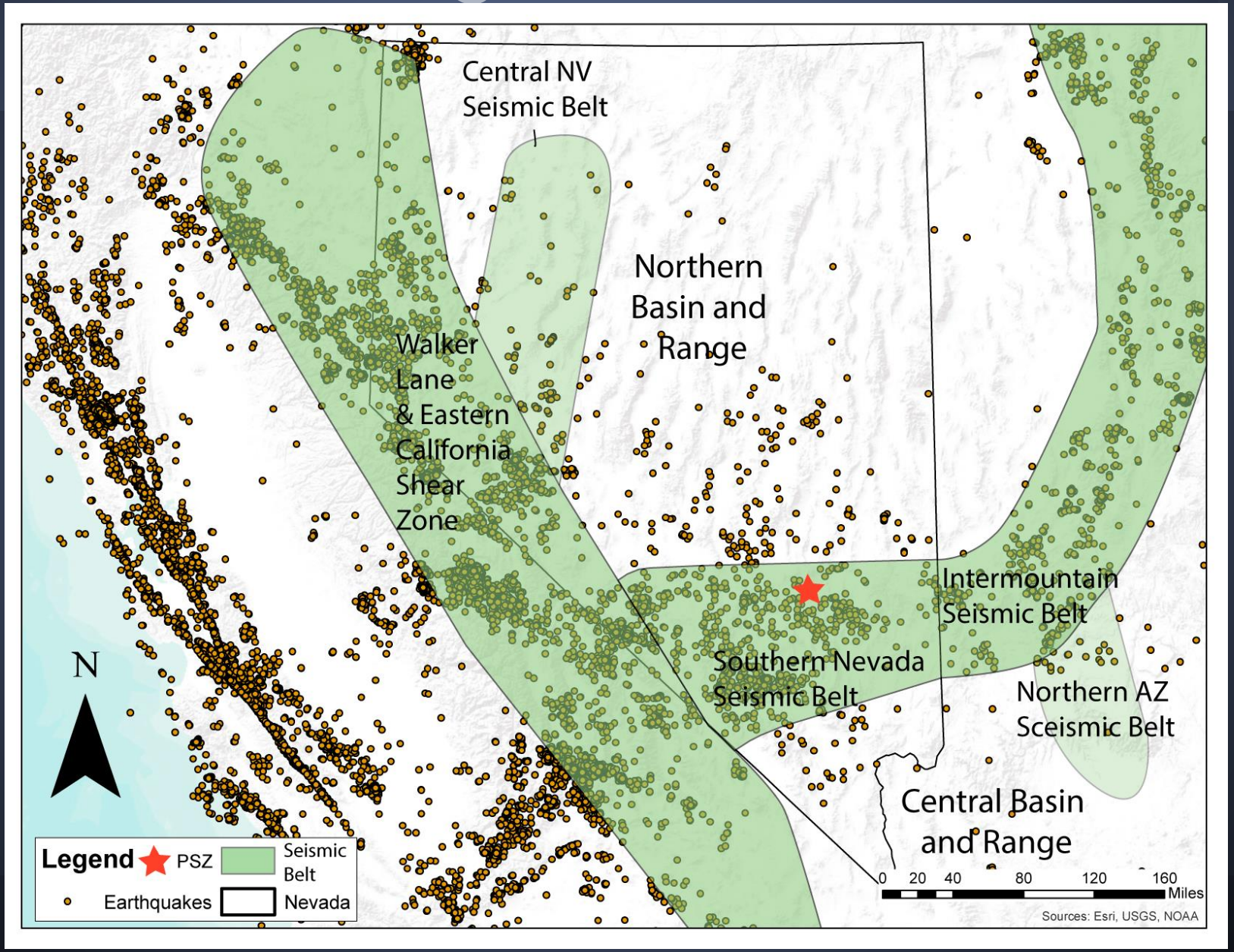
-Mesozoic Sevier Thrusts

-Cenozoic Extension

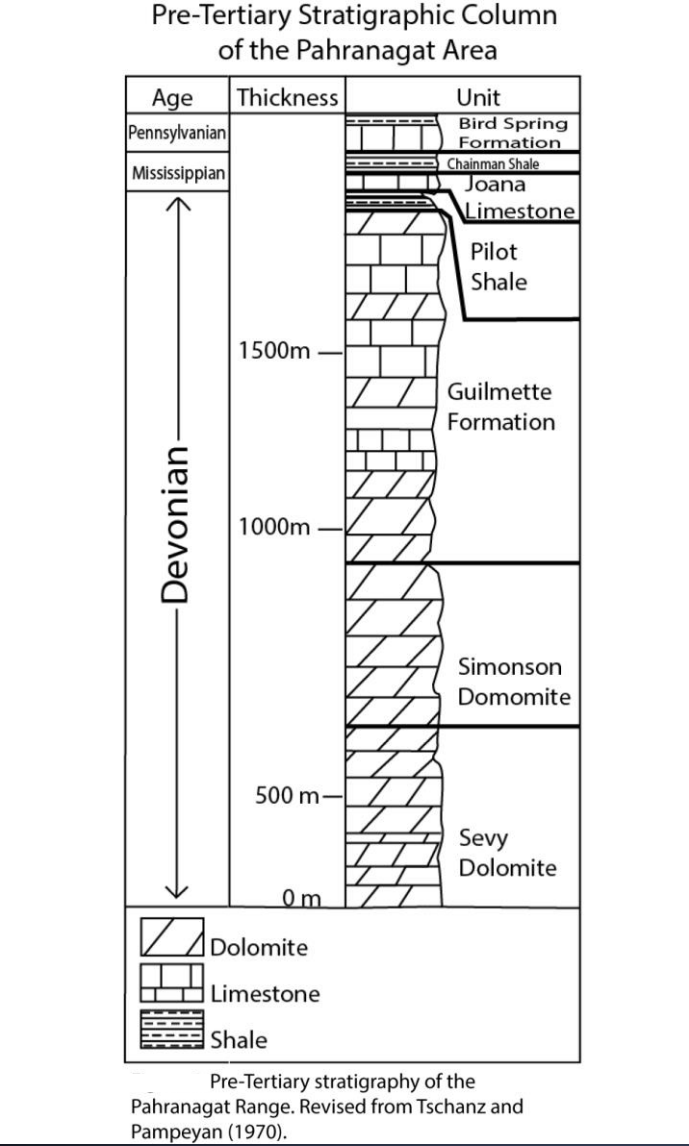
-Pahranagat Shear Zone

-Quaternary Faults

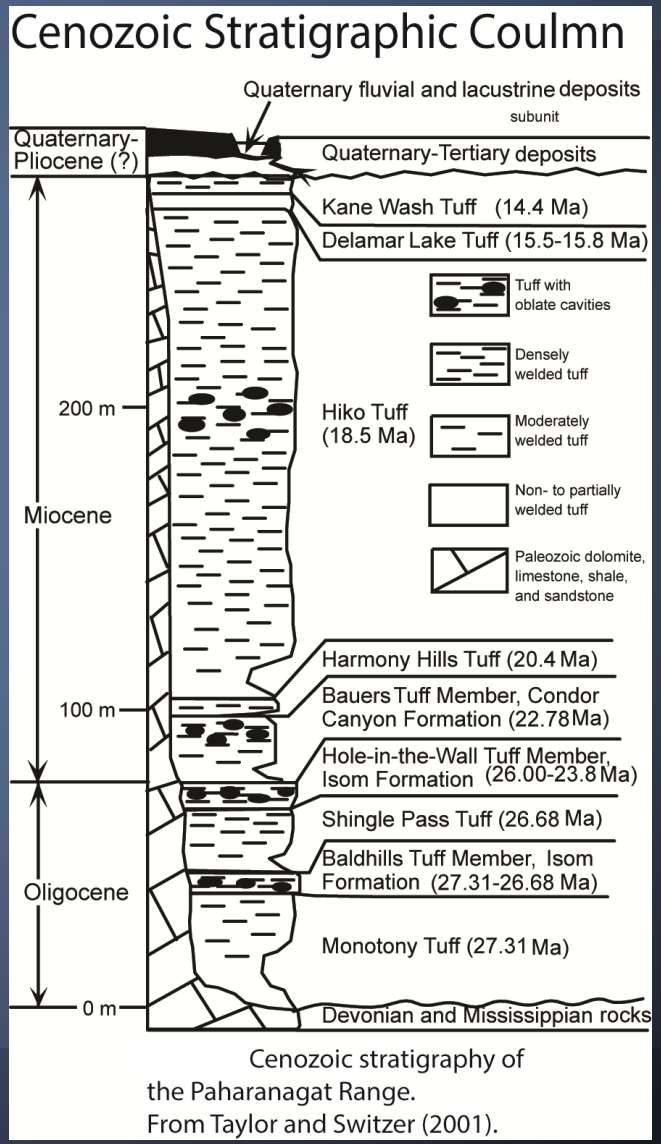
Tectonic Setting



Stratigraphy

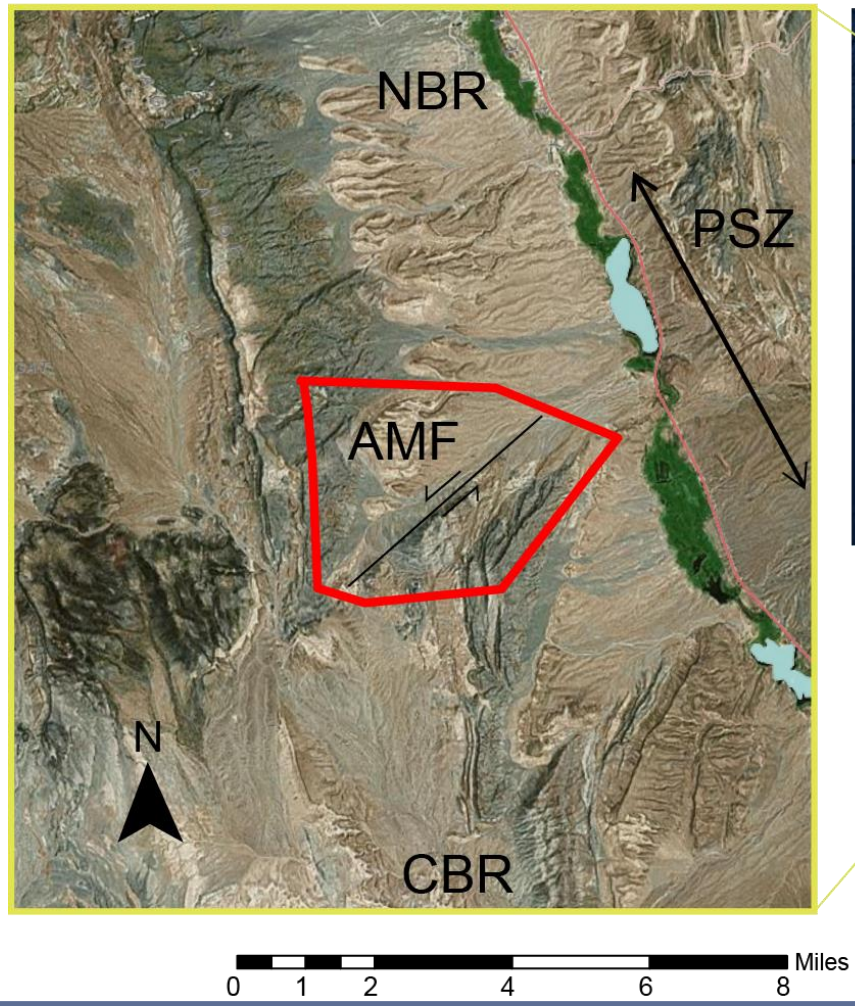


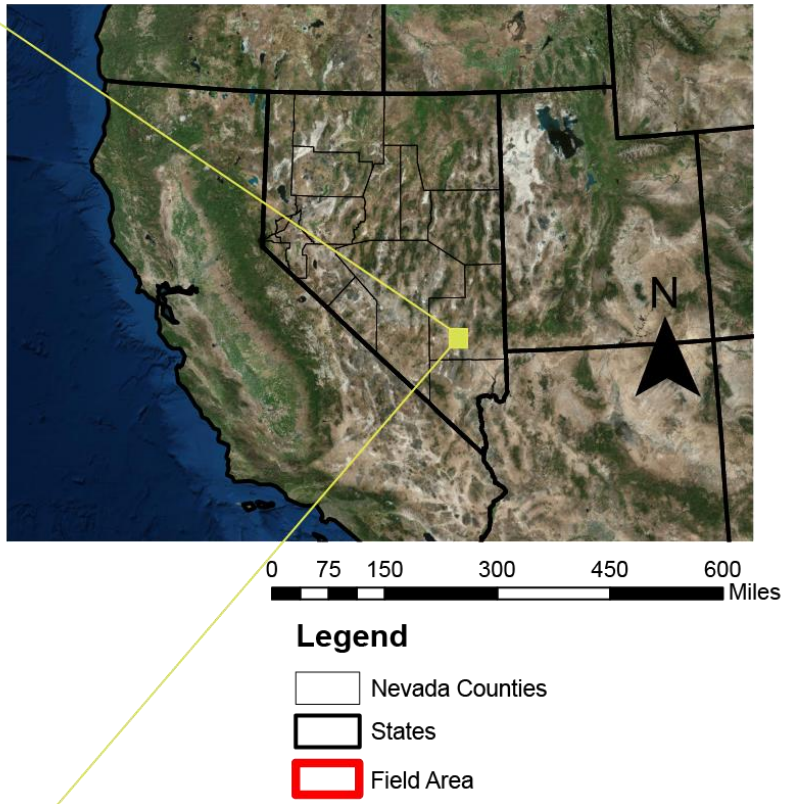
Pre-Tertiary stratigraphy of the Pahranagat Range. Revised from Tschanz and Pampeyan (1970).



Cenozoic stratigraphy of the Paharanagat Range. From Taylor and Switzer (2001).

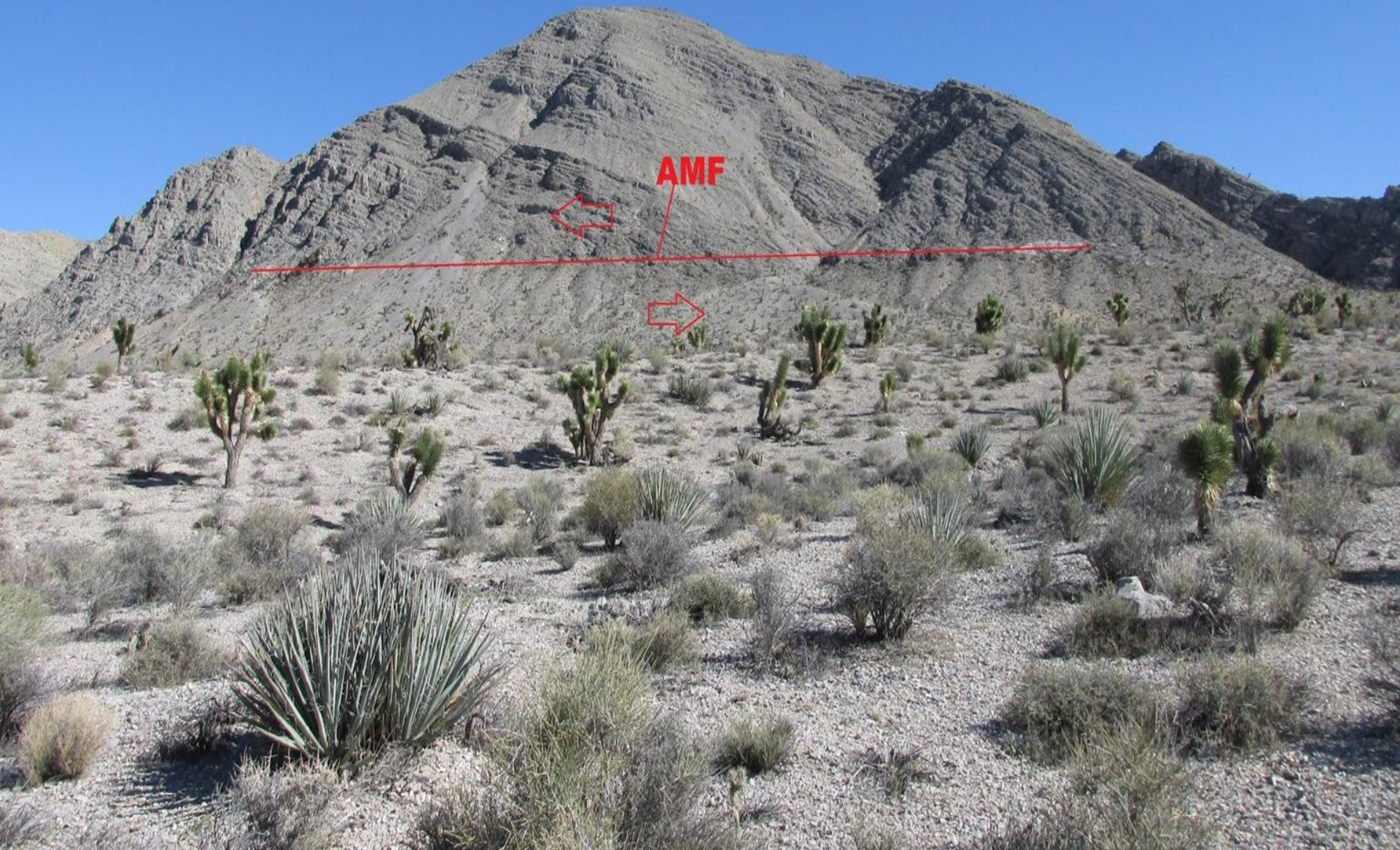
Location Map of the AMF in the PSZ






AMF

Low Mountain Front Sinuosity



Possible interpretations of the AMF

-Jayko (2007) showed normal faults on both sides of the AMF

-Accommodation Zone

- -Differences in strain between north and central B&R
- -Cut by a strike-slip fault

-Transfer Fault

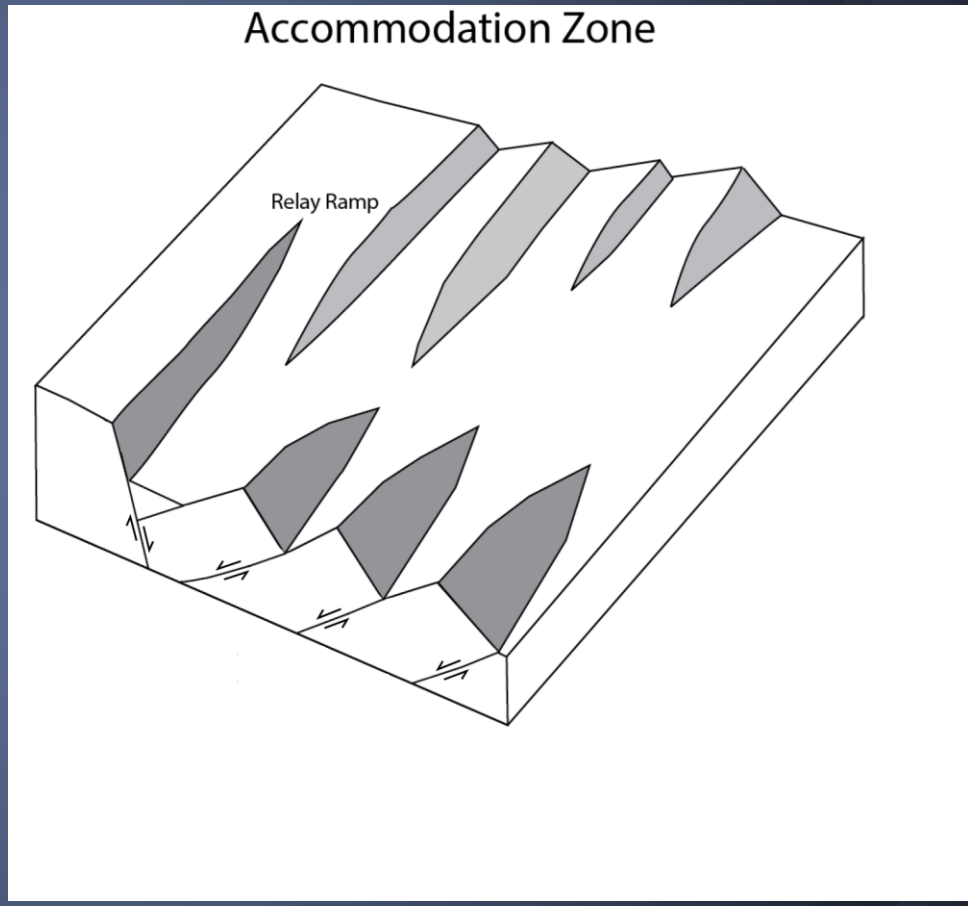
- -Termination zone for normal faults
- -Kinematically compatible

Accommodation Zone

-Accommodates differences in strain and/or timing between CBR and NBR

-If the AMF is an Accommodation zone, we expect to see relay ramps and folds in the geologic map data

-In this case, the AMF is a younger strike-slip fault cutting a pre-existing accommodation zone



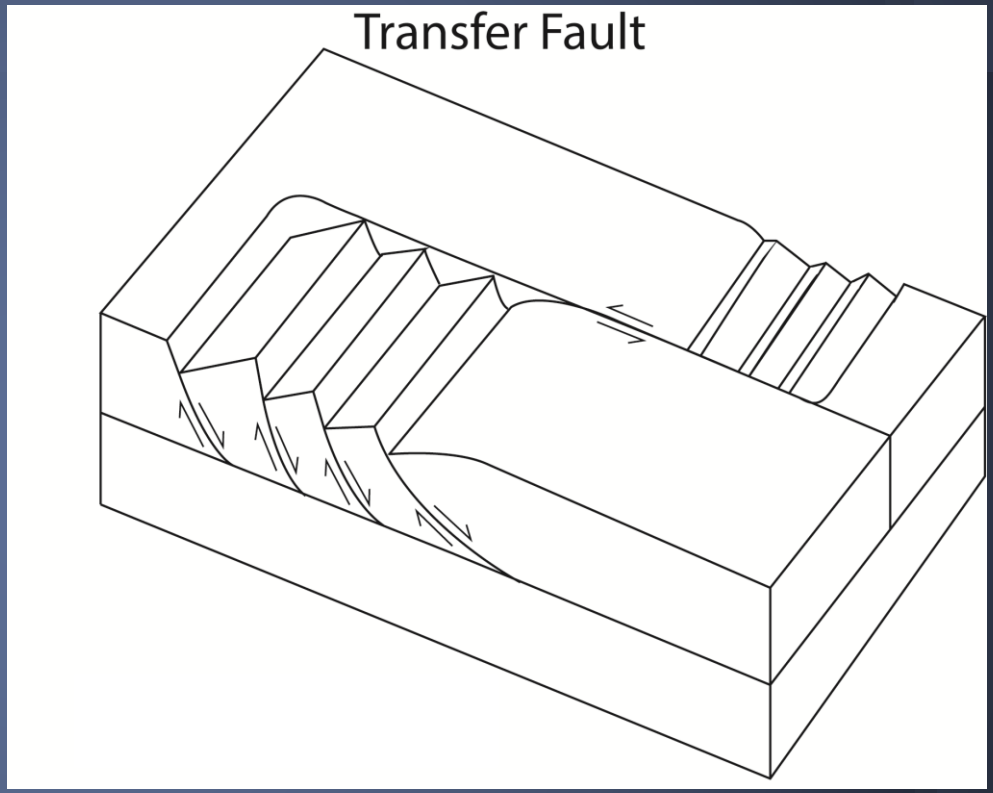
Transfer Fault

-Termination area for normal faults where they are linked together

-Connects the normal faults, strikes normal to the strike of the normal faults, accommodates movement between offset normal faults

-If the AMF is a transfer fault we will see a series of kinematically compatible normal faults connected and terminating into the strike-slip fault

-The strike-slip fault and the normal faults formed synchronously and within the same stress field



Field Work

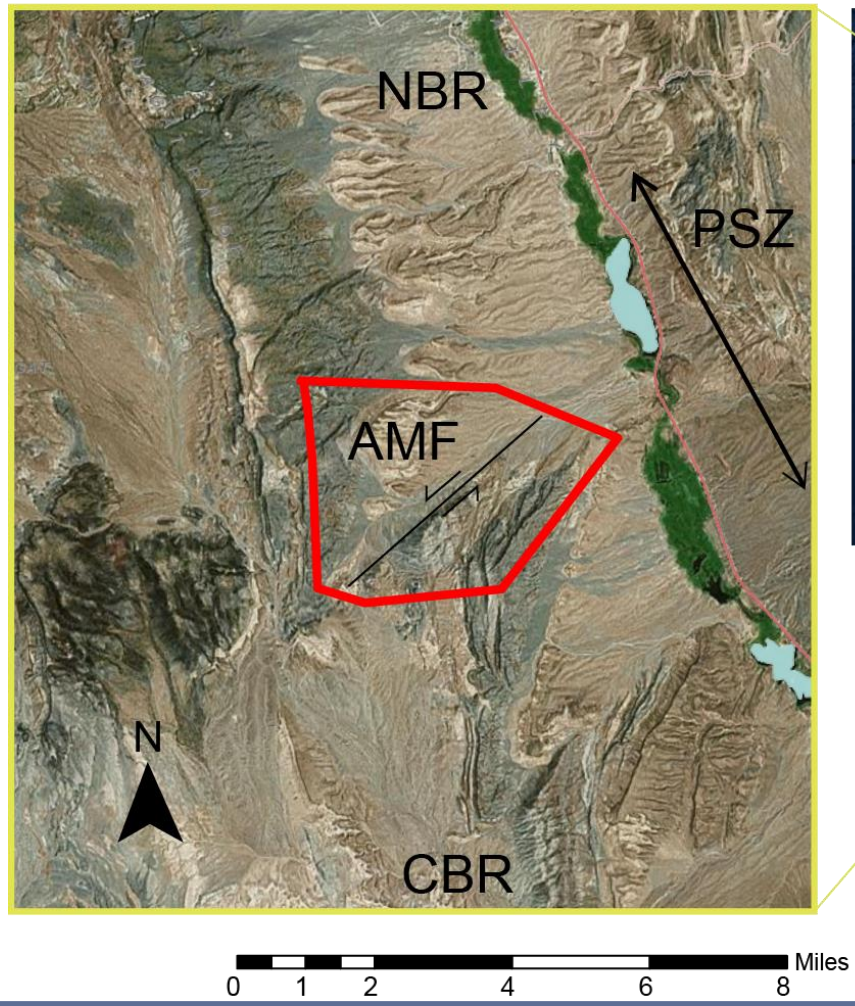
-Mapping at 1:12,000

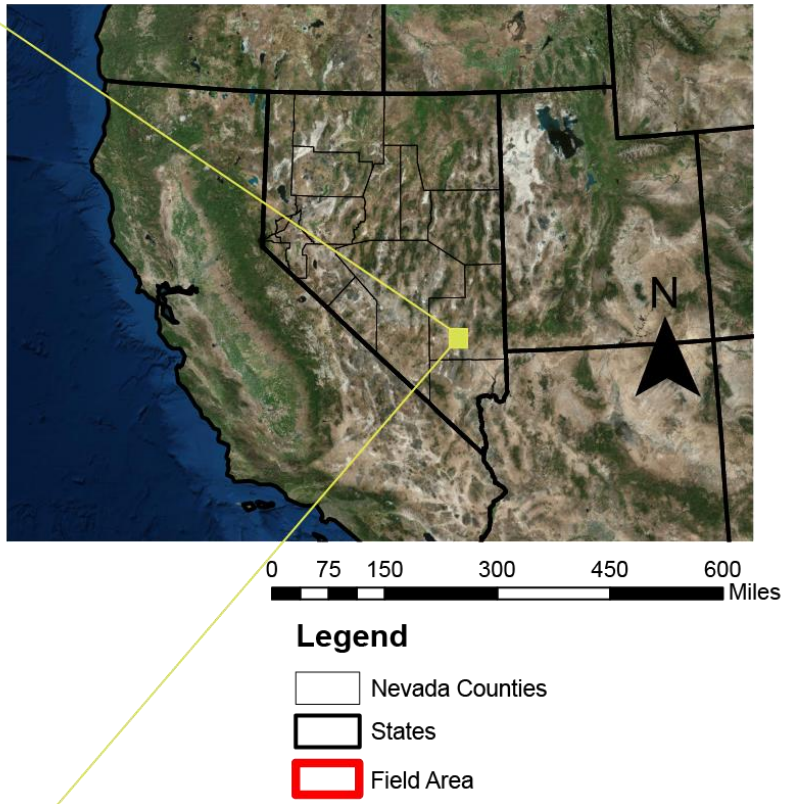
-10 mi^2 area

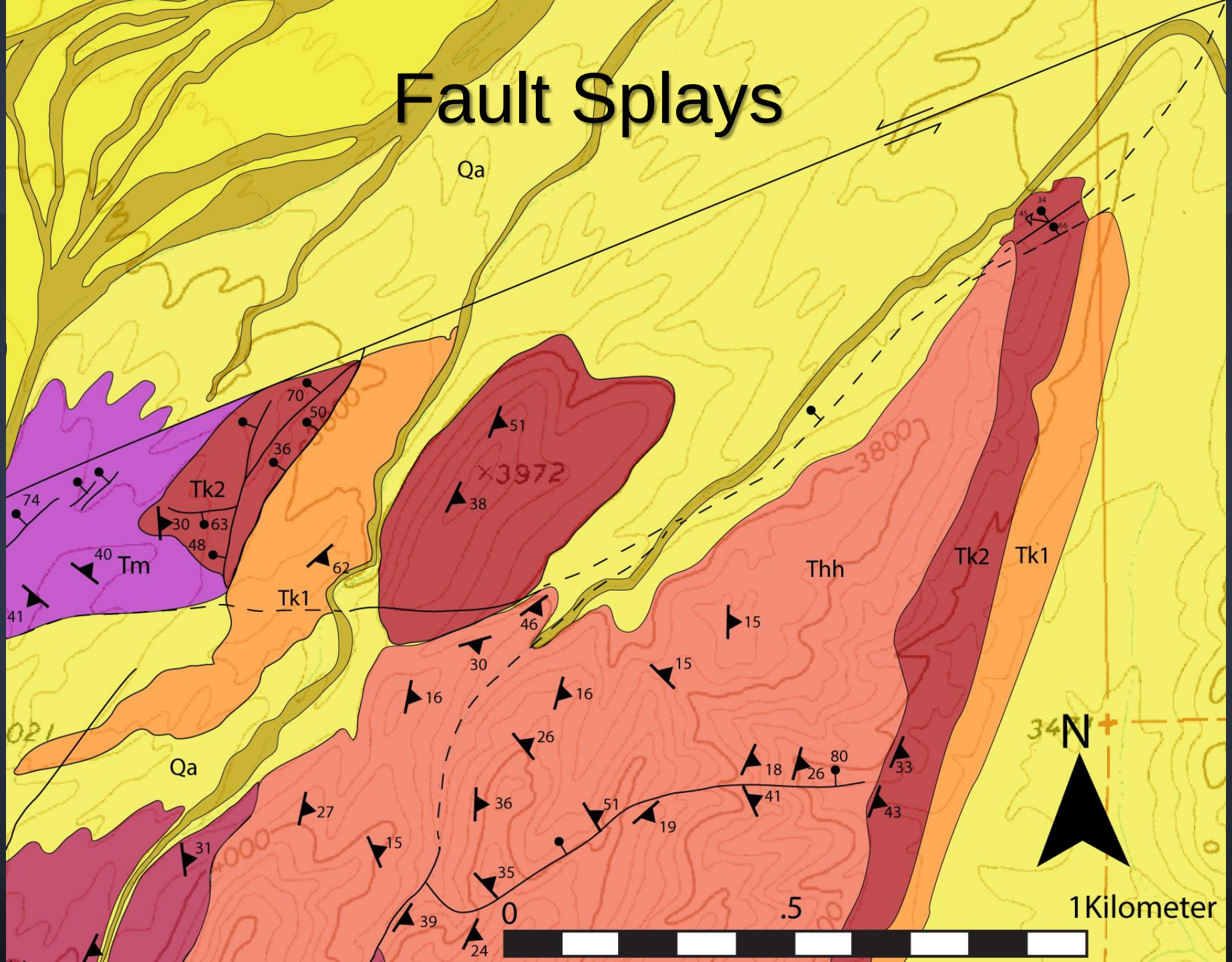
-Stereographic analysis

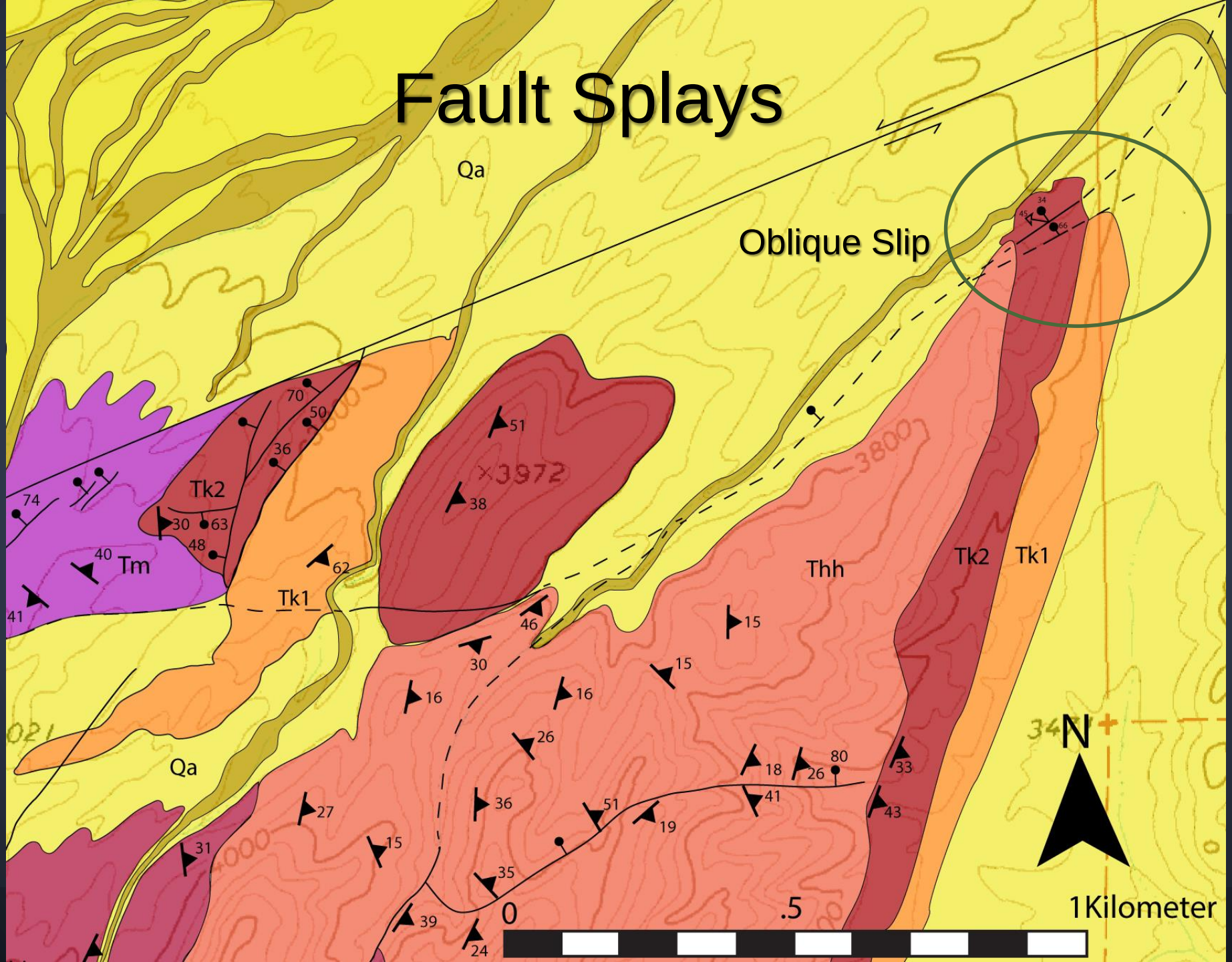
-Fence diagram composed of 6 cross sections

Location Map of the AMF in the PSZ



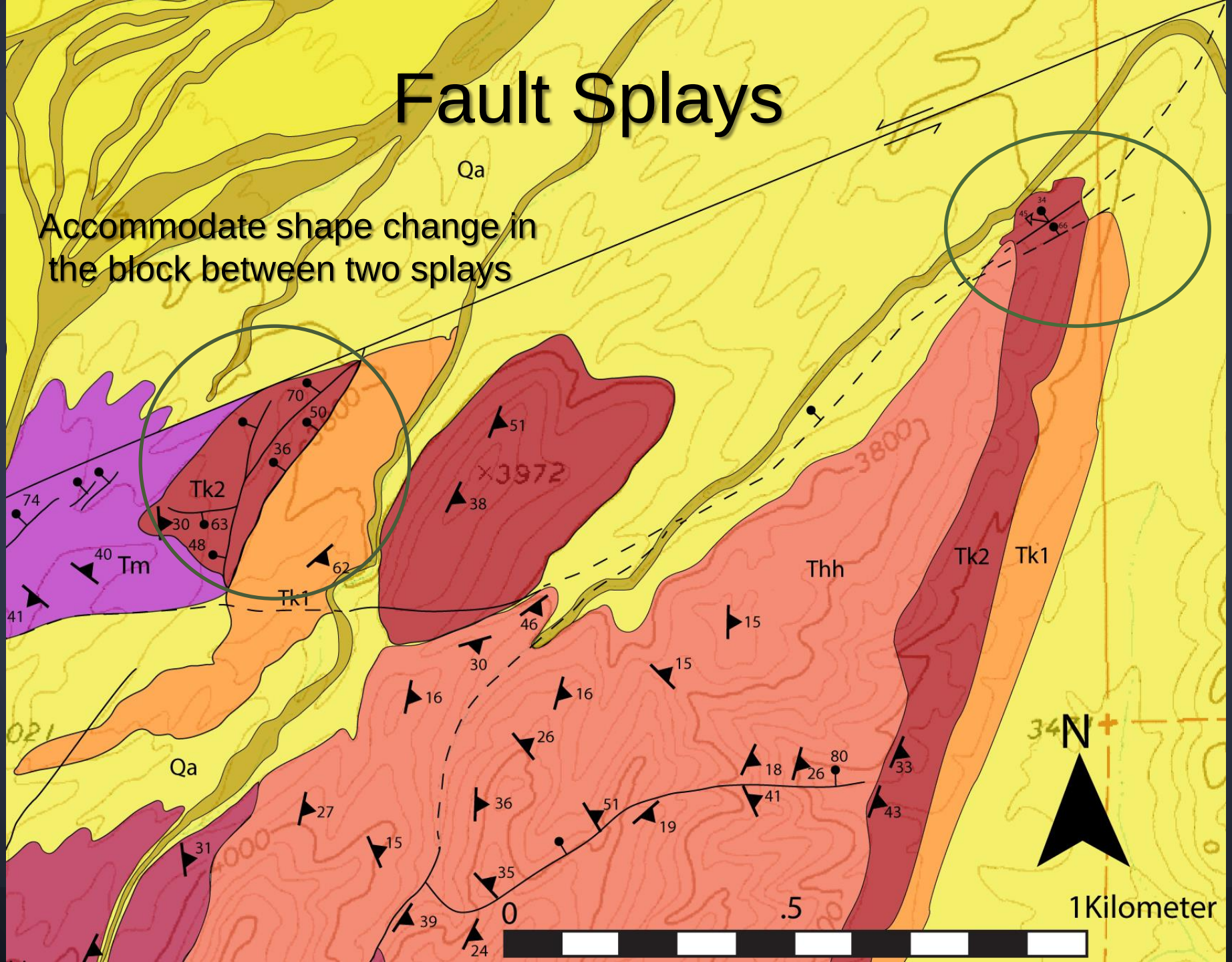



Fault Splays
Qa
Tk2
Tk1
Tm
Thh
Qa
70
50
36
74
30
63
48
40
62
41
51
38
46
30
15
16
16
26
15
18
26
80
33
41
43
36
51
19
27
15
31
35
39
24
0
.5
1Kilometer
N


Fault Splays
Qa
Oblique Slip
Tk2
Tk1
Tm
Thh
Qa
N
0
.5
1Kilometer

Fault Splays

Accommodate shape change in the block between two splays



Tk2
Tk1
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70
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39
24
16
N
0
.5
1Kilometer

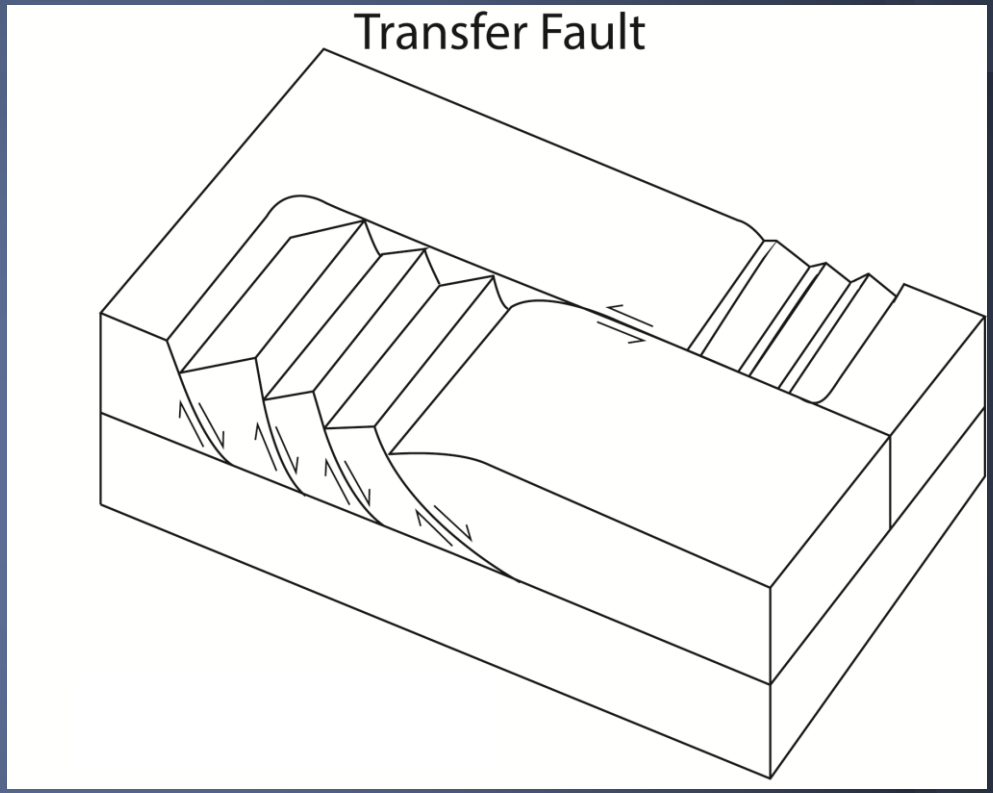
Transfer Fault

-Preliminary anaylsis indicatesthat faults within the 14 Ma Kane Wash Tuff are kinematically compatible with the AMF

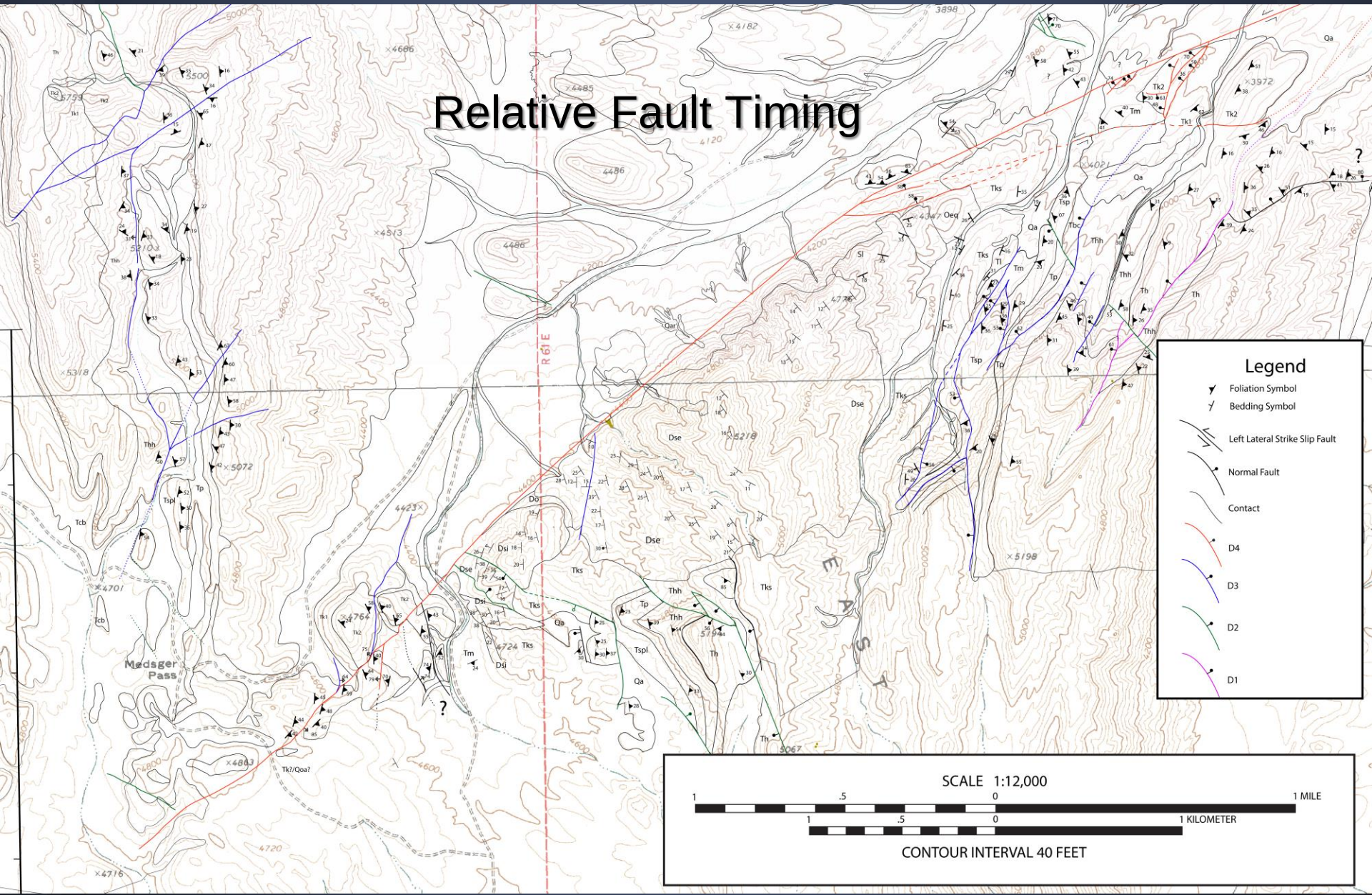
-Termination area for normal faults where they are linked together

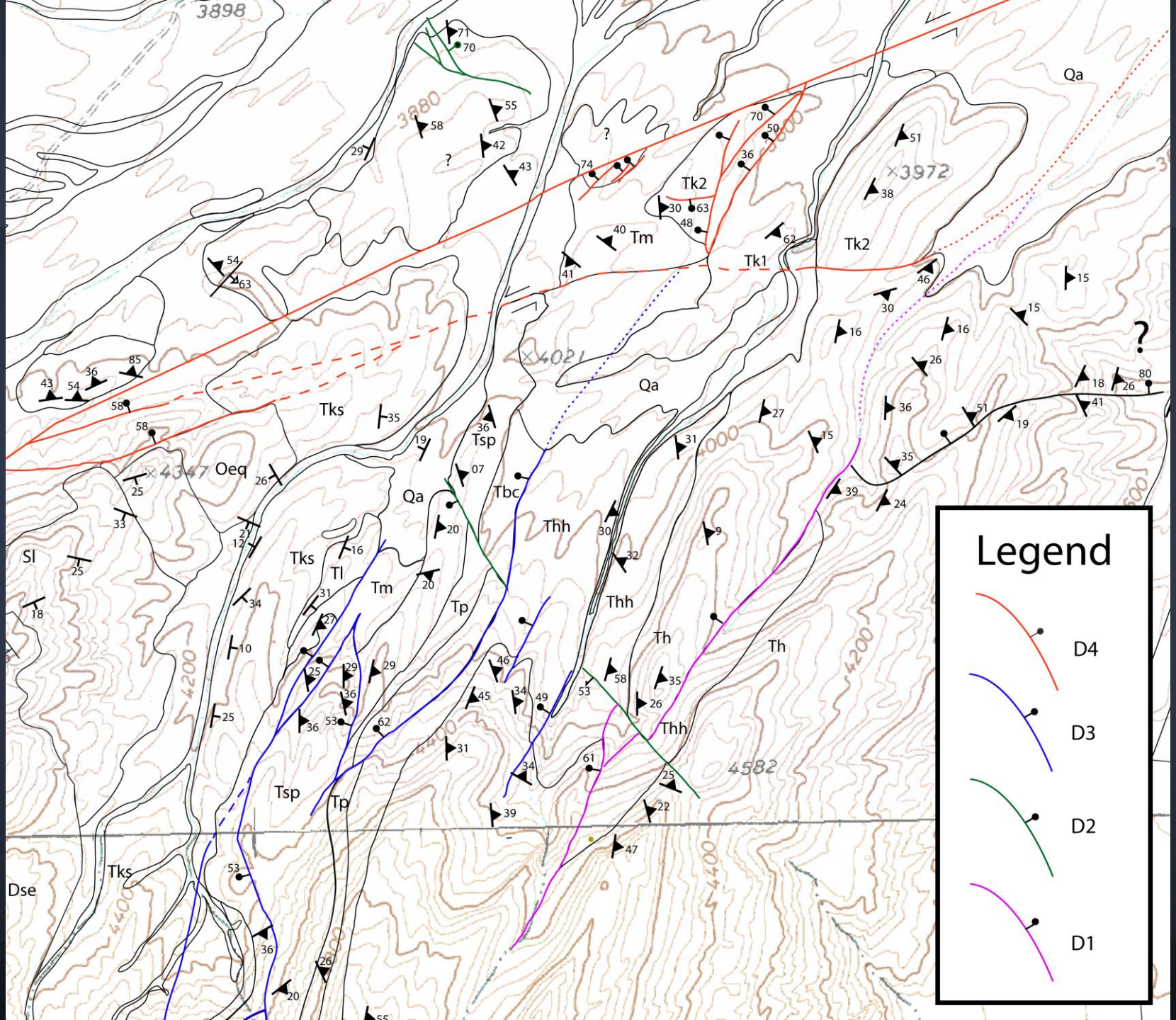
-The AMF is a transfer fault since we see a series of kinematically compatible normal faults connected and terminating into the strike-slip fault

-This is the youngest deformation in the area



Relative Fault Timing




Legend
D4
D3
D2
D1
Qa
Tk2
Tk1
Tm
Tks
Tsp
Tbc
Thh
Th
Tp
Tl
Sl
Oeq
Dse
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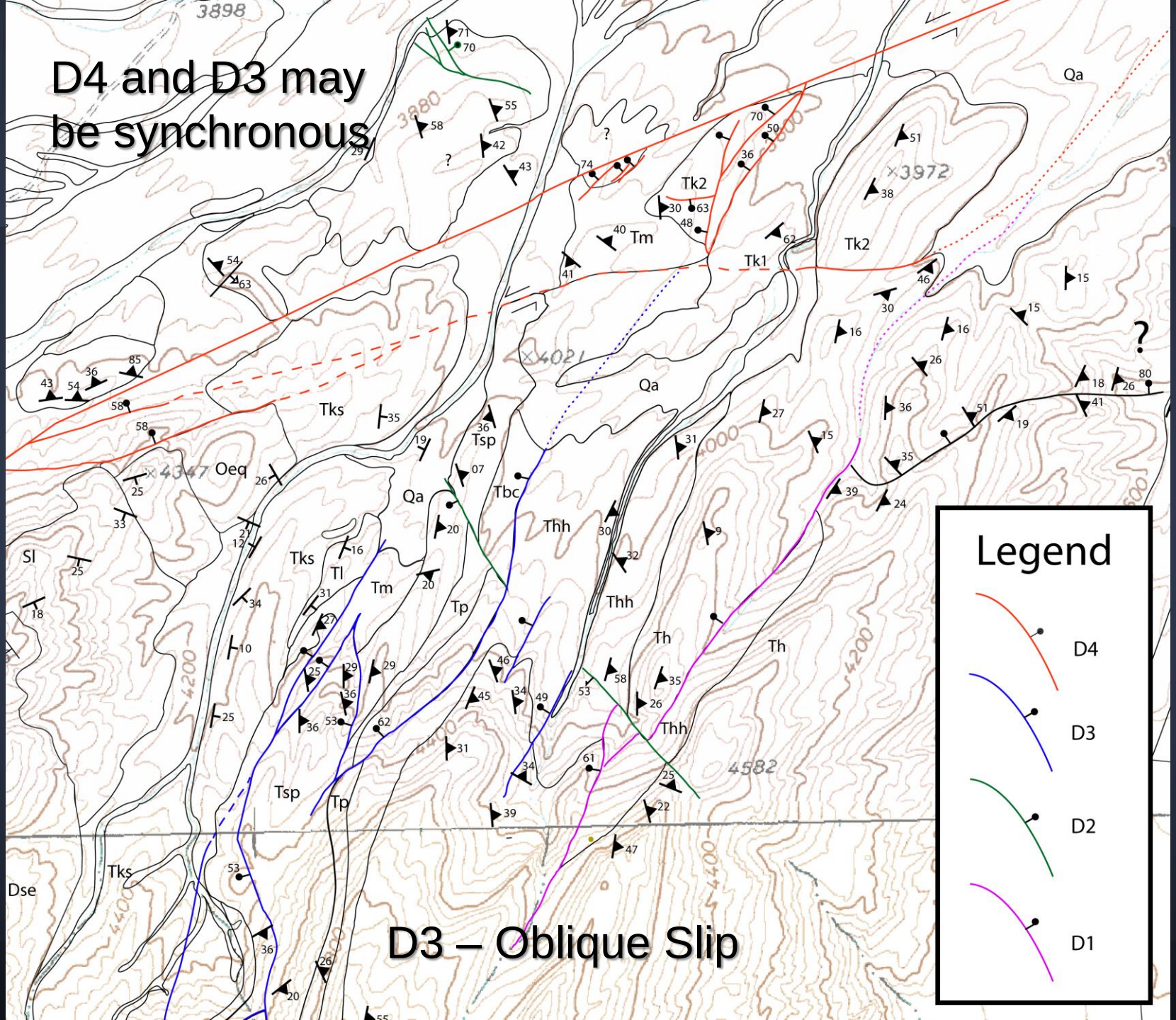
3880
3800
3972
4021
4347
4200
4400
4582


D4 and D3 may be synchronous
Legend
D4
D3
D2
D1
D3 – Oblique Slip
Qa
Tk2
Tk1
Tm
Tks
Tsp
Tbc
Thh
Th
Tp
Tl
Oeq
Sl
Dse
3898
3880
4021
3972
4347
4200
4582
4400

Summary

-The AMF is a transfer fault

-2 splay S-S in E

-3-4 faulting events with AMF being the youngest

- The PSZ may pose a seismic hazard to southern Nevada due to recent earthquakes

-Strike slip fault with normal faults as a transfer sytem over printed 2 sets of older faults

Acknowledgements

Thanks to:

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