Kinematics and Timing of Deformation of Nellis Dunes Recreational Area, Nevada*

Shaimaa Abdelhaleem[1] and Wanda J. Taylor[1]

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Abstract

Kinematics and origin of transfer, accommodation and strike-slip zones is of paramount significance in understanding the kinematic models of continental extension. The Las Vegas Valley Shear Zone (LVVSZ) is a NW-striking right-lateral fault system in the central Basin and Range province. Despite its prominence among the structures of the region and its role in the regional tectonic development, little is understood about its eastern portion. Nellis Dunes Recreational Area (NDRA), north of Frenchman Mountain, lies along the eastern part of LVVSZ. The area exposes structures, the Muddy Creek Formation and Quaternary deposits. Previous mapping suggested that the area under the NDRA formed as a pull-apart basin between the LVVSZ in the northern part of the area and the Munition fault that lies to south and bounds the northern end of the Frenchman Mountain block. However, some structural geometries are inconsistent with the regional pull-apart basin model of Nellis basin. The purpose of this study is to collect and analyze more detailed data and suggest a deformation model consistent with the entire fold and fault geometries. Larger scale mapping (1:8,000) provided complex structural geometries and kinematics. Secondary NE-oriented folds are interpreted to be related to right-lateral strike-slip faults that dominate the northwestern and northeastern parts of NDRA, while the central part is dominated by NW-oriented folds with NE-striking normal faults. Structural analysis showed that area exhibits three different strains. The right-lateral faults are part of the LVVSZ and cut Muddy Creek Formation suggesting that the LVVSZ was active after 4.7 Ma. Later, during the Quaternary, the LVVSZ was cut by NE-oriented left-lateral strike-slip faults with associated folds consistent with the recent NE strain direction. The northern end of Frenchman Mountain fault curves to the NE forming a left-lateral fault splay in the southern part of NDRA. Consequently, NE-striking faults and NW-oriented folds dominated the southern part of NDRA as secondary structures associated with that left-lateral deformation.

Selected References

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PS – AAPG 2015, Oxnard, CA.

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- Study Area: NDRA
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- Methods
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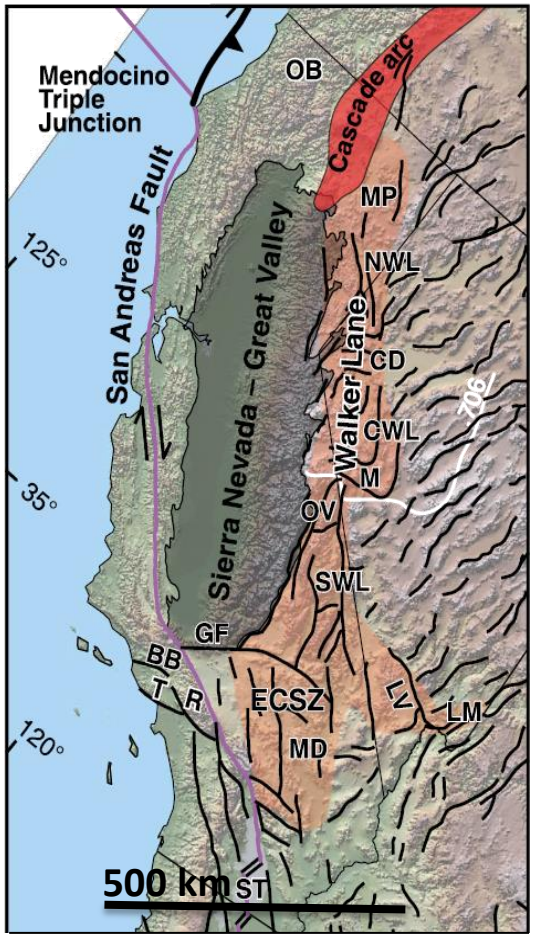

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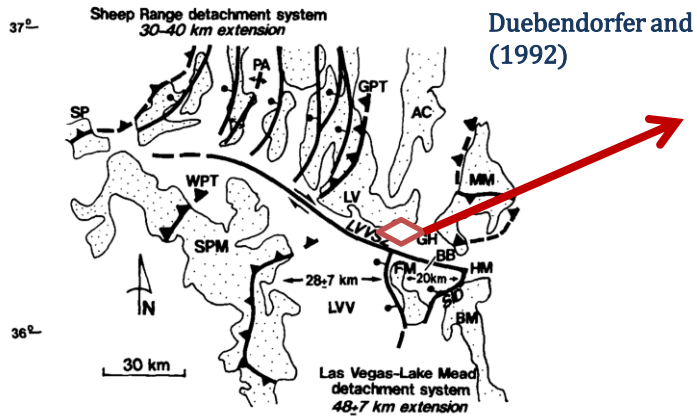
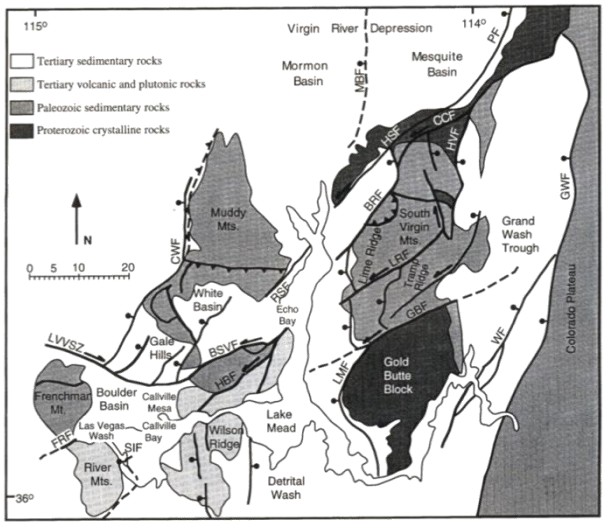


Duebendorfer and Black (1992)

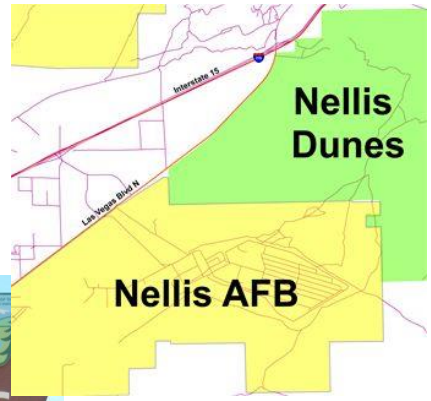
NDRA



Duebendorfer et al. (1998)

LVVSZ

- McLaurin et al. (2011)
- Buck et al. (2011)
- Goossens et al. (2008)
- Beard et al. (2007)
- Ekren (1968)
  - GSA Memoir 110 - Two papers



NDRA

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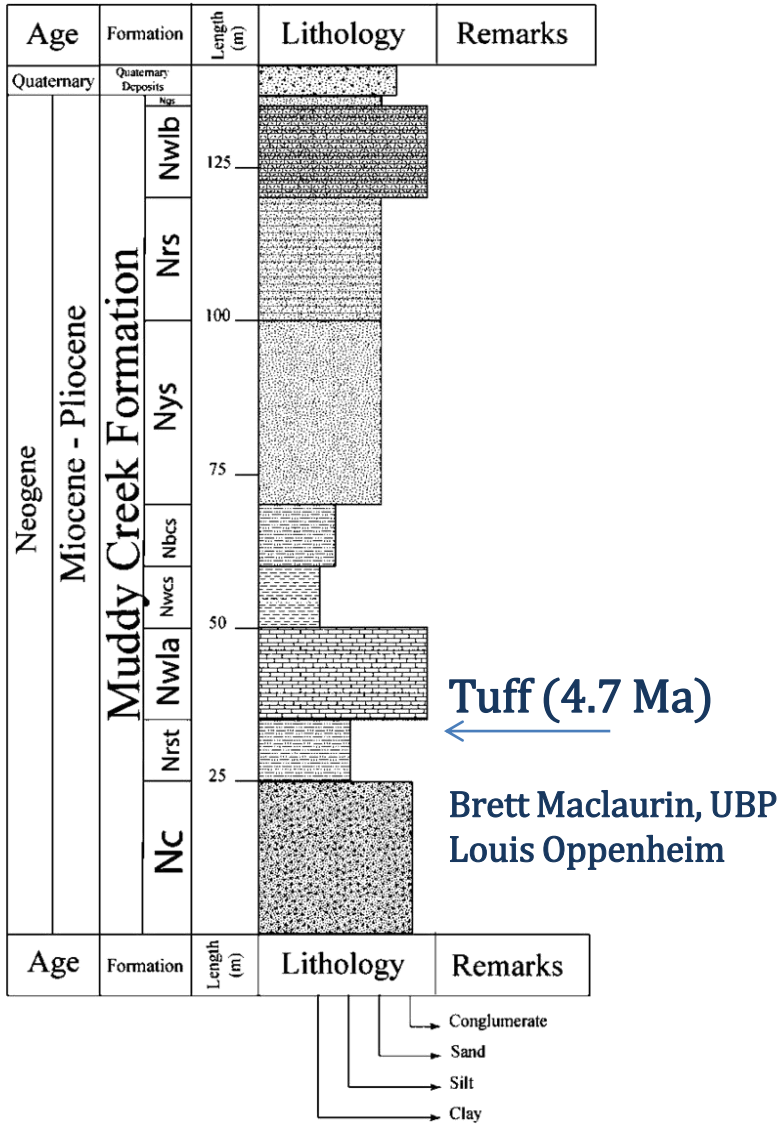
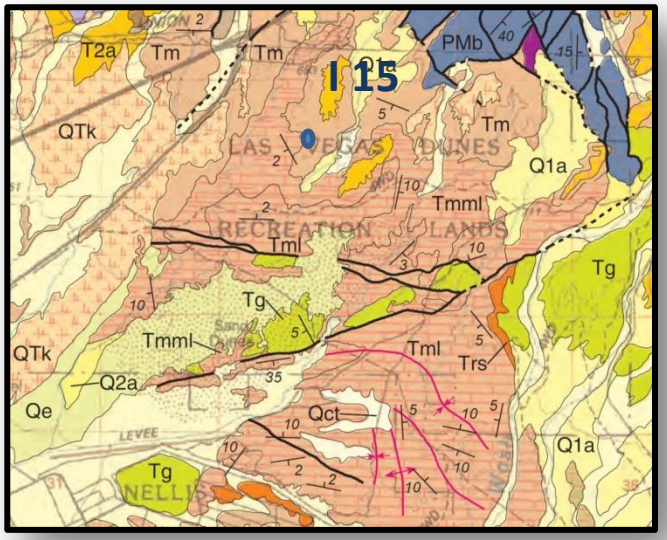
NDRA Stratigraphy

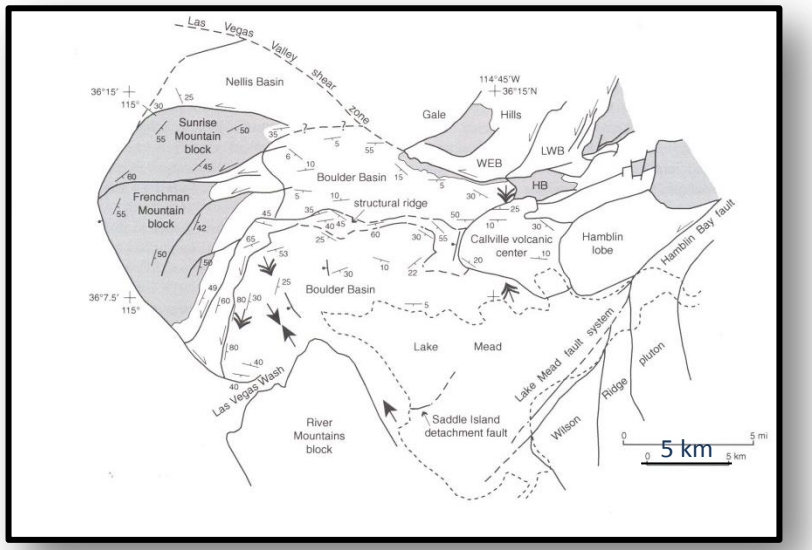
Age range 8.5 - <4.7 Ma



NDRA



Beard et al. (2007)



Anderson and Beard (2010)

Different Maps?!

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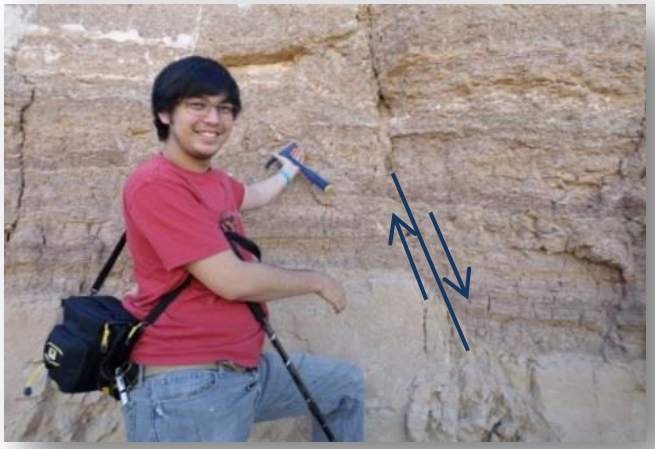

Surprise!

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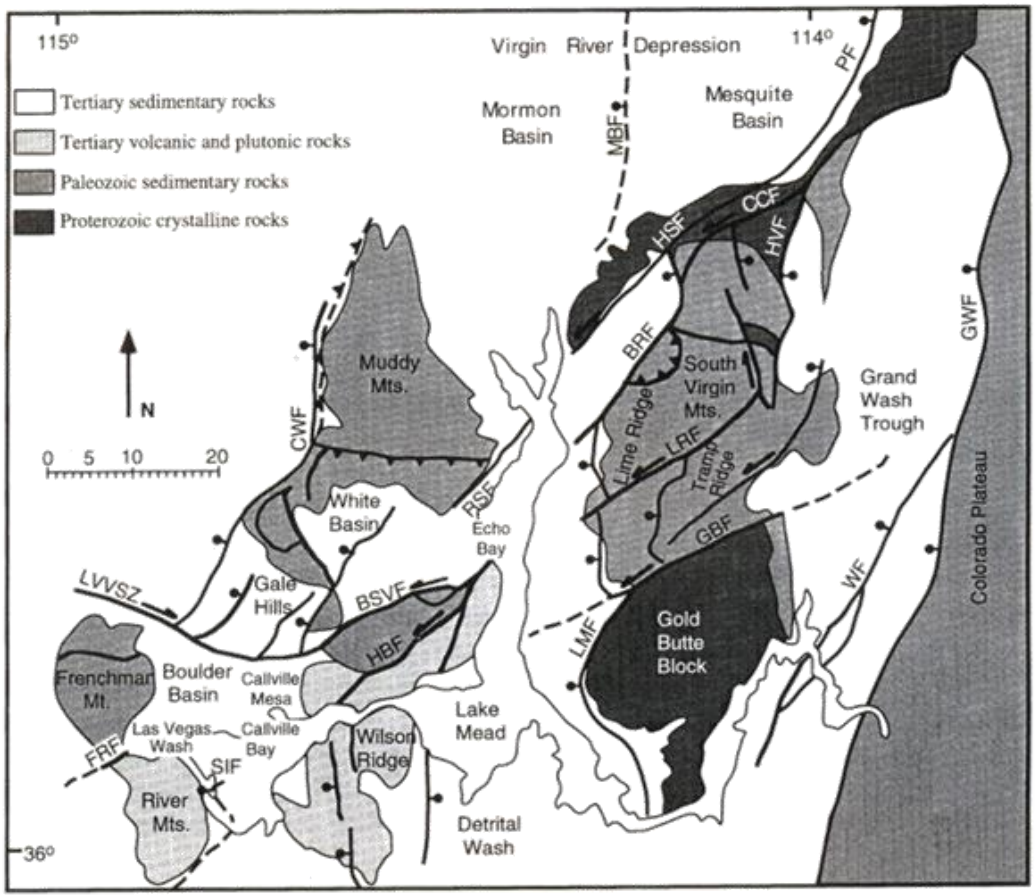

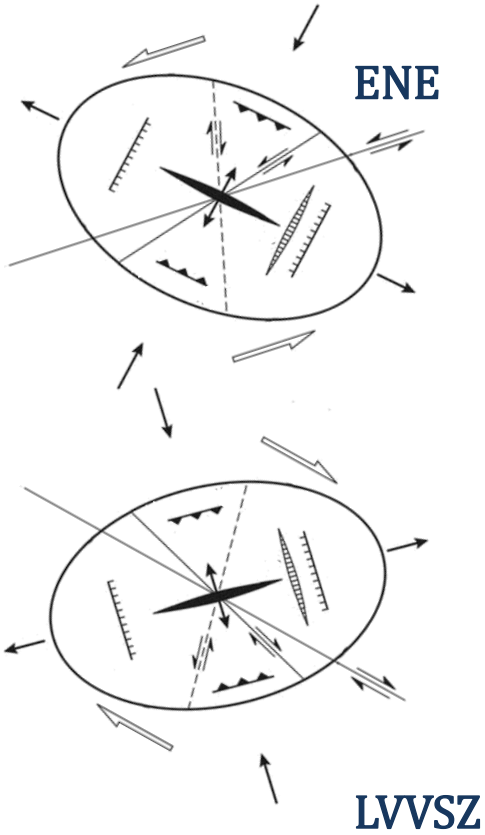

Duebendorfer et al. (1998)

Right-Lateral? LVVSZ?

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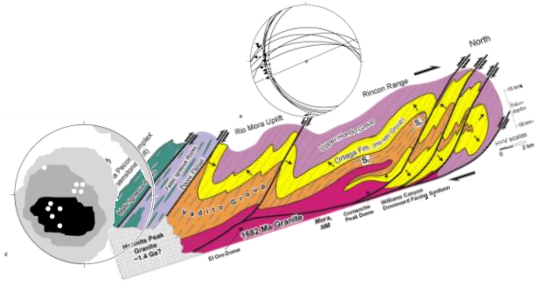
Map

1:12,000
1:8,000



Analyze

Kinematic
Compatability

So we decided ….

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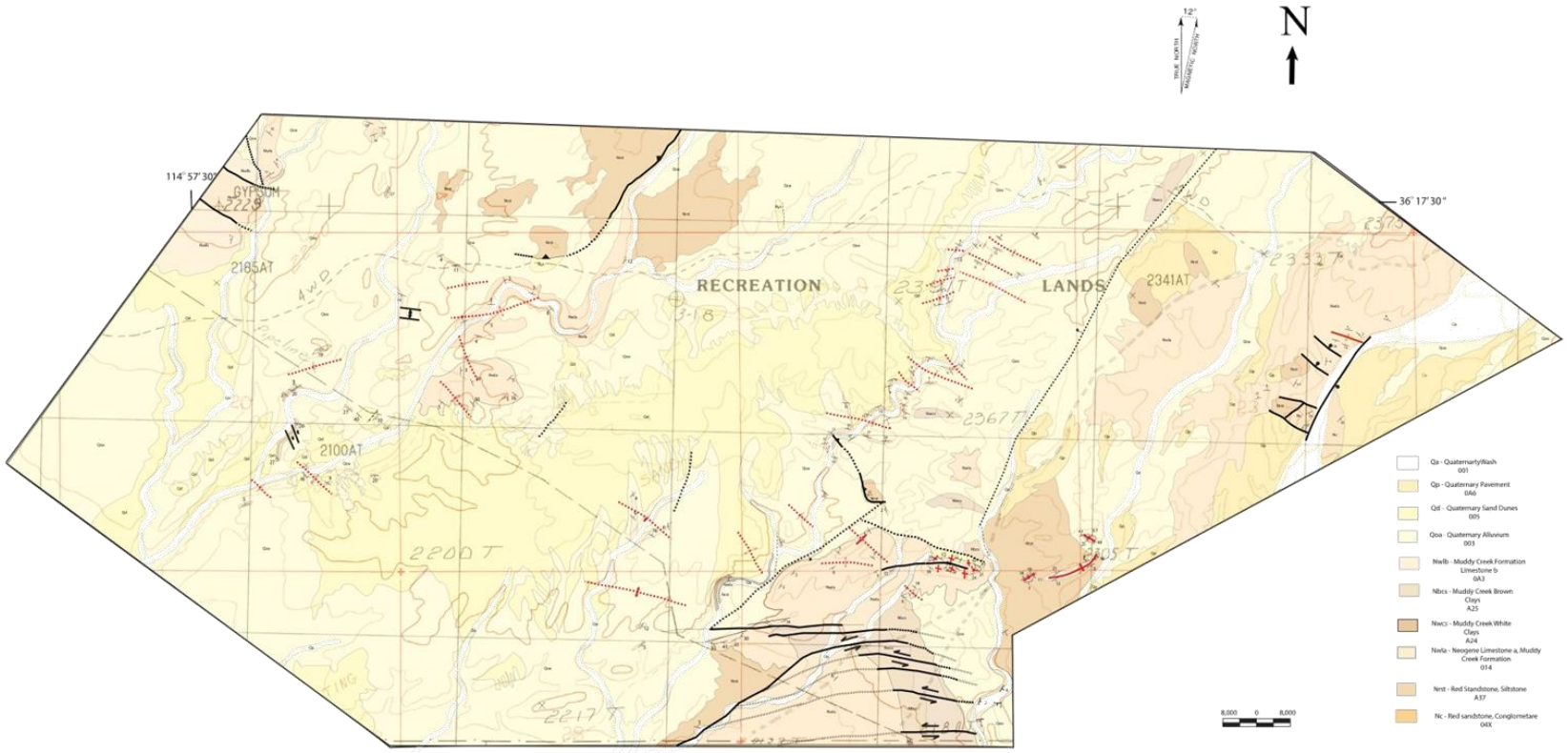

What did we find?

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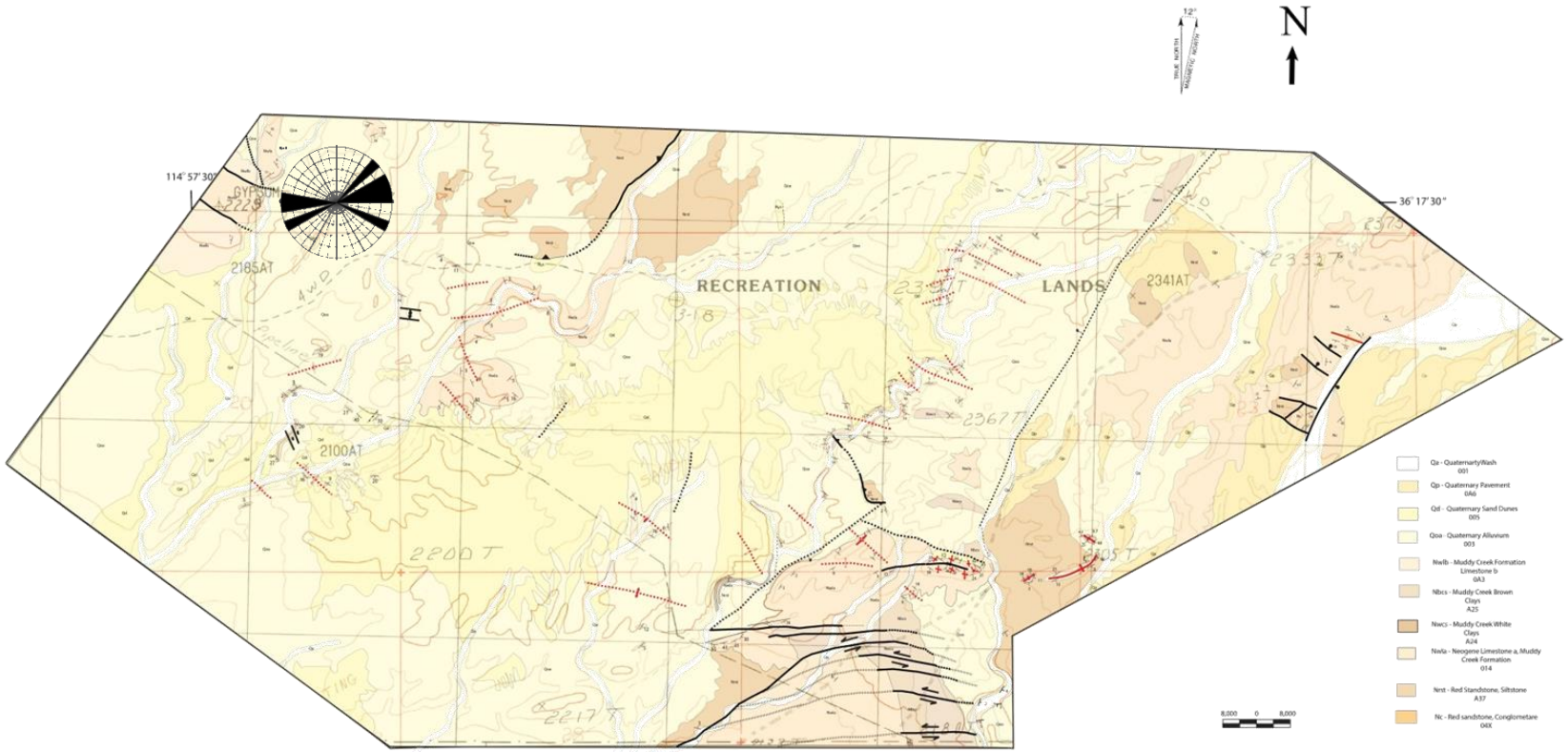

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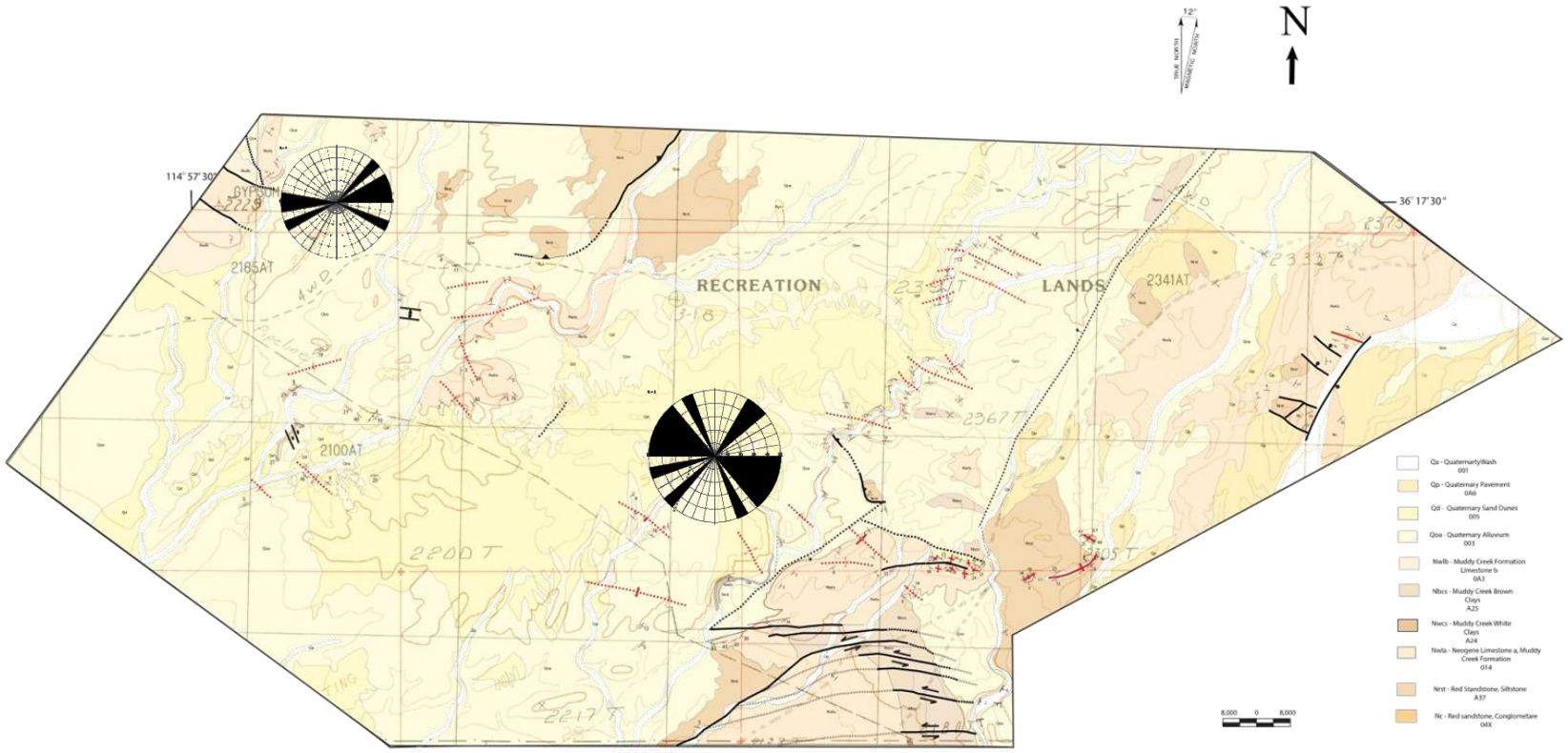

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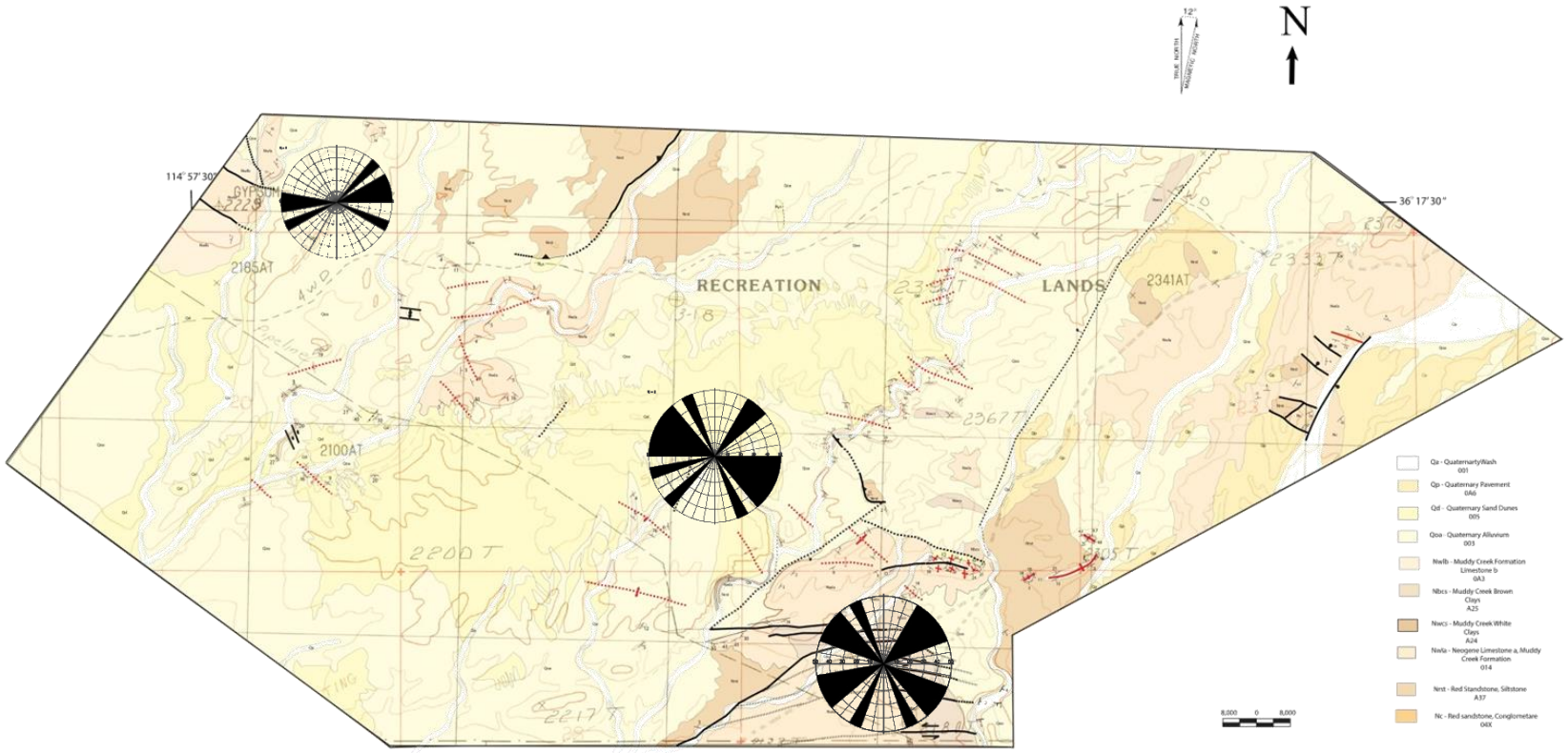

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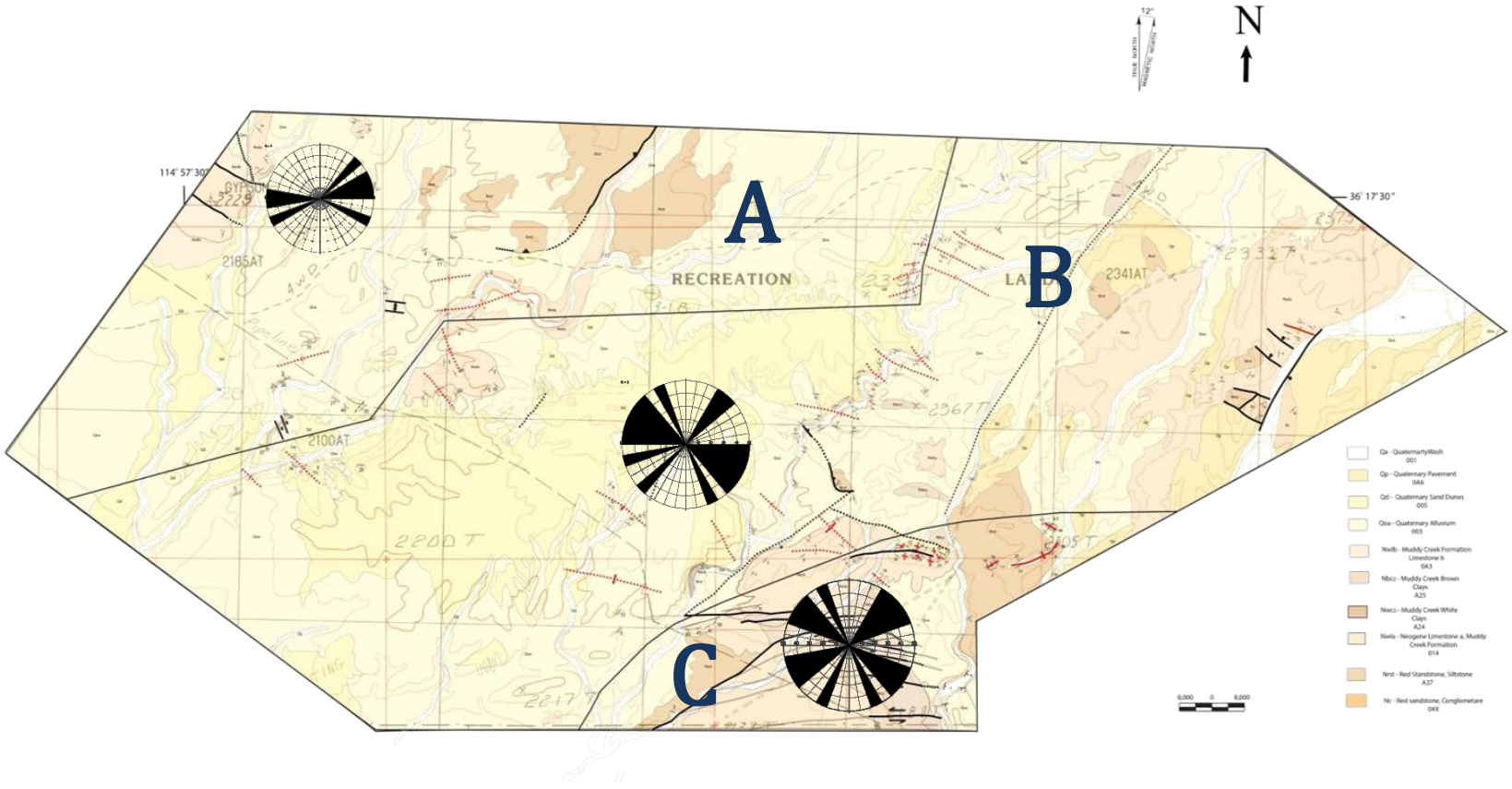

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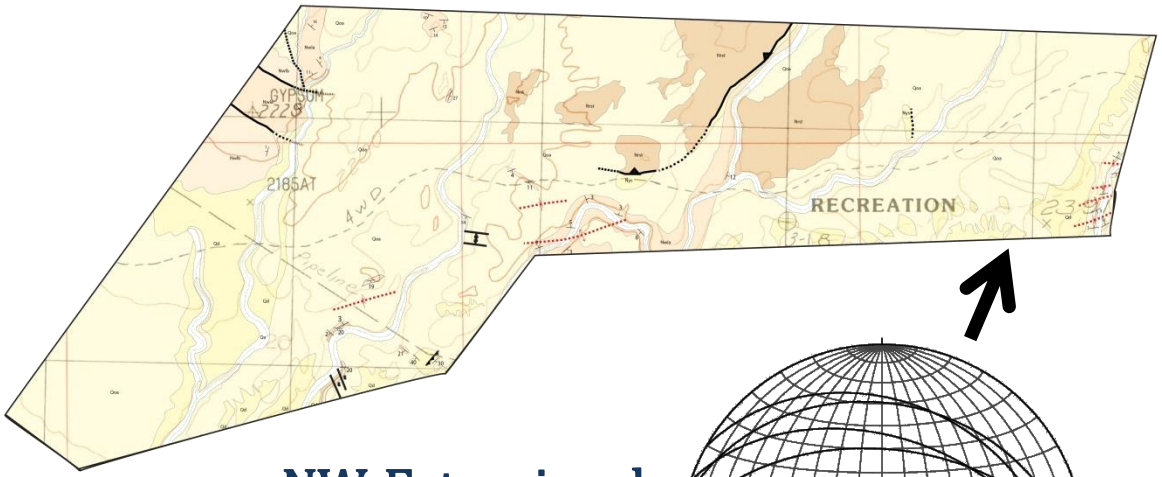
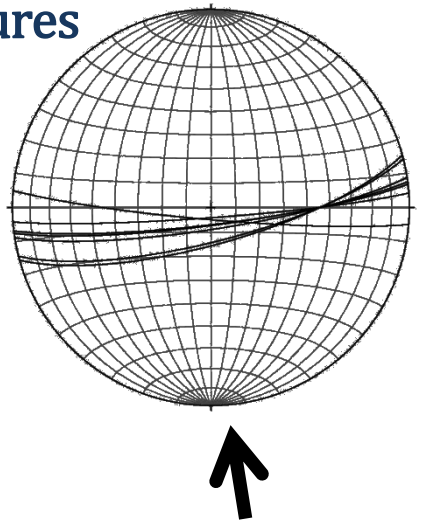
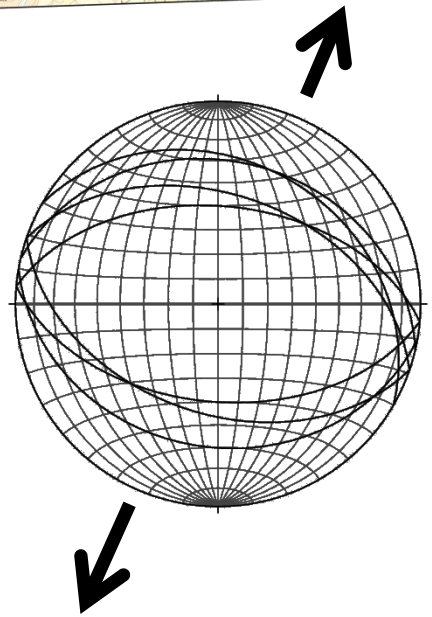


ENE to NE-Compressional Structures



NW-Extensional Structures



Domain A

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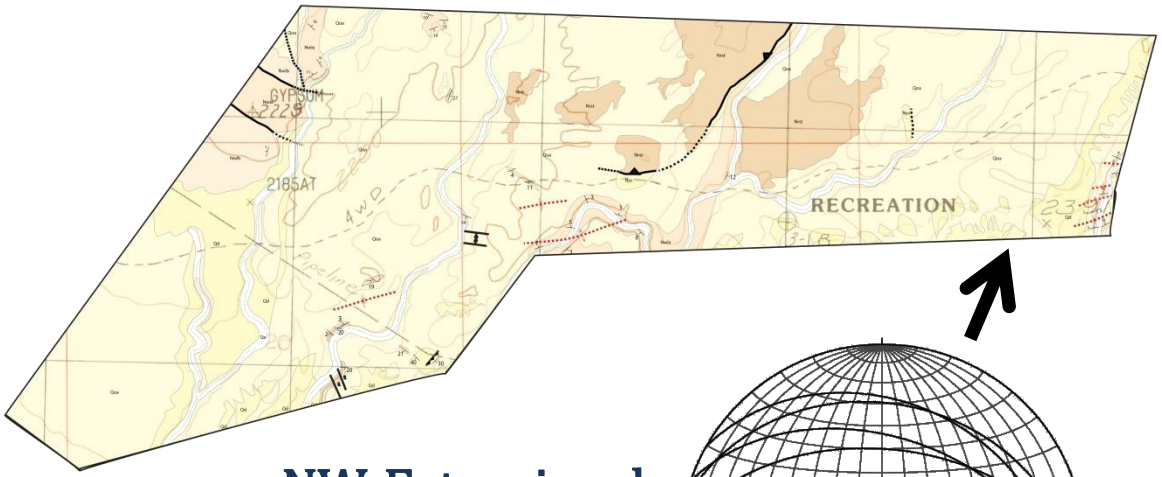

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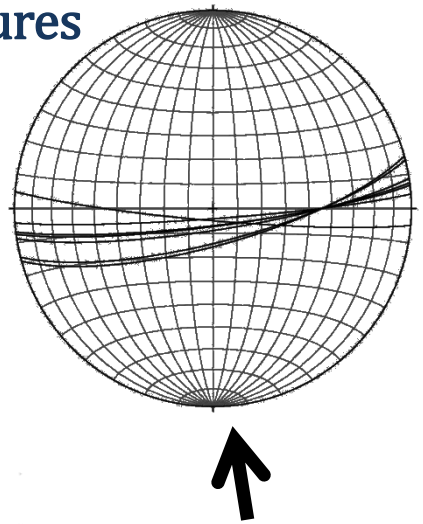

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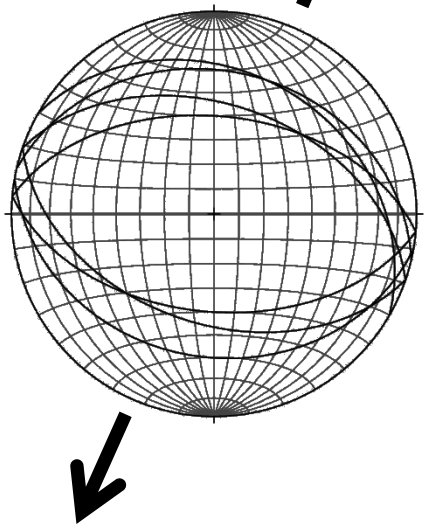

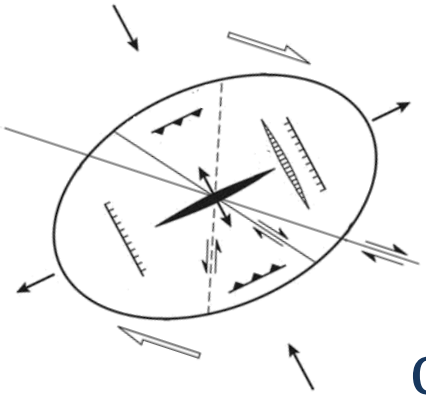

LVVSZ Orientation

Domain A

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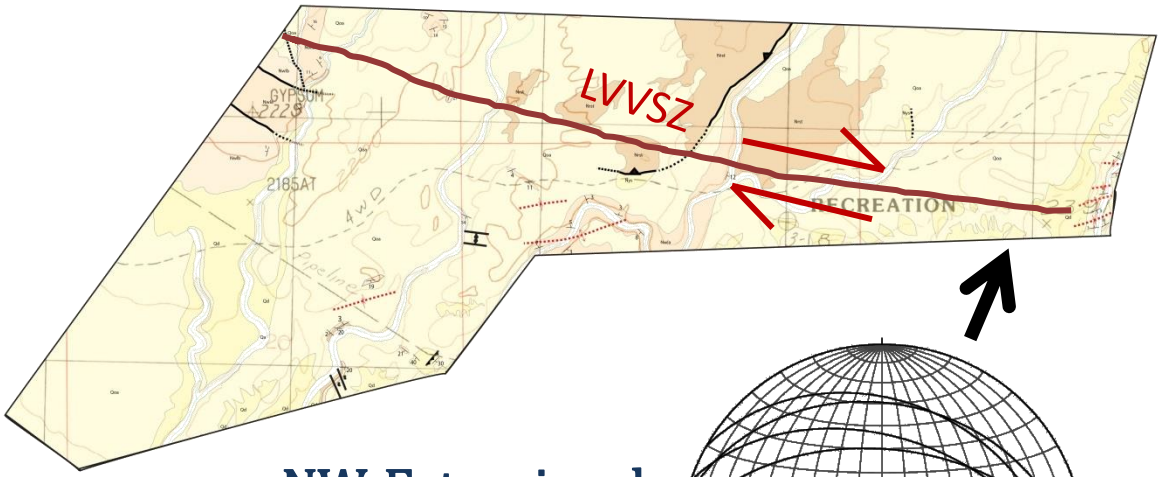

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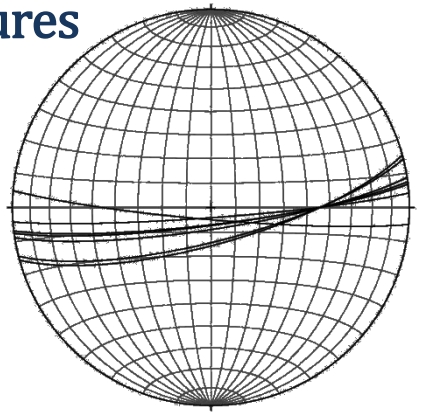

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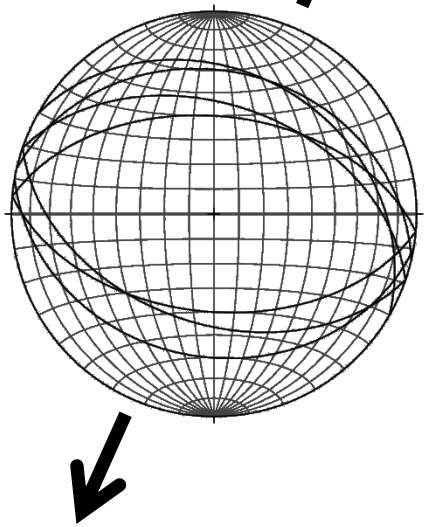

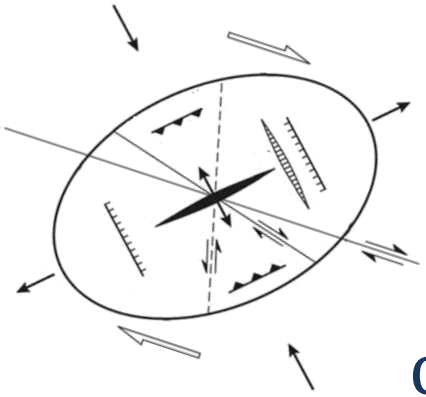

LVVSZ Orientation

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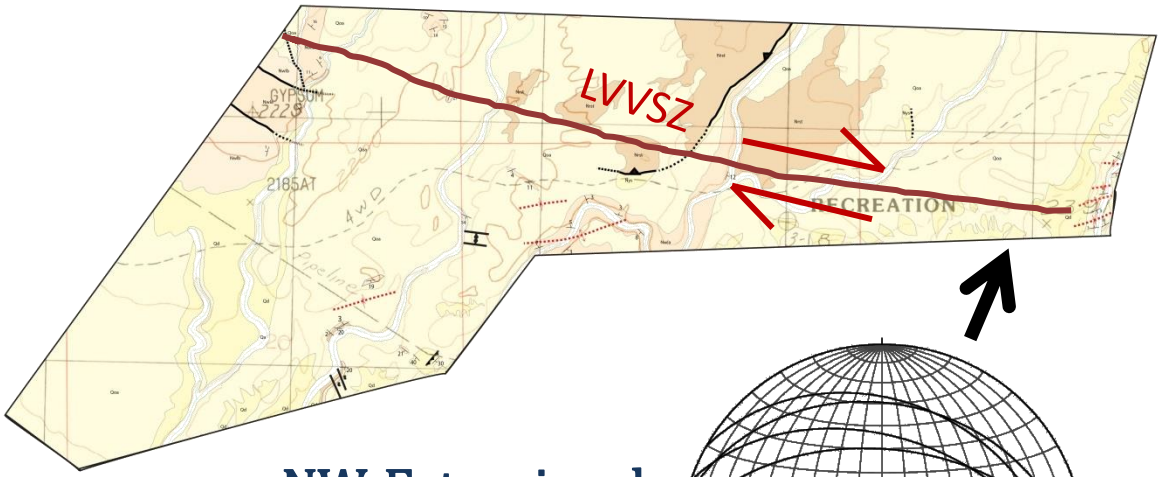

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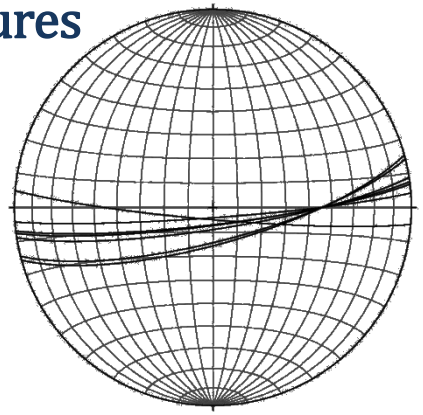

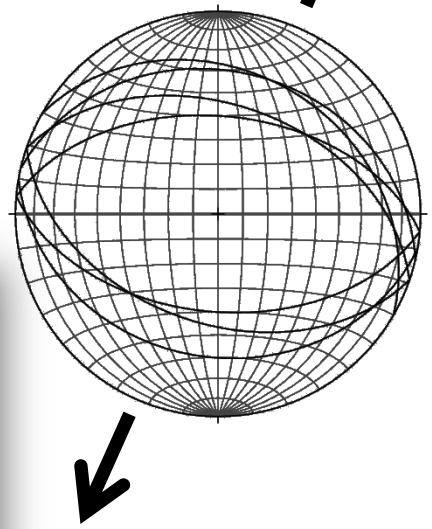

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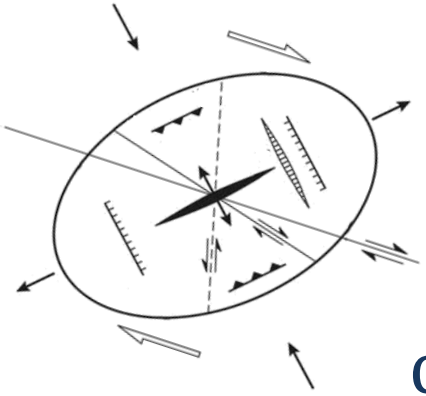

LVVSZ Orientation

Domain A

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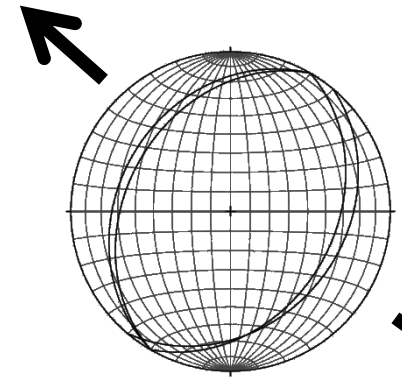

NE-Extensional Structures

NW-Compressional Structures

Domain B

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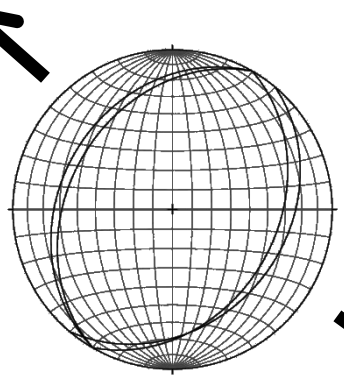

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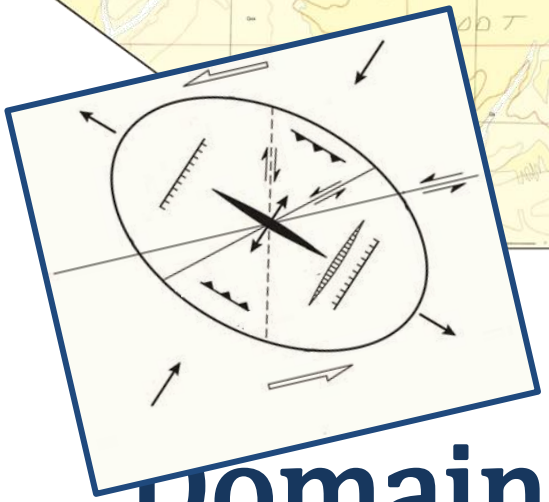

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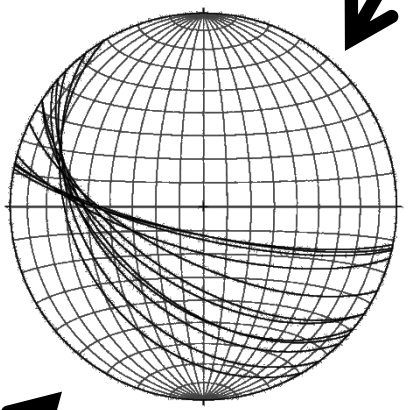

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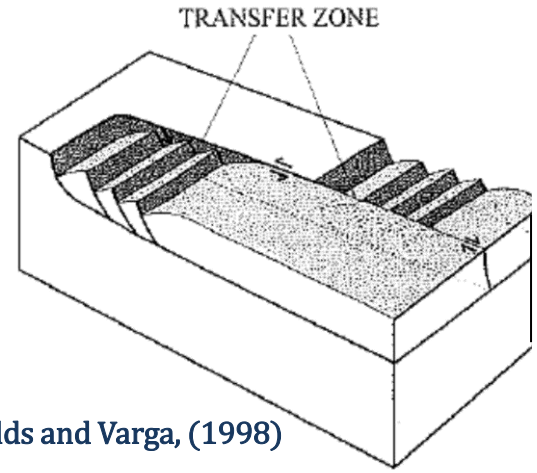
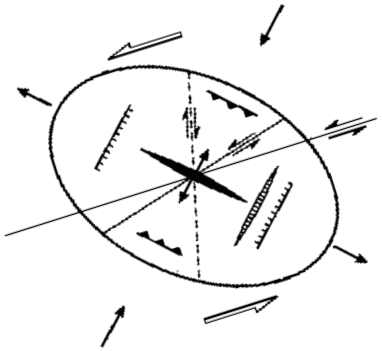
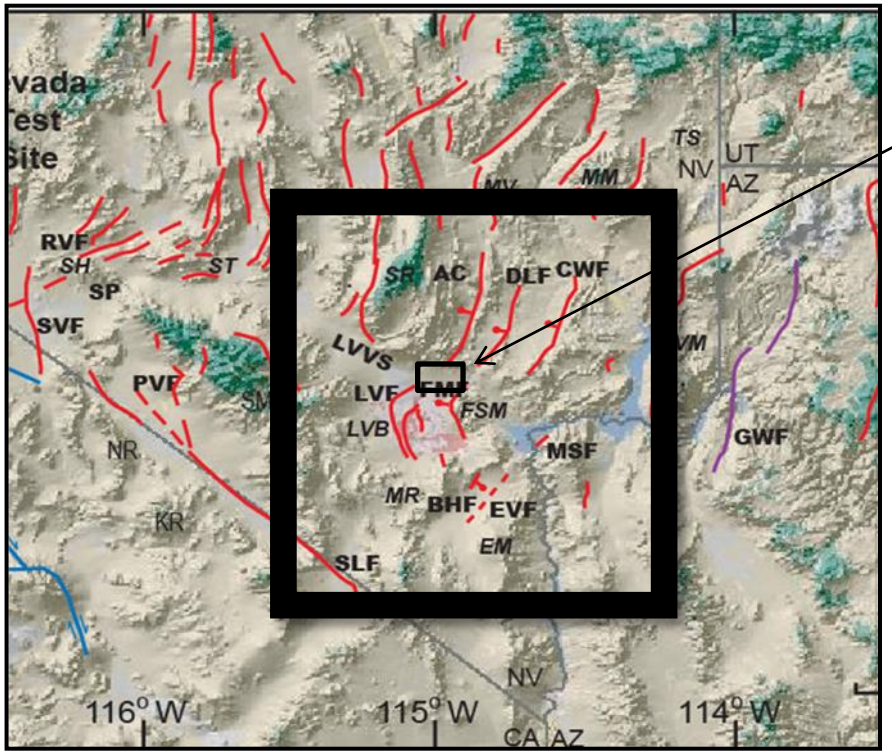


Faulds and Varga, (1998)





Quaternary Faults

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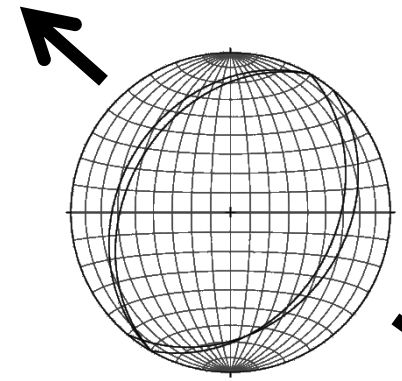

NE-Extensional Structures

NW-Compressional Structures

Domain B

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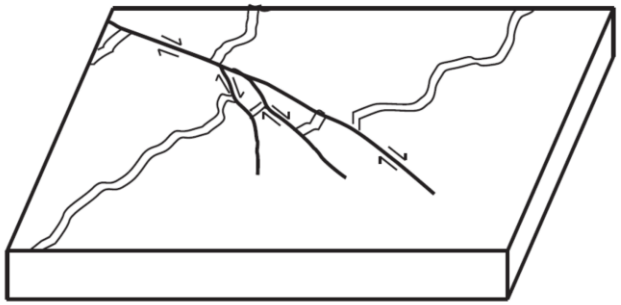

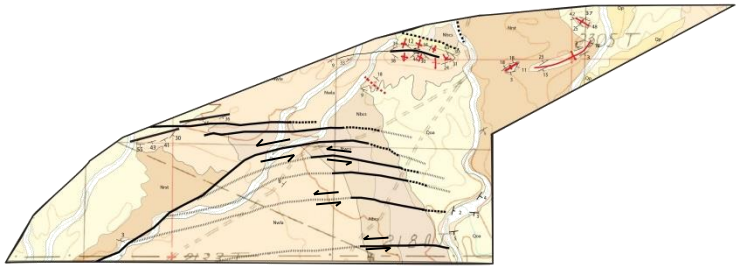

Domain C

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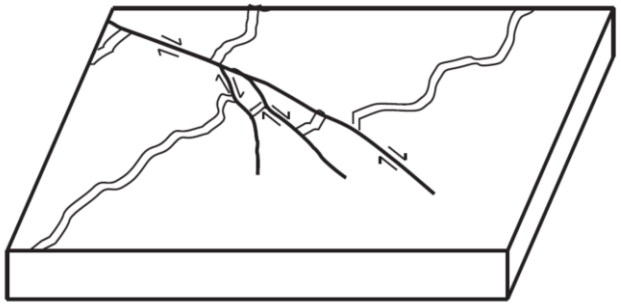

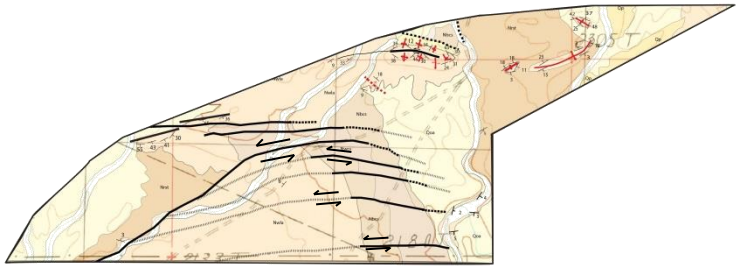

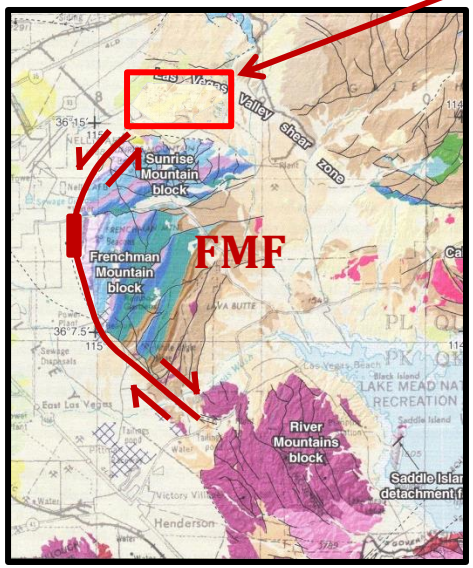

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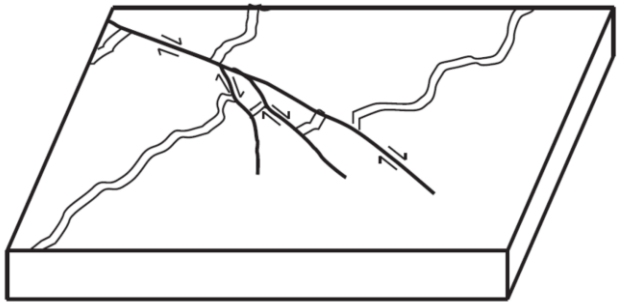
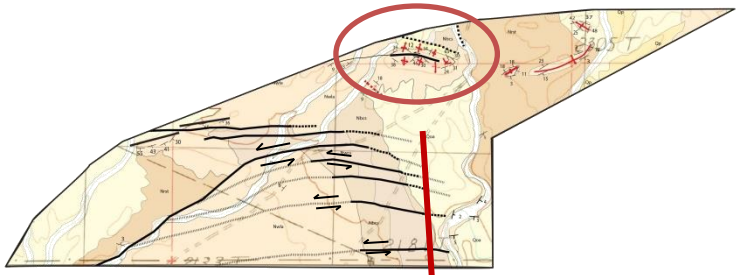
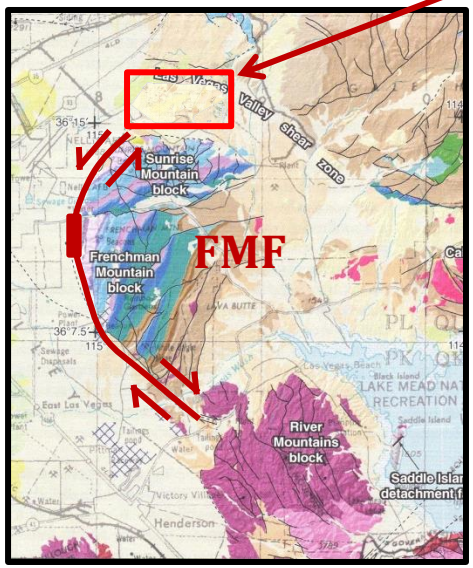
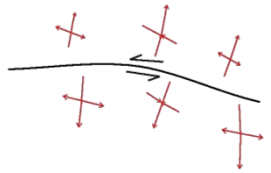
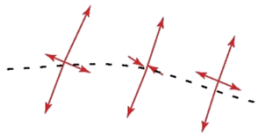




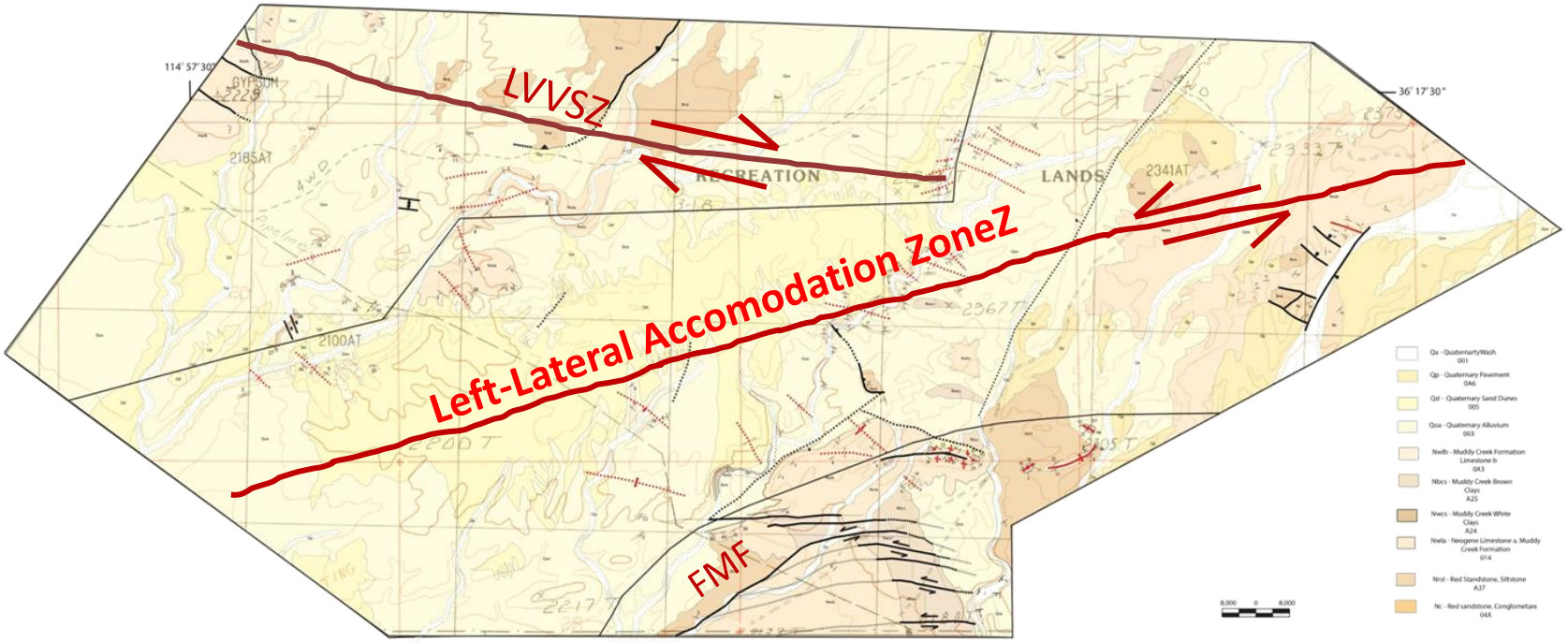






Domain C

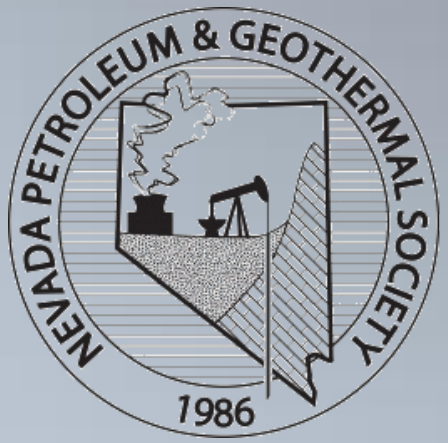
UNLV



- NDRA is deformed by three deformations rather than LVVSZ only
  - LVVSZ developed through the NW part and stopped moving before Quaternary.
  - During Quaternary, an ENE-oriented accommodation zone has developed through the central part overprinting LVVSZ.
  - FMF terminates in the southern part forming a horsetail splay later than LVVSZ.

UNLV

ExxonMobil



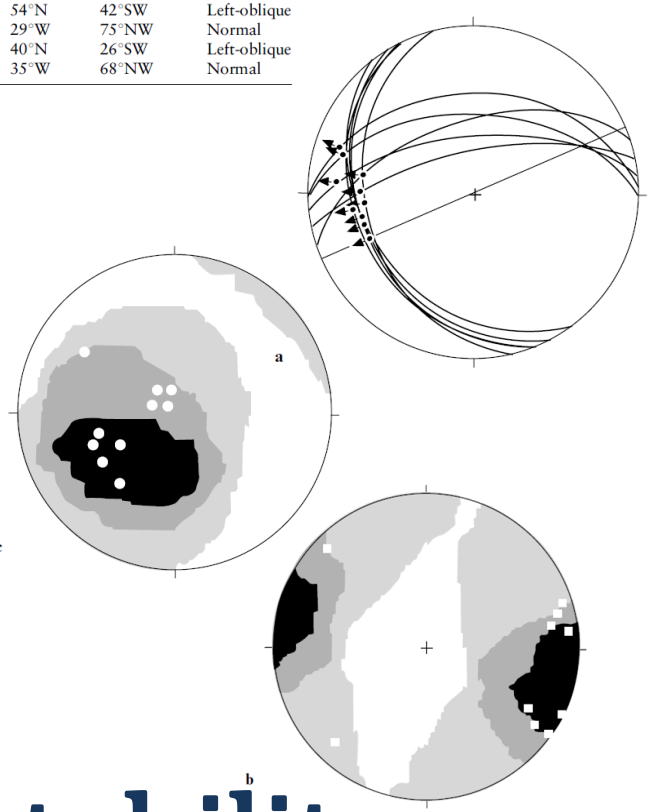
Thank You

- To test kinematic compatibility, analyses are done that include fault slip sense, fault strike, fold orientation plotted on stereographs and fence diagrams / 3D models.

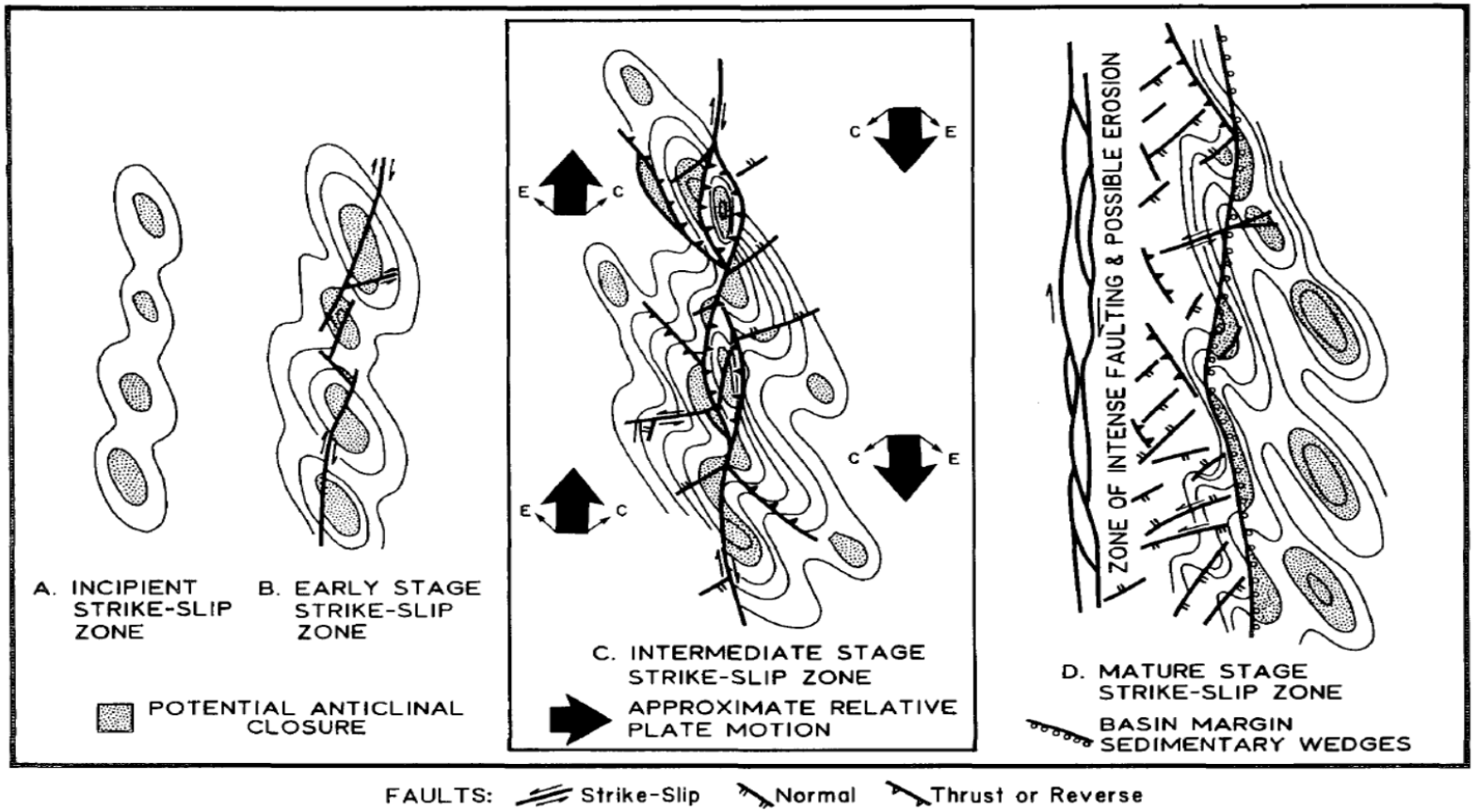
- Structures are kinematically compatible if:

  1. They formed during to the same deformational episode, and
  2. Yield single stress (shortening or extensional) axes.

Strike of fault	Dip of fault	Pitch of slickenlines	Dominant slip sense
345°	34°W	82°NW	Normal
078°	70°N	35°SW	Left-oblique
329°	32°W	78°NW	Normal
090°	51°N	25°W	Left-oblique
084°	62°N	21°SW	Left-oblique
066°	90°	32°SW	Left-oblique
071°	54°N	42°SW	Left-oblique
335°	29°W	75°NW	Normal
088°	40°N	26°SW	Left-oblique
321°	35°W	68°NW	Normal

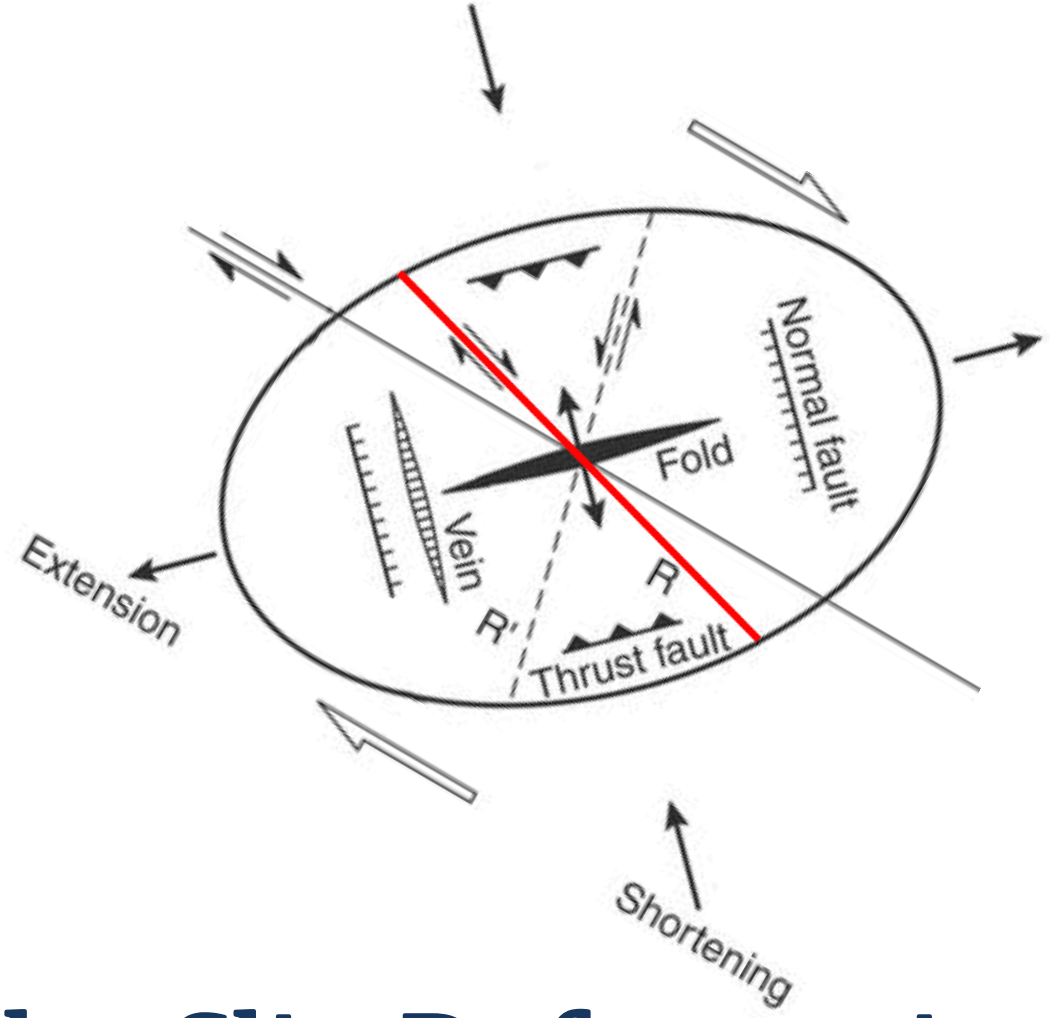


Kinematic Compatability



Sylvester (1988)

Strike-Slip Deformation



Strike-Slip Deformation