

# HUCKTUFF, HOMINY

August 2014

by  
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## RISE OF THE TETONS

- I. Prologue: my own geohistory
- II. Laramide history
- III. Hucktuff and the West Side tilt
- IV. Early history of the West Side tilt
- V. The Hominy Peak evidence
- VI. The regional connection
- VII. What next? My future geohistory

THANKS TO:  
numerous

Bob Smith  
Bob Spoelhof  
Charlie Woodward  
[David Love]

## I. My Geohistory

- |           |   |
|-----------|---|
| 2006      | Awakening (via "extinction", D, Erwin)<br>Alamo impact              |
| 2007-2010 | Devonian "field studies"  |
| 2011      | Geissman GTH presentation   |
| 2012      | My Devonian GTH presentation  |
| 2012-2014 | The "tilt problem"<br>West Side caves & hydrology<br>(Bob Benedict) |

## Setting the geological stage

370 Ma

Alamo impact in S. Nevada  
} Tsunami arrives here into  
shallow intertidal seas.

50 - 80 Ma

Laramide orogeny

~50 Ma  
Absaroka volcanic activity  
(Honning Peak andesite)

2-10 Ma

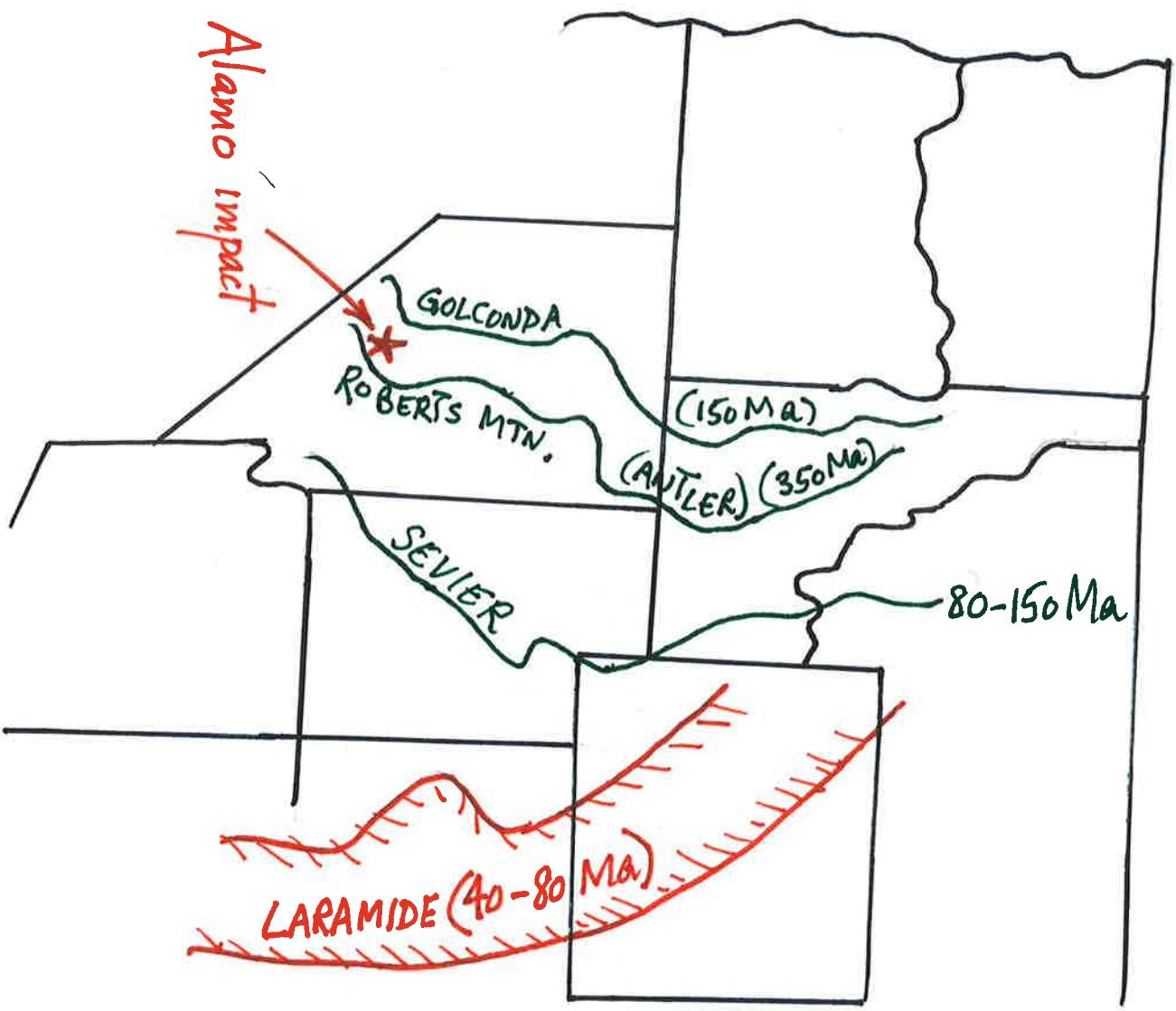
Teton range begins to rise  
(Jackson Hole sinks)

2 Ma  
Yellowstone caldera eruption (Hucktuff)

2 Ma - Now

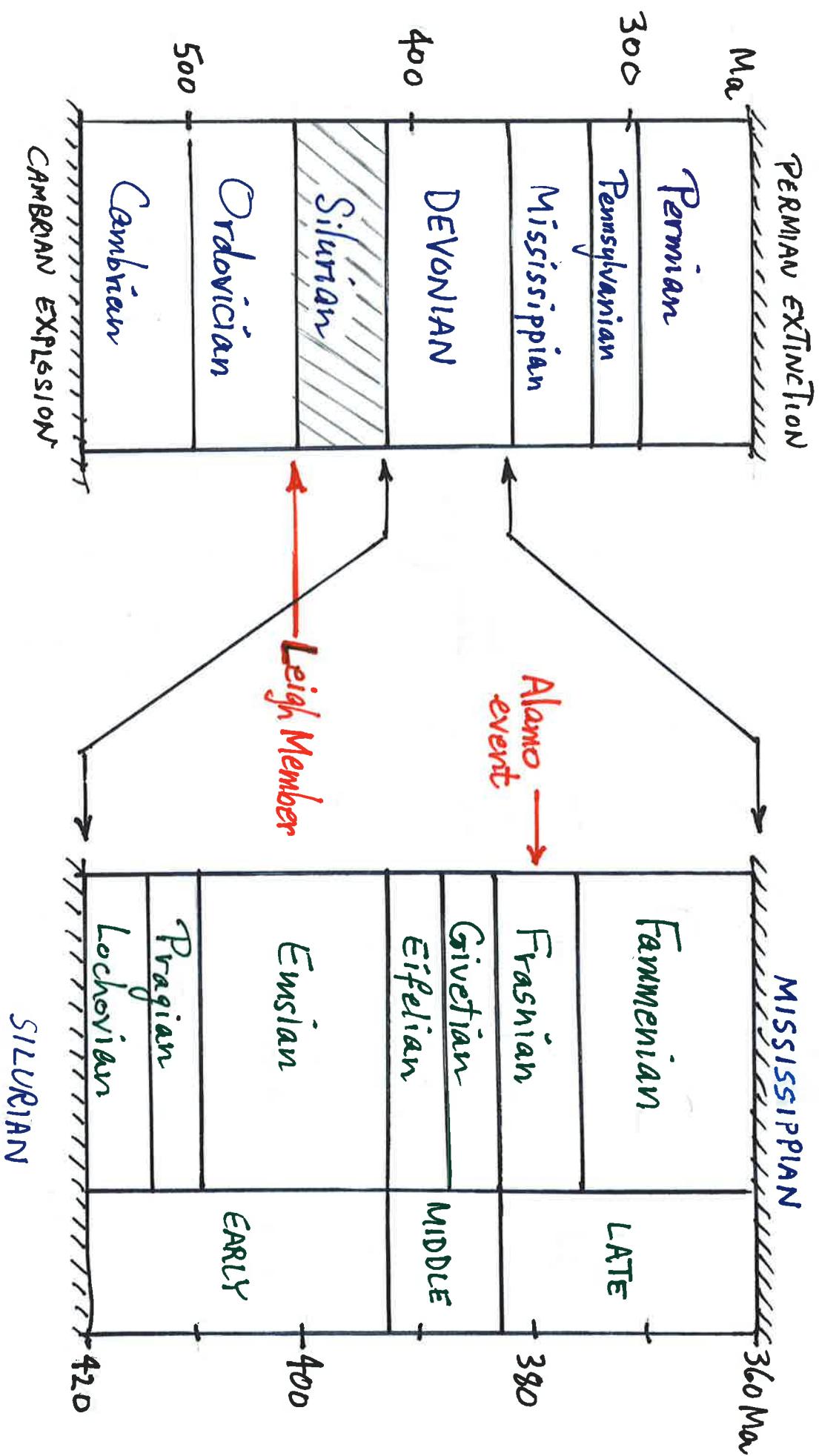
Tetons continue to rise

## REGIONAL TECTONIC HISTORY

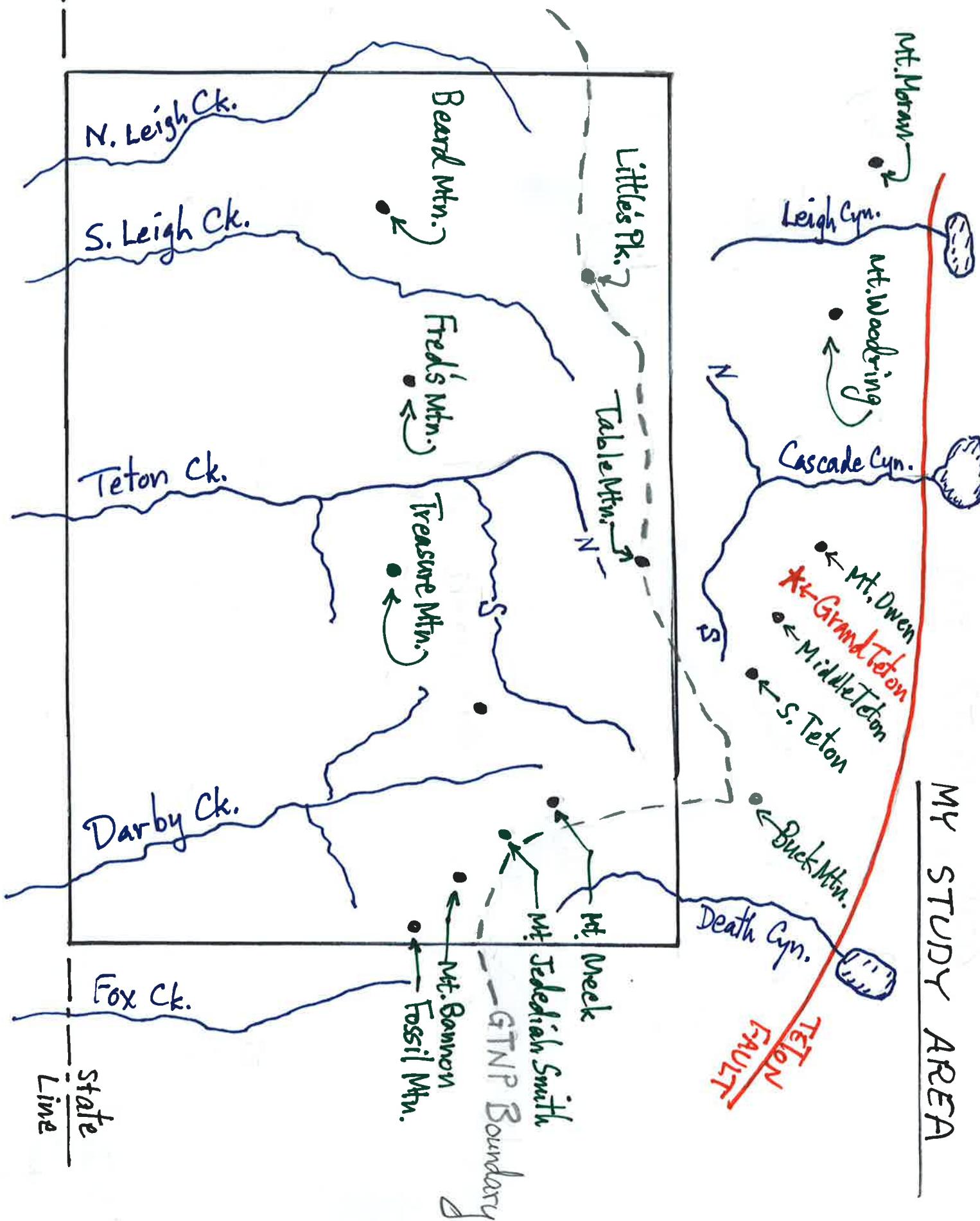


350 Ma - 20 Ma: Nevada  
squished  
20 Ma - Now: Nevada  
stretched

# GEOLINGO



# MY STUDY AREA



## Summary of my Devonian work:

- No tsunami evidence found
- Strata need to be (conodont) dated
- Best possibility: hydrology  
Tidal channels  $\leftrightarrow$  porous channels
- Evidence: Devonian springs  
Possible role of caves
- More discussion at end of talk?

## The main subject of this talk:

- How did the West Side strata get tilted?
  - When did the tilt occur?
  - The idea: volcanic deposits overlay the old strata
- 50 Ma: Homing Peak formation  
(Grand Targhee)
- 2 Ma: Huckleberry Ridge tuff  
(Teton Canyon flanks)
- Tilt of these recent deposits differs from the tilt of the strata.

## II. Laramide History

Laramide orogeny:

- Rise of ranges to the south of Jackson  
(cf. GT talk by Adolf Yonkee)
- Rise of Gros Ventre Extension
- Targhee Uplift
- Absaroka volcanism

# "Creation of the Teton Landscape"

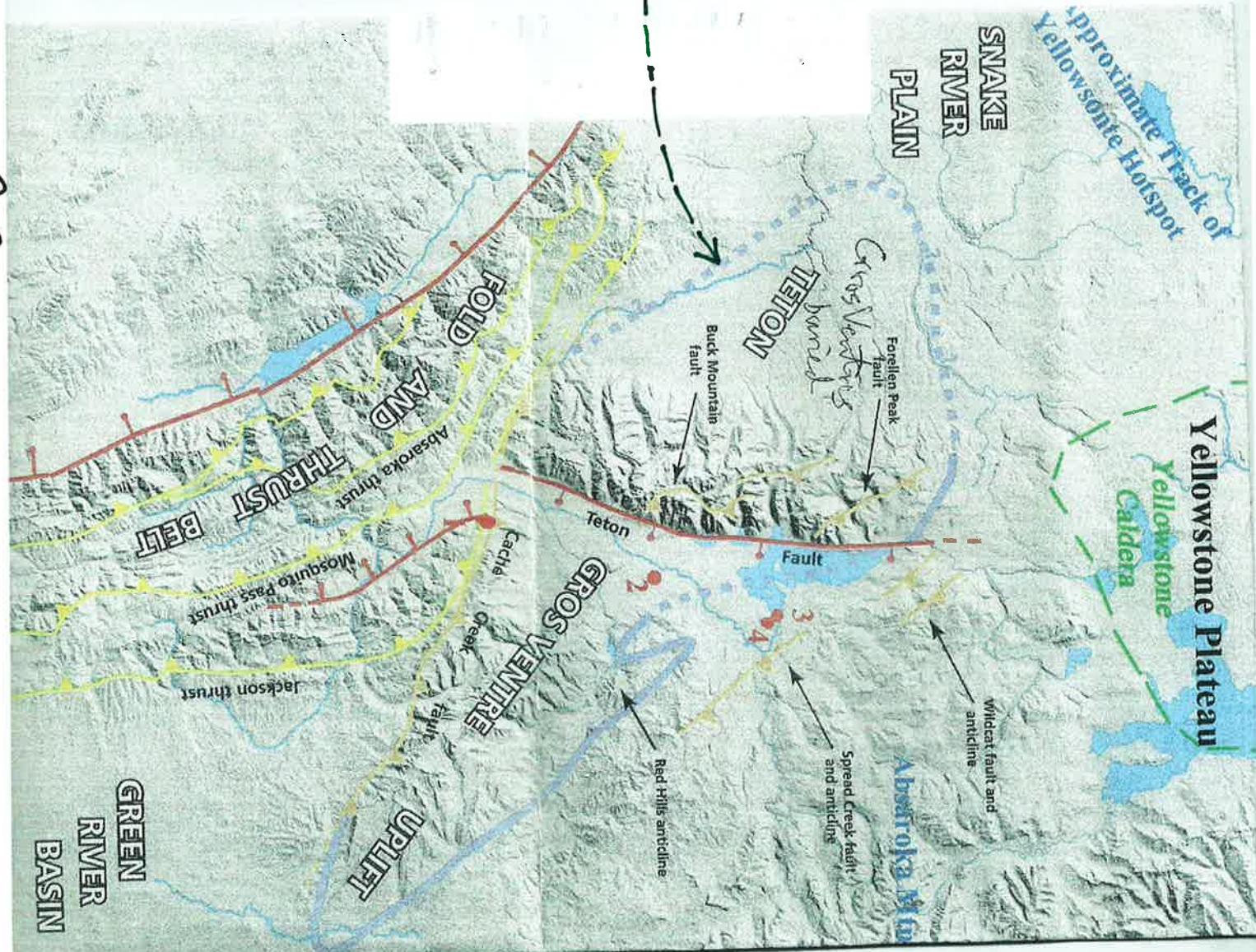
Love, Reed, & Pierce

(P. 55)

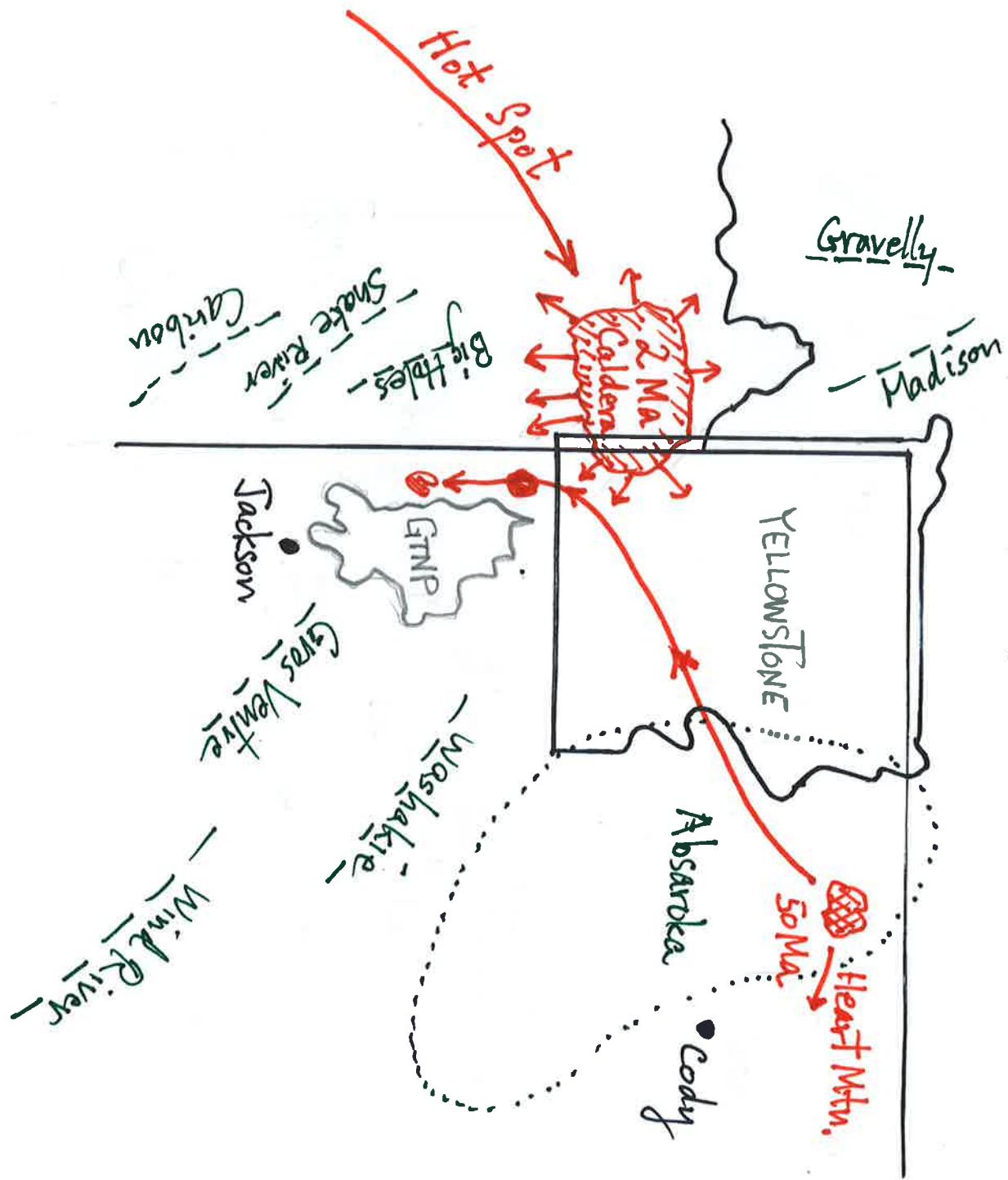
Dashed-line  
caption:

"Anybody's guess"

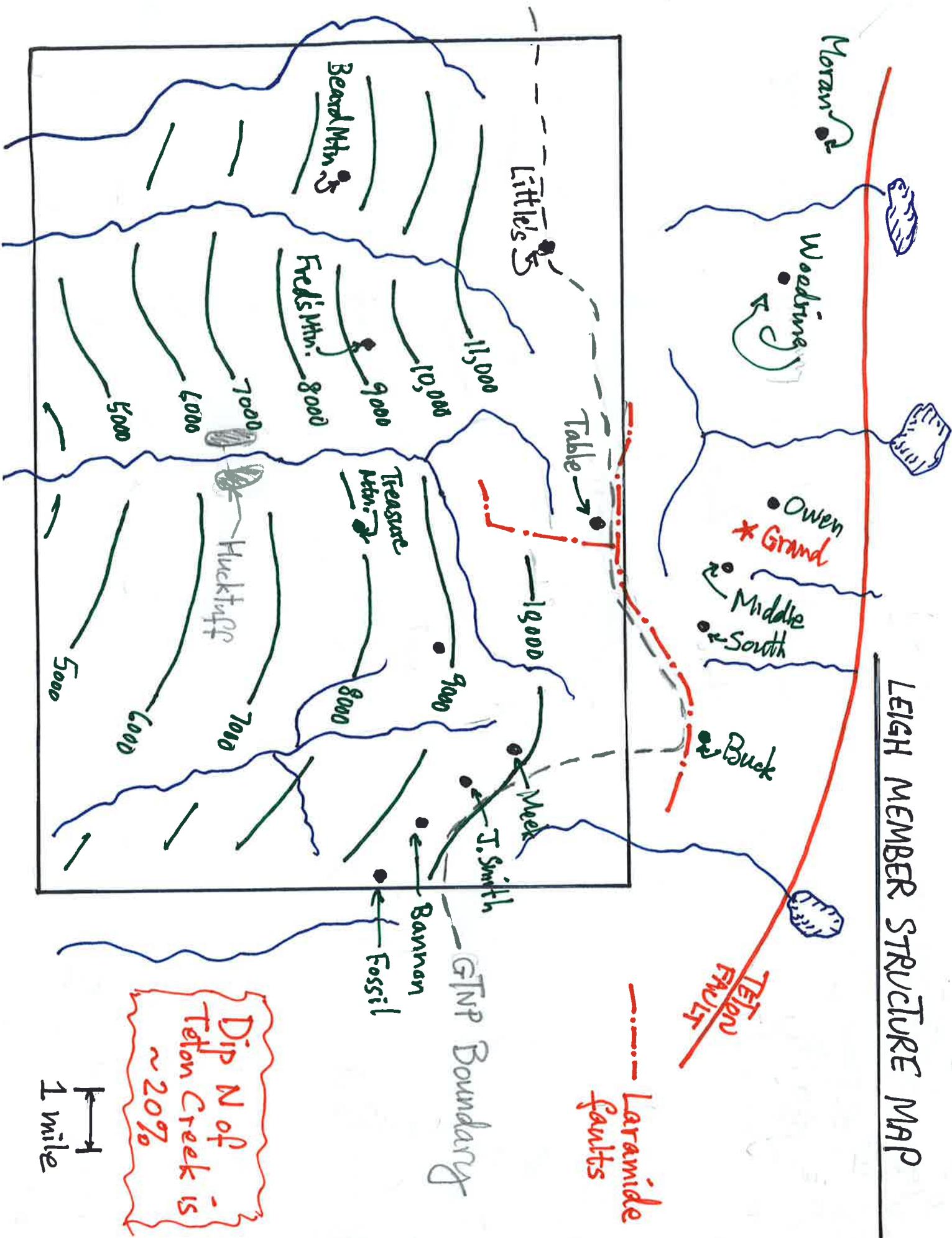
"Like the Cheshire cat  
in Alice in Wonderland,  
the Targhee uplift  
vanished, leaving behind  
only its smile."



# THE REGIONAL PICTURE



# LEIGH MEMBER STRUCTURE MAP



### III. HUCKLEBERRY RIDGE TUFF

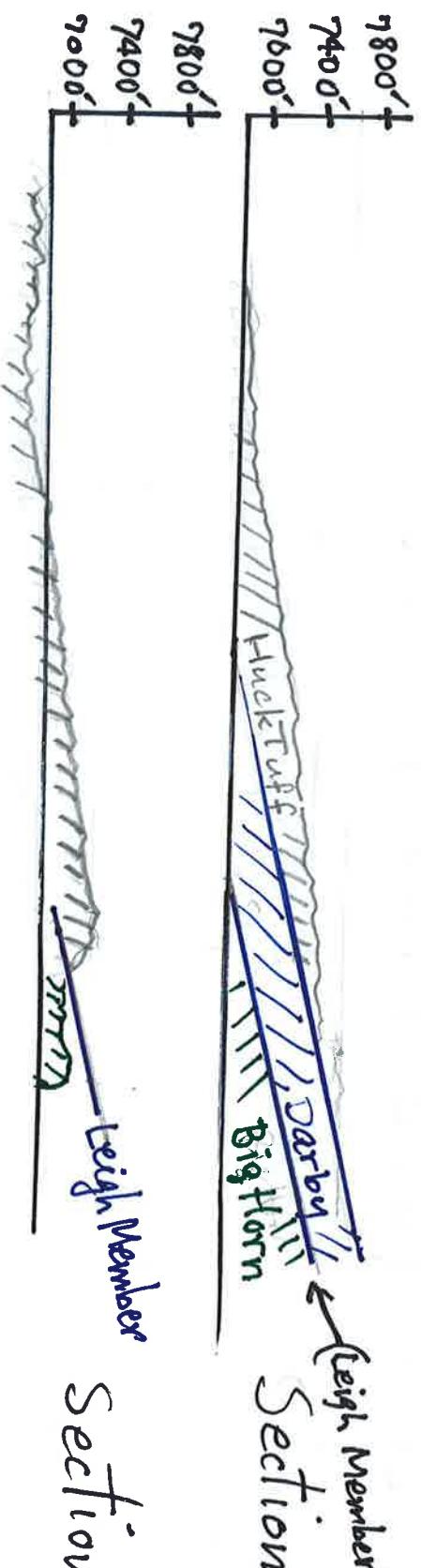
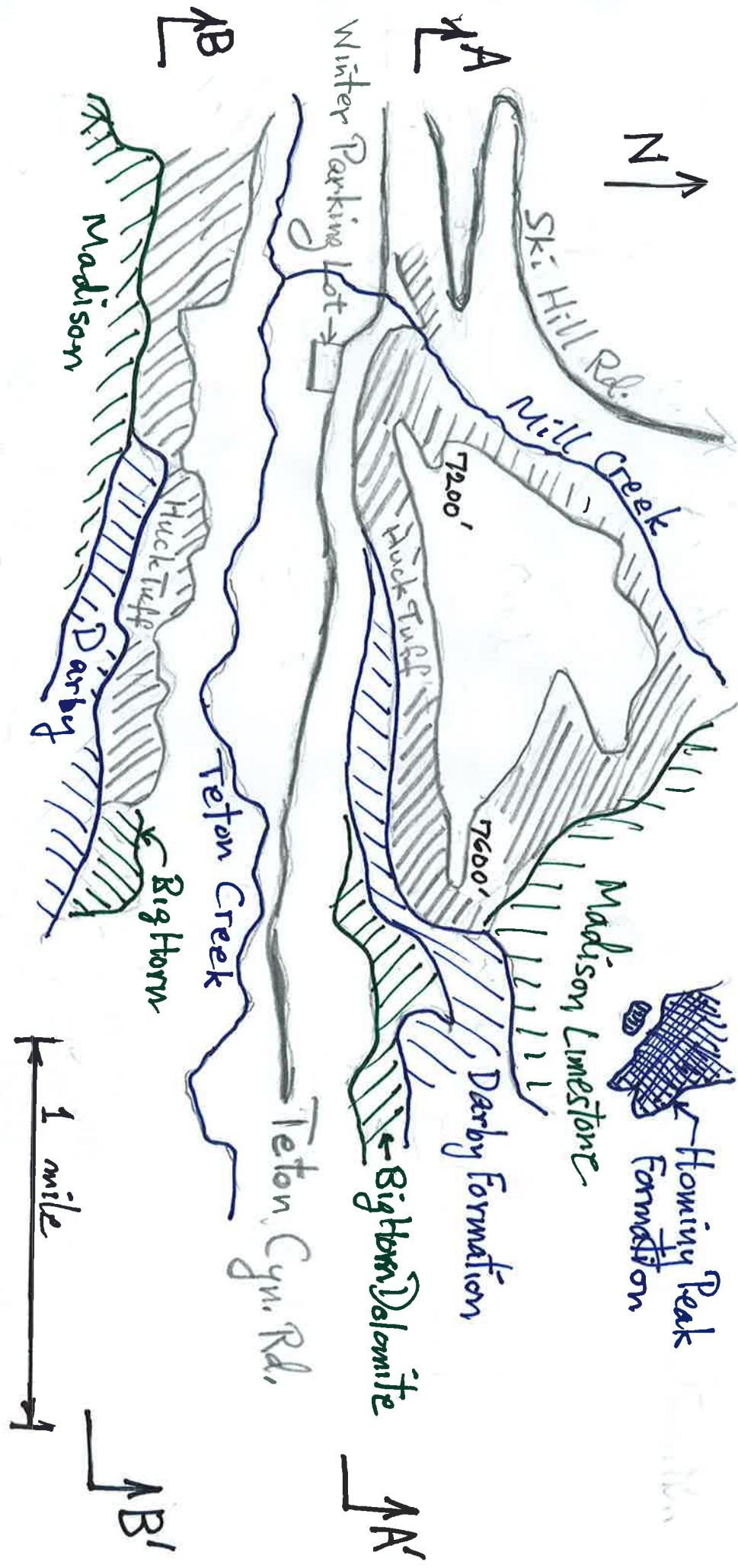
- Deposits in the West Side foothills
- Were they rotated after deposition?
- Geissman paleomagnetism



2 Ma

- Geissman's conclusion:  $\geq 50\%$  of tilt in the last 2 million years.
- I meet Geissman & offer to find more backcountry sites.
- I locate several candidate sites.
- I disconnect from Geissman
- I conclude that field evidence by itself is quite convincing.
- Best evidence is the N & S flanks of Teton Canyon.

WSGS Love Series Geological Map (Granite Basin)

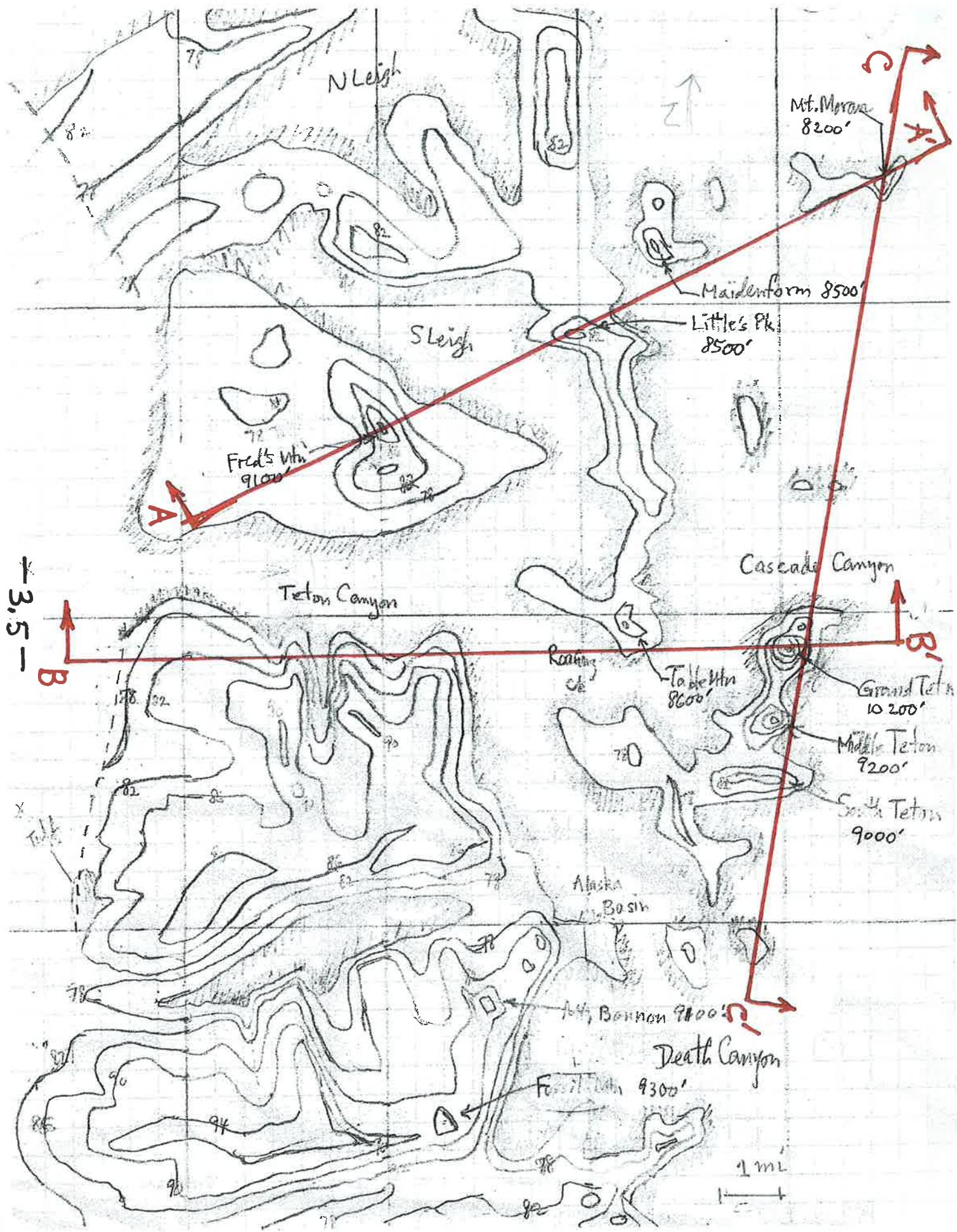


## My conclusion

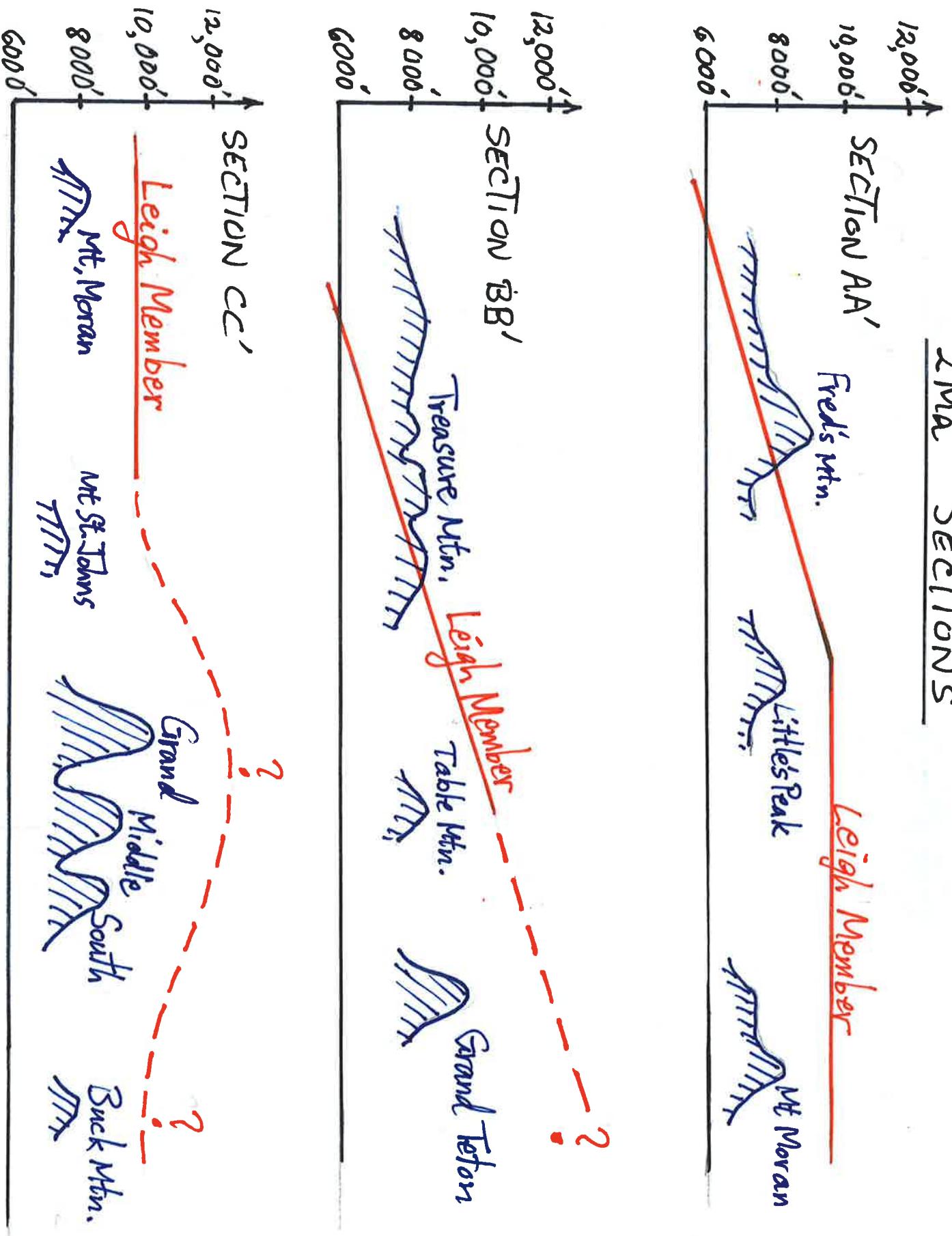
- $\gtrsim 50\%$  of tilt is within the last 2 Ma
- Accuracy  $\sim 20\%$  (?)
- Topo map of 2 Ma terrain can be made,

Note:

- Elevation of the terrain in the topo map depends on the location of the hinge of the "trap-door."
- BUT the topographical features do not depend upon the location of the hinge.



## 2 Ma SECTIONS



Byrd, Smith, & Gerissman

*Journal of Geophysical Research* 99, B10, p20,095 (1994)

BIRD ET AL.: TETON FAULT, TOPOGRAPHY, NEOTECTONICS, DEFORMATION

20,101

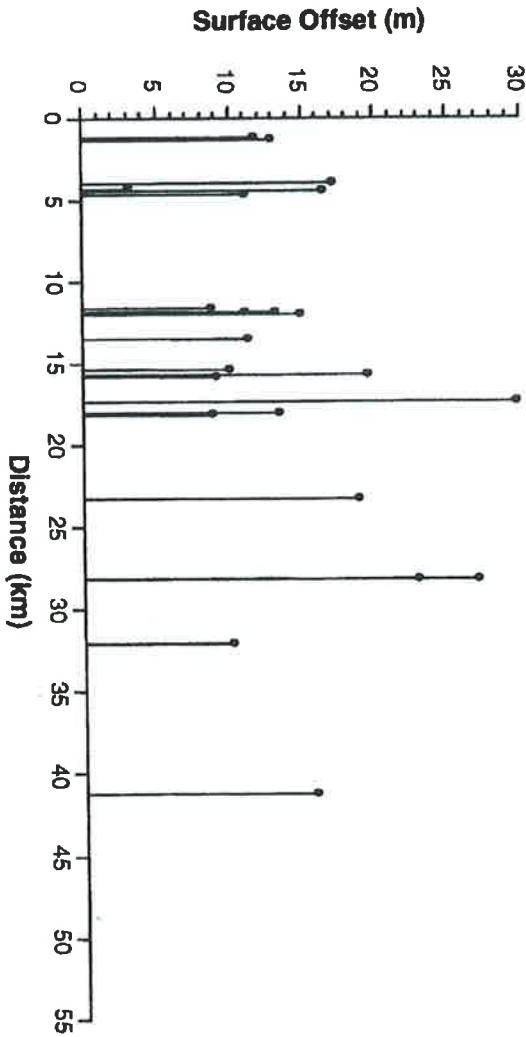
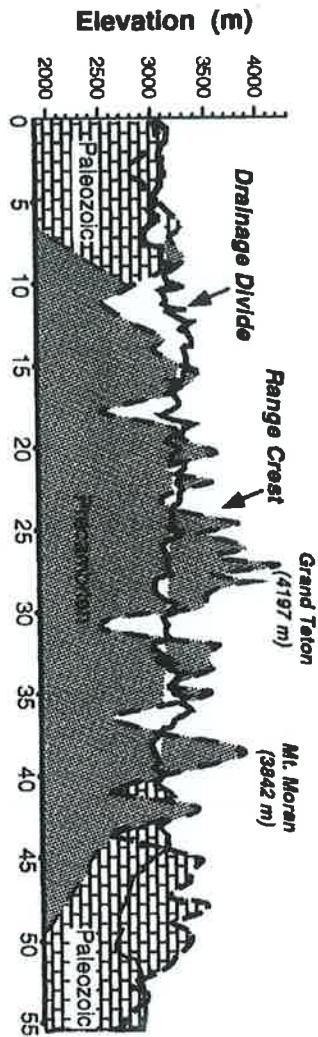


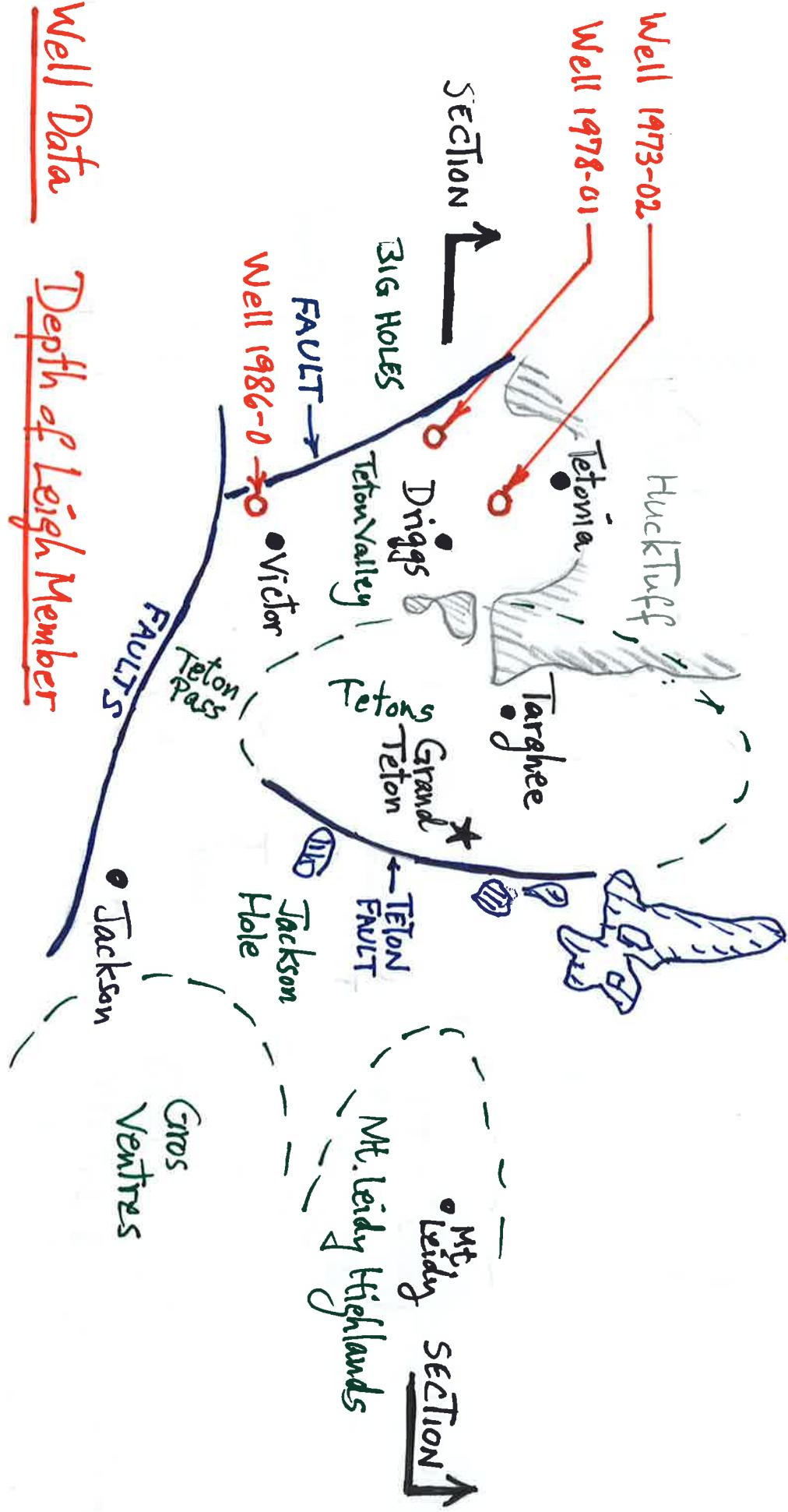
Figure 3. Plot showing drainage divide, range crest topography and surface offset across the Teton fault. (a) Topographic expression of the Teton range crest and drainage divide and generalized distribution of Paleozoic and Precambrian age rocks along each feature; and (b) postglacial surface offset along the Teton fault determined from fault scarp profiles [Byrd, 1994].

-3,7-

## IV. Early Teton History (2 Ma - 10 Ma)

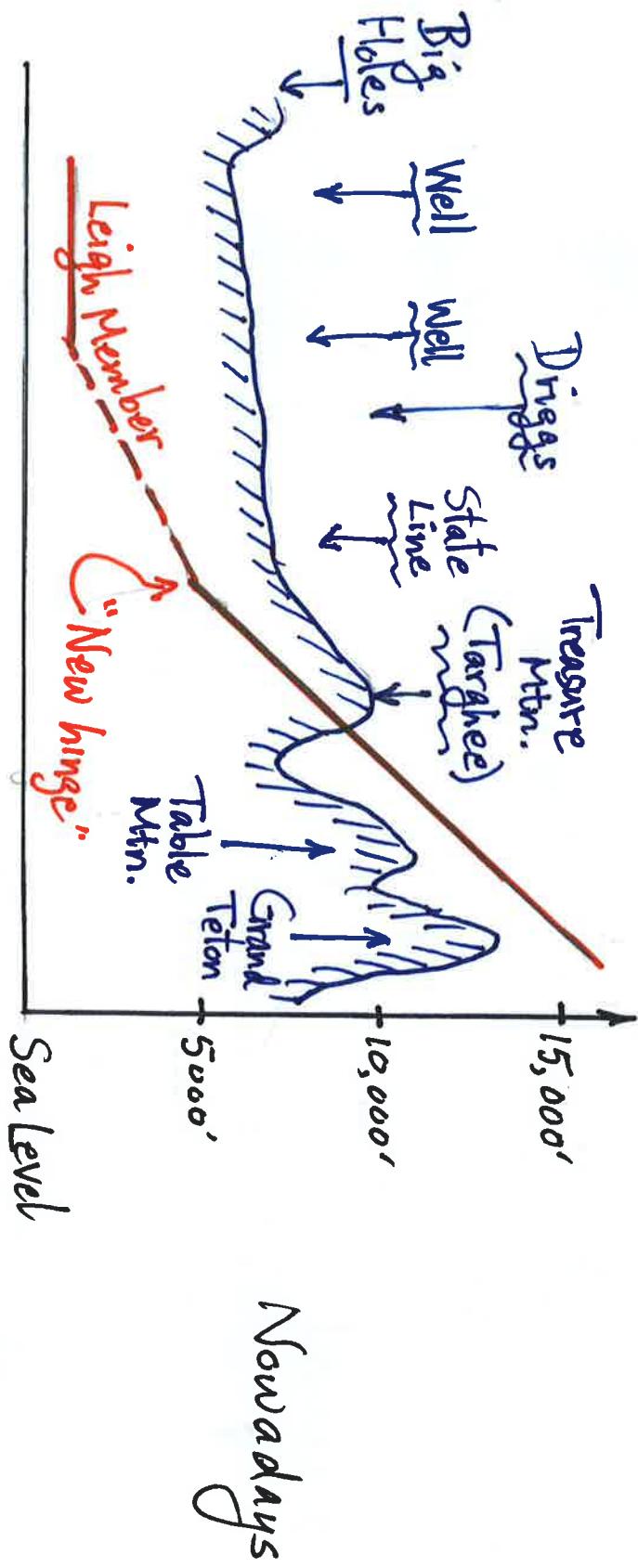
- Tetons did rise some in that period
- How much rotation of the West Side strata occurred in that period?
- My guess: not much
  - ~3% !?!
- The evidence:
  - Common sense
  - Cities Service deep well near Driggs

## THE REGIONAL PICTURE



<u>Well Data</u>	<u>Depth of Leigh Member</u>
1986-00	5400'
1978-01	500'
1973-02	4400'

All wells have surface elevations ~ 6100'  
[ Thanks to Bob Spoelstra ]



"Old hinge" → Leigh Member  
Leigh Member  
+5000'  
Sea Level  
10 Ma  
(more or less)

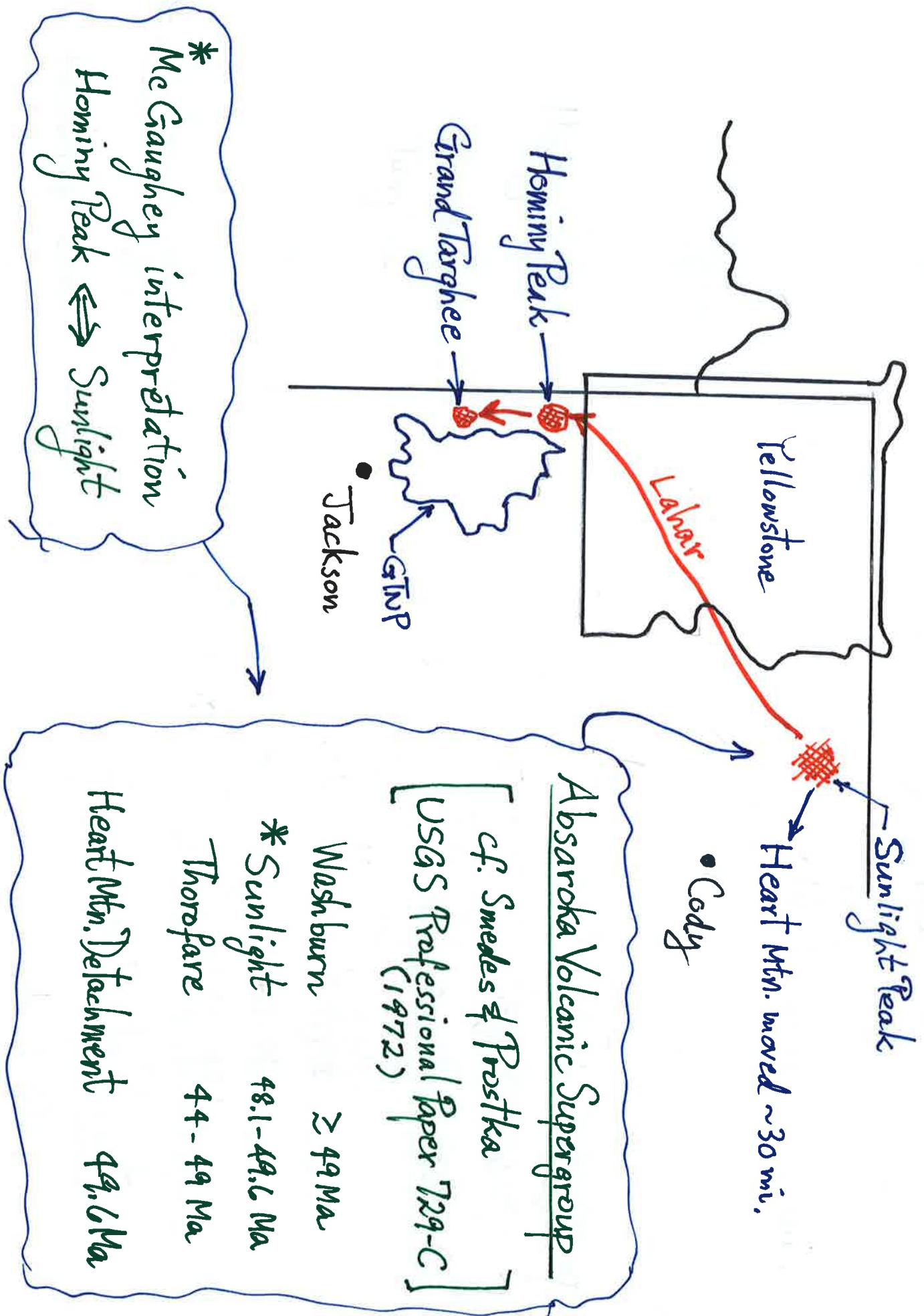
## Advantages of this scenario:

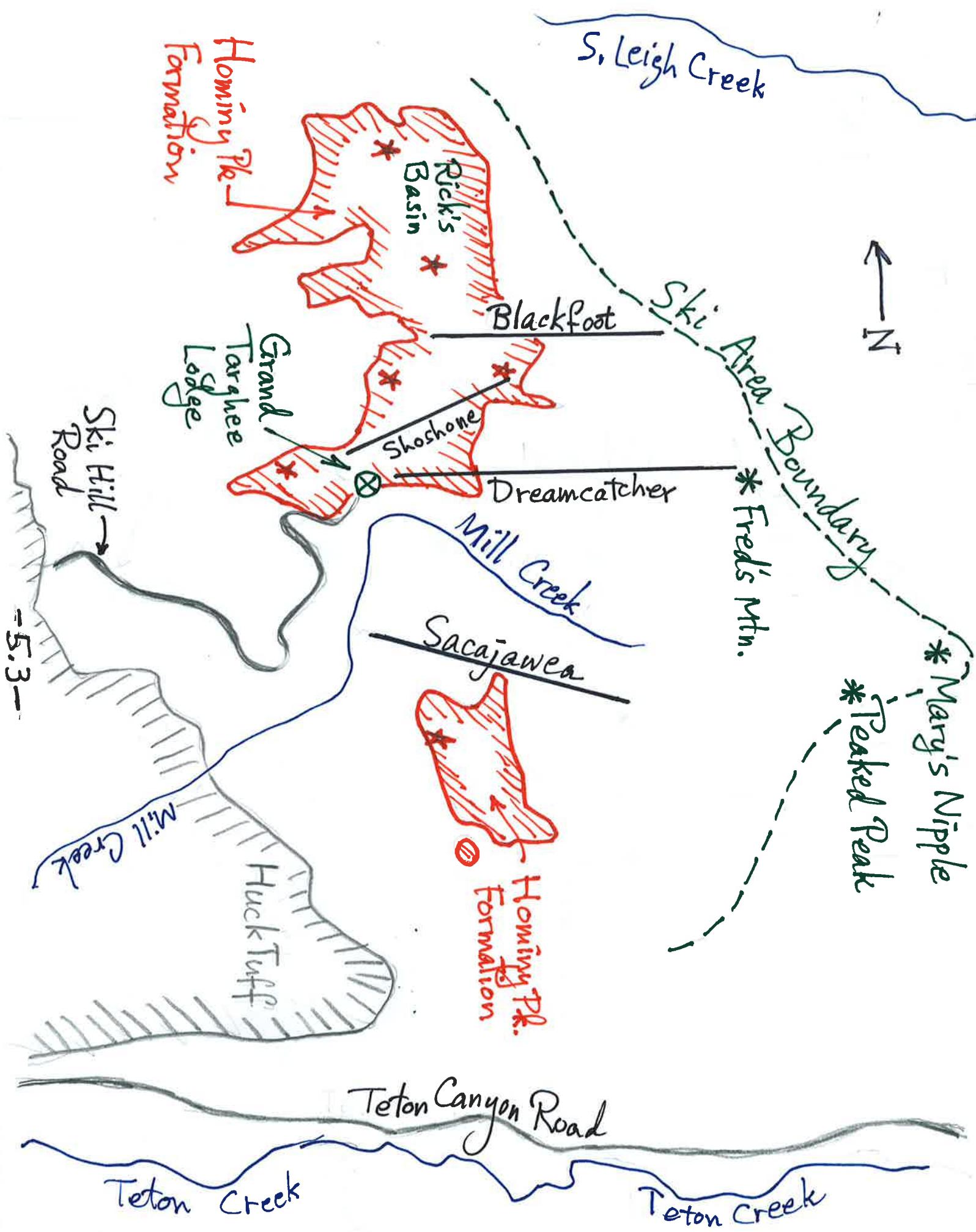
- Grand Teton remains supreme.
- Syncline near the well helps to explain the huge volume of water and its high pressure (4Mgal/day of hot water)
- "Old hinge" near the Big Horn may be useful in describing the Targhee uplift.

## V. The Hominin Peak Formation

- 50 Ma "andesite"
  - 1 square mile at 8000' on Grand Targhee
  - ~200' deep
- Type section is near Hominin Peak 15-20 mi N of Targhee.
  - 10 square miles
  - ~2000' deep
- Well-studied by David Love in 1970's  
(Love, Leopold, & Love, USGS Professional Paper 932-B)
- Origin: Lahar originating in the Absarokas?  
(McGaughey, 2011 Keck Symposium)

## THE SUNLIGHT EVENTS





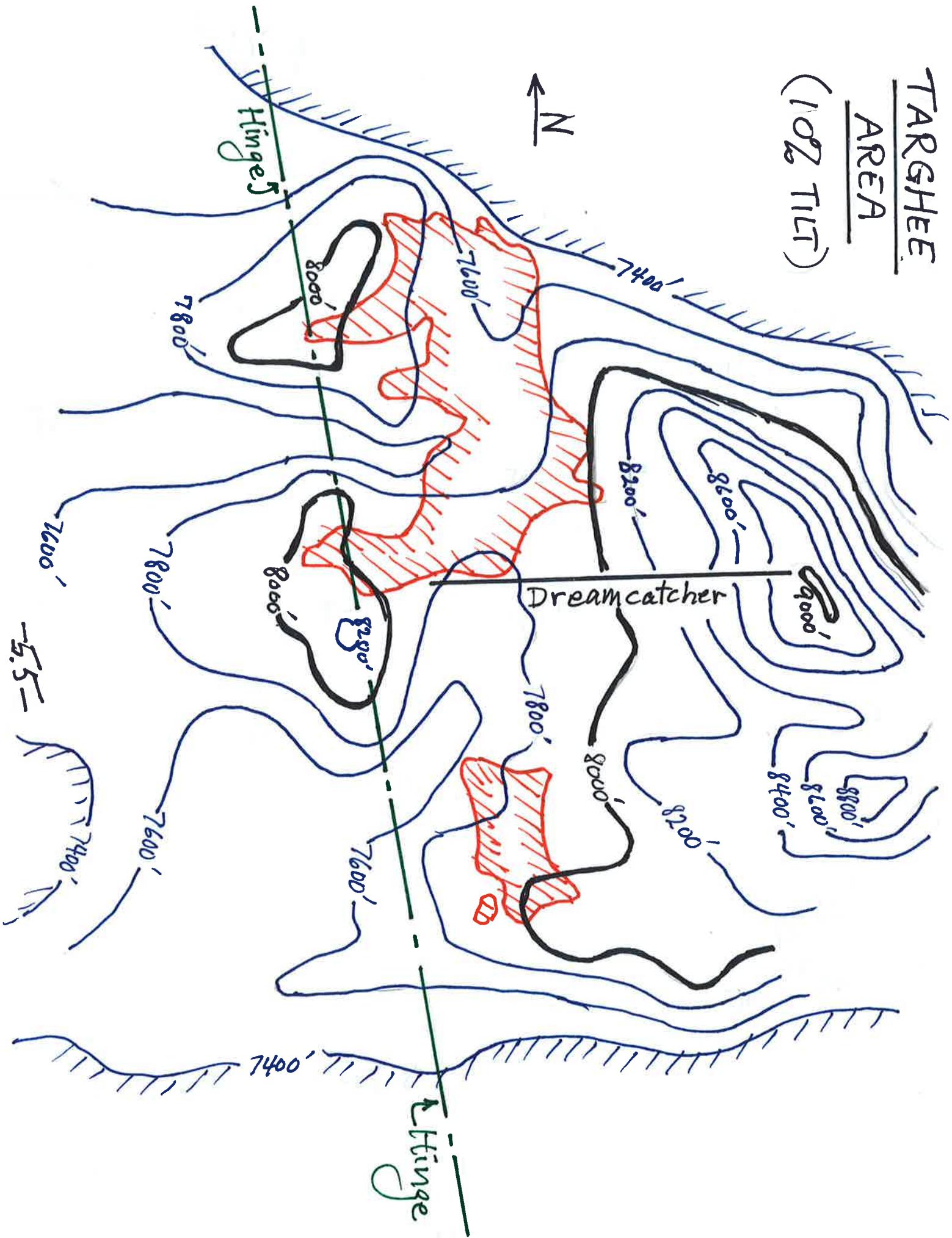
- Assume that the Hominy Peak deposit was originally (E-W) horizontal. It then becomes a measure of tilt.
- Data are consistent with no rotation prior to 2 Ma.
- Data are still consistent with 6% of extra rotation during 50 Ma - 2 Ma.
- Love chooses 30% extra rotation. I do not think this makes sense. (I will choose 3%)

# TARGHEE

## AREA

(10° TILT)

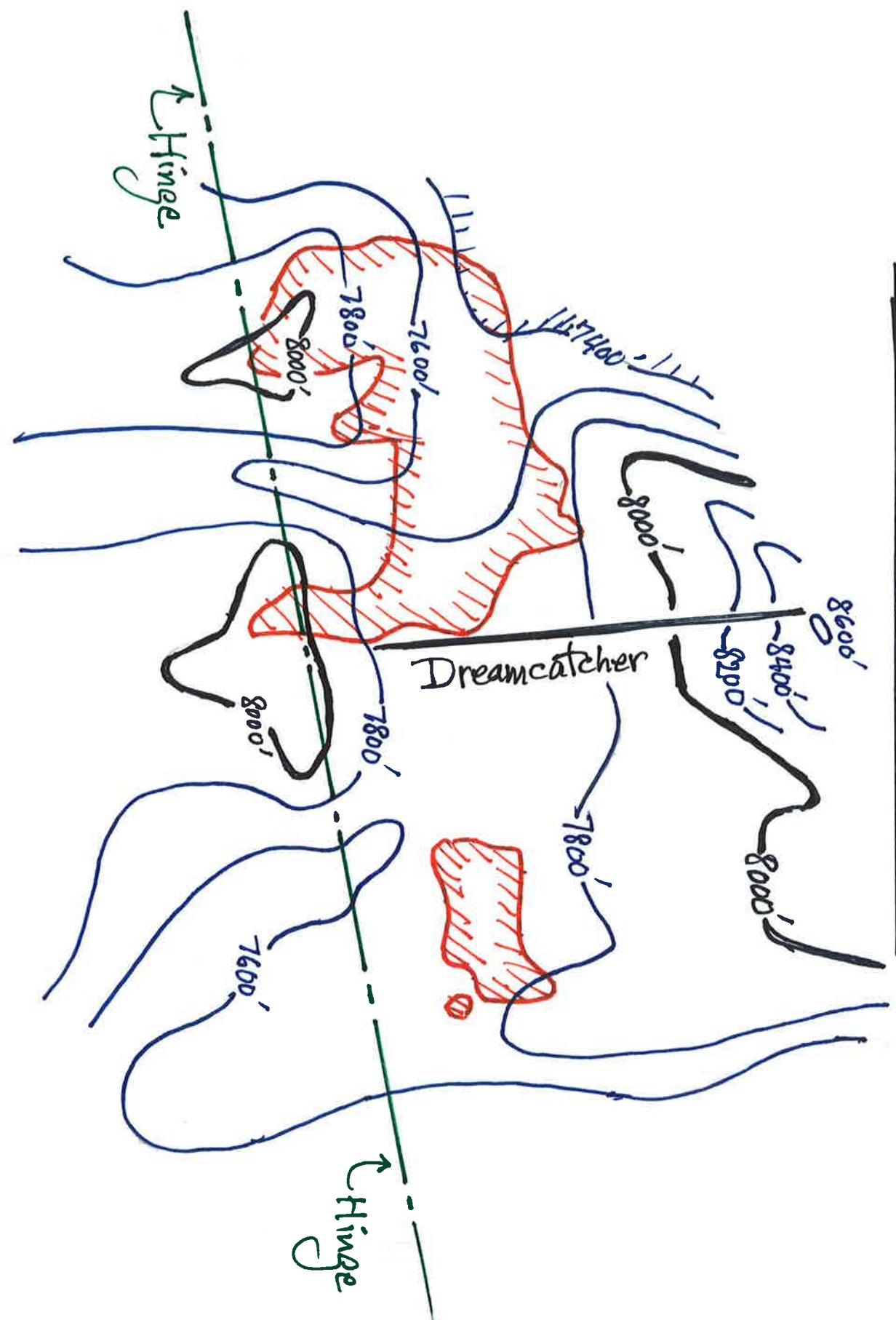
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## TARGHEE AREA ( $10\% + 6\% \text{ TILT}$ )

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# Love, Leopold, & Love

(p. 30)

30

GEOLOGY OF THE TETON-JACKSON HOLE REGION, NORTHWESTERN WYOMING

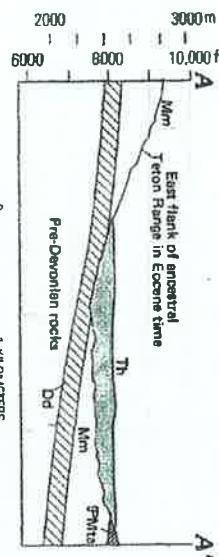
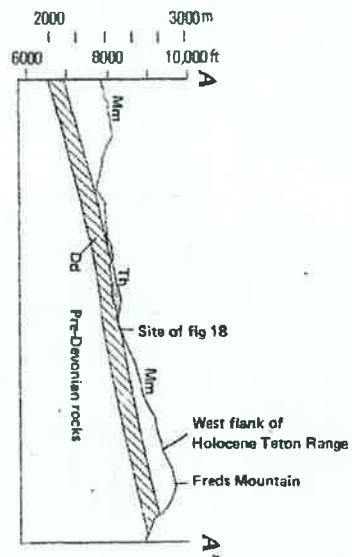
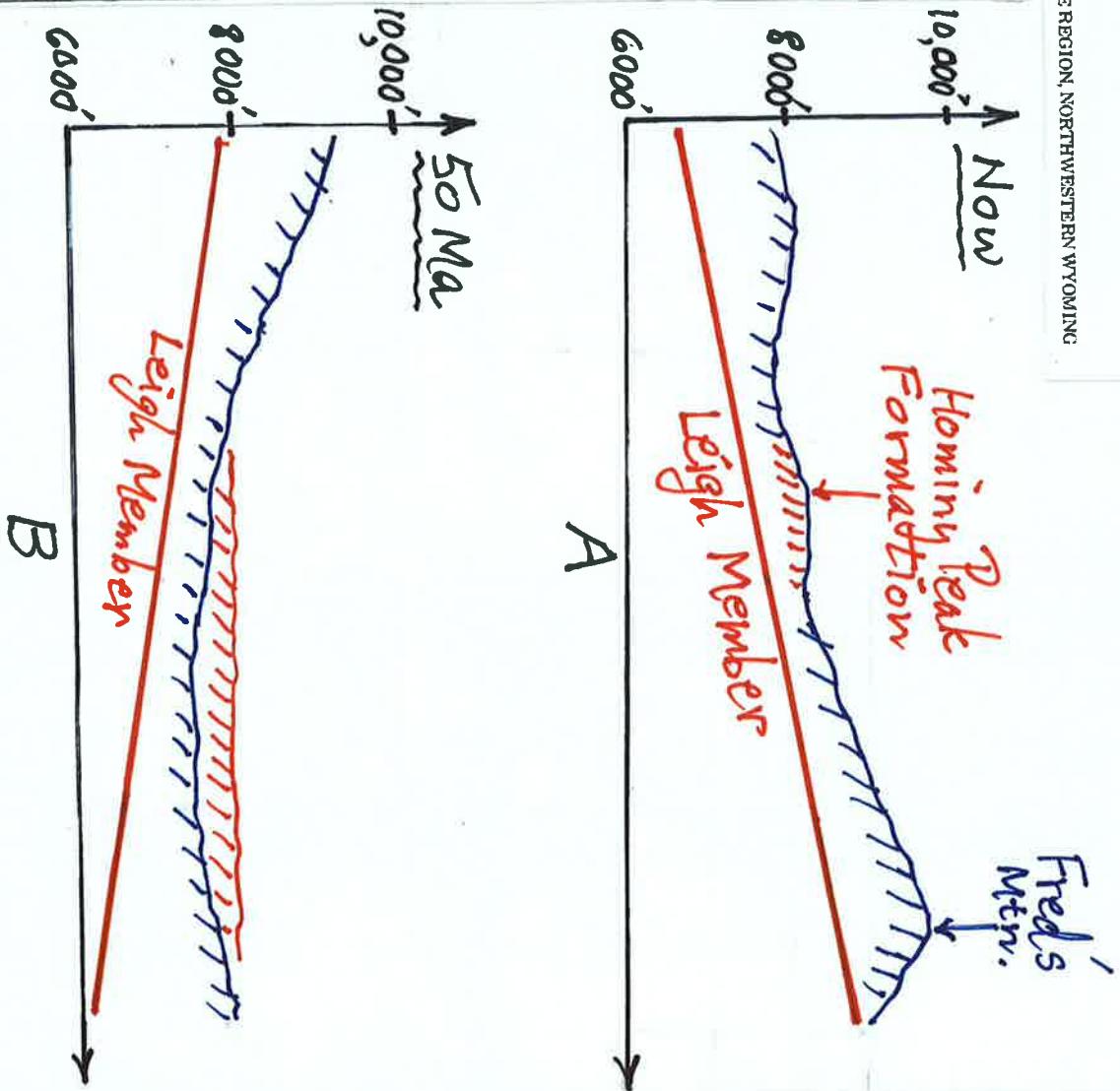


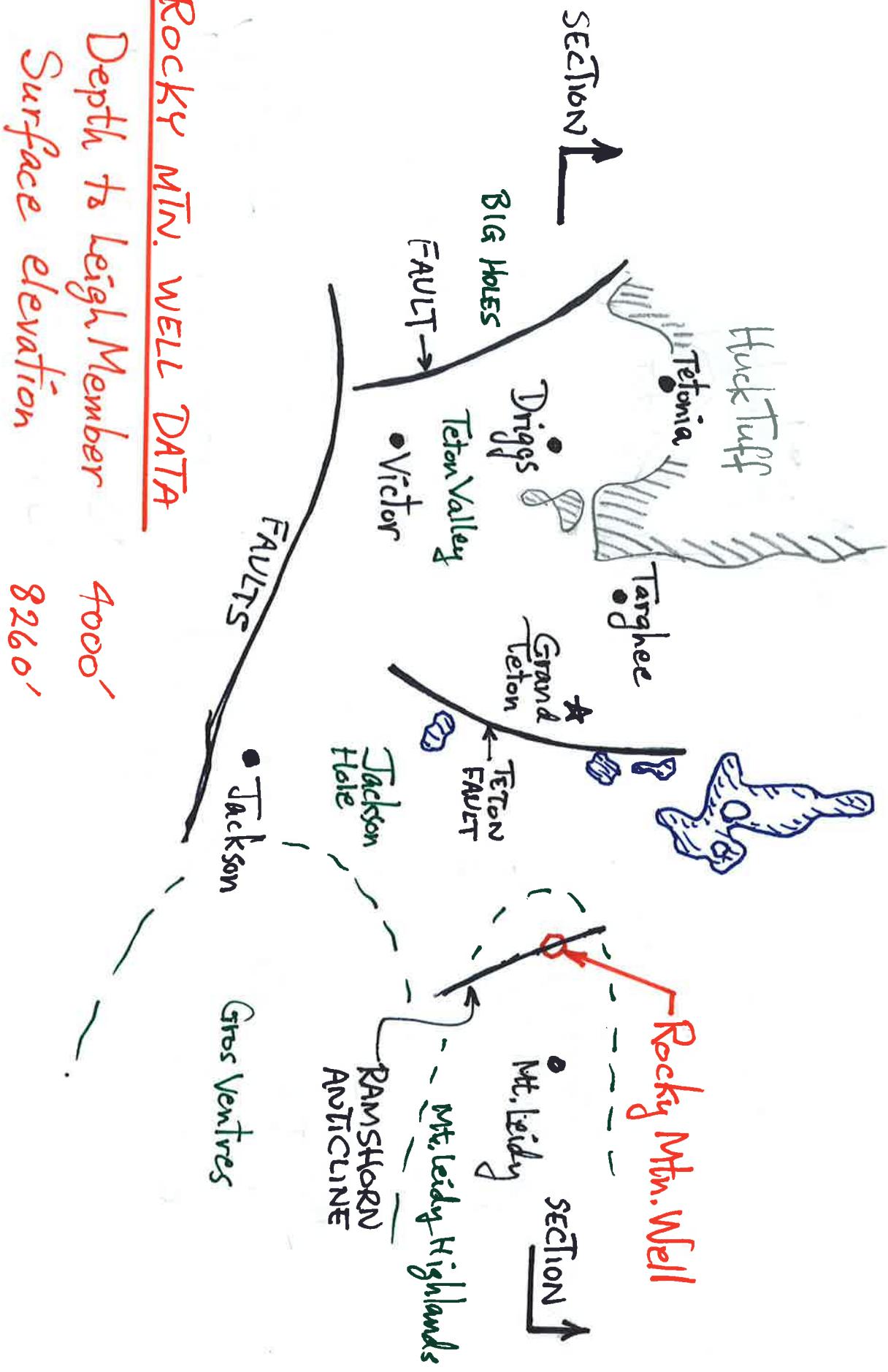
FIGURE 18.—Cross sections of rocks in the Grand Targhee Resort area. Section A. Present positions of rocks. Section B. Hypothetical position of rocks in middle Eocene time, determined by rotating section A 20°, until the Hornimy Peak Formation (Mm) is horizontal in an east-west plane, as it was believed to have been in middle Eocene time. No depositional dip is allowed for because the cross section is at approximately right angles to the stream carrying Hornimy Peak debris southward along a strike valley cut in part in soft rocks of the Derby Formation (Dd). No vertical exaggeration is in either section. Other rock units: Tensleep Sandstone and Amsden Formation (Pennsylvanian and Mississippian, (Pm); Madison Limestone (Mississippian, Mm).



## VI. The Regional Connection

- Summary of tilt in my study area:
  - 50 Ma - 10 Ma ~6° dip (to west)
  - 2 Ma ~10° "
  - Now ~20° "
- What is the bigger picture (especially eastward)?
- How does Leigh Member extrapolate to the other side of Jackson Hole (Shadow Mtn. # Mt. Leidy)?
- How does Leigh Member extrapolate elsewhere into Teton Valley (especially northwestward)?

## THE REGIONAL PICTURE (AGAIN)

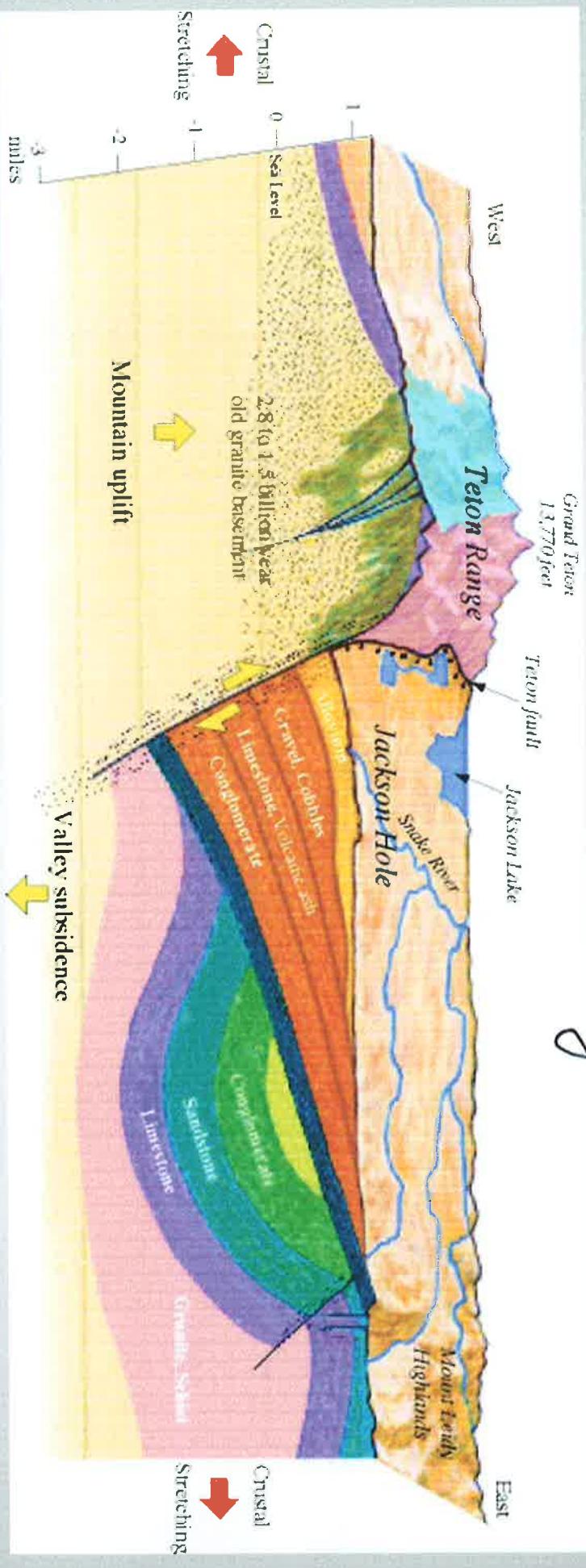


## Jackson Hole data:

- Shadow Mtn. (Rams horn Anticline) well log  
(Zehel, WGA Guidebook, 1956)
- Bob Smith slides
- USGS Map I-730 (Love, Reed, Christiansen, & Stacy)
- Undone homework

The Teton fault separates the uplifted mountain block from the down-dropped valley block by an estimated ~8 km (~30,000 feet).

(Courtesy, Bob Smith, U. of Utah)



**The Teton fault is a *normal* fault, typical of the Basin-Range with vertical displacement produced by stretching of the earth's crust to the west at 2-3 mm/yr.**

**Much of the fault is displacement is below the ground level -- Jackson Hole has dropped while the Tetons have risen. But sedimentation has filled the valley keeping up with the subsidence leaving the mountain block standing high.**

Love, Reed, Christiansen, & Stacy (1973)

U.S.G.S. Map I-730

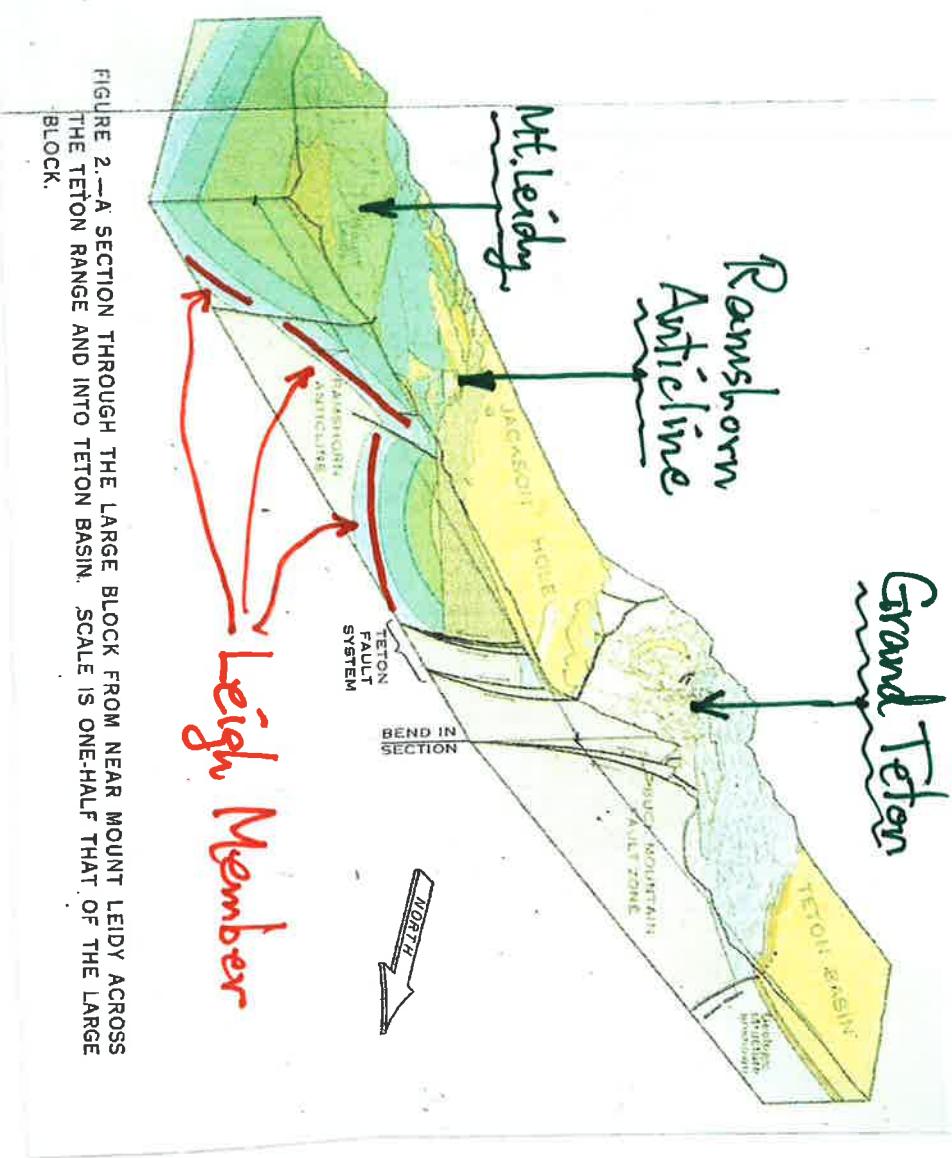
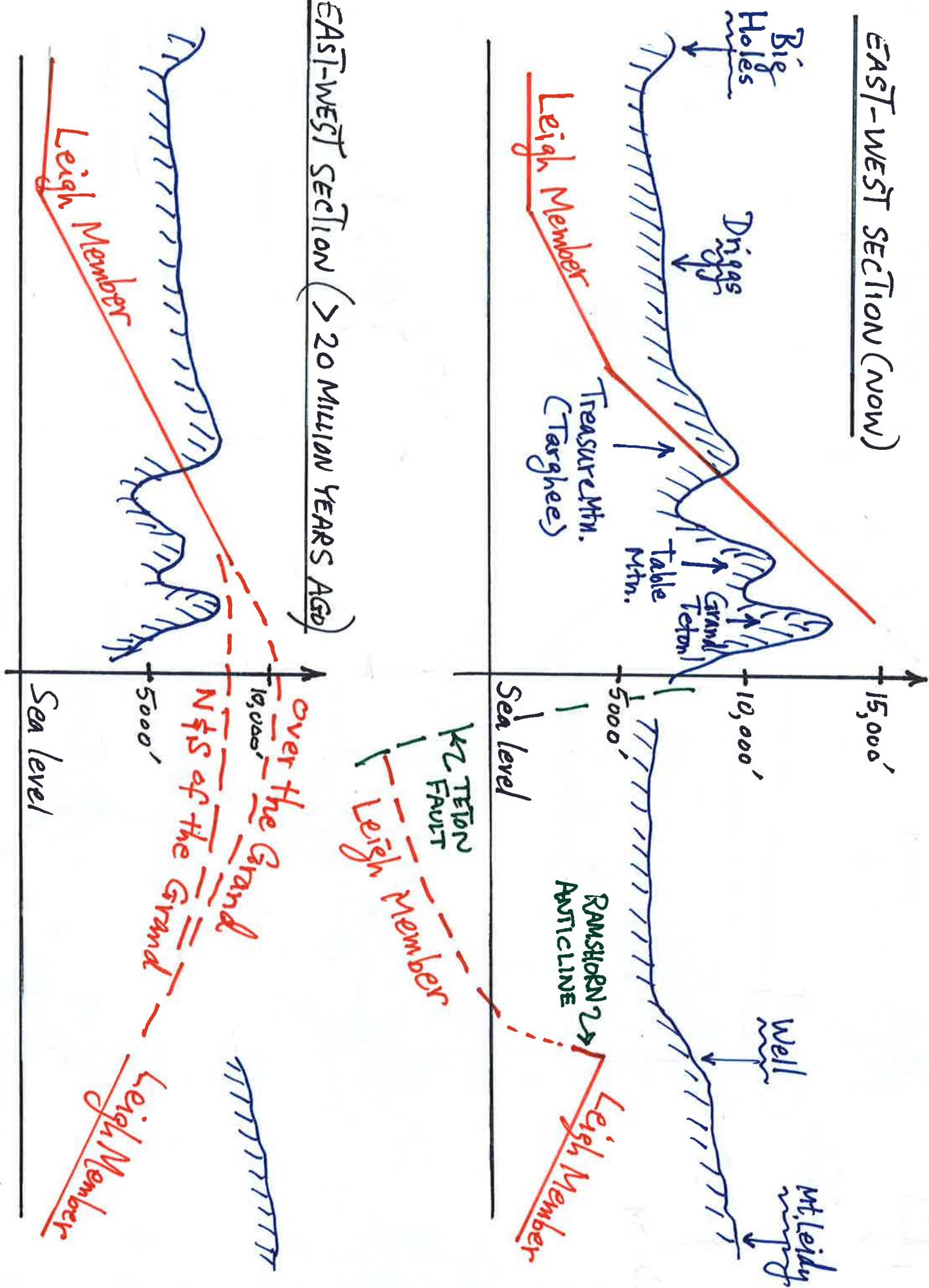


FIGURE 2.—A SECTION THROUGH THE LARGE BLOCK FROM NEAR MOUNT LEIDY ACROSS THE TETON RANGE AND INTO TETON BASIN. SCALE IS ONE-HALF THAT OF THE LARGE BLOCK.

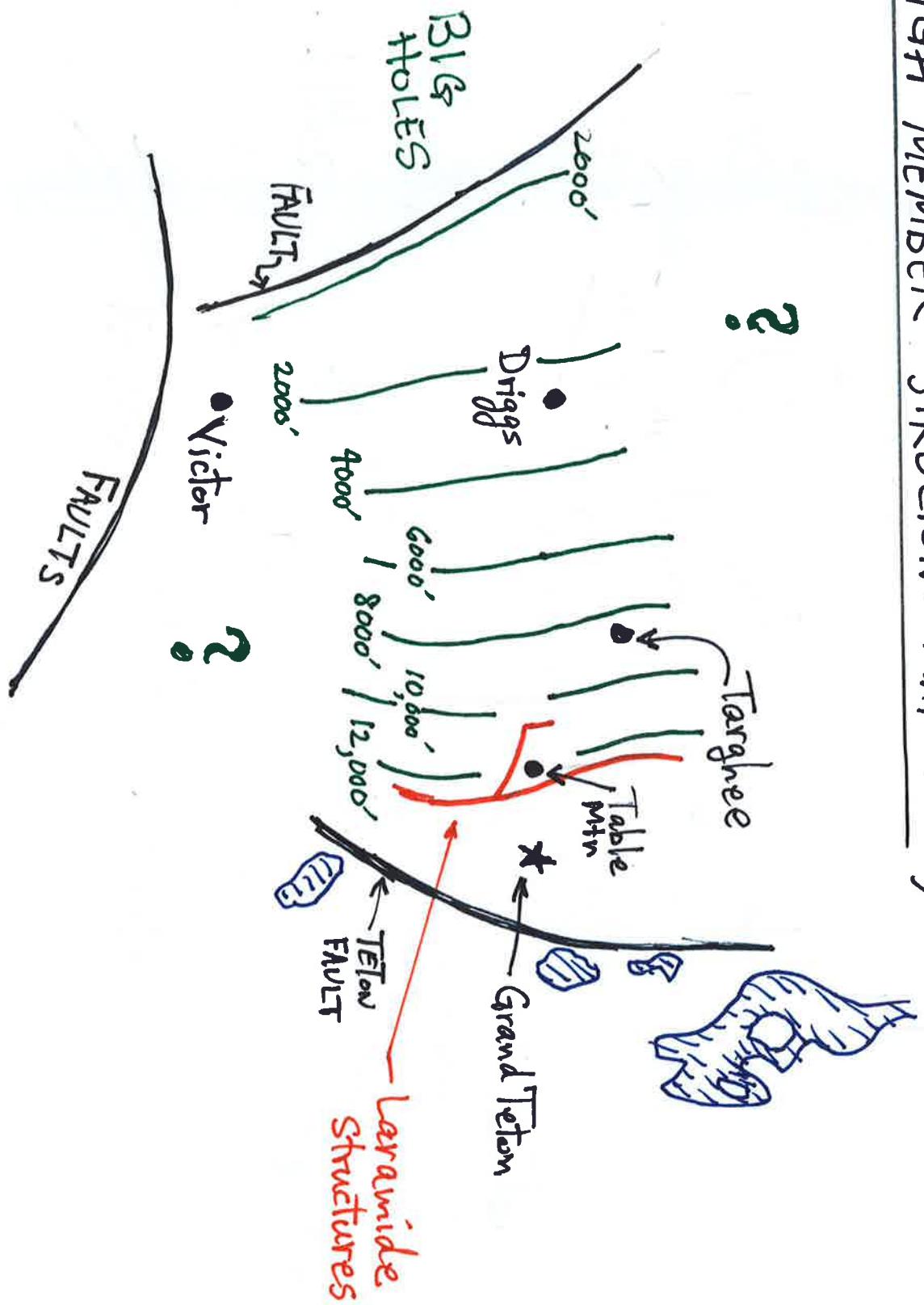
## EAST-WEST SECTION (now)



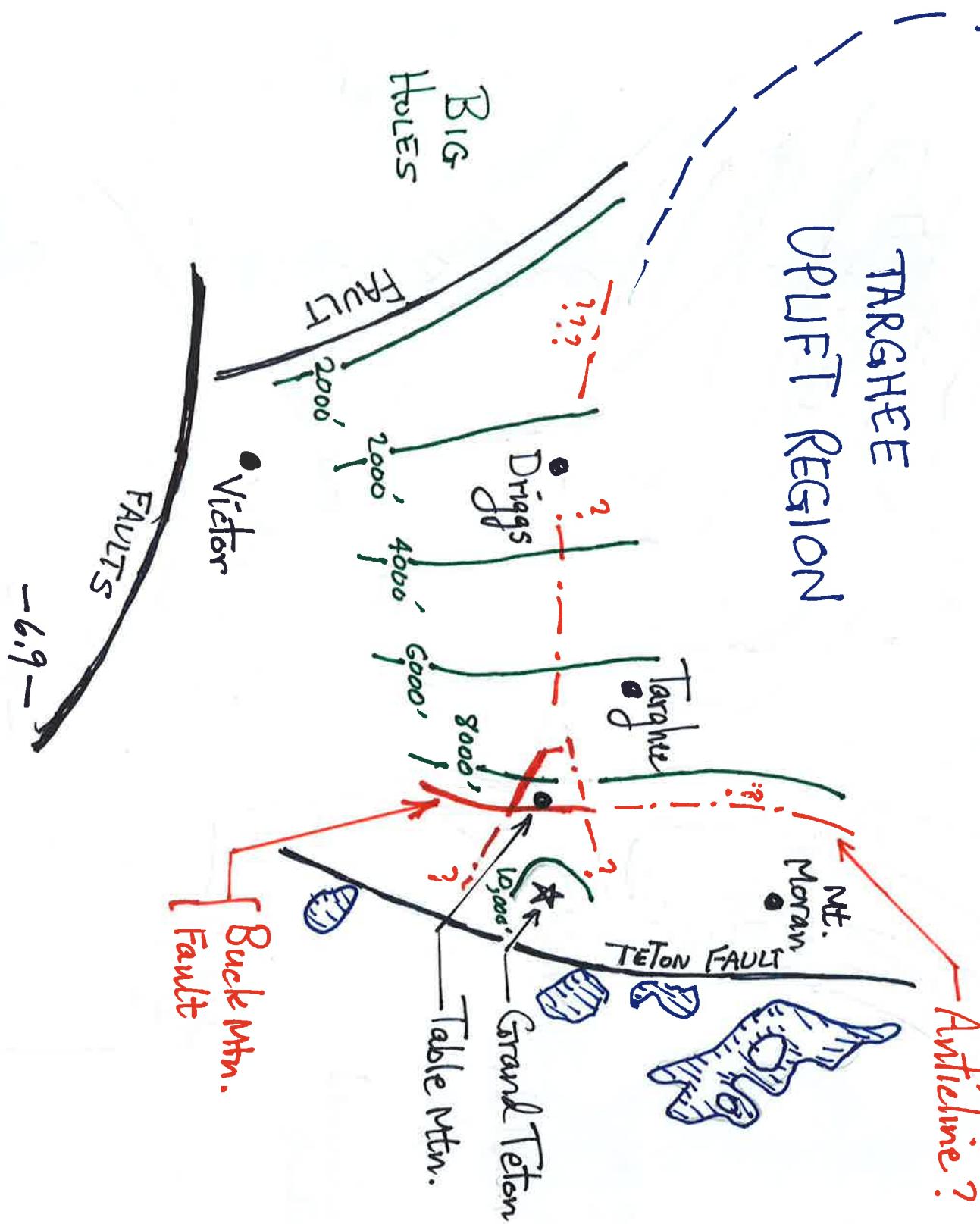
## What about the Targhee uplift?

- Where does the Leigh Member still exist?  
(Isopach maps)
- What does the Leigh Member structure map look like?
- Scenarios are (probably) not simple,

## LEIGH MEMBER STRUCTURE MAP (NOW)



# LEIGHT MEMBER STRUCTURE MAP (SOMA)?



## VII. What Next? My Future Geohistory

- Graze the Hominy Peak deposit
- Back to Alamo / Devonian
  - Hydrology
  - Caves
- Regional structure maps
  - Leigh
  - Jefferson
  - Birdbear
  - Three Forks

} Western U.S.
- Teton Valley earthquake data