Amargosa Chaos: A Product of Multiphase Deformation

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T1: Death Valley Tectonics
Tribute to Lauren and Benny
How did you walk into this problem?

'*'This is a mess'!

'*'I don't know, it is your thesis!
Noble’s Chaos (1941)

*Three Chaos “phases”*

- **Calico Phase**: Cenozoic Volcanics
- **Jubilee Phase**: Landslide Breccias
- **Virgin Spring**: Neoprot. Sed Rocks

*VS Chaos: “arrangement of the blocks is confused and disordered—chaotic”*

*formed in upper plate of “enormous” thrust fault*
Wright and Troxel’s Chaos (1984)

*“Four deformational events”*

Metamorphism of basement
Deposition of Pahrump (Super)group
Regional folding [Desert Hound Anctline]
Extensional chaos “largely or wholly movement on normal faults”

*“has consisted, in general, of a continuum featured by normal faulting.

*“not a regional surface of dislocation” acknowledged in previous talk from Miller
*Focus on geometry, mechanics, and the "continuum normal faulting" called for by Wright and Troxel (1984)

*find some order of Noble (1941) confused, "whale-shaped lozenges"

The overall geometry and the mechanics of the formation of the chaos, however, continue to puzzle us. Particularly perplexing is the manner by which a relatively large mass of chaos can be strongly extended while the immediately underlying block of the complex apparently is not. We have suggested (Wright and...
Castonguay’s Chaos (2013)

*area provides review of textbook-like features!
*sed rocks & struct.
*intrus. and volcs.
*gneiss and schist
*fans, falls, dunes
*folds and faults
*breccia, gouge, slicken
*contact and hydrothermal
*mining
Castonguay’s Chaos (2013)

*area provides review of textbook-like features!
...but it’s a mess!
Castonguay’s Chaos (2013)

*Six deformational events within VS chaos*

D1:
D2:
D3:
D4:
D5:
D6:
Castonguay’s Chaos (2013)

*Six deformational events within VS chaos*

D1: thrusts and folds (Castonguay, GSA 2012, Querétaro, MX)

D2: 

D3: 

D4: 

D5: 

D6: active Black Mountain front (Bodin ?)
Castonguay’s Chaos (2013)

*Six deformational events within VS chaos*

D1: thrusts and folds (Castonguay, GSA 2012, Querétaro, MX)
D2: 
D3: 
D4: 
D5: Domino faults (W&T #4 & Topping, next talk)
D6: active Black Mountain front (Bodin ?)
Castonguay’s Chaos (2013)

*Six deformational events within VS chaos*

- D1: thrusts and folds (Castonguay, GSA 2012, Querétaro, MX)
- D2: presently low-angle normal faults
- D3: regional folding (W&T #3; Turtlebacks)
- D4: Amargosa ‘surface’ (Miller)
- D5: Domino faults (W&T #4 & Topping, next talk)
- D6: active Black Mountain front (Bodin ?)
D4: Amargosa ‘surface’  

Miller (2018), previous talk

ble as a segment of his Amargosa thrust, extends beyond the most northwesternly exposures of the Pahrump Group and splays into the complex. There, too, southwest of the fault, the

Wright and Troxel (1984), regarding Noble (1941)

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Scenario A)
NO fold geometry
6 km / \sin(25) = 14.2 \text{ km}

Scenario B)
Pure Dip-slip
8-15 \text{ km}

Scenario C)
Pure Right-lateral
\sim 2.8 \text{ km}
D3: Broad Folds

Desert Hound Anticline
D3: Broad Folds
Chaos (?) Syncline
*Scallywag Syncline*
D3: Broad Folds
Desert Hound Anticline and Scallywag Syncline

Mancktelow and Pavlis (1994)
D2: Presently Low-angle normal faults

Plot showing areas labeled Basm., Noonday Dol., Beck Sp., and Crystal Springs w/ diabase.
D2: Presently Low

- Angle normal faults

*courtesy of Marli Miller*
D2: Presently Low-angle normal faults

*courtesy of Marli Miller
D2: Presently Low-angle normal faults, Which are folded...

D3: Broad Folds

Stereonet Analysis:

- 60, S35E
- 30, S20E

D2: ‘Shingle Faults’

\[
\text{200m} \div \sin(25^\circ) = 473 \text{ m}
\]

If the average difference between bedding and fault is 25°, and the stratigraphic offset is ~200m, then:
D2: Slip Assessments

Three Assumptions:
1) No previous deformation
2) Constant fault dip at depth
3) Generalized Stratigraphy

Crystal = 470 km

480m  2555m  600m  400m

Beck  Noonday  Johnnie  U. Johnnie

~4.5 km of slip
D2: ‘Shingle Faults’

Legend:
- GABS Basin Rocks
- Contact within Basement
- Base of Neoproterozoic
- Range Front Fault D6
- Domino Faults D5
- Dextral Amargosa D4
- Chaos Syncline D3
- Desert Hound Anticline
- Upper Johnnie Fault
- Johnnie Fault
- Noon Fault
- Beck Fault
- Crystal Fault
- Thrust Faults

Legend:
- C

Map showing various fault lines and geological features.
D2: ‘Shingle Faults’

Legend:
- GABS Basin Rocks
- Contact within Basement
- Base of Neoproterozoic
- Range Front Fault D6
- Domino Faults D5
- Dextral Amargosa D4
- Chaos Syncline D3
- Desert Hound Anticline
- Upper Johnnie Fault
- Johnnie Fault
- Noon Fault
- Beck Fault
- Crystal Fault
- Thrust Faults D1

C
C'

Chaos Syncline and folded Chaos Faults
Amargosa Fault
Noonday slab
Johnnie slab
Backslab
Crystal slab
D2: Presently Low-angle normal faults

Exentional Nappes?
Castonguay’s Chaos (2013)

*Six deformational events within VS chaos
  D1: thrusts and folds (Castonguay, GSA 2012, Querétaro, MX)
  D2: presently low-angle normal faults
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  D6: active Black Mountain front (Bodin ?)

*modern arrangement depends on earlier deformation

Chaos: small differences in initial conditions within a Dynamical system may lead to deterministic chaos.
Thank you!

Questions?

Marli and Kris
2011

Daughter
Neva
In the
Chaos

Lauren Memorial FT,
2013

Benny Memorial FT,
Sept. 2017

Benny and Sammy, 2011

UO Structural Geology FT, 2008

David and Sammy, 2011
This is a photo of Dorothy Noble and John Wollhemberg taken by Levi Noble. The three of them were en route to Bass Camp (there were two Bass Camps one on the rim and the other on the Colorado River) where Levi camped during his field work on his Ph.D. thesis. See USGS open file report no. 3 by Wright and Truax.