DEVONIAN STRATIGRAPHY IN THE TETONS

Jim Bjorken (bj)

I. INTRODUCTION TO THE DEVONIAN
II. THE WESTERN U.S. DURING THE DEVONIAN
III. THE ALAMO BOLIDE IMPACT
IV. OVERVIEW OF THE TETON DEVONIAN
V. MY OWN STUDIES IN THE TETONS
VI. SLIDE SHOW

GJH 27SEPT 2012
I. THE BIG PICTURE

UNIVERSE

Now

5 Ga

Planet Earth

Star & Galaxy Formation

BIG BANG

108 Ga

4 Ga

2 Ga

EARTH FORMED

PLANET EARTH

Black Dikes

Tetons Metamorphic Rock

Advanced Life

Advanced Life

Mammals

KT Extinction

Dinosaurs

Permian Extinction

Madison Limestone

Flathead Sandstone

Cambrian Explosion

Tetons Stratigraphy

200 Ma

400 Ma

0
Devonian Flora & Fauna

- Great big fish (placoderms)
- Lots of plant life (forests)
- Amphibians
- Beginnings of land life

5 ft.
CONODONTS

- Microfossils (barely visible)
- Ubiquitous worldwide (oceanic)
- Rapid evolution
- The best Devonian time standard
  - 35 zones within F-F stages (25 Ma)
  - Fixes the geoclock to 0.5-1 Ma (~0.2% accuracy)
  - Isotope methods have problems at 1% accuracy
- More on conodonts later
II. WESTERN U.S. PALEOHISTORY: LATE DEVONIAN (360 Ma)

Source: Ron Blakey
WESTERN U.S.: EARLY MISSISSIPPIAN (240Ma)

Source: Ron Blakey
WESTERN U.S.: LATE DEVONIAN (375 Ma)

Source:
Johnson, Sandberg, & Poole
"Devonian of the World"
(Canadian Soc. of Petroleum Geologists)
Memoir #14 1989
MY OWN
SEAFLOOR MAP

(At time of)
(Alamo impact)
SCHEMATIC OF THE PLATE TECTONICS

- Island arc (Allochthon)
- Proto-Antler Forebulge
- Pilot Basin
- Backbulge
- Carbonate platform

- Section is through Central Nevada
- Middle Frasnian (360 Ma)

Source: SDS Field Trip Guidebook 2007
PLATE-TECTONIC COMPLICATIONS

350Ma - 20Ma: Nevada Squished
20Ma - Now: Nevada Stretched

A Good Source:
Fiero, "Geology of the Great Basin"
SEA LEVEL HISTORY

<table>
<thead>
<tr>
<th>MISSISSIPPIAN</th>
<th>FRASNIAN</th>
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<tbody>
<tr>
<td>(Darby-Formation Units)</td>
<td>Birdbear?</td>
</tr>
<tr>
<td>Cottonwood Canyon</td>
<td>Maywood?</td>
</tr>
<tr>
<td>Three Forks</td>
<td>Beartooth Butte</td>
</tr>
</tbody>
</table>

- 360 Ma - (EXTINCTION)
- 365 Ma -
- 370 Ma - Extinction
- 375 Ma -
- 380 Ma -
- 385 Ma -

FALL ← RISE
(50 - 100 m.??)

Source: SDS Guidebook (2007)
III. THE ALAMO BOLIDE IMPACT

- WHERE? SE Nevada (just east of Site 51)
- WHEN? Mid-Permian (382 Ma)

- OCEANIC IMPACT: On edge of carbonate platform (depth ~200m?)
- BIG TSUNAMI: Initial wave height ~300m??

- CRATER DIAMETER: ~50 km.
- CRATER DEPTH: 1.5-2.5 km.

- Crater paleogeography messed up by plate tectonics (Antler orogeny)
- Site 51 is off limits

- EVIDENCE:
  - Megabreccia
  - Shocked quartz
  - Iridium
  - Widespread stratigraphic evidence
  - More...
WHAT MIGHT TSUNAMI EVIDENCE LOOK LIKE?

- Unusual beds
- High-energy breccia (poorly sorted elastics)
- Site-to-site variability
- Erosion channels
- Carbon fragments (from forest fires)
MY HISTORY

2006
- Awakening to earth science (D. Irwin, "Extinction")
- Learn about Alamo impact
- Consultation with experts
- Photomapping of Teton Devonian

2007
- Field work
- SDS field trip/symposium (Sept.) in Nevada

2008
- Field work / conodont search

2009
- Mt. Meek N Ridge
- Ranie Lynds section (Fred's Mtn.)

2010
- Exploration of outlying sites

2011
- Huckleberry Ridge Tuff

2012
- G J H
EXPERTS WHO HAVE HELPED ME

• Charlie Sandberg
• Jared Morrow
• Melanie Ramsmeier
• Glenn Embree
• Forest Gahn
• Gordon Baird
• Carleton Brett
• Alex Bartholemeow
• Jed Day
• Paul Link
• Leif Tapanila
• Peter Isaacson
• George Grader
• Ranie Lynds

• USGS (Denver)
• San Diego State Univ.
• National Park Service (Denver)
• BYU Idaho (Rexburg)
• SUNY Fredonia (NY)
• U. of Cincinnati
• SUNY New Paltz (NY)
• Illinois State Univ. (Normal, IL)
• Idaho State Univ. (Pocatello)
• U. of Idaho (Moscow)
• U. of Wyoming (Laramie)

- 3.5 -
## Teton Devonian History

<table>
<thead>
<tr>
<th>Researcher</th>
<th>Year</th>
<th>Institution</th>
<th>Stratigraphic Sections</th>
<th>Misc.</th>
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<tbody>
<tr>
<td>Eliot Blackwelder</td>
<td>1911-18</td>
<td>U. Chicago</td>
<td></td>
<td>Name of Darby Formation</td>
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<tr>
<td>Helen Foster</td>
<td>1947</td>
<td>U. Michigan thesis</td>
<td></td>
<td>Mt. Glory</td>
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<tr>
<td>C.C. Reeves</td>
<td>1964</td>
<td>Texas Tech (Lubbock)</td>
<td>Teton Canyon (Boy Scout Camp)</td>
<td>Fish fossils</td>
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<tr>
<td>David Mikesh</td>
<td>1965</td>
<td>U. Iowa thesis</td>
<td>Teton Canyon (South Fork)</td>
<td>Incomplete Section</td>
</tr>
<tr>
<td>Anthony Bensen</td>
<td>1965</td>
<td>Pan Am Petroleum</td>
<td>Teton Canyon (Darby Canyon Taylor Mtn.)</td>
<td></td>
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<tr>
<td>Ronnie Lynds</td>
<td>2009</td>
<td>U. Wyoming</td>
<td>Fred's Mtn.</td>
<td>Definitive</td>
</tr>
</tbody>
</table>

- 4.1 -
V. MY EXPERIENCES IN THE TETONS

- Finding good sites
- Stratigraphic sections
- Correlating the data
- Dating the samples (conodonts)
- Hydrology
DEVONIAN EXPOSURES IN THE TETONS

Moran
Leigh Cyn.
Woodring
Cascade Cyn.
Owen
Grand
Garnet Cyn.
South
Avalanche Cyn.

Death Cyn.
Buck

Teton Fault

Little's
Table

N. Leigh Ck.
S. Leigh Ck.
Teton Ck.

N.
S.

GTNP Boundary

Study Area

-5.2-
GOOD DARBY EXPOSURES

Good Sites
My Personal Sites

- Moran
- Leih Cyn.
- Woodring
- Cascade Cyn.
- Owen
- Grand
- Middle
- South
- Barnett Cyn.
- South
- Buck
- Death Cyn.
- Teton Fault
- N. Ridge Mt. Meek
- Meek
- J. Smith
- GTNP Boundary
- W. Ridge Fossil Mtn.
- N. Fork Darby ch.
- Darby Cyn.
- Teton Cyn (Boy Scout camp)
- Teton Cyn
- Milk Ck.
- Road
- S. Leigh Ck.
- N. Leigh Ck.
- Fred's
- Mary's Darby Ridge
- Mary's E. Ridge
- Wedge E. Ridge
- Devil's Staircase
- Little's
- Table

Study Area
State Line

-5,-3-
GENERAL REMARKS

- Cottonwood Canyon: most prominent on Mary's Nipple
- Three Forks: usually covered
- Birdbeart: often forms sensation cliffs
- Jefferson: sequence structure often evident
- Maywood/Beartooth Butte: obscure role; dating needed
- Darby/Big Horn unconformity: not easy to pinpoint
- N. Darby Ck. & Mill Ck. partial sections poorly linked to others.
- Dating the strata via conodonts very important.
- My sampling interval was typically 2" - 6".
- Most samples are dolomite.
- But limestone beds are there.
- Benson's "detrital units" were poorly studied by me.
CONODONTS

- Typical yield: a few/kg of rock
- Limestone only
- Procedure:
  - Crush the rock (mortar & pestle)
  - Dissolve in vinegar
  - Sieve the residue
  - Discard the coarsest
  - Discard the finest
  - Separate via density using two (toxic) heavy liquids
  - Scan residue under microscope

**Bottom Line:** I tried & failed - 5.6 -
HYDROLOGY

- Caves exist within the Darby Formation.
  (Thanks here to Bob Benedict)

- Cave entrance is located below the Birdbear in the Jefferson.

- Several springs can credibly be attributed to a permeable/soluble bed in the Jefferson (detrital unit Bore)

- Tilt of strata implies huge hydrostatic pressure buildup of trapped water \[\Rightarrow\] fossil springs ???

- Are the springs associated with paleo-channels ??
"Sample A" found in 1947, Mt. Glory, Lower Darby, by Helen Foster

Fig. 40. Bothriolepis, dermal bone ornament (x 3/4). A; B. darbiensis, sp. nov., left half of centro-nuchal plate, Univ. Mich. 27547, Teton Pass, Wyoming.