

Association of Environmental and Engineering Geologists

THE BEAR RIVER FAULT ZONE, WYOMING AND UTAH: REVISTED

Michael W. West, Ph.D., P.E., P.G.

In 1983, Gibbons & Dickey (U.S. Geological Survey) identified an anomalous zone of late Quaternary faulting in southwestern Wyoming, approximately 129 km east of the Wasatch Front, then generally considered to be the eastern margin of the Basin and Range tectonic province. Subsequent studies (West, 1989; 1992) of the Bear River fault zone (BRFZ) indicated Holocene tectonic extension was superimposed on and controlled by pre-existing thrust faults. Holocene deformation also had implications for development of the transition between the eastern Basin and Range and the Middle Rocky Mountains/Colorado Plateau tectonic provinces.

Localization of extensional movement along pre-existing low-angle thrusts was in conflict with the prevailing model for large-magnitude earthquakes accompanied by surface faulting in the Intermountain Seismic Belt (ISB). The model relating surface faulting, subsurface structure and earthquake magnitude was either more complex than previously thought or, alternatively, a seismogenic cycle operates at different stages of development in parts of the ISB. Study of late Quaternary surface faulting in north-central Utah and southwestern Wyoming provided important clues to these questions.

In 2008-09, the U.S. Geological Survey, as part of studies related to the Yucca Mountain nuclear waste repository, assessed maximum hazards/risks posed by known seismogenic faults in the Basin and Range province. These studies suggest that the BRFZ represents the greatest potential earthquake hazard in the Basin and Range province, based on apparent net slip per surface faulting event.

The BRFZ extends over 40 km from southeast of Evanston, Wyoming to an apparent complex intersection with the North Flank fault of the Uinta Mountains in north-central Utah. The fault zone consists of well-defined scarps each about 3.0 to 3.5 km in length arranged in a right en echelon pattern. Major scarps strike N 20°W to N 20°E and show consistent, down-to-the-west displacement. Short antithetic, down-to-the-east scarps strike N 15-20°W.

(Abstract continued on next page)

MEETING DATE

Thursday
April 8TH, 2010

TIME

5:45 p.m. Social Hour
6:30 p.m. Dinner
7:30 p.m. Presentation

LOCATION

**Berthoud Hall,
Colorado School of
Mines**

1516 Illinois St.
Golden, Co 80401
Room 205
See Map Below

COST

\$25 Members
\$27 Non-members

RESERVATIONS

meetings@aeqrms.org
or
WWW.AEGRMS.ORG

**BY NOON,
TUESDAY
April 6TH**

(Michael W. West Abstract, continued)

Near the south end of the fault zone, scarps in Pleistocene glacial deposits show strong angular discordance (70°) with the main north-northeast pattern of faulting. Late Quaternary movement is indicated by scarps ranging from <1 to 15+ meters high in till, outwash, alluvium and bedrock of the Eocene-age Wasatch Formation; beheading and reversal of streams, and sag ponds.

Neotectonic deformation results from regional east-west extension superimposed on the Darby-Hogsback and Absaroka thrust plates. Preexisting thrust faults were reactivated in a normal sense and caused propagation of "new" listric normal faults over stress points, particularly at the transition from thrust ramps to flats. The BRZ developed above the Darby-Hogsback ramp and has experienced recurrent, Holocene movement over a length of 21 to 25 miles (34 to 40 km) with net vertical tectonic displacements ranging from less than 3 feet to greater than 16 feet (<1 to >5 meters) per event. Two distinct surface faulting events are represented by scarps and associated scarp-derived colluvial deposits.

Ages of surface rupture were estimated by radiocarbon dating of tectonically-buried and modern A-horizons and other organic material exposed in trenches excavated across late Quaternary fault scarps. Calibrated radiometric ages indicate surface faulting events occurred at 4620 ± 690 and 2370 ± 1050 radiocarbon years before present (yrBP). Recurrence intervals, based on these ages, range from about 2250 to over 2370 years.

Surface rupture lengths of 34 to 40 km, vertical tectonic displacements of <1 to >5 meters per event, and slip rates of 0.8 to 2.7 mm/year indicate the BRZ produced paleoearthquakes of magnitude 7.5. The mean age of latest surface rupture ($2370 \pm$ yrBP) and minimum apparent recurrence interval (2250 years) suggest a major earthquake could occur at any time in southwestern Wyoming and north-central Utah.

The Martin Ranch scarp, about 7.2 km to west of the BRZ, is coincident with the leading edge of the Absaroka thrust and developed in response to normal reactivation of the preexisting thrust plane. Related tectonic deformation, extending at least 10 km south of the Martin Ranch scarp, deflected the channel of the Bear River. Scarp-derived colluvial deposits record one surface faulting event over a length of 5.0 km. Mean net vertical tectonic displacements for the single event range from 0.8 to 1.4 meters. The age of latest surface rupture is coeval with latest surface rupture in the Bear River fault zone, 2370 ± 1050 yrBP. Similar ages of movement suggest displacement along the Martin Ranch scarp occurred as a simultaneous response to east-west extension superimposed on preexisting thrust and ramp-normal faults.

Fault scarps displacing Pleistocene geomorphic surfaces and associated outwash/alluvium and regional, eastward tilt of terrace surfaces indicate the leading edge of the Darby-Hogsback thrust was also reactivated but now may be inactive due to development of the BRZ over the ramp structure to the west. Normal displacements along the leading edge of the Darby-Hogsback fault are believed responsible for apparent separation of the Bear and Green River drainage basins less than 600 ka.

Research in southwestern Wyoming and north-central Utah, in comparison with the Hebgen Lake (1959) and Borah Peak (1983) earthquake areas, suggests different levels of maturity and tectonic/structural relationships exist with time and location in the ISB/eastern Basin and Range transition zone. Hebgen Lake and Borah Peak represent mature seismogenesis manifested by imposing fault-bounded mountain blocks and evidence of recurrent normal fault movements with great displacements. The Bear River fault zone and normally-reactivated thrust faults represent an early, youthful stage of seismogenesis in a preexisting thrust-faulted terrain. Continued tectonic deformation may produce fault-bounded mountain ranges with remnants of thrust plates preserved within the block similar to the Wasatch Mountains east of Salt Lake City. Major seismogenic faults, which may be "blind" sub-decollement structures in early stages of extension, eventually rupture the surface as a 45° to 60° planar faults. The early tectonic relationship between regional extension and normally reactivated leading edges of thrust faults and ramp structures is destroyed with time.

Need for Newsletter Editors

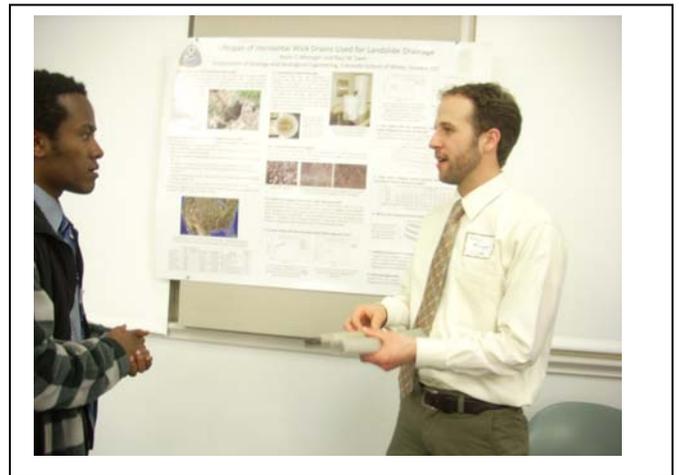
I will be stepping down as newsletter editor this spring after 9 years. The Section is in need of one or two people to take the role of newsletter editor(s). The section would also like to add some “fresh blood” to the board, of which the newsletter editor is a member. If you are interested in assuming the role of newsletter editor and helping to guide the Section, please e-mail newsletter@aeqrms.org. The editor usually spends 1 to 2 hours a month preparing the newsletter and coordinating/obtaining presentation abstracts. I will provide you with the necessary templates and information. Julia, Jill, and I will also help guide the new editors on our standard procedures and we will not completely toss the lucky individuals to the sharks!

Ed Friend

Student Night photos:



Chair-Elect Nate Soule with student poster presenters. From left: Nate Soule, SDSMT's Katrina Knodel and Jacob Dow, and CSM's Matthew Minnick and Kevin Mininger



Kevin Mininger at right explaining his horizontal wick drain research to Henok Tiruneh from SDSMT. Kevin's presentation earned him the Brunton GEO Transit donated by Golder Associates (Thanks Liv and congratulations Kevin!)

Upcoming Meeting

<p>May 13</p>	<p>AEG-RMS Section Meeting & Family Night Speaker: Vince Matthews, Colorado Geological Survey Topic: TBD</p>	<p>CSM Berthoud Hall Room 243</p>
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Many thanks to our AEG members and CSM, SDSMT and CSU students and professors who attended, contributed to and helped with Student Night:

- **Janine Weber** for providing beverages
- Dry Dock Brewery and Beer Hut in Aurora for donating ingredients
- Our esteemed poster judges who missed out on dinner because of their poster-judging diligence: **Becky Roland, Roger Barker** and **Dr. Dave Noe**
- **Dr. Kurt Katzenstein** and his three students who made the long drive from SDSMT to participate
- Our student poster presenters: **Jacob Dow/Katrina Knodel, Matthew Minnick**, last minute participant **Brian Sanford** and Brunton recipient **Kevin Mininger**
- **Nate Soule** for putting together the Student Night Program (you DID take one, didn't you?)
- **Holly Brunkal** and the **CSM Student Chapter** for coordinating the Silent Auction, the meeting room, the resume books, etc.
- And our generous...

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THANK YOU!!!

CGS Job Opening

The Colorado Geological Survey has an opening for a senior level geologist (Physical Science Researcher/Scientist III) with expertise in petroleum and natural gas exploration, and CO₂ Sequestration science.

Minimum requirements are a Bachelor's degree from an accredited college or university in geology, petroleum geology, or other closely related geoscience subject area and four years of experience in petroleum and natural gas exploration. Experience should include project management and report writing. Graduate-level coursework in geology including petroleum, natural gas, and/or geologic CO₂ sequestration is highly desirable, as well as experience in CO₂ sequestration research, studies, or applications.

Applications must be submitted by April 28, 2010. Applicant must be a resident of Colorado.

A detailed description of the duties and requirements of the position and how to apply can be found at the following website:

<http://www.gssa.state.co.us/announce/Job%20Announcements.nsf/54c67aad0c28fbac87257448005063b7/6a6b6f184b118e96872576e9005d8ae7?OpenDocument>

Passing of an AEG – Rocky Mountain Section Member

Dr. Charles S. Robinson, Ph.D., P.E. passed away quietly early Saturday, March 20, 2010 attended by family. Having a long and distinguished career in the United States Navy, United States Geological Survey, and private practice Robby will be missed by his many friends and colleagues. Robby is survived by; his wife of 60 years Elizabeth (Libby), children, Virginia Owen, Charlie, Peter, and Bob; 7 grandchildren, and 3 great grandchildren. No memorial services are planned. It was Robby's wish that in lieu of gifts or flowers please contribute in his honor to the Hospice of Saint John (303-462-1481 www.hospiceofsaintjohn.org).

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