The Rocky Mountain Section Newsletter

April 2013

Association of Environmental and Engineering Geologists

MEETING DATE

Thursday
April 11th, 2013

TIME

5:45 pm Social Hour
6:30 pm Dinner
7:30 pm Presentation

LOCATION
American Mountaineering Center
710 10th St.
Golden, CO 80401
Conference Rooms A & B
(Across from the climbing wall in the foyer)
See Map Below

COST
$25 Members
$30 Non-members
$10 Retired members
$10 Students (first meeting free)

RESERVATIONS:
click: aegrms.org/rsvp
or email:
meetings@aegrms.org

BY NOON, TUESDAY
April 9TH

April Section Meeting
with AEG 2013 Distinguished Jahns Lecturer

James McCalpin

Paleoseismology: Has it Reduced Seismic Hazards, and if not, How Do We Change Course?

Thursday, April 11, 2013
American Mountaineering Center
Conference Rooms A & B
710 10th Street, Golden CO 80401

Abstract

Recent deadly earthquakes have shaken public confidence in our methods for assessing seismic hazards, and has earthquake scientists (including paleoseismologists) wonder what we are doing wrong. As a result of the 2009 L'Aquila earthquake in Italy, six scientists were convicted of manslaughter for failing to warn the public before the earthquake. The 2011 Tohoku earthquake in Japan was a full magnitude larger (M9.0) than the design value for the Fukushima Nuclear Power Plant and the local coastal seawalls, resulting in 15,870 deaths and tens of billions of $US in damages. In both countries, seismic hazard assessment is considered sophisticated and uses paleoseismic data and Probabilistic Seismic Hazard Assessments (PSHA) to ensure that low-probability earthquakes are adequately considered. Yet despite that fact, we are still experiencing deadly "surprises." The situation suggests that there is a flaw somewhere in the flow chart of seismic hazards assessment and mitigation.

When modern paleoseismology was developed in the 1970s, it promised to supplement the short historic/instrumental record of earthquakes (50 yrs to a few centuries) by 2-3 orders of magnitude in time. By studying the surface ruptures of Holocene/late Quaternary earthquakes, we could estimate M_{max} for each active fault and the return time of M_{max}, thus filling in the "missing" large-magnitude part of the earthquake frequency-magnitude curves. The seismic source parameters coming from paleoseismology are these: M_{max}, return period of M_{max} (recurrence interval), and slip rate.
(Continued on page 2)

Jahns Abstract, cont.

However, **Seismic source characterization** is only the first half in Seismic Hazard Assessment; it is followed by **Ground Motion Prediction**, to create the output of PSHA (a hazard curve of ground motions and their associated probabilities/return periods). Perhaps the failure can be traced to the GMP process, or to the **PSHA procedure** in general. The ground motions predicted then must be used in **engineering design** (for new buildings) and retrofits (for existing buildings). But the degree to which design is actually performed is dependent on **liability** and **government regulations**. Based on my experience with PSHA and paleoseismic data inputs, I have the following conclusions:

THE MAIN REASONS WHY PSHAs <u>UNDERESTIMATE</u> THE HAZARD

1. Unknown active faults are close to the site and generate unanticipated M_{max} earthquakes: *1994, M6.7, Northridge, CA, reverse/blind; 2001, M7.7, Bhuj, India, reverse/blind; 2003 M6.6, Bam, Iran, reverse/blind; 2007, M6.6, Honshu, Japan, reverse/blind (shut down K-K NPP); 2009, M6.3, L'Aquila, Italy, normal/ nearly blind; 2010-11, M7.1 and M6.3, Christchurch, NZ, strike-slip*

2. Active faults are known close to site, but their return time is underestimated, and/or their conditional probability of rupture was never calculated. Most PSHAs ignore the position of a fault within its seismic cycle, and assume that the probability of M_{max} is time-independent (i.e., the same within every year of the cycle). Conditional Probability says that the annual probability of M_{max} is time-dependent (i.e., it increases as the fault reaches the end of its seismic cycle of strain accumulation and then release). *2005, M7.6, Kashmir, reverse; 2008, M7.9, Sichuan, reverse; 2010, M7.0, Haiti, reverse*

3. Active faults are known close to site, but their M_{max} is underestimated. Large underestimates occur when M_{max} earthquakes break multiple segments, and the PSHA assumed only single-segment ruptures: *2011, M9.0, Fukushima, Japan; subduction megathrust*

4. Active faults are known close to the site, and their M_{max} and recurrence times are correctly known, but the secondary damaging effects are underestimated: *Tsunami, 2004, Sumatra, M9.1; Tsunami, 2011, Japan, M9.0*

THE MAIN REASONS WHY PSHAs <u>OVERESTIMATE</u> THE HAZARD

1. Assuming that the recurrence time is shorter than it actually is. This is common when a fault shows a "temporal cluster" of late Quaternary paleoearthquakes with recurrence times much shorter than the long-term average. For the sake of conservatism the PSHA assumes we are still in a cluster today, and the intra-cluster recurrence is heavily weighted in the logic tree, rather than the long-term average or intercluster rate. This is done even when contemporary GPS vectors show that strain rates today (present seismic cycle) are essentially equal to the long-term average rate: Mears Fault, OK, cluster of two late Quaternary events, previous event in the Pennsylvanian; Cheraw Fault, CO, cluster of three late Quaternary events, but only three more in the past 1 Ma; Pajarito Fault, NM, supposed cluster of three Holocene events, recurrence of 4 kyr compared to long-term recurrence of 18-20 kyr; Some faults in interior Australia

My observations suggest that paleoseismologists should do the following to better estimate the true hazard:

1. Use new imaging tools (e.g. LiDAR, geophysics) to discover presently-unknown blind faults near cities and critical sites.

2. Increase the precision of measuring the mean recurrence time of a fault and its elapsed time (time since the Most Recent Event). This would included dating long sequences of paleoearthquakes to measure the variability in recurrence and any possible clustering in time, and the causes of clustering (random versus deterministic).

3. Use the new information above to calculate the Conditional Probability of future M_{max} ruptures, and put that information into the PSHA.

4. Develop a new comprehensive PSHA that includes all hazards from earthquakes (surface rupture, ground motion, and ground failure). The first two methods already exist, although Probabilistic Fault Displacement Hazard Analysis currently is subject to large uncertainties, due to lack of data on secondary coseismic faulting. There is currently no formal method of PSHA for ground failure, which tends to be very site-specific (i.e., for many sites the probability of ground failure is zero, regardless of the ground motion).

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Words from the Chair

Greetings Rocky Mountain Section,

Student Night last month was a great success with 8 presenters from the Colorado School of Mines and the South Dakota School of Mines and Technology, including **Katie Aurand, Brett Arpin, Yodit Asmare, Casey Dowling, Ben Lowry, Ryan Marsters, Kevin McCoy, and Justin Rittgers.** We were very pleased to hear from so many students this year! **Katie Aurand** took home the grand prize for her poster and research presentation. All the student presenters were impressive and the Section enjoyed learning of their ongoing research. There was not only a great student turnout, but our members and supporters came through again this year with generous donations for students. Thank you to all who sponsored this event! Student Night was a success because of the efforts of other contributors as well, including Paul Santi, Jerry Higgins, Kurt Katzenstein, Jill Carlson, Carlos Hernandez and all the CSM Student Chapter officers, Diana Cook, Dave Glater, Kevin Mininger, Casey Dowling, and Kevin McCoy.

This month I am excited to welcome the 2012-2013 Jahns Lecturer to our section meeting: James P. McCalpin of GEO-HAZ Consulting, Inc. located in Crestone, Colorado (www.geohaz.com). James will be presenting on one of his specialties, Paleoseismology, a talk you will not want to miss. It is always a pleasure to have the traveling Jahns Lecturer visit our section, and I'm sure many members will appreciate connecting with our fellow Coloradoan.

Next month the AEG Board of Directors mid-year meeting takes place on the weekend of May 18, directly following the Shlemon Speciality Conference in Denver on May 16-17. If you have any comments or concerns you would like represented to the Board, let me know via email or at the April meeting.

We are nearing the end of our 2012-2013 year and our summer hiatus is looming in the near future. Please take some time (5 minutes) to fill out the field trip survey so we can start planning trips for the summer, fall, and beyond. We want your input so we can plan according to our membership's interests and availabilities.

Julia Frazier
AEG RMS Chair

Field Trip Survey

The AEG-RMS Field Trip Committee is conducting a brief, one-page survey about member preferences for 2013 field trips. Please click on this link to participate:

http://www.surveymonkey.com/s/37KNXDY

There are instructions in SurveyMonkey on how to fill out the survey. Questions? Please contact Dana Willis at Dana.Willis @ newmont.com.

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THANK YOU to all of our generous 2013 Student Night Sponsors

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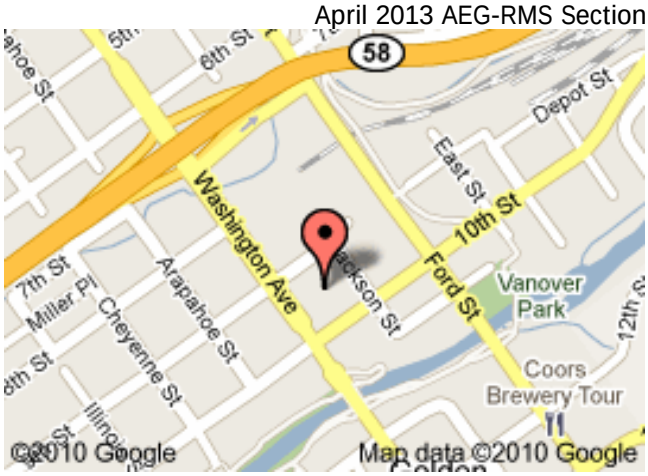
April 2013 AEG-RMS Section Meeting Location (Google map link):



Upcoming Meetings

May 9 – Bill Schultz, USGS

May 16-17 -- AEG Shlemon Specialty Conference on **Dam Foundation Failures and Incidents**, Hyatt Regency Denver Tech Center
Information
Early registration deadline extended to April 1!

May 1 - **Abstracts** for AEG Annual Meeting due

September 8-15 -- **AEG Annual Meeting** in Seattle