Freshman Seminar FS/Ge016 Earthquakes and Volcanoes, Fall 2021

Weekly class meeting, Wed afternoons, 2:05--3:55 p.m., Arms 251

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Ombudsperson: TBA

Reading and useful links:

- The Million Death Quake by Roger Musson (Palgrave Macmillan, 2012) – required
- Eruptions that Shook the World by Clive Oppenheimer (Oxford Univ. Press, 2011) – required; e-book available from Caltech library
- Field Guide to the San Andreas Fault by David K. Lynch (Thule Scientific, 2014). Required. We can provide each student a PDF copy of this book for individual use.
- USGS fact sheets about major volcanoes
  Pinatubo: Lahars, Benefits of monitoring, Cataclysmic eruption
- "Putting Down Roots in Earthquake Country" brochure. You can download it at https://www.earthquakecountry.org/booklets/
- USGS Shakeout Scenario Circular (24 pages) http://pubs.usgs.gov/circ/1324/
- *The ShakeOut Scenario* (USGS Open-File Report 2008-1150; http://pubs.usgs.gov/of/2008/1150/).
  - Earthquake Early Warning fact sheet
  - USGS Information about Induced Earthquakes

Class meeting weekly topics:

Sept. 29. Introduction. View fault map of California. View geological map of California. View relief map of southern California. Review web sites about recent earthquakes, magnitude, intensity, and moment. USGS Earthquake Web Site. Discuss volcanoes in California and their tectonic setting.

October 6: Review major geological concepts related to faulting (p 1-32 of Lynch's book). Review information about the Salton Sea. Links: Salton Sea state recreation area brochure (7 pages, with colored maps). Discuss the difference between Volcanic Eruption Magnitude and Earthquake Magnitude.

October 13: Discussion of the Shakeout scheduled for 10:21 on 10/21. General aspects of earthquake preparedness. Discussion of chapters 1-3 of Musson's earthquake book. History of slip events on the San Andreas fault and related faults. Reading: Chapters 4 and 5 of Mussett & Khan. Select your big earthquake and your big volcanic eruption for your focus later on during November. (List of earthquakes and volcanic eruptions is currently on p. 4 of this document.)

October 20: Discussion of stereographic projections. Learn how to understand, and construct, focal mechanisms of earthquakes. How we use earthquakes to image Earth's interior. In class: Review content of Mussett & Khan ch. 4 and 5, and work on some examples from Chapter 5 of M&K.

October 27: Technology: seismometers for Earth, Mars, and Venus. Infrasound and fiber optics to study earthquakes. Discuss chapters 4-6 of Musson's earthquake book. In class: discuss how to make maps for our upcoming field trip. Discuss chapters 1-2 of Eruptions book.

Nov. 3. Past big earthquakes and past big volcanic eruptions. Start work on your own, on individual analyses of great earthquakes and volcanic eruptions (a different one for each student). In class: discuss how to find the information needed for your projects. Discuss ch. 3-4 of Eruptions book and 7-9 of Musson.

One-day field trip will be on one of the following dates: Nov 6, 7, 13 or 14.

Nov 10: Hawaii eruptions, seismicity, tsunamis. Large Igneous Provinces. Discuss chapters 5-6 of Eruptions book.

Nov. 17: Yellowstone and North American earthquakes and volcanoes. Discuss chapters 7-9 of Musson's Earthquakes Book and Ch. 7-8 of Eruptions book.

November 24. Discuss earthquake early warning efforts in southern California and elsewhere. Discuss induced seismicity (earthquakes caused by human activities). Discuss volcanic eruption preparation for US West Coast. Technology: using signals from earthquakes to measure processes related to climate change. Discuss chapter 9-12 of Musson's book.

December 1: Students present observations of the great earthquakes and volcanic eruptions; course wrap-up; students fill out TQFR forms.

(Dec. 3 is the last day of classes.)

Field trip locations for a future trip to the Southern San Andreas Fault:

- **Thousand Palms Oasis**
- **Painted Canyon, Mecca Hills**
- **Salton Sea recreation area visitor center and vicinity**
- **Salt Creek (east of highway 111)**
- **Bombay Beach**
- **Red Hill Marina**
- **Sonny Bono Salton Sea Visitor's center https://www.fws.gov/refuge/sonny_bono_salton_sea/**

Web sites to use to make maps and images:

Geological Map of California https://maps.conservation.ca.gov/cgs/gmc/

Fault Map of California https://maps.conservation.ca.gov/cgs/fam

Google Earth (make some maps without the faults on them)

National Map Advanced Viewer: https://viewer.nationalmap.gov/advanced-viewer/

BLM land use map: BLM land use map https://blm-egis.maps.arcgis.com/home/index.html

National Geological Map Database: https://ngmdb.usgs.gov/mapview This web site provides much more detail on the geological maps compared to the data from the Geological Map of California.

Kmz file of Quaternary faults and folds in the USA: https://earthquake.usgs.gov/static/lfs/nshm/qfaults/qfaults.kmz (Make some maps with the faults on them)

List of Important Earthquakes to study (each student should choose a different one)

1. April 4, 2010 – El Mayor-Cucapah, NW Baja California, Mexico – M 7.2
2. Dec. 26, 2004 – Off the west coast of northern Sumatra – M 9.1
3. March 11, 2011 – Tohoku, Japan – M 9.1
4. Feb. 27, 2010 – Maule, Chile – M 8.8
5. April 11, 2012 – off the west coast of Northern Sumatra – M 8.6
6. September 29, 2009 – Samoa Islands region – M 8.1
7. September 8, 2017 – 101 km SSW of Tres Picos, Mexico – M 8.2
8. January 12, 2010 – Haiti region – M 7.0
9. November 13, 2016 – Kaikoura, New Zealand – M 7.8
10. April 25, 2015 – Gorkha, Nepal – M 7.8
11. July 4, 2019 – Ridgecrest, CA sequence – M 6.4 and 7.1
12. September 19, 2017 – Puebla, Mexico – M 7.1
13. November 11, 2002 – Central Alaska – M 7.9
14. September 2, 2021 – Acapulco, Mexico – M 7.0
15. August 14, 2021 – Haiti - Mw 7.2
16. March 4, 2021 - New Zealand & Kermadec Islands - M7.4 and M8.1
17. August 12, 2021 – South Sandwich Islands – M 7.5

List of Important Volcanic locations to study (each student should choose a different one)

1. Iceland, Grímsvötn. Since 2010
2. Hawaii, Kilauea, since 1990
3. White Island, New Zealand (2019)
4. Pinatubo, Philippines (1991)
5. Mt St Helens (1980)
6. Nevado del Ruiz, Colombia (1985)
7. Etna, Italy
8. Turrialba, Costa Rica
9. Popocatepetl, Mexico
10. Rabaul, Papua New Guinea
11. Erta Ale, Ethiopia
12. Colima, Mexico
13. Nyiragongo, Democratic Republic of the Congo
14. Ol Doinyo Lengai, Tanzania
15. Tungurahua, Ecuador
16. Mt Pelee, West Indies

17. Mt Fuji, Japan
18. Unzen, Japan
19. Cumbre Vieja, Spain (2021)