Geology and Geophysics 454: Engineering Geology
Spring Semester, 2019, 3.0 Units
MWF 9:30-10:20
POST 703

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Class Themes

• Engineers & geologists need to work together
  – Appreciate advantages and challenges
  – Accomplished through written group projects

• 4-step Approach
  – Recognition
  – Characterization
  – Evaluation
  – Assessment

Dr. Richard Jahns
Lecture Themes

I 4-step approach and application to a broad variety of "real-world" situations

II Impact of geology on people, engineering structures, and engineering operations (including planning)

III Selected case histories and discussions of the underlying phenomena
Student Learning Outcomes (SLOs)

Students will develop their ability to:
(1) recognize, characterize, evaluate, and assess the relevance and significance of geologic conditions and geologic processes to matters of engineering relevance;
(2) apply mathematics and physics to problems of common interest to engineers and geologists;
(3) apply the scientific method to practical problems in applied geology;
(4) communicate in written form through a series of group projects;
(5) plan, organize, and complete multi-disciplinary technical projects in a timely manner;
(6) develop their ability to understand and apply geologic principles to help explain geologic phenomena that impact the planning, design, construction, and operation of engineering projects.
<table>
<thead>
<tr>
<th>Assignment</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Homework I</td>
<td>5%</td>
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<tr>
<td>Group Project I (report)</td>
<td>25%</td>
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<tr>
<td>Homework II</td>
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<tr>
<td>Group Project I (report)</td>
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<tr>
<td>Homework III</td>
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<tr>
<td>Group Project III (report)</td>
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<td>Field trip</td>
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<td>Class Participation</td>
<td>5%</td>
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<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
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Class Projects

• Opportunities to
  – Practice 4-step approach
  – Develop individual and collective writing skills
  – Organize and conduct group projects
  – Improve technical writing
  – Accept and provide constructive criticism

• Students will write a total of at least 16 pages

• Grades assigned based on overall report, with adjustments for sections written by individuals
General Organization of Reports

• Cover page
• Summary
• Introduction
  – Definition of problem
  – Scope of report
• Geology (with illustrations)
• Engineering (with illustrations)
• Recommendations and Conclusions
• References

2/8/19
References on Technical Reports

• SAN LUIS OBISPO COUNTY GUIDELINES FOR ENGINEERING GEOLOGY REPORTS

• Guidelines for Preparing Geological Reports for Regional-Scale Environmental and Resource Management Planning
  https://www.conservation.ca.gov/cgs/Documents/Publications/Note_52.pdf

• Guideline for Preparing Engineering Geologic Reports

• County of Los Angeles Department of Public Works, Manual for Preparation of Geotechnical Reports

• CITY OF CALABASAS DEPARTMENT OF PUBLIC WORKS, MANUAL FOR THE PREPARATION OF GEOLOGIC AND GEOTECHNICAL REPORTS

• GEOTECHNICAL ENGINEERING REPORT (EAST END BRIDGE OVER OHIO RIVER)

• Washington State Dept. of Transportation, Conceptual or Preliminary Level Geotechnical Reports (Section 23.3.1)
Graphical Representation of Geologic Data

A Maps
- Show spatial distribution, orientations, and ages of features; 3-D geometric information

B Cross sections
- Show spatial distribution, apparent orientations, and ages of features; 2-D geometric information

C Borehole logs
- 1-D representation of features

D Stratigraphic columns
- Show age and thickness of geologic units

E Stereographic projections
- Show orientations of features, but not spatial distribution
Care in the Use of Language

A good paragraph
• Topic sentence establishes the theme
• Development of thought
• Concluding sentence that relates directly to topic

A good abstract (summary)
• Should concisely and clearly describe the essential information
• Is not a table of contents with verbs
• Concluding sentence that relates directly to topic
• See “Scrutiny of the Abstract”, by K.K. Landes
Care in the Use of Language

Degree of Confidence (High to low)
• Know
• Conclude
• Realize
• Recognize
• Understand
• See
• Think
• Infer
• Feel
• Suggest
• Hint

* Avoid the word “believe” due to connotations of religion and faith

Errors or Phrases to Avoid
• Capitalizing “north”
• Confusing “it’s” for “its”
• Waste phrases
  – “It is ...” (What is “it”?)
  – “There are...”
### Care in the Use of Language: Distinguish between time and place

<table>
<thead>
<tr>
<th>Time Words</th>
<th>Place Words</th>
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<tbody>
<tr>
<td>When</td>
<td>Where</td>
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<tr>
<td>Frequently</td>
<td>Commonly</td>
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<tr>
<td>Often</td>
<td>Typically</td>
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<td>Usually</td>
<td>Generally</td>
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<td>Occasionally</td>
<td>Locally</td>
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<tr>
<td>Sometimes</td>
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</tr>
<tr>
<td>While</td>
<td>Whereas</td>
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Good Writing Style

• The Elements of Style, by Strunk and White
Good Writing Style

• Suggestions to Authors of the Reports of the United States Geological Survey
  – Perhaps the most definitive reference to technical writing for geology and engineering geology
Specific Lecture Topics

A  Geologic materials (composition, geometry, & properties)
   1  Rocks
   2  Sedimentary deposits
   3  Soils

B  Geologic structures
   1  Folds
   2  Fractures

C  Geologic processes
   1  Earthquakes
   2  Landslides
   3  Rockfalls
   4  Coastal processes (e.g., erosion)
   5  Ground subsidence

D  Introduction to concepts of hazards and risks

E  Mechanics
Earthquake

Christchurch, NZ earthquake, 2/22/2011, M = 7.1, $3 billion damage

www.youtube.com/watch?v=T32YvIEYS7
Landslides

Preonzo, Switzerland, May 14, 2012, 300,000 m³

https://www.youtube.com/watch?v=0hpKmu-pc-Q
Rockfall

Taiwan, August 31, 2013

https://www.youtube.com/watch?v=uOJfcTZME0U
Rockfall
Kalihi, April 12, 2012

Residents thankful rock fall spared their lives - Hawaii News Now - KGMB and KHNL.mp4
Ground Subsidence

Sinkhole, Guangzhou, China, January 29, 2013

https://www.youtube.com/watch?v=3i6l7ZcOpk
Introduction

I Main Topics
A Engineers, Geologists, & Society
B Approach to Engineering Geology
C Importance of geology for engineering
D Importance of case histories
E Mechanics
II Engineers, Geologists, & Society

A  Engineers
   1  Solve problems
   2  Typically run geotechnical firms
   3  Have sign-off authority
   4  Emphasize quantitative analyses
   5  Models simplify reality (and commonly are overly simplistic)

B  Geologists
   1  Study problems
   2  Emphasize qualitative analysis (traditionally)
   3  See earth as complex (heterogeneous & anisotropic)

C  Society
   1  Pays the bills
   2  Passes laws to regulate responses, establish liability, etc.
   3  Many citizens lack a solid (geo)technical background
   4  Confused by conflicting analyses
III Approach to Engineering Geology

A  **Hazard Recognition** (Regional & site-specific)
   1  Hazard = condition, process, or potential event that poses a threat to personal or economic health, safety, or welfare
   2  Province of geologist & engineer

B  **Hazard Characterization** (Regional & site-specific)
   1  Characterization: thorough description of system state & history
      a  What are the essential (and/or recurring) features/processes?
      b  Where are the features? (geometry)
      c  What are their engineering and hydrologic properties?
      d  When did the geologic feature (structure/rock/deposit) form?
   2  Province of geologist & engineer

C  **Risk Evaluation** (Involves probabilities)
   1  Risk = function (product) of probability of occurrence and potential loss.
   2  Example: Teton Dam.  \( R = (1.5\times10^{-4}/\text{yr}) (\$7\times10^8) \approx \$10^5/\text{yr} \)
   3  Province of geologist & engineer

D  **Risk Assessment**
   1  Is the level of risk tolerable?
   2  Province of society at large
Importance of Geology for Engineering

• The current state and future behavior depend on geologic process that created and deformed the earth materials
• Geologic past a predictor of future
• Properly accounting for geology maximizes safe project completion and minimizes cost
• In-situ geologic masses are large, heterogeneous, anisotropic, deformed, and opaque – inherently difficult to analyze in a laboratory
Complex Geology
Homestake Mine, South Dakota

Dikes and folded rock in open-pit mine

Geologic cross section

http://upload.wikimedia.org/wikipedia/commons/7/7c/Homestake3.jpg
Geologic Map of Oahu
Sherrod et al., 2007
Fractured Basalt
Devils Throat pit crater
Importance of Case Histories

A  Learn from the experience of others
B  What has happened can happen
C  Problems occur when all four of the above steps not executed
D  Heterogeneities, discontinuities, and anisotropy matter
E  Demands vs. sufficiency of data often conflict
   1  Too little time
   2  Too little data
   3  Too much data
   4  Incorrect or inadequate data
F  Inadequate understanding of geologic processes: trouble
G  Illuminate how individuals and organizations operate
IV Mechanics

A How do the processes operate?
B What factors are important?
C Increasingly emphasized as part of quantitative analyses
D What are the assumptions in the analyses?
Additional References

• A Scrutiny of the Abstract, II, by K.K. Landes
• Scrutiny of the introduction, by Jon Claerbout
  http://sepwww.stanford.edu/sep/prof/Intro.html
• Coastal hazards on Oahu
  http://pubs.usgs.gov/imap/i2761/sections/3_Oahu.pdf
• Geologic map of State of Hawaii
• Subsurface geology and hydrogeology of Honolulu
  http://scholarspace.manoa.hawaii.edu/handle/10125/1989
• Landslide hazard zonation, by D.J. Varnes