California Rocks!
Please pick these up...

- New *revised* schedule & readings
- Mono Craters map
- Project guidelines
- Your San Andreas fault maps
Migration of the Mendocino triple junction

30 million years ago

20 million years ago

10 million years ago

Present

EXPLANATION

Spreading center (divergent boundary)

Subduction zone (convergent boundary)

Transform fault area show relative movement SFS, San Andreas Fault zone

Triple plate junction M, Mendocino R, Rivera

Mary Leech
Igneous rocks
Volcanic & plutonic

Volcanic

Plutonic
Plutonic & volcanic equivalents

**Felsic**
- Granite
- Rhyolite
- Obsidian
- Andesite
- Basalt

**Mafic**
- Gabbro

Mary Leech
Classifying Sierran granites

Lighter-colored; pink, white, black

Yosemite

Darker-colored; black & white to nearly all black
Paleozoic passive margin to the Mesozoic active margin

Sierra Nevada batholith forms 210 Ma to 75 Ma

Similar to today’s Andes Mountains
Extent of the Precambrian basement rocks

p. 428 in California Geology

Fig. 18-1 Presumed extent of the crystalline basement in the western United States, based on known distribution of rocks older than 600 million years old. (Source: Stewart, J.H., and Suczek, C.A. 1977. Cambrian and Late Precambrian Paleogeography and Tectonics in the Western U.S. Los Angeles: Pacific Section of the Society of Economic Paleontologists and Mineralogists.)
Sierra Nevada and the Basin & Range
At 80 Ma the subduction rate increased and the subducting slab flattened out - moving the batholith east....
Batholith migrated eastward over time

p. 157, 159 in *California Geology*
Yosemite Valley

In the Cretaceous (120-80 Ma) - the bulk of plutons were emplaced.
Accreted terranes in the Sierra foothills

p. 165 in *California Geology*

- Oceanic terranes collided with the North American continent in the Paleozoic (before ~250 Ma)
- Some were “exotic” and some came from near the continental margin
California’s Gold

- Native gold
- Lode deposits in quartz veins
  Heat from the intrusion of the Sierra Nevada mobilized the gold in veins
- Placer deposits in stream beds
  Gold is dense (sinks) and resistant to chemical weathering (stable & doesn’t react)
Roof pendants in the Sierra Nevada

- Metamorphic remnants of the roof of the magma chamber
- Metamorphosed Paleozoic sedimentary rocks from the passive continental margin

Fig. 8-21 Map showing roof pendants in the Sierra Nevada. (Source: Modified from Lahren, M., and Schwiebert, R. 1994. Geological Society of America Bulletin.)
20,000 y.a. - Glaciers in Yosemite

p. 186 in *California Geology*
Half dome and Tenaya Canyon
Exfoliation of massive granite

Massive = few fractures/joints

Release of pressure from removal of overlying rock and glaciers causes “flaking off” of layers.
Glacial striations

Rock fragments etched striations into underlying granite

Show direction of movement of a glacier
Lake Yosemite

Flat-bottomed, not the typical U-shaped valley
Glacial features
Cirques

Tioga Pass
Mt. Ranier glaciers
Glaciers form U-shaped valleys
Glacial retreat leaves U-shaped valleys

U-Shaped Valley

©1993 Chip McMillan

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Sierran glacial features

Hanging valleys

A smaller glacier flowed down this valley and flowed into the bigger valley.

U-shaped valley

A larger U-shaped valley formed from a glacier flowing to the right.
Lateral moraines and merging glaciers

Lateral Moraines merge to form a Medial Moraine
Medial moraines
More merging glaciers
Moraines in the eastern Sierra Nevada
Geological features in the Mono Lake area

Range - front normal fault

Lundy Canyon

Sierras

Morraines

Paleo shore lines

Mono Lake

Geologic History:
1) Formation of rocks of the Sierra Nevada - plutonism/metamorphism
2) Uplift of Sierras (or drop of Mono Basin) due to extension in the Basin & Range
3) Glaciers carved canyon and left moraine deposits
4) Lake level drops, leaving Paleo shore lines on moraines
5) Movement along the normal fault, offsetting moraines

*Note - 4 & 5 could be concurrent or reversed

Mary Leech
Tioga and Tahoe moraines

p. 191 in *California Geology*

**Tioga-age moraines**
- Smaller
- Sharper crests

**Tahoe-age moraines**
- Bigger
- More rounded ridges
- More dissected by streams
Extent of ice during Tioga glaciation

p. 185 in *California Geology*
Tioga moraine in the field
Terminal and recessional moraines
# Glacial periods

p. 192 in *California Geology*

## Table B-1  SIERRA NEVADA GLACIATION

<table>
<thead>
<tr>
<th>Time</th>
<th>Glacial/Interglacial Period</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,000 to present</td>
<td>Holocene</td>
<td>Present period of global warming</td>
</tr>
<tr>
<td>18,000-22,000</td>
<td>Tioga</td>
<td>Peak of most recent glacial period</td>
</tr>
<tr>
<td>105,000-125,000</td>
<td>Unnamed in Sierra</td>
<td>Prior interglacial period worldwide</td>
</tr>
<tr>
<td>130,000-160,000</td>
<td>Tahoe (?)*</td>
<td>Age of older moraines in Sierran valleys</td>
</tr>
<tr>
<td>790,000</td>
<td>Sherwin</td>
<td>Till underlying Bishop Ash (see Chapter 5)</td>
</tr>
<tr>
<td>2.2-2.4 million</td>
<td></td>
<td>Beginning of worldwide Pleistocene glaciation</td>
</tr>
</tbody>
</table>

*Some investigators believe that the Tahoe moraines were formed after the 150,000- to 125,000-year warm period. The age of the Tahoe glaciation is still in dispute.*
Tectonic cross-section through California

p. 436 in *California Geology*

Fig. 18-9. Schematic cross sections across A, northern and B, central California, showing the tectonic framework of the provinces. (Source: Danielson, J., and May, A. 1992. Weed, Calif.: Shasta Valley College.)
Basin & Range normal faults
Pleistocene Lakes

Was Pleistocene Lake Russell, now Mono Lake.
Mono Lake exercise

Please use the color topo maps and aerial photos.

To begin:
(1) Circle volcanic craters and cones
(2) Mark areas of pyroclastic or ash flows around volcanic cones
(3) Mark moraines - separate Tioga- from Tahoe-age moraines

Next:
(4) Mark cirques, tarns, aretes, horns, etc.
(5) Use photos and stereoscope to find old Mono Lake shorelines

If you have time:
(6) Use photos to find former Lake Russell shorelines
(8) Mark approximate location of normal fault marking the boundary between the Sierra Nevada and the Basin & Range

Create a legend as you go…

Please don’t forget to bring your maps with you next week.

Mary Leech