GEOLOGY 25 - LECTURE 5C

National Parks of the Sierra Nevada: *Sequoia & Kings Canyon NPs*

[Textbook Chs. 19 & 1 (p. 22-23)]

Sequoia & Kings Canyon National Parks

General Characteristics

The glacially carved topography of the highest elevations of Sequoia-Kings Canyon ranks among the most remote and rugged terrain in the contiguous U.S.

- much of the two parks is above treeline (the upper elevation limit of tree growth). The Arctic-alpine habitat requires plants to adapt to low temperatures, extremes of temperature, strong winds and short growing season. They typically form low-growing mats or gnarly shrubs in response.

As you might expect, there are many similarities in the geology and landscapes of Sequoia, Kings Canyon, and Yosemite national parks. High elevations, deep canyons, granitic rocks, and glaciated, alpine terrain characterize all three parks.

Sequoia & Kings Canyon share a common boundary and are jointly administered by the NPS

- elevations in the parks range from about 1370' in the western approaches to a high of ~14,500' at Mt. Whitney, the highest peak in the Sierra as well as in the entire lower 48.
- the John Muir trail and Pacific Crest trail run along the spine of the Sierra crest through the high elevations at the eastern edge of the parks
- three paved roads lead into the western edges of the park to see the giant sequoia trees and reach elevations of ~7800 ft, but no roads penetrate into the high country to the east

The two parks were originally established to preserve the groves of giant sequoia trees that thrive at intermediate elevations in the western portions of both parks. By volume, giant sequoias are the largest trees on the planet. The General Sherman tree in the Great Forest of Sequoia National Park earns the honor of Earth's largest living tree and is estimated to be over 2200 years old.

The highest peaks in Sequoia-Kings Canyon are aligned north-south along the crest of the Sierran escarpment, forming the eastern boundary of the parks. Twelve peaks rise above 14,000' and several others are higher than 13,000'.

Three main rivers drain the parks: the Kaweah, Kings and Kern. The stream networks of each of these rivers cut V-shaped valleys through the highlands. Glaciers have modified these valleys as they grew and retreated through the Ice Ages, rounding them into U-shaped valleys.

- several of the canyons carved by the rivers and modified by glaciers are over 4000' deep

The southernmost glaciers in North America reside in shaded, north-facing basins along the crest of the range in the John Muir Wilderness just outside the northern border of Kings Canyon NP.

- less than a mile long, and about a third of a square mile in area
- currently retreating as it melts into an adjacent lake

Rocks of Sequoia – Kings Canyon

Granitic rocks of the Sierran batholith dominate the bedrock in Sequoia – Kings Canyon
- the granitic plutons are cut by vertical joint sets, often at right angles, which create angular peaks and steep cliff-faces where rockfalls have broken away along joint planes
- exfoliation jointing creates domes, just as in Yosemite and elsewhere in the Sierra

You've learned about sedimentary rocks of the Colorado Plateau, volcanic igneous rocks of the Cascades, and plutonic igneous rocks of the Sierran batholith. In S-KC, the third major category of rock is common.

Metamorphic rocks are created from previously existing rocks that have been subject to extreme temperatures and pressures. When subjected to intense pressures and high temperatures that occur during mountain-building events, the elements composing the rock rearrange themselves by diffusion through the solid rock (i.e., without melting) until they achieve a more stable atomic configuration. Metamorphism typically occurs deep in the crust, often within the deep roots of mountains. So the original minerals composing the original rock will metamorphose into a new set of minerals composing a new rock.
- for example, a clay-rich shale (a sedimentary rock) may transform into **slate** (a platy metamorphic rock)
- under higher pressures and temperatures, a slate may transform into a metamorphic rock called **schist**. And with great pressure and temperature, the schist may transform into a metamorphic rock called **gneiss**. At the highest pressures and temperatures just below melting, the rock may deform like a plastic into tightly folded gneiss.

What do the metamorphic rocks represent and when did metamorphism occur?
In Sequoia/Kings Canyon NPs, large masses of metamorphic rock are surrounded and underlain by the granitic plutons.
These masses are remnants of the **country rock** that was already present when the granitic magmas rose up beneath during the mid- to late Mesozoic. They were intruded by the magmas and were partly metamorphosed by the heat of intrusion.
- because the country rock was already there when the magma intruded, the country rock has to be older than the granites. (i.e., the metamorphic rocks are older than the granites)
- the remnant metamorphic country rocks and the surrounding granite have been modified by weathering and erosion
- these metamorphic rocks comprise about 20% of the bedrock within Sequoia – Kings Canyon national parks. They are all that remain from the much larger mass of rock that once formed the country rock that the granitic magma intruded into. Most of that original metamorphic country rock has been eroded away.

Metamorphism may occur deep within the roots of growing mountain ranges, or it may occur under the high pressures associated with subduction zones, or it may occur when rocks are subjected to the intense heat of magma.
During the Mesozoic, convergent margin tectonism that formed the ancestral Sierra Nevada caused intense pressures and temperatures associated with subduction, compressional mountain-

building, and magma emplacement - all of these factors affected the pre-existing country rocks to some degree – deforming and metamorphosing the pre-existing country rock.

After magmatism ended in the ancestral Sierra Nevada around 80 m.y. ago, tens of millions of years of erosion stripped away the volcanic crest of the ancestral Sierra as well as most of the metamorphosed country rock, exposing the granitic rocks beneath and leaving behind random pods of metamorphosed rock. Late Cenozoic uplift of the modern Sierra Nevada further elevated these metamorphic rocks to the surface.

Some of the pre-existing country rock was composed of limestone, left behind after deposition in an ancient shallow tropical sea that once covered the western U.S.

- limestone will metamorphose to become **marble**. Large masses of marble are common within Sequoia-Kings Canyon.
- marble will dissolve in slightly acidic groundwater. Over 200 **caves** have been discovered in pods of marble in the two parks.

Alpine Glaciers and the Sequoia-Kings Canyon Landscape

Recall that the last 2.6 m.y. of the Ice Ages are formally called the **Pleistocene Ice Ages**. The end of the Pleistocene occurred about 12,000 years ago when the planet entered a phase of natural interglacial warming called the **Holocene**.

- during the peak glacial advances, over half of the park area was covered in glacial ice, with the highest peaks of rock sticking up above the white expanse.

During Pleistocene glacial maxima, advancing alpine glaciers naturally followed the river canyons, abrading and scouring rock as the ice and its load of sedimentary debris slowly crept downslope. The meandering V-shaped river valleys were straightened and re-sculpted into **U-shaped glacial valleys**.

- the maximum downslope extent of alpine glaciation can be determined by the locations of the transition from straight U-shaped valleys upstream to sinuous V-shaped valleys downstream.

Sequoia-Kings Canyon has all of the glacial landscape features as Yosemite. Here are a few new glacial landforms to add to our repertoire:

cirques - bowl-shaped amphitheaters at the heads of glacial valleys carved by the ice. Commonly marked by steep headwalls. Cirques mark the main zone of accumulation of alpine glaciers.

- the lowest part of cirque basins frequently contain small bodies of water called **tarn lakes**.
- the glacial ice often erodes deeply into the underlying rock with a cirque basin. As glaciers melt, exposing the rock floor and walls of the cirque to view, meltwater may accumulate in the deepest part of the basin, forming a tarn lake.
- the steep, narrow, knife-like ridges between cirques or between adjacent U-shaped valleys are called **aretes**.
- aretes formed the narrow walls between adjacent glaciers, then were exposed after glacial retreat

How do cirques, tarns, and aretes form?

glacial plucking: rock at the base of the glacier is quarried away to form the steep walls of cirque basins and the deepened central bowl that becomes the tarn. Plucking (aka "quarrying") occurs when meltwater along the base of the glacier infiltrates into joints in the underlying rock, then freezes and expands, slowly wedging away blocks of rock. The blocks of rock are eventually detached and incorporated into the base of the glacier then transported away from the cirque basin as the ice moves downslope.

- wherever you see a steep cliff face underlain by a small lake, you can bet that it's a cirque basin where a massive glacier used to reside
- glacial plucking and **abrasion** are the two main erosional processes that allow glaciers to modify the underlying rock

Often a chain of small lakes will form within a cirque basin or U-shaped valley where the most deeply carved bottom of the basin is filled with meltwater. These chains of lakes are called **paternoster lakes**. The bowl-like depressions within the U-shaped valleys were formed by glacial plucking.

- tarn lakes and paternoster lakes eventually fill with sediment and vegetation starts to take hold. Glacial lakes commonly evolve into flat-floored *meadows* common to the Sierra Nevada

Unfortunately, the spectacular beauty of Sequoia – Kings Canyon national parks is commonly obscured by air pollution that originates in the Central Valley and Bay Area. Warm winds rise up the flanks of the Sierra, transporting smog and ozone to the parks where it settles as a yellowish-gray haze within valleys and canyons. Currently, Sequoia – Kings Canyon has the unwanted distinction of having the worst air quality in the National Park System.

Visit during the cooler off-season when the air quality is better and the tourists are fewer.

Best hikes in Sequoia / Kings Canyon NPs
https://www.alltrails.com/parks/us/california/sequoia-national-park
https://www.nps.gov/seki/planyourvisit/dayhikes.htm

A few websites with relevant material if you're not using the textbook

National Park Service – Geology of Sequoia and Kings Canyon NPs
http://www.nps.gov/seki/naturescience/geology_overview.htm

Wikipedia – Geology of Sequoia, & Kings Canyon NPs
http://en.wikipedia.org/wiki/Sequoia_National_Park
http://en.wikipedia.org/wiki/Kings_Canyon_National_Park

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