Geology and rocks of the Stanford campus

California Rocks!

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During this field trip, we will get a chance to look at some of California's most common rock types and contemplate aspects of the geology of the Stanford campus.

Sandstone on campus

The sandstone making up the quad buildings is a local rock type, mapped as part of the Chico Formation of Late Cretaceous to Early Tertiary age; it is now interpreted as an unnamed Early Eocene arkosic sandstone (58 to 37 Ma). Opened in 1891, Stanford University was built in the style of California's Spanish missions using the sandstone quarried from the northern end of the Santa Teresa Hills, south of San Jose. A special railway line was built just to haul about 800 cubic feet of stone daily to Stanford form the Greystone Quarry. These sandstones represent some of the oldest stratified sediments overlapping the highly deformed deep water sediments, basalt, and ultramafic rocks of the Franciscan Complex, which underwent deformation during subduction of sea floor beneath California.

This sandstone represents a moderately deep-water subsea fan and channel deposit that is lithologically and stratigraphically identical to rocks of the same age in the Sierra Azul, near Loma Prieta to the southwest. When these sediments were being deposited, you could have sipped margaritas on the beach at the foot of the Sierra Nevada and to visit what is now Stanford would have required a submarine… Fluctuating sea levels and uplift of the land later combined to raise these marine rocks into a "high and dry" position in the modern Santa Teresa Hills.

STOP 1: Geology Corner, Stanford Quad

Look carefully at the sandstone. What are most of the grains composed of in this sandstone? Do you see any evidence for fossils? Outside the door to the Geology Corner, part of the building has been replaced with seismically safer, rebar-enclosing, look-alike man-made material. Look carefully at the walls and at the columns of the building. Which is fake and which is real? How did you figure this out?

As we walk up the small incline, or bump, in the ground from Geology Corner to the Mitchell building we see the expression of a monocline fold. This is somewhat unusual because most folds in the underlying rock don't actually have a topographic "bump" at the surface…weathering and erosion tend to modify or erase the bump long before we can come along and see it. It is also interesting that, under the grass, soil, and cement, the geologic material beneath Stanford is Late Quaternary alluvium (less than a few hundred thousand years old)…very young, largely unconsolidated sediments.

One of the few known marine megafossils in the Eocene sandstone is a turritellid gastropod mold near the northwest corner of Building 550. Can you spot it?

Granites on campus

STOP 2: North stairwell, Mitchell Earth Sciences building
Look at the large slab of 86 Ma granodiorite with large pink orthoclase feldspar phenocrysts. This rock is from the crest of the Sierra Nevada near Sonora Pass, California. The concentric zones within each large orthoclase crystal show different stages of growth; the dark zone of biotite and hornblende represents a change in pressure, temperature, or composition of the melt about midway through the growth of the large crystals.

Also take a look at the dark, banded glaucophane schist of the Franciscan Complex. This sample is from the Tiburon Peninsula, Marin County, California; similar blocks are dated at 160 Ma. Minerals you might be able to see include blue glaucophane, white mica, green epidote, sphene, and 2 mm red garnet. This rock was buried more than 20-30 km deep in the subduction zone that existed along the west coast 100-200 million years ago.

STOP 3: South stairwell, Mitchell Earth Sciences building
Go look at the flat granite slab table in the sunken patio on the west (Lagunita) side of the Mitchell building. What is the main feature of interest here? Look at the minerals carefully and identify them. Can you think of any explanations for what you see as the main feature of this rock table? This is called a pegmatite.

The darker rock slab with circles or "orbs" is an unusual rock (an orbicular diorite) whose interpretation is controversial. The going interpretation is that this rock formed in a zone (near where the batholith meets the surrounding country rock) where hot fluids rose upwards during the crystallization of a large magma chamber. The hot magmatic fluids carried fragments of rocks (the centers of the orbs) upwards and new minerals crystallized around the fragments as they rose. The dark minerals are hornblende and the light plagioclase in this rock, which is more mafic than the granite you just looked at.

STOP 4: Green Earth Sciences building
The rocks you see on the walls of the Green building are Ordovician (430-500 Ma) Mankato Stone, or more formally, the Oneota Dolomite Member of the Prairie du Chein Formation quarried in Blue Earth county, Minnesota. These shallow marine rocks formed when shallow seas covered most of North America. Burrowing marine organisms, most likely clams or shrimp, that moved through the soft sandy muds produced the mottled texture in these rocks - so extensive was this burrowing that there is little or no evidence left of the original sedimentary layers.

Walk to the south corner of the patio in front of the Green building (next to the Durand building). The large slabs of granite and granite benches here are true California rocks, from granites of the Sierra Nevada from a quarry near Fresno. What is the main feature on the cut bench closest to Durand? What mineral is here in abundance that is not in the other granites you looked at? Look for a red mineral.

STOP 5: Arco and Industry Courtyards, Green Earth Sciences building
These natural rock benches are erosion blocks of Eocene Green River Formation (35-55 Ma, a ripple laminated sandstone to fine-grained siltstone facies from eastern Utah. These rocks offer a chance to see both the side and top view of the layers formed when these sands were shifting about in an ancient lake bed.

Basalts and Ultramafic rocks on campus

Volcanic rock that solidified from mafic (Iron- and magnesium-rich) lava is called basalt, and its plutonic equivalent is gabbro. Basalt covers more of the earth's surface than any other type of rock as it forms the floor of all ocean basins. Basalt may show a pillowed structure if it was erupted underwater, formed when lava congealed into blobs or tongues that in cross-section look like pillows.

STOP 6: Stone retainer walls between the Mitchell and Geology Corner buildings
The stone retainer walls between the Mitchell building and the Geology Corner building are serpentinized mafic to ultramafic rocks that were once probably gabbros and diabase/basalts, parts of ocean crust that was added to the continent by the subduction and accretion process that formed the Franciscan Complex. Also note the slickensides developed on some of these stones - they are the result of slip along small faults during deformation. The striations are most easily seen on the white scab-like surfaces of serpentinite that occur here and there on the stones.

Ultramafic rocks that represent the earth's mantle are present in many regions of California, and mostly represent the underpinning of pieces and slabs of oceanic crust (see above) that have been scraped up and now form part of the Franciscan Complex. Ultramafic rocks are often altered by fluids to serpentine, a mineral associated with asbestos (such minerals take many forms and it is only the very long-fiber asbestos that has been linked to disease…). Serpentine can work as a grease or lubricating rock type along faults and can actually flow and thus is quite mobile compare to other rock types. There is a slab of ultramafic rocks outside of the Mitchell building (quad side). What is the evidence that it flowed rather than fractured during deformation?

Fossils on campus

STOP 7: Women's bathroom, Geology Corner building
The women's (and men's?) bathrooms in Geology Corner have a nice mix of a shell or fossil-rich "coquina" limestone that came from Provence, France; and the stall walls are made of a polished black limestone that is highly burrowed by organisms (probably worms and so-called "trace" fossils).