Professional Soil Scientists Association of California
Annual Meeting & Field Tour

Santa Cruz Island

June 12-16, 2023

Field Guide

Geology, soils, history: an integrated view

Photo Source: Highsmith, Carol M, photographer. Aerial view of Santa Cruz Island, one of eight islands in the Channel Islands archipelago located in Santa Barbara Channel of the Pacific Ocean off the coast of Southern California. Photograph. Retrieved from the Library of Congress, <www.loc.gov/item/2013631288/>.

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Santa Cruz Island, California

Field Guide -- Geology, soils, history: an integrated view

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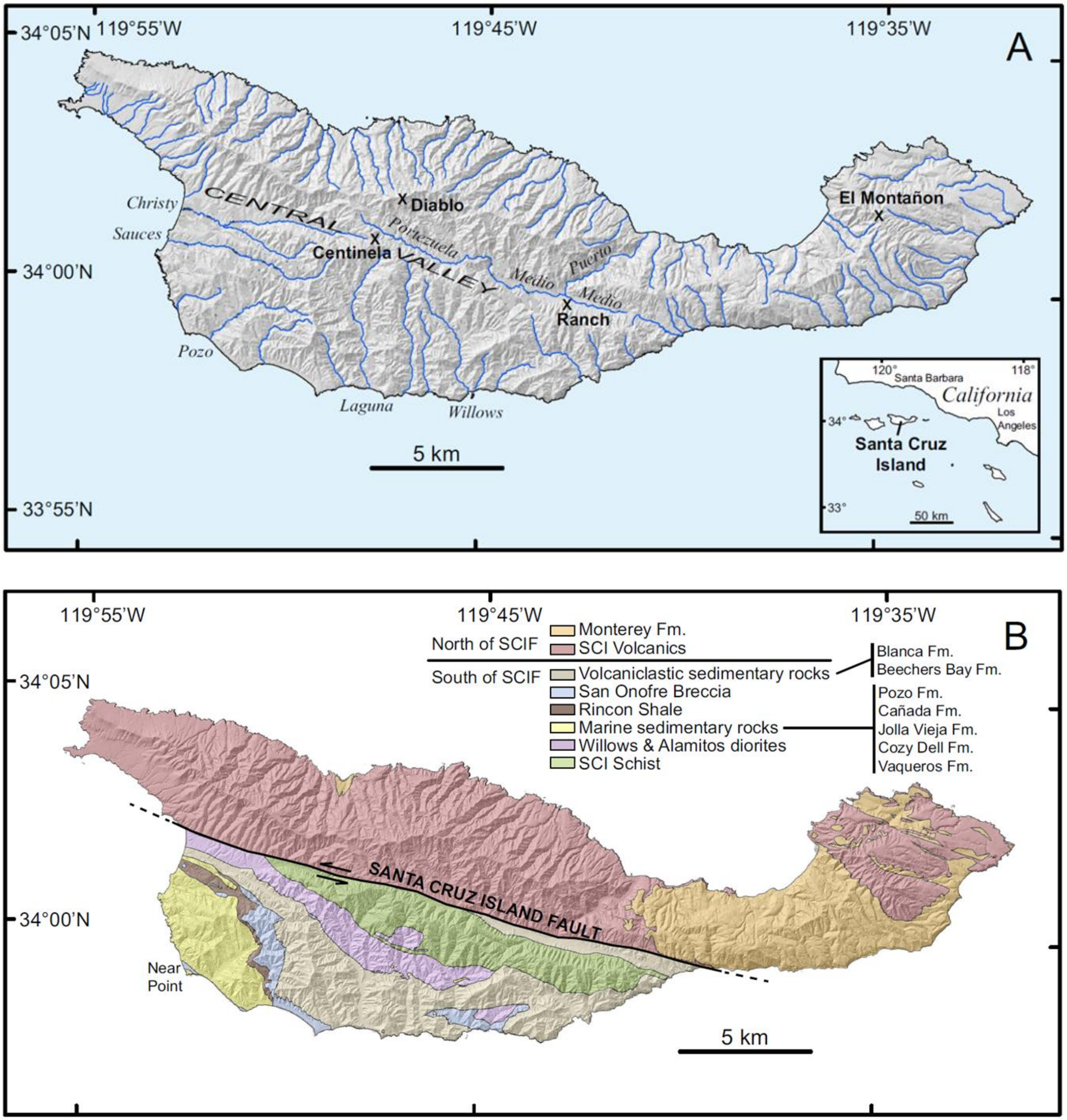


Figure 1. (A) Map of Santa Cruz Island showing names of major drainages and physiographic features. (B) Generalized bedrock geologic map of Santa Cruz Island (after Dibblee 2001a, 2001b). Surficial deposits including landslides and river alluvium are not shown. Only the primary strand of the Santa Cruz Island fault (SCIF) is shown here. Numerous other faults of small to intermediate size and displacement are also not shown. *Maps are excerpts from Schuman et al., 2018, Late Quaternary fluvial history of Santa Cruz Island; used with permission.*

Introduction[3]

Welcome to the 2023 Field Meeting of the Professional Soil Scientists Association of California (PSSAC). This meeting provides a rare opportunity to visit Santa Cruz Island, a remnant of prehistoric coastal southern California isolated off the coast. Santa Cruz Island features some of the most southwestward positioned subaerial geologic outcrops of the North American landmass. An extensive body of geologic research has been done on the island, from late Quaternary sea-level and climate changes to the tectonic evolution of the western North American plate boundary. A detailed soil survey of the Channel Islands was completed in the early 2000s. We will experience the island's natural beauty with our focus on exploring its geology, geomorphology, and soils, and we'll dig some into cultural history, archeology, and accelerated geomorphic processes & erosion resulting from land use. The meeting is designed to mesh with the mission of the University of California Reserve System. We plan to observe and discuss past and present research projects and mapping activities and contribute to the increased understanding and wise stewardship of the island's soils, vegetation, and cultural resources. We are housed at UC Field Station.

Many of the field stops will take us to areas closed to public access and difficult to reach. A few stops are within Channel Islands National Park on the eastern side of SCI, but most fall within the 76 percent of the island owned and managed by The Nature Conservancy. This five-day trip requires 4WD vehicles and includes a few 0.4-to-2.4-kilometer (~0.25 to 1.50 mile) hikes.

Field-trip days are valuable, given the logistical difficulty of reaching many of the stops. There will be more opportunities to read, review and debate the geology, soils, and related ecology and history of the island in the evening at the UC Field Station or back on the mainland. Accordingly, the guidebook is designed with a Road Log of Field Stops, Topical Notes, and figures to emphasize key observations at each stop. Figures 1–5 serve to introduce the island's physiography, geology, and soil framework, and it is advised that trip participants become acquainted with these figures initially.

Santa Cruz Island Overview[4]

Santa Cruz Island lies 22 miles off the coast of Santa Barbara County and is the largest island in Channel Islands National Park. It is 22 miles long, and measures from two to six miles across, for a total of 61,972 acres. Two parallel mountain ranges more than 2,000 feet high create a major central valley, with steep canyons that descend off rugged peaks to the coast. The island is the most biologically diverse of the eight southern California Channel Islands and is home to 12 endemic species. Four terrestrial vertebrates are endemic to Santa Cruz Island: the Santa Cruz Island Fox (Urocyon littoralis santacruzae); the Santa Cruz Island Scrub Jay (Aphelcoma coerulescens insularis); the Santa Cruz Island Harvest Mouse (Reithrodontomys megalotis santacruzae); and the Santa Cruz Island Deer Mouse (Peromyscus maniculatus santacruzae). The Island Spotted Skunk (Spilogale gracilis amphialus) is endemic to several Channel Islands. Because the island is so big and its physiography is so diverse, it hosts several

[3] This guidebook contains excerpts from "Santa Cruz Island field trip: Geology, history, and research opportunities," The Geological Society of America (GSA), Field Guide 59. Prepared by Davis, T.L., Behl, R.J., O'Sullivan, K.M., Raskin, S., and Bryne, S., 2020. Used with GSA permission.

[4] From "Coastal Conservancy, SCI Habitat Restoration", 2008. File No. 08-133-01.

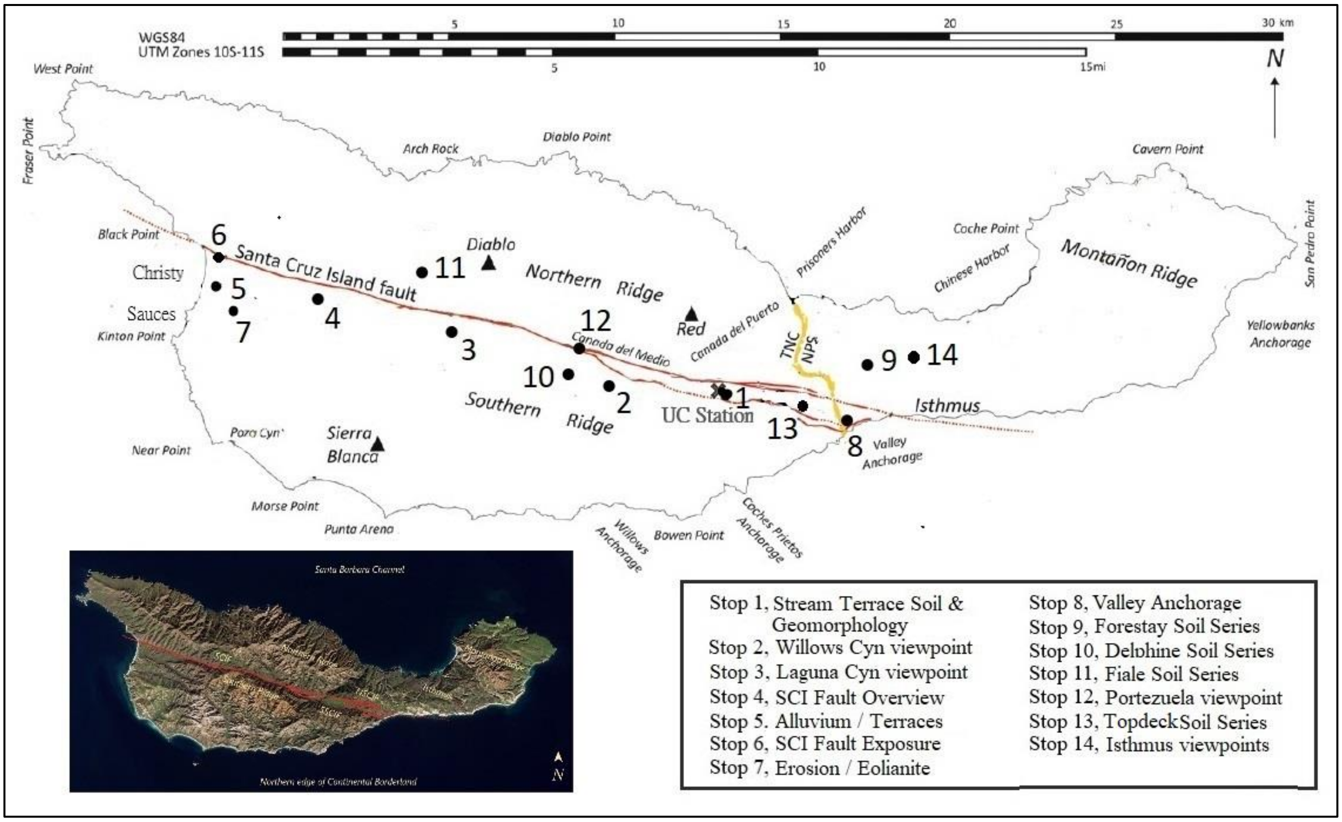


Figure 2. Map of Santa Cruz Islan showing fieldtrip stops. Red lines are strands of the Santa Cruz Island fault as mapped by Dibblee (2001a, 2001b). Yellow line is the boundary between The Nature Conservancy (TNC) and the National Park Service (NPS) sides of the island. Image inset source: Copernicus Sentinel-2, ESA - https://scihub.copernicus.eu/dhus/#/home Date: 2019-02-11 Sensor: MSI on Sentinel-2B Resolution: 10m RGB Composites: True color, Band 4-3-2. Retrieved from Wikipedia (CC BY-SA 3.0 igo)

vegetation communities, including Bishop pine forest, oak woodland, riparian woodland, chaparral, coastal sage scrub, valley and foothill grassland, coastal bluff, coastal marsh, and beach and dune systems. Santa Cruz Island hosts the largest vascular flora of the Channel Islands: 650 species, 74% of which (480 taxa) are native. Eight plants are endemic to Santa Cruz Island. Eight plant species found on Santa Cruz Island are federally listed as endangered, and one is listed as threatened.

There are very few structures on Santa Cruz Island today. On the 24% of the island owned by the National Park Service, improvements include several trails, two public campgrounds, a dock at Prisoners Harbor and Scorpion Harbor, one ranger station and a small U.S. Navy facility. The remaining 76% of the island, owned by TNC, includes the historic main ranch complex, another set of ranch buildings known as Christy Ranch, the University of California field station, researcher cabins, two airstrips, and a small native plant nursery. A few dirt roads traverse the island.

The habitat for native species on the island, most notably the listed plants and animals, has been fundamentally altered by historical land use. For much of the past two centuries, sheep, cattle and pigs scoured the landscape, causing widespread devastation of the island ecosystem. By the end of the 20th century, the impact of feral pigs was likened to that of an oil spill, demanding nothing short of emergency intervention and response. Ungulates ate island plants that evolved without secondary chemical compounds to deter grazers. This caused widespread, severe soil erosion and landscape destabilization, and promoted the conversion of shrubland into non-native annual grasslands. Although sheep and cattle were removed in the late 20th century, and pigs were gone by 2007, their impacts on the island remain. Non-native invasive plant species are the most problematic threat on the island today. As of 1995, 170 non-native plant species were recorded on Santa Cruz Island.

Figure 3. Google Earth image of Santa Cruz Island showing field-stops and routes.

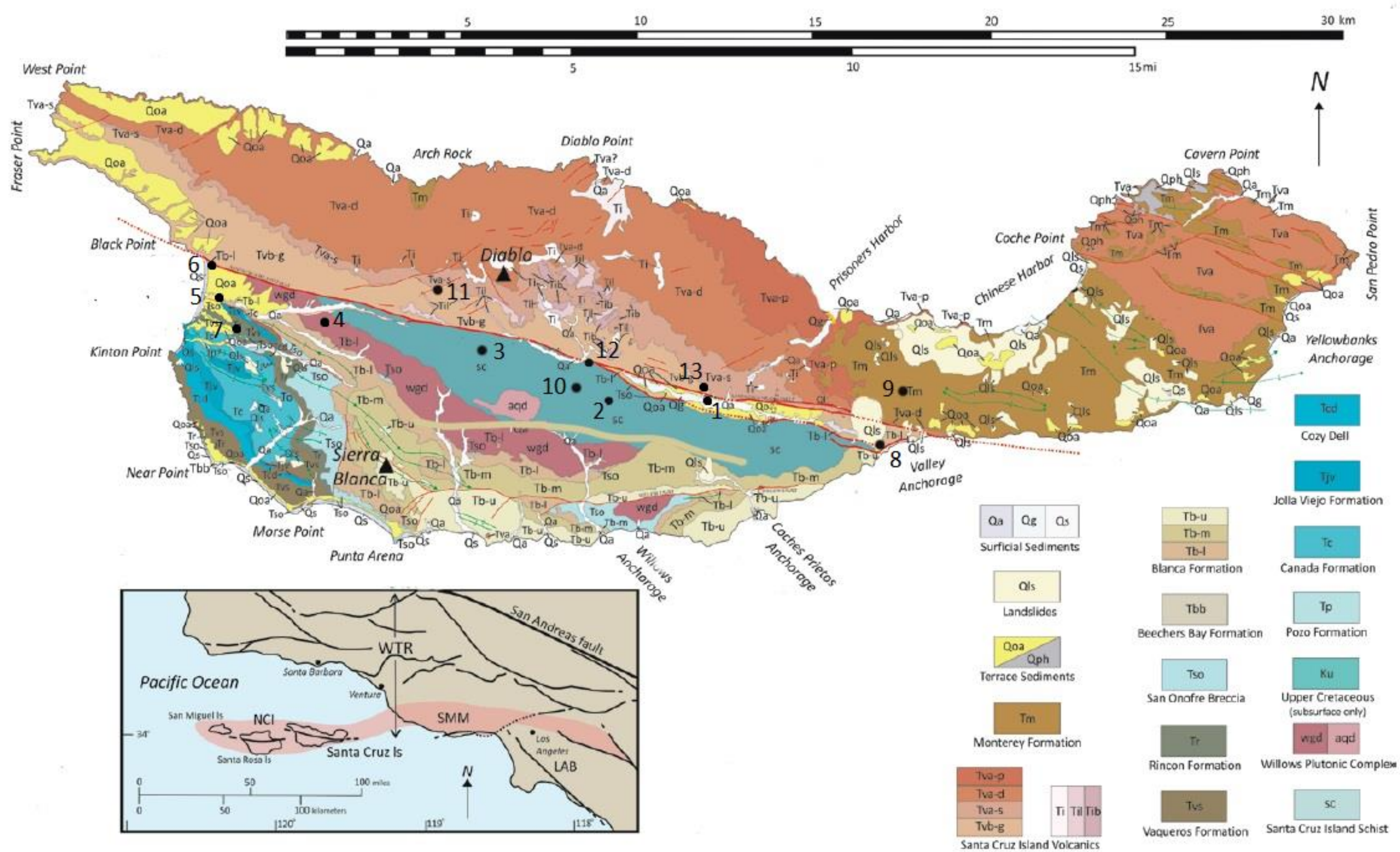


Figure 4. Geologic map of Santa Cruz Island showing field stops and key geographic points. Geological mapping modified from Dibblee (2001a, 2001b). Red lines are strands of the Santa Cruz Island Fault. Map inset shows the western Transverse Ranges (WTR) and the ~200-km-long antiformal trend beneath the Los Angeles Basin (LAB), Santa Monica Mountains (SMM) and the Northern Channel Island (NCI) (pink fill).

Day 1, Monday, June 12, 2023, 0.8 ft low tide @ 11:48 a.m. PDT, Sunrise 5:54 a.m., Sunset 8:11 p.m., Last Quarter Moon

Ferry from Ventura to SCI Prisoners Harbor dock, unload into vehicles and drive to UC Field Station (9:00 AM-12:00 PM). Eat lunch check into rooms at the Field Station—participants bring their own lunch on the first day (12:00-1:30 PM).

Talks at the Field Station (1:30-3:30 PM)

- Welcome, facility layout, ground rules, and safety (L. Laughrin, SCIR Director)
- Preview of the itinerary and guidebook (D. Smith, PSSAC).
- Overview of SCI history and natural setting (SCIR Director)
- Overview of geology and geomorphology and short videos introducing SCI's geologic history (N. Pinter, UCD)
- Q&A and a break (30 min)

Stop 1. Soil Pit (Cummulic Haploxerolls), stream terraces, fluvial geomorphology (33.997101, -119.723373) (3:30-5:00 PM)

A short walk from the Field Station takes us to a soil pit opened in stratified alluvium on the same stream terrace as the Station location (Figs. 6 and 9). e we will view and discuss the soil profile and soil mapping (Figs). We'll walk down onto the next 2 lower stream terraces to reach the current active stream channel ("geomorphic surface 1"). Standing in the active channel we can view a soil profile in the cutbank on the riser to "surface 2" and compare this soil profile to the properties observed in the soil pit on "surface 3". Note the differences in plant communities on each of the 3 surfaces (Figs 6 and 7) and the bar and channel microtopography on surfaces 2 and 3 as well. What other aspects of geomorphology and watershed hydrology can we discuss here?

Dinner and Socialization (6:00-8:00PM).

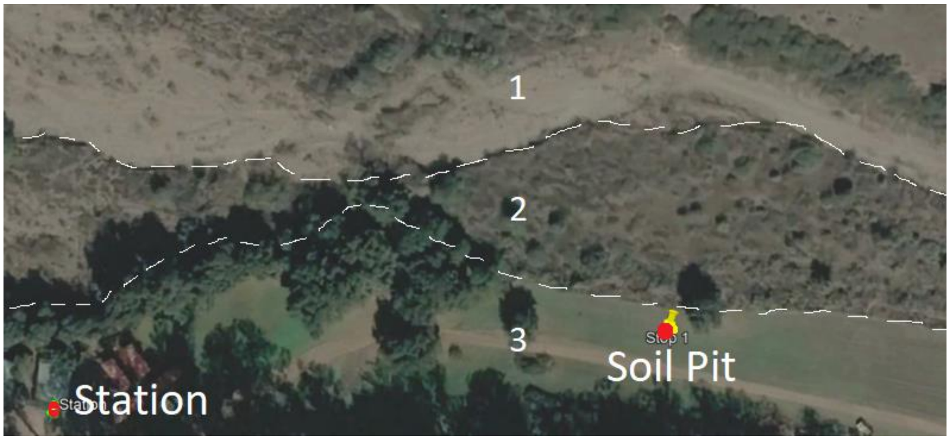


Figure 6 – Location of the soil pit and geomorphic surfaces relative to the location of the Station.

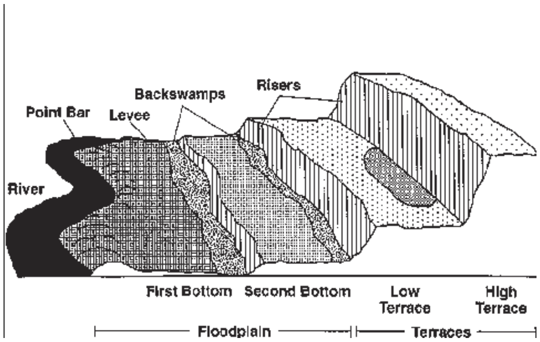


Figure 7 – An idealized river valley transect.

Figure 8 – Cutbank on riser to geomorphic surface 2.

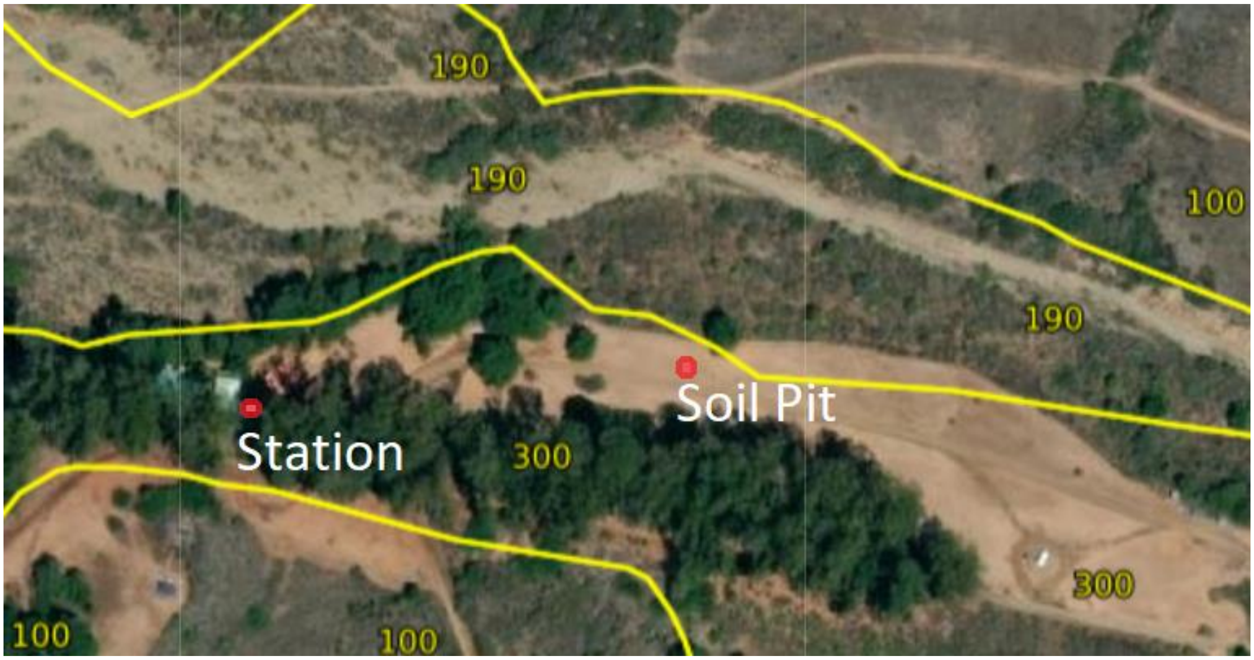


Figure 9 -- Soil map… (NRCS and UCD Soil Web).

Typic Xerofluvents-Riverwash complex, 0 to 8 percent slopes (190)

▲ Map Unit Composition

70% - ***Typic Xerofluvents***
Geomorphic Position: *stream terraces*
drainageways

15% - ***Riverwash***
Geomorphic Position: *drainageways*
Horizon data n/a

7% - ***Cumulic Haploxerolls***
Geomorphic Position: *stream terraces*
flood plains
Horizon data n/a | View Similar Data

6% - ***Pachic Haploxerolls***
Geomorphic Position: *stream terraces*
flood plains
Horizon data n/a | View Similar Data

1% - ***Rock outcrop***
Geomorphic Position: *stream terraces*
flood plains
Horizon data n/a

1% - ***Typic Fluvaquents***
Geomorphic Position: *drainageways*
Horizon data n/a

Cumulic Haploxerolls, 2 to 8 percent slopes (300)

▲ Map Unit Composition

85% - ***Cumulic Haploxerolls***
Geomorphic Position: *stream terraces*
flood plains

5% - ***Fiale***
Geomorphic Position: *hills*
Horizon data n/a | View Similar Data

4% - ***Pachic Argixerolls***
Geomorphic Position: *stream terraces*
flood plains
Horizon data n/a

3% - ***Fluventic Haploxerolls***
Geomorphic Position: *stream terraces*
flood plains
Horizon data n/a | View Similar Data

2% - ***Riverwash***
Geomorphic Position: *stream terraces*
flood plains
Horizon data n/a

1% - ***Typic Fluvaquents***
Geomorphic Position: *stream terraces*
flood plains
Horizon data n/a

Figure10 – Soil map unit composition…

Day 2, Tuesday, June 13, 2023, 1.3 ft low tide @ 12:34 p.m. PDT, Sunrise 5:45 a.m., Sunset 8:12 p.m.

Day 2 involves the longest field day of the week. We'll eat breakfast one-half-hour earlier than the rest of the days and forego technical talks at the Station on this day so that we have time to travel out the western side of the island for "not-to-be-missed" field stops.

Breakfast (7:00-8:00 AM)

Stop 2. Southern Ridge viewpoint above Willows Canyon (33.996650, -119.753896)

Drive about 2.3 miles to a viewpoint and a very brief stop for physiographic and geologic orientation. Along the way, note the outcrops of Santa Cruz Island schist (the island's oldest geology) as the road climbs from the valley up to the crest of the Southern Ridge. The SCI schist parent material weathers to dark-red soil.

From Stop 2, much of the south side of the island is visible, and the soil colors are helpful for distinguishing some of the principal rock units. Looking south into Willows Canyon, the brick-red soil marks the extent of the SCI Schist and, further down canyon, the whitish-gray soil is above the Willows Plutonic Complex. Further down the canyon are south-dipping, light-tan and whitish gray strata of the early to middle Miocene Blanca Formation that consists of thick-bedded volcaniclastic conglomerate, tuffaceous sandstone, and tuff.

To the north is the steep drop into the Canada del Medio with the trace of the north branch of the SCI fault at the break in slope along the north edge of the valley. This view is dominated by the rugged Northern Ridge that is underlain by SCI Volcanics, and to the left is the highest point on the island, Diablo Pk (2429 ft).

Views to the west from near here show the brick red color of the soil formed in schist parent material in contrast to the more gray-colored soil from volcaniclastic and plutonic igneous parent materials (Fig. 10).

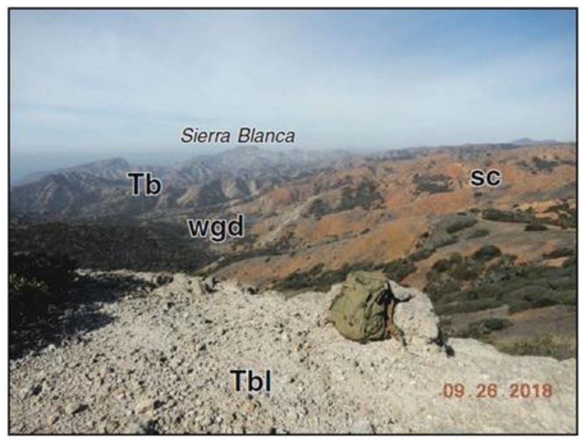


Figure 10 -View looking west from near Stop 2 (on Hill 1484). sc--Santa Cruz Island schist; wgd--Willows Plutonic Complex: Tb and Tb1—Blanca Formation and lower member. Photo from GSA Field Guide 59.

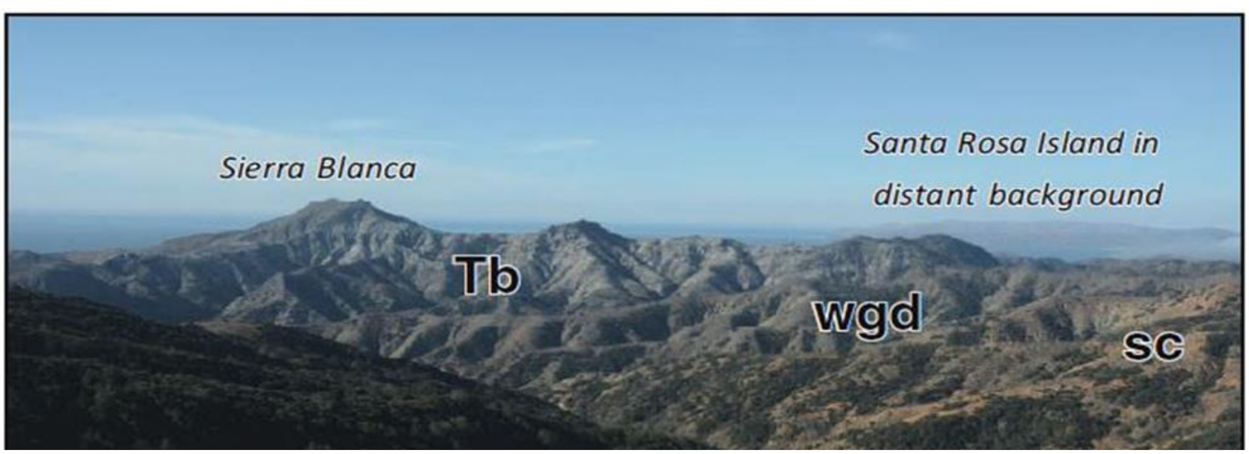


Figure 11. Looking southwest from the Southern Ridge Road above upper Laguna Canyon, near Stop 3. Below the Sierra Blanca and the north (right), the Blanca Formation is folded by a set of northwest trending anticlines and synclines. Tb—Blanca Fm; ;wgd—Willows Plutonic Complex; sc—Santa Cruz Island schist. Photo from GSA Field Guide 59.

Stop 3. Southern Ridge viewpoint above Laguna Canyon (34.007570, -119.786920) (8:40-9:20 AM)

Drive for another ~2.5 miles to another selected viewpoint for a second short stop and general physiographic and geologic orientation. Visible to the southwest is the prominent Sierra Blanca Pk and its nearly complete section of south-dipping Blanca Formation (Fig. 11). East of the Sierra Blanca, folds and the Willows fault within the Blanca Formation are east-west trending, but the structural trend becomes northwesterly to the west of the Sierra Blanca. To the north, beyond the central valley, is the Northern Ridge underlain by SCI Volcanics with Diablo Peak (aka Devils Peak) just east of due north. The eruptive center of the SCI Volcanics is postulated to be just east of Diablo Peak (Boles, 2015) and north of Canada del Portezuela (Nolf and Nolf, 1969).

Stop 4. Santa Cruz Island Fault Overview (34.01760, -119.84029). (9:20-10:40 AM)

Continue along the Ridge Road for another ~3.9 miles to a spot where the east-west trace of the SCI fault across the island is well expressed in the topography and in the far west of the island, as seen from this stop, are very well-preserved drainage offsets. Northwest of Stop 4 and along the lower portion of the Northern Ridge, several left-lateral drainage deflections along the trace of the fault are clearly visible (Figs. 12 and 13). Offsets measure as much as 579 m (1910 ft) (Patterson, 1979; Pinter and Sorlien, 1991) and formed during the late Pleistocene and Holocene. (See topical note on "Late Quaternary History of the Santa Cruz Island Fault.")

Outcrops of the Willows Plutonic Complex visible from here are thought to be part of a remnant island-arc (Sorensen, 1985) and part of a larger collection of exotic terranes emplaced along the California Borderland. The complex consists mainly of hornblende gabbro and hornblende diorite with minor amounts of leucotonalite, gabbro, and ultramafics. There are many dikes that crosscut the unit and some areas are intensely altered. (See topical notes on "Exotic Terranes" and "Santa Cruz Island and the Progression of Plate Margin Ideas".)

Figure 12 -- Google Earth aerial oblique image showing Stop 4 and the trace of the SCI fault across the western portion of Santa Cruz Island. Between the LL markings is a set of left-lateral drainage deflections.

Figure 13 -- Left-lateral gully offsets or deflections along trace of the SCI fault (red arrows). View is from Centinela, about 2 miles east and up valley from Stop 4. The Northern Ridge, underlain by north dipping SCI volcanics, is on the skyline. The upper portion of the ridge consists of resistant layers of volcanic breccia.

Stop 5. Holocene alluvium, stratigraphy, and late Quaternary marine terraces (34.023224, -119.872342). (10:40-11:55 AM)

Descending from the ridge, drive ~2.5 miles to reach the Christy Ranch houses <u>where we will stop for a bathroom break</u> before proceeding another ~0.2 miles to Stop 5. The low-lying, very flat-topped, westernmost part of the island at Fraser Point can be seen from various overlooks along the way and above Christy Beach. Fraser Point is capped by a late Quaternary marine terrace (Figs.14 and 15). (See topical note on "Late Quaternary Marine Terraces".) At stop 5 we will disembark from

Figure 14 -- Google Earth view of the westernmost Santa Cruz Island.

vehicle to view and discuss fluvial terraces and alluvial stratigraphy (Figs. 16 and 17) in the cutbanks of gullies below the Christy Ranch houses.

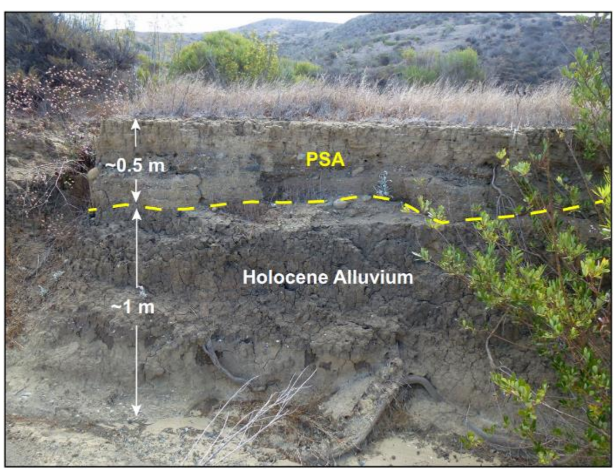


Figure 16 -- Exposure of sediment in Cañada Pozo showing postsettlement alluvium (PSA) layer overlying Holocene alluvium. This photo is from a nearby location (not stop 5) but exemplifies the kinds of alluvial "packages" found on westernmost SCI, and a view of the PSA accumulation that may have been accelerated by heavy grazing (something to discuss here and at other stops during the week). Photo is from Schumann and Pagati, 2018, used with permission.

Figure 15 -- Map of westernmost Santa Cruz Island, California, showing the distribution of Quaternary marine terraces (modified from Pinter et al., 1998a, 1998b, 2003; Muhs and Groves, 2018; used with permission from Western North American Naturalist). Pinter et al. identified three marine terrace levels: T1, T2, and T3 (from youngest to oldest).

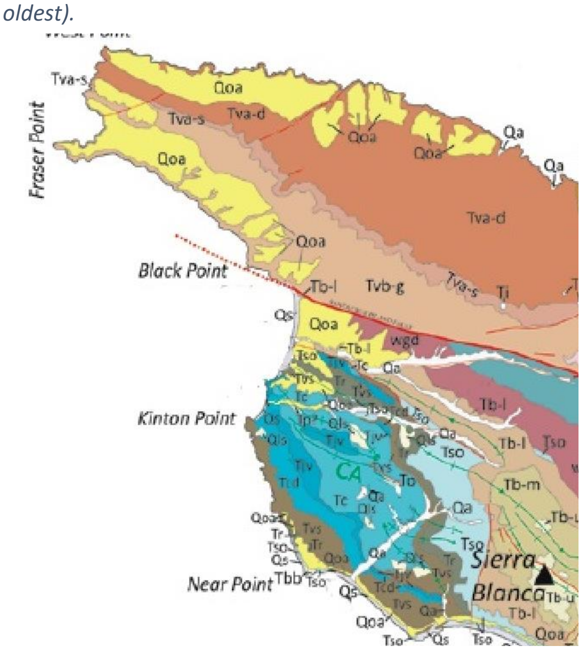


Figure 17 –Note the overall mapping of "terrace sediments (Qoa)" on Dibblee's (2001a) geology map, including the Holocene alluvium in the area of Stop 5. This, in contrast to Figure 15 that shows only Quaternary marine terraces specifically.

Figure 18 -- The fault exposure on the sea-cliff indicates at least 25 m of vertical separation since the late Pleistocene (base of the nonmarine deposit is not exposed). The sea-cliff exposure juxtaposes SCI volcanics against nonmarine alluvial deposits of latest Pleistocene age (Pinter and Sorlien, 1991; Pinter et al., 1998b). The whitish fault zone (fz) dips steeply to the north; its whitish color is due to the abundance of pulverized light-colored Blanca Formation more than clay-rich gouge. View is from the beach toward the east. Photo from GSA Field Guide 59.

Lunch at Christy Beach (34.022901, -119.876547). (11:55 AM-12:30 PM)

We'll travel another ~0.25 miles to the nearby Christy Beach for a 30-minute lunchtime.

Stop 6. Santa Cruz Island Fault Exposure (34.031064, -119.872885). (12:30-1:15PM)

Drive ~ 1.2 miles from the beach to reach Stop 6, which is located above a sea-cliff where the SCI fault scarp is exposed (Fig. 18). The scarp is visible from the beach, but the hike down is challenging from here, so instead we'll discuss the latest Pleistocene and Holocene history of the area while standing on the fault line. Pinter et al. (1998b) mapped a series of trench walls dug near to here into the nonmarine deposits that are cut by the SCI in order to determine its latest Pleistocene and Holocene history.

Stop 7. Eroded area and carbonate eolianite (34.015049, -119.867566). (1:15-2:20 PM)

Drive ~ 2.0 miles from Stop 6 to Stop 7, which is located on the ridge between Christy and Sauces canyons. Here, we will view a patch of exposed Pleistocene eolianite in an eroded area and discuss this caliche forest, paleobotany, and related "pisolites" and soils on other islands. From And, depending on time, we'll also talk about island fire history and erosion and island evolution.

Return drive to the Station (including break/stretch mini stops). (2:10-5:00 PM)

Drive ~12.3 miles from Stop 7 to the airstrip, then up the Central Valley Road to Centinela (Fig. 19) before climbing back onto the Southern Ridge Road to return to the Station.

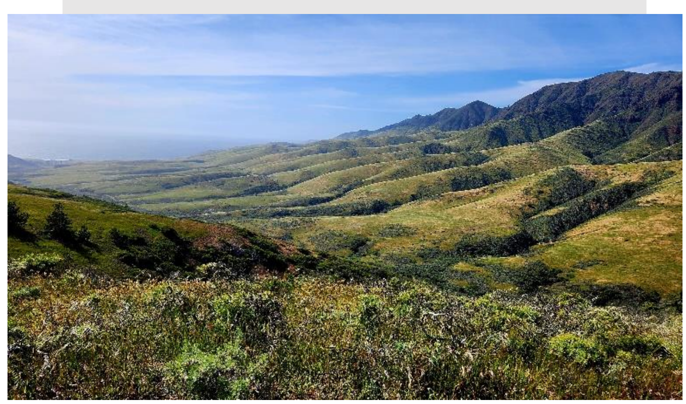


Figure 19 – View from near Centinela, looking back to the west side of the island down the Cañada Cervada drainage. Centinela is on a saddle that straddles the SCI fault between the island's Northern and Southern Ridges. And it's a drainage divide between the east-flowing Cañada del Medio drainage and the west-flowing Cañada Cervada drainage. The trace of the SCI fault stands out from this location.

Day 3, Wednesday, June 14, 2023, 1.7 ft low tide @ 1:16 p.m. PDT, Sunrise 5:45 a.m., Sunset 8:12 p.m.

Breakfast (7:30-8:30 AM)

Talks at the Field Station (8:30-11:00 AM)

- Chumash culture and history (E. Fishburn, Chairwoman, Barbareño Band of Chumash Indians)
- Archaeology (B. Holguin, UCLA)
- Coffee break
- Tour SCI Foundation collection *Archaeology Museum* (in cooperation with TNC and others) (E. Fishburn, B. Holguin)

Stop 8 (and Lunch). Valley Anchorage -- geology, landslide, archaeology (33.985377, -119.667814) (11:00 AM – 1:25 PM)

Drive ~3.6 miles from the Station to the Valley Anchorage parking area (Fig. 20) where we will eat lunch.

Figure 20 -- Aerial oblique view of Stop 1 parking area. (Google Earth).

The view to the southeast from here looks out over Valley Anchorage in the direction of the Santa Monica Basin. The parking area is on top of a large landslide (Qls) from the Monterey Formation (Tm) as illustrated on geology maps (Figs. 21 and 22). There are midden deposits underneath and downslope from the parking area.

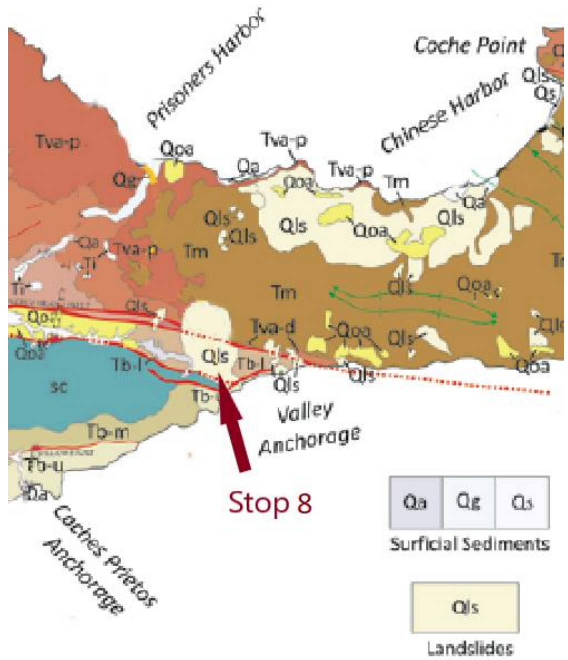


Figure 21 -- Geology map showing the locations of large landslides (Qls). From GSA Guidebook 59.

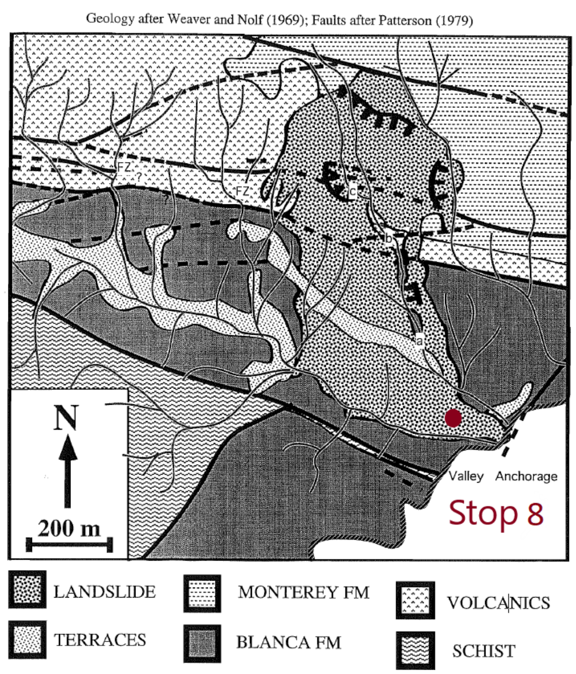


Figure 22 – Geology map showing the Valley Anchorage landslide and surrounding area in greater detail. From Sorlien, 1994.

The geology adjacent to the landslide includes volcaniclastic sedimentary rocks of the Blanca Formation (Tb-u and Tb-l), a narrow band of SCI schist (sc), and SCI volcanics (Tva-b and

Tva-p). Note the nearby fault traces shown on the geology maps, one of which can be seen exposed in the sea cliff to the southwest (Fig. 23).

Figure 23 – Fault exposure in sea cliff at Valley Anchorage.

The soil survey (Fig. 24) mapped *Fantail gravelly loam, 30 to 75 percent slopes (map unit symbol "230")* on the landslide. Fantail soils are moderately deep, well drained soils that formed in materials derived from Monterey shale.

Figure 24 -- Soil survey map of the area surrounding the Valley Anchorage parking area (Stop 8).

Stop 9. Forestay Soil Series formed in Monterey shale (33.997278, -119.666139).
(1:25 -3:20 PM)

Drive back onto the main road and north into the Channel Islands National Park portion of the island. Turn right on Navy Road and go for ~0.4 miles to park for Stop 9. We'll walk in an SSE direction along the ridge for ~0.2 mi to the Forestay soil pit on a shoulder slope under oaks (Fig. 25).

Figure 25 -- Aerial oblique view of Forestay soil series pit location (Stop 9). Google Earth.

The Forestay series consists of very deep, well drained soils that formed in shale._ *Taxonomic Class: Clayey-skeletal, smectitic, mesic Ultic Palexerolls.* We will examine and discuss the soil profile description and soil laboratory data (refer to Appendix E).

The soil pit is located within a delineation of soil survey map unit: Fantail, thin surface-Forestay-Fantail association, 20 to 75 percent slopes (200) (Fig. 26).

Figure 26 — Soil survey map of the area surrounding the Forestay soil pit (Stop 9).

Muhs et. al. (2008) hypothesizes that some soils on Northern Channel Islands are overlain by silt-rich mantles from airborne dust that came from the Mojave Desert on mainland California and Baja California, or from the continental shelf during glacial low stands of sea. A few copies of this paper are available at the meeting to read for those who'd like. The paper's authors present geochemical evidence of aeolian silt mantles preserved in soils on marine terraces in study sites on the eastern side of Santa Cruz Island. Silt content in the soil surface layer(s) of the soils they sampled contrast sharply with underlying clay-rich horizons. It's interesting to note a possible silt mantle in the Forestay lab data.

Return drive to the Station. (3:20-4:30 PM)

Dinner and Socialization (6:00-8:00PM).

Day 4, Thursday, June 15, 2023, 2.0 ft low tide @ 1:56 p.m. PDT, Sunrise 5:45 a.m., Sunset 8:12 p.m.

Breakfast (7:30-8:30 AM)

Talks at the Field Station (8:30-10:45 AM)

- Arborist treefall assessment (D. Kelly)
- Geomorphology, climate, land use, and erosion (K. Johnson, UC Natural Reserve System)
- Channel Islands Soil Survey (T. Cullum-Muyres, USDA-NRCS)
- Coffee break

Stop 10. Delphine Soil Series formed in schist (33.998417, -119.761722). (10:45-12:00 PM)

Drive about 3 miles from the Station to reach the Stop 10 parking area alongside Southern Ridge Road. We'll walk a short way down a side ridge and over the shoulder to the Delphine soil series pit (Fig. 27) where we will examine and discuss the soil profile description and soil laboratory data (Appendix C).

The Delphine series consists of shallow, well drained soils formed in residuum from schist. They have lithic contact commonly overlain by a Cr horizon (paralithic material). *Taxonomic class: Loamy-skeletal, mixed, superactive, thermic, shallow Typic Haploxeralfs.*

The Delphine soil pit is within a delineation of soil survey map unit 241, Delphine-Badland-Miasotus complex, 30 to 75 percent slopes (Fig. 28). The soil map units (MU) immediately adjacent to MU241 include MU120, Miasotus-Yardarm association, 30 to 75 percent slopes in schist on the north side of the Southern Ridge, and MU310, Livigne-Macool-Badland complex, 30 to 70 percent slopes in diorite and gabbro to the south.

Figure 27 -- Aerial view of the Delphine soil series pit location (Stop 10). Google Earth.

The Miastous soil, the main component of MU120, and the Delphine soils are similar

Figure 28 -- Soil survey map of the area surrounding the Delphine soil pit (Stop 10).

soils in that they are both shallow, loamy-skeletal Alfisols formed in schist. However, the Miatous soil, with a mesic soil temperature regime, is mapped on more north-facing slopes, and Delpine soil is mapped on the hotter, dryer more generally south-facing slopes with a thermic soil temperature regime. Note the contrast in plant communities between MU's 120 and 241. The soils in MU310 to the south of the Delphine pit are formed from diorite and gabbro and are whitish-gray colored as compared to the reddish-colored Delphine and Miatous soils.

Stop 11 (and Lunch). Fiale Soil Series formed in SCI volcanics (34.017415, -119.799360). (12:20 PM – 3:05 PM)

We'll stop for lunch at a view spot enroute between Stops 10 and 11. We'll then drive down from the Southern Ridge through the schist geology (south of the fault), through a road intersection (crossing the SCI fault) at the place called Centinela, and then north up the road on the other side into SCI volcanics geology to reach Stop 10 (Fig. 29).

Figure 29 -- Aerial oblique view of the Fiale soil series pit location (Stop 11). Google Earth.

Centinela is a place that we've discussed before. It is a saddle and drainage divide between the east-flowing Canada del Medio drainage and the west-flowing Canada Cervada drainage, and the SCI fault cuts through the saddle. The fault's shear zone is partially visible in local outcrops.

Proceed to the soil pit where we will examine and discuss an exposed soil profile of the Fiale soil series and associated soil laboratory data (Appendix D) from a nearby sample site.

The Fiale series consists of moderately deep, moderately well drained soils that formed in materials derived from basalt, andesite and breccia (SCI volcanics). *Taxonomic class: Fine, smectitic, thermic Aridic Haploxererts.*

The pit is located within a delineation of soil survey map unit 100, Fiale-Tongva-Topdeck association, 15 to 60 percent slopes (Fig 30).

Figure 30 -- Soil survey map of the area surrounding the Fiale soil pit (Stop 11).

Stop 12. Portezuela ("small door") viewpoint (34.006572, -119.757118). (3:05-4:15 PM)

Head east, toward the Station, down the Cañada del Medio Road (the Central Valley) for about 3 miles to Portezuela (Stop 12). This spot provides a good view eastward of the Central Valley as it trends toward Valley Anchorage. Down-drainage of Stop 12 (to the east), the SCI fault splits into northern and southern branches that are positioned along their respective valley edges, showing the influence of the SCI fault on formation of the valley. In the far distance and left of the valley, the U.S. Navy facility on the crest of the isthmus portion of the island is visible.

This spot is also interesting because, near here, the course of the Cañada del Medio drainage was drastically altered at some point in the past (Figs. 31 and 32). Was the Cañada del Medio drainage blocked by a landslide (possibly triggered by an earthquake), or captured by the Cañada del Portezuela drainage, or is there some other explanation?

Return drive to the Station. *Drive~ 2.2 miles to the Station.* (4:15 4:45 PM)

Dinner and Socialization (6:00-8:00PM)

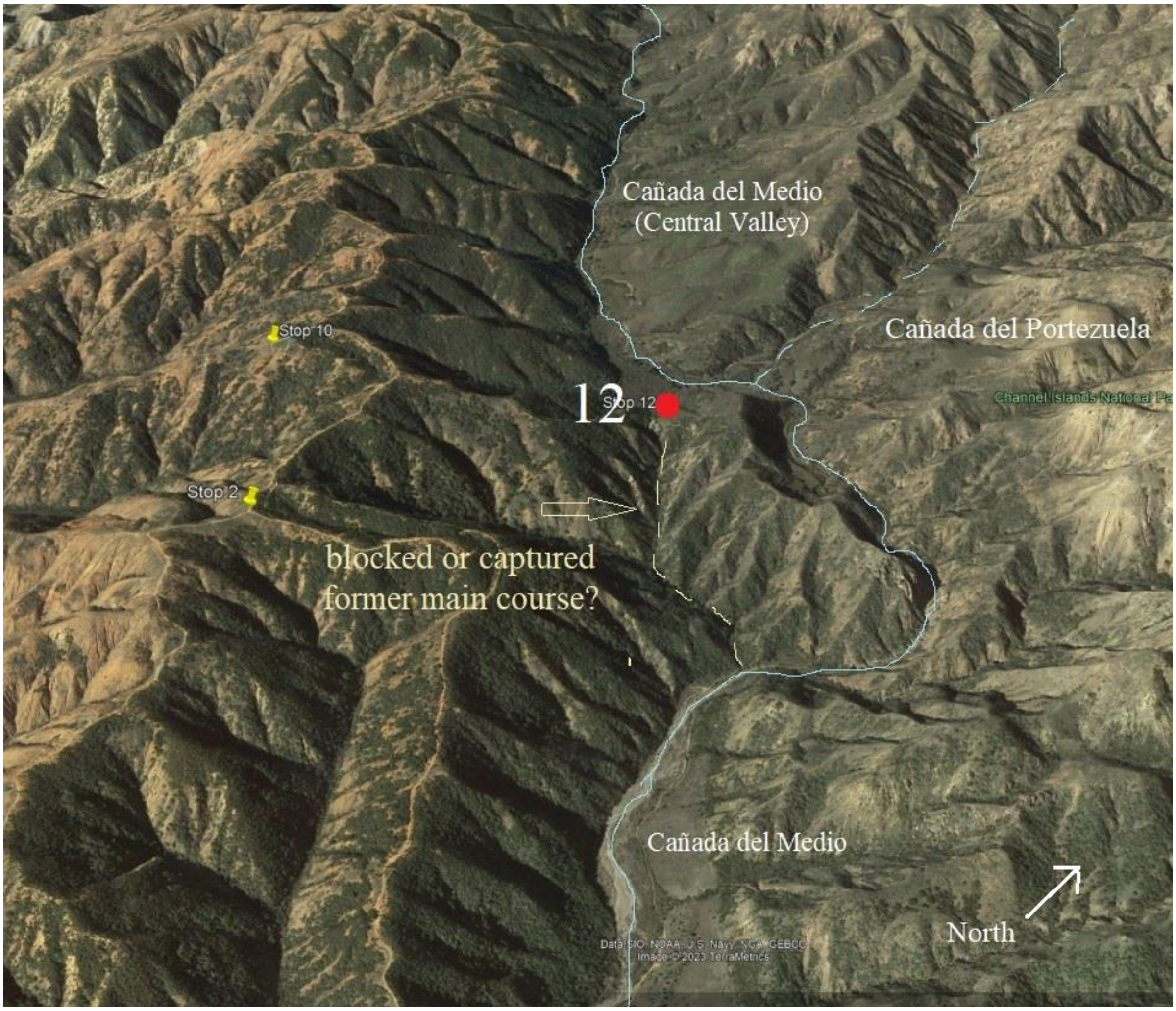


Figure 31 – Aerial oblique view looking to the northwest up the Central Valley from over Stop 12. The trace of the SCI fault is mapped essentially straight through the valley at this point, but the Canada del Medio drainage bends around it. Google Earth.

Figure 1 – Aerial oblique view looking north over the top of Stop 12. Google Earth.

Day 5, Friday, June 16 23, 2.2 ft low tide @ 2:34 p.m. PDT, Sunrise 5:45 a.m., Sunset 8:13 p.m.

Breakfast (7:30-8:30 AM)

Clean UC Station. Clean the facility and pack and load gear into trucks (8:30-10:00 AM)

Talks at the Field Station (10:00-11:30 AM)

- Tour SCI Foundation collections (in cooperation with TNC and others): *Ranch History* – Spanish Land Grant, Edwin and Carey Stanton, Vineyards and Winery, Beekeepers House, Chapel (L. Laughrin, UC Station Director)

Lunch (12:00-12:30 PM)

Stop 13 (and Lunch). Topdeck soil series formed in SCI volcanics. (33°59'24.01"N, 119°40'49.21"W) (11:30 AM-1:30 PM)

Drive east from Stanton Ranch about 2.1 miles to the Conservancy Airfield requiring about 25 minutes. We will eat lunch (30 minutes) at or near the orchard, and then go back to the short walk upslope to the Topdeck soil pit (Fig. 33). The walk distance from the road up to the pit is about 220 feet with about 60 feet of elevation gain. The soil profile description and soil laboratory data (Appendix F).

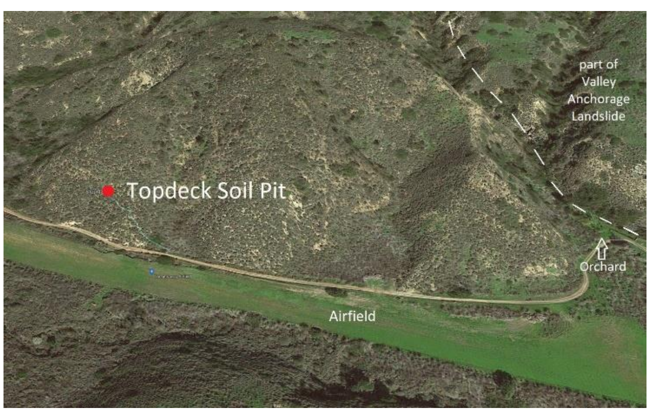


Figure 33. Aerial oblique view of the Topdeck soil series pit location (Stop 13). Google Earth.

The pit is located within a soil survey delineation of map unit 271, Topdeck-Spinnaker-Tongva complex 30 to 75 percent slopes (Fig. 34). Topdeck series consists of shallow, well drained soils that formed in colluvium and residuum from basalt, breccia, and andesite. *Taxonomic Class: Loamy, mixed, superactive, thermic Lithic Argixerolls.*

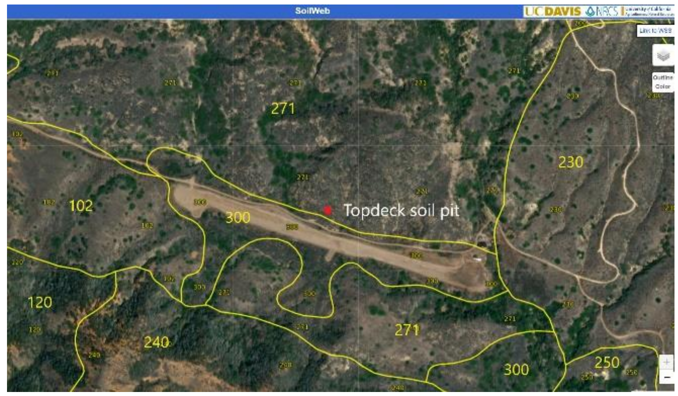


Figure 34. Soil survey map of the area surrounding the Fiale soil pit (Stop 13).

Stop 14. Eastside--Isthmus viewpoints for Monterey Formation, Chinese Harbor, Montañon Ridge. (1:30-2:55 PM)

Drive ~3.25 miles from Stop 13 to the water tower viewpoint that is Stop 14 (Figs. 35 and 36). Here we will spend about 45 minutes discussing various points of view including the Monterey Formation, Chinese Harbor and mega-landslides, and Montañon Ridge and chert sources.

Return drive to the Prisoners Harbor. (2:55-3:50 PM)

Unload gear from trucks to the dock at the ferry loading area. Drivers will return UC vehicles to the nearby UC parking area. The other participants have the option to view wetland restoration interpretive signs placed by NPS during their free time.

Ferry returns to Ventura (4:30-5:30 PM)

Figure 35 – Aerial oblique view looking east over Stop 14 on the isthmus of Santa Cruz Islan. Google Earth.

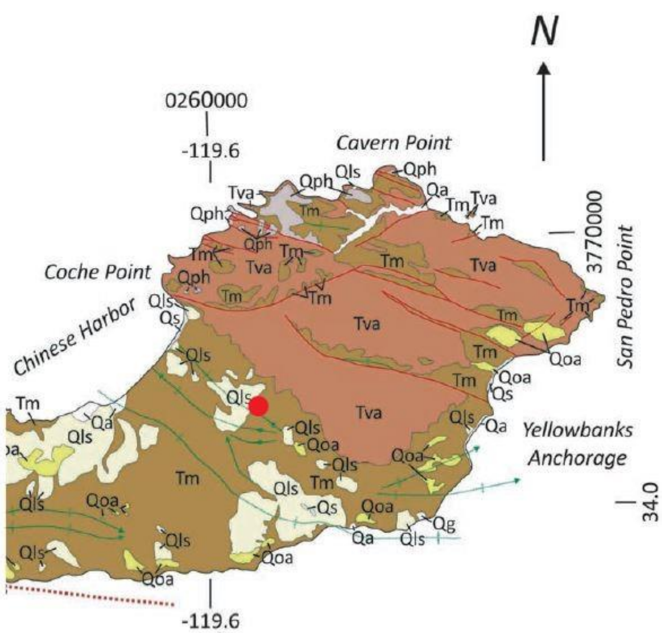


Figure 36 - Redrafted and revised portion of Dibblee's (2001b) Geologic Map of Eastern Santa Cruz Island showing Eastern SCI and El Montanon highlands. Monetery Formation (Tm). Santa Cruz Island volcanics (Tva). Landslides (Qls). From GSA Field Guide 59.

Prisoners Wetland and Lower Canada del Puerto Restoration – an optional self-guided walk if time allows while waiting for the ferry at Prisoners Harbor on Day 5.

The NPS and TNC collaborated on a wetland restoration project in this area (Figs, 37 and 38). The project removed eucalyptus trees that outcompete native vegetation, use an enormous amount of water, and create a fire hazard. The restoration also replaced a thick mat of invasive Kikuyu grass with 15,000 native wetland plants of high wildlife value and exposed groundwater that had been buried for over 100 years. The resulting improved habitat quality attracted many bird species rarely found in the park, along with the endemic island scrub-jay and Santa Cruz island fox. With the installation of interpretive corrals, two trails, a viewing deck, and three interpretive signs, visitors have opportunities to view wildlife and experience the rich history at Prisoners Harbor.

Historic Prisoners Harbor around 1892.

Prisoners Harbor around 2010. (NPS photo from https://www.nps.gov/articles/prisoners-harbor-coastal-wetland-restoration.htm).)

Santa Cruz Island and the Progression of Plate Margin Ideas

Santa Cruz Island's location along the southwestern edge of the western Transverse Ranges, and adjacent to the northern edge of the offshore Continental Borderland Province, provides a key field location to study the geology of southern California and plate margin processes. In the late 1970s, 1980s, and 1990s, volcanic and sedimentary rocks on SCI played an important role in the discovery that the island and the western Transverse Ranges had rotated ~90° clockwise since the early Miocene (Kamerling and Luyendyk, 1979; Luyendyk et al., 1980; Hornafius, 1985). Clockwise rotation of the Miocene rocks of the western Transverse Ranges (Fig. 38) is now broadly accepted in the geologic community (Fritsche et al., 2001; Hillhouse, 2010). Northward drift of the combined Pacific-Monterey plates beneath the margin produced right shear that resulted in clockwise rotation (Fig. 38). Atwater (1998) and Atwater and Stock (1998) provide comprehensive but condensed accounting of an enormous amount of research by many investigators since the 1960s (and some earlier).

While large clockwise rotation of Miocene rock is well documented, the rifting and rotation model(s) described above raises questions. As Dibblee (1982a) noted, rotating the western Transverse Ranges 90°, or even more, as a coherent block presents space problems with adjacent blocks that are difficult, if not impossible, to account for in the geologic mapping. Dibblee may have been referring to the lack of map-scale structures, convergent or extensional, that would document Miocene deformation. Dickinson's (1996) model of fault accommodation may offer a solution to Dibblee's question but needs to be evaluated at map-scale.

Late Quaternary History of the Santa Cruz Island Fault

The late Quaternary displacement history of the SCI fault has been studied through landform analysis and trenching of the fault trace (Patterson, 1979; Pinter and Sorlien, 1991; Pinter et al., 1998a, 1998b). The following is summarized from Pinter et al. (1998a, 1998b): Mapping of a trench site located above the sea cliff at Christy Beach, and nearby terrace deposits indicate multiple large-magnitude earthquake events have occurred on the fault during the late Pleistocene and Holocene with the latest event ca. 5 ka. Displacement of adjacent marine terraces, dated by uranium series, and other landforms show an average left-lateral slip rate of 0.8 mm/yr and reverse slip of 0.1–0.2 mm/yr. Average late Quaternary recurrence interval is estimated to be at least 2.7 k.y. and probably between 4 and 5 k.y. with earthquake magnitudes of 7.2–7.5 Mw. These estimates are similar to other faults along the southern margin of the western Transverse Ranges, i.e., Malibu Coast, Santa Monica, Hollywood, and Raymond faults, suggesting a connected system of faults that is characterized by large infrequent earthquakes.

Late Quaternary Marine Terraces

Santa Cruz Island and several of the other Channel Islands of southern California preserve an exceptionally good record of major late Quaternary sea-level fluctuations as a result of major climatic changes. Understanding periods of higher than present sea level and their impacts are currently of great societal interest and recognized as important subjects for future research by the latest report of the Intergovernmental Panel on Climate Change (Church et al., 2013; Masson-Delmotte et al., 2013). The last interglacial (LIG) is considered by many to be a relevant analog for the future, as the mass of polar ice was significantly less during the LIG and sea level was higher than today (Murray-Wallace and Woodroffe, 2014). In addition, the elevations and ages of late Quaternary terraces are used to

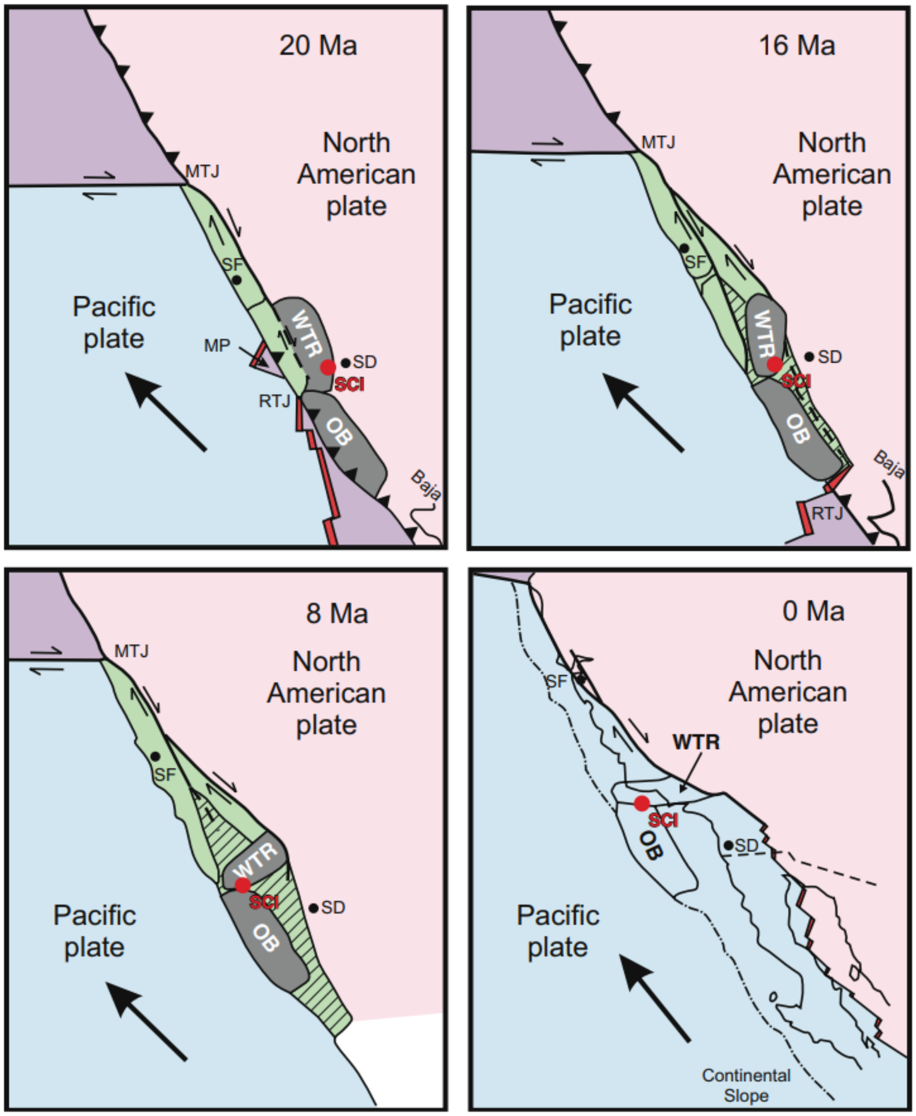
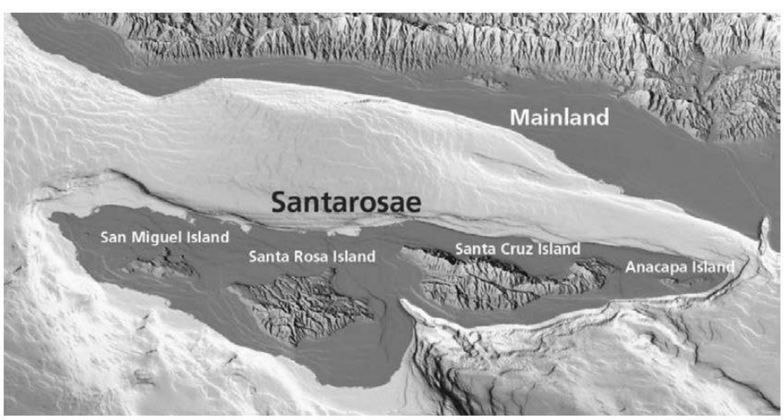


Figure 38. Simplified tectonic model of Pacific–North American plate interactions and movement of crustal blocks from 20 Ma to present (modified from Nicholson et al., 1994; Miller, 2002). Thick black lines—active continental strike-slip faults; red dot—approximate location of future Santa Cruz island (SCI); green fill—Monterey microplate capture of edge North American plate. Abbreviations: MP—Monterey plate; MTJ—Mendocino triple junction; OB—outer-borderland block; RTJ—Rivera triple junction; SD—San Diego; SF—San Francisco; WTR—Western Transverse Ranges block. The Rivera triple junction lay at or near the southwest boundary of the outer borderland at 20 Ma, an opportune time to inject mafic melt into the outer-borderland block. By 16 Ma, the Rivera triple junction had jumped to the southern end of the outer-borderland block, and the processes of extension (cross-hatched areas), block rotation, and translation had begun. These processes offered another opportunity for addition of mafic material to the outer borderland and the extended terranes via partial melts associated with extension.



Although never connected to the mainland by a land bridge, the four northern islands were once part of the Pleistocene 'superisland' known as Santarosae, nearly four times as large as the combined areas of the modern Channel Islands. The dark shaded area on the map depicts ancient coast of Santarosae and California around 20,000 years ago when sea level was 100 meters (approximately 350 feet) lower than it is today. As the ice sheets and glaciers melted and the sea level rose, only the highest parts of Santarosae remained as modern islands. (Adapted from a map by geologist Tom Rockwell) estimate tectonic uplift rates that are important to seismic risk evaluation.

The present elevation of marine terraces along the Pacific Coast of North America that formed during the LIG (~120 ka) are the result of three coeval processes: eustatic sea-level changes, glacial isostatic adjustment (GIA), and vertical tectonic movements that are common to the Pacific–North American plate margin. Worldwide eustatic sea level during the LIG is considered to be between ~3 and ~10 m above present level with 6 ± 3 m commonly quoted (Muhs and Groves, 2018; see review in Murray-Wallace and Woodroffe, 2014). These values match well with LIG terraces at Isla Guadalupe off western Mexico, located far enough from the plate boundary to be tectonically stable. Any departure from the ~3 to ~10 m above present sea-level elevation for LIG terraces is a sign of uplift or subsidence. GIA results from large ice sheets covering large portions of North America as recently as 20 ka, with ice sheet loading and removal affecting the crust and lithosphere. Marine terraces have significant uplift at locations occupied and adjacent to former ice sheets, and uplift decreases with distance from paleoloads. Coastal California, while not under an ice sheet in the late Quaternary, occupies an "intermediate field" for GIA effects (Muhs and Groves, 2018). Modeled estimates of GIA for the LIG along the California coast are ~11 to ~13 m above present sea level (Creveling et al., 2015) to 12 to 13 m above present sea level (Simms et al., 2016). Understanding GIA is key to determining the impact of rising seas during the LIG and estimating tectonic uplift rates for seismic risk evaluations. How well the modeled rates match the field evidence is discussed below.

Along the high-energy Pacific coastline of North America, sea-level changes are recorded in the geologic record as marine terraces commonly preserved in a staircase-like coastal topography. Terraces are remnant wave-cut platforms that formed during interglacial periods of high sea-level stands with a thin covering of mostly non-marine sand and gravel. Maximum paleo-sea levels are most precisely recorded by shoreline angles that form where the ancient sea-cliff and wave-cut platform intersected. Detailed mapping and precise elevation measurement of the shoreline angle, in conjunction with radiocarbon, uranium-series, and amino-acid dating methods of marine fossils, have been key to building a detailed chronology of climatically driven eustatic sea-level changes and determining tectonic uplift rates.

Santa Cruz Island was uplifted during the Quaternary, as was much of coastal California, and where geomorphic preservation is favorable, late Quaternary marine terraces remain. Well-preserved marine terraces in westernmost SCI near West and Fraser Points, and between Kinton Point and Punta Arena were mapped and measured in detail by Pinter et al. (1998a, 2003) (Fig. 42). Pinter et al. identified three terrace levels: T1, T2, and T3 (from youngest to oldest). Uranium-series ages of fossil corals from T1 near Near Point and above Stop 11B (Fig. 25) are ~120 ka, i.e., the LIG (Pinter et al., 1998a). LIG is within the range of MIS 5.5, or 5e (Shackleton and Opdyke, 1973) that occurred ~130 ka to ~115 ka (MIS—marine isotope substage of the foraminiferal oxygen isotope record of deep-sea cores [Martinson et al., 1987]). Close to Pinter et al.'s (1998a) fossil coral sample location, amino-acid dating of the gastropod Chlorostoma plot within the ~120 ka or 120 ka to 100 ka aminozones (Muhs and Groves, 2018), consistent with the nearby U-series age.

At Fraser Point, the T1 surface (youngest marine terrace, Pinter et al., 1998b) is 6–8 m above present sea level, but its deposits lack corals, one of the few marine invertebrates that incorporate uranium from seawater into their skeletons during growth. Amino-acid dating of fossil mollusks is an alternative dating method that provides relative ages that can be tied over distance. Amino-acid dating of Chlorostoma from T1 deposits at Fraser Point places the deposit in the ~120 ka or 120 ka to 100 ka aminozones. At Fraser Point, the next older terrace is T2 and it is 20–40 m above present sea level, and T3, the oldest terrace, is ~120 m above present sea level. Both higher marine terraces are undated and older than T1, as the island has a history of continual uplift during the Quaternary.

The shoreline angle elevations at Fraser Point, integrated with the modeled GIA estimates of paleo–sea level during the LIG by Creveling et al. (2015) and Simms et al. (2016) require ~3 to ~6 m of subsidence since the LIG high-sea stand, and tectonic subsidence is not considered valid due to the tectonic setting and history (Muhs and Groves, 2018). However, one could make a very speculative case that young subsidence is occurring in westernmost SCI. The traces of the Santa Cruz and Santa Rosa Island faults form a releasing left step in a left-lateral fault system that has well-documented strike displacements during the late Quaternary (Dibblee, 1982b; Pinter et al., 1998b). However, it is more likely the modeled GIA estimates of Creveling et al. (2015) and Simms et al. (2016) since the LIG are too high, given the LIG terrace elevations at Fraser Point, on nearby southern California islands, and at Isla Guadalupe (Muhs and Groves, 2018).

Quaternary tectonic uplift rates are key to seismic risk evaluation in regions undergoing active convergence, based on the assumption that the higher the rate, the more frequent the earthquakes. Uplift rates are an especially critical measurement in convergent belts with blind thrusts such as in the Transverse Ranges and Coast Ranges of California, where surface rupture observations are absent (Namson and Davis, 1988a, 1988b; Davis et al., 1989). At SCI and the other Northern Channel Islands published uplifts vary greatly. Sorlien (1994) postulated an uplift rate of 0.5–1.0 m/k.y. for the Northern Channel Islands, based on terraces at Santa Rosa Island. Pinter et al. (2003) estimated the anticlinorium forming Santa Cruz and Anacapa Islands has an uplift rate of 0.7 m/k.y. at its crest with the submerged limbs subsiding at a rate of 0.8 m/k.y., for the last 400 k.y. In comparison, uplift rates for the Northern Channel Islands that incorporate the GIA effects are lower (e.g., Muhs et al., 2012). San Miguel and Santa Rosa Islands range from 0.12 to 0.15 m/k.y. since the LIG (Muhs et al., 2014). The elevation and age of the LIG terrace (T1) on western SCI (Pinter et al., 1998a, 1998b, 2003) indicate a maximum rate of ~0.09 m/k.y., and possibly no uplift at all in the northwesternmost part of the island (Fraser Point), according to Muhs and Groves (2018). Furthermore, Muhs and Groves' (2018) uplift rates are an order of magnitude less than those of Chaytor et al. (2008), who calculated a 1.5 m/k.y. rate during the last ~23 k.y. by mapping and dating a submerged terrace just south of the Northern Channel Islands, which developed during the last glacial maximum. Muhs and Groves (2018) explain that the high uplift rate of Chaytor et al. (2008) is an artifact that did not account sufficiently for the significant GIA effect along the California Coast since the LIG (Muhs et al., 2012).

PREHISTORIC CHERT USE ON EAST SANTA CRUZ ISLAND

Introduction

During the late Holocene, Santa Cruz Island, the largest and most ecologically diverse of the eight Channel Islands, was home to substantial populations of Island Chumash people (Munns and Arnold, 2002). These Chumash communities, including those on Santa Cruz Island, were primarily coastal, sedentary, averaged 50–250 persons per village, and relied on a wide variety of nearshore and offshore marine resources and local and imported plant resources (Arnold, 1992, p. 66). The island's prehistoric chronology is shown in Table 1.

TABLE 1. SANTA CRUZ ISLAND PREHISTORIC CHRONOLOGY
(DATA FROM ARNOLD AND WALSH, 2010; PERRY, 2004)

Period	Years before Present
Paleo-Indian	13,000–6500
Early	6500–2500
Middle	2500–800
Transitional	800–650
Late	650-200

East Santa Cruz Island Chert Sources

Near the El Montañon highlands—aka Montañon Ridge—a high volcanic range that divides the eastern tip of Santa Cruz Island from the rest of the landmass (Fig. 51), are more than a dozen large outcroppings of chert that were quarried on a small scale for thousands of years to make various implements (Arnold and Walsh, 2010, p. 117). Large outcroppings of chert-bearing strata of the Monterey Formation are exposed at the surface immediately west of this range, and smaller outcrops are found to the east (Munns and Arnold, 2002, p. 128). The most abundant and highest-quality chert sources are situated in and around El Montañon, the prominent ridgeline that separates the east end of Santa Cruz Island from the rest of the island (Perry and Jazwa,2010, p. 180).

The Miocene-aged Monterey Formation, identified as marine biogenic shale, was mapped by Weaver and Nolf (1969) and Dibblee (2001b) and described by Weaver and Meyer (1969) and Dibblee (2001b). The Monterey Formation (Tm) shale member is buff to white, chalky and siliceous with thin-bedded chert, bentonite; contains foraminifers, moderately lithified; and as much as 1300 m in exposed thickness (Weaver and Meyer, 1969; Dibblee, 2001b). More detail is provided on the Monterey Formation here: the road log descriptions at Stops 9, 9B, 9C, 13,13B; and see topical note section on "The Monterey Formation."

Major chert source localities are restricted to the eastern end of the island, primarily to an area known as the "Contact Zone," where blonde-to-brown cherts and shales of the Monterey Formation meet the massive Santa Cruz Island Volcanics (Fig. 51) (Arnold et al., 2001, p. 115). The cherts from these quarries are a visually distinctive variant of Monterey Formation chert (Arnold et al., 2001, p. 113). Commonly called "Santa Cruz Island Blonde chert" due to its light-brown color, this material is well-suited for flintknapping due to its high-silica content and blocky, rather than laminar structure (Arnold et al., 2001, p. 115; Perry and Jazwa, 2010, p. 180). Flintknapping is defined as forming stone implements by controlling the fracture of the objective piece (Andrefsky, 2005, p. 255).

In all, some 26 chert quarries have been documented on eastern Santa Cruz Island (Perry and Jazwa, 2010). This cluster of chert quarries was the only major source of medium- to high-grade chert near the coastline between Point Conception and San Diego, making it a valuable and controllable resource (Arnold and Walsh, 2010, p. 117). As well, the chert outcrops on eastern Santa Cruz Island were an important resource to the Chumash since chert resources are more limited on the other Channel Islands (Perry and Jazwa, 2010).

Exploitation and Utilization of Santa Cruz Island Chert Resources

While the Santa Cruz Island chert outcrops were used throughout the last ~10,000 years, there was significant variability in chert exploitation during this time span (Perry and Jazwa 2010). Scattered biface preforms and debitage at local sites show that early exploitation of the quarries focused on making large cores and bifacial tools (Arnold and Walsh, 2010, p. 117). A core is the nucleus or mass of rock that functions primarily as a source for detached pieces (Andrefsky, 2005, p. 254). A biface is a tool that has two surfaces (faces) that meet to form a single edge that circumscribes the tool (Andrefsky, 2005, p. 253). Preforms represent the stage of production of a lithic tool just prior to reaching a finished form (Andrefsky, 2005, p. 260). Debitage consists of detached pieces that are discarded during the reduction process (Andrefsky, 2005, p. 254).

During the middle Holocene, chert quarrying appears to have been dispersed and opportunistic, and was focused on the production of bifaces, drills, and other chert tools. Drills are tools that are used in a rotary motion to perforate materials. Prior to the advent of the microlithic industry and extending into more recent times as a secondary use, the Santa Cruz Island chert also served as raw material for making small numbers of drills, which were used for drilling wood, larger shell artifacts, and other materials, as well as for bifacial tools (Arnold et al., 2001, p. 113).

In the late Middle period (see Table 1), flintknappers began to make modest numbers of small chert drills for perforating shell disk beads, and these have been found at several dozen coastal Chumash sites on both sides of the channel (Arnold and Walsh, 2010, p. 117; Munns and Arnold, 2002, p. 143).

Microblade Production

By about A.D. 1150–1200, the Island Chumash appear to have secured access to the large chert quarries along the El Montañon Ridge and at nearby outcrops on the eastern portion of Santa Cruz Island (Fig. 51) (Munns and Arnold, 2002, p. 143). The blocky chert from these quarries is well suited for making microblades, and had been used for the preceding 200–300 years by both mainland and island residents for the low-intensity manufacture of microblades (Munns and Arnold, 2002, p. 143). Microblades are whole or fragmentary microliths (narrow and <50 mm long), produced from microblade cores, with no bits (Arnold et al., 2001, p. 114). Microliths are very small blades usually in geometric form that are used in composite tools.

Two types of microblades have been identified: (1) trapezoidal, and (2) triangular with dorsal retouch (TDR). The trapezoidal form dominated the late Middle period, whereas the TDR microblades were produced in significantly higher quantities during the Late period (Perry, 2004).

As the Transitional period progressed, the communities participating in microblade and shell bead manufacture became confined almost exclusively to the Northern Channel Islands. Specialists at sites within 8 km of the chert-bearing zone, including Chinese Harbor, Prisoners Harbor, a few sites on the eastern tip of Santa Cruz Island, and several quarries, manufactured millions of microblades over the next 500–600 years (Munns and Arnold, 2002, p. 143).

Shell Bead Manufacture

During the Late Holocene, chert quarrying was focused on microlith production associated with the manufacture of shell beads (Perry and Jazwa, 2010). Most of the microblades were transported to a number of specialized bead-making communities elsewhere on the island, as well as to Santa Rosa and San Miguel Islands (Munns and Arnold, 2002, p. 143).

From the 1100s to the early 1800s, tremendous quantities of chert microdrills and Olivella beads were manufactured on the islands on a sustained basis (Arnold and Walsh, 2010, p. 117). Microdrills are modified microblades and include some or all of a retouched bit (Arnold et al., 2001, p. 114).

Chert microdrills were used to drill callus cup beads from the purple dwarf olive (Olivella biplicata, a small sea snail) shell. Olivella callus beads were used historically as a standard of value and reportedly functioned as currency during the Late period (Arnold, 1992, p. 73).

Many archaeologists have described the islands as the exclusive "mint" for the shell bead money, which was used throughout southern California (Arnold and Walsh, 2010, p. 119). The Santa Cruz Island quarry zone and nearby villages represent the most intensive, large-scale microblade industry known in the Americas. The roughly 20 specialized bead-making villages on Santa Cruz, Santa Rosa, and San Miguel Islands constituted perhaps the most extensive pre-Columbian shell-working industry north of Mexico, even surpassing the scale of shell crafts associated with the great Mississippian cultures (Arnold and Walsh, 2010, p. 119).

Large-scale microlith and bead-manufacturing specialization persisted throughout the Late period and well into the Historic era. Islanders were the primary suppliers of beads for the entire Chumash sphere, and a number of their mainland neighbors such as the Gabrielino/Tongva. Even after glass beads and iron needles introduced by the Spanish began to circulate in notable numbers (~A.D. 1782) in both mainland and island contexts, islanders continued to make very large quantities of shell beads, some with chert microdrills and some with needles (Munns and Arnold, 2002, p. 143).

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Flora of Santa Cruz Island

Isolated off Santa Barbara, Santa Cruz Island is home to 60 endemic species found no place else in the world. Some of these species include the Santa Cruz Island bushmallow (Malacothamnus fasciculatus var. nesioticus) and the island malacothrix (Malacothrix squalida). Below is an introduction to some of the flora that can be found on the island, organized by the principal geologic unit in which they can be found.

Santa Cruz Island Schist. The SCI Schist hosts a wide variety of plant communities including "chaparral, coastal-sage scrub, grasslands, island woodland, pine forest, riparian woodland, riparian scrub and oak woodland" (Junak et al., 1995, p. 10). Some of the indicator species of the chaparral are manzanita plants (such as Arctostaphylos insularis and A. tomentosa subsp. insulicola). In the woodlands, look for the Santa Cruz Island ironwood trees (Lyonothamnus floribundus subsp. aspleniifolius). These are a remnant species that were once found on mainland California and now only exist naturally on the Channel Islands. The ironwood trees tend to grow at a certain altitude to take advantage of the prevalent fog and to avoid the temperature extremes of the inland valleys.

Santa Cruz Island Volcanics. "Santa Cruz Island Volcanics support a variety of tree dominated plant communities" (Junak et al., 1995, p. 11). The canyons and north-facing slopes provide excellent habitat for oak trees (such as Quercus agrifolia and Quercus tomentella), willow (Salix spp.) and maple (Acer macrophyllum). Two beautiful native plant species can also be found on the SCI Volcanics; the Santa Cruz Island buckwheat (Eriogonum arborescens) and Northern Island hazardia (island bristleweed) (Hazardia detonosa) (Figs. 43 and 44). The range of these plants is restricted to Santa Cruz Island and some of the other Northern Channel Islands. Also found in the volcanics are prickly pear cactus. There are several species (including Opuntia littoralis, O. oricola, and a hybrid) found on Santa Cruz Island, and one way they can be distinguished are by their leaf pad shapes. The fruits of the Opuntia are edible, though laden with spikes. The Opuntia also hosts the cochineal insect, an insect that can be used as a source of dye for clothing.

As you walk through Canada del Puerto, keep an eye out for the low-growing Santa Cruz Island silver lotus (Acmispon argophyllus var. niveus) (Fig. 45). This rare plant is endemic to SCI. The SCI Volcanics are also home to other endemic species, including the Santa Cruz Island live-forever (Dudleya nesiotica)—a rare succulent whose range is confined to a small portion of the island.

Monterey Formation. "Monterey Shale primarily supports grassland, with scattered stands of chaparral dominated by scrub oaks, coastal-sage scrub, and an extensive Bishop pine forest" (Junak et al., 1995, p. 12). Monterey shale is "relatively impermeable to water" and the area is more prone to slides, which in turn affects the "soil formation and may inhibit the establishment of some plant communities" (Junak et al., 1995, p, 12). The rare white-haired manzanita (Arctostaphylos viridissima) can be found on the Monterey Shale.

One of the indicator species of coastal-sage scrub is coastal sagebrush, which is also known as California sagebrush (Artemisa californica) (Fig. 46). This sweet-smelling plant has medicinal properties and can be used as a topical pain salve.

Invasive plants. Santa Cruz Island was ranched from around 1850 to the 1980s. During this time, native vegetation was heavily impacted by grazing from sheep and rooting from domestic and feral pigs. Also, during this time, non-native species, such as European grasses and fennel were introduced to support the ranching and human life on the island. Other weeds were also accidentally or purposely introduced. Most of these introduced plants did not have natural predators, and some did well growing in the disturbed soil due to the livestock activity on the island. This created an ideal habitat for these invasive plant species to take over and crowd out native vegetation. Many efforts have been made and continue to be made to remove these invasive species and restore native habitat, although the impact of this period is still very noticeable today.

Around the Field Station. The large eucalyptus stands that surround the UC Field Station are an example of introduced species to Santa Cruz Island. These trees consume large amounts of water and can significantly alter valuable water flow on the island. Efforts are being made to remove some of these trees to restore water flows and former wetland habitat (such as the wetland by Prisoners Harbor).

Appendix A: **Soil Survey Map Unit Legend – Santa Cruz Island**

Map unit symbol and name (Soil Survey Staff, 2022)
100—Fiale-Tongva-Topdeck association, 15 to 60 percent slopes
101—Spinnaker-Tongva-Fiale association, 15 to 75 percent slopes
102—Fiale-Topdeck association, 2 to 8 percent slopes
120—Miasotus-Yardarm association, 30 to 75 percent slopes
130—Frigate-Yardarm association, 30 to 75 percent slopes
150—Halyard-Topdeck-Tongva complex, 15 to 75 percent slopes
152—Halyard-Starboard association, 2 to 20 percent slopes
153—Halyard-Topdeck association, 4 to 15 percent slopes
155—Halyard-Fiale association, 2 to 9 percent slopes
160—Beaches-Abaft complex, 0 to 5 percent slopes
180—Typic Argixerolls, 0 to 8 percent slopes
190—Typic Xerofluvents-Riverwash complex, 0 to 8 percent slopes
200—Fantail, thin surface-Forestay-Fantail association, 20 to 75 percent slopes
210—Lospinos-Forestay complex, 2 to 20 percent slopes
211—Lospinos loam, 8 to 30 percent slopes
212—Lospinos-Rock outcrop complex, 30 to 75 percent slopes
230—Fantail gravelly loam, 30 to 75 percent slopes
240—Delphine-Miasotus-Yardarm association, 30 to 75 percent slopes
241—Delphine-Badland-Miasotus complex, 30 to 75 percent slopes
250—Spinnaker-Starboard-Rock outcrop complex, 30 to 75 percent
251—Spinnaker-Rock outcrop complex, 30 to 75 percent
260—Starboard-Spinnaker-Rock outcrop complex, 30 to 75 percent
262—Halyard-Fantail association, 30 to 85 percent slopes
263—Starboard-Pachic Argixerolls-Rock outcrop complex, 30 to 75 percent
270—Topdeck-Rock outcrop-Spinnaker complex, 30 to 75 percent slopes
271—Topdeck-Spinnaker-Tongva complex 30 to 75 percent slopes
272—Topdeck-Starboard-Rock outcrop complex, 15 to 75 percent slopes
290—Rock outcrop-Topdeck-Starboard complex, 30 to 80 percent slopes
291—Rock outcrop-Spinnaker-Topdeck complex, 30 to 80 percent slopes
300—Cumulic Haploxerolls, 2 to 8 percent slopes
310—Livigne-Macool-Badland complex, 30 to 70 percent slopes
311—Livinge-Gunwale association, 30 to 75 percent slopes
321—Rudder-Spinnaker, moist-Rock outcrop complex, 30 to 75 percent slopes
713—Windage-Ballast complex, 20 to 55 percent slopes
721—Buoy fine sandy loam, 9 to 30 percent slopes
761—Lodestone-Typic Xerorthents-Windage complex, 25 to 60 percent slopes
762—Lodestone-Ballast-Halyard complex, 20 to 55 percent slopes
780—Typic Argixerolls complex, 30 to 75 percent slopes
800— Ballast-Halyard-Typic Argixerolls complex, 9 to 50 percent slopes

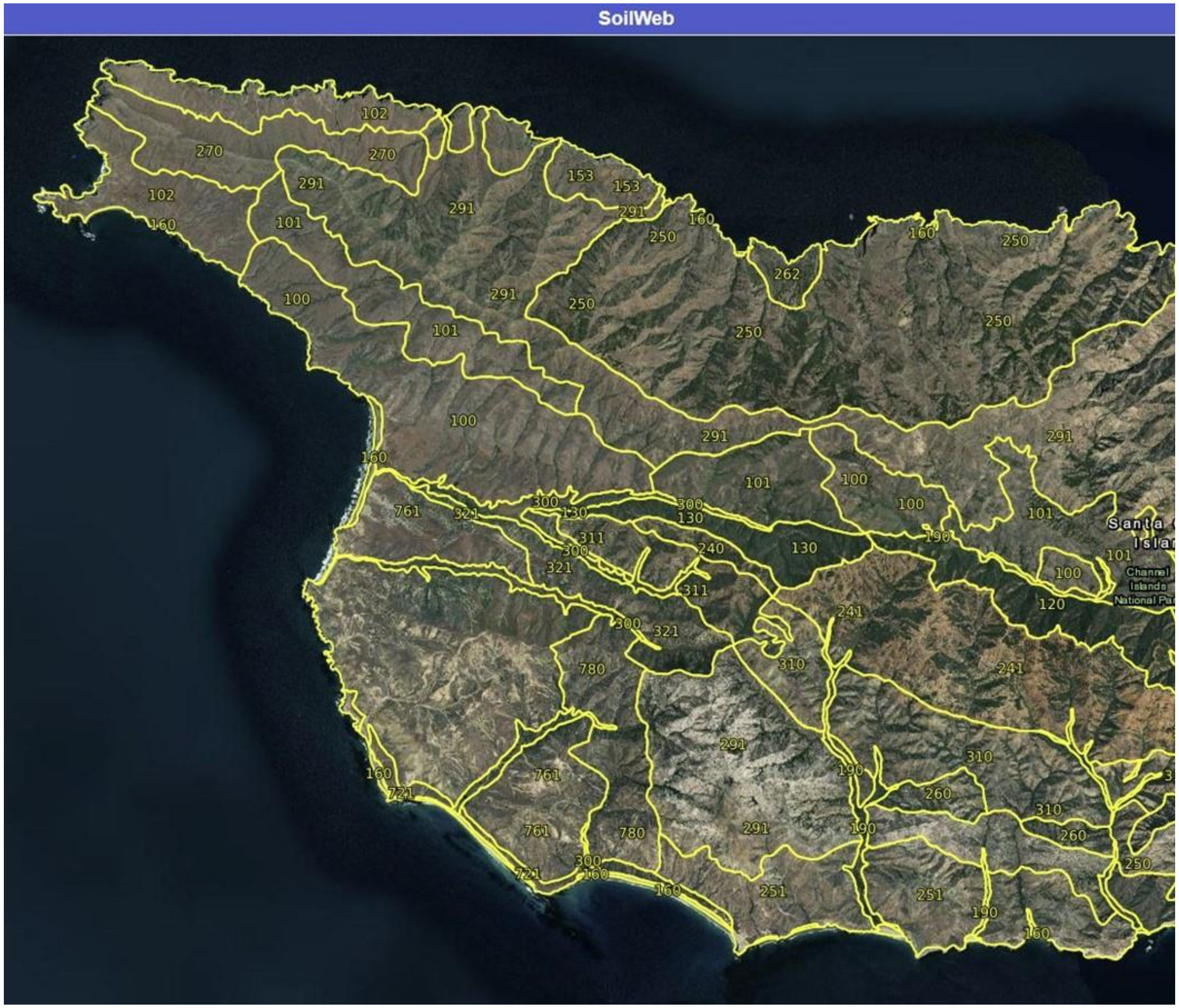

Figure 5a. – Soil map, western portion of Santa Cruz Island.

Figure 2 – Soil map, eastern portion Santa Cruz Island.

Appendix B: **Taxonomic Classification of the Soils – Santa Cruz Island**

Soil Survey Area: Channel Islands Area, California, Parts of Santa Barbara and Los Angeles Counties (Soil Survey Staff, 2022)	
Soil name	*Family or higher taxonomic classification*
Abaft	Mixed, thermic Typic Xeropsamments
Ballast	Fine, smectitic, thermic Typic Calcixerolls
Buoy	Coarse-loamy over clayey, mixed over smectitic, superactive, thermic Typic Palexeralfs
Cumulic Haploxerolls	Cumulic Haploxerolls
Delphine	Loamy-skeletal, mixed, superactive, thermic, shallow Typic Haploxeralfs
Fantail	Clayey-skeletal, smectitic, thermic Pachic Argixerolls
Fiale	Fine, smectitic, thermic Aridic Haploxererts
Forestay	Clayey-skeletal, smectitic, mesic Ultic Palexerolls
Frigate	Loamy-skeletal, mixed, superactive, isomesic Typic Haploxerepts
Gunwale	Fine-loamy, mixed, superactive, isomesic Ultic Haploxeralfs
Halyard	Fine, smectitic, thermic Pachic Argixerolls
Livigne	Loamy, mixed, superactive, thermic, shallow Typic Argixerolls
Lodestone	Fine, smectitic, thermic Aridic Calcixererts
Lospinos	Loamy-skeletal, mixed, superactive, thermic Pachic Argixerolls
Macool	Fine, smectitic, mesic Typic Argixerolls
Miasotus	Loamy-skeletal, mixed, superactive, mesic, shallow Typic Haploxeralfs
Pachic Argixerolls	Loamy-skeletal, mixed, superactive, thermic Pachic Argixerolls
Rudder	Coarse-loamy, mixed, superactive, isomesic Typic Haploxerepts
Spinnaker	Loamy, mixed, superactive, thermic Lithic Haploxerepts
Starboard	Fine-loamy, mixed, superactive, mesic Pachic Argixerolls
Tongva	Fine-loamy, mixed, superactive, thermic Pachic Argixerolls
Topdeck	Loamy, mixed, superactive, thermic Lithic Argixerolls
Typic Argixerolls	Typic Argixerolls
Typic Xerofluvents	Typic Xerofluvents
Typic Xerofluvents	Typic Xerofluvents
Windage	Fine, smectitic, thermic Pachic Argixerolls
Yardarm	Fine-loamy, mixed, superactive, mesic Typic Argixerolls

Soil Taxonomic Classification System

The system of soil classification used by the National Cooperative Soil Survey has six categories (Soil Survey Staff, 1999 and 2003). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. This table shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Twelve soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Alfisols.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udalfs (*Ud*, meaning humid, plus *alfs*, from Alfisols).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Hapludalfs (*Hapl*, meaning minimal horizonation, plus *udalfs,* the suborder of the Alfisols that has a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other taxonomic class. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Hapludalfs.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineralogy class, cation-exchange activity class, soil temperature regime, soil depth, and reaction class. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, active, mesic Typic Hapludalfs.

SERIES. The series consists of soils within a family that have horizons similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile.

Appendix C: Delphine Soil Profile Description and Laboratory Data

(https://ncsslabdatamart.sc.egov.usda.gov/)

Print Date: Mar 5 2023
Description Date: Jul 13 2003
Describer: ARW County: Santa Barbara
Site ID: CA03688SC043 MLRA: 20 -- Southern California Mountains
Soil Survey Area: CA688 -- Channel Islands Area, California, Parts Santa Barbara and Los Angeles Co
Pedon ID: CA03688SC043 Map Unit: 240 -- Delphine-Miasotus-Yardarm association, 30 to 75% slopes
Std Latitude: 33.9984167 Std Longitude: -119.7617222
Lab Pedon #: 05N0105
Soil Name as Correlated: Delphine
Classification: Loamy-skeletal, mixed, superactive, thermic, shallow Typic Haploxerepts
Primary Earth Cover: Shrub cover
Parent Material: schist
Geomorphic Setting: on side slope of island on side slope of hill
Upslope Shape: convex Cross Slope Shape: convex
Particle Size Control Section: 2 to 36 cm.
Surface Fragments: 60.0 percent 2- to 75-millimeter
Diagnostic Features: ochric epipedon 0 to 2 cm.
argillic horizon 2 to 36 cm.
lithic contact 36 to 53 cm.
paralithic materials 53 to 54 cm.

A--0 to 2 centimeters (0.0 to 0.8 inches); brown (7.5YR 5/4) broken face very gravelly loam, brown (7.5YR 4/4) broken face, moist; 22 percent clay; moderate thin platy structure; slightly hard, very friable, slightly sticky, slightly plastic; 40 percent 2 to 75-millimeter Schist fragments, by HCl, 1 normal; slightly acid, pH 6.4; abrupt smooth boundary. Lab sample # 05N00488

Bw1--2 to 24 centimeters (0.8 to 9.4 inches); yellowish red (5YR 5/6) broken face extremely gravelly clay loam, yellowish red (5YR 4/6) broken face, moist; 30 percent clay; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; 70 percent 2 to 75-millimeter Schist fragments, by HCl, 1 normal; slightly acid, pH 6.3; clear wavy boundary. Lab sample # 05N00489

Bt2--24 to 36 centimeters (9.4 to 14.2 inches); yellowish red (5YR 5/6) broken face extremely gravelly clay loam, yellowish red (5YR 4/6) broken face, moist; 34 percent clay; weak fine subangular blocky structure; slightly hard, very friable, moderately sticky, moderately plastic; 70 percent 2 to 75-millimeter Schist fragments, by HCl, 1 normal; slightly acid, pH 6.2; clear wavy boundary. Lab sample # 05N00490

Cr--36 to 53 centimeters (14.2 to 20.9 inches); clear wavy boundary.

R--53 to 54 centimeters (20.9 to 21.3 inches); bedrock.

Appendix C – Delphine Soil Pit

*** Primary Characterization Data ***

(Santa Barbara, California)

Pedon ID: CA03688SC043

Print Date: Mar 27 2023 9:04AM

Sampled as on Jul 11, 2003: Delphine ; Loamy-skeletal, mixed, superactive, thermic, shallow Typic Haploxerept
Revised to correlated: Delphine ; Loamy-skeletal, mixed, superactive, thermic, shallow Typic Haploxerepts

SSL - Project C2005USCA008 Channel Islands Nat. Park
- Site ID CA03688SC043 Lat: 33° 59' 54.30" north Long: 119° 45' 42.20" west MLRA: 20
- Pedon No. 05N0105
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Kellogg Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
05N00488	A	A	0-2	S03CA-083-001-1			GRV-L	SIL
05N00489	Bw1	Bw1	2-24	S03CA-083-001-2			GRX-CL	SIL
05N00490	Bw2	Bw2	24-36	S03CA-083-001-3			GRX-CL	SIL

Pedon Calculations

Calculation Name	Result	Units of Measure
Weighted Particles, 0.1-75mm, 75 mm Base	17	% wt
Volume, >2mm, Weighted Average	0	% vol
Clay, total, Weighted Average	16	% wt
Clay, carbonate free, Weighted Average	16	% wt
CEC Activity, CEC7/Clay, Weighted Average, CECd, Set 1	0.92	(NA)

Weighted averages based on control section: 0-36 cm

PSDA & Rock Fragments

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
					(- - - - - Total - - - - - -)			(- - Clay - - -)		(- - - - Silt - - - - -)		(- - - - - - - - - - - - Sand - - - - - - - - - - - -)					(Rock Fragments (mm))				
				Lab Text-ure	Clay < .002	Silt .002 -.05	Sand .05 -2	Fine < .0002	CO_3 < .002	Fine .002 -.02	Coarse .02 -.05	VF .05 -.10	F .10 -.25	M .25 -.50	C .5 -1	VC 1 -2	(- - - - - - - - Weight - - - - - - - -) 2 -5	5 -20	20 -75	.1- 75	>2 mm wt % whole soil
Layer	Depth (cm)	Horz	Prep		(- % of <2mm Mineral Soil -)												(- - - - - - - % of <75mm - - - - - -)				
					3A1a1a			3A1a1a		3A1a1a		3A1a1a	3A1a1a	3A1a1a	3A1a1a	3A1a1a					
05N00488	0-2	A	S	sil	8.4	66.8	24.8	3.3		29.4	37.4	10.3	3.6	4.1	4.7	2.1	2	--	--	16	2
05N00489	2-24	Bw1	S	sil	12.0	65.4	22.6	3.9		30.8	34.6	5.8	5.2	4.9	4.7	2.0	--	--	--	17	--
05N00490	24-36	Bw2	S	sil	24.3	56.2	19.5	12.5		34.5	21.7	3.4	2.9	4.2	8.0	1.0	--	--	--	16	--

Bulk Density & Moisture

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(Bulk Density) 33 kPa	Oven Dry	Cole Whole Soil	(- - - - - - - - - - - Water Content - - - - - - - - - - -) 6 kPa	10 kPa	33 kPa	1500 kPa	1500 kPa Moist	(Air Dry-Oven Dry) (- - - - Ratio - - - -)		WRD Whole Corrected Soil	Aggst Stabl 2-0.5mm	(- - Ratio/Clay - -) CEC7	1500 kPa
Layer	Depth (cm)	Horz	Prep	(- - - g cm^{-3} - - -)			(- - - - - - - - - - - - pct of < 2mm - - - - - - - - - - - -)							cm^3 cm^{-3}	%		
										3C2a1a		3D1					
05N00488	0-2	A	S							8.7		1.016				1.56	1.04
05N00489	2-24	Bw1	S							7.7		1.025				1.01	0.64
05N00490	24-36	Bw2	S							12.9		1.037				0.65	0.53

Carbon & Extractions

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-
				(- - - - - Total - - - - -) C	N	S	Est OC	OC (WB)	C/N Ratio	(- - - Dith-Cit Ext - - -) Fe	Al	Mn	(- - - - - - Ammonium Oxalate Extraction - - - - - -) Al+½Fe	ODOE	Fe	Al	Si	Mn	(- - - Na Pyro-Phosphate - - -) C	Fe	Al	Mn
Layer	Depth (cm)	Horz	Prep	(- - - - - - - - - - % of <2 mm - - - - - - - - - -)						(- - - - - - - - - - - - - - - - - - - % of < 2mm - - - - - - - - - - - - - - - - -)								mg kg^{-1}	(- - - - - - % of < 2mm - - - - -)			
				4H2a	4H2a	4H2a				4G1	4G1	4G1										
05N00488	0-2	A	S	3.14	0.28	--	3.1		11	3.5	0.2	tr										
05N00489	2-24	Bw1	S	1.10	0.11	--	1.1		10	4.2	0.2	tr										
05N00490	24-36	Bw2	S	0.22	0.02	--	0.2		13	4.3	0.3	tr										

CEC & Bases

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(- - - - - - NH_4OAC Extractable Bases - - - - -) Ca	Mg	Na	K	Sum Bases	Acid-ity	Extr Al	KCl Mn	CEC8 Sum Cats	CEC7 NH_4 OAC	ECEC Bases +Al	Al Sat	(- - - - Base - - - -) (- Saturation -) Sum	NH_4OAC
Layer	Depth (cm)	Horz	Prep	(- - - - - - - - - - - - - - - - - - cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - % - - - - - - - -)		
				4B1a1a	4B1a1a	4B1a1a	4B1a1a		4B2b1a1				4B1a1a				
05N00488	0-2	A	S	10.3*	4.2	1.7	0.6	16.8	8.3			25.1	13.1			67	100
05N00489	2-24	Bw1	S	15.4*	7.9	0.2	--	23.5	6.7			30.2	12.1			78	100
05N00490	24-36	Bw2	S	11.3*	18.4	0.2	--	29.9	7.3			37.2	15.8			80	100

*Extractable Ca may contain Ca from calcium carbonate or gypsum., CEC7 base saturation set to 100.

Salt

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-
				(- Water Extracted From Saturated Paste -) Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	PO_4	Br	OAC	SO_4	NO_2	NO_3	H_2O	Total Salts	Elec Cond	1:2 Elec Cond	Exch Na
Layer	Depth (cm)	Horz	Prep	(- - - - - mmol(+) L^{-1} - - - - -)				(- mmol(-) L^{-1} -)										(- - - - % - - - -)		(- - dS m^{-1} - -)		%
05N00488	0-2	A	S																			13
05N00489	2-24	Bw1	S																			1
05N00490	24-36	Bw2	S																			1

pH & Carbonates

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-
				(- - - - - - - - - - - - - - - - - - pH - - - - - - - - - - - - - - - - - -) KCl	$CaCl_2$ 0.01M 1:2	H_2O 1:1	Sat Paste	Oxid	NaF	(- - Carbonate - -) As $CaCO_3$ <2mm	<20mm	(- - Gypsum - - -) As $CaSO_4$*$2H_2O$ <2mm	<20mm	Resist ohms
Layer	Depth (cm)	Horz	Prep							(- - - - - - - - - - - - - % - - - - - - - - - - - -)				cm^{-1}
					4C1a2a	4C1a2a			4C1a1a1					
05N00488	0-2	A	S		5.7	6.2			7.7					
05N00489	2-24	Bw1	S		6.2	6.9			8.1					
05N00490	24-36	Bw2	S		6.4	7.0			8.3					

*** Primary Characterization Data ***

Pedon ID: CA03688SC043 (Santa Barbara, California) Print Date: Mar 27 2023 9:04AM

Sampled As : Delphine Loamy-skeletal, mixed, superactive, thermic, shallow Typic Haploxerept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 05N0105

Clay Mineralogy (<.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Elemental				EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract			7A1a1															tion
Layer	(cm)	Horz	ion	(- - - - - - - - - peak size - - - - - - - - - -)					(- - - - - - - - - % - - - - - - - - - -)				(- - - - - - - - - - - - - - - - - - - % -)							mg g^{-1}	
05N00489	2.0-24.0	Bw1	tcly	VR 3	KK 2	QZ 1															VERM
05N00490	24.0-36.0	Bw2	tcly	VR 3	KH 2	MM 2	MT 1	GE 1													VERM
				QZ 1																	

FRACTION INTERPRETATION:

tcly - Total Clay <0.002 mm

MINERAL INTERPRETATION:

GE Goethite	KH Halloysite	KK Kaolinite	MM Montmorillonite-Mica	MT Montmorillonite
QZ Quartz	VR Vermiculite			

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

INTERPRETATION (BY HORIZON):

VERM - Vermiculitic

Sand - Silt Mineralogy (2.0-0.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Optical				EGME	Inter
													Tot Re			Grain Count				Retn	preta
	Depth		Fract													7B1a2					tion
Layer	(cm)	Horz	ion	(- - - - - - - - peak size - - - - - - - - -)					(- - - - - - - - % - - - - - - - - - -)				(- - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
05N00489	2.0-24.0	Bw1	csi										60	QZ 55	FK 21	BT 9	PR 8	FE 3	MS 2		SMIX
														OP 2	FP tr	PO tr	GS tr	HN tr	TM tr		

FRACTION INTERPRETATION:

csi - Coarse Silt 0.02-0.05 mm

MINERAL INTERPRETATION:

BT Biotite	FE Iron Oxides (Goethite	FK Potassium Feldspar	FP Plagioclase Feldspar	GS Glass
HN Hornblende	MS Muscovite	OP Opaques	PO Plant Opal	PR Pyroxene
QZ Quartz	TM Tourmaline			

INTERPRETATION (BY HORIZON):

SMIX - Mixed Sand

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Appendix D: Fiale Soil Profile Description and Laboratory Data

(https://ncsslabdatamart.sc.egov.usda.gov/)

Print Date: *Mar 5 2023*
Description Date: *Jun 24 2004*
Describer: *MEB,ARW,KP,JS* ***County:*** *Santa Barbara*
Site ID: *CA04688SC069* ***MLRA:*** *20 -- Southern California Mountains*
Soil Survey Area: *CA688 -- Channel Islands Area, California, Parts Santa Barbara and Los Angeles Co*
Map Unit: *100 -- Fiale-Tongva-Topdeck association, 15 to 60 percent slopes*
Lab Source ID: *NSSL* ***Std Latitude:*** *34.0225278*
Lab Pedon #: *05N0106* ***Std Longitude:*** *-119.8022500*
Soil Name as Correlated: *Fiale*
Classification: *Fine, smectitic, thermic Aridic Haploxererts*
Primary Earth Cover: *Grass/herbaceous cover*
Parent Material: *residuum*
Bedrock Kind: *Basic volcanic breccia*
Geomorphic Setting: *on side slope of island on side slope of hill*
Upslope Shape: *convex* ***Cross Slope Shape:*** *convex*
Particle Size Control Section: *25 to 72 cm.*
Surface Fragments: *15.0 percent 2- to 75-millimeter Volcanic rock fragments and 5.0 percent 75- to 250-millimeter Volcanic rock fragments*
Diagnostic Features: *ochric epipedon 0 to 18 cm.*
argillic horizon 6 to 55 cm.

Oi--0 to 2 centimeters (0.0 to 0.8 inches); dark grayish brown (10YR 4/2) broken face, black (10YR 2/1) broken face, moist; 5 percent 2 to 75-millimeter unspecified fragments, by HCl, 1 normal.

A--2 to 16 centimeters (0.8 to 6.3 inches); dark grayish brown (10YR 4/2) broken face clay loam, black (10YR 2/1) broken face, moist; 39 percent clay; strong medium subangular blocky, and moderate medium angular blocky structure; moderately hard, firm, moderately sticky, very plastic; common very fine roots; common very fine interstitial and common very fine tubular and common fine dendritic tubular pores; distinct clay films on all faces of peds; 5 percent 5 to 75-millimeter unspecified fragments and 5 percent 2 to 5-millimeter unspecified fragments; noneffervescent, by HCl, 1 normal; slightly alkaline, pH 7.6, Phenol red; clear smooth boundary. Lab sample # 05N00491. discontinuous - phpvsfiid 267563; discontinuous - phpvsfiid 267563

Bss--16 to 44 centimeters (6.3 to 17.3 inches); dark grayish brown (10YR 4/2) broken face clay, very dark brown (10YR 2/2) broken face, moist; 50 percent clay; moderate very coarse prismatic, and strong very coarse subangular blocky structure; very hard, firm, very sticky, very plastic; common very fine roots; distinct slickensides (pedogenic) on all faces of peds; 3 percent 2 to 75-millimeter unspecified fragments; noneffervescent, by HCl, 1 normal; neutral, pH 7.2, Phenol red; clear wavy boundary. Lab sample # 05N00492. continuous - phpvsfiid 267564; continuous - phpvsfiid 267564

Bt--44 to 72 centimeters (17.3 to 28.3 inches); olive brown (2.5Y 4/4) broken face clay loam, very dark grayish brown (2.5Y 3/2) broken face, moist; 38 percent clay; massive; very hard, firm, very sticky, very plastic; common very fine roots and common fine roots; 10 percent 10YR 4/6), dry, and 10YR 4/6), moist,; 3 percent 2 to 75-millimeter unspecified fragments; noneffervescent, by HCl, 1 normal; neutral, pH 7.0, Phenol red; clear wavy boundary. Lab sample # 05N00493

Cr--72 to 73 centimeters (28.3 to 28.7 inches); noneffervescent, by HCl, 1 normal.

Appendix D – Fiale Soil Pit

*** Primary Characterization Data ***

(Santa Barbara, California)

Pedon ID: CA04688SC069

Print Date: Mar 27 2023 9:34AM

Sampled as on Jun 22, 2004: Fiale ; Fine, smectitic, thermic Aridic Haploxerert
Revised to correlated: Fiale ; Fine, smectitic, thermic Aridic Haploxererts

SSL - Project C2005USCA008 Channel Islands Nat. Park
- Site ID CA04688SC069 Lat: 34° 1' 21.10" north Long: 119° 48' 8.10" west MLRA: 20
- Pedon No. 05N0106
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Kellogg Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
05N00491	A	A	2-16	S04CA-083-002-2			GR-CL	CL
05N00492	Bss	Bss	16-44	S04CA-083-002-3			C	C
05N00493	Bt	Bt	44-72	S04CA-083-002-4			CL	CL

Pedon Calculations

Calculation Name	Result	Units of Measure
Weighted Particles, 0.1-75mm, 75 mm Base	32	% wt
Volume, >2mm, Weighted Average	7	% vol
Clay, total, Weighted Average	37	% wt
Clay, carbonate free, Weighted Average	37	% wt
CEC Activity, CEC7/Clay, Weighted Average, CECd, Set 1	1.02	(NA)

Weighted averages based on control section: 10-60 cm

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Lab Texture	-2- Total Clay < .002	-3- Total Silt .002 -.05	-4- Total Sand .05 -2	-5- Clay Fine < .0002	-6- Clay CO_3 < .002	-7- Silt Fine .002 -.02	-8- Silt Coarse .02 -.05	-9- Sand VF .05 -.10	-10- Sand F .10 -.25	-11- Sand M .25 -.50	-12- Sand C .5 -1	-13- Sand VC 1 -2	-14- Rock Fragments Weight 2 -5	-15- 5 -20	-16- 20 -75	-17- .1- 75	-18- >2 mm wt % whole soil
					(% of <2mm Mineral Soil) 3A1a1a			3A1a1a		3A1a1a		3A1a1a	3A1a1a	3A1a1a	3A1a1a	3A1a1a	(% of <75mm)				
05N00491	2-16	A	S	cl	39.4	33.8	26.8	27.6		18.9	14.9	6.5	8.7	5.7	5.2	0.7	tr	2	--	22	2
05N00492	16-44	Bss	S	c	40.5	32.4	27.1	30.1		17.0	15.4	6.4	9.3	5.3	4.2	1.9	8	1	--	28	9
05N00493	44-72	Bt	S	cl	28.5	31.5	40.0	21.9		9.9	21.6	11.9	15.8	9.4	1.9	1.0	8	14	--	44	22

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- Bulk Density 33 kPa (g cm^{-3}) DbWR1	-2- Bulk Density Oven Dry (g cm^{-3}) DbWR1	-3- Cole Whole Soil	-4- Water Content 6 kPa	-5- Water Content 10 kPa	-6- Water Content 33 kPa (pct of < 2mm) DbWR1	-7- Water Content 1500 kPa 3C2a1a	-8- Water Content 1500 kPa Moist	-9- (Air Dry-Oven Dry) Ratio 3D1	-10- Corrected	-11- WRD Whole Soil cm^3 cm^{-3}	-12- Aggst Stabl 2-0.5mm %	-13- Ratio/Clay CEC7	-14- Ratio/Clay 1500 kPa
05N00491	2-16	A	S	1.31	1.72	0.094			29.8	21.0		1.051		0.11		0.95	0.53
05N00492	16-44	Bss	S	1.30	1.78	0.104			32.0	21.5		1.058		0.13		1.00	0.53
05N00493	44-72	Bt	S	1.29	1.75	0.091			32.7	16.4		1.047		0.18		1.09	0.58

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- Total C (% of <2 mm) 4H2a	-2- Total N 4H2a	-3- Total S 4H2a	-4- Est OC	-5- OC (WB)	-6- C/N Ratio	-7- Dith-Cit Ext Fe (% of < 2mm) 4G1	-8- Dith-Cit Ext Al 4G1	-9- Dith-Cit Ext Mn 4G1	-10- Ammonium Oxalate Al+½Fe	-11- ODOE	-12- Fe	-13- Al	-14- Si	-15- Mn (mg kg^{-1})	-16- Na Pyro-Phosphate C (% of < 2mm)	-17- Fe	-18- Al	-19- Mn
05N00491	2-16	A	S	1.62	0.18	--	1.6		9	1.7	0.2	0.1										
05N00492	16-44	Bss	S	1.16	0.10	--	1.2		12	1.7	0.2	0.1										
05N00493	44-72	Bt	S	0.45	0.06	--	0.5		8	1.6	0.1	tr										

CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1- NH_4OAC Extractable Bases Ca (cmol(+) kg^{-1}) 4B1a1a	-2- Mg 4B1a1a	-3- Na 4B1a1a	-4- K 4B1a1a	-5- Sum Bases	-6- Acidity 4B2b1a1	-7- Extr Al	-8- KCl Mn (mg kg^{-1})	-9- CEC8 Sum Cats (cmol(+) kg^{-1})	-10- CEC7 NH_4 OAC 4B1a1a	-11- ECEC Bases +Al	-12- Al Sat (%)	-13- Base Saturation Sum (%)	-14- Base Saturation NH_4OAC (%)
05N00491	2-16	A	S	13.6*	22.9	0.4	0.7	37.6	6.4			44.0	37.4			85	100
05N00492	16-44	Bss	S	15.6*	24.5	0.5	0.3	40.9	5.8			46.7	40.3			88	100
05N00493	44-72	Bt	S	12.6*	20.0	0.4	0.2	33.2	3.9			37.1	31.0			89	100

*Extractable Ca may contain Ca from calcium carbonate or gypsum., CEC7 base saturation set to 100.

Salt

Layer	Depth (cm)	Horz	Prep	-1- Ca (mmol(+) L^{-1})	-2- Mg	-3- Na	-4- K	-5- CO_3 (mmol(-) L^{-1})	-6- HCO_3	-7- F	-8- Cl	-9- PO_4	-10- Br	-11- OAC	-12- SO_4	-13- NO_2	-14- NO_3	-15- H_2O (%)	-16- Total Salts (%)	-17- Elec Cond (dS m^{-1})	-18- 1:2 Elec Cond (dS m^{-1})	-19- Exch Na (%)
				(Water Extracted From Saturated Paste)																		
05N00491	2-16	A	S																			1
05N00492	16-44	Bss	S																			1
05N00493	44-72	Bt	S																			1

pH & Carbonates

Layer	Depth (cm)	Horz	Prep	-1- pH KCl	-2- pH $CaCl_2$ 0.01M 1:2 4C1a2a	-3- pH H_2O 1:1 4C1a2a	-4- pH Sat Paste	-5- pH Oxid	-6- pH NaF 4C1a1a1	-7- Carbonate As $CaCO_3$ <2mm (%)	-8- Carbonate As $CaCO_3$ <20mm (%)	-9- Gypsum As $CaSO_4 \cdot 2H_2O$ <2mm (%)	-10- Gypsum As $CaSO_4 \cdot 2H_2O$ <20mm (%)	-11- Resist ohms cm^{-1}
05N00491	2-16	A	S		6.3	6.6			8.5					
05N00492	16-44	Bss	S		6.4	6.9			8.7					
05N00493	44-72	Bt	S		6.9	7.3			8.6					

*** Primary Characterization Data ***
(Santa Barbara, California)

Pedon ID: CA04688SC069
Sampled As : Fiale
USDA-NRCS-NSSC-Soil Survey Laboratory

Fine, smectitic, thermic Aridic Haploxerert
; Pedon No. 05N0106

Print Date: Mar 27 2023 9:34AM

Clay Mineralogy (<.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Elemental				EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
						7A1a1															tion
				(- - - - - - - - - peak size - - - - - - - - - -)					(- - - - - - - - - % - - - - - - - - - -)				(- % -)							mg g^{-1}	
05N00492	16.0-44.0	Bss	tcly	HS 4	FP 1	FK 1	CR 1														CMIX
05N00493	44.0-72.0	Bt	tcly	HS 5	FK 1	CR 1															CMIX

FRACTION INTERPRETATION:
tcly - Total Clay <0.002 mm

MINERAL INTERPRETATION:
CR Cristobalite | FK Potassium Feldspar | FP Plagioclase Feldspar | HS Hydroxy-Interlayered Smectite |

RELATIVE PEAK SIZE: 5 Very Large | 4 Large | 3 Medium | 2 Small | 1 Very Small | 6 No Peaks

INTERPRETATION (BY HORIZON):
CMIX - Mixed Clay

Sand - Silt Mineralogy (2.0-0.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Optical				EGME	Inter
													Tot Re			Grain Count				Retn	preta
																7B1a2					tion
				(- - - - - - - - peak size - - - - - - - - -)					(- - - - - - - - - % - - - - - - - - - -)				(- % - - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
05N00492	16.0-44.0	Bss	csi										32	FP 51	QZ 19	OP 9	ZE 4	FE 3	GS 3		SMIX
														FK 2	PR 2	AR 2	PO 1	HN 1	BT 1		
														FG 1	MS tr	FZ tr	ZR tr	TM tr			
05N00493	44.0-72.0	Bt	csi										31	FP 35	PR 26	QZ 15	OP 15	FK 2	AR 1		SMIX
														ZE 1	BT 1	FG 1	GS 1	HN 1	FE 1		
														MS tr	CD tr	FZ tr	PO tr	SS tr	TM tr		

FRACTION INTERPRETATION:
csi - Coarse Silt 0.02-0.05 mm

MINERAL INTERPRETATION:

AR Weatherable Aggregates	BT Biotite	CD Chert (Chalcedony	FE Iron Oxides (Goethite	FG Glass Coated Feldspar
FK Potassium Feldspar	FP Plagioclase Feldspar	FZ Feldspathoids	GS Glass	HN Hornblende
MS Muscovite	OP Opaques	PO Plant Opal	PR Pyroxene	QZ Quartz
SS Sponge Spicule	TM Tourmaline	ZE Zeolite	ZR Zircon	

INTERPRETATION (BY HORIZON):
SMIX - Mixed Sand

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Appendix E: **Forestay Soil Profile Description and Laboratory Data**

(https://ncsslabdatamart.sc.egov.usda.gov/)

Description Date: May 13 2003
Describer: MEB
Site ID: CA03688SC041 Std Latitude: 33.9972778, Std Longitude: -119.6661389
MLRA: 20 -- Southern California Mountains
Soil Survey Area: CA688 -- Channel Islands Area, Calif, Parts of Santa Barbara and Los Angeles Co
Pedon ID: CA03688SC041
Map Unit: 200 -- Fantail, thin surface-Forestay-Fantail association, 20 to 75 percent slopes
Soil Name as Correlated: Forestay
Classification: Clayey-skeletal, smectitic, mesic Ultic Palexerolls
Particle Size Control Section: 68 to 100 cm.
Parent Material: residuum weathered from shale

Oi--0 to 5 centimeters (0.0 to 2.0 inches); dark grayish brown (10YR 4/2) broken face, black (10YR 2/1) broken face, moist; , by HCl, 1 normal. Lab sample # 05N00481

A1--5 to 10 centimeters (2.0 to 3.9 inches); very dark grayish brown (10YR 3/2) broken face gravelly loam, black (10YR 2/1) broken face, moist; 50 percent sand; 10 percent clay; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; 15 percent 2 to 75-millimeter unspecified fragments, by HCl, 1 normal; neutral, pH 6.8, Cresol red; clear smooth boundary. Lab sample # 05N00482

A2--10 to 38 centimeters (3.9 to 15.0 inches); very dark grayish brown (10YR 3/2) broken face gravelly loam, black (10YR 2/1) broken face, moist; 45 percent sand; 15 percent clay; moderate fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; 20 percent 2 to 75-millimeter unspecified fragments, by HCl, 1 normal; neutral, pH6.8, Cresol red; clear smooth boundary. Lab sample # 05N00483

A3--38 to 68 centimeters (15.0 to 26.8 inches); dark grayish brown (10YR 4/2) broken face very gravelly sandy loam, very dark brown (10YR 2/2) broken face, moist; 65 percent sand; 15 percent clay; moderate medium angular blocky structure; soft, very friable, nonsticky, nonplastic; 35 percent 2 to 75-millimeter unspecified fragments, by HCl, 1 normal; neutral, pH 6.6, Cresol red; clear smooth boundary. Lab sample # 05N00484

Bt1--68 to 89 centimeters (26.8 to 35.0 inches); brown (10YR 5/3) broken face very gravelly clay, dark brown (10YR 3/3) broken face, moist; 25 percent sand; 55 percent clay; massive; moderately hard, very firm, very sticky, very plastic; 60 percent 2 to 75-millimeter unspecified fragments, by HCl, 1 normal; neutral, pH 6.6, Cresol red; clear smooth boundary. Lab sample # 05N00485

Bt2--89 to 115 centimeters (35.0 to 45.3 inches); brown (10YR 5/3) broken face gravelly clay, dark brown (10YR 3/3) broken face, moist; 25 percent sand; 55 percent clay; massive; moderately hard, very firm, very sticky, very plastic; 25 percent 2 to 75-millimeter unspecified fragments, by HCl, 1 normal; neutral, pH 6.6, Cresol red; clear smooth boundary. Lab sample # 05N00486

Bt3--115 to 152 centimeters (45.3 to 59.8 inches); brown (10YR 5/3) broken face very gravelly clay, dark brown (10YR 3/3) broken face, moist; 25 percent sand; 55 percent clay; massive; moderately hard, very firm, very sticky, very plastic; 60 percent 2 to 75-millimeter unspecified fragments, by HCl, 1 normal; neutral, pH 6.6, Cresol red. Lab sample #05N00487

Appendix E – Forestay Soil Pit

*** Primary Characterization Data ***

(Santa Barbara, California)

Pedon ID: CA03688SC041

Print Date: Mar 27 2023 9:44AM

Sampled as on May 11, 2003: Forestay ; Clayey-skeletal, smectitic, mesic Pachic Palexeroll
Revised to correlated: Forestay ; Clayey-skeletal, smectitic, mesic Ultic Palexerolls

SSL - Project C2005USCA008 Channel Islands Nat. Park
- Site ID CA03688SC041 Lat: 33° 59' 50.20" north Long: 119° 39' 58.10" west MLRA: 20
- Pedon No. 05N0104
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Kellogg Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
05N00481	Oe	Oe	0-5	S03CA-083-003-1				
05N00482	A1	A1	5-10	S03CA-083-003-2			GR-L	L
05N00483	A2	A2	10-38	S03CA-083-003-3			GR-L	L
05N00484	A3	A3	38-68	S03CA-083-003-4			GRV-SL	COSL
05N00485	Bt1	Bt1	68-89	S03CA-083-003-5			GRV-C	C
05N00486	Bt2	Bt2	89-115	S03CA-083-003-6			GR-C	C
05N00487	Bt3	Bt3	115-150	S03CA-083-003-7			GRV-C	C

Pedon Calculations

Calculation Name	Result	Units of Measure
Weighted Particles, 0.1-75mm, 75 mm Base	71	% wt
Volume, >2mm, Weighted Average	30	% vol
Clay, total, Weighted Average	55	% wt
Clay, carbonate free, Weighted Average	55	% wt
CEC Activity, CEC7/Clay, Weighted Average, CECd, Set 1	0.62	(NA)

Weighted averages based on control section: 68-100 cm

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Lab Texture	-2- Total Clay <.002	-3- Total Silt .002-.05	-4- Total Sand .05-2	-5- Clay Fine <.0002	-6- Clay CO3 <.002	-7- Silt Fine .002-.02	-8- Silt Coarse .02-.05	-9- Sand VF .05-.10	-10- Sand F .10-.25	-11- Sand M .25-.50	-12- Sand C .5-1	-13- Sand VC 1-2	-14- Rock Fragments Weight 2-5	-15- 5-20	-16- 20-75	-17- .1-75	-18- >2 mm wt % whole soil
					(- - - % of <2mm Mineral Soil - - -) 3A1a1a			3A1a1a		3A1a1a		3A1a1a	3A1a1a	3A1a1a	3A1a1a	3A1a1a	(- - - % of <75mm - - -)				
05N00481	0-5	Oe	S														42	6	--	--	48
05N00482	5-10	A1	S	l	26.4	41.7	31.9	6.2		19.4	22.3	3.2	3.1	4.7	12.4	8.5	16	6	--	44	22
05N00483	10-38	A2	S	l	22.0	49.4	28.6	7.9		26.2	23.2	3.3	3.4	5.6	7.5	8.8	11	18	--	47	29
05N00484	38-68	A3	S	cosl	19.4	25.0	55.6	6.7		14.7	10.3	4.9	5.4	12.6	19.9	12.8	15	25	2	71	42
05N00485	68-89	Bt1	S	c	55.8	9.5	34.7	39.3		4.3	5.2	1.8	4.4	7.0	10.8	10.7	28	35	--	75	63
05N00486	89-115	Bt2	S	c	52.2	7.4	40.4	36.5		2.8	4.6	2.5	5.7	8.5	12.8	10.9	15	25	tr	63	40
05N00487	115-150	Bt3	S	c	51.0	10.5	38.5	33.0		4.6	5.9	2.5	5.9	8.4	12.0	9.7	18	22	2	63	42

*** Primary Characterization Data ***

(Santa Barbara, California)

Pedon ID: CA03688SC041

Print Date: Mar 27 2023 9:44AM

Sampled As : Forestay ; Clayey-skeletal, smectitic, mesic Pachic Palexeroll

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 05N0104

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- Bulk Density 33 kPa	-2- Bulk Density Oven Dry	-3- Cole Whole Soil	-4- Water Content 6 kPa	-5- 10 kPa	-6- 33 kPa	-7- 1500 kPa	-8- 1500 kPa Moist	-9- Air Dry-Oven Dry Ratio	-10- Corrected	-11- WRD Whole Soil	-12- Aggst Stabl 2-0.5mm	-13- Ratio/Clay CEC7	-14- Ratio/Clay 1500 kPa
				(- - - g cm^{-3} - - -) DbWR1	DbWR1		(- - - pct of < 2mm - - -)		DbWR1	3C2a1a		3D1		cm^3 cm^{-3}	%		
05N00481	0-5	Oe	S							84.9		1.082					
05N00481	0-5	Oe	M							126.4		1.144					
05N00482	5-10	A1	S							84.8		1.073				2.66	3.21
05N00483	10-38	A2	S	1.06	1.09	0.008			28.1	20.7		1.030		0.07		1.58	0.94
05N00484	38-68	A3	S							18.1		1.017				0.67	0.93
05N00485	68-89	Bt1	S	0.82	1.02	0.047			54.6	29.5		1.048		0.13		0.64	0.53
05N00486	89-115	Bt2	S	1.12	1.40	0.058			33.2	23.2		1.056		0.09		0.57	0.44
05N00487	115-150	Bt3	S							24.1		1.054				0.69	0.47

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- Total C	-2- Total N	-3- Total S	-4- Est OC	-5- OC (WB)	-6- C/N Ratio	-7- Dith-Cit Ext Fe	-8- Al	-9- Mn	-10- Ammonium Oxalate Extraction Al+½Fe	-11- ODOE	-12- Fe	-13- Al	-14- Si	-15- Mn	-16- Na Pyro-Phosphate C	-17- Fe	-18- Al	-19- Mn
				(- - - % of <2 mm - - -) 4H2a	4H2a	4H2a				(- - - % of < 2mm - - -) 4G1	4G1	4G1						mg kg^{-1}	(- - - % of < 2mm - - -)			
05N00481	0-5	Oe	S	35.98	1.47	--	36.0		24													
05N00482	5-10	A1	S	27.34	1.78	0.07	27.3		15	0.6	0.1	0.1										
05N00483	10-38	A2	S	5.13	0.44	--	5.1		12	1.1	0.1	0.1										
05N00484	38-68	A3	S	0.40	0.06	--	0.4		7	0.5	0.1	--										
05N00485	68-89	Bt1	S	0.66	0.10	--	0.7		6	1.4	0.4	--										
05N00486	89-115	Bt2	S	0.17	0.05	--	0.2		3	0.9	0.3	--										
05N00487	115-150	Bt3	S	0.37	0.09	--	0.4		4	1.0	0.3	--										

CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1- NH_4OAC Extractable Bases Ca	-2- Mg	-3- Na	-4- K	-5- Sum Bases	-6- Acidity	-7- Extr Al	-8- KCl Mn	-9- CEC8 Sum Cats	-10- CEC7 NH_4 OAC	-11- ECEC Bases +Al	-12- Al Sat	-13- Base Saturation Sum	-14- Base Saturation NH_4OAC
				(- - - cmol(+) kg^{-1} - - -) 4B1a1a	4B1a1a	4B1a1a	4B1a1a		4B2b1a1	4B3a1a	mg kg^{-1} 4B3a1a	(- - - cmol(+) kg^{-1} - - -)	4B1a1a		(- - - % - - -)		
05N00481	0-5	Oe	S	49.1	11.2	0.6	8.2	69.1	64.3	--	16.5	133.4	71.1			52	97
05N00481	0-5	Oe	M	50.2	12.0	0.6	9.2	72.0					84.0				86
05N00482	5-10	A1	S	43.8	5.9	0.1	2.2	52.0	56.1	--	9.3	108.1	70.2			48	74
05N00483	10-38	A2	S	27.6	3.5	0.1	2.3	33.5	12.3			45.8	34.7			73	97
05N00484	38-68	A3	S	4.6	3.0	0.5	1.4	9.5	6.7	0.1	--	16.2	13.0	9.6	1	59	73
05N00485	68-89	Bt1	S	7.0	9.8	1.5	0.7	19.0	24.7	9.6	--	43.7	35.7	28.6	34	43	53
05N00486	89-115	Bt2	S	5.1	7.2	1.8	0.2	14.3	23.1	12.7	--	37.4	30.0	27.0	47	38	48
05N00487	115-150	Bt3	S	7.0	8.0	2.5	0.3	17.8	25.1	11.4	0.6	42.9	35.3	29.2	39	41	50

Appendix E – Forestay Soil Pit

*** Primary Characterization Data ***

(Santa Barbara, California)

Pedon ID: CA03688SC041
Sampled As : Forestay
USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 05N0104

Clayey-skeletal, smectitic, mesic Pachic Palexeroll

Print Date: Mar 27 2023 9:44AM

pH & Carbonates

Layer	Depth (cm)	Horz	Prep	-1- pH KCl	-2- pH $CaCl_2$ 0.01M 1:2 4C1a2a	-3- pH H_2O 1:1 4C1a2a	-4- pH Sat Paste	-5- pH Oxid	-6- pH NaF 4C1a1a1	-7- Carbonate As $CaCO_3$ <2mm (%)	-8- Carbonate As $CaCO_3$ <20mm (%)	-9- Gypsum As $CaSO_4 \cdot 2H_2O$ <2mm (%)	-10- Gypsum As $CaSO_4 \cdot 2H_2O$ <20mm (%)	-11- Resist ohms cm^{-1}
05N00481	0-5	Oe	S		5.0	5.3								
05N00482	5-10	A1	S		4.9	5.4			6.6					
05N00483	10-38	A2	S		5.7	6.4			7.8					
05N00484	38-68	A3	S		4.7	5.5			8.1					
05N00485	68-89	Bt1	S		3.9	4.4			7.6					
05N00486	89-115	Bt2	S		3.7	4.3			7.8					
05N00487	115-150	Bt3	S		3.8	4.2			7.8					

Organic

Layer	Depth (cm)	Horz	Prep	-1- Mineral Content (%) 5A	-2- OM TC*1.724 (%)	-3- OM+ Min (%)	-4- Total C 4H2a	-5- Total N 4H2a	-6- C/N ratio	-7- Fiber Content Unrub % (by vol)	-8- Fiber Content Rub	-9- NaPyro Color	-10- Decomp State	-11- Limnic Matter	-12- pH $CaCl_2$	-13- pH H_2O 4C1a2a	-14- Bulk Density 33 kPa	-15- Bulk Density 33 kPa rewet g cm^{-3}	-16- Bulk Density OD	-17- Proj Subs cm cm^{-1}
05N00481	0-5	Oe	S		62	104	35.98	1.47	24							5.3				34
05N00481	0-5	Oe	MW	42																
05N00482	5-10	A1	S	51			27.34	1.78	15							5.4				13
05N00483	10-38	A2	S				5.13	0.44	12							6.4				14
05N00484	38-68	A3	S				0.40	0.06	7							5.5				28
05N00485	68-89	Bt1	S				0.66	0.10	6							4.4				34
05N00486	89-115	Bt2	S				0.17	0.05	3							4.3				22
05N00487	115-150	Bt3	S				0.37	0.09	4							4.2				28

Clay Mineralogy (<.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Elemental				EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
						7A1a1															tion
				(- - - - - - - - - peak size				- - - - - - - - - -)	(- - - - - - - - - %			- - - - - - - - - -)	(- %						- -)	mg g^{-1}	
05N00482	5.0-10.0	A1	tcly	MI 1	CR 1	QZ 1	FP 1														CMIX
05N00485	68.0-89.0	Bt1	tcly	HS 4	CR 2	KK 2	QZ 1														CMIX
05N00487	115.0-150.0	Bt3	tcly	HS 3	CR 2	KK 1	QZ 1														CMIX

FRACTION INTERPRETATION:

tcly - Total Clay <0.002 mm

MINERAL INTERPRETATION:

CR Cristobalite	FP Plagioclase Feldspar	HS Hydroxy-Interlayered Smectite	KK Kaolinite	MI Mica
QZ Quartz				

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

INTERPRETATION (BY HORIZON):

CMIX - Mixed Clay

Sand - Silt Mineralogy (2.0-0.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Optical				EGME	Inter
													Tot Re			Grain Count				Retn	preta
																7B1a2					tion
				(- - - - - - - - peak size				- - - - - - - - -)	(- - - - - - - - %			- - - - - - - - - -)	(- %						- - - - - - - - - - - - - - - - - -)	mg g^{-1}	
05N00485	68.0-89.0	Bt1	csi										21	GS 67	QZ 19	FK 7	GA 2	FE 1	MS 1		GLSS
														FP 1	PO 1	AR 1	ZR tr	SS tr	PR tr		
														OP tr	HN tr	FG tr	BY tr	BT tr			
05N00486	89.0-115.0	Bt2	csi										7	GS 88	QZ 7	FK 2	AR 1	QG 1	BT 1		GLSS
														MS 1	OP tr	FP tr	PO tr	GA tr	FG tr		
														HN tr	FE tr	PR tr					
05N00487	115.0-150.0	Bt3	csi										18	GS 72	QZ 16	FK 6	PR 1	HN 1	FE 1		GLSS
														BT 1	GA 1	PO 1	BY tr	QG tr	MZ tr		
														MS tr	OP tr	FP tr	AR tr	ZR tr			

FRACTION INTERPRETATION:

csi - Coarse Silt 0.02-0.05 mm

MINERAL INTERPRETATION:

AR Weatherable Aggregates	BT Biotite	BY Beryl	FE Iron Oxides (Goethite	FG Glass Coated Feldspar
FK Potassium Feldspar	FP Plagioclase Feldspar	GA Glass Aggregates	GS Glass	HN Hornblende
MS Muscovite	MZ Monazite	OP Opaques	PO Plant Opal	PR Pyroxene
QG Glass Coated Quartz	QZ Quartz	SS Sponge Spicule	ZR Zircon	

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Appendix F: Topdeck Soil Profile Description and Laboratory Data

(https://ncsslabdatamart.sc.egov.usda.gov/)

Print Date: Mar 5 2023
Description Date: Aug 12 2003
Describer: MB
Site ID: CA03688SC40
Soil Survey Area: CA688 -- Channel Islands Area, California, Parts of SantaBarbara and Los Angeles Counties
Pedon ID: S2004CA083007
Lab Source ID: SSL
Lab Pedon #: 05N0107
Soil Name as Correlated: Topdeck
Classification: Loamy, mixed, superactive, thermic Lithic Argixerolls
Physiographic Division:
Local Physiographic Area:
Geomorphic Setting: on backslope of side slope of hill on backslope of side slope of island
Upslope Shape: convex
Cross Slope Shape: convex
Particle Size Control Section: 16 to 45 cm.

Description origin: NASIS
Diagnostic Features: Mollic epipedon, argillic horizon, lithic contact

Country: United States
State: California
County: Santa Barbara
MLRA: 20 -- Southern California Mountains
Map Unit: 271 -- Topdeck-Spinnaker-Tongva complex 30 to 75 percent slopes
Std Latitude: 33.9900017
Std Longitude: -119.6803360

Primary Earth Cover: Shrub cover
Bedrock Kind: Andesite
Bedrock Depth: 45 centimeters

Bedrock Hardness: very strongly coherent cemented
Bedrock Fracture Interval: 10 to less than 45 centimeters
Surface Fragments: 20.0 percent 2- to 75-millimeter and 10.0 percent 75- to 250-millimeter and 1.0percent 250- to 600-millimeter
Description database: KSSL

Oi--0 to 1 centimeters (0.0 to 0.4 inches); slightly decomposed plant material; abrupt wavy boundary.

A--1 to 16 centimeters (0.4 to 6.3 inches); dark grayish brown (10YR 4/2) gravelly loam, very dark brown (10YR 2/2), moist; 40 percent sand; 10 percent clay; strong fine subangular blocky structure; soft, very friable, nonsticky, slightly plastic; 5 percent 75 to 250-millimeter unspecified fragments and 10 percent 2 to 75-millimeter unspecified fragments; neutral,pH 7.2, Phenol red; clear wavy boundary.

Bt1--16 to 30 centimeters (6.3 to 11.8 inches); dark grayish brown (10YR 4/2) gravelly loam, very dark brown (10YR 2/2), moist; 35 percent sand; 25 percent clay; strong fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; 1 percent 75 to 250-millimeter unspecified fragments and 20 percent 2 to 75-millimeterunspecified fragments; slightly alkaline, pH 7.4, Phenol red; clear wavy boundary. Lab sample # 05N00494

Bt2--30 to 45 centimeters (11.8 to 17.7 inches); very dark grayish brown (10YR 3/2) gravelly clay loam, very dark brown (10YR 2/2), moist; 30 percent sand; 38 percent clay; strong fine subangular blocky structure; moderately hard, very friable, slightly sticky, moderately plastic; 30 percent 2 to 75-millimeter unspecified fragments; slightly alkaline, pH 7.4, Phenol red; abrupt smooth boundary. Lab sample # 05N00494

R--45 to 46 centimeters (17.7 to 18.1 inches); very strongly coherent cemented Andesite bedrock, fractured at intervals of 10 to less than 45 centimeters;

Appendix F – Topdeck Soil Pit

*** Primary Characterization Data ***

(Santa Barbara, California)

Pedon ID: S2004CA083007

Print Date: Mar 27 2023 9:44AM

Sampled as on Aug 10, 2003: Topdeck ; Loamy, mixed, superactive, thermic Lithic Argixeroll
Revised to correlated: Topdeck ; Loamy, mixed, superactive, thermic Lithic Argixerolls

SSL - Project C2005USCA008 Channel Islands Nat. Park
- Site ID CA03688SC40 Lat: 33° 59' 24.01" north Long: 119° 40' 49.21" west MLRA: 20
- Pedon No. 05N0107
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Kellogg Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
05N00494	Bt	Bt	16-45	S04CA-083-007-1			GR-L	L

Pedon Calculations

Calculation Name	Result	Units of Measure
Weighted Particles, 0.1-75mm, 75 mm Base	44	% wt
Volume, >2mm, Weighted Average	19	% vol
Clay, total, Weighted Average	26	% wt
Clay, carbonate free, Weighted Average	26	% wt

Weighted averages based on control section: 16-45 cm

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Lab Texture	-2- Total Clay < .002	-3- Total Silt .002 -.05	-4- Total Sand .05 -2	-5- Clay Fine < .0002	-6- Clay CO3 < .002	-7- Silt Fine .002 -.02	-8- Silt Coarse .02 -.05	-9- Sand VF .05 -.10	-10- Sand F .10 -.25	-11- Sand M .25 -.50	-12- Sand C .5 -1	-13- Sand VC 1 -2	-14- Rock Fragments (mm) Weight 2 -5	-15- Weight 5 -20	-16- Weight 20 -75	-17- Weight .1- 75	-18- >2 mm wt % whole soil
					(- - - % of <2mm Mineral Soil											- - -)	(- - - % of <75mm			- - -)	
					3A1a1a			3A1a1a		3A1a1a		3A1a1a	3A1a1a	3A1a1a	3A1a1a	3A1a1a					
05N00494	16-45	Bt	S	l	26.2	48.1	25.7	13.1		26.7	21.4	6.1	6.1	5.6	5.0	2.9	8	14	8	44	31

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- Bulk Density 33 kPa	-2- Bulk Density Oven Dry	-3- Cole Whole Soil	-4- Water Content 6 kPa	-5- Water Content 10 kPa	-6- Water Content 33 kPa	-7- Water Content 1500 kPa	-8- 1500 kPa Moist	-9- Air Dry-Oven Dry Ratio	-10- Corrected	-11- WRD Whole Soil	-12- Aggst Stabl 2-0.5mm	-13- Ratio/Clay CEC7	-14- Ratio/Clay 1500 kPa
				(- - - g cm^{-3}	- - -)		(- - - pct of < 2mm				- - -)			cm^3 cm^{-3}	%		
												3D1					
05N00494	16-45	Bt	S									1.025					

*** Primary Characterization Data ***

(Santa Barbara, California)

Pedon ID: S2004CA083007

Print Date: Mar 27 2023 9:44AM

Sampled As : Topdeck Loamy, mixed, superactive, thermic Lithic Argixeroll

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 05N0107

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- Total C	-2- Total N	-3- Total S	-4- Est OC	-5- OC (WB)	-6- C/N Ratio	-7- Dith-Cit Ext Fe	-8- Dith-Cit Ext Al	-9- Dith-Cit Ext Mn	-10- Ammonium Oxalate Extraction Al+½Fe	-11- ODOE	-12- Fe	-13- Al	-14- Si	-15- Mn	-16- Na Pyro-Phosphate C	-17- Fe	-18- Al	-19- Mn
				(- - - % of <2 mm					- - -)	(- - - % of < 2mm								mg kg^{-1}	(- - - % of < 2mm			- - -)
										4G1	4G1	4G1		4G2	4G2	4G2	4G2	4G2				
05N00494	16-45	Bt	S							1.7	0.1	tr	0.14	0.06	0.13	0.07	0.09	165.6				

pH & Carbonates

Layer	Depth (cm)	Horz	Prep	-1- pH KCl	-2- pH $CaCl_2$ 0.01M 1:2	-3- pH H_2O 1:1	-4- pH Sat Paste	-5- pH Oxid	-6- pH NaF	-7- Carbonate As $CaCO_3$ <2mm	-8- Carbonate As $CaCO_3$ <20mm	-9- Gypsum As $CaSO_4$*$2H_2O$ <2mm	-10- Gypsum As $CaSO_4$*$2H_2O$ <20mm	-11- Resist ohms cm^{-1}
									4C1a1a1	(- - - %			- - -)	
05N00494	16-45	Bt	S						8.3					

Phosphorous

Layer	Depth (cm)	Horz	Prep	-1- Melanic Index	-2- Phosphorous NZ	-3- Acid Oxal	-4- Anion Exch	-5- Resin Available	-6- Capacity	-7- Bray 1	-8- Bray 2	-9- Olsen	-10- H_2O	-11- Citric Acid	-12- Mehlich III	KCl Extr NO_3
					%	(- - - mg kg^{-1}									- - -)	
					4D8a1	4G2										
05N00494	16-45	Bt	S		17	--										

*** Primary Characterization Data ***

Pedon ID: S2004CA083007 (Santa Barbara, California) Print Date: Mar 27 2023 9:44AM

Sampled As : Topdeck Loamy, mixed, superactive, thermic Lithic Argixeroll

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 05N0107

Clay Mineralogy (<.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Elemental				EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract			7A1a1															tion
Layer	(cm)	Horz	ion	(- - - - - - - - - peak size - - - - - - - - - -)					(- - - - - - - - - % - - - - - - - - - -)				(- % -)							mg g^{-1}	
05N00494	16.0-45.0	Bt	tcly	KH 2	MT 1	MI 1	QZ 1	CR 1													CMIX

FRACTION INTERPRETATION:

tcly - Total Clay <0.002 mm

MINERAL INTERPRETATION:

CR Cristobalite KH Halloysite MI Mica MT Montmorillonite QZ Quartz

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

INTERPRETATION (BY HORIZON):

CMIX - Mixed Clay

Sand - Silt Mineralogy (2.0-0.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Optical				EGME	Inter
													Tot Re			Grain Count				Retn	preta
	Depth		Fract													7B1a2					tion
Layer	(cm)	Horz	ion	(- - - - - - - - peak size - - - - - - - - -)					(- - - - - - - - % - - - - - - - - - -)				(- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
05N00494	16.0-45.0	Bt	csi											OT 100	PO tr	SS tr	GS tr				

FRACTION INTERPRETATION:

csi - Coarse Silt 0.02-0.05 mm

MINERAL INTERPRETATION:

GS Glass OT Other PO Plant Opal SS Sponge Spicule

Appendix G: Comments and Recommendations on Four Pedon Descriptions and associated Laboratory Data Santa Cruz Island, California

Christopher W. Smith, Ph.D., Senior Soil Scientist Retired, USDA Natural Resources Conservation Service, 3/21/2023

Soil Temperature Regimes (Source: Weatherwx.com) -- Applicable to all soils:

MAAT = 61.9°F or 16.6°C

MAST = 16.6 – 2°C = 14.6°C = <15°C therefore marginally mesic

MWAT = Ave. of J, F, M = 14.6°C

MWST = 14.6°C – 2°C = 12.6°C

MSAT = 17.8°C

MSST = 17.8°C – 2C = 15.8°C

Recommendation: 15.8°C – 12.6°C = 3.2°C difference in MSST-MWST, which is less than a 6°C difference. Therefore, the *indication is that soil temperature regimes on the island are "iso" (i.e., isomesic).* Note that other weather data sources may vary, and aspect was not considered under this approximation analysis. Recommend that temperature sensors or a Scan Station be installed to solidify placement. Mainland coastal zone may also prove to be iso. Determine where isothermic transitions to isomesic from north to south along the coast and how far iso conditions extend inland.

Delphine Series

Assigned Taxonomic Placement: Loamy-Skeletal, mixed, superactive, thermic, shallow, Typic Haploxerepts

Recommended Taxonomic Placement: Loamy-Skeletal, *vermiculitic*, superactive, *isomesic*, shallow, Typic Haploxerepts. Vermiculite is dominant clay mineral per the NSSL data.

Pedon Description:

- Assigned horizon designations: A, Bt1, Bt2

- Horizon Description: Horizons state …, by HCl, 1 normal, … . This applies to carbonate presence but none present. Remove.

- No clay films present. The t subscript definition states that there "should" be evidence of clay translocation such as clay films. Not mandatory but the ratio of fine clay/total clay from second horizon to third horizon is >1.2 therefore a t suffix can be used with the third horizon. First to second horizon ratio is <1.2. *Recommend revising horizons to A, Bw, Bt, Cr, R.*

Lab data observations:

- High organic carbon in the surface layer for a xeric soil moisture regime. Need a description of the vegetation.

- Exchangeable potassium levels absent below 2 cm depth. Clay and coarse silt mineralogy suggest a moderate amount of weathering and moderate amount of weatherable minerals. Some potassium should be released from K feldspars and biotite. Also, salt spray should deposit some K. Reason for absence of K in the subsoil is curious and unknown.

Fertility Capability Classification (FCC) and interpretation (Smith, C., 1989. Ph.D. Dissertation):

- L"R-d'k = shallow loamy soil with >35% gravel over soft bedrock at <50 cm depth. Low available water holding capacity. Moisture deficit for much of the warmer portion of the growing season. Adequate Calcium and magnesium presence. Low potassium levels. Adequate CEC and pH. Salt and sodium content low.

Fiale Series

<u>Assigned Taxonomic Placement:</u> Fine, smectitic, thermic Aridic Haploxererts

<u>Recommended Taxonomic Placement:</u> Fine, *mixed, isomesic*, Aridic* Haploxererts

> * Good probability of this being true based on cursory review of monthly rainfall (online sources). Soil moisture should be measured or estimated by the Newhall model (revised by Van Wambecke or other models) to validate placement.

Pedon Description:

- Assigned horizon designations: Oi, A, Bss, Bt. Recommend change to Oi, A, Bss, *C*.
- Horizon Description: Elevation stated to be 1317 meters. This should be changed to feet.
- Oi horizon has no mention of fibric material or undecomposed plant material.
- <u>A horizon clay films implies absent eroded surface layer</u>. 20% surface fragments supports this idea.
- Bt horizon is massive, lighter color, has no clay films and has <1.2 x fine clay/total clay than overlying horizon. *Recommend changing Bt to C horizon.*
- No cracking to the surface is noted, but must do so during part of the year to meet Vertisol criteria (criteria 3 for Vertisols). Footnote implies cracks must extend to the surface as it must control infiltration in a dry soil). *This should be verified to support Vertisol placement.*

Lab Data Observations:

- Dominant clay fraction I Bss and Bt (C) horizons is HS (hydroxy-interlayered smectite, HIS) and does not qualify for smectitic family. *Change to mixed mineralogy.* Apparently, there is sufficient shrink-swell via HIS to qualify for Vertisol placement.

- Ca:Mg reversed and is typical of basic igneous parent material. This may limit some plant species from populating this soil. Vegetation species should be entered in pedon description.

FCC Classification:

- Cd'v = clayey soil with high shrink-swell potential and if sloping, may cause increased runoff after cracks close. Moisture deficit for much of the warmer portion of the growing season. High shrink-swell potential may damage fine roots. Adequate Calcium and magnesium presence. Adequate CEC and pH. Salt and sodium content low.

Forestay Series

Assigned Taxonomic Placement: clayey-skeletal, smectitic, mesic Ultic Palexerolls

Recommemded Taxonomic Placement: clayey-skeletal, *mixed, isomesic* Ultic Palexer*alfs*

Pedon Description:

- Lab data sheet shows Oe1 and A horizon. A horizon has high OC and should be Oe2. Needs field checking.

- Horizon designations should be *Oe1, Oe2, A1, A2, Bt1, Bt2, Bt3*. No clay films due to massive designations. Field check to verify. Check for clay films in pores. No pores noted. Need to include and state no pores if so. However, lab data shows fine clay/total clay > than A2 (ex A3), therefore t subscript stands.

Lab data observations:

- Dominant clay fraction I Bt1 and Bt3 horizons is HS (hydroxy-interlayered smectite, HIS) and does not qualify for smectitic family. *Change to mixed mineralogy.*
- There is significant glass present. This readily weatherable mineral can be found in Monterey shale. This coupled with degrading smectite, is incongruous. It is possible the clay is inherited from the parent material. That would question the presence of an argillic horizon.
- Additionally, silt and sand, calculated on a clay free basis, is as follows:

Depth (cm)	silt%	sand%
5 – 10	56.7	43.3
10 – 38	63.3	36.7
38 – 68	31.0	69.0
68 – 89	21.5	78.5
89 – 115	15.5	84.5
115 – 152	21.4	78.6

- There is a clear change in silt and sand percents at 38 cm suggesting a possible different source of mineral material above 38 cm. Clay size muscovite and plagioclase feldspar are present in the 5 – 10 cm horizon but not in lower layers. Muscovite in an upper horizon could persist as it is a mineral resistant to weathering but it should be seen in lower horizons if it were inherited from the shale parent material. The feldspar is a significantly more weatherable mineral and is less likely to be found in an upper horizon. Both of these minerals' presence support the idea of an imported source.

- The KCl extractable Al is very high. This may be a source of the Al-hydroxy interlayering of the HIS. The pH values of 4.2 – 4.4 are in keeping with the high KCl Al presence and an environment conducive to degradation of smectite.

- Base saturation (NH_4OAC) in the 89 – 115 cm horizon is 48%. Strictly adhering to taxonomic requirements, this soil is therefore not a Mollisol. The lab has ignored this. This horizon should be re-analized or satellite soil descriptions and samples taken. Presently, this soil classifies as an Alfisol.

FCC Classification:

- OL'd' = Organic surface layer and gravelly loamy subsurface layer. Adequate Calcium and magnesium presence. Adequate CEC and pH. Salt and sodium content low. . Moisture deficit for much of the warmer portion of the growing season.

Topdeck Series

Assigned Taxonomic Placement: Loamy, mixed, superactive, thermic, Lithic Argixerolls

Recommended Taxonomic Placement: As assigned above.

Pedon Description:

- No clay films noted and insufficient data to determine fine clay/total clay ratio increase to verify t subscript. Pores should be described and checked for films.

Lab data observations:

- Mixed mineralogy confirmed by x-ray analysis of the total clay fraction in the Bt horizon.

FCC Classification:

- L'C'Rd'. Gravelly loamy surface layer over gravelly clayey subsurface layer. Adequate Calcium and magnesium presence. No potassium deficiency assumed due to probable contribution by salt spray. Adequate CEC and pH. Salt and sodium content low. Available moisture reduced by gravelly textures and bedrock at less than 50 cm depth. Moisture deficit for much of the warmer portion of the growing season.

Note: FCC system and symbol definitions are available on request at csmithsail@aol.com.

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