# Vineyard Variability Due To Differences in Soil

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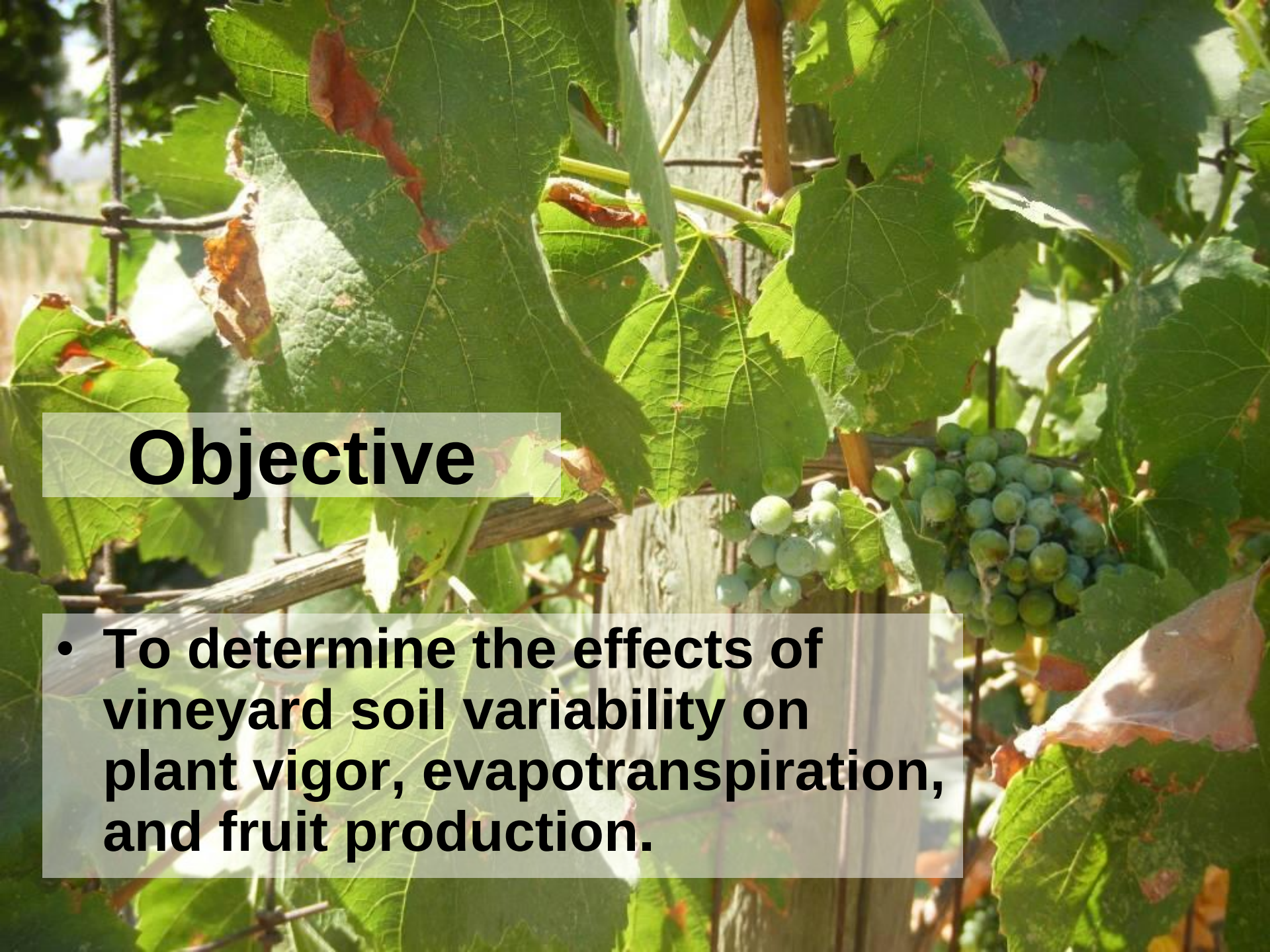
# Background

- **We know that soils are important, but how much do they affect grape productivity and fruit quality?**

- **Some studies suggest a role for soil texture, mineralogy and chemistry in determining plant vigor, grapevine yield and fruit characteristics.**

- **Soil properties can also influence evapotranspiration and plant water requirements.**



# Objective

- To determine the effects of vineyard soil variability on plant vigor, evapotranspiration, and fruit production.

# Experimental Design

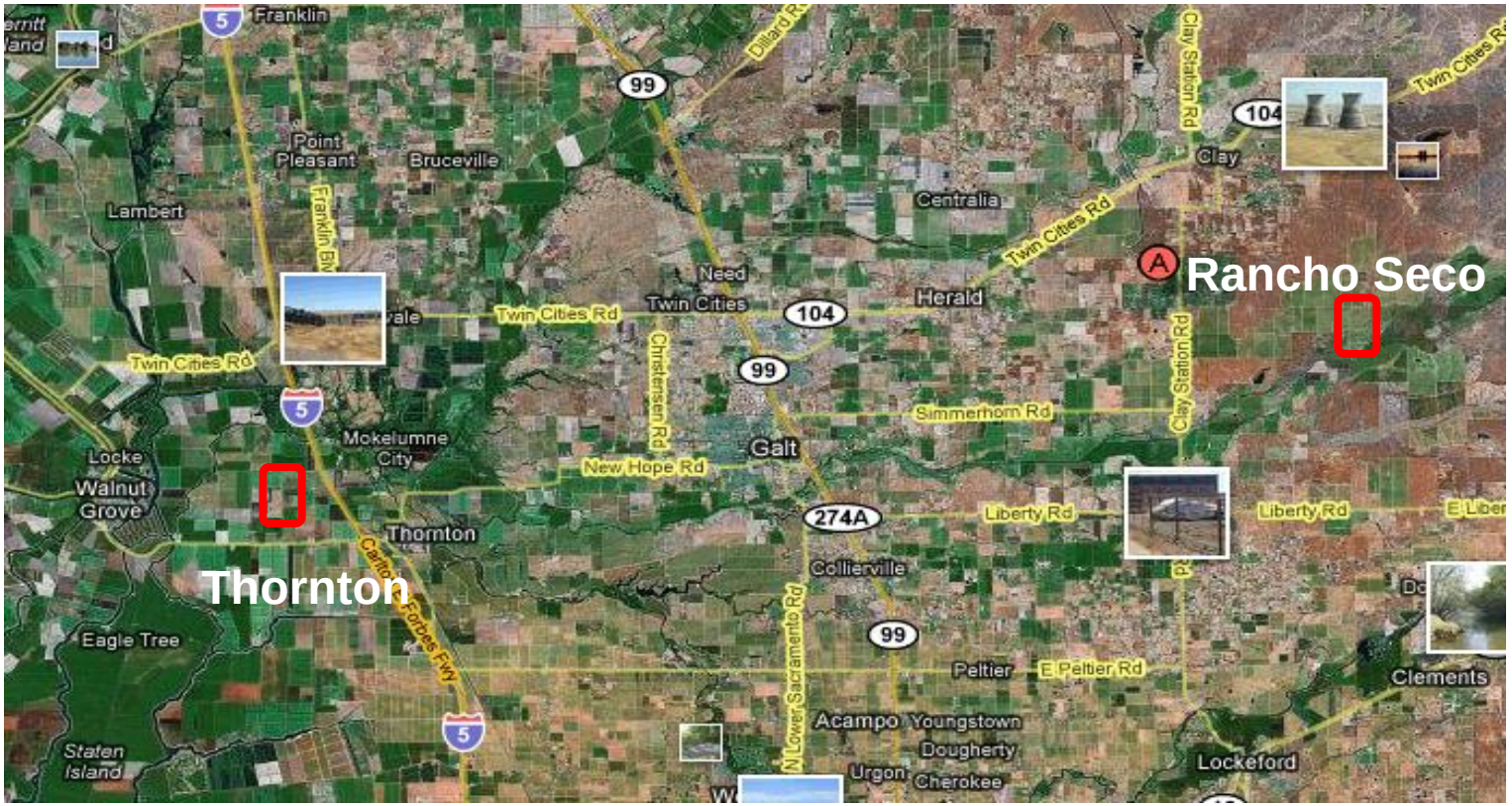
- **Two vineyards in California were found by the owners to have variability in plant growth characteristics.**

- **We tested for differences in the soils and the plants using a variety of methods.**

# Methods

- Soil description, mapping and analysis
- Evapotranspiration measurements
- Plant and fruit measurements
  - Yield
  - Pruning weights

# Vineyard Locations and Topography



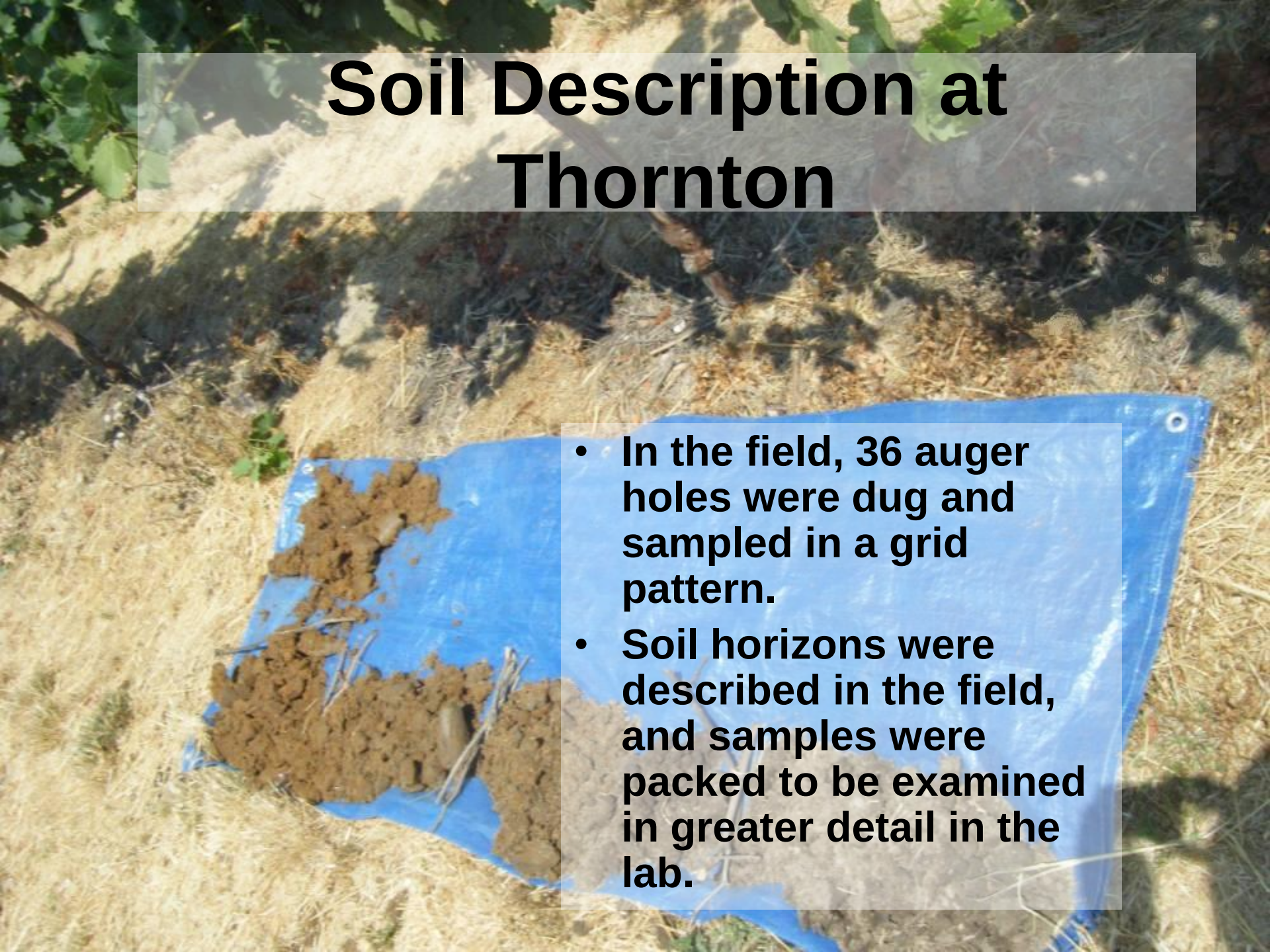

- **The Thornton vineyard was set on the basin rim of the Sacramento River Delta.**
- **The Rancho Seco vineyard was located on a terrace set amid rolling hills.**

# Geological History of the Two Sites

- **The Thornton vineyard was underlain by two different soils on river alluvium of Holocene age.**

- **The Rancho Seco vineyard was set on a dissected old alluvial fan of the Plio-Pleistocene Laguna formation.**

# Soil Description at Thornton



- In the field, 36 auger holes were dug and sampled in a grid pattern.
- Soil horizons were described in the field, and samples were packed to be examined in greater detail in the lab.

# Redoximorphic Features

- Thornton soils had redoximorphic features (red, gray and blue stains) caused by the presence of a shallow water table in parts of the vineyard.

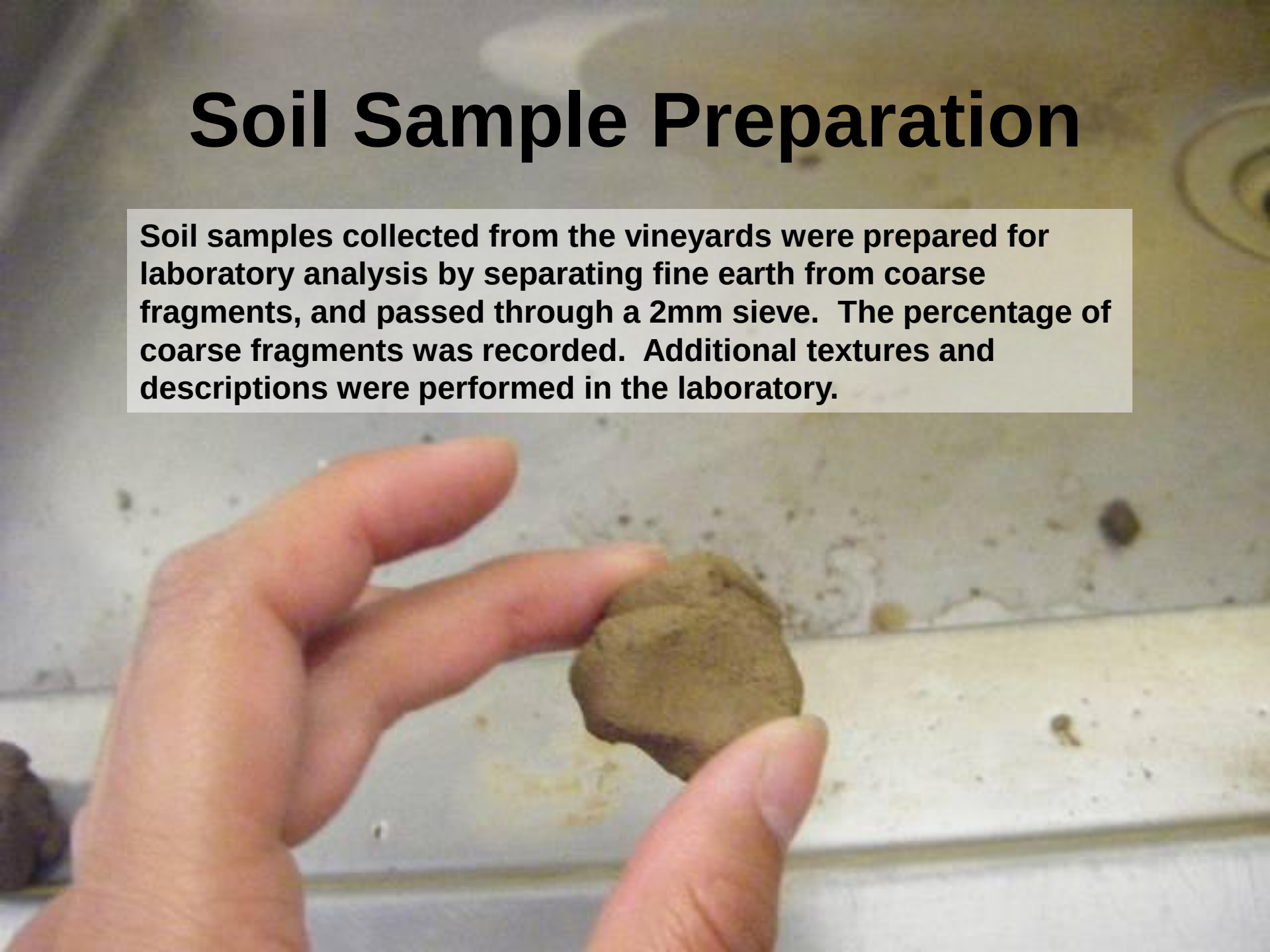
# Laboratory Soil Description and Analyses

**This table shows an example of soil descriptions for row 355 of the Thornton vineyard. Soil depth, color and hand textures are recorded.**

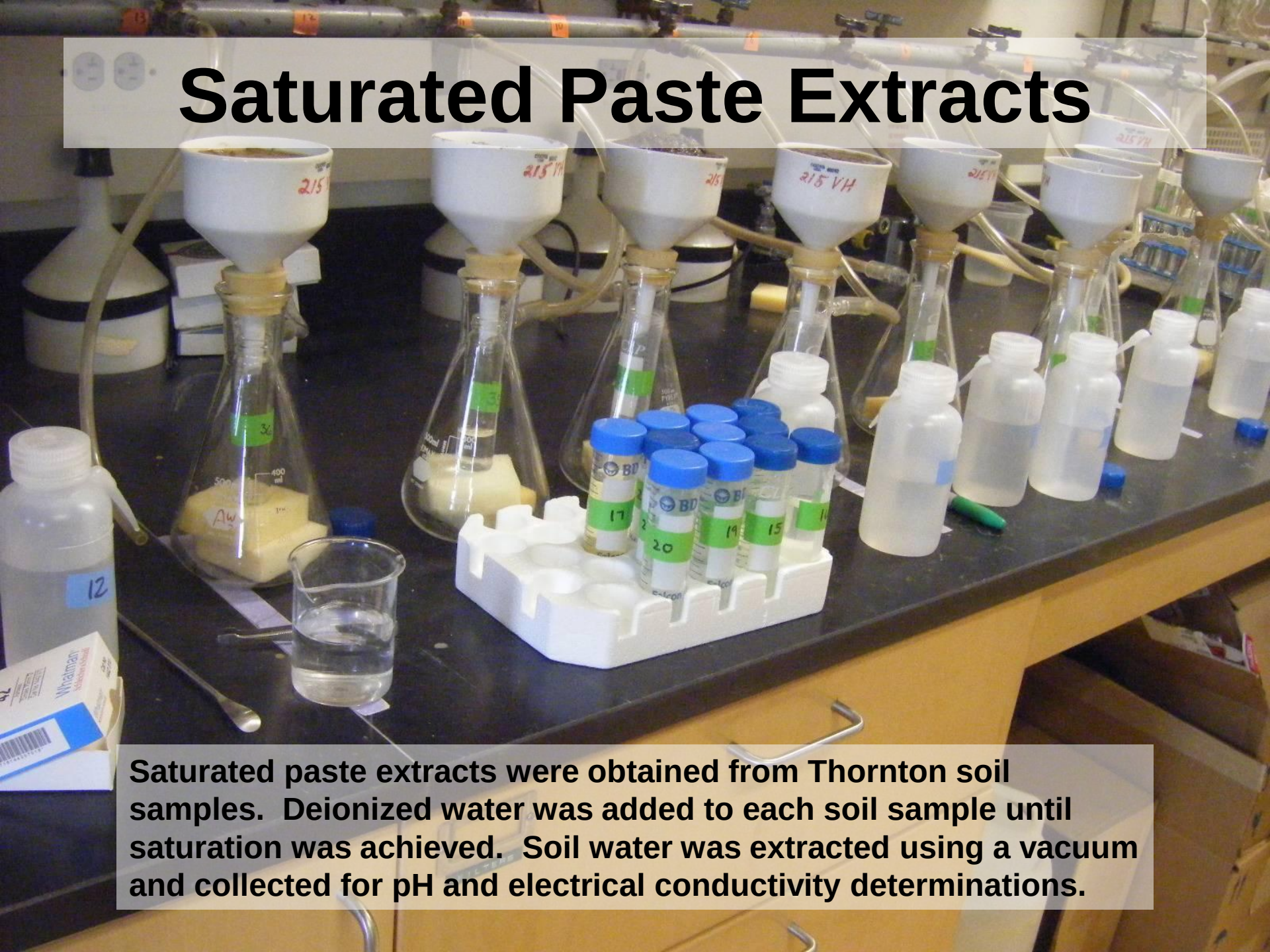
| | | | | | |
|---|---|---|---|---|---|
| Vine 14-15 | Ripeness 0% | Root 60 inches | | | |
| | Ap | 0-18 | 10YR 5/2 | 10YR 3/2 | SiC |
| | A/E | 18-21 | 10YR 5/1 | 10YR 3/2 | SiCL |
| | Bt | 21-40 | 10YR 5/1 | 10YR 3/3 | C |
| | Bt2 | 40-60 | 10YR 5/3 | 10YR 4/4 | C |
| | | | | | |
| **Vine 45** | Ripeness 50-60% | Roots 36 inches | | | |
| | Ap | 0-18 | 10YR 5/1 | 10YR 3/2 | C |
| | Bt | 18-36 | 10YR 5/4 | 10YR 4/3 | C |
| | BCtq | 36-54 | 10YR 5/8 | 10YR 4/4 | SCL |
| | C | 54-62 | | 10YR 4/4 | SCL |
| | | | | | |
| Vine 74-75 | Ripeness 5% | Roots 40 inches | | | |
| | Ap | 0-13 | 10YR 5/2 | 10YR 3/2 | CL/SiCL |
| | Bt | 13-37 | 10YR 5/2 | 10YR 4/4 | C |
| | Cq1 | 37-54 | 10YR 6/6 | 10YR 4/4 | C/CL |
| | Cq2 | 54-60 | 10YR 5/4 | 10YR 4/4 | SCL |
| | | | | | |
| Vine 105 | Ripeness 10% | | | | |
| | Ap | 0-15 | 10YR 5/2 | 10YR 3/2 | CL |
| | Bt1 | 15-32 | 10YR 5/2 | 10YR 3/3 | SCL |
| | Bt2 | 32-50 | 10YR 5/3 | 10YR 4/3 | SCL |
| | Bt3 | 50-60 | 10YR 5/8 | 10YR 4/4 | SC |
| | | | | | |
| Vine 140 | Ripeness <5% | | | | |
| | Ap | 0-14 | 10YR 5/2 | 10YR 2/2 | CL |
| | A1 | 14-34 | 10YR 5/2 | 10YR 3/2 | SiCL |
| | Bt1 | 34-52 | 10YR 5/2 | 10YR 4/3 | Ct |
| | Bt2 | 52-62 | 10YR 4/2 | 10YR 4/3 | Ct |
| | | | | | |
| Vine 175 | Ripeness <5% | Roots 60 inches | vigorous vines | | |
| | Ap | 0-11 | 10YR 4/2 | 10YR 3/2 | C |
| | A | 11-30. | 10YR 6/2 | 10YR 3/2 | C |
| | Bt1 | 30-50 | 10YR 4/4 | 10YR 4/3 | Ct |
| | Bt2 | 50-60 | 10YR 5/6 | 10YR 4/3 | Ct |

# Soil Sample Preparation

**Soil samples collected from the vineyards were prepared for laboratory analysis by separating fine earth from coarse fragments, and passed through a 2mm sieve. The percentage of coarse fragments was recorded. Additional textures and descriptions were performed in the laboratory.**



# Saturated Paste Extracts




**Saturated paste extracts were obtained from Thornton soil samples. Deionized water was added to each soil sample until saturation was achieved. Soil water was extracted using a vacuum and collected for pH and electrical conductivity determinations.**

# Differences in Soil Type

| | Horizon | Depth, cm | %SP | pH | EC | %BS | Texture |
|---|---|---|---|---|---|---|---|
| Thornton 415E | Ap | 0-36 | 54 | 5.6 | 0.77 | 70.3 | Silty Clay Loam |
| | AC | 36-66 | 71 | 6.1 | 0.37 | 67.8 | Silty Clay Loam |
| | 2Ab/C | 66-102 | 70 | 6.5 | 0.19 | 67.2 | Silty Clay Loam |
| | C1 | 102-122 | 57 | 6.6 | 0.20 | 71.4 | Loam |
| | C2 | 122-152 | 54 | 6.8 | 0.22 | 74.0 | Sandy Loam |
| Thornton 362W | Ap | 0-30 | 54 | 6.8 | 0.57 | 75.3 | Clay Loam |
| | BA | 30-56 | 35 | 7.1 | 0.33 | 81.4 | Loam |
| | Bt | 56-102 | 46 | 7.7 | 0.56 | 121.7 | Clay Loam |
| | Bt2 | 102-117 | 43 | 7.6 | 0.51 | 136.3 | Clay Loam |
| | BCt | 117-152 | 40 | 7.5 | 0.39 | 90.3 | Sandy Clay Loam |

SP, Water content at saturation; EC, electrical conductivity (dS/M); %BS, percent base saturation

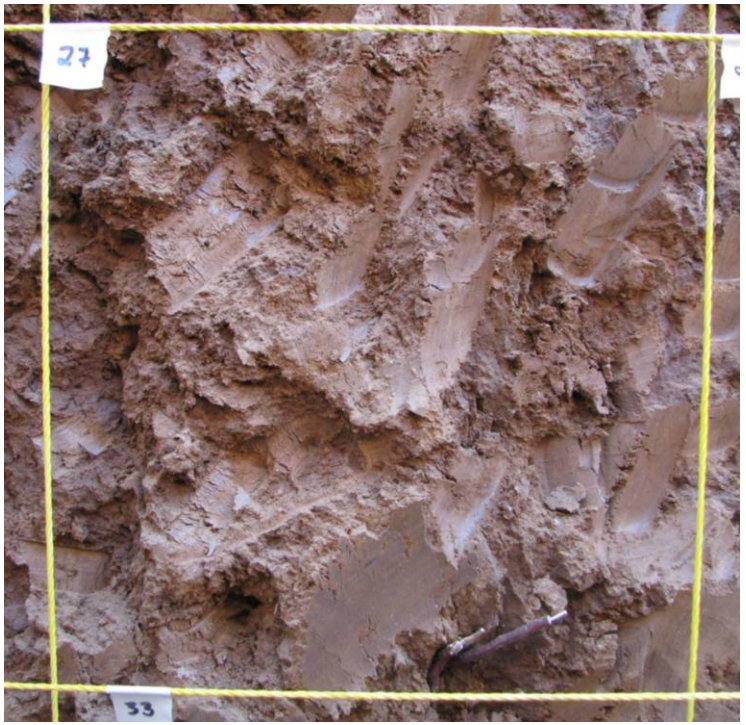
**The difference in soil type was obvious in Rows 416 and 362. Differences were noted in soil morphology, water content at saturation, pH, electrical conductivity, base saturation and texture.**

# Soil Description at Rancho Seco

- **Here we dug pits with a backhoe to get a broader view of the soils. We found a strong contrast in gravel content and soil texture between the two sampling sites.**

***Very gravelly soil***

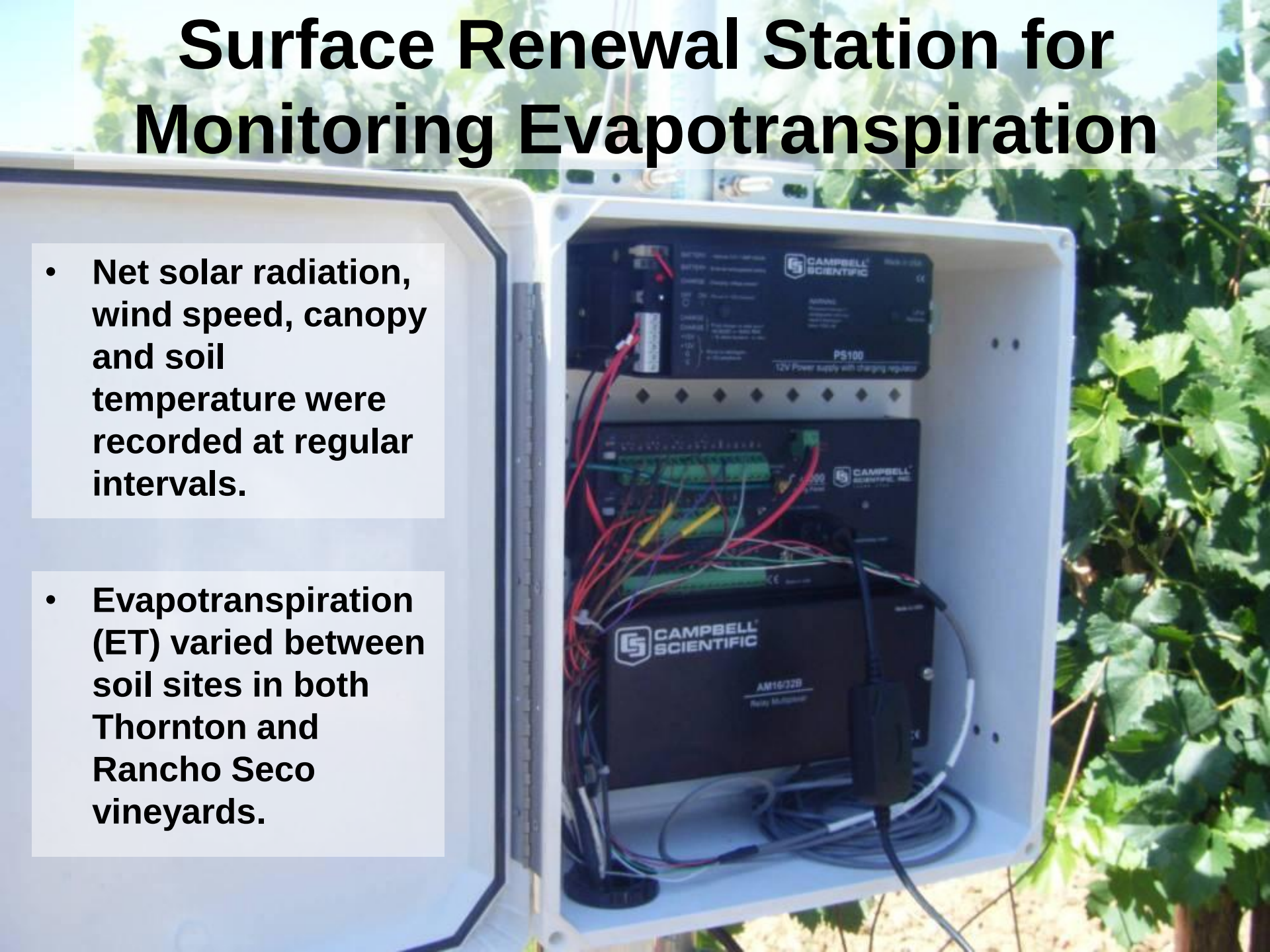

***Very clayey soil, no gravels***



# Surface Renewal Station for Monitoring Evapotranspiration

- Net solar radiation, wind speed, canopy and soil temperature were recorded at regular intervals.

- Evapotranspiration (ET) varied between soil sites in both Thornton and Rancho Seco vineyards.



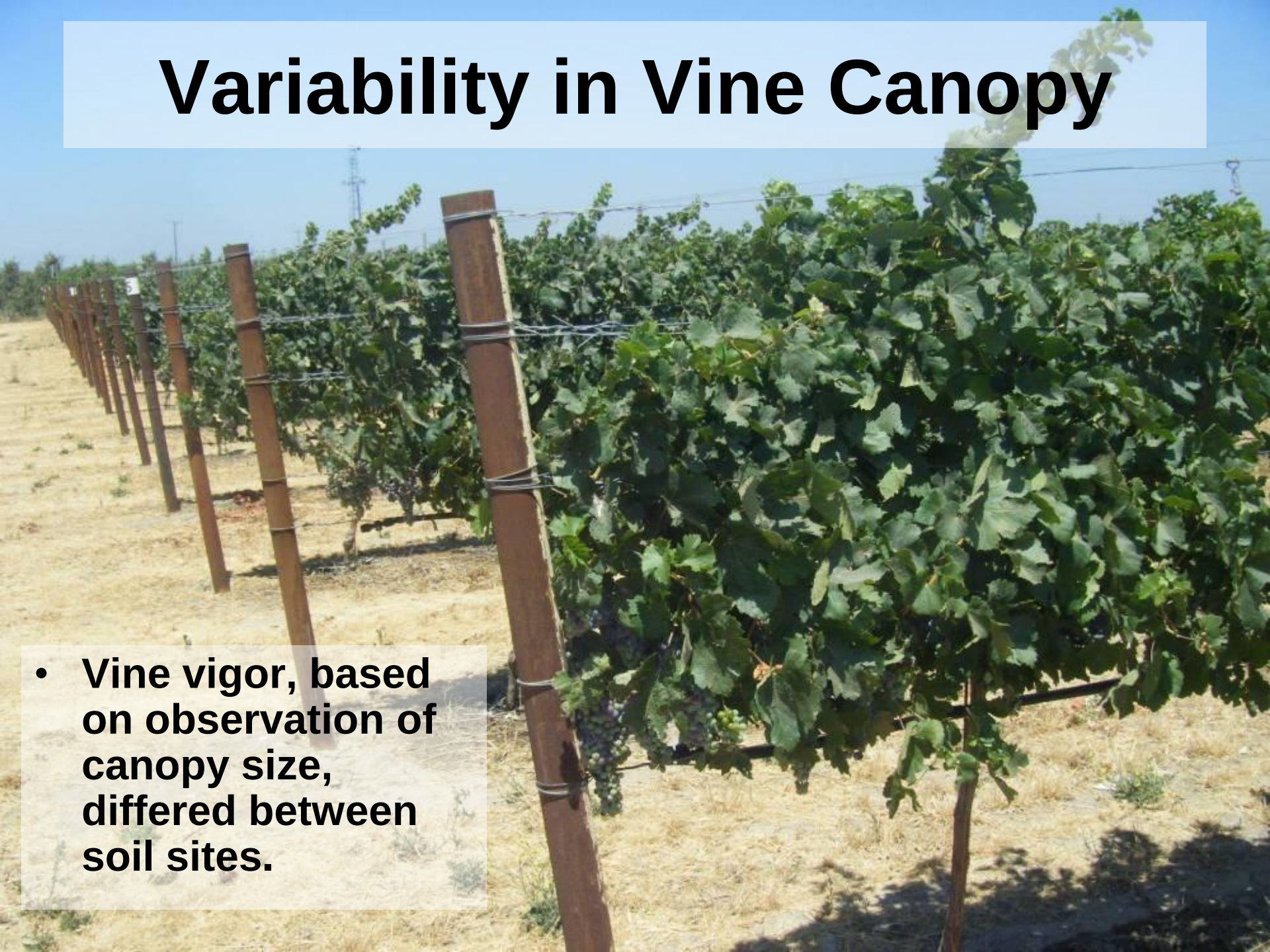
# Above-Ground Monitoring Instruments

- Thermocouples measure air temperature
- Net radiometer measures solar radiation
- Infrared thermometer measures vine canopy temperature

# EM38 Conductivity Meter

- **A portable device to measure soil electrical conductivity and produce a soil variability map.**

# Variability in Vine Canopy



- **Vine vigor, based on observation of canopy size, differed between soil sites.**

# Canopy Differences


We graphed canopy vigor following a grid pattern.

At Thornton site 362, the canopy was less vigorous than at site 415.

- Very Vigorous
- Vigorous
- Medium +
- Medium
- Medium -
- Low +
- Low
- Very low vigor

# Relationship Between Soil pH and Vine Vigor

| | | 355 | | | 415 | | | 455 |
|---|---|---|---|---|---|---|---|---|
| | | | 2 | 0-11 | 7.36 | 2 | 0-6 | 6.56 |
| | | | | 11-27 | 7.45 | | 6-12 | 6.64 |
| 15 | 0-18 | 5.34 | | 27-740 | 7.4 | | 12-42 | 6.86 |
| | 18-21 | 5.87 | | 40-60 | 7.92 | | 42-60 | 7.42 |
| | 21-40 | 6.38 | 32 | 0-14 | 6.2 | 32 | 0-16 | 7.53 |
| | 40-60 | 7.06 | | 14-34 | 6.39 | | 16-37 | 8.63 |
| 45 | 0-18 | 6.87 | | 34-52 | 6.59 | | 37-54 | 8.5 |
| | 18-36 | 8.79 | | 52-60 | 7.22 | | 54-60 | 8.64 |
| | 36-54 | 8.4 | 62 | 0-11 | 7.15 | 62 | 0-12 | 7.78 |
| | 54-62 | 8.04 | | 11-20 | 7.46 | | 12-30 | 7.73 |
| 74-75 | 0-13 | 7.29 | | 20-36 | 8.02 | | 30-55 | 7.79 |
| | 13-37 | 7.62 | | 36-60 | 8.29 | | 55-60 | 7.85 |
| | 37-54 | 8.32 | 92 | 0-13 | 7.92 | 92 | 0-13 | 7.03 |
| | 54-60 | 8.23 | | 13-22 | 7.88 | | 13-27 | 7.06 |
| 105 | 0-15 | 7.29 | | 22-40 | 8.07 | | 27-42 | 7.28 |
| | 15-32 | 7.45 | | 40-54 | 8.1 | | 42-60 | 7.51 |
| | 32-50 | 7.49 | | 54-60 | 8.1 | 122 | 0-14 | 7.17 |
| | 50-60 | 7.47 | 122 | 0-14 | 5.65 | | 14-30 | 7.92 |
| 140 | 0-14 | 7.12 | | 14-30 | 6.01 | | 30-52 | 8.07 |
| | 14-34 | 7.42 | | 30-40 | 6.17 | | 52-60 | 8.1 |
| | 34-52 | 7.53 | | 40-60 | 6.45 | 152 | 0-14 | 7.83 |
| | 52-60 | 7.89 | 152 | 0-14 | 6.16 | | 14-40 | 7.74 |
| 175 | 0-11 | 7.42 | | 14-28 | 6.33 | | 40-48 | 7.64 |
| | 11-30 | 7.58 | | 28-46 | 6.49 | | 48-60 | 7.73 |
| | 30-50 | 7.62 | | 46-60 | 6.8 | | | |
| | 50-60 | 7.47 | | | | | | |

**In general, lower vine vigor was associated with soils having a mild to moderately alkaline pH.**

**Higher vine vigor was associated with soils having neutral pH.**

# Summary and Discussion

- **Soil samples were acquired from two vineyards, each containing contrating soil types.**
- **Soil samples were evaluated in the field and in the laboratory.**
- **Instrumentation was used to monitor evapotranspiration and microclimate conditions.**
- **Plant vigor and yield were evaluated at each site.**
- **Although analysis is ongoing, preliminary findings suggest a complex relationship between soil properties, plant vigor and fruit yield.**

# Acknowledgments

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