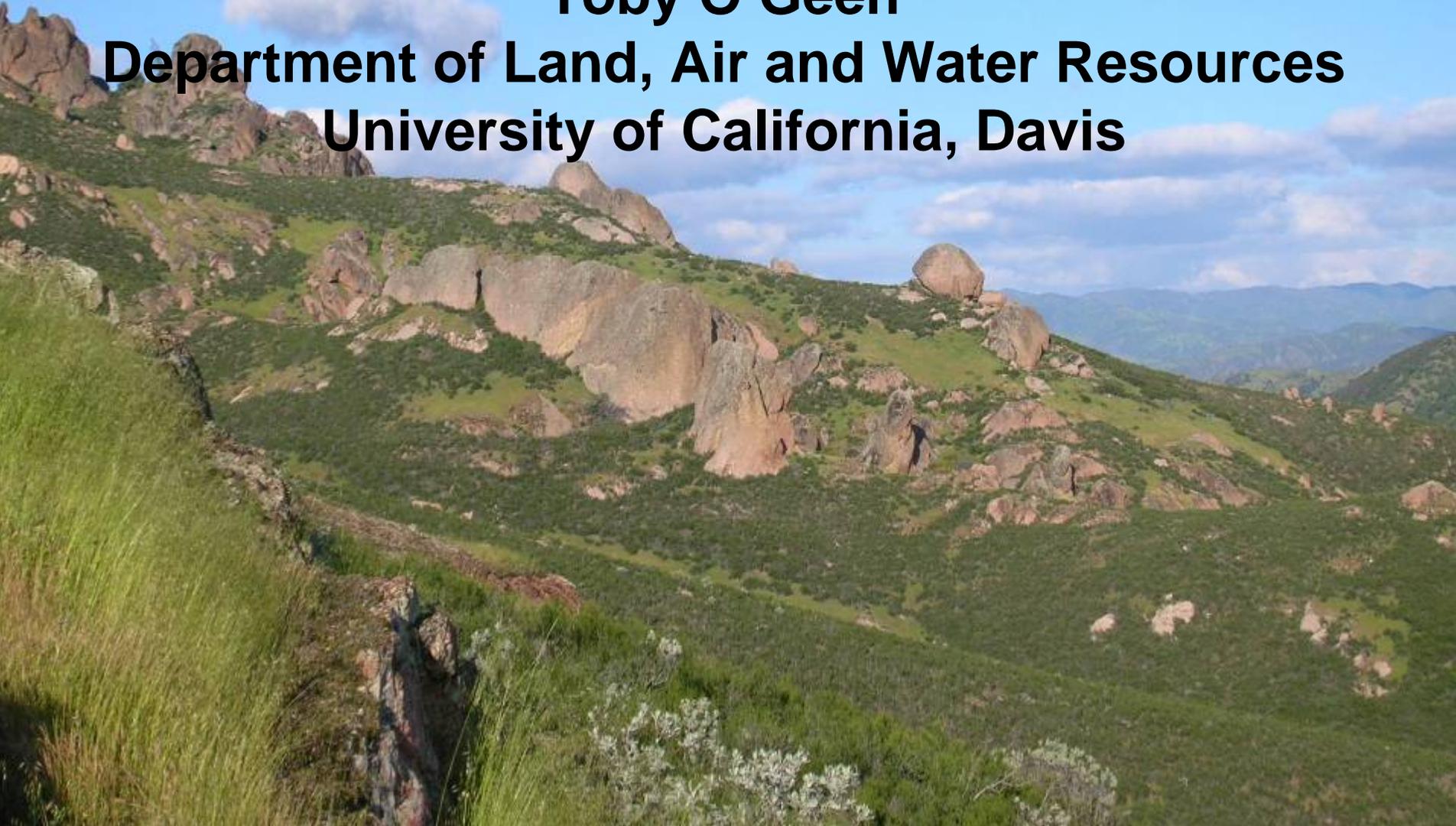


***An Update on Benchmark Soilscales to
Predict Effects of Climatic Change in the
Western USA***

Toby O'Geen

**Department of Land, Air and Water Resources
University of California, Davis**



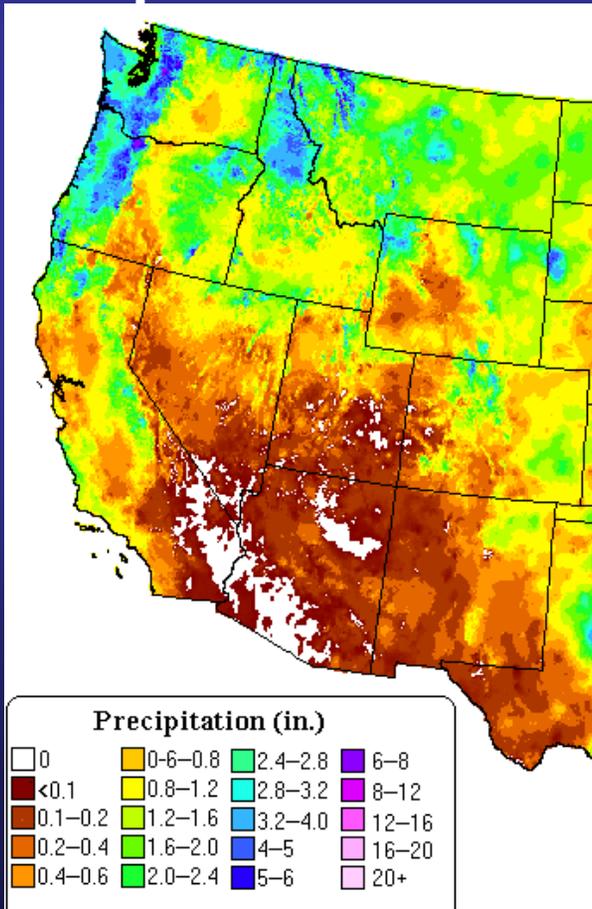
Project team:

- **Arizona- Craig Rasmussen**
- **California- Bob Graham, Randy Dahlgren, Ben Houlton, Toby O'Geen, Mike Singer & Randy Southard**
- **Colorado-Keith Paustain?**
- **Idaho-Paul McDaniel**
- **Nevada-Brenda Buck**
- **New Mexico-Curtis Monger**
- **Oregon-Jay Noller and Ron Reuter**
- **Utah-Janis Boettinger**
- **Washington-Bruce Frazier**
- **Wyoming-Jay Norton**

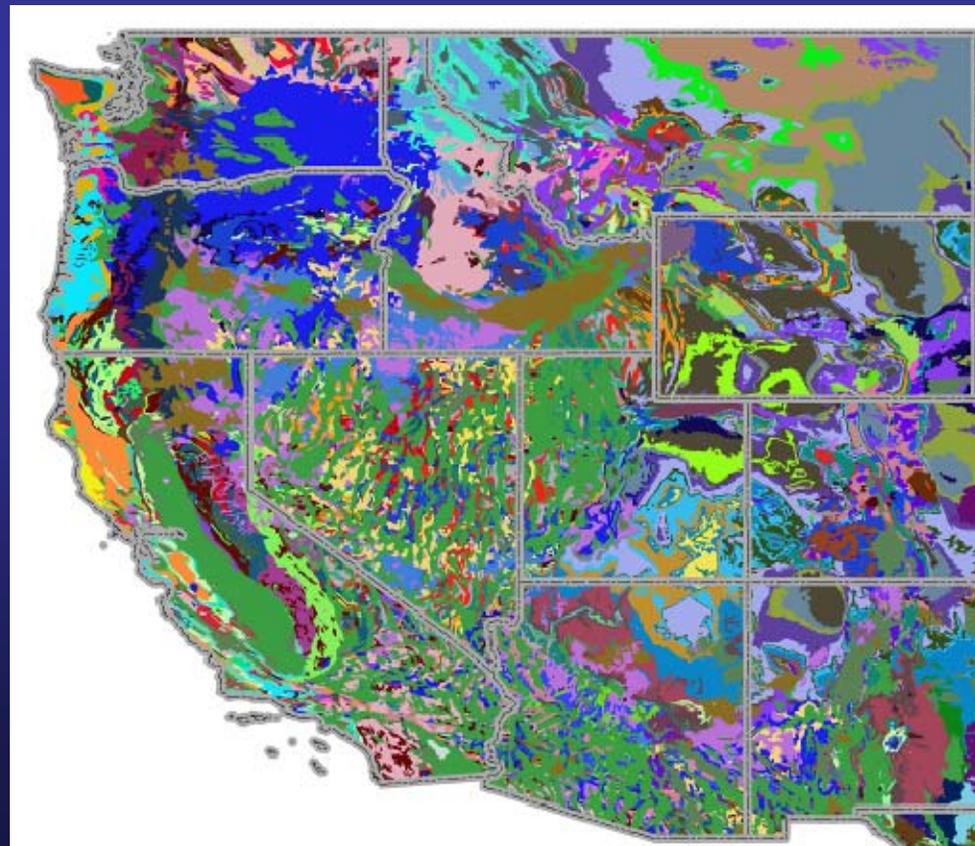
Objective 1

Study the impacts of climate change on soil processes in benchmark soilscapes located across regional bioclimatic sequences in the west

Precipitation in March



Geology of Western US



Bioclimatic sequences of benchmark soilscapes in the west

..... Transported materials

— Granite

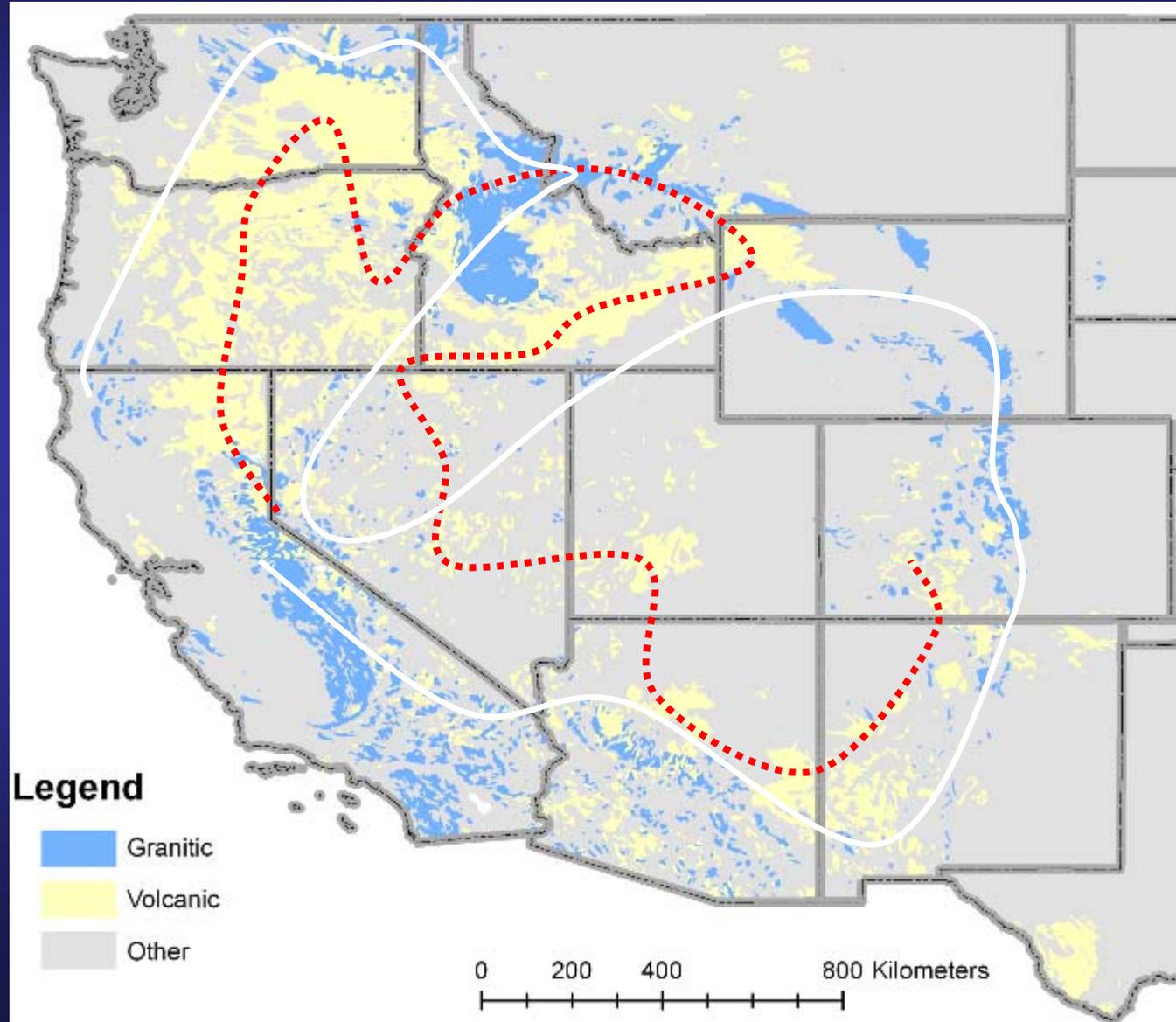
Transects spanning:

Hyperthermic - Cryic
&
Aridic - Aquic

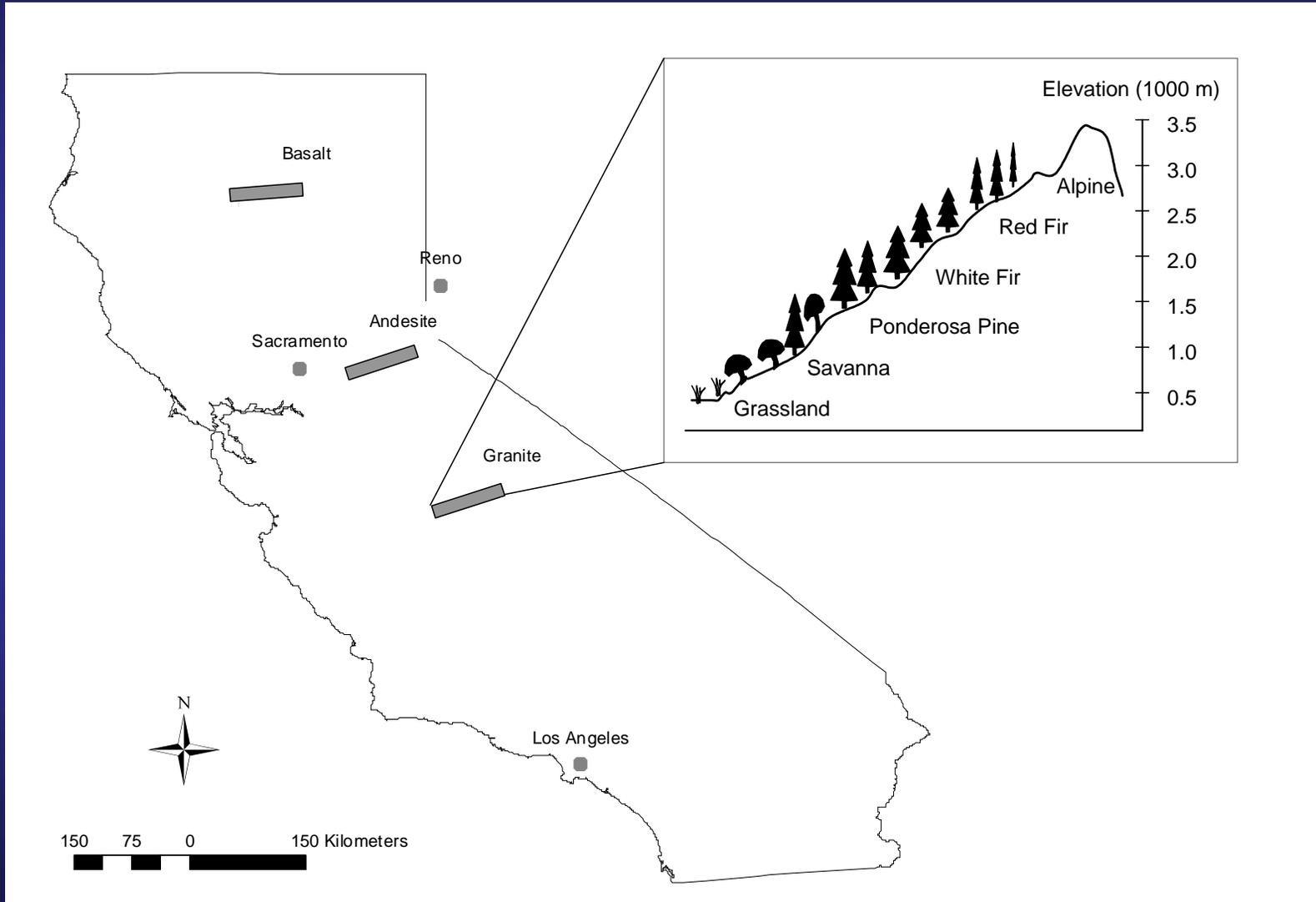
Legend



0 200 400 800 Kilometers



Example of a developmental sequence within the regional project



Objective 2

• **Characterize biogeochemical, mineralogical, physical and morphological properties of soils through the National Soil Survey Laboratory**



- **Field support from regional offices**



- **Soil Survey Laboratory support for lab analysis**

Laboratory Characterization

CEC

B.S.%

Total N

SOC

Active C

pH

EC

Extractable Fe, Mn, Al, Si

XRD

PSA

CaCO₃

Bulk density

Available water

Ksat

Available P

Opportunities to compare dynamic soil properties

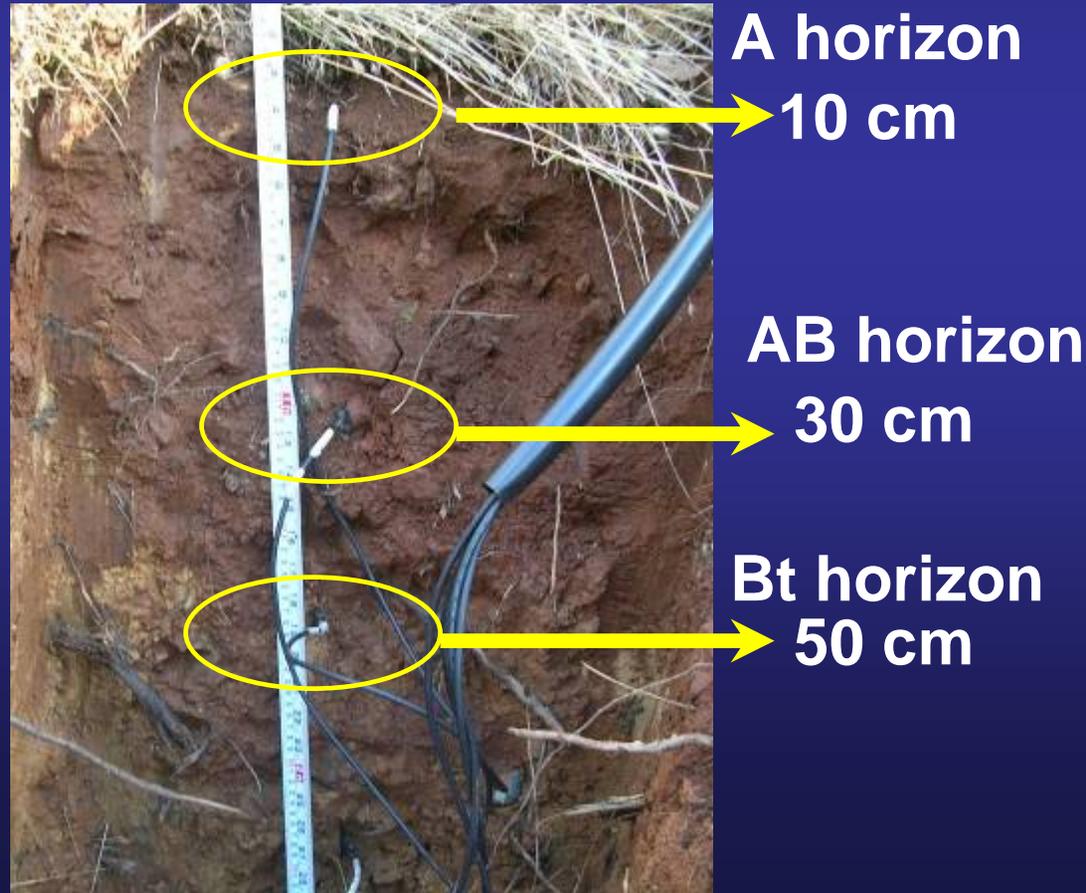
Objective 3

- Monitor soil temperature and soil moisture (primary climatic drivers of pedogenesis).



Soil moisture: Decagon EC-5 probe with em5b datalogger

Soil temp.: Decagon ECT probe at 10 and 50 cm



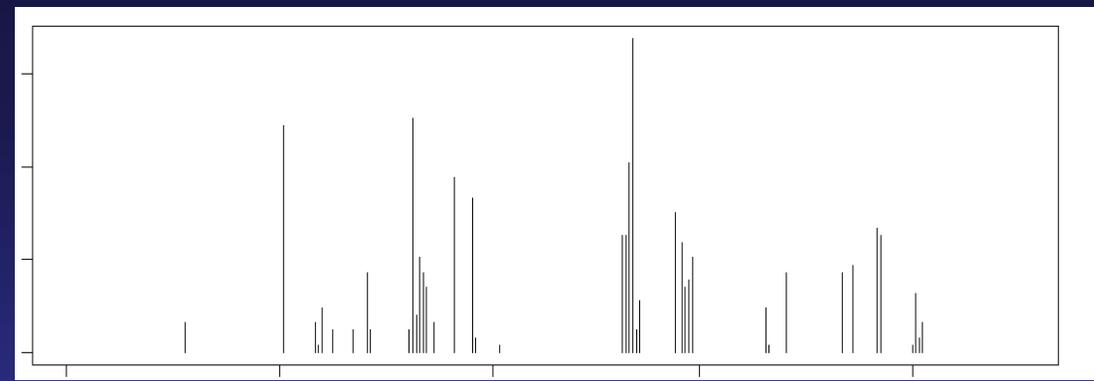
Temporal moisture distribution

duration at saturation, field capacity and soil moisture deficit.

Daily prec. (in)

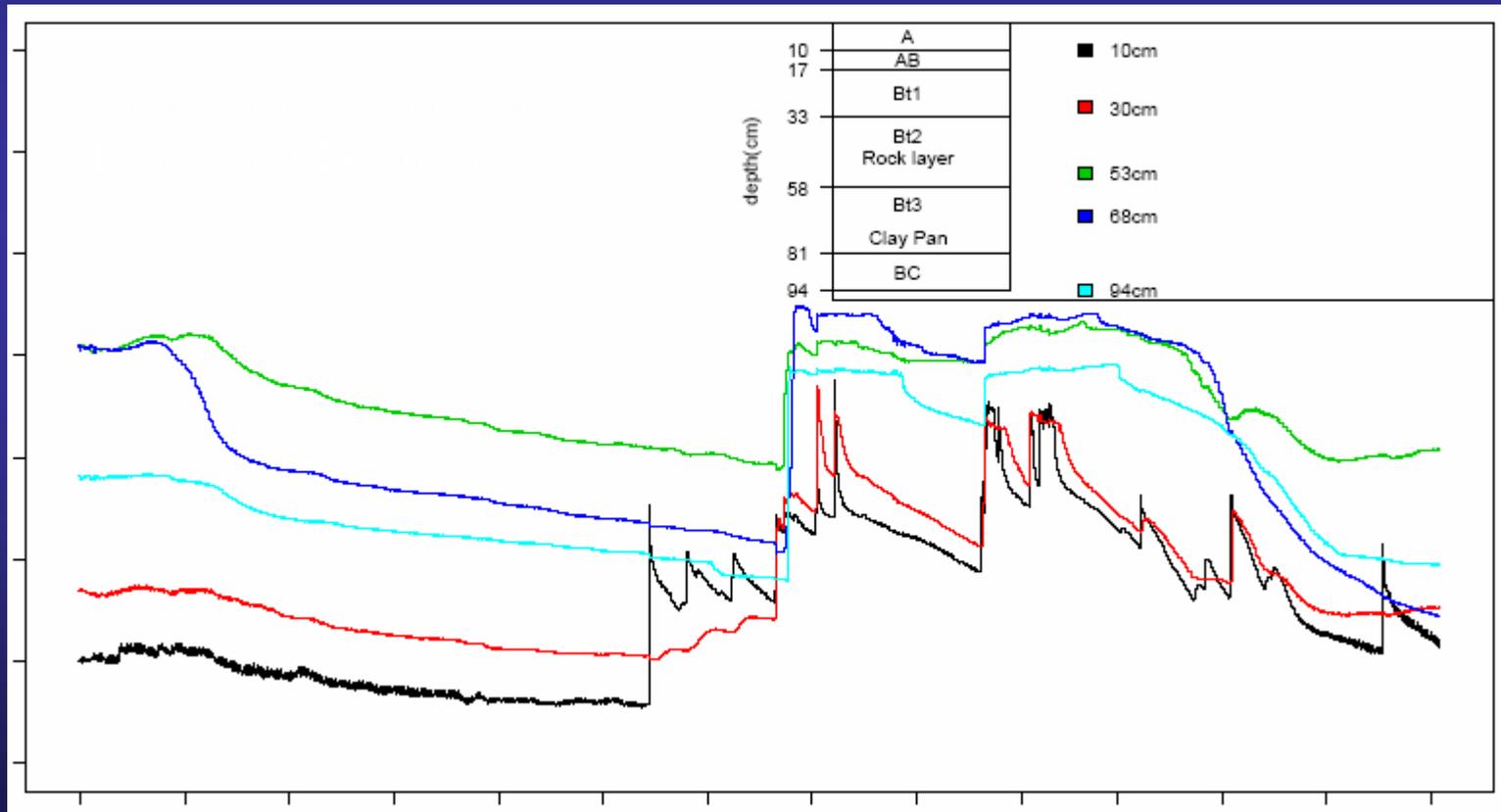
1.5
1.0
0.5
0.0

Sept Nov Jan Mar May



Volumetric Water (m³/m³)

0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0



Jun Aug Oct Dec Feb Apr Jun

Time

Objective 4

- **Conduct experiments that quantify the impacts of climate on ecosystem services governed by soil forming processes:**

Soil Forming Processes

Weathering & secondary mineral formation

Organic matter accumulation/decomposition

Soil water relationships

Ecosystem Services

Nutrient cycling

Carbon storage

Regulation of quantity and quality of water supply

Weathering intensity, lithium feldspar decomposition

Ion exchange resin zero tension lysimeter at 30 cm depth

Lithium Feldspar

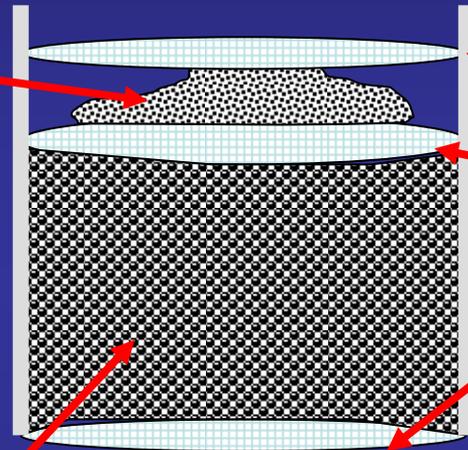
Fine sand size

Petalite (lithium

feldspathoid) Quartz,

na-feldspar,

Rb-K feldspar



Stainless steel mesh
(45 μm)

Cation and anion
exchange resins

8 people x 2 sites x 3 reps x 1 depth =
48 lysimeters with feldspar and 48 with
quartz sand



Organic matter accumulation/decomposition



8 people x 3 reps/yr x 3 sites x 4 years = 288 bags
containing 15 -20 g of ponderosa pine litter



Hillslopes 2-40%

Elevation 67 to 615 m

Oak woodland (blue oak, interior live oak, foothill pine and annual grasses)

Northern California Sierra Foothills -Toby O'Geen

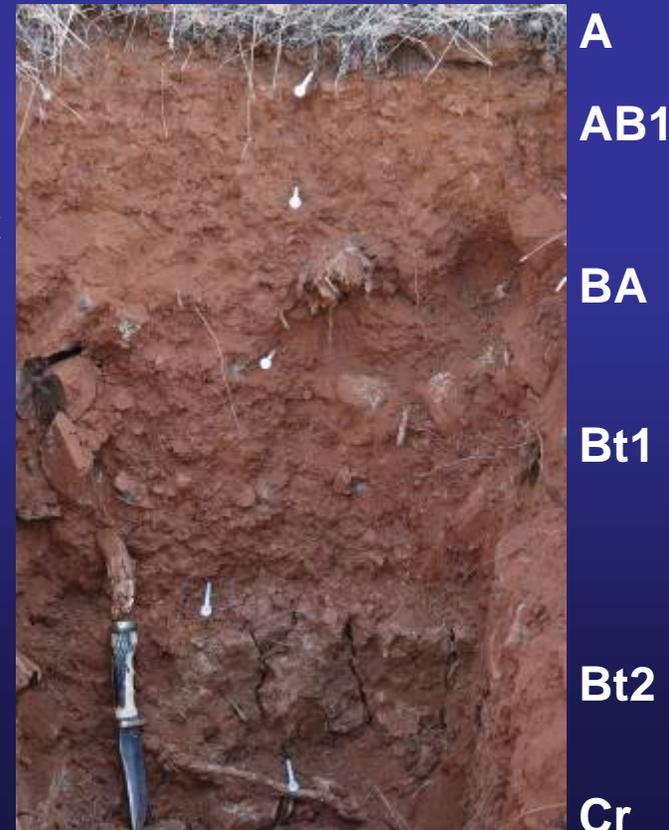
thermic/xeric: MAP 711 mm, MAT 16 °C

mean summer temp 32 °C

mean winter 2.7 to 6 °C

metavolcanic colluvium and residuum

Fine, mixed, superactive, thermic
Mollic Haploxeralfs (Argonaut)



100 soil profiles with soil moisture sensors



Hillslopes 2-30%

Elevation 210 to 520 m

Oak woodland (blue oak, interior live oak, foothill pine and annual grasses)

Southern California Sierra Foothills-Toby O'Geen

granitic colluvium and residuum

thermic/xeric MAP 486 mm

mean summer temp 24-27 °C

mean winter temp. 4-10 °C

Coarse-loamy, mixed, active, thermic
Mollic Haploxerafs (Ahwahnee)

15 profiles \ (summit, sideslopes, N vs S, valley, and canopy or no canopy



A

AB

Bt

Cr

University of California - Riverside

R.C. Graham

- **White Mountains, California**
- **elevational transect: 5,000 - 14,000 ft.**
 - **USGS/UCSD climate stations every 1,000 ft.**
- **granitic bedrock**
- **shadscale - big sagebrush - pinyon/juniper -
limber pine - alpine grasslands**
- **aridic - ustic (?); mesic - cryic**
- **Torriorthents - Camborthids - Cryepts - Cryolls**

New Mexico



Argic Petrocalcic



Curtis Monger

Parent Material: siliceous river alluvium (mid-Pleistocene)

Vegetation: desert shrubs (formerly grama grassland)

Climate: thermic/aridic

Medicine Bow National Forest, WY

Jay Norton

Two transects, granite / quartz monzonite & quartzite

- Elevation range: ~2500 to 3600 m
- Temperature (°C): Frigid/Cryic -15 to 25
- Moisture is snowfall dominant: Udic ~1300 to 4500 mm as snow
- Soils: Typic Dystrocryepts, Typic Haplocryalfs, Humic Dystrocryepts
- Vegetation: Lodgepole pine dominant
Limberpine, Subalpine fir, Englemann spruce, and Rocky Mountain alpine tundra spp. at highest elevations



**Mountain slopes
2-35%**

**1600-400 ft elev.
(635-1270 m)**

**western redcedar,
Douglas-fir, grand fir,
western larch,
western white pine**

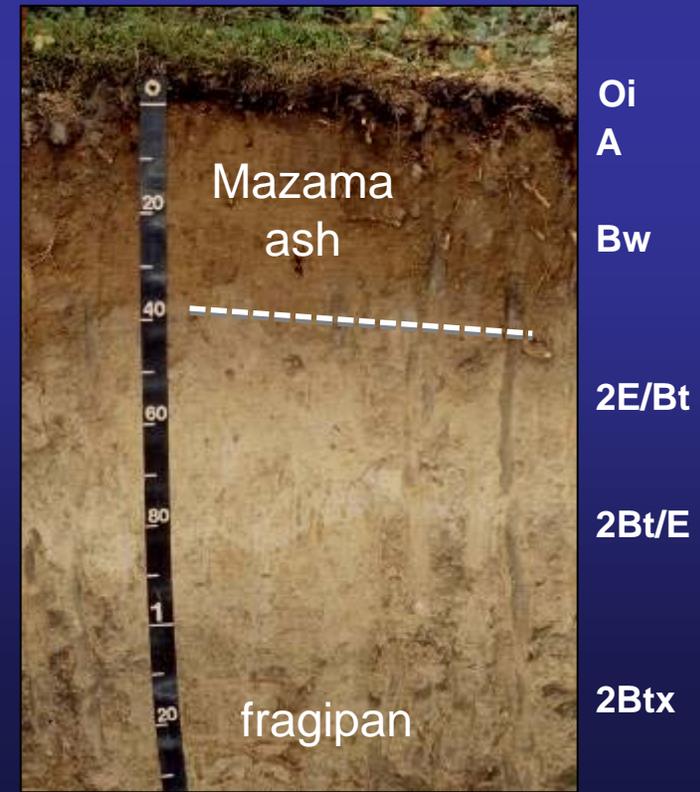
Paul McDaniel

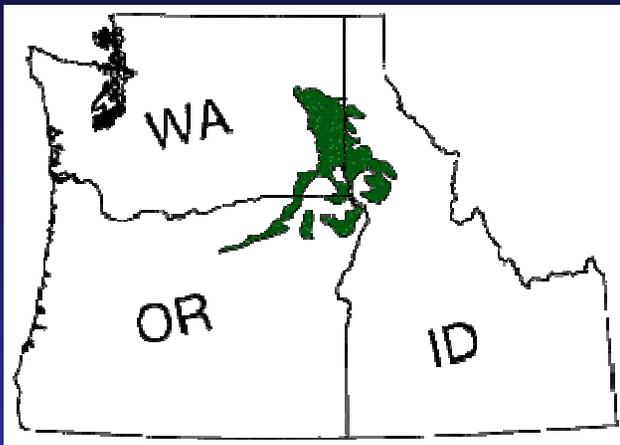
Udic SMR (635-1270 mm MAP)

Frigid STR (3-7 °C)

**Thick Mazama ash mantle over
loess/reworked loess**

Alfic Udivitrands (Threebear series)





Palouse Landscape



Washington-Bruce Frazier

Palouse Loess deposits

Mesic/Xeric

MAP = 400 mm

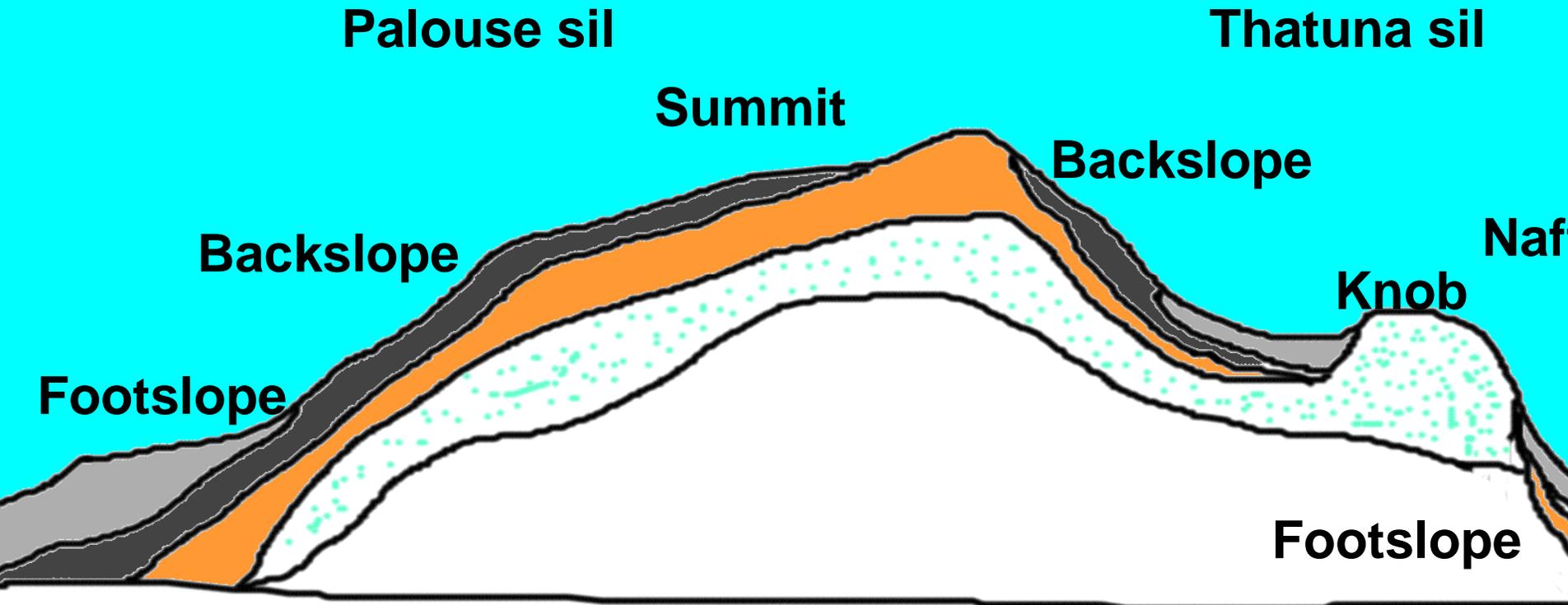
MAT = 10 °C

Native veg. bunchgrass steppe

Blue bunch wheatgrass



Palouse Loess Stratigraphy



Plow down



Top soil



Sub soil



Clay accum.

Oregon-Jay Noller and Ron Reuter

1. Mazama Pumice-Blanketed Soilscape

Pumiceous tephra ejected from Mt. Mazama which aprons hundreds of square kilometers east and north of Crater Lake, Oregon

MAP 50-20 inches and MAT ~ 35-45 F

2. Willamette Valley Soilscape

Chronosequence of fluvial terraces,
Willamette Valley

Mesic: 8-13 °C Xeric-Udic: 890-1525 mm

Arizona-Craig Rasmussen

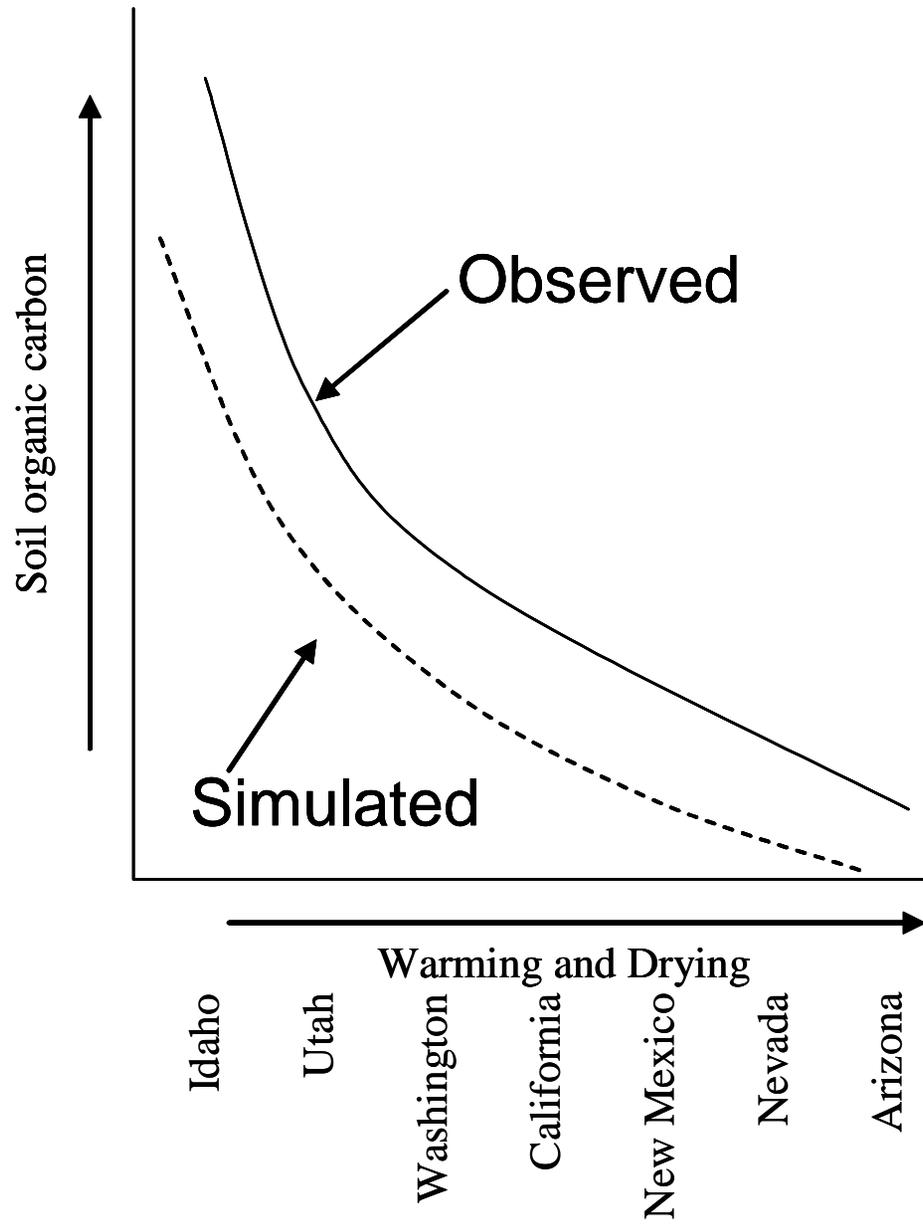
**Sonoran Desert benchmark soil landscape,
Saguaro National Park (SNP), east of Tucson,
Arizona**

Granitic parent material 800-2650 m in elevation

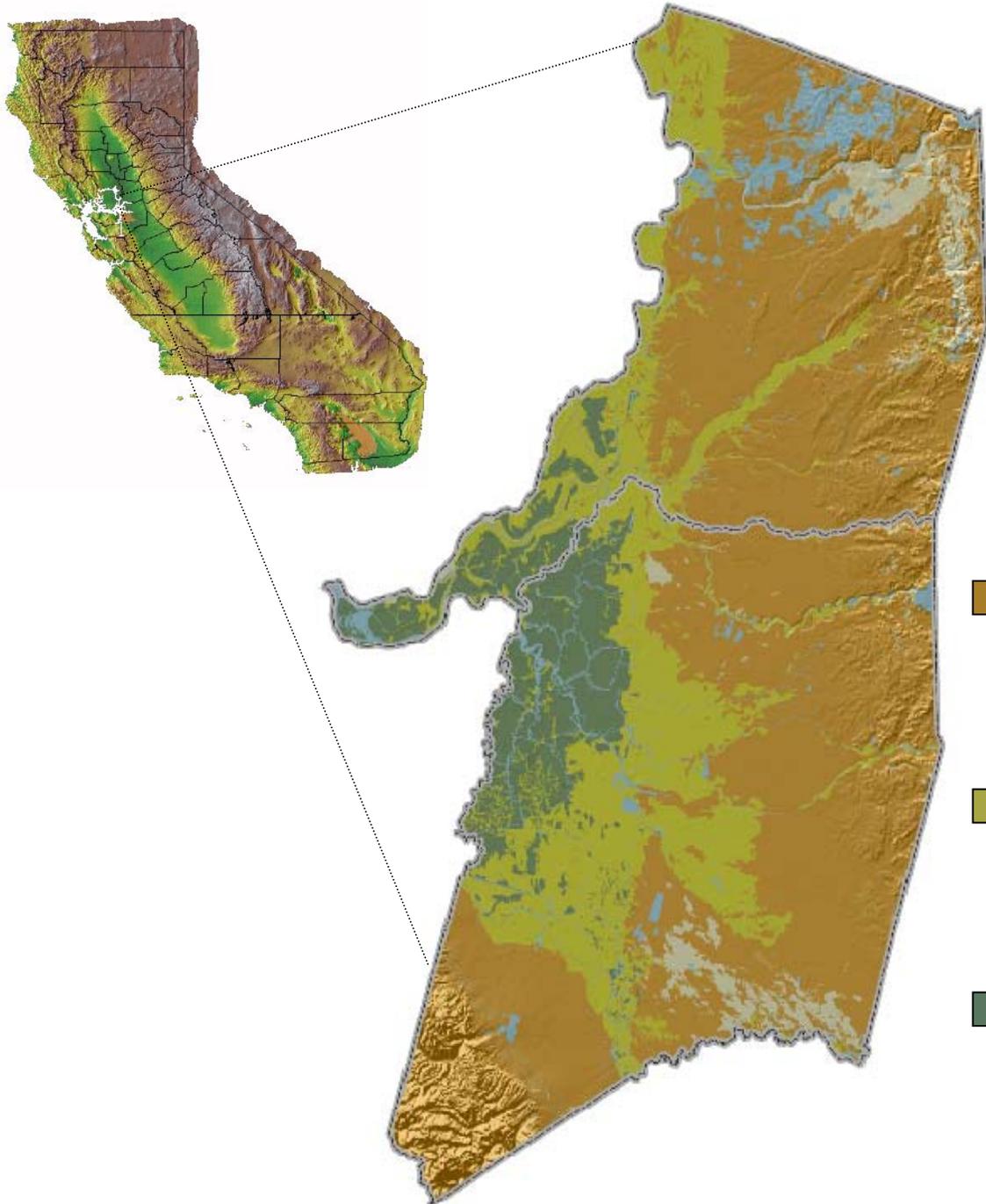
MAT 10-20 C and MAP 300-800 mm

**Mixed desert-scrub (<1200m); mixed grass
and oak woodland (1200-1700m); pinyon-
juniper woodland (1700-2000m); ponderosa
pine and fir forest (<2000m)**

Thank You



What is a benchmark soilscape?



- Old dissected terraces and alluvial fans
(Redding, San Joaquin, Corning)
- Recent alluvium and basin rim deposits
(Tokay, Columbia, Kingdon)
- Smectitic Basin Alluvium
Stockton, Capay

Perched water collection system

Perched water is collected from four soil horizons in three soil profiles. Water is routed to tipping buckets for flow measurement and stored in containers for water quality analysis.

