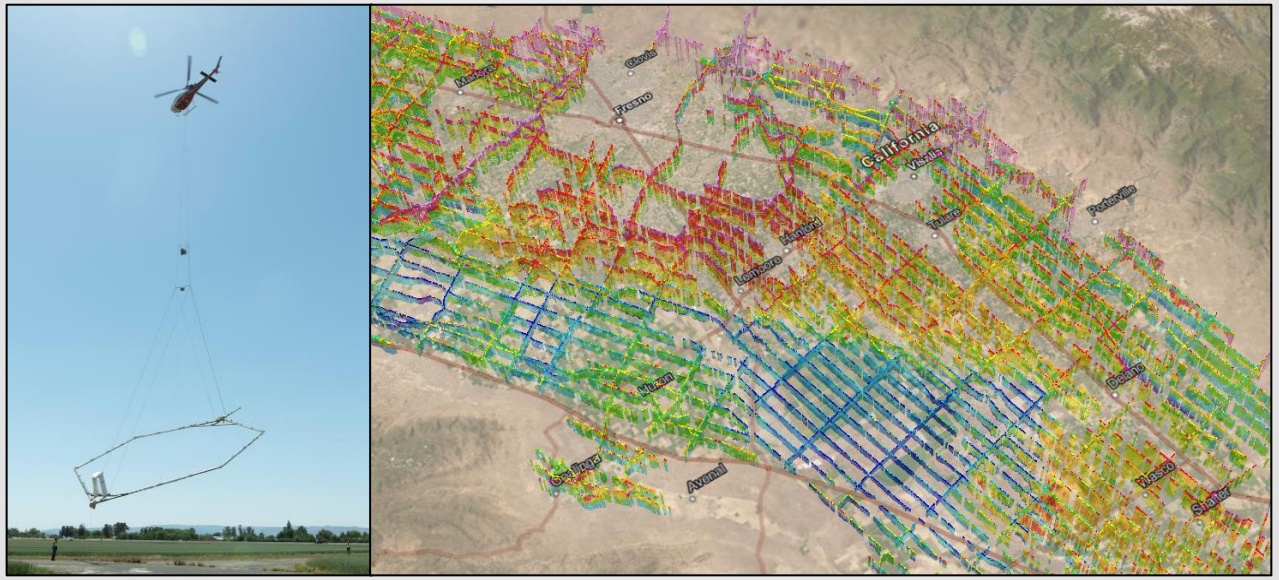
California's Statewide Airborne Electromagnetic (AEM) Surveys

CWEMF – AEM Data Applications to Groundwater Models

September 28, 2022



Katherine Dlubac, Steven Springhorn, Benjamin Brezing

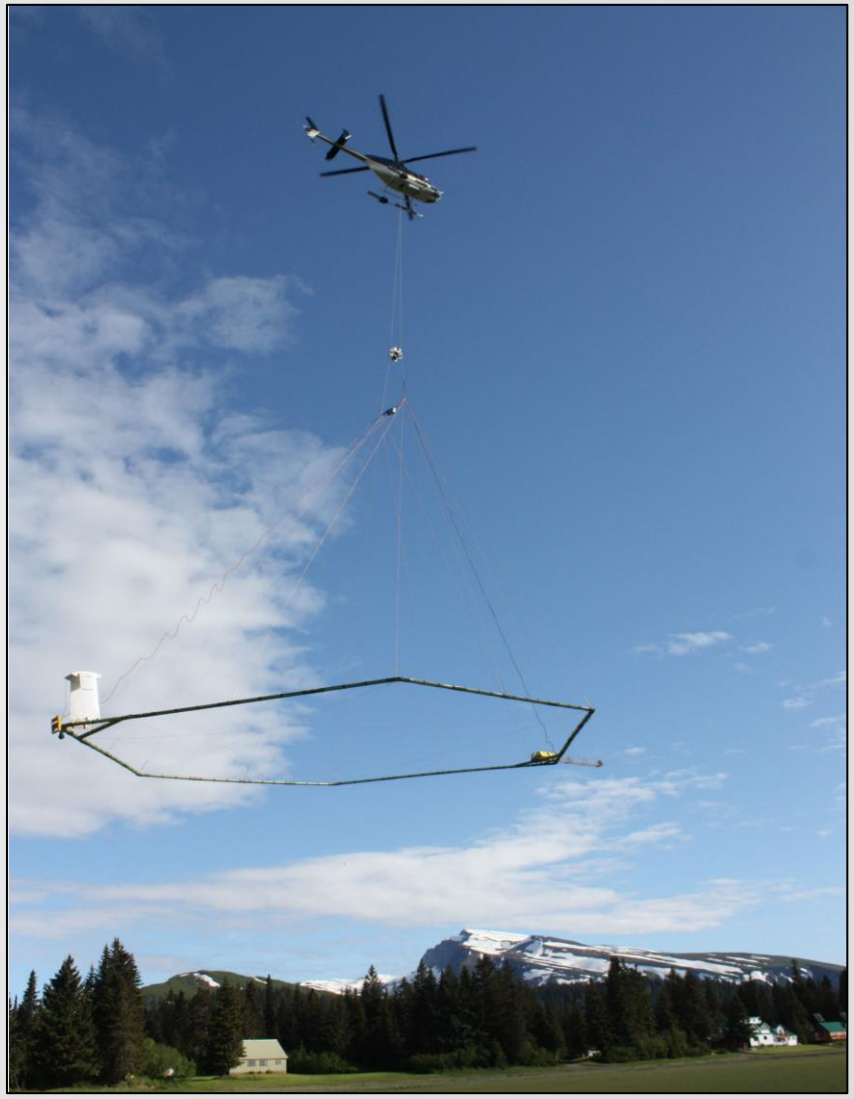
California Department of Water Resources, Sustainable Groundwater Management Office

Statewide AEM Surveys Overview

- Project goal to improve the understanding of large-scale aquifer structures, refine hydrologic conceptual models, texture models, and groundwater flow models, and support the implementation of the Sustainable Groundwater Management Act (SGMA).
- Funded through California Proposition 68.
- Conducted in all high- and medium-priority groundwater basins, where data collection is feasible.
- Data collected in coarsely spaced grid (2 by 8-mile grid) with input from local, state, and federal agencies on areas of interest.
- Surveys conducted from 2021-2024.

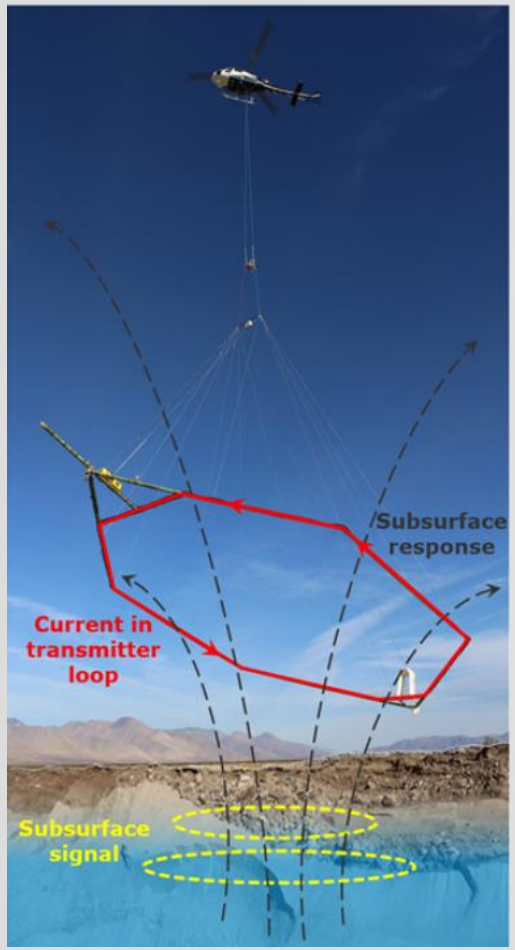
AEM Method and Limitations

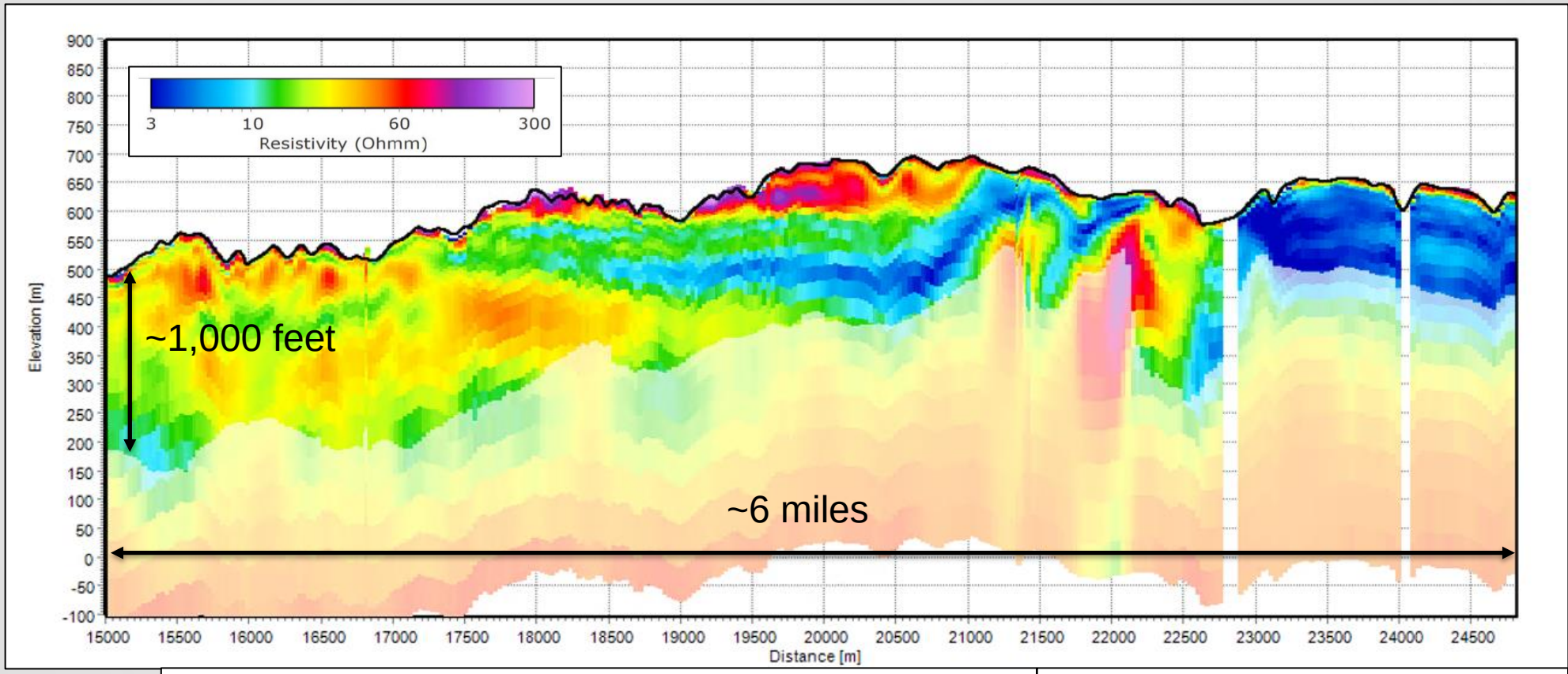
- Airborne geophysical method.
- Helicopter flies at 200 feet above ground.
- Noise generated is less than operating a lawn mower.
- Pilots follow all regulations.
- Surveys not conducted over areas for safety and data quality concers:
  - Urban areas
  - Buildings
  - Confined livestock



AEM Method and Resistivity Profile

Send signals into earth and the measure the EM response





Less Resistive: fine grain-dominated materials or high TDS
More Resistive: coarse grain-dominated materials

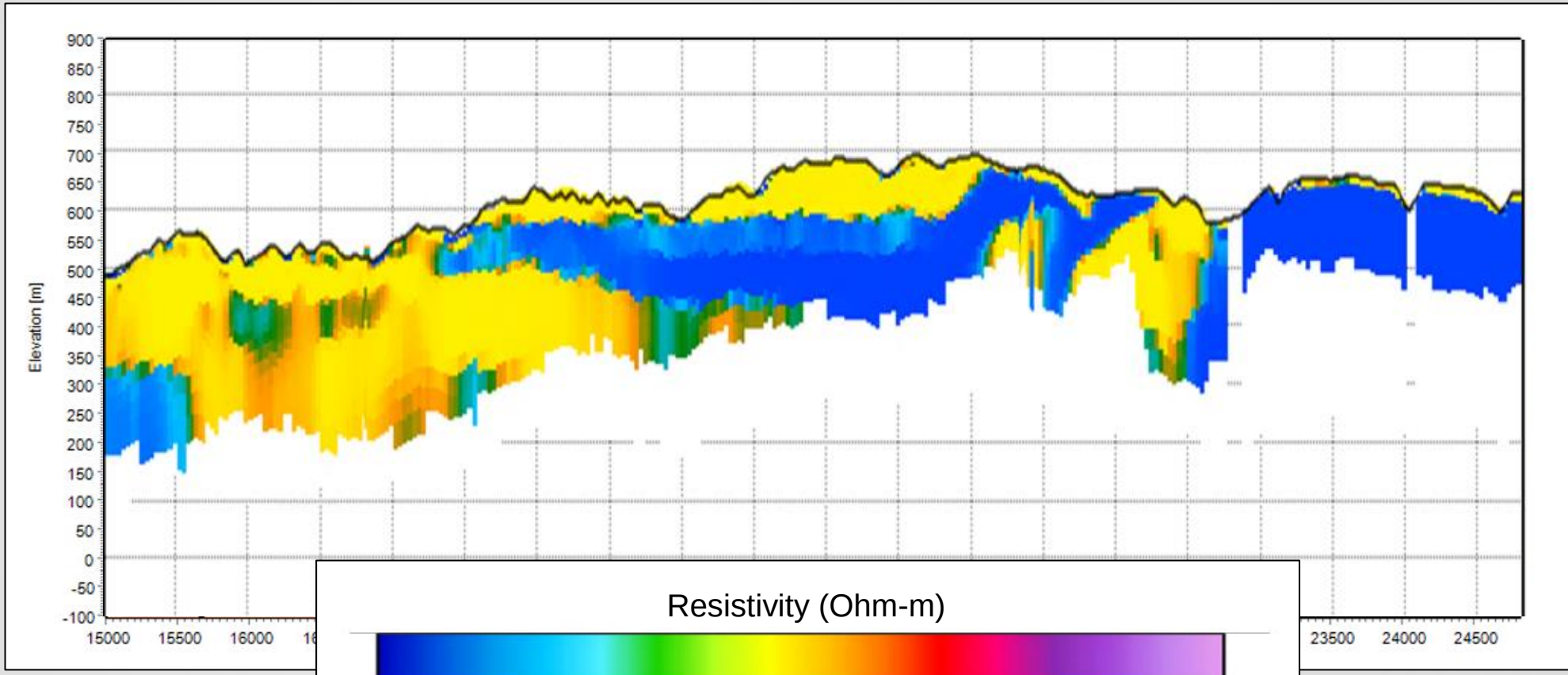
Depth of investigation: ~1,000 feet
Vertical resolution:
- Shallow: ~10 feet
- Deep: ~100 feet

AEM Data Interpretation

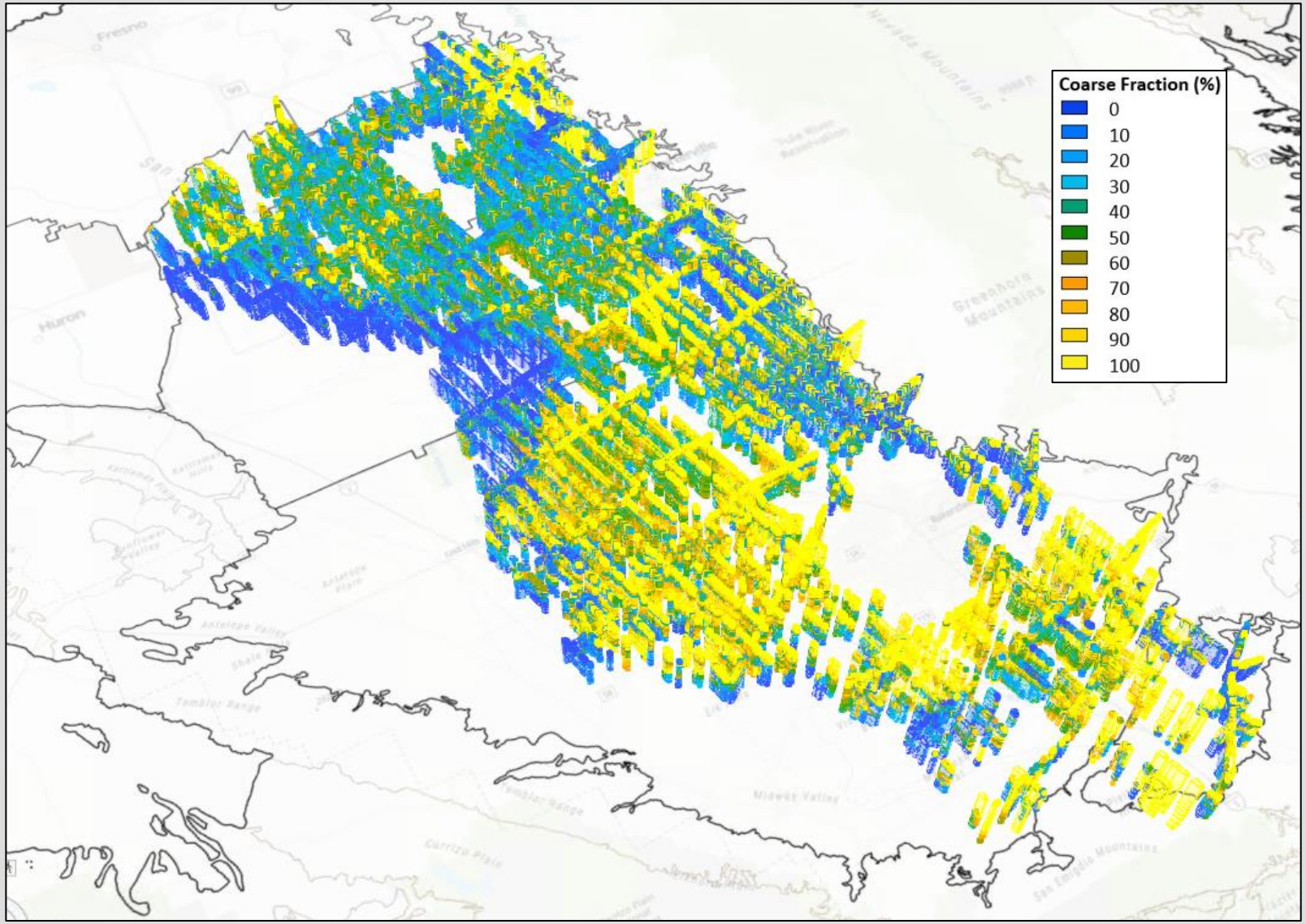
AEM data interpreted from resistivity to lithology using ***supporting data***

Existing supporting data:

- Lithology logs
- Geophysical data
- Groundwater quality (TDS)
- Groundwater levels

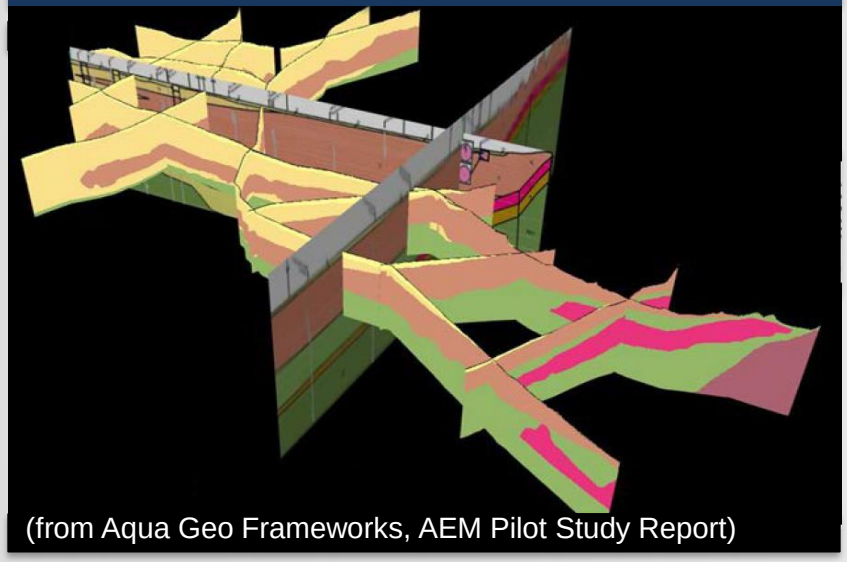


Basin-Wide Regional Aquifer Structure



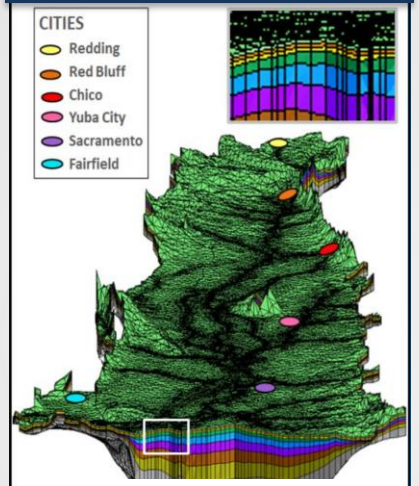
Examples of AEM Data Use

Hydrogeologic conceptual model



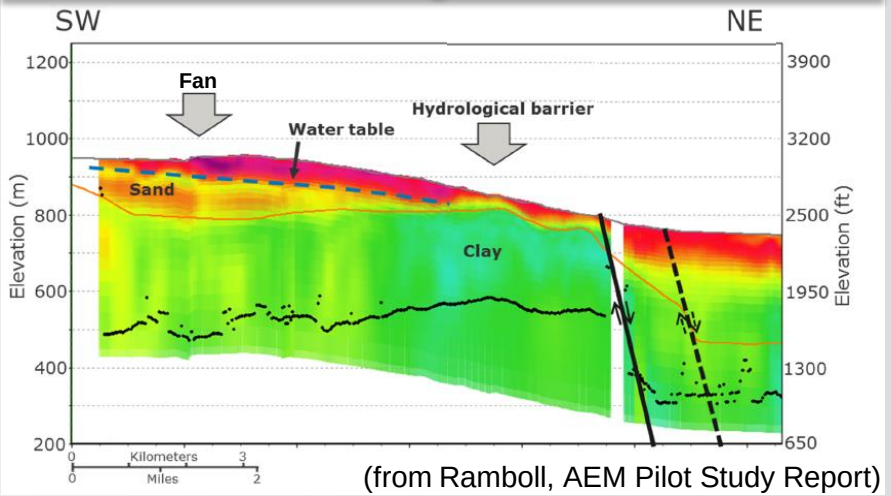
(from Aqua Geo Frameworks, AEM Pilot Study Report)

Groundwater flow models



(from DWR, SVSim Report)

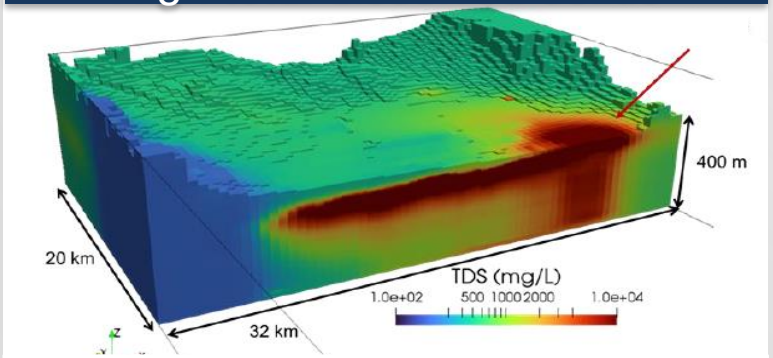
Recharge areas



(from Ramboll, AEM Pilot Study Report)

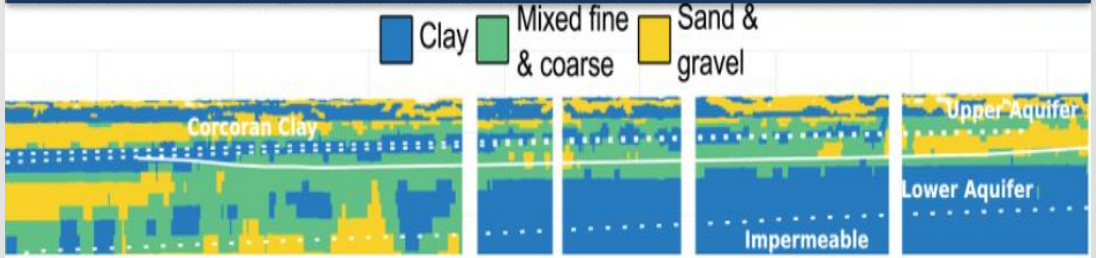
Site wells

High total dissolved solids



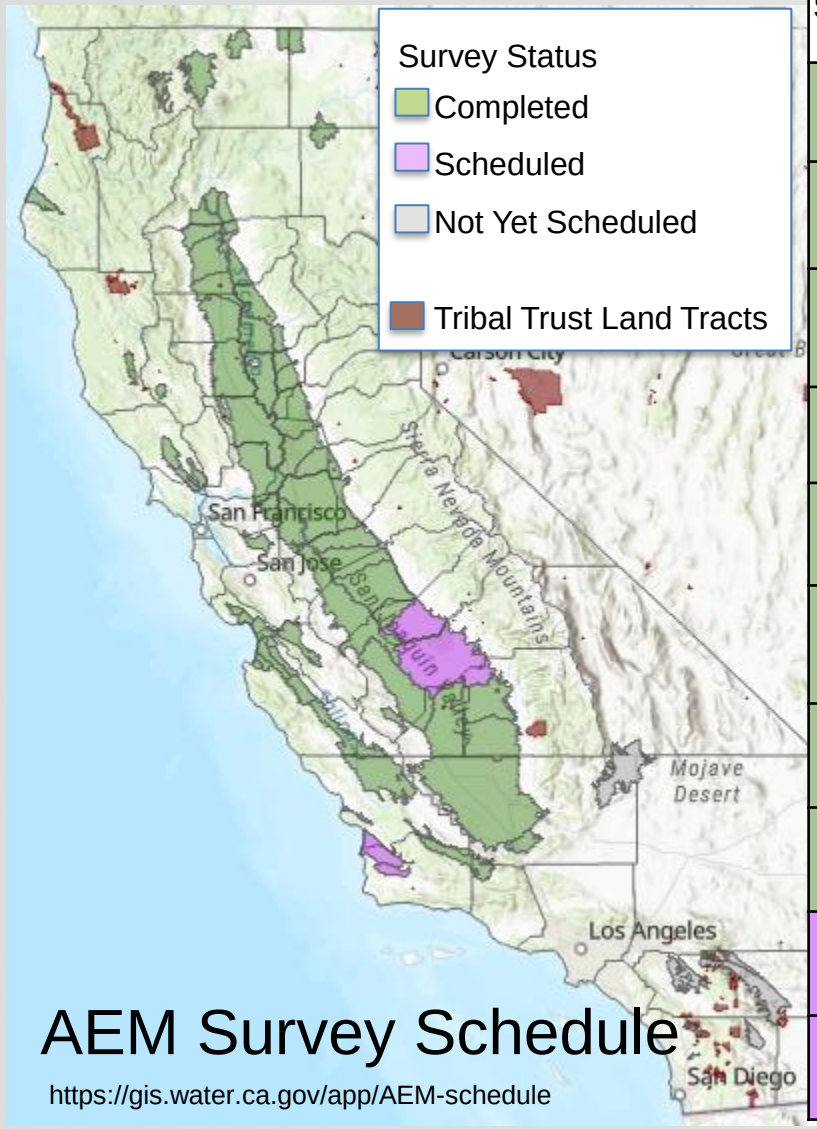
(from Stanford University, AEM Pilot Study Report)

Clays susceptible to compaction



(from Knight et al., 2018)

AEM Survey Status and Survey Lines



AEM Survey Schedule

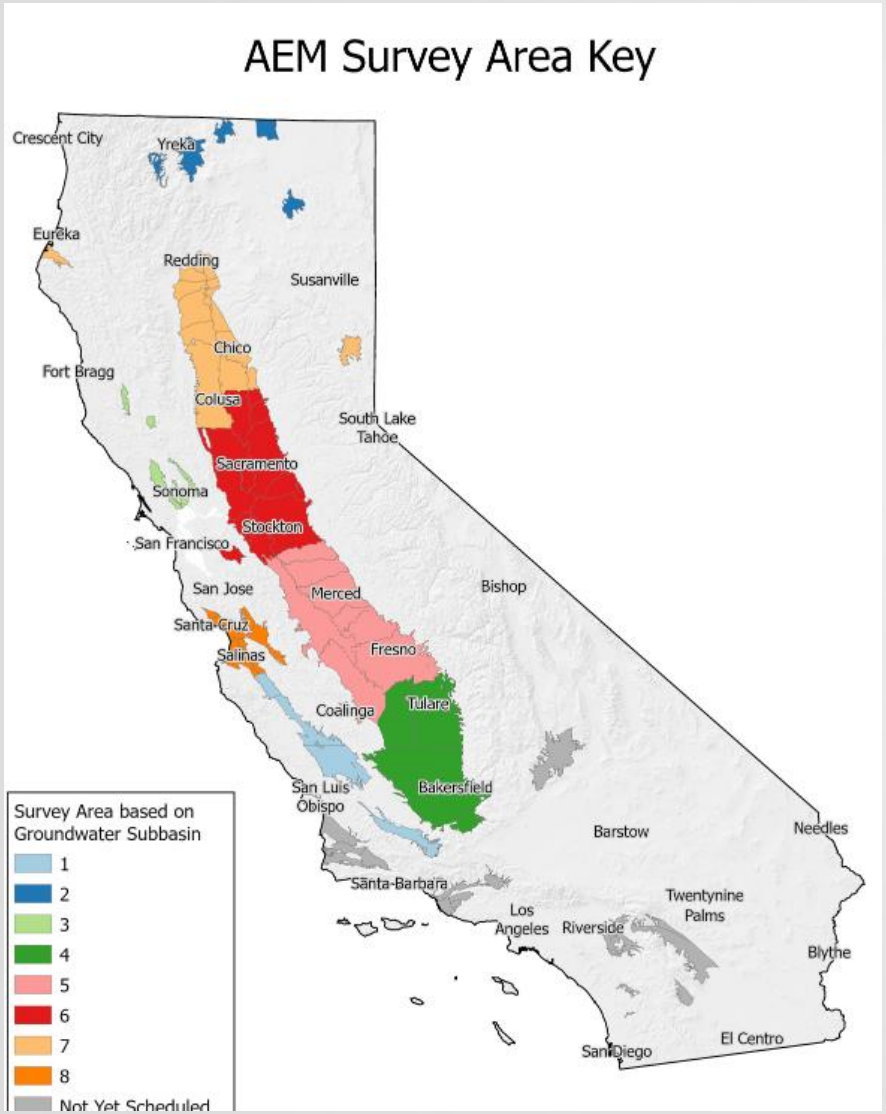
https://gis.water.ca.gov/app/AEM-schedule

Survey Area	Survey Area Description	Data Collection/ Completion Date
1	Salinas Valley & Cuyama	August 2021
2	Northern Basins	November 2021
3	Northern SF Bay, Ukiah, Big Valley	November 2021
4	Southern San Joaquin	December 2021 & March 2022
5	Central San Joaquin	March 2022
6	Northern San Joaquin & Southern Sacramento	April 2022
7	Northern Sacramento, Eel River, Sierra	May 2022
8	Monterey Bay Area	November 2022
9	San Luis Obispo & Santa Barbara County Areas	April 2023
10	Pilot Study1: Madera and Kings	April 2023

Survey Lines

https://data.cnra.ca.gov/dataset/aem/resource/8a020073-20e4-4feb-9271-fe8f76c99a85

Data Report and Dataset Publication

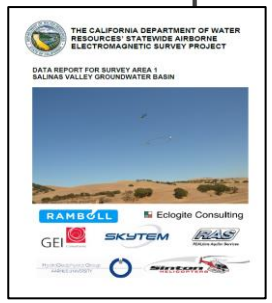


CALIFORNIA NATURAL RESOURCES AGENCY

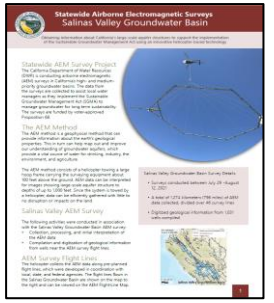
https://data.cnra.ca.gov/dataset/aem

Survey Area Data Package

Data Report



Fact Sheet



AEM Data

ZIP

- 01_Raw Data
- 02_Database
- 03_Sections_and_Thematic_Maps
- 04_XYZ_Ascii
- Readme
- Readme_DWR_Disclaimer

Supporting Data

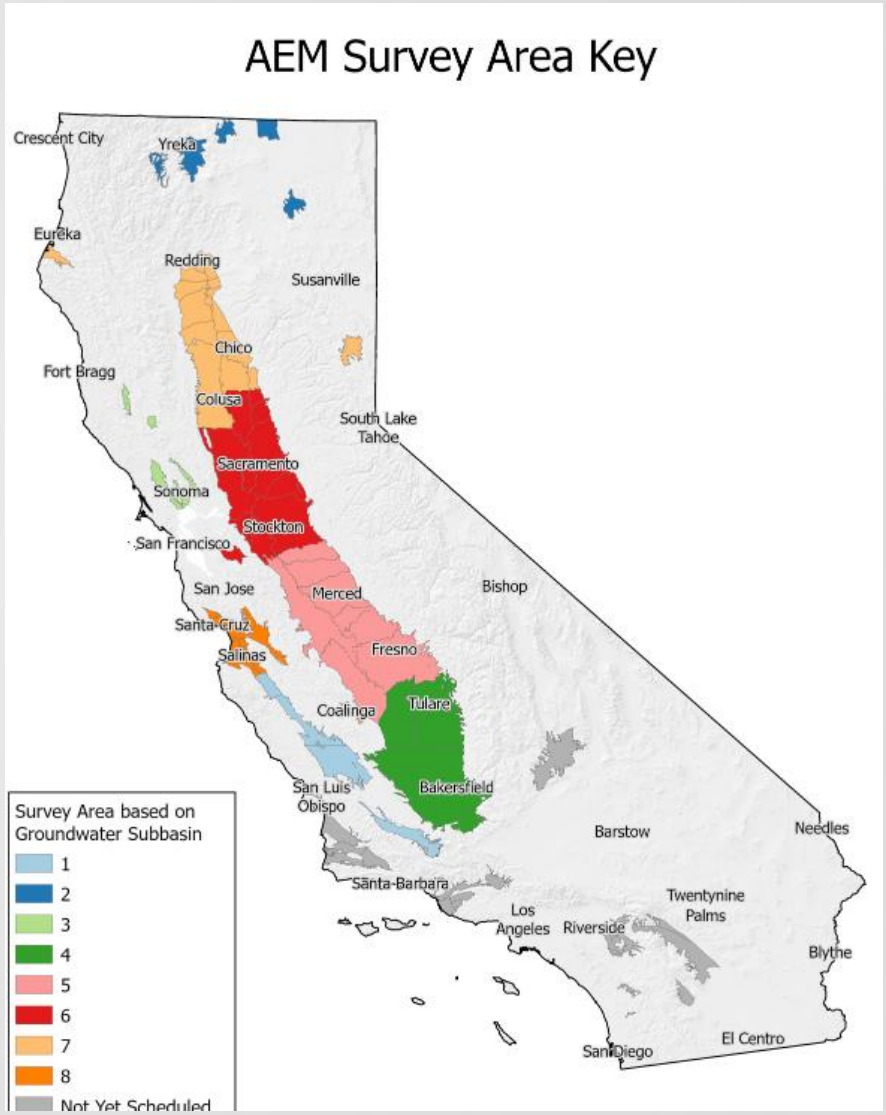
ZIP

- AEM_WELL_INFO_csv_WO1_2022C
- AEM_WELL_LITHOLOGY_csv_WO1
- AEM_WELL_WATER_LEVEL_csv_W
- AEM_WELL_WATER_QUALITY_csv_
- Geophysics_WO1_20211213
- ReadMe
- Readme_DWR_Disclaimer

Available on rolling basis; products published 3 to 12 months after surveys complete

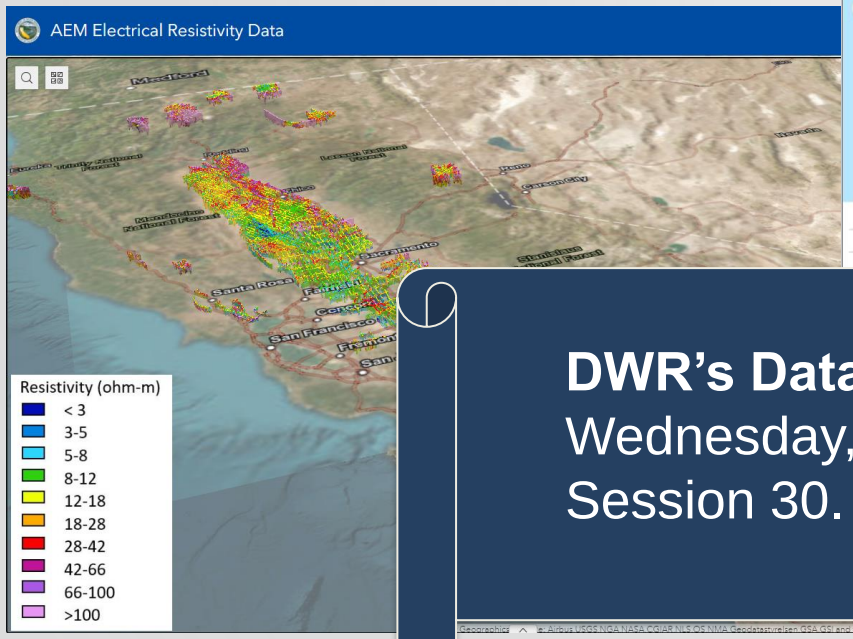
Data Publication Schedule

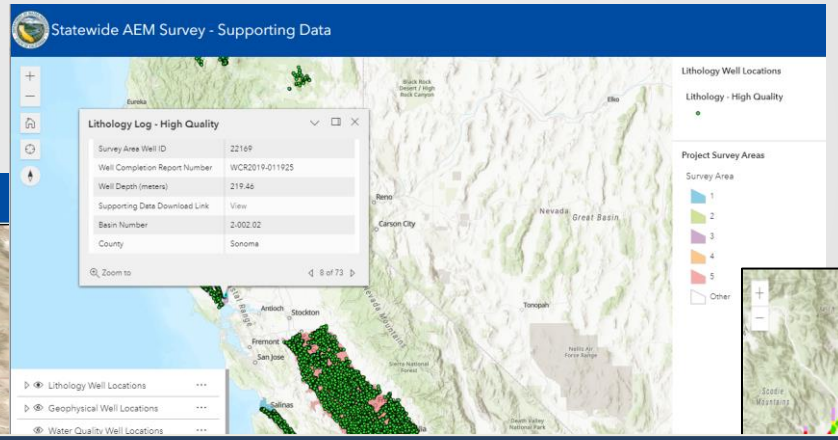
Survey Area	Survey Area Description	Inverted AEM Data (Resistivity)	Supporting Data	Interpreted AEM Data (Texture)
1	Salinas Valley & Cuyama	Available	Available	Available
2	Northern Basins	Available	Available	Available
3	North Bay, Ukiah, Big Valley	Available	Available	Available
4	Southern San Joaquin	Available	Available	Available
5	Central San Joaquin	Available	Available	April 2023
6	Northern San Joaquin & Southern Sacramento	Available	May 2023	May 2023
7	Northern Sacramento, Eel River, Sierra	Available	June 2023	June 2023
8	Monterey Bay Area	Available	July 2023	August 2023

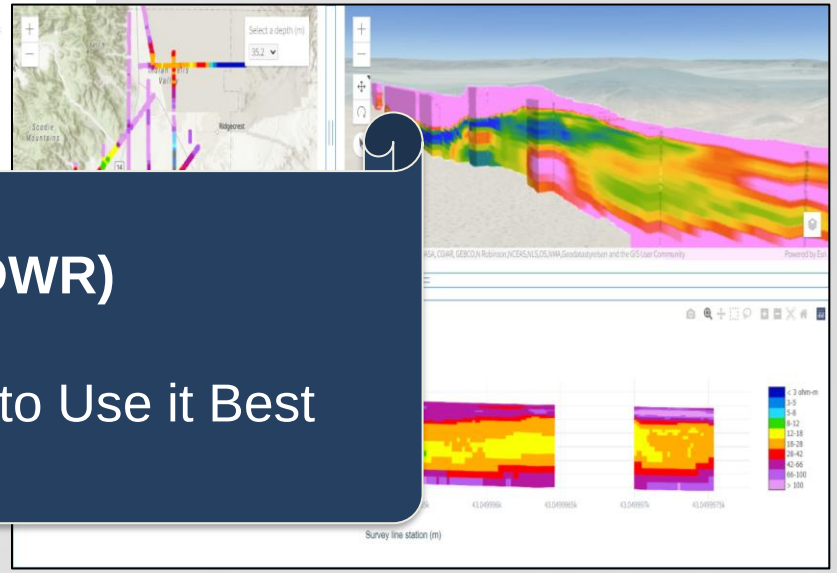


Data Use and Support Tools

- Data Viewers – AEM data, AEM interpretations, Supporting data (available)
- Advanced Data Viewers – (coming soon)
- Integrated Analysis of Subsurface Data (later this year) – Next Presentations





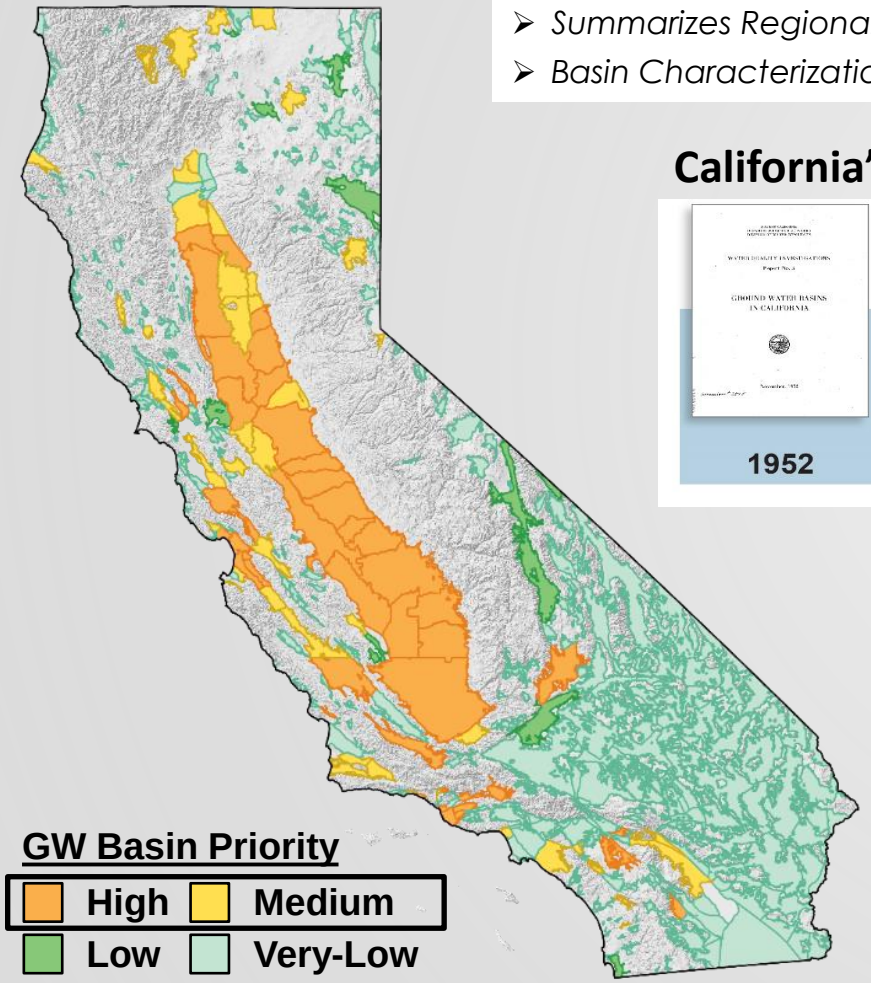


DWR's Data and Tools – Ben Brezing (DWR)
Wednesday, 10:00-11:45 am
Session 30. Data, Data Everywhere: How to Use it Best

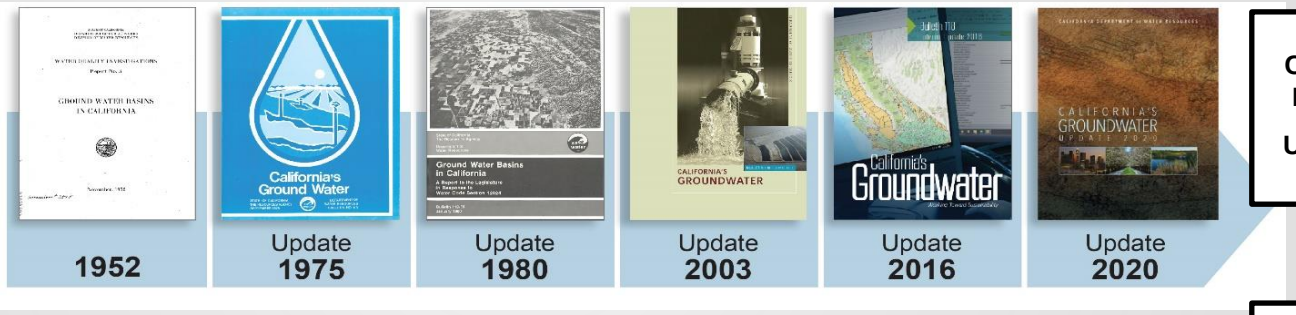
California's Groundwater Publication

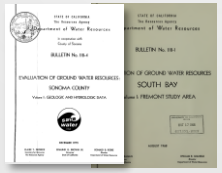
California's Groundwater (Bulletin 118)

- *Statutorily required report on CA's Groundwater, updated no less than every 5 years*
- *Summarizes Regional and Statewide Groundwater Management and Monitoring Information*
- *Basin Characterization: Hydrogeologic Mapping + GW Conditions → GW Flow Modeling*



California's Groundwater (Bulletin 118) Timeline





Regional & Subbasin Reports

Regional Basin Characterization

Groundwater Adjudications

Groundwater Management Plans

>120 Groundwater Sustainability Plans & Alternatives

Local Basin Characterization

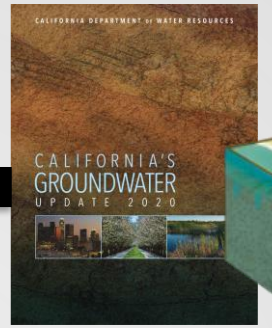
California's Groundwater Basin Characterization

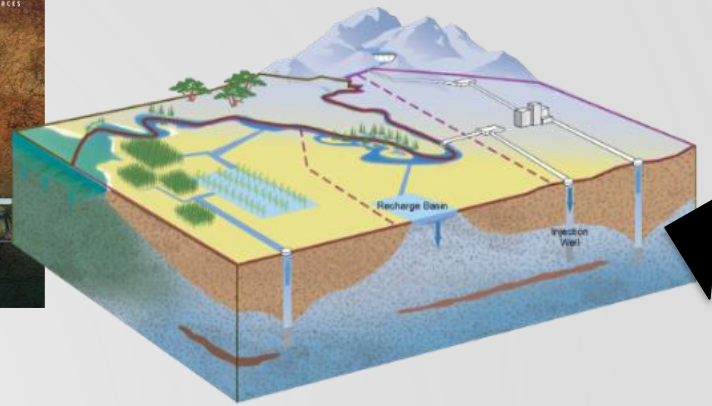
Document Archive

California's Groundwater 5 Year Update

Regional Basin Characterization

Local Basin Characterization





Data Collection

Reconnaissance grid

Statewide AEM Surveys

Goal: to characterize large-scale aquifer properties

Pilot Studies

Goal: to address SGMA implementation initiatives at local scale

Practical Applications

- *Recharge*
- *SW/GW Interaction*
- *Subsidence*
- *Base of Fresh Water*
- *Vulnerable Domestic Wells*
- *Seawater intrusion*

Methodologies

- *Infill AEM*
- *Ground-based geophysics*
  - *tTEM*
  - *FloaTEM*
- *NMR-logs, E-logs*
- *Cone Penetrometer*
- *Lithology logs*
- *New wells*
- *Well re-activation*

Available Datasets

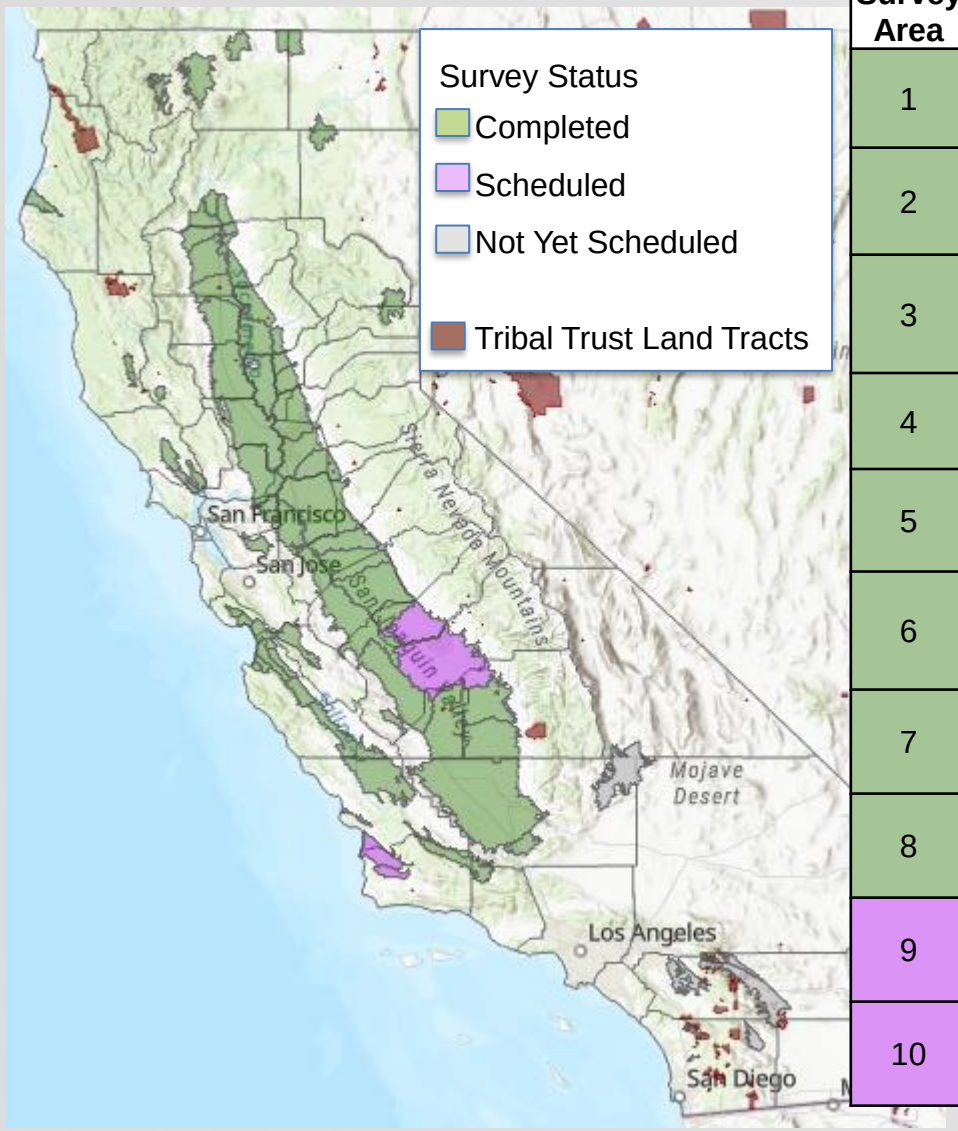
- **Geophysics**: Statewide AEM, Infill AEM, tTEM/FloaTEM, NMR/e-logs
- **Wells**: Locations, Lithology, Well Details, Dry Wells
- **GW Levels**: GW Stations, GW Measurements
- **Subsidence**: InSAR, CGPS, Extensometers
- **WQ**: DWR WQ, Board WQ
- **Land Use**: Crop Mapping Statewide, County Level

Data Analysis

Integrated Analysis of Subsurface Data

*Goal: to integrate **all** available (new and existing) data to develop basin-wide hydrogeologic conceptual model*

Pilot Study 1: Portion of Kings and Madera Subbasins



Survey Area	Survey Area Description	Data Collection/ Completion Date
1	Salinas Valley & Cuyama	August 2021
2	Northern Basins	November 2021
3	Northern SF Bay, Ukiah, Big Valley	November 2021
4	Southern San Joaquin	December 2021 & March 2022
5	Central San Joaquin	March 2022
6	Northern San Joaquin & Southern Sacramento	April 2022
7	Northern Sacramento, Eel River, Sierra	May 2022
8	Monterey Bay Area	November 2022
9	San Luis Obispo & Santa Barbara County Areas	April 2023
10	Pilot Study1: Madera and Kings	April 2023

Pilot Study Goals:

- Understand shallow groundwater recharge mechanisms
- Locate fast path recharge pathways
- Improve understanding of surface water groundwater interaction
- Collect additional data
  - Infill AEM
  - tTEM
  - FloaTEM
  - CPT
- Integrate all available data into texture and hydrostratigraphic models using new tools

Thank you!

Statewide AEM Survey Project Website: https://water.ca.gov/Programs/SGMA/AEM

CNRA Open Data Portal Page: https://data.cnra.ca.gov/dataset/aem

General email: AEM@water.ca.gov

AEM Project Manager email: Kathrerine.Dlubac@water.ca.gov