

# **An Independent Assessment of Scientific and Technical Information on Advanced Well Stimulation Technologies in California**

Legislative Briefing, February 2015



**CCST**

CALIFORNIA COUNCIL ON  
SCIENCE & TECHNOLOGY



# Purpose of this briefing

The California Council on Science and Technology (CCST) released the first volume of a report entitled, "*An Independent Scientific Assessment of Well Stimulation in California*" commissioned by the California Natural Resources Agency pursuant to SB 4 (Pavley).

This briefing is intended to:

- To provide information on the findings and conclusions of Volume I
- To provide an overview of what Volume II and III will contain

# California Council on Science and Technology (CCST)

- CCST is a nonpartisan, impartial, not-for-profit corporation established via Assembly Concurrent Resolution (ACR 162) in 1988 to provide objective advice from California's best scientists and research institutions on policy issues involving science.
- CCST is dedicated to providing impartial expertise that extends beyond the resources or perspective of any single institution.
- CCST is governed by a Board of Directors and studies are funded by government agencies, foundations and other private sponsors.

# California Council on Science and Technology

CCST regularly issues important, peer-reviewed reports authored by the State's foremost technical experts to address some of society's toughest challenges related to water, energy, innovation, and STEM education in California.

Our role is to oversee a very rigorous process, which includes:

- Convening study teams with an appropriate range of expertise for the task
- Providing a balance of points of view on CCST teams and reports
- Screening for potential conflicts of interest (*point of view is different from conflict of interest*)
- Conducting an extensive and rigorous peer review by experts who were not involved in writing the report, and who also undergo a conflict of interest screening

This process, modeled after the National Academies, ensures the product is credible and responsive to the study charge.



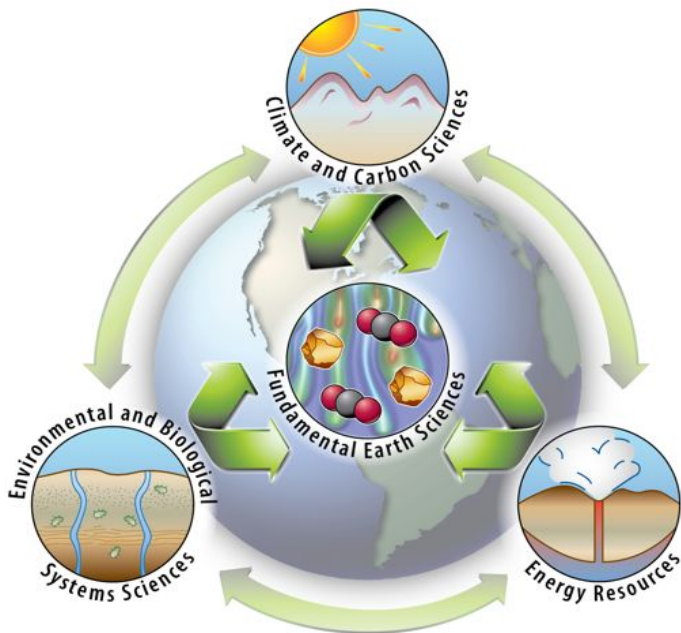
# Lawrence Berkeley National Laboratory

- Discovery science, energy innovation and environmental solutions
- ~\$800 Million Budget; 4,200 Employees; 1,000 Students
- 13 Nobel Prizes – most recent in 2011 for the discovery of dark energy
- 70 members of the National Academy of Sciences (~3% of the Academy)
- 10,000 researchers from industry/universities annually use the Lab's unique research facilities.

## Earth Sciences at Berkeley Lab

### MISSION

...to create new knowledge and capabilities needed to enable sustainable stewardship of **critical environmental systems** and judicious use of the Earth's **natural energy resources**.



Managed by the University of California for the U.S. Department of Energy



# Who Performed the Study

- **The CCST's California Well Stimulation Steering Committee**
  - Provided oversight, scientific guidance and input for the project
- **Lawrence Berkeley National Laboratory (Berkeley Lab)**
  - Performed the majority of the analysis
- **Subcontractors:**
  - The Pacific Institute
  - Physicians, Scientists and Engineers for Healthy Energy
  - Stanford University
  - Dan Gautier (USGS retired)
  - Scripps Institute of Oceanography
  - CSU Stanislaus Endangered Species Recovery Program
  - University of the Pacific

# Steering Committee Members

- Jane C. S. Long (Chair)
- Jens Birkholzer (LBNL Lead)
- Peter Gleick (Impacts to Water)
- Dan Tormey (Impacts of WST in CA)
- Larry Lake (Petroleum Engineering)
- Seth Shonkoff (Public Health)
- Dan Hill (WST)
- Don Gautier (Petroleum Geology)
- Tom McKone (Risk Assessment)
- William Minner (WST Design and Practice in CA)
- Roger Aines (Geochemistry)
- Amy Myers Jaffe (Environmental Practice in Petroleum, Oil Business)
- Sam Traina (Environmental Engineering)

Ex Officio:

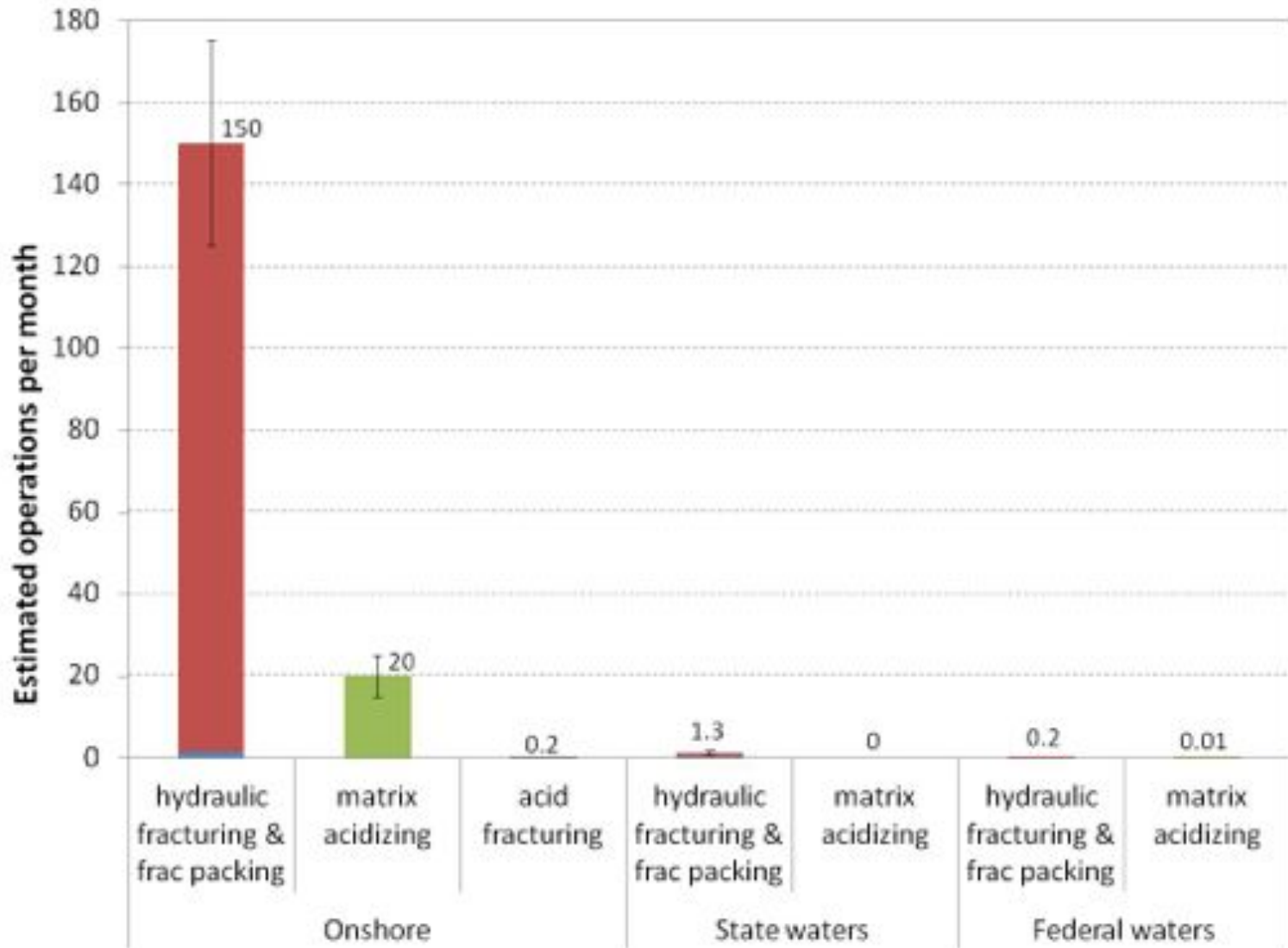
- Laura Feinstein (Project Manager)

## The study will be produced in three volumes plus a summary

Title	Deliver to CNRA
VOLUME I: Well Stimulation Technologies and their Past, Present and Potential Future Use in California	Jan 1, 2015
VOLUME II: Generic and Potential Environmental Impacts of Well Stimulation Treatments	July 1, 2015
VOLUME III: Case Studies with Selected Evaluations of Environmental and Public Health Risk	July 1, 2015
Summary Report: Vernacular summary of major findings, conclusions and recommendations.	July 1, 2015

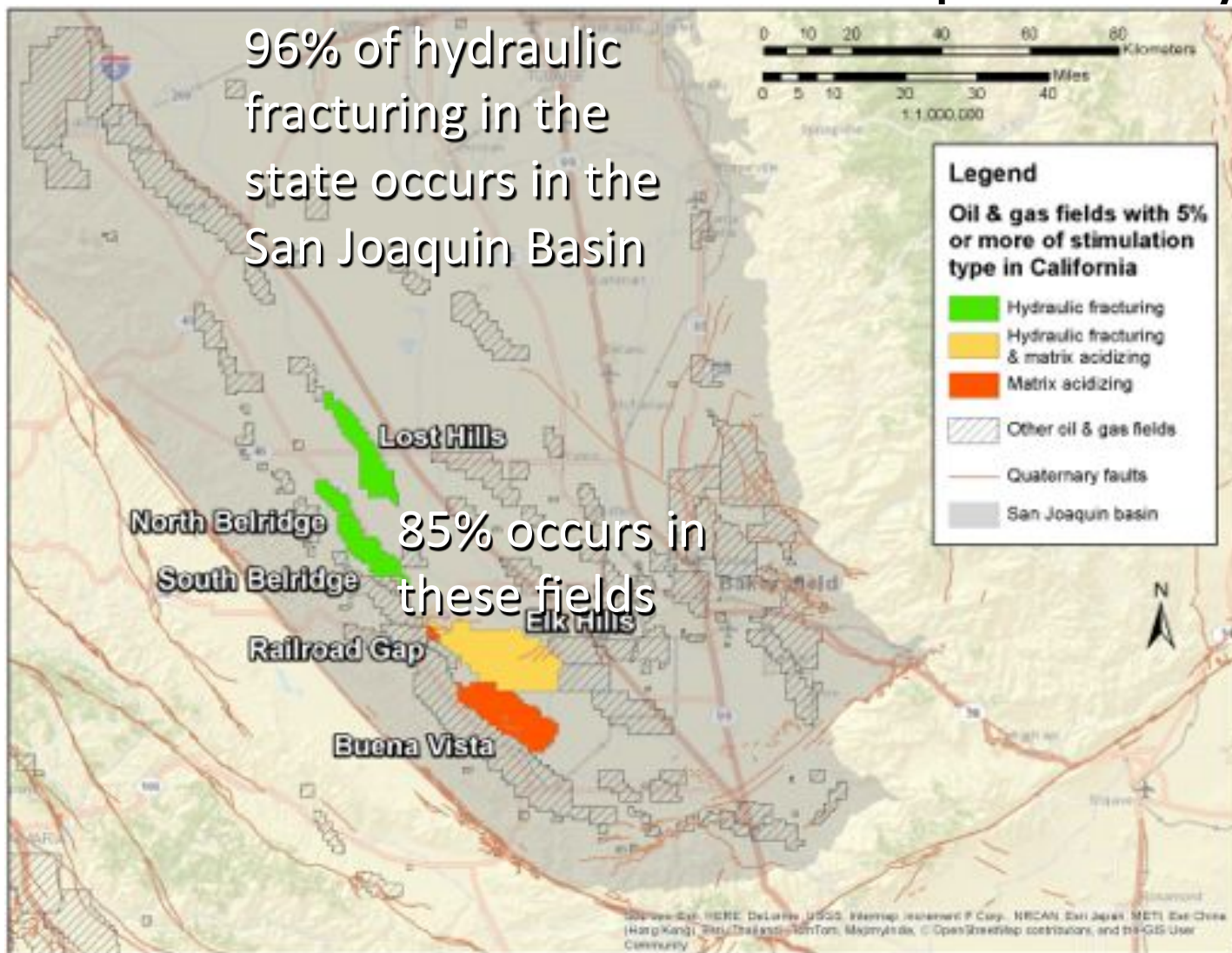


# Almost all Stimulation Activity is Hydraulic Fracturing of Oil Wells Onshore

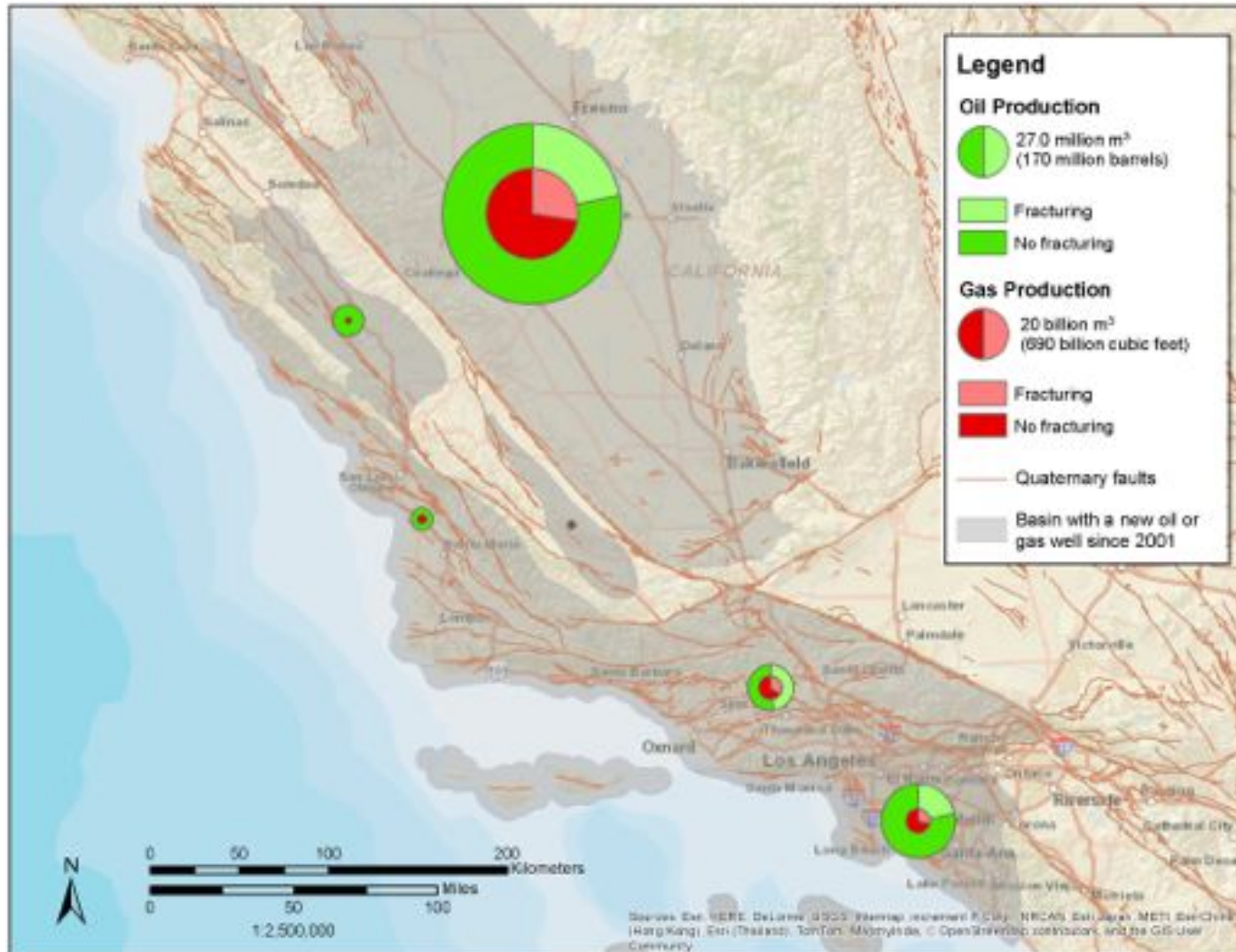


“An Independent Scientific Assessment of Well Stimulation in California”, January 2015

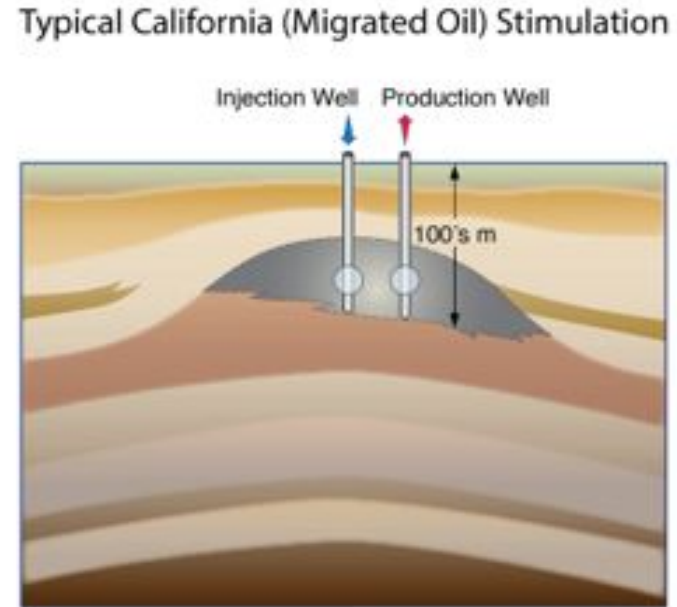
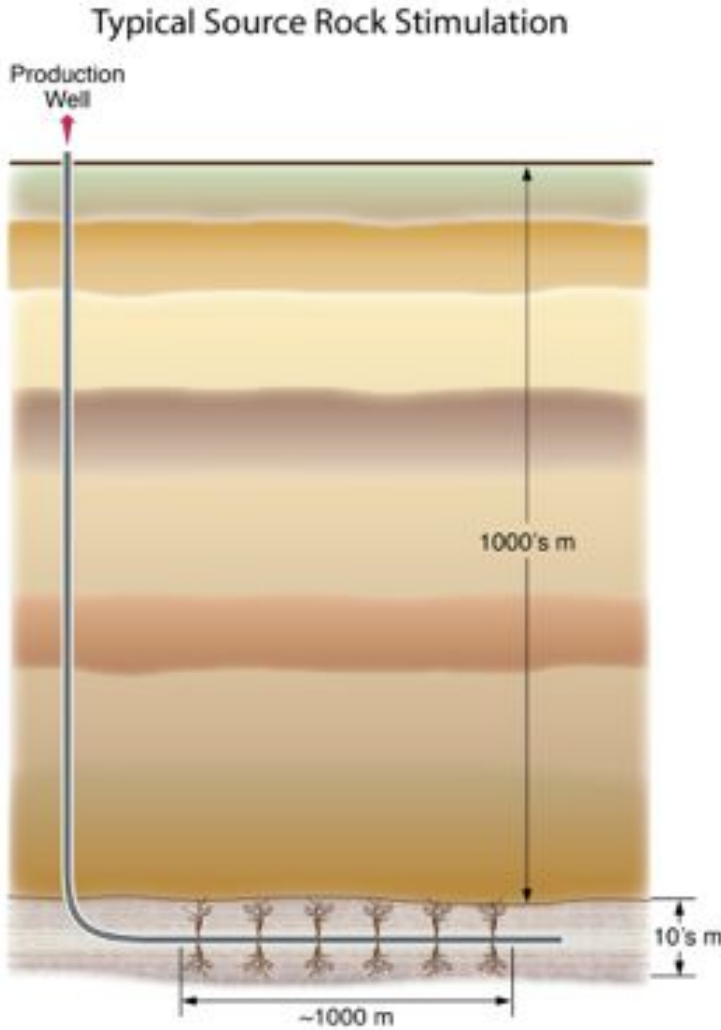
# Nearly all hydraulic fracturing and matrix acidizing occurs in six fields in the San Joaquin Valley



# Hydraulic fracturing has facilitated about 20% of oil and gas production in CA since 2001



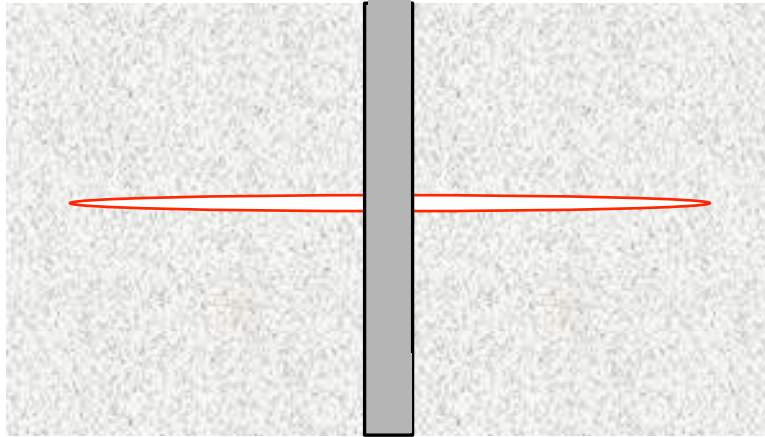
# Stimulated Wells in California Tend to be Vertical



ESD14-047

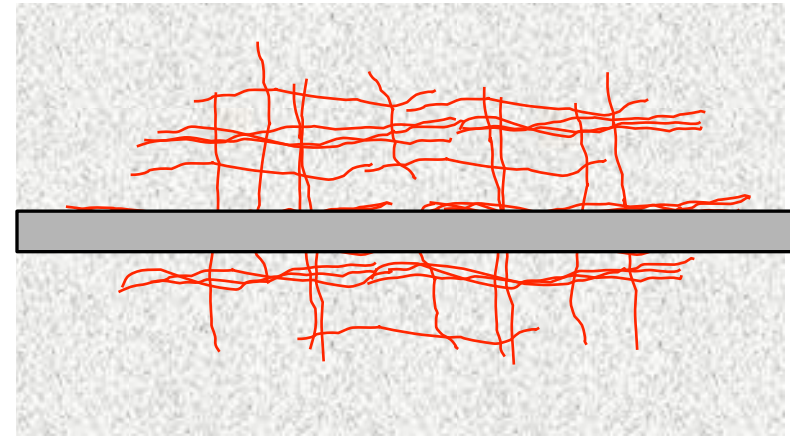
# CA Hydraulic Fractures: Smaller and Simpler

## Typical California Application



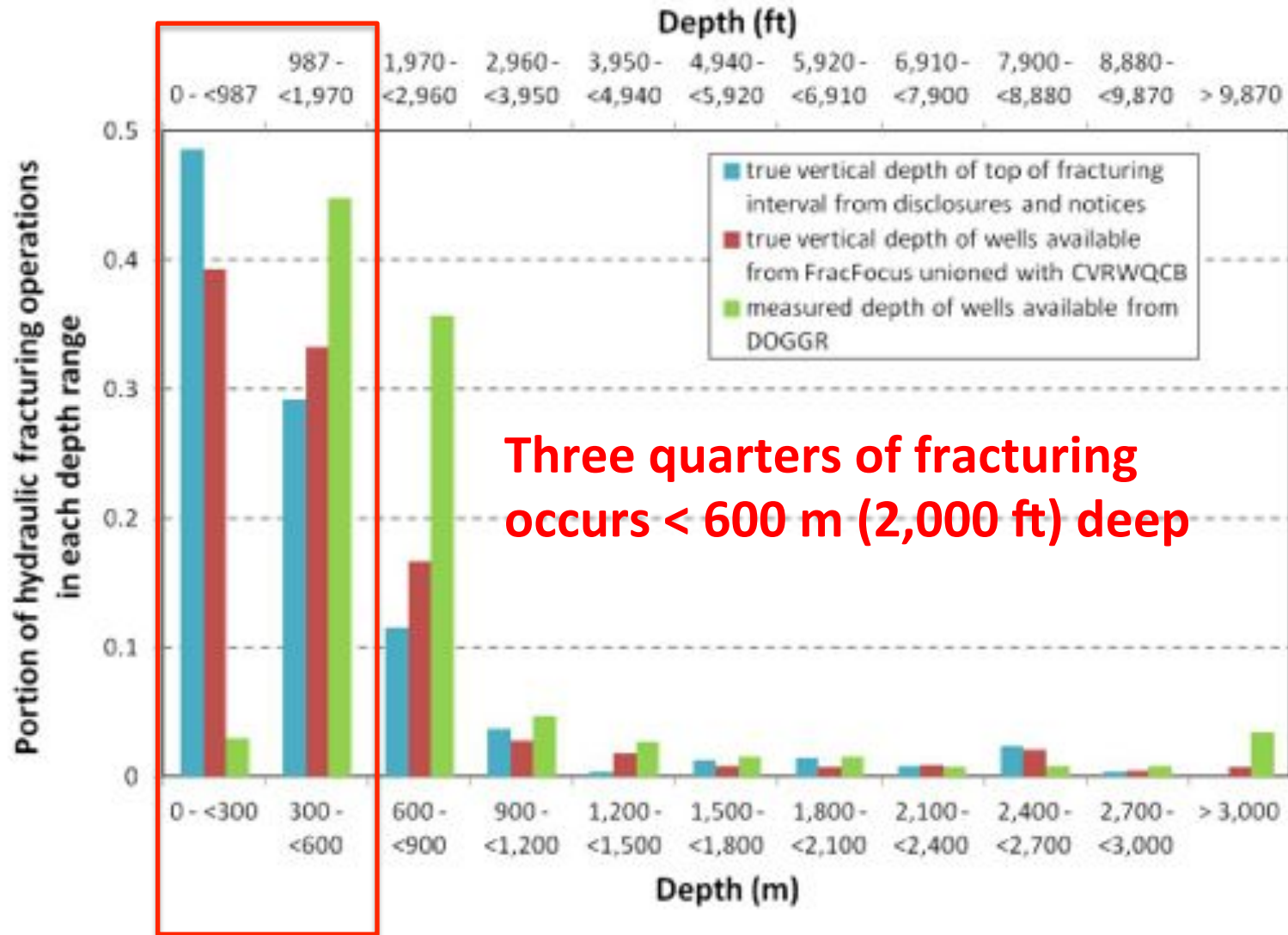
- Smaller volumes of water
- Gel-based (Guar gum) additive
- Simpler fractures with larger aperture

## High Volume – Horizontal Well Application

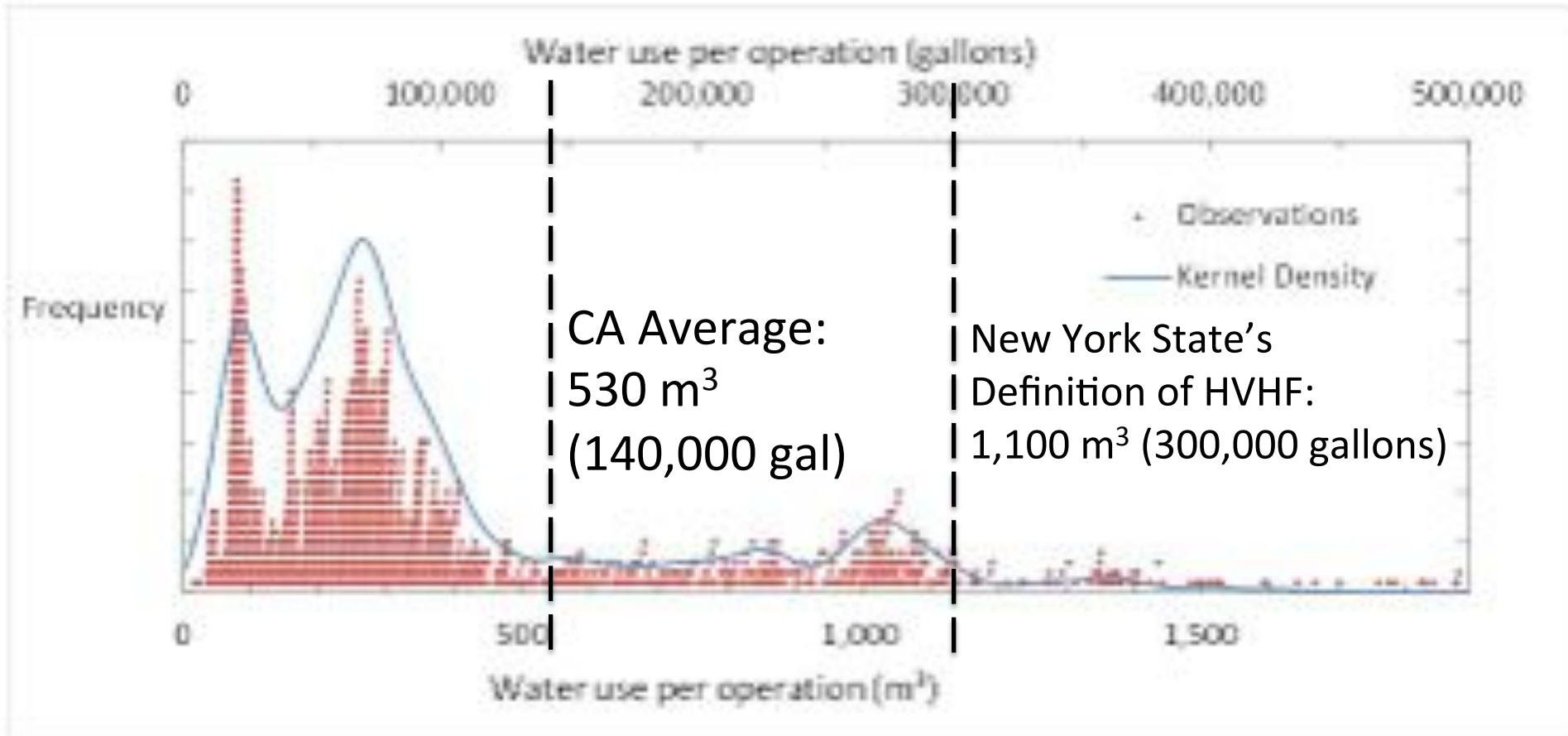


- Larger volumes of water
- Slick-water (detergents) additives
- Complex fracture networks
- (Banned in New York)

# Fracturing Depth

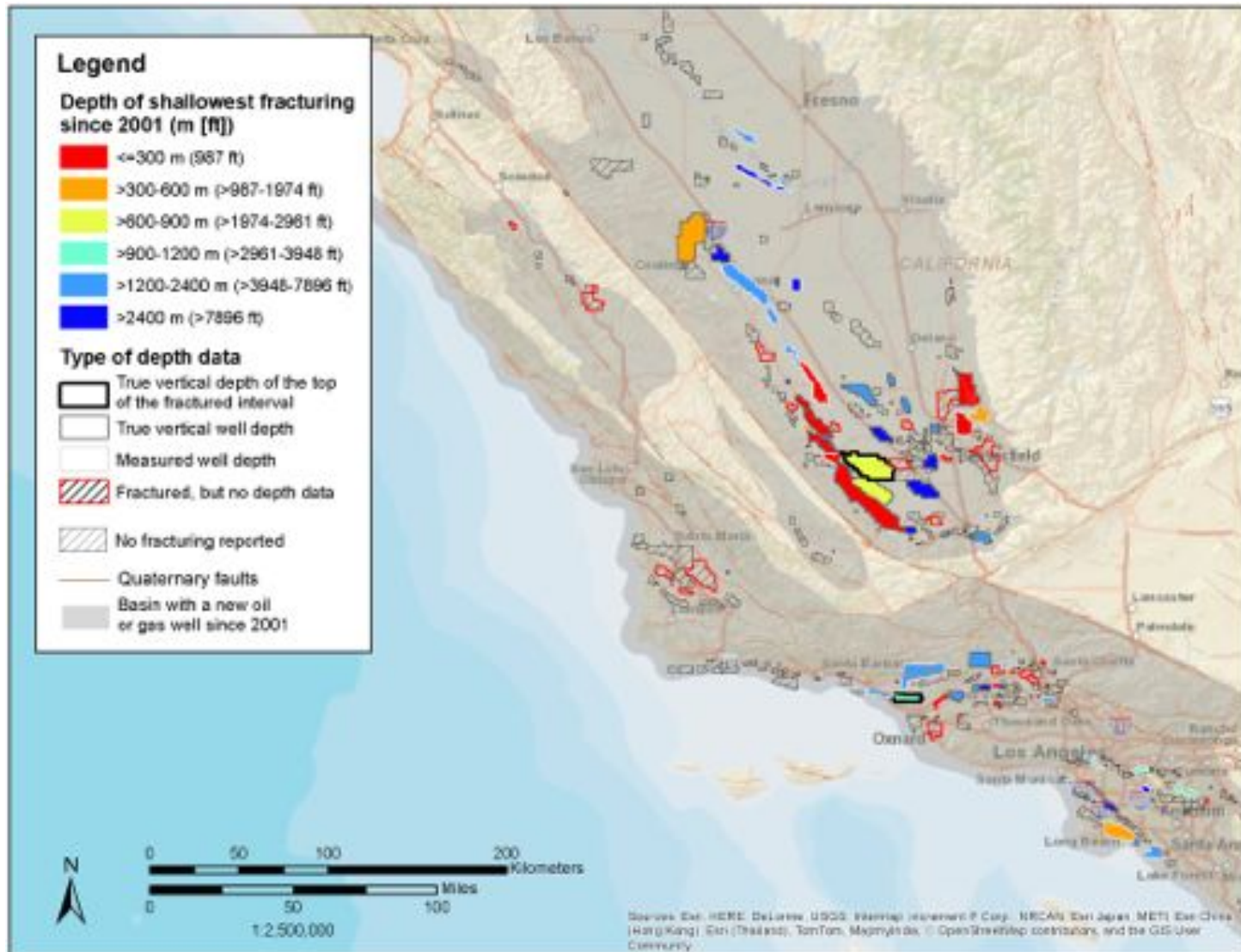


# What is high-volume hydraulic fracturing (HVHF)?



The cutoff for what is called “high-volume” hydraulic fracturing is arbitrary. New York State’s cutoff of 300,000 gallons and above is larger than more than 90% of California operations.

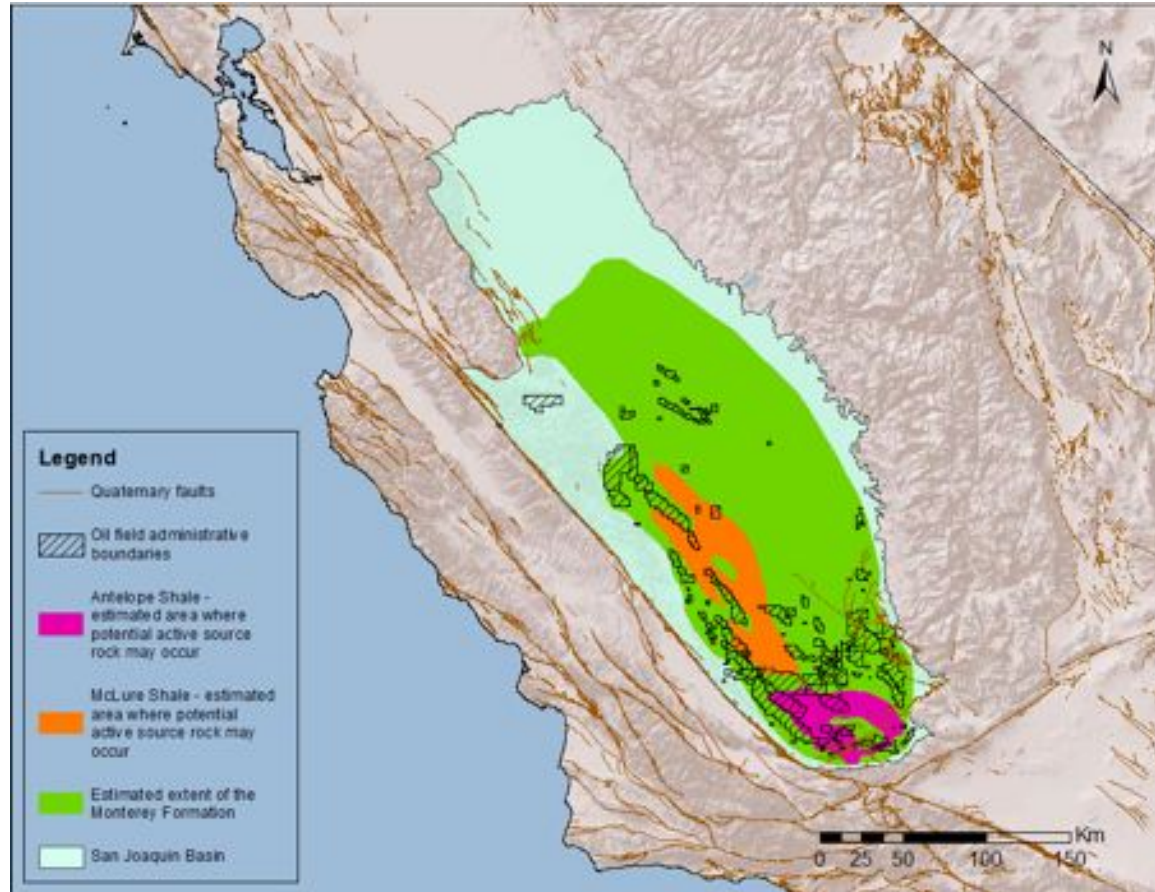
# Shallowest Depth By Field





# Could WST allow production of unconventional resources?

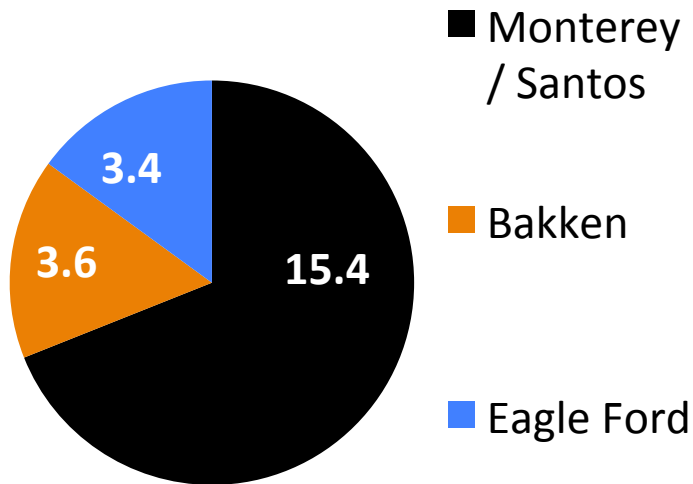
- Unconventional oil in deeper, low permeability **source rocks**
  - Monterey Formation
  - Soda Lake Shale, Vaqueros Formation
  - Tumey Formation
  - Kreyenhagen Formation
  - Moreno Formation



San Joaquin Basin – Monterey data from Magoon et al., 2009

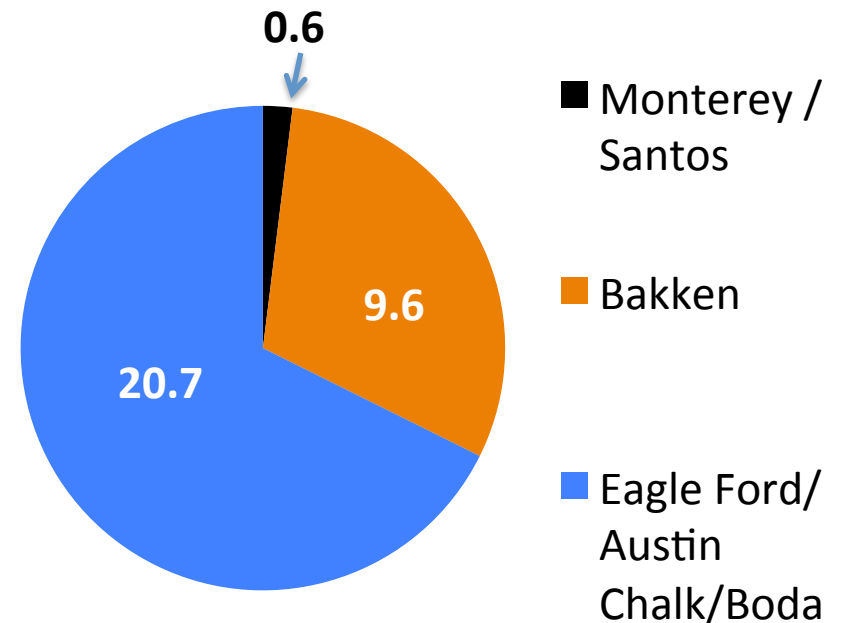
# Energy Information Administration (EIA) Estimates of Technically Recoverable Oil Shale

EIA/INTEK (2011)



22.4 BBO

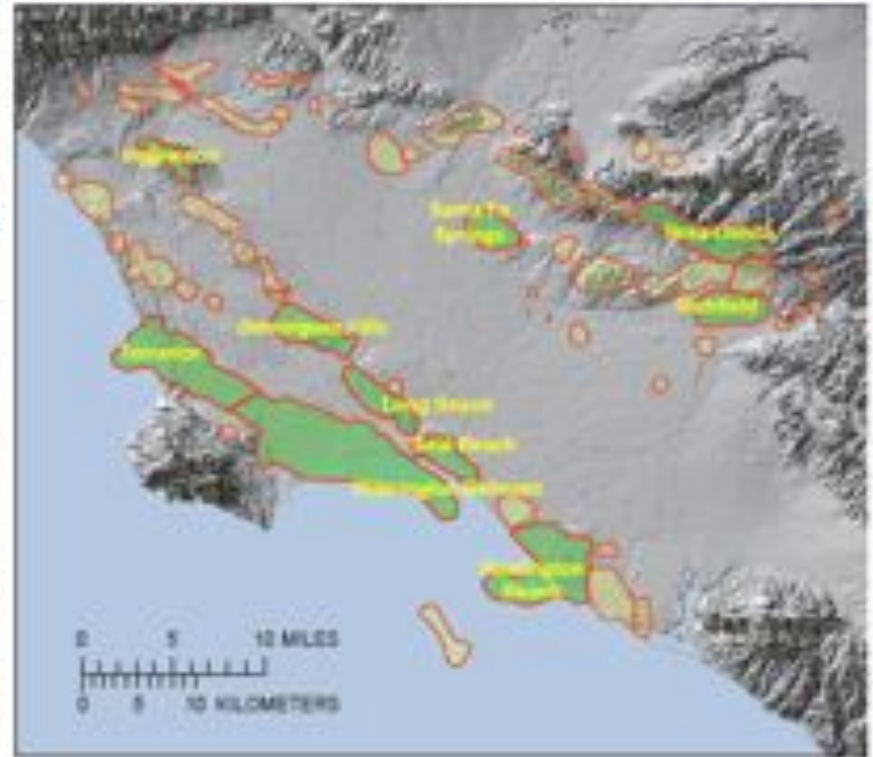
EIA (2014)



30.6 BBO

Both estimates of the Monterey oil shale play are highly uncertain

Current technology could add 4.9 to 15.6 billion barrels from just 19 giant San Joaquin and L.A. basin fields,

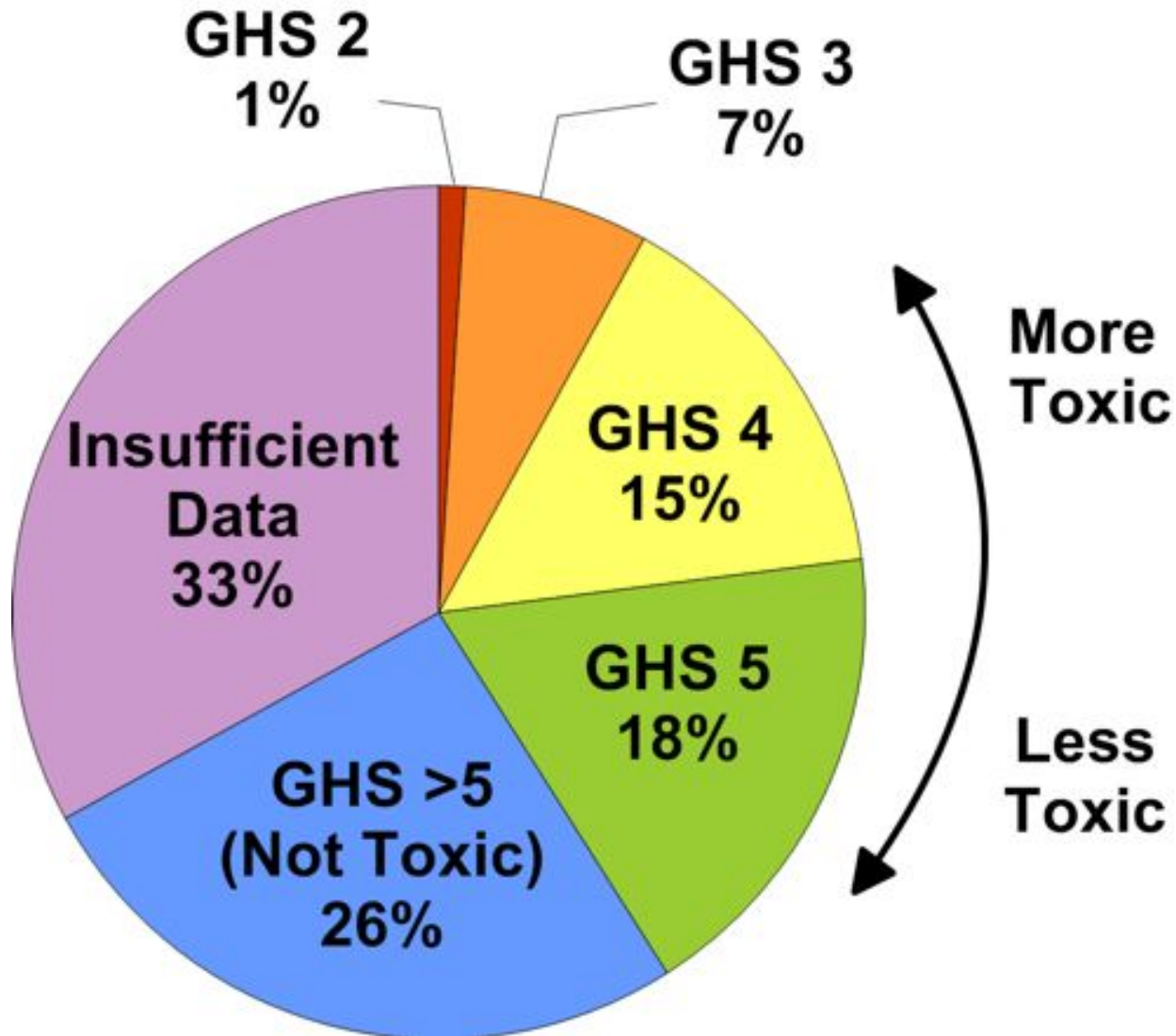


USGS Fact Sheet 2012-3120;  
USGS Fact Sheet 2012-3050

# Some impact results from the BLM study

- Chemicals
- Water
- Seismicity

# Mammalian Toxicity of WST Chemicals



"An Independent Scientific Assessment of Well Stimulation in California", January 2015

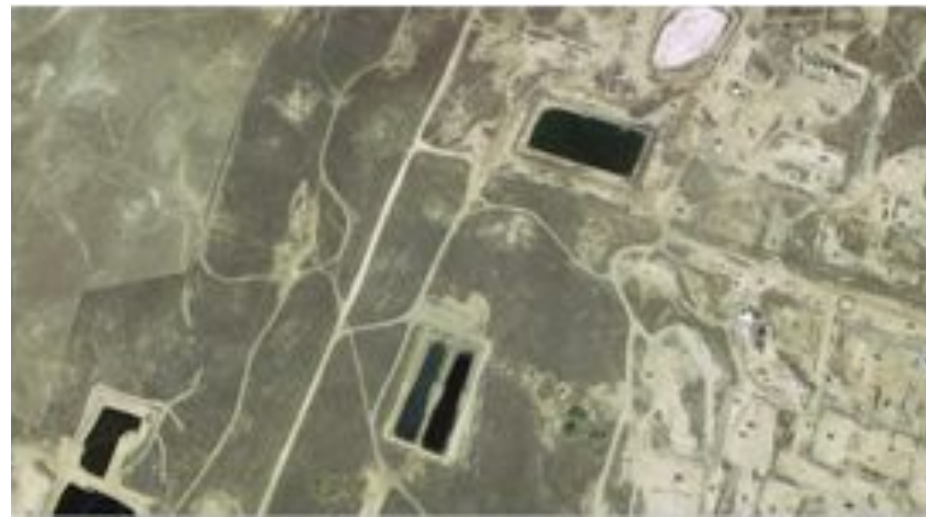
# Flowback and Produced Water

In California, produced water and flowback water are co-mingled and managed together. Current practice could allow flowback water to be mixed with produced water for use in irrigation and for the disposal of oil and gas wastewater into unlined pits.



Produced water used for irrigation in Cawelo water district

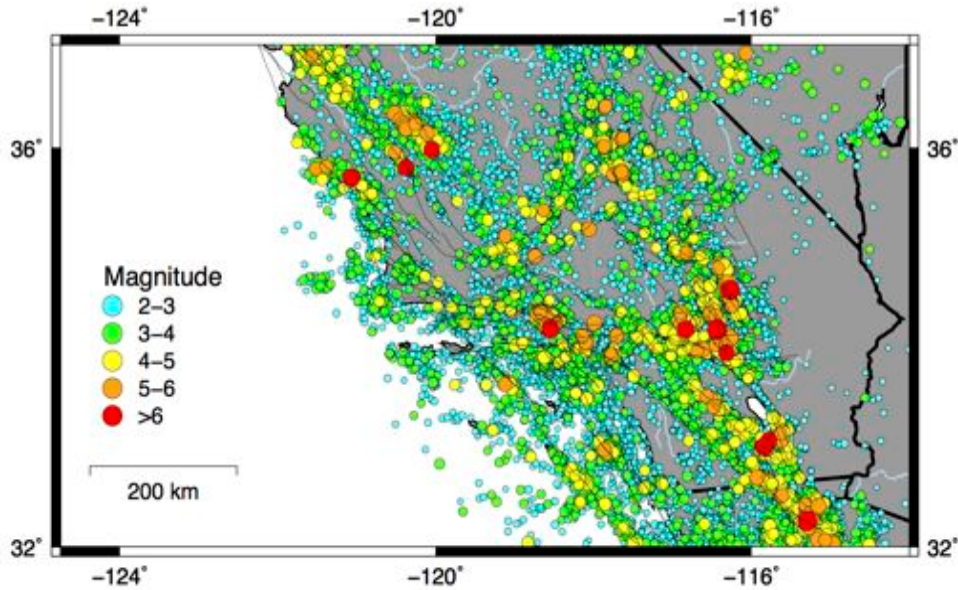
Source: Lauren Sommers



Unlined pits in Kern County

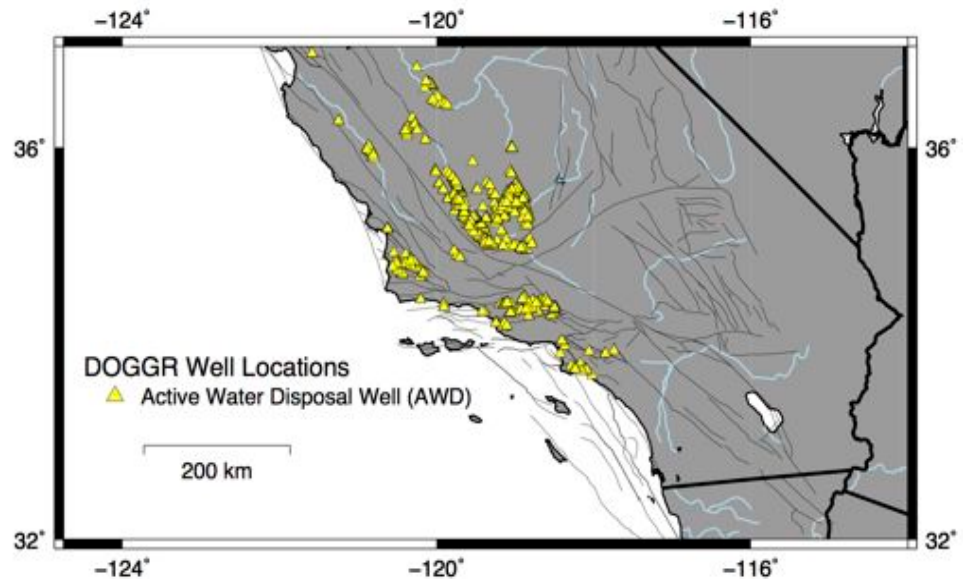
Source : Google Earth

# California Seismicity and Wastewater Disposal Wells



High-precision earthquake locations 1981-2011 from Hauksson et al. (2012)

Locations of 1509 active water disposal wells from DOGGR with UCERF3 FM3.1 faults (Field et al., 2014)



# Volume II Potential Impacts of WST

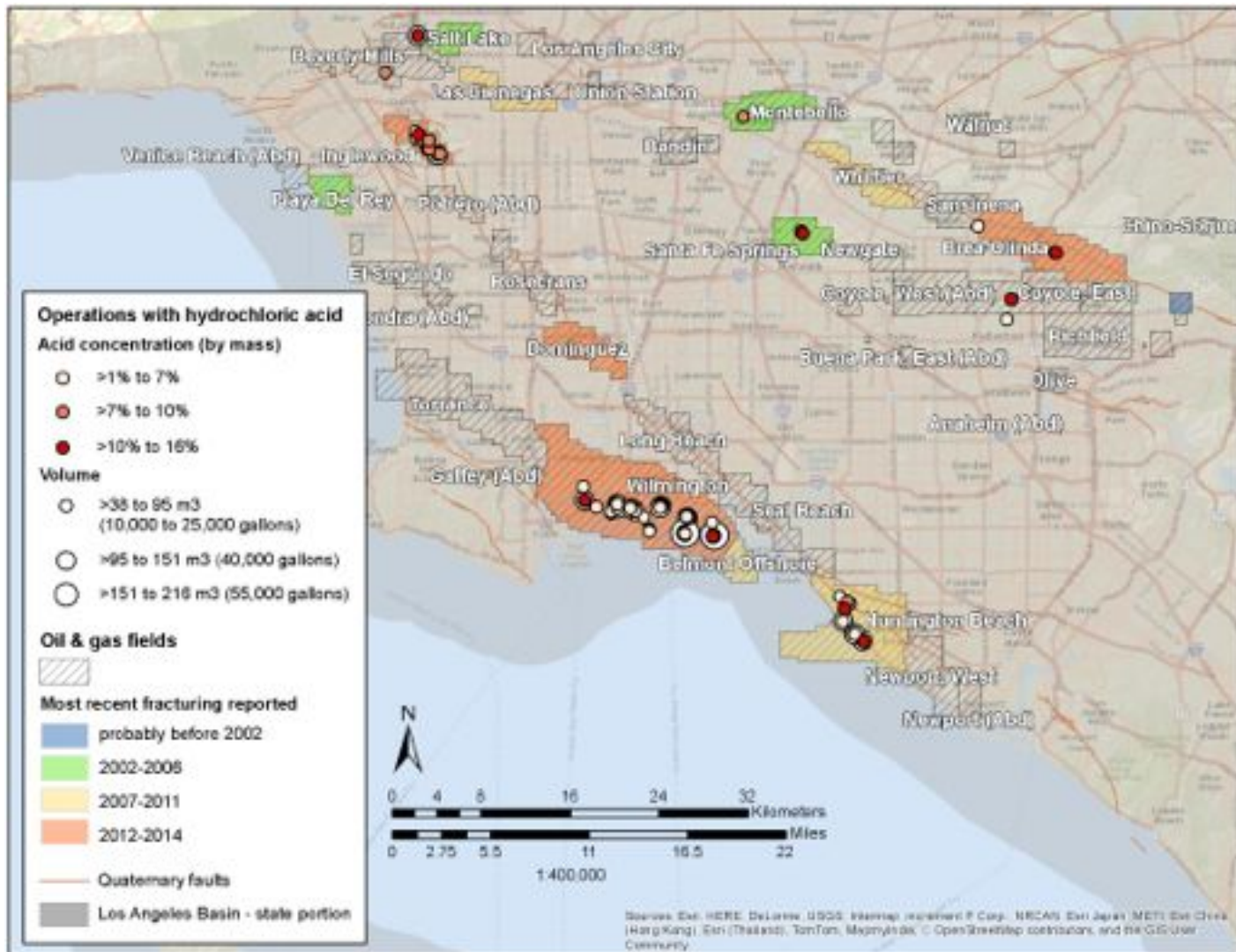
- Water Impacts
- Atmospheric Impacts
- Induced Seismicity
- Traffic, Noise and Light
- Human Health
- Ecological Impacts
- Hazard Analysis
- What do we know?
- Alternative Practices
- Data Gaps



# Vol III The case studies

- Los Angeles
  - Urban environment
  - Acid use
  - Comparison of oil left vs. shale oil
- San Joaquin Valley
  - Disposition of water containing fracking fluids
  - Other issues
  - The future as a projection of the present
- Oil shale potential of the Monterey
  - Potential impacts in the geography of the shale oil window
  - How to make a good estimate
- Offshore production
  - What do we know about what is happening?

# Los Angeles Basin Acidizing



# Natural Gas

- Large-scale **development of unconventional natural gas resources that would require WST** such as shale gas and basin-center “tight gas” is **considered geologically unlikely in California**