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

**We will begin shortly.**

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

Post-Release Briefing, January 2015

# How to Participate

You should be able to hear the audio over your computer speakers. If you are having difficulties hearing the speakers, please listen over your phone by calling:
1-866-740-1260
Code: 4651707#

We will answer questions at the end.
Please submit questions to the using the "chat" feature in the lower left corner of your screen.

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# Purpose of this briefing

The California Council on Science and Technology (CCST) is releasing the first volume of a report entitled, "An Independent Scientific Assessment of Well Stimulation in California" commissioned by the California Natural Resources Agency in response to California Senate Bill 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

# CCST's Independent Review of Scientific and Technical Information on Well Stimulation Technologies in California

- This is an independent scientific expert study
- Purpose of the study is to conduct an independent scientific assessment of the past, present and potential future uses of well stimulation and its impacts in California

# 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

# 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

In recent years, CCST has produced a series of reports on innovation, water, energy, and STEM education in California.

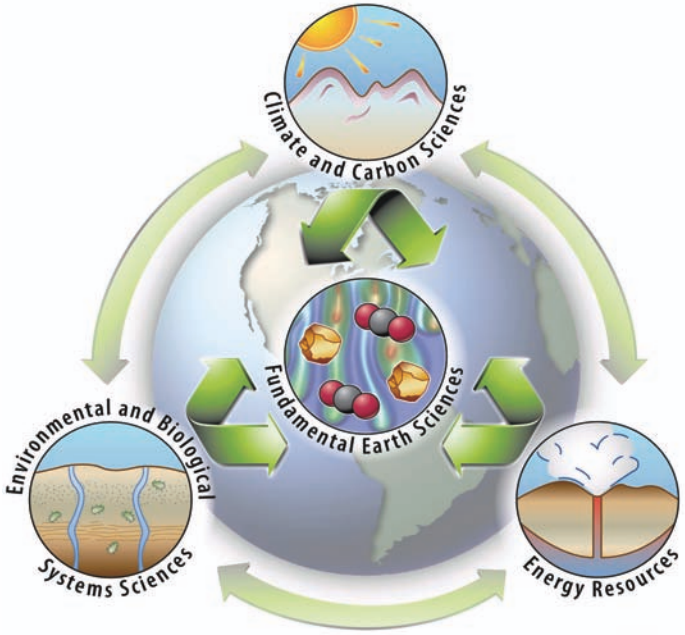
Our role is to oversee a very rigorous process. This involves:

- Convening the most relevant experts to put together a robust and balanced team
- Addressing any potential conflict of interest issues
- And conducting an extensive and rigorous peer review

This process, modeled after the National Academy of Sciences, 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

# 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 Basis of our Assessment

- Prior work for Bureau of Land Management (BLM).
- Peer-reviewed published literature.
- Analysis of available data from California Division of Oil, Gas and Geothermal Resources (CDOGGR) and other publicly available sources.
- Other relevant publications including reports and theses. We state the qualifications of the information used in the report.
- The expertise of the committee and scientific community to identify issues.
- CCST solicited nominations of information from the public.

# A Prior Study for BLM

- What is past, current and potential future practice in onshore well stimulation technologies including hydraulic fracturing, acid fracturing and matrix acidizing in California?
- Where might these technologies allow expanded production of oil onshore in California?
- What are the potential direct environmental hazards of these specific technologies in California?
- http://www.ccst.us/BLMreport

## 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 |

# Coming attractions

- Volume II  Impacts
- Volume III  Case Studies
- Summary Report

# Volume II  Potential Impacts of WST

- Water Impacts
- Atmospheric Impacts
- Induced Seismicity
- Traffic, Noise and Light
- Human Health
- Ecological Impacts
- Hazard Analysis

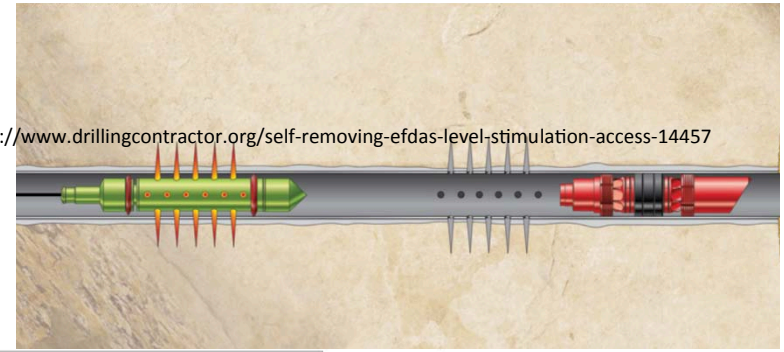
- What do we know?
- Alternative Practices
- Data Gaps

# Vol III The case studies

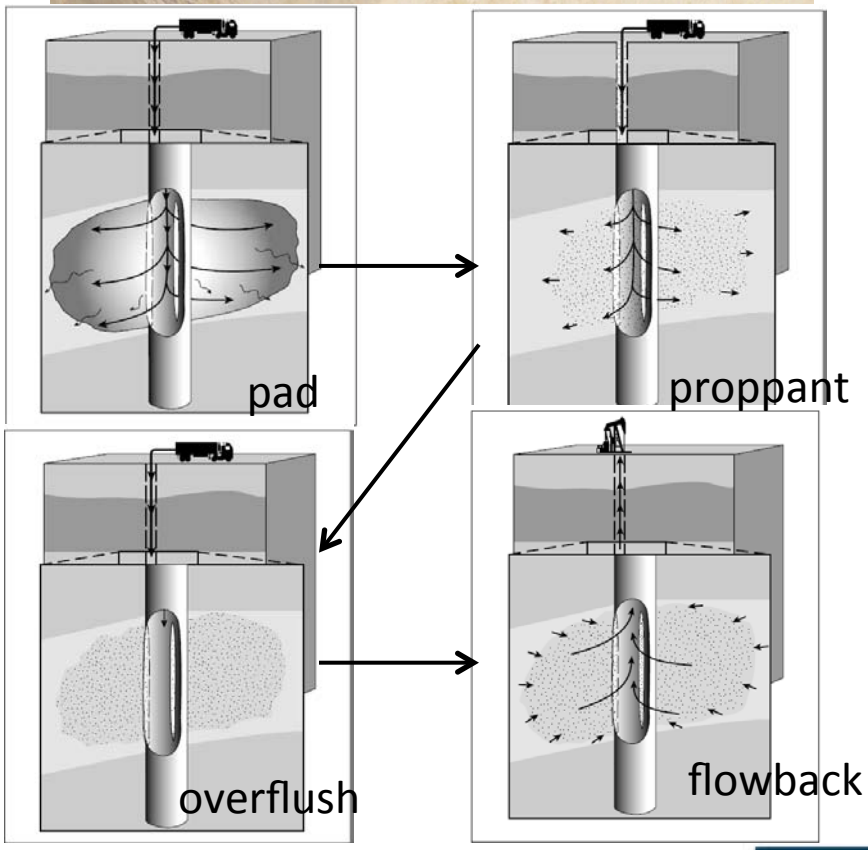
- Los Angeles
  - Urban environment
  - Acid use
  - Comparison of oil left vs. shale oil
- San Joaquin Valley
  - Disposition of water containing fracking fluids
  - Other issues
  - The future as a projection of the present
- Oil shale potential of the Monterey
  - Potential impacts in the geography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

# Hydraulic Fracturing In California

- Frac Packing:  Small-volume, near well maintenance
- Intermediate volume-- continuation of decades of practice
- High-volume,typically horizontal well - not generally used in California
- Acid fracturing not used in California because CA doesn't have carbonate (e.g. limestone) reservoirs



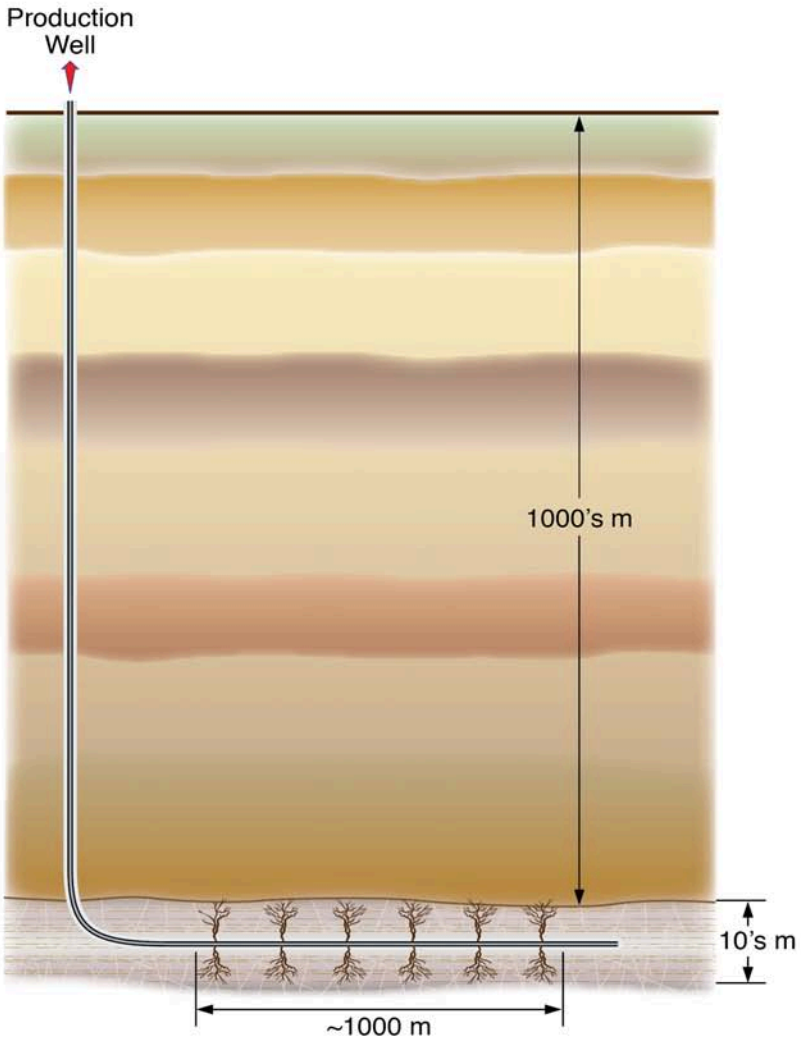
http://www.drillingcontractor.org/self-removing-efdas-level-stimulation-access-14457



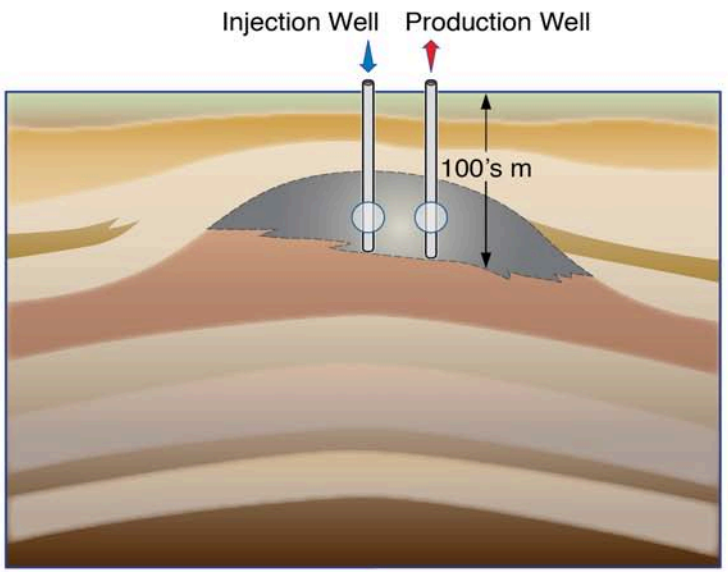

modified from Economides and Nolte (2000)

# Stimulated Wells in California Tend to be Vertical

Typical Source Rock Stimulation



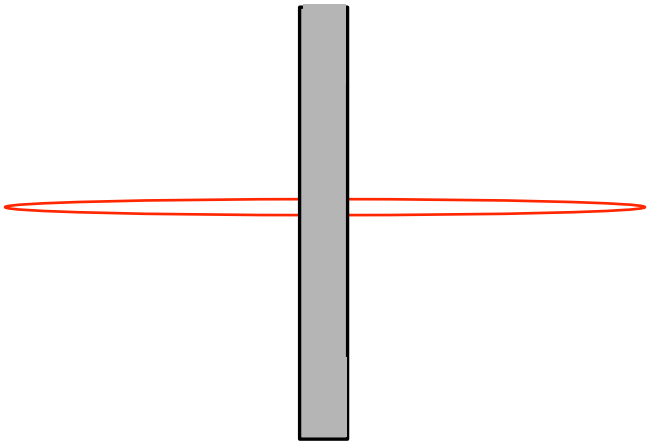

Typical California (Migrated Oil) Stimulation




ESD14-047

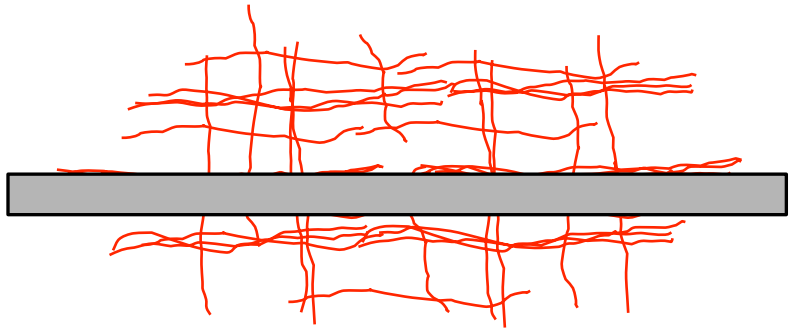
# CA Hydraulic Fractures: Smaller and Simpler

## Typical California Application



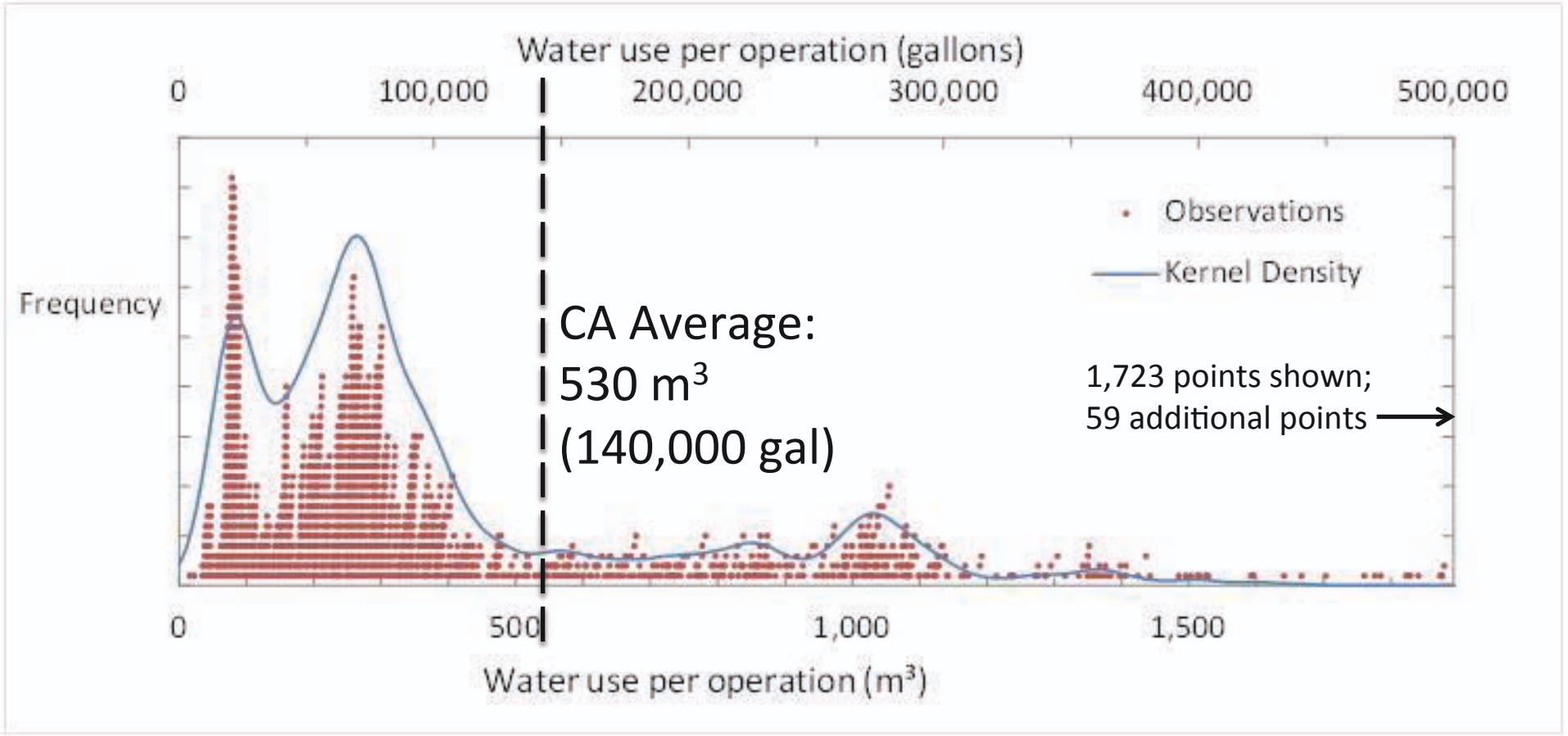
- Smaller volumes of water
- Gel-based (Guar gum) additive
- Simpler fractures with larger aperture

## High Volume – Horizontal Well Application



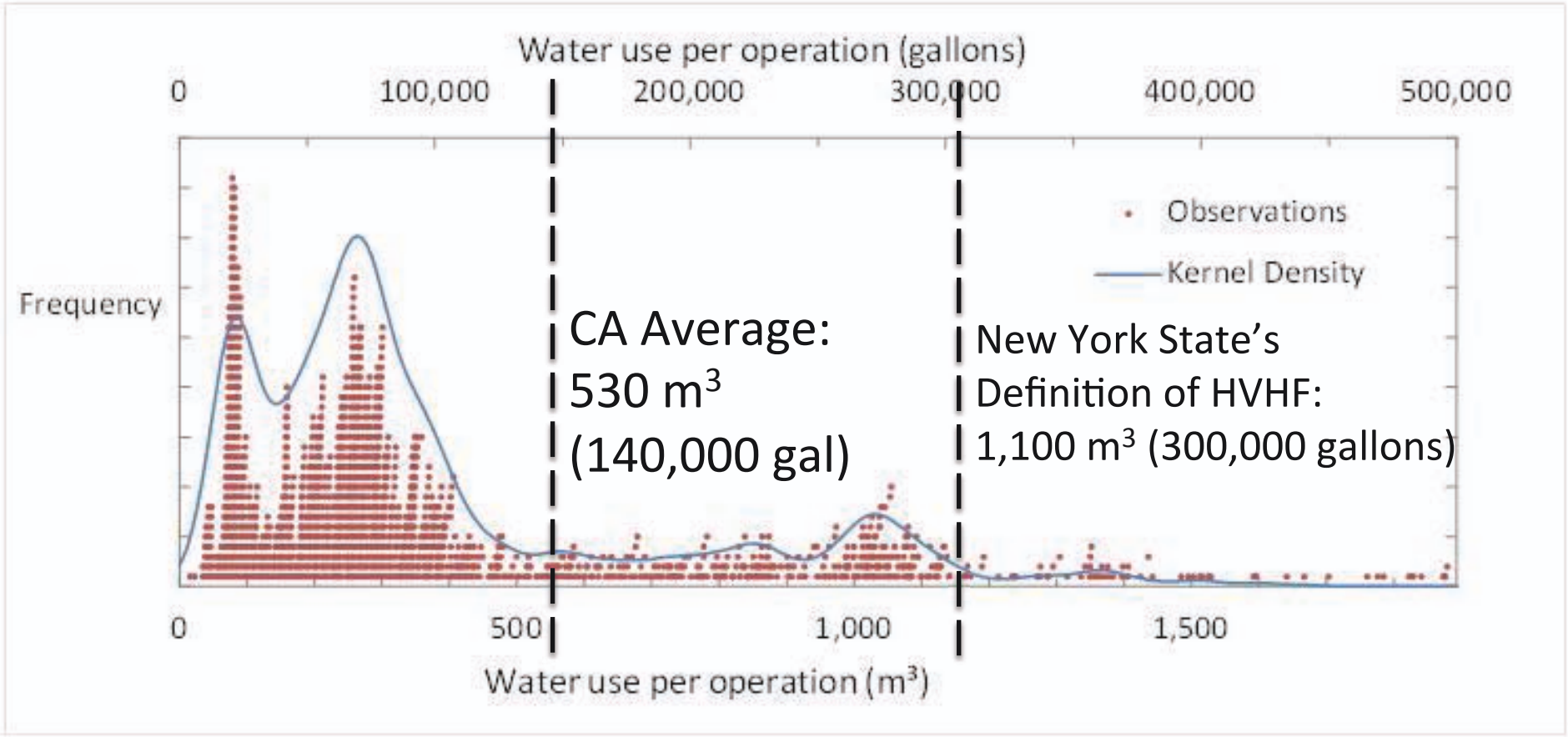
- Larger volumes of water
- Slick-water (detergents) additives
- Complex fracture networks
- (Banned in New York)

# Distribution of water use per hydraulic fracturing operation in California?



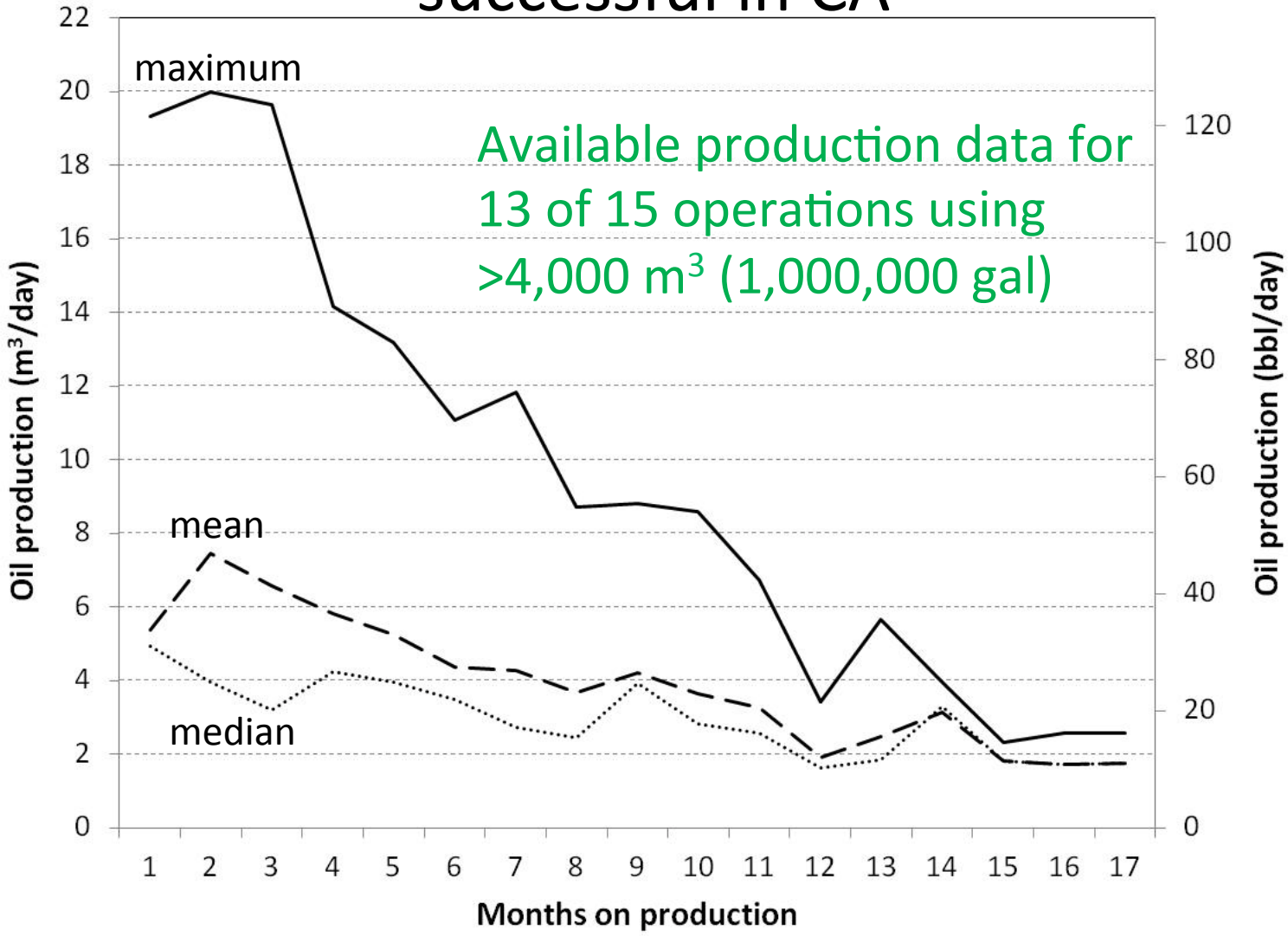

Much less than the >4,000 $m^3$ (1,000,000 gal) per operation typical elsewhere (e.g., Eagle Ford, Bakken)

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

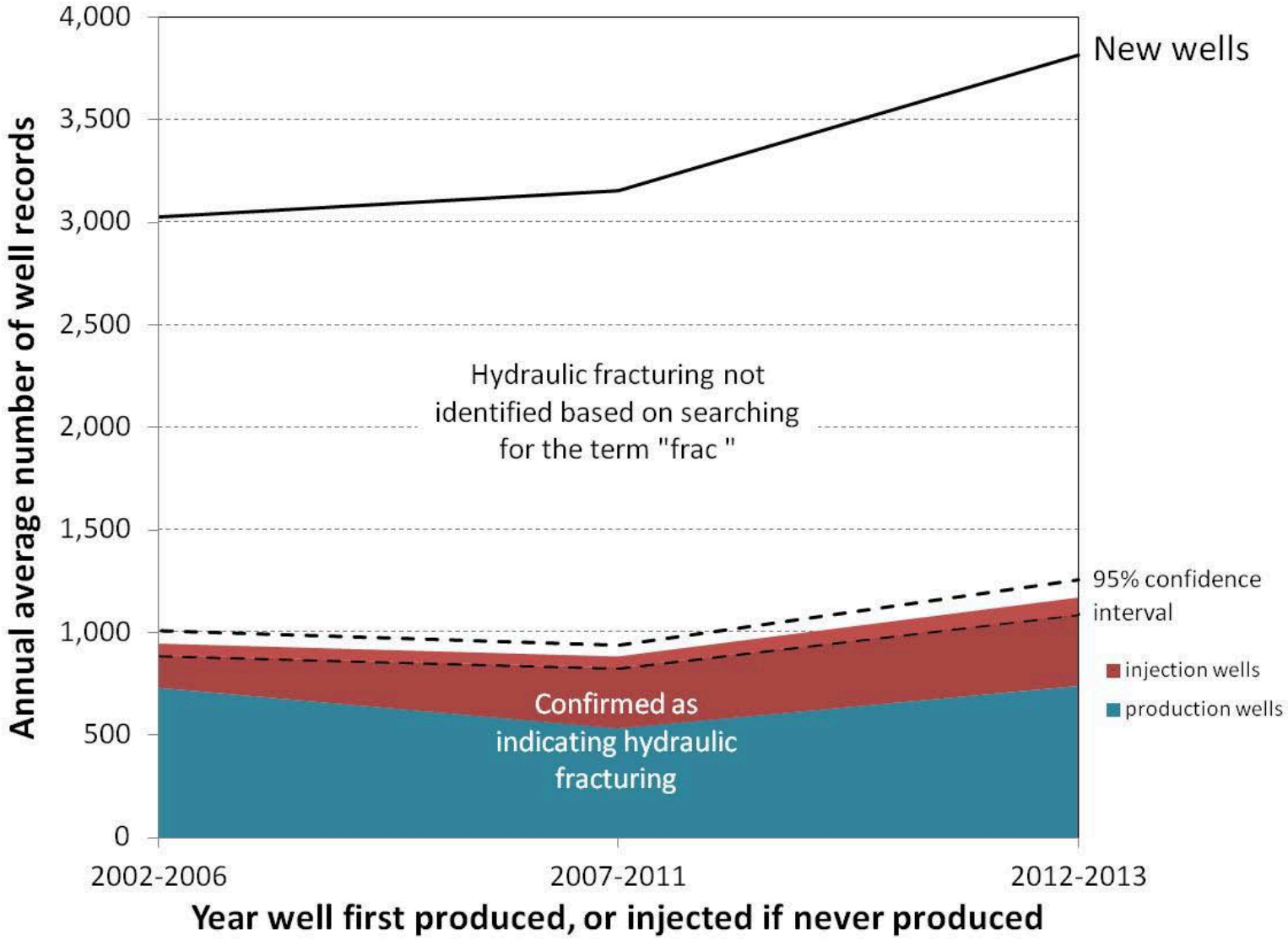



The cutoff for what is called "high-volume" hydraulic fracturing is arbitrary. New York State's cutoff of 300,000 gallons and above is larger than more than 90% of California operations.

# “Large-Volume” fracturing hasn’t been particularly successful in CA

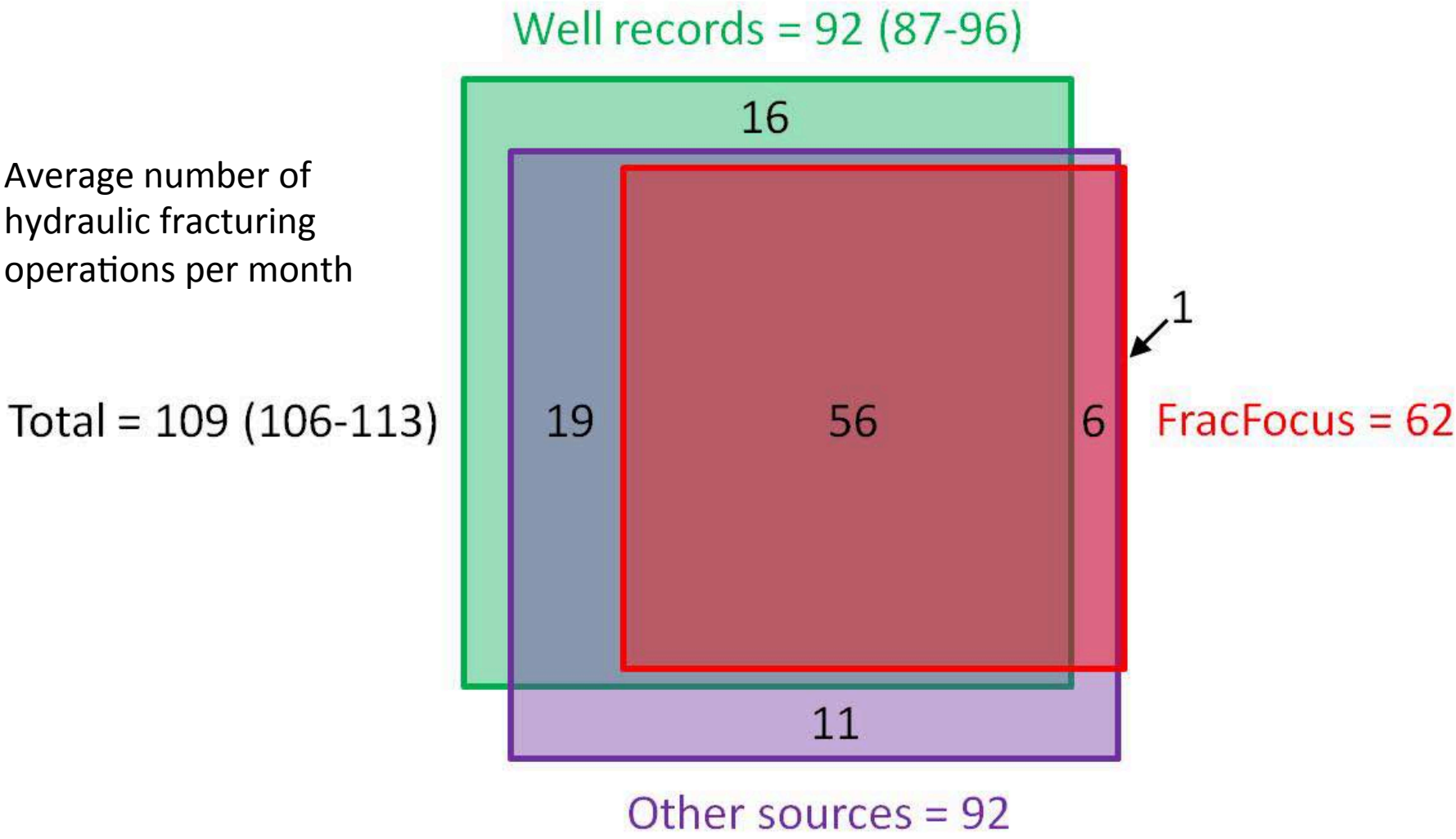


# Well Record Search Results

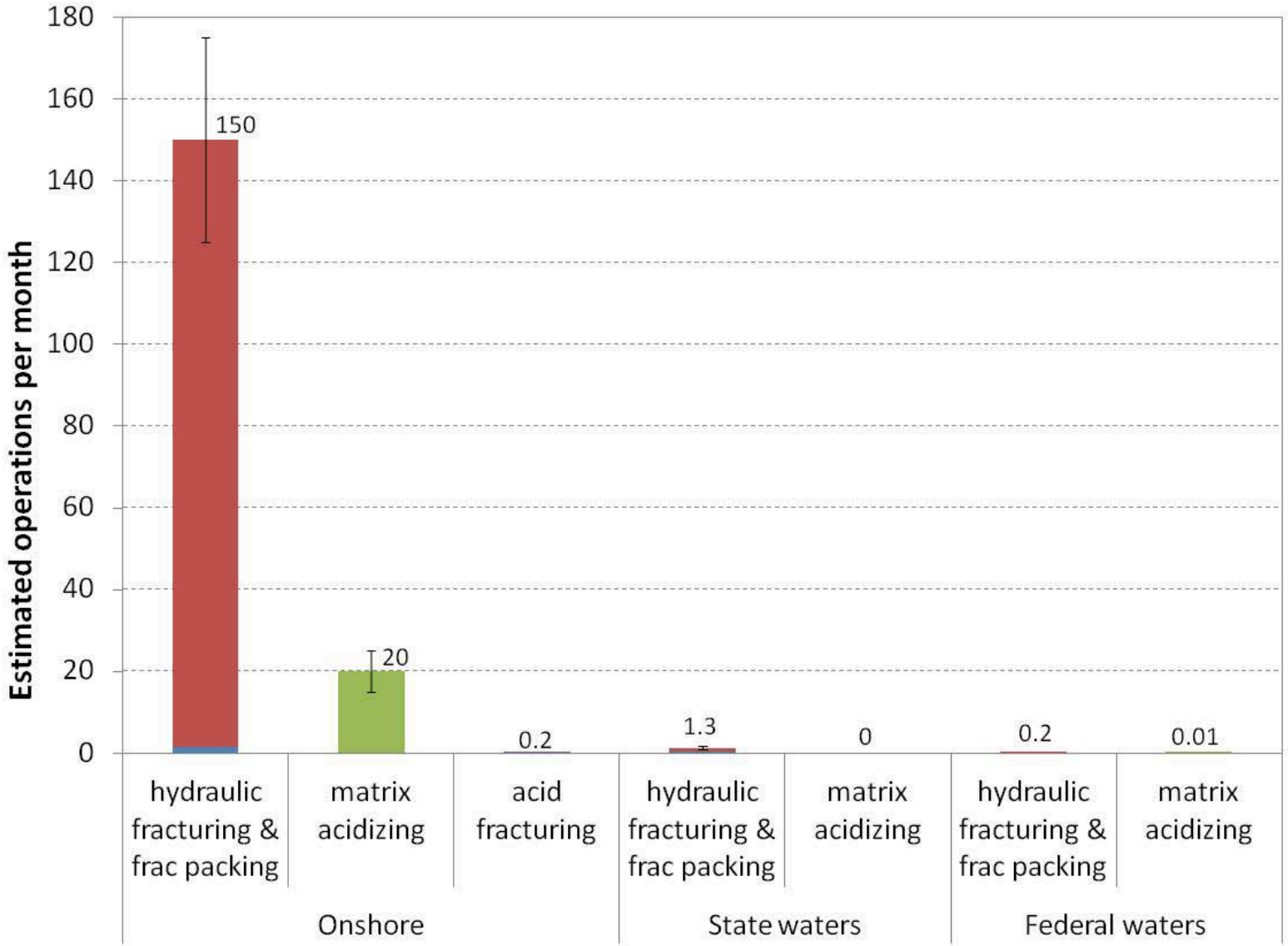


# Different data sources give similar results for the amount of hydraulic fracturing being done in the state

Average number of hydraulic fracturing operations per month



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



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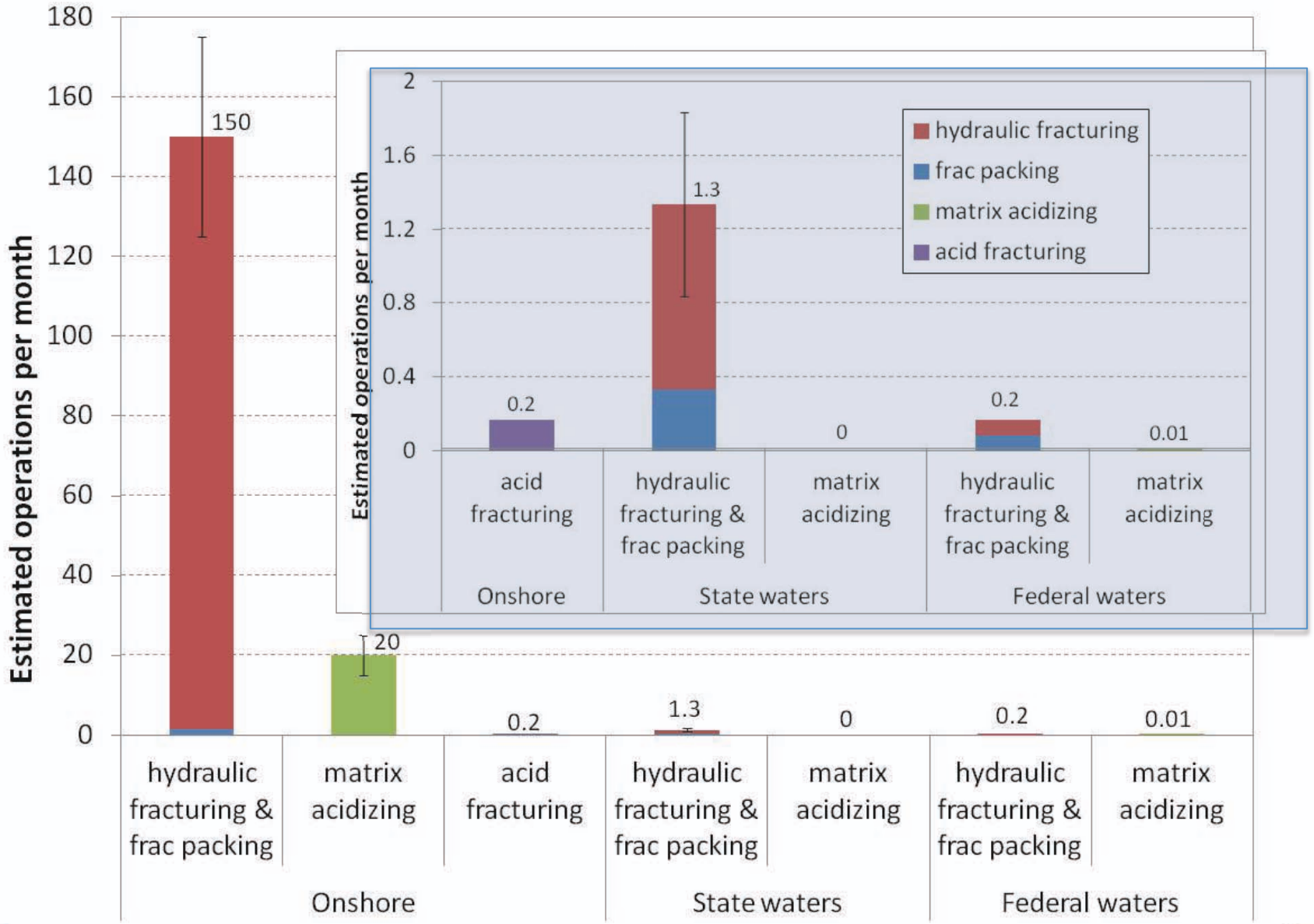
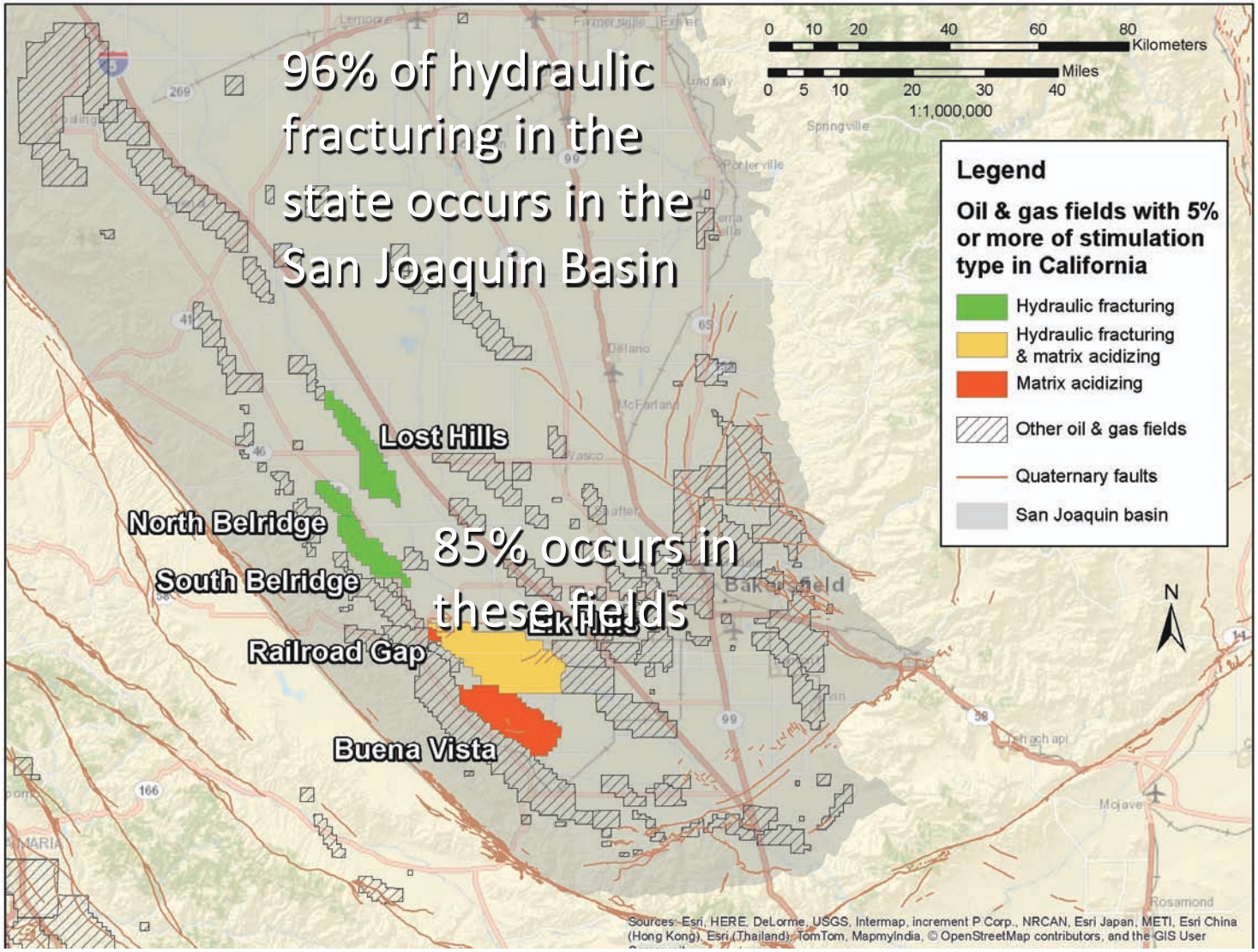


# Nearly all hydraulic fracturing and matrix acidizing occurs in six fields in the San Joaquin Valley



# Logistics Limit Hydraulic Fracturing From Federal Offshore Platforms

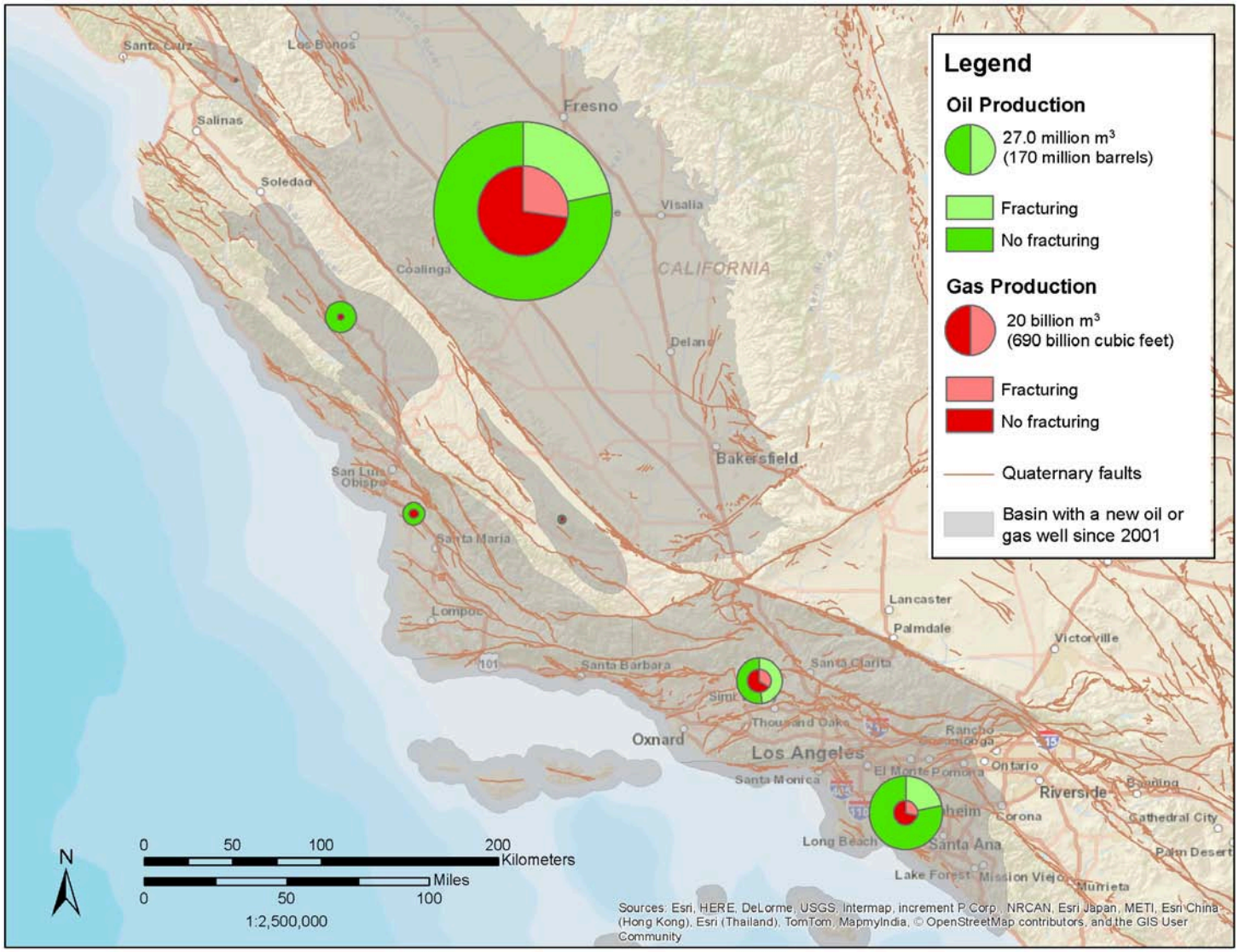
Production from man-made islands in State waters uses frac-packs and hydraulic fracturing similarly to onshore usage in the same reservoirs

Offshore fields tend to have, on average, higher permeability than onshore, favoring frac-packs and matrix acidizing treatments

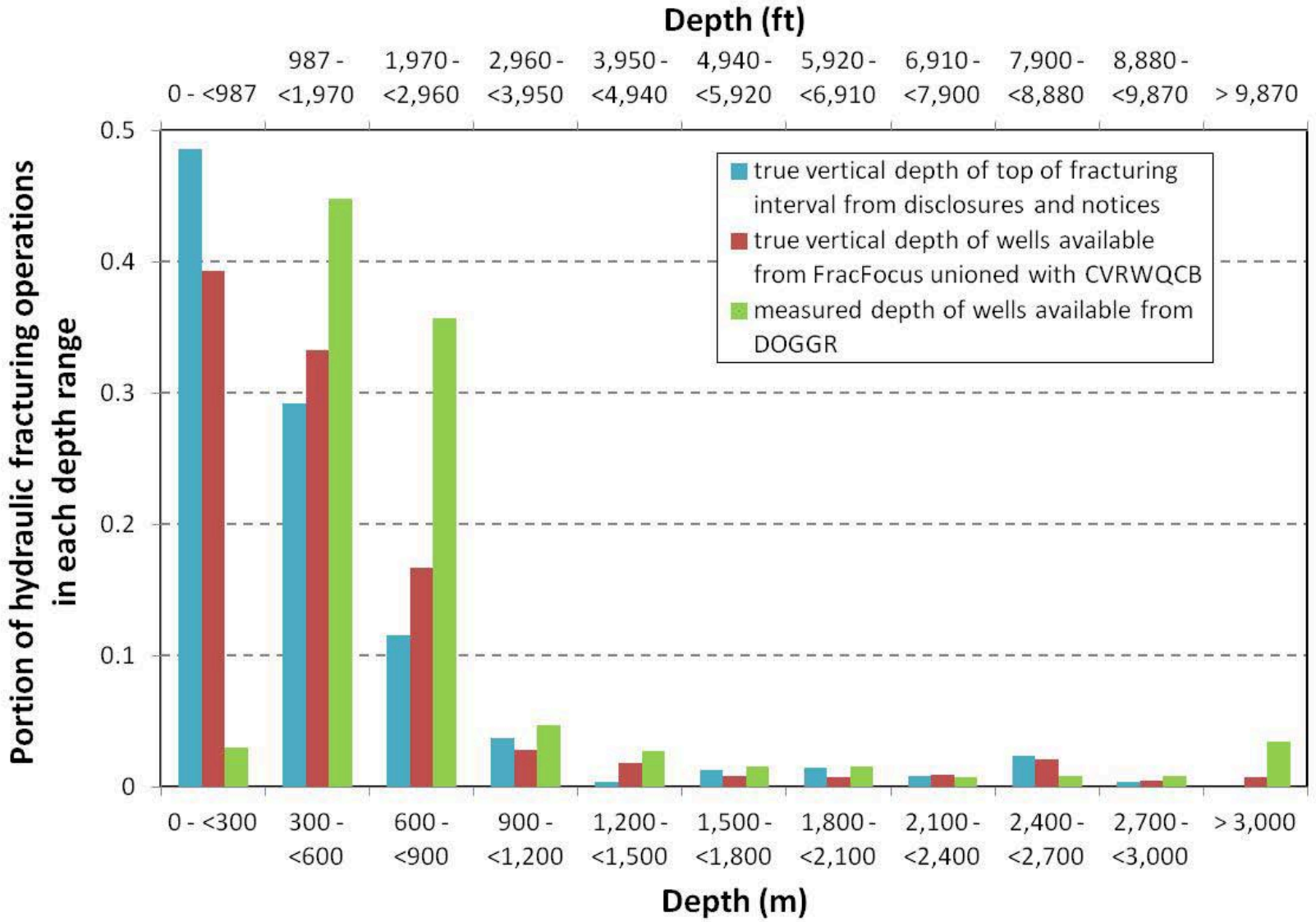
# Natural Gas

- 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**

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



# Fracturing Depth



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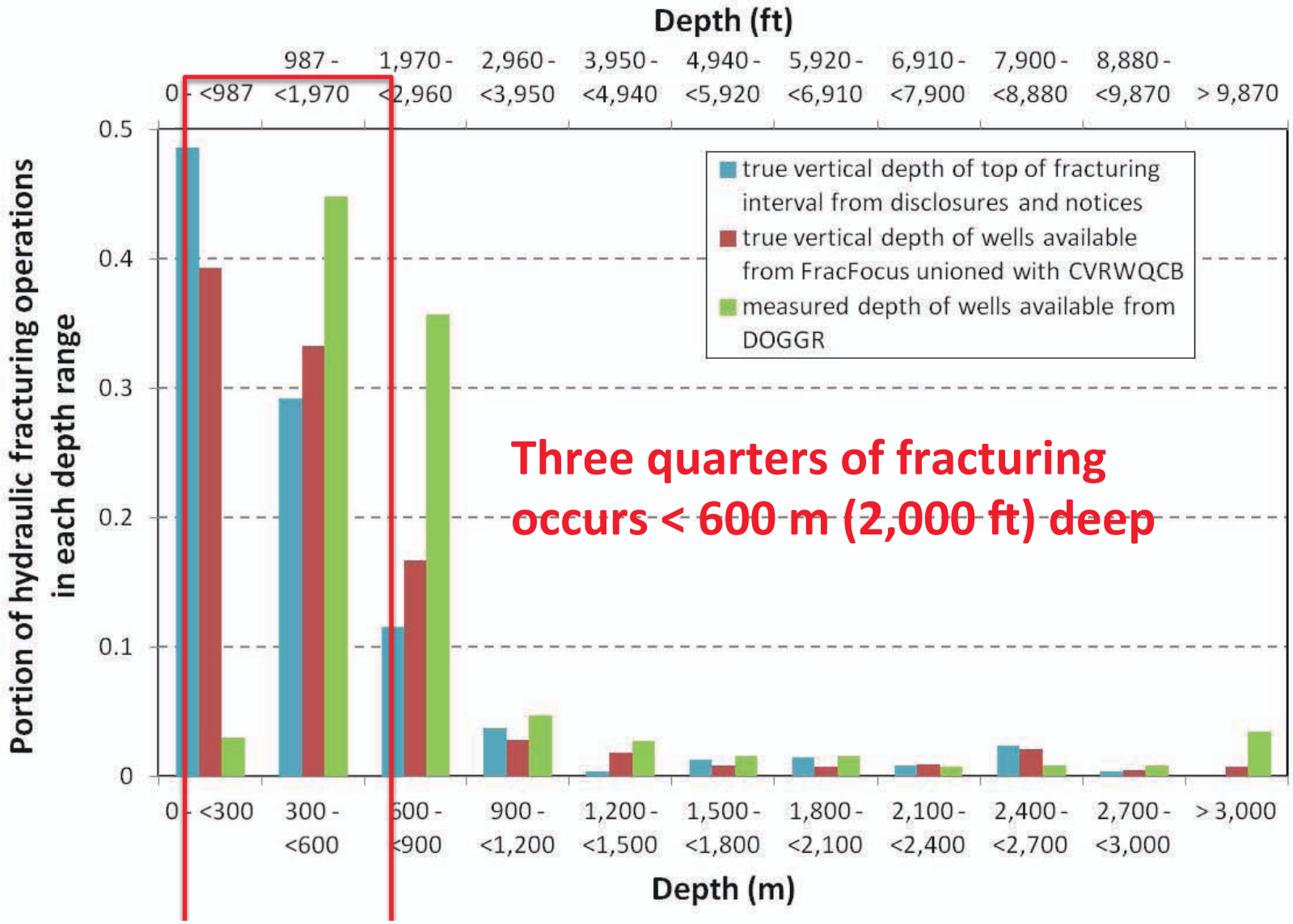
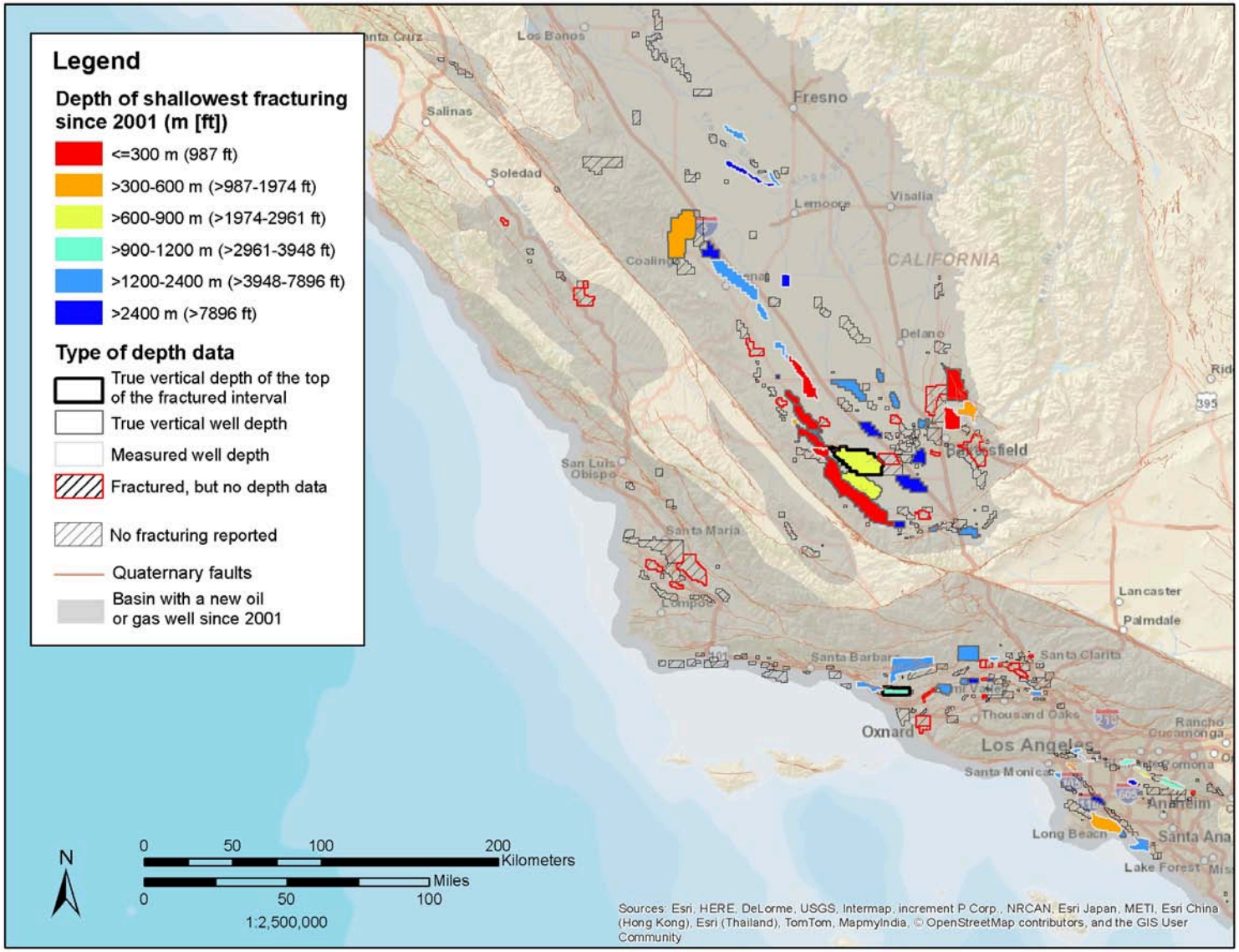


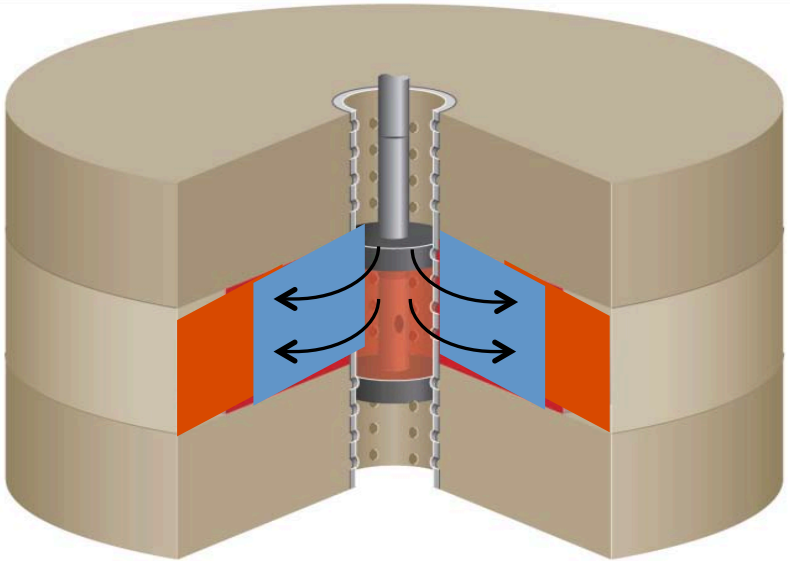
# Shallowest Depth By Field



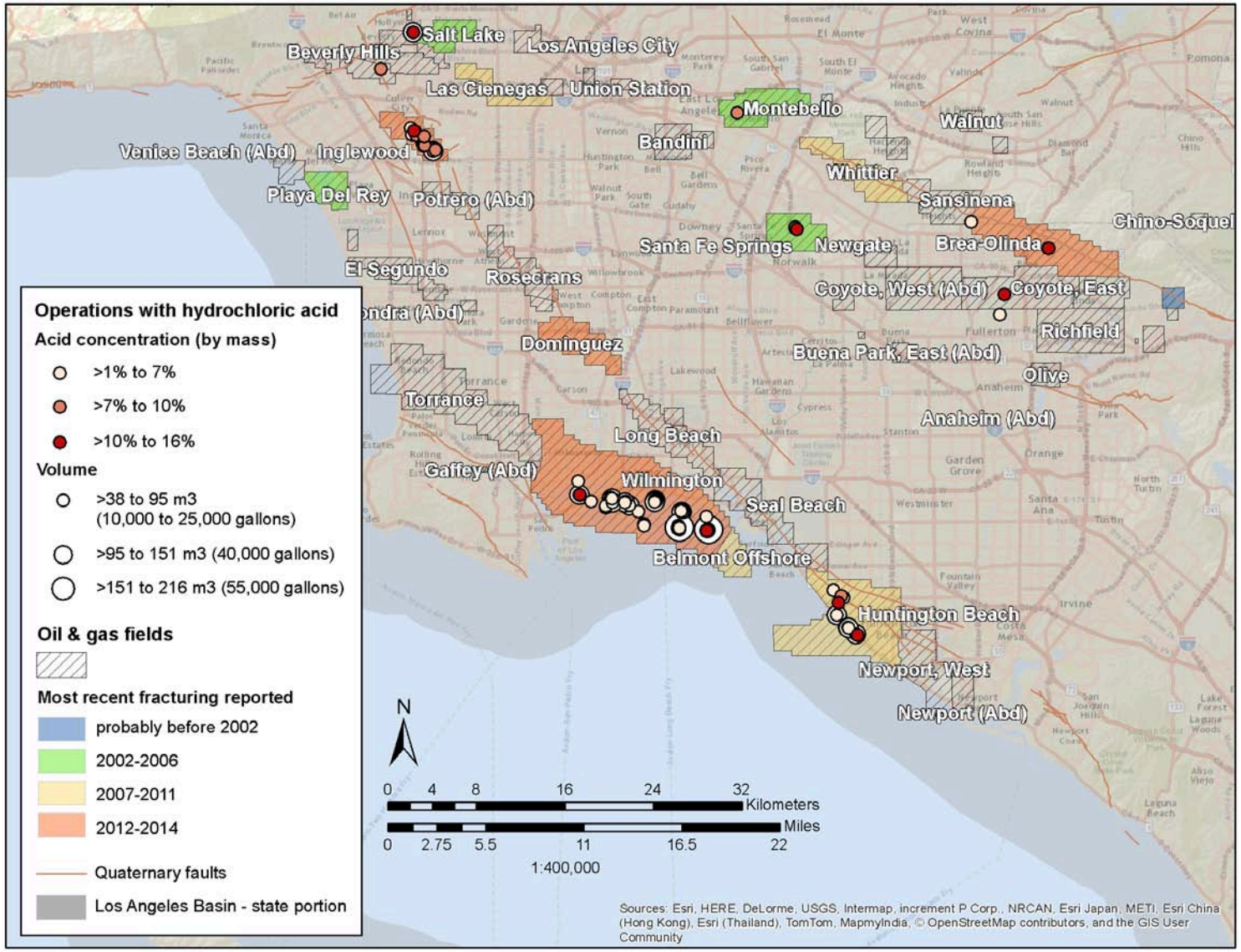
# Matrix Acidizing Process in California

HCL and HF injected into sandstone to enlarge pores in the rock and increase flow of oil to the well

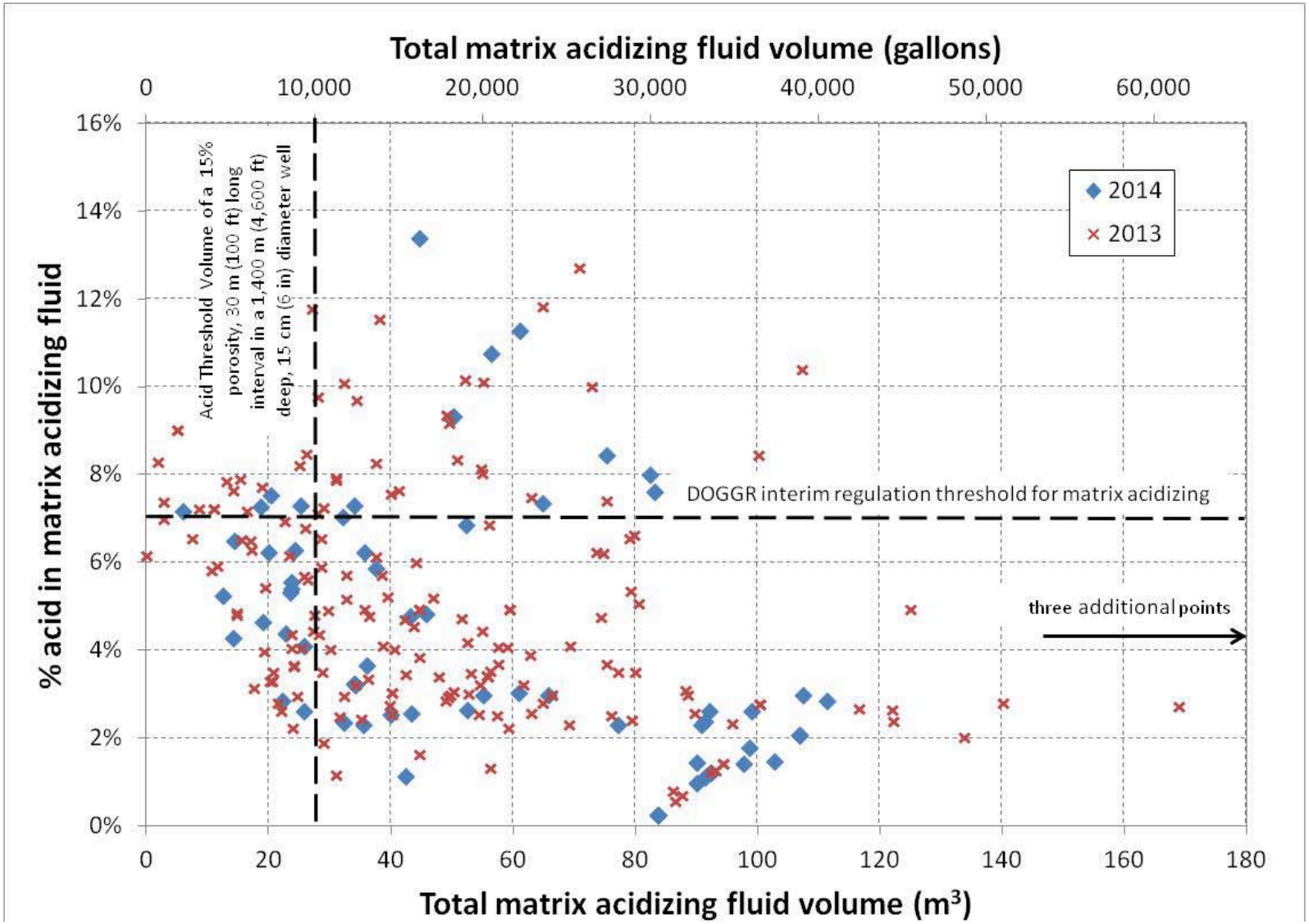
- Frequency of use is about 10% that of hydraulic fracturing
- Will not be a "game-changer" in California
- Smaller amounts of acid are also used for well maintenance



# Los Angeles Basin Acidizing

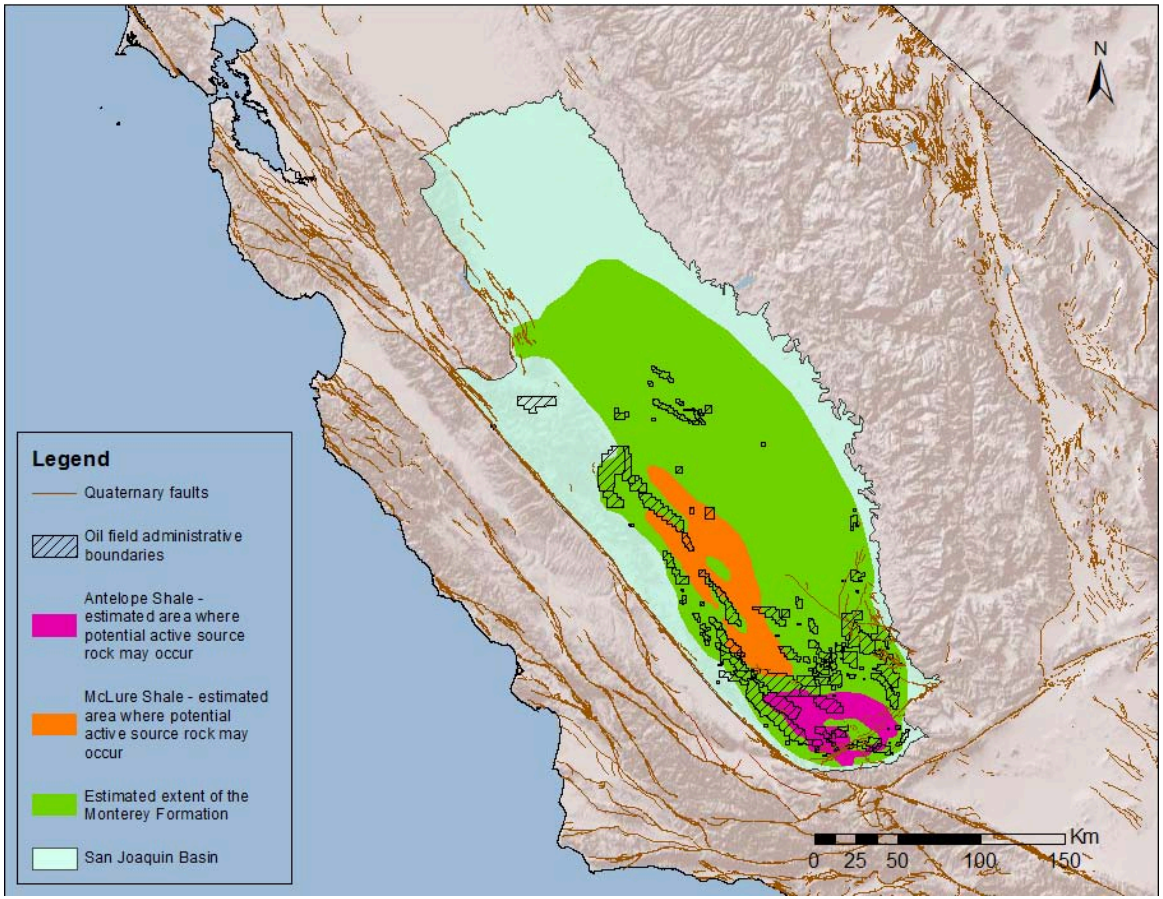


# Definition of Acid Stimulation will give different results: All acid use stimulates the matrix to some extent



# Could WST allow production of unconventional resources?

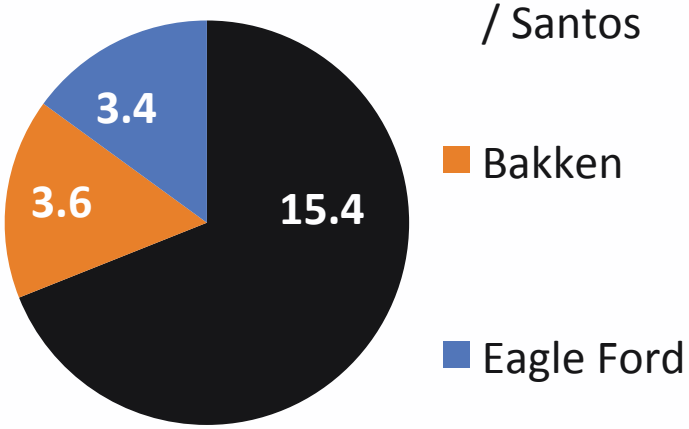
- Unconventional oil in deeper, low permeability **source rocks**
  - Monterey Formation
  - Soda Lake Shale, Vaqueros Formation
  - Tumey Formation
  - Kreyenhagen Formation
  - Moreno Formation




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

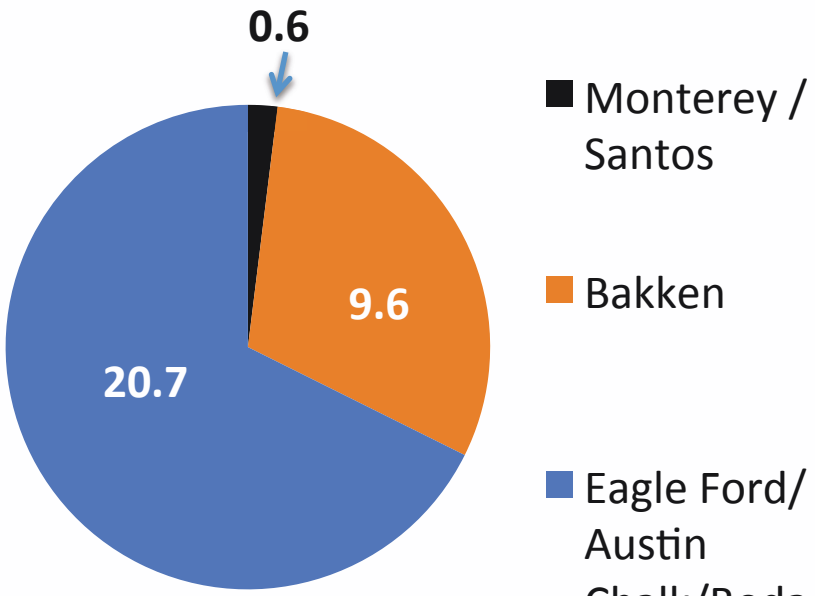
# Energy Information Administration (EIA) Estimates of Technically Recoverable Oil Shale

**EIA/INTEK (2011)**




**22.4 BBO**

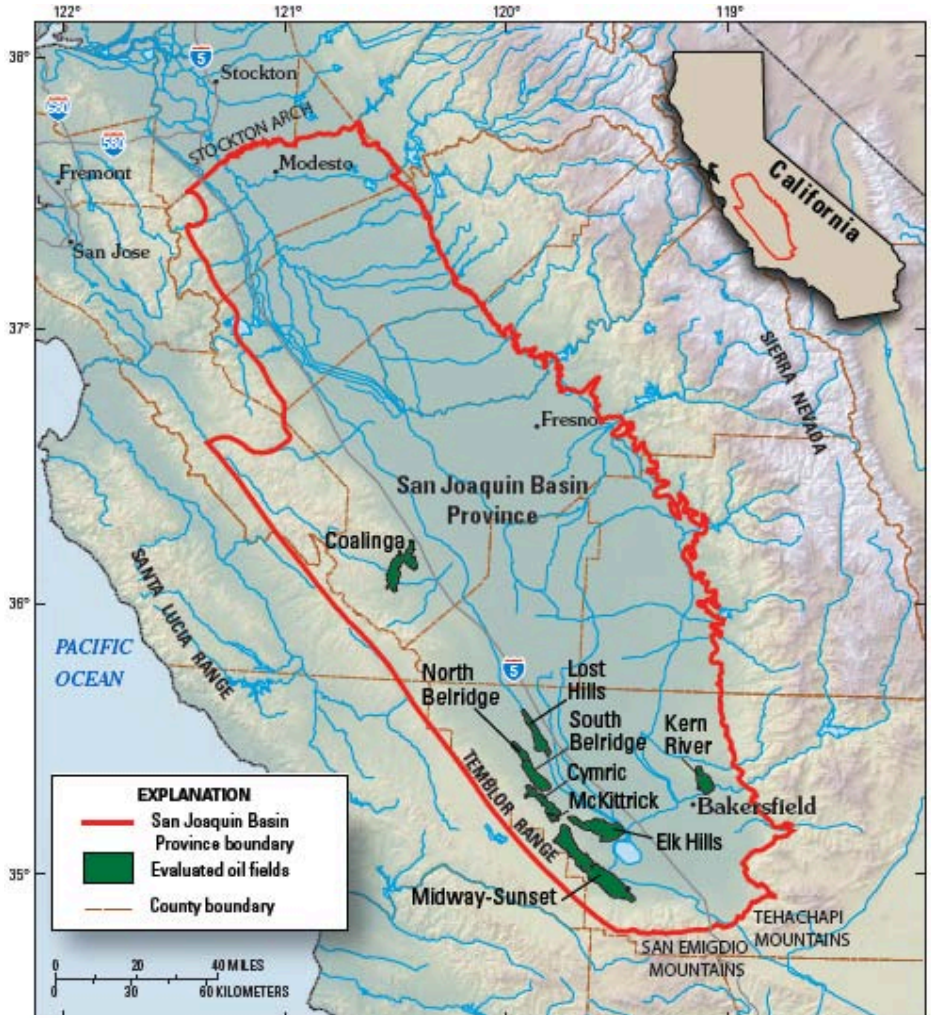
**EIA (2014)**

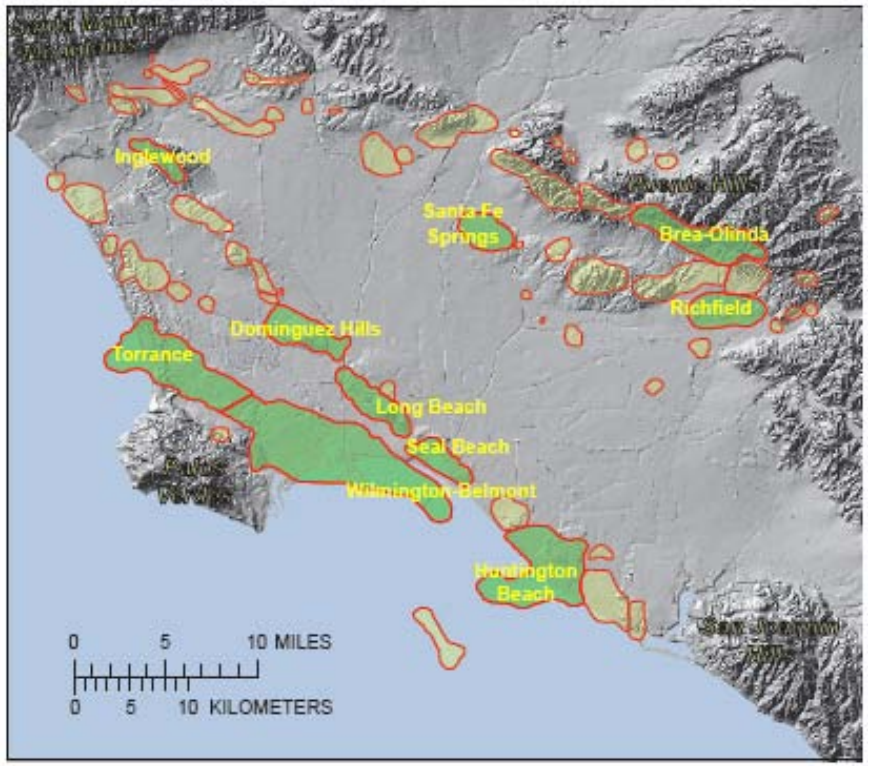



**30.6 BBO**

**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

# Question and Answer Session

We will take questions about the content and process of the scientific study.

Use the “chat” feature to submit questions in writing.

The chat entry box is in the lower left hand corner of your window. Enter a question and click “send.”

If you don’t see the chat box, you may need to click on the “show chat” button in the upper left hand corner.