Using Oil Field Chemical Analyses to Determine Salinity Gradients and the Depth to Underground Sources of Drinking Water in Kern County's Oilfields

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Abstract

The use of well stimulation techniques such as hydraulic fracturing and acidizing to recover remaining oil reserves as well as to unlock new sources of oil and gas from shales has increased in many areas of the country. While this has caused an increase in US oil production and a consequential independence from foreign sources of oil, it has also created great public concern about its potential to negatively impact groundwater supplies. As a result of these concerns, the California legislature passed SB 4 (the so-called ‘fracking bill’) in September 2013. The bill requires the state to identify potable groundwater resources which require protection and develop a monitoring program to protect these resources in areas where hydraulic fracturing occurs.

In the past, oil producers set surface casing to protect the base of fresh water (BFW) which is defined as waters containing less than 3000 ppm total dissolved solids (TDS). However, the US Environmental Protection Agency (EPA) requires state agencies to protect Underground Sources of Drinking Water (USDW). Waters classified as USDW’s have less than 10,000 ppm TDS and are considered to have potential for remediation for agriculture, landscaping and industrial uses. In this study we examine data from geochemical analyses in oil and water wells in order to determine the depth to USDW’s in various oilfields throughout Kern County, California. The depth to the base of the USDW’s is controlled by a number of factors including location, depth and stratigraphy.
Using Oil Field Chemical Analyses to Determine Salinity Gradients and the Depth to Underground Sources of Drinking Water in Kern County's Oilfields
BASE OF FRESH WATER (BFW): < 3000 PPM
UNDERGROUND SOURCE OF DRINKING WATER (USDW): 3000-10,000 PPM

Very little data available for waters with TDS > 1500 ppm
GOALS

USE CHEMICAL ANALYSES TO:

A) DETERMINE THE DISTRIBUTION OF WATER SALINITY AT VARIOUS DEPTHS WITHIN THE BASIN TO IDENTIFY PROTECTED WATERS

B) DETERMINE THE DEGREE OF ACCURACY IN USING GEOPHYSICAL LOGS WHERE ANALYSES ARE UNAVAILABLE
DATA

• DOGGR GEOCHEMICAL ANALYSES—USED FOR DEEPER AQUIFER CHARACTERIZATION (JOSH MEYER)

• SWRCB, USGS, DWR AND KCWA WATER WELL ANALYSES—USED FOR SHALLOW AQUIFER CHARACTERIZATION (STEPHEN ANDERSON)

• GEOPHYSICAL LOG DATA ANALYSIS—CALIBRATED TO GEOCHEMICAL ANALYSES FOR AREAS WITH LITTLE GEOCHEMICAL DATA (DAVID KONG)
~550 scanned analyses from 1927-2014

...entered into spreadsheet

...and GIS database
# DATABASE

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<td>DATE PERFORATED</td>
<td>TDS</td>
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QUALITY CONTROL

• DATE TESTED VS. DATE PERF’D: PREFER A LONG TIME PERIOD BEFORE TESTING TO BE SURE ZONE HAS CHANCE TO “CLEAN UP”

• CHARGE BALANCE-- SHOULD BE +/- 1.5% OR ANALYSIS IS CONSIDERED SUSPECT

• REMARKS—SOURCE OF SAMPLE (DST VS. PRODUCED WATER), SAMPLED BEFORE OR AFTER INJECTION COMMENCED?
QUALITY CONTROL

• DATE TESTED VS. DATE PERF’D: PREFER A LONG TIME PERIOD BEFORE TESTING TO BE SURE ZONE HAS CHANCE TO “CLEAN UP”

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• REMARKS—SOURCE OF SAMPLE (DST VS. PRODUCED WATER), SAMPLED BEFORE OR AFTER INJECTION COMMENCED?
# CHARGE BALANCE

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</table>
QUALITY CONTROL

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• CHARGE BALANCE-- SHOULDBE +/- 1.5% OR ANALYSIS IS CONSIDERED SUSPECT

• REMARKS—SOURCE OF SAMPLE (DST VS. PRODUCED WATER), SAMPLED BEFORE OR AFTER INJECTION COMMENCED?
Chemical Analysis Data 3D
LINEAR BEHAVIOR WITH DEPTH... 😊
LINEAR BEHAVIOR WITH DEPTH... 😊

Wheeler Ridge

\[ y = 2.7453x + 9434.6 \]

\[ R^2 = 0.618 \]
EXPONENTIAL BEHAVIOR WITH DEPTH 😞
EXPONENTIAL BEHAVIOR WITH DEPTH 😞

Edison

TDS

depth

- Chanac
- Santa Margarita/Fruitvale
- Nozu
- Olcese
- Jewett
- Vedder/Pyramid Hill
- basement
NON-BEHAVIOR WITH DEPTH.... 😞
NON-BEHAVIOR WITH DEPTH.... 😞
OLCESE OFTEN SALINE ON EAST SIDE
OLCESE OFTEN SALINE ON EAST SIDE

Kern River

Edison

- Chanac
- Santa Margarita/Fruitvale
- Olcese
- Vedder
- Famoso

- Chanac
- Santa Margarita/Fruitvale
- Nozu
- Olcese
- Jewett
- Vedder/Pyramid Hill
- basement
TULARE IS OF MOST CONCERN ON WEST SIDE
TULARE IS OF MOST CONCERN ON WEST SIDE

Cymric

South Belridge

TDS

depth

Tulare
Etchegoin
Reef Ridge
Carneros
Phacoides
Oceanic

Tulare
Tulare/diatomite
Antelope
Reef Ridge
DO TDS VALUES CHANGE WITH TIME IN STEAMFLOODS?
DO TDS VALUES CHANGE WITH TIME IN STEAMFLOODS?

Potter TDS vs. time—Midway-Sunset

Tulare TDS vs. time-Cymric
WHERE WE NEED LOG ANALYSIS…
WHERE WE NEED LOG ANALYSIS...

All samples too saline

All samples too fresh

….and wherever we don’t have enough chemical analyses to draw conclusions
LOG ANALYSIS