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Stratigraphic and structural controls on groundwater salinity variations in the Poso Creek Oil Field, Kern County, California, USA

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S1. *Produced water samples*

Some of the total dissolved solids (TDS) data from Dataset A were not used in the TDS model for one of four reasons. 1) The sample was taken from a holding tank with produced water from many wells and therefore the exact location was unknown. 2) The sample was taken after injection occurred in that well and altered its original conditions. 3) Nearly all the resistivity data collected (Dataset B) are from the early 1960s and represent natural TDS conditions, not modern, post-injection conditions. Therefore, the TDS sample was omitted if the sample date was from the modern era (>1980) or unknown. 4) The TDS model systematically overpredicted TDS samples under 650 mg/L. It was assumed 650 mg/L was approximately the lower limit of the TDS model capabilities and samples less than 650 mg/L were removed. Note the TDS model predictions under this amount may have more associated uncertainty. However, TDS below 650 mg/L should not have any impact on model interpretations. Available TDS measurements from

shallower groundwater wells in the study area (Metzger et al. 2018) were all below the 650 mg/L threshold and thereby were not used in the TDS model.

Figures

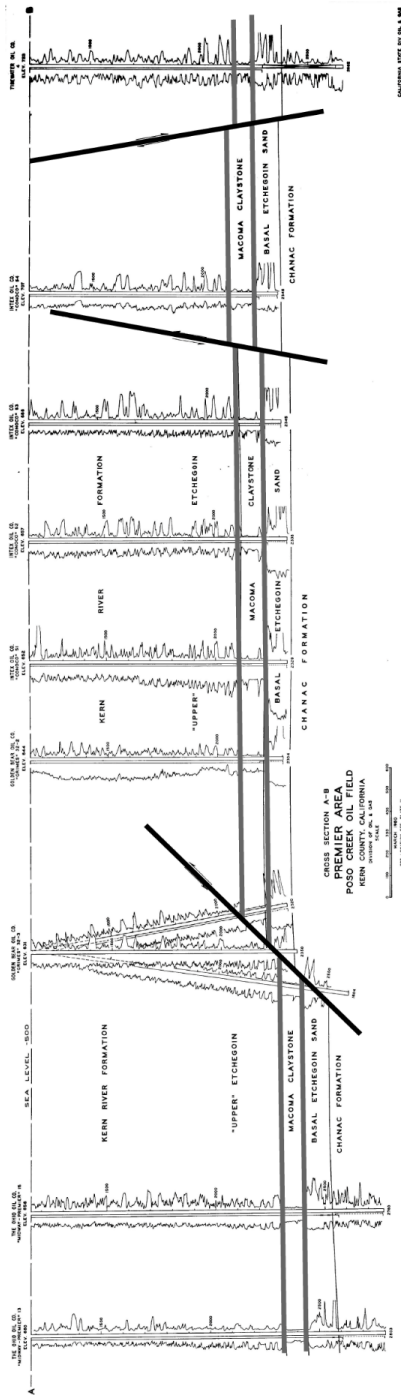


Fig. S1) Geologic cross section with geophysical well logs modified from Weddle (1959), location shown on Fig. 1. The Macoma claystone is outlined in gray and the normal faults are bold. The Macoma claystone delineates the overlying aquifer from the oil production zone below. Water disposal occurs in the Santa Margarita Sandstone (shown on Fig.2 and Fig. S2) just below the Chanac Formation.

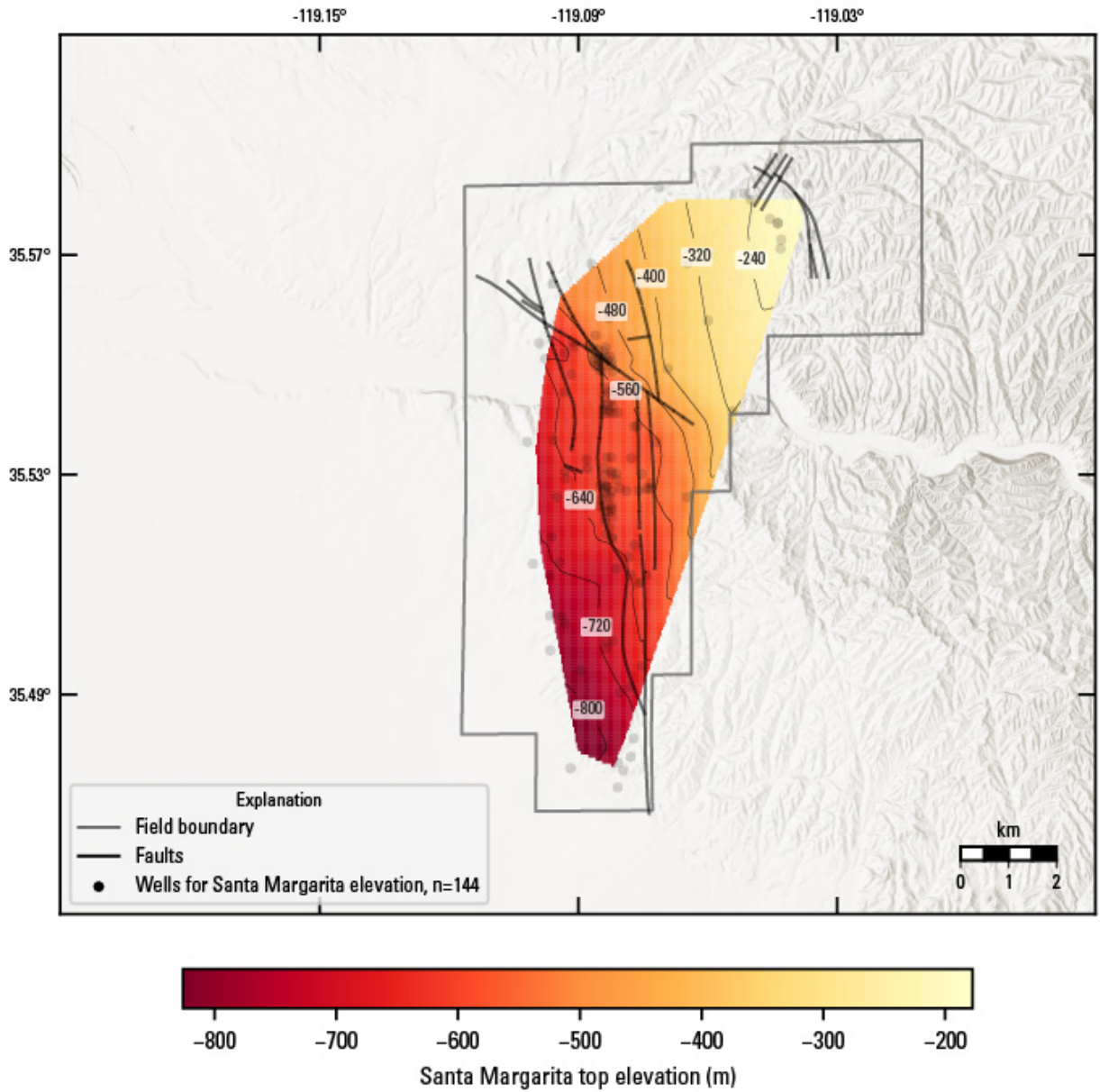


Fig. S2) Map showing the elevation of the top of the Santa Margarita Sandstone in the Poso Creek Oil Field area. This formation is predominantly used for produced water disposal. Faults from Weddle (1959), well locations and field boundary data from CalGEM (2019c), background from ESRI.

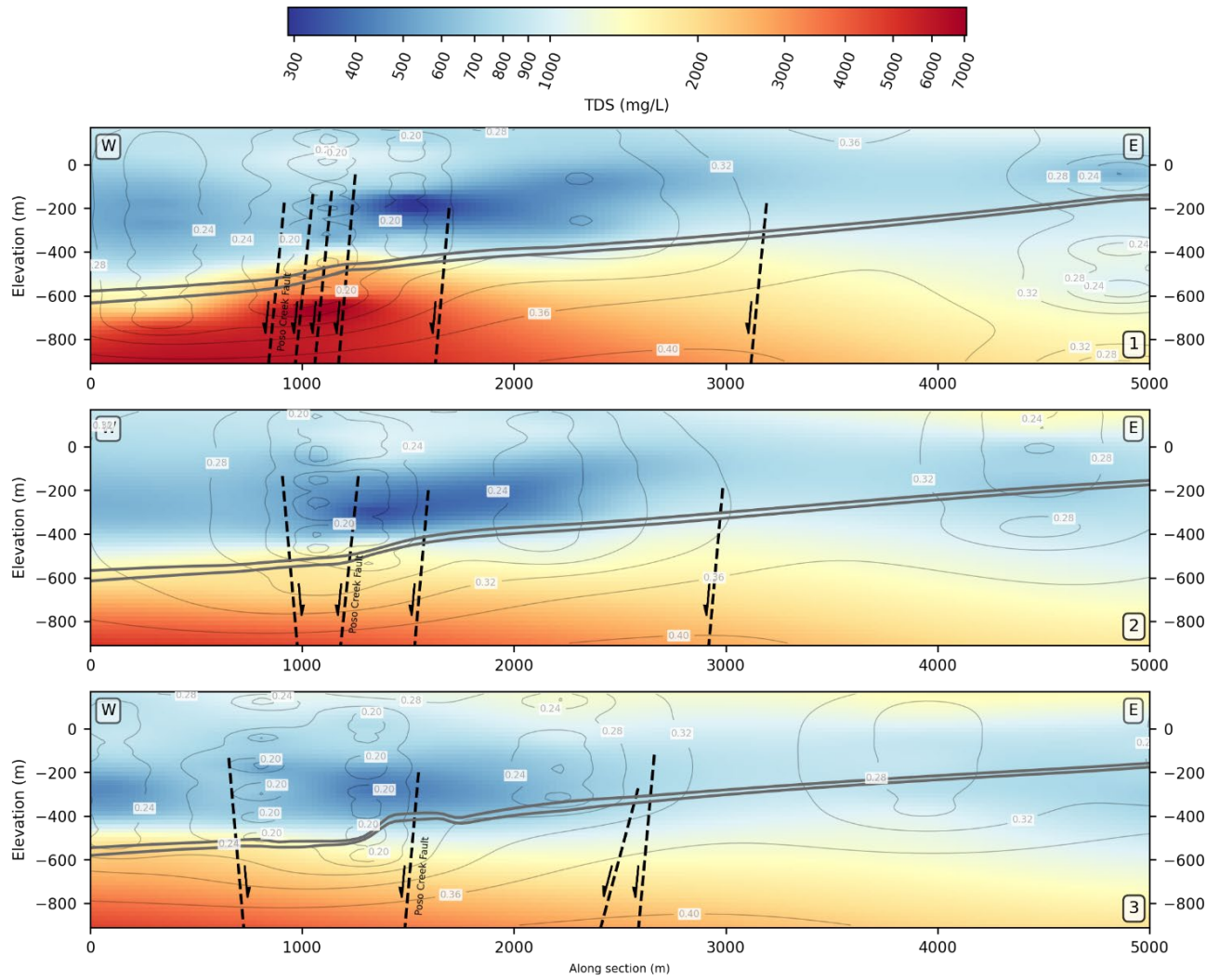


Fig. S3) Total dissolved solids (TDS) cross sections in the Poso Creek fault area with standard deviation (for log TDS) contoured. Uncertainty is lower when TDS estimates are closer to input data points (produced water TDS and formation resistivity). See Fig.1 for cross section locations. There is no vertical exaggeration.

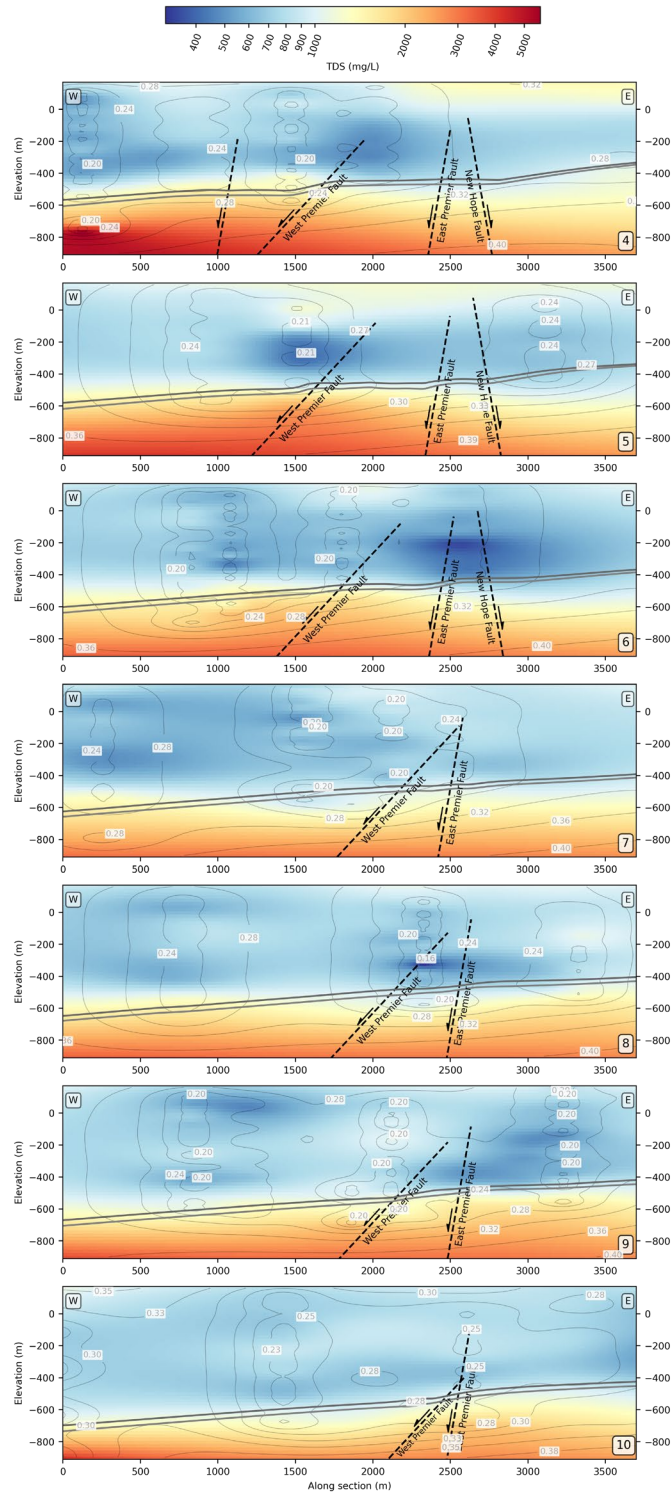


Fig. S4) Total dissolved solids (TDS) cross sections in the Premier fault area with standard deviation (for log TDS) contoured. Uncertainty is lower when TDS estimates are closer to input data points (produced water TDS and formation resistivity). See Fig.1 for cross section locations. There is no vertical exaggeration.

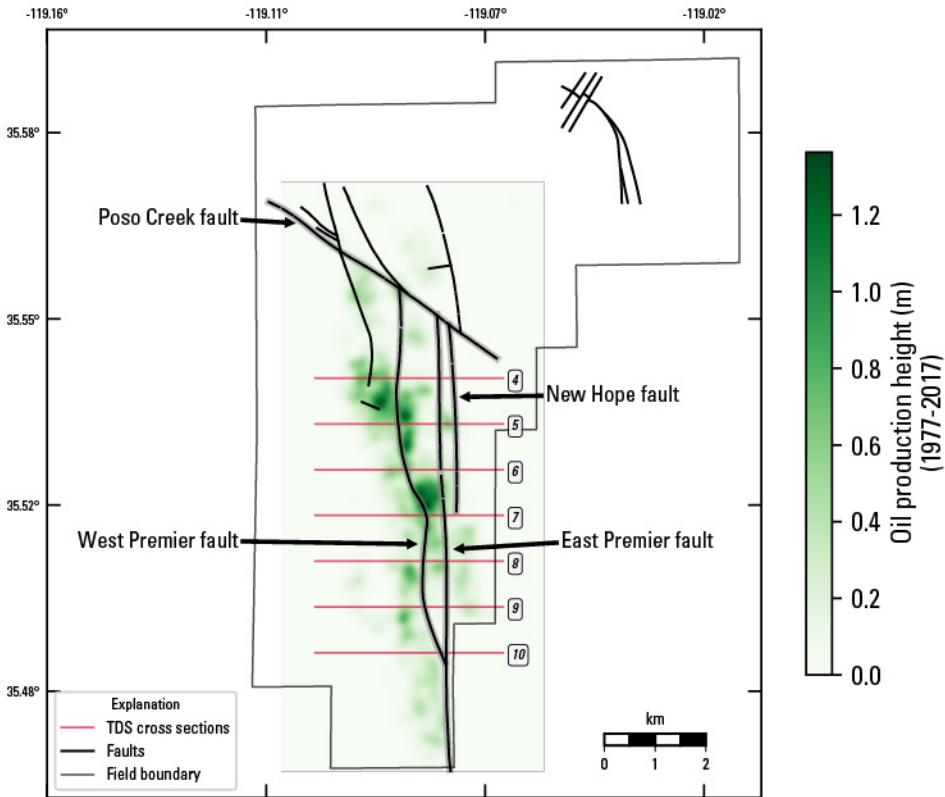


Fig. S5) Oil production map in the Poso Creek Premier area. Cumulative oil production data for each well was smoothed with a 2-D Gaussian function with a width of 100 m; total oil production in an area can be determined through integration. Oil production patterns suggest the West Premier and East Premier faults at least partially trap oil where fault offset is highest (see Fig. 7). Oil production in the McVan area in the northeast part of the field was not included. Data from CalGEM (2019).

ESM References

CalGEM (2019) Well Search. CalGEM, Sacramento, CA.

<https://secure.conservation.ca.gov/WellSearch>. Accessed December 2019

Metzger LF, Davis TA, Peterson MF, Brilmyer CA, Johnson JC (2018) Water and petroleum well data used for preliminary regional groundwater salinity mapping near selected oil fields in central and southern California. US Geol Surv data release.

<https://doi.org/10.5066/F7RN373C>

Weddle JR (1959) Premier and Enas areas of Poso Creek Oil Field: summary of operations 45. California Division of Oil and Gas, Sacramento, pp 41–50