

Hydrogeology of East-Central Union County, Northeastern New Mexico

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New Mexico Tech



AQUIFER
MAPPING
PROGRAM

New Mexico Bureau of Geology & Mineral Resources

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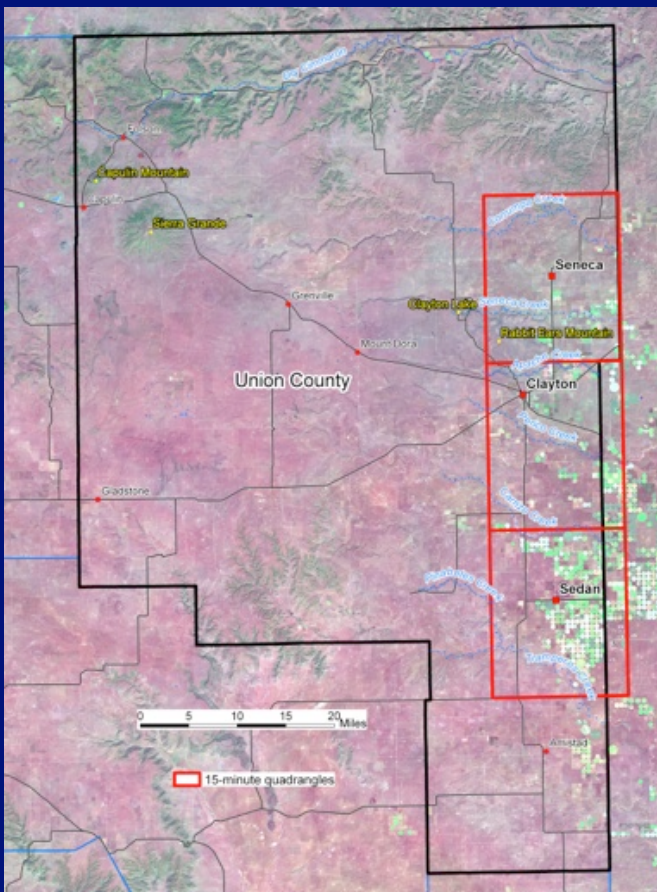
What are the important hydrogeologic issues in Union County?

- ▶ The local economy – irrigated agriculture and ranching – and municipal water supply of Clayton are entirely dependent on groundwater
- ▶ Large water level declines have pitted the Town of Clayton against local irrigators
- ▶ NESWCD desired a regional hydrogeology study to better understand the aquifer

Goals of the present study

- ▶ Characterize the geology of the aquifer – formations, thickness, depth etc.
- ▶ Characterize water level and saturated thickness changes over time
- ▶ Create an aquifer conceptual model utilizing subsurface geology, water level data, and water chemistry and age dating

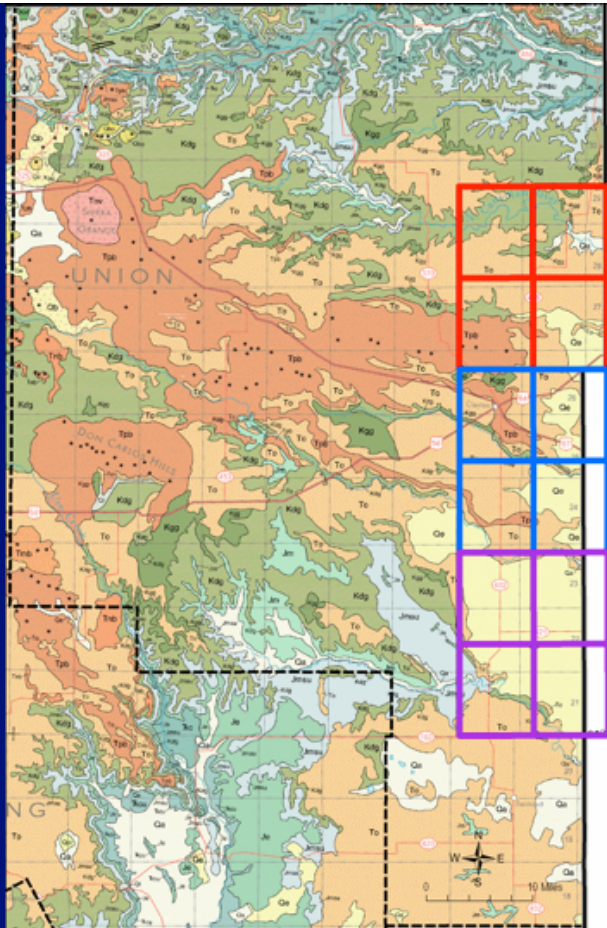
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Study Area

- ▶ Seneca, Clayton, and Sedan 15" quadrangles
- ▶ ~ 720 square miles
- ▶ Encompasses most of the irrigated acreage in the county

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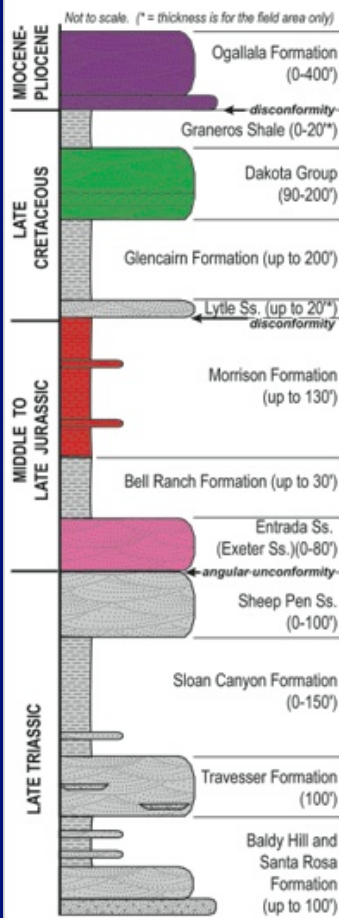


Geology

- ▶ Base from state geologic map
- ▶ Geology in Union County simplified from NMBGMR Bulletin 63
- ▶ Ogallala Formation – light tan
- ▶ Basalt – reddish-tan
- ▶ Cretaceous rocks (Graneros shale Dakota formation, etc) beneath Ogallala – shades of green
- ▶ Jurassic rocks (Morrison and Entrada formations)– shades of blue
- ▶ Revisions for this study by K. Ziegler

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Stratigraphic column



- ▶ Ogallala formation = To
- ▶ Dakota sandstone = Kd
- ▶ Morrison formation = Jm
- ▶ Entrada sandstone = Je

Modified from
K. Zeigler

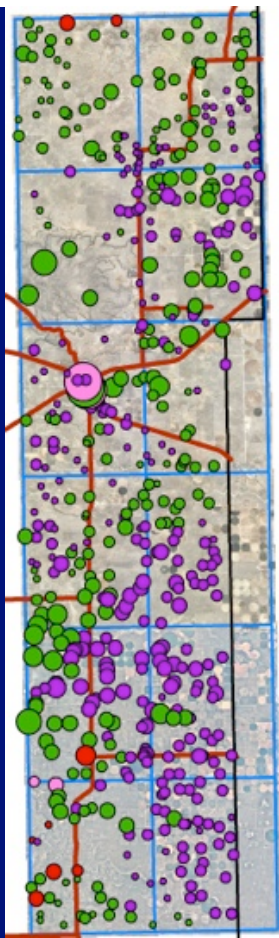
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Ogallala formation / High Plains aquifer



- ▶ Ogallala Formation and underlying hydraulically connected rocks
- ▶ Covers 174,000 mi²
- ▶ To is mostly thin and discontinuous in Union County - underlying rocks are more important as aquifers
- ▶ Previous hydrology work and recharge studies focused on southern High Plains

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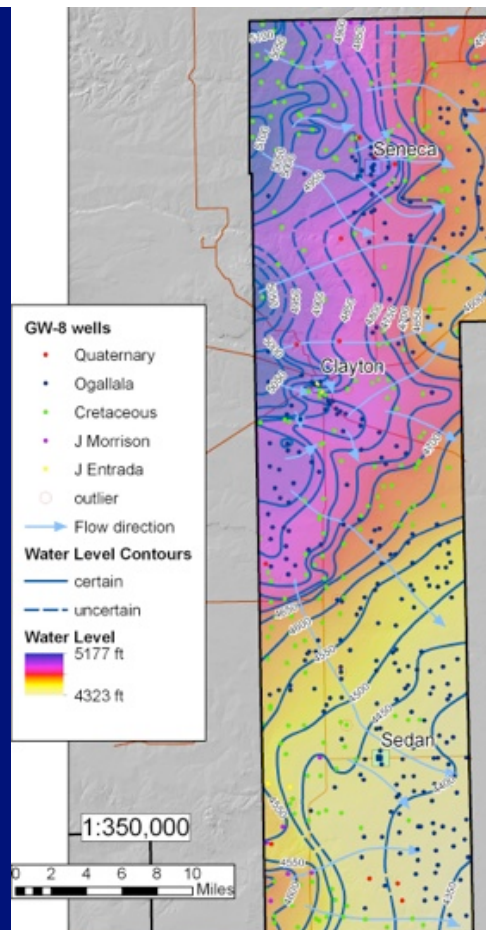
Historic Well Inventory

- ▶ Well information from NMBGMR Groundwater Report 8 (1967)
- ▶ More than 500 wells
- ▶ Purple = Ogallala and Quaternary
- ▶ Green = Cretaceous (mostly Dakota)
- ▶ Red = Morrison
- ▶ Pink = Entrada
- ▶ Symbol size proportional to depth of well (<10 - 800 ft)
- ▶ Used with fewer, more recent well logs, to determine subsurface geology and historic (1954) water table

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Water Table - 1954 Conditions

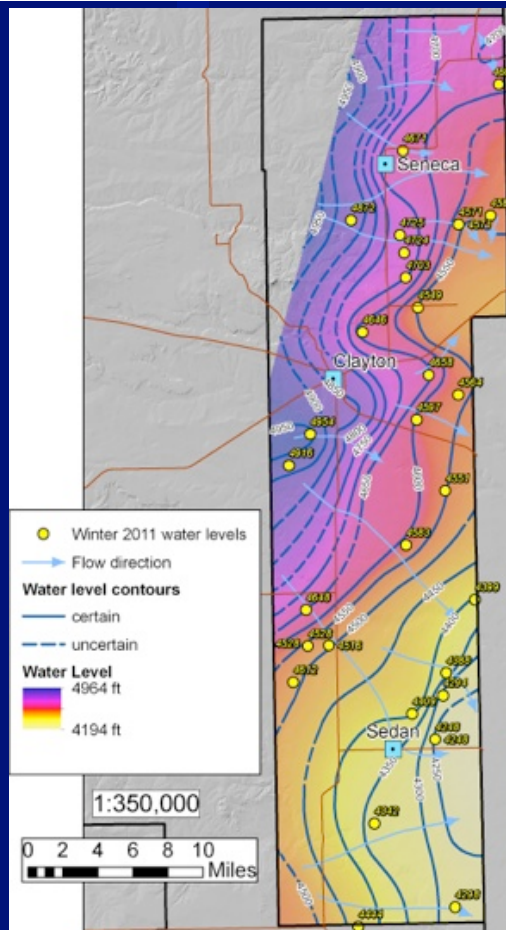
- ▶ Wells from NMBGMR Groundwater Report 8 (1967)
- ▶ Hundreds of water levels
- ▶ Levels corrected to accurate ground surface
- ▶ Blue arrows show inferred flow paths – W to E in the north, NW to SE in the south



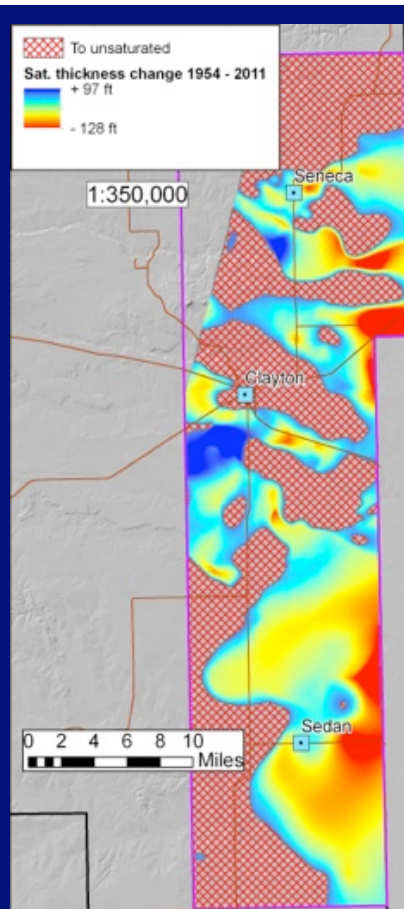
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Water Table - Winter 2011 Conditions

- ▶ Water level data from NESWCD measurements and NMOSE records
- ▶ Minimal data in NW triangular area
- ▶ 32 water levels
- ▶ Blue arrows show modern flow paths – diverted into groundwater basins



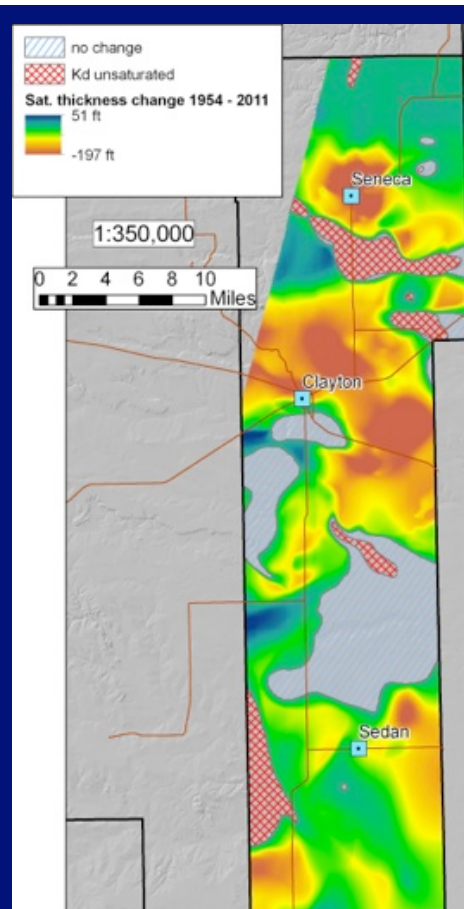
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Saturated thickness changes

- ▶ Change in saturation from 1954 to 2011
- ▶ **Depends on many factors:** original sat. thickness, hydraulic properties and connectivity, amount and location of pumping, recharge (?)

← Ogallala
Dakota →

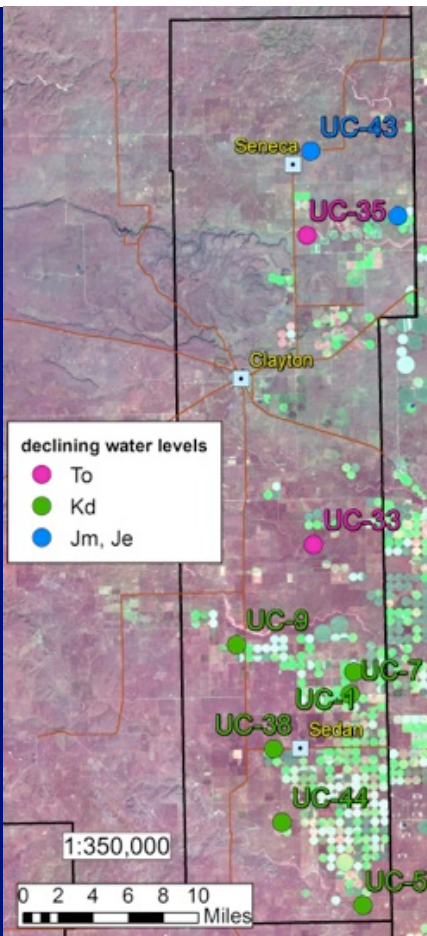


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NMBGMR well database

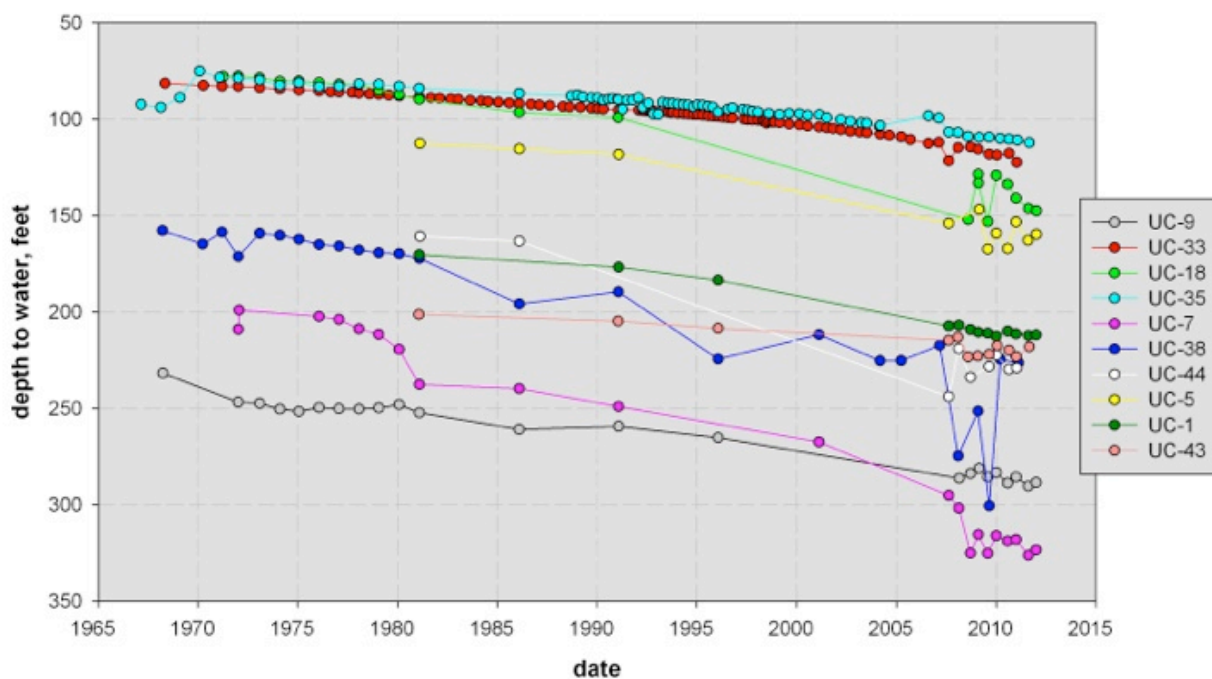
Periodic water levels

- ▶ Wells measured in past by USGS and NESWCD
- ▶ Have water level measurements over many years
- ▶ Some data back to 1960s



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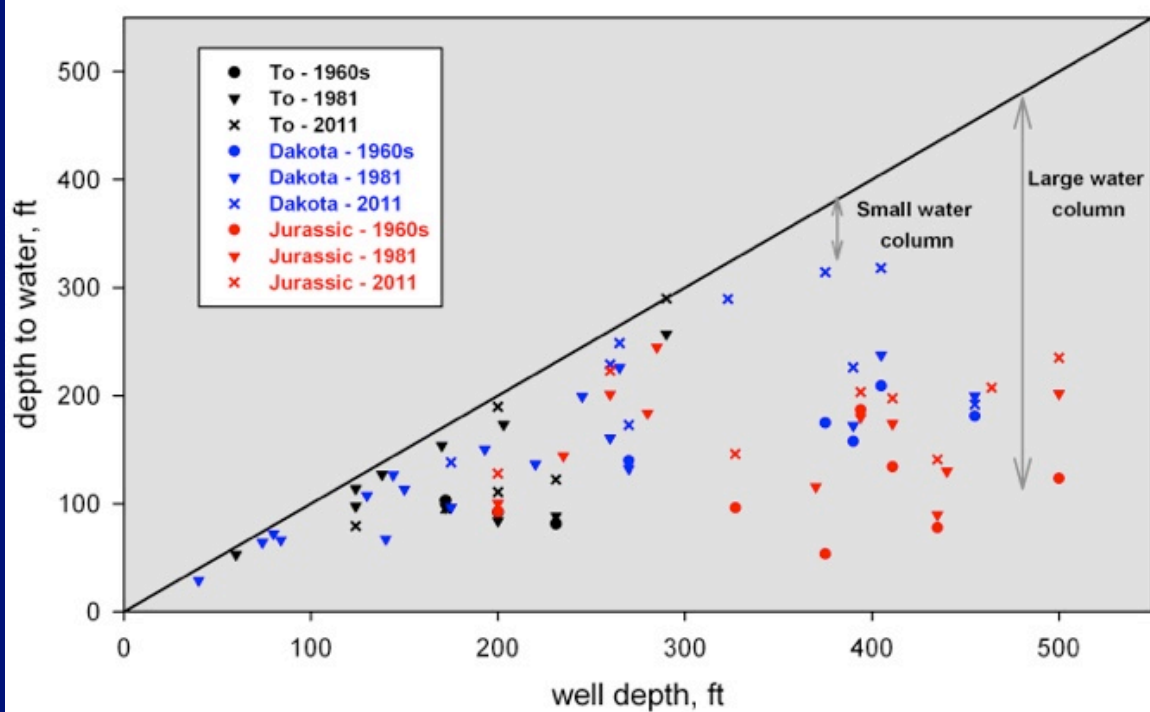
Declining Hydrographs



- ▶ Note the similar, declining, slopes of all the hydrographs, ~ **0.8 - 1.2 ft/yr**

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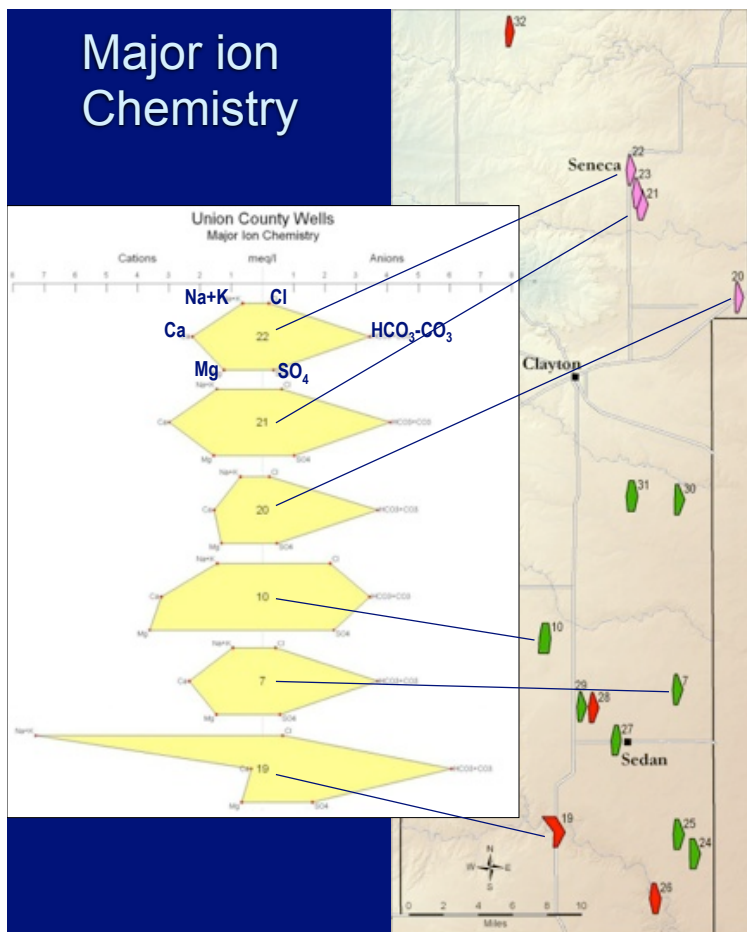
Water levels in different formations



- ▶ Deep J and Kd wbs probably partially confined; smaller water columns over time

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Major ion Chemistry

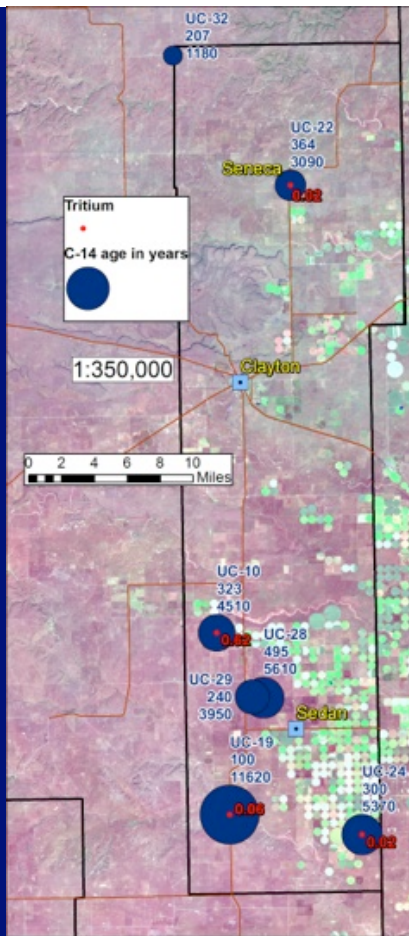


- ▶ **Stiff diagrams:** Shape shows relative amounts, size shows concentration
- ▶ Kd, Jm, Je
- ▶ Most waters are Ca-Mg-HCO₃ ± SO₄; similar across formations
- ▶ UC10 is Mg-Ca-HCO₃-SO₄-Cl
- ▶ UC19 is Na-HCO₃, probable influence of flow through Jm shales – cation exchange; doesn't mix with other waters

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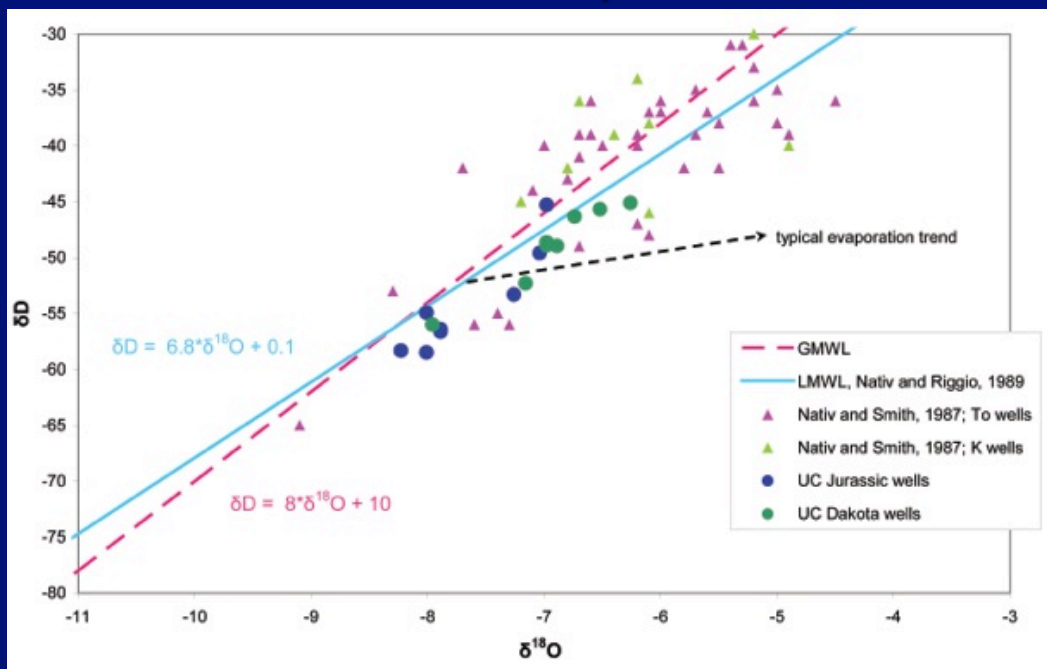
Groundwater Age

- ▶ Sampled wells 100 – 495 ft TD
- ▶ Apparent ^{14}C age and tritium concentrations in TU
- ▶ Tritium essentially zero – older than 1952
- ▶ ^{14}C ages 1180 to 11620 years, youngest in NW
- ▶ Chemical variations not correlated with age / residence time except UC-19
- ▶ Results consistent with geology, hydrographs, and chemistry
- ▶ *No evidence for recent recharge*



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Stable isotopes



- ▶ Recharge processes similar to the southern High Plains– rapid infiltration, little evaporation
- ▶ Where? Playas, volcanic rocks, bedrock streambeds, probably west of study area
- ▶ *But volume/rate is small – many times less than the decline rate of wells.*

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Conclusions

- ▶ Ogallala formation is of minimal importance in Union County, most wells completed in deeper Cretaceous and Jurassic units
- ▶ These rocks form one complex, layered aquifer, with variable hydrologic connections, and increasing confinement with depth
- ▶ No evidence for recent recharge in water level or chemistry data
- ▶ Recharge probably occurs, but at rate much smaller than withdrawals
- ▶ Sampled waters probably recharged west of study area in playas, on volcanic rocks, and in bedrock stream channels and/or pavements

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Acknowledgements

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