Integration of Carbon-14 and Oxygen-18 as a Basis for Differentiating between Pleistocene and Post-Pleistocene Groundwater Ages along Flow Paths in Two West Texas Bolson Aquifers

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Trans-Pecos Sub-Province of Basin and Range Province

Source: Bedinger, et al., 1985

Groundwater Basins of Hudspeth County, Texas

Hueco Bolson

Eagle Flat Basin

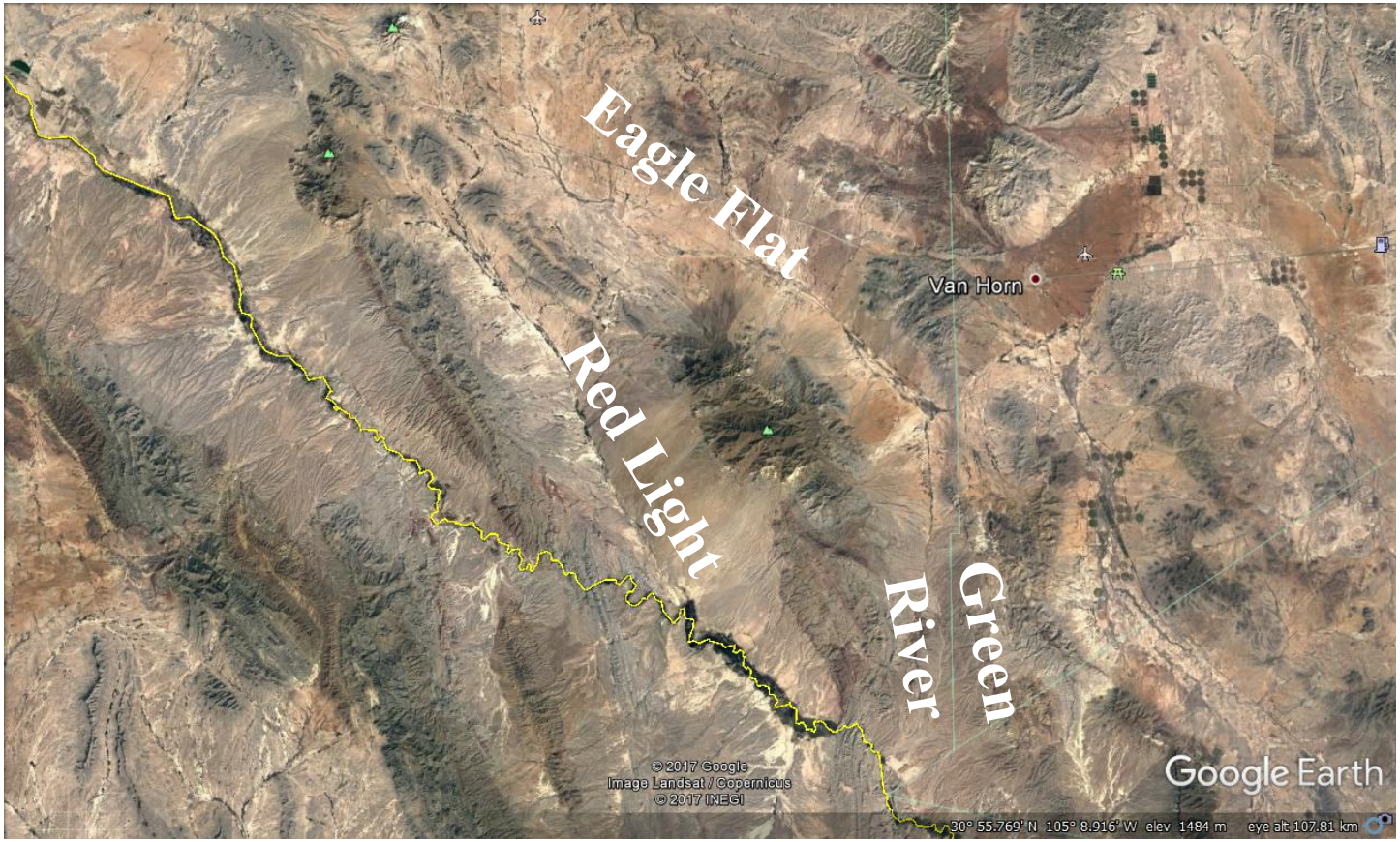
Red Light Draw

Green River Valley

Salt Basin

Diablo Plateau

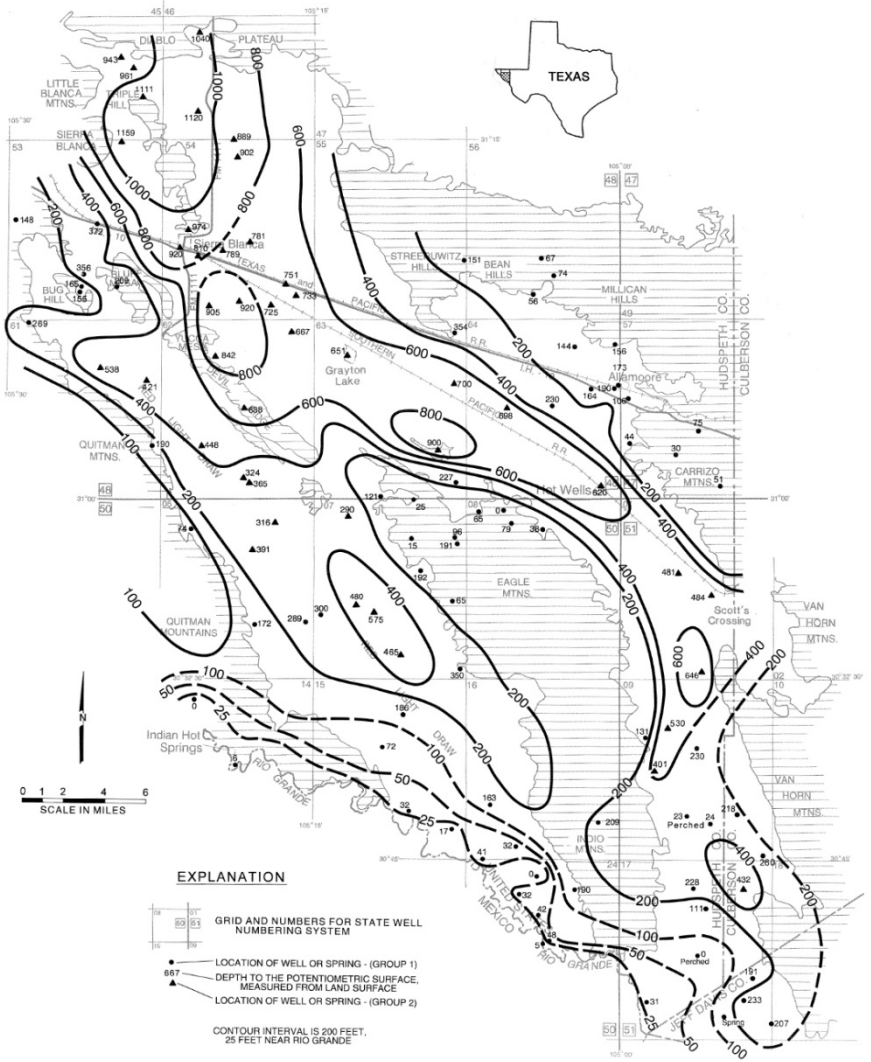
Basins in Area of Investigation



Depth to Groundwater
Feet Below Surface

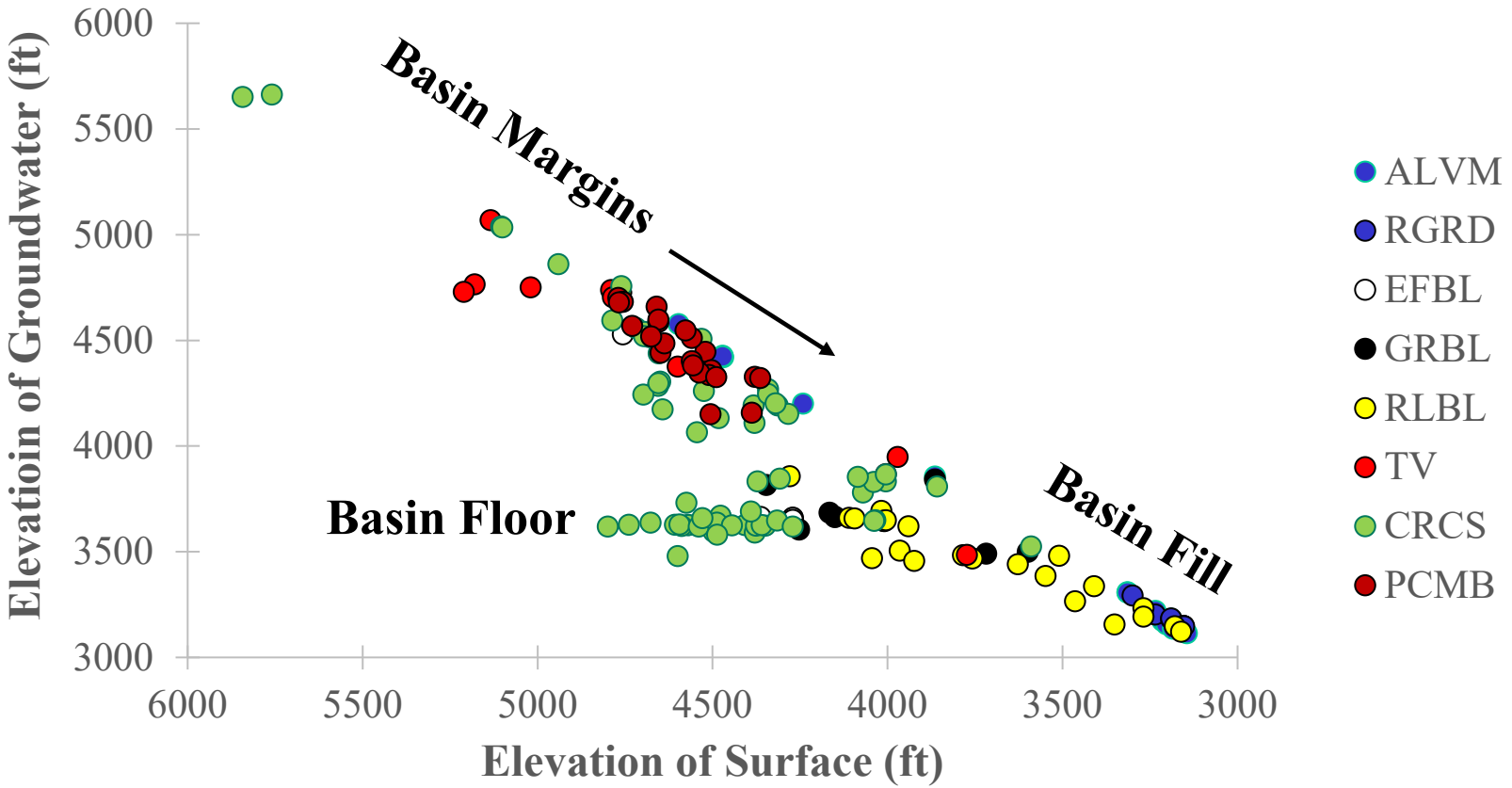
Greatest depths are beneath floor of Eagle Flat Basin (600 to >800 ft) and along the axis of Red Light Draw

The only area of discharge is in southern Red Light Draw, along the Rio Grande



Source: Darling et al, 1994

Elevation of Land and Groundwater Surfaces

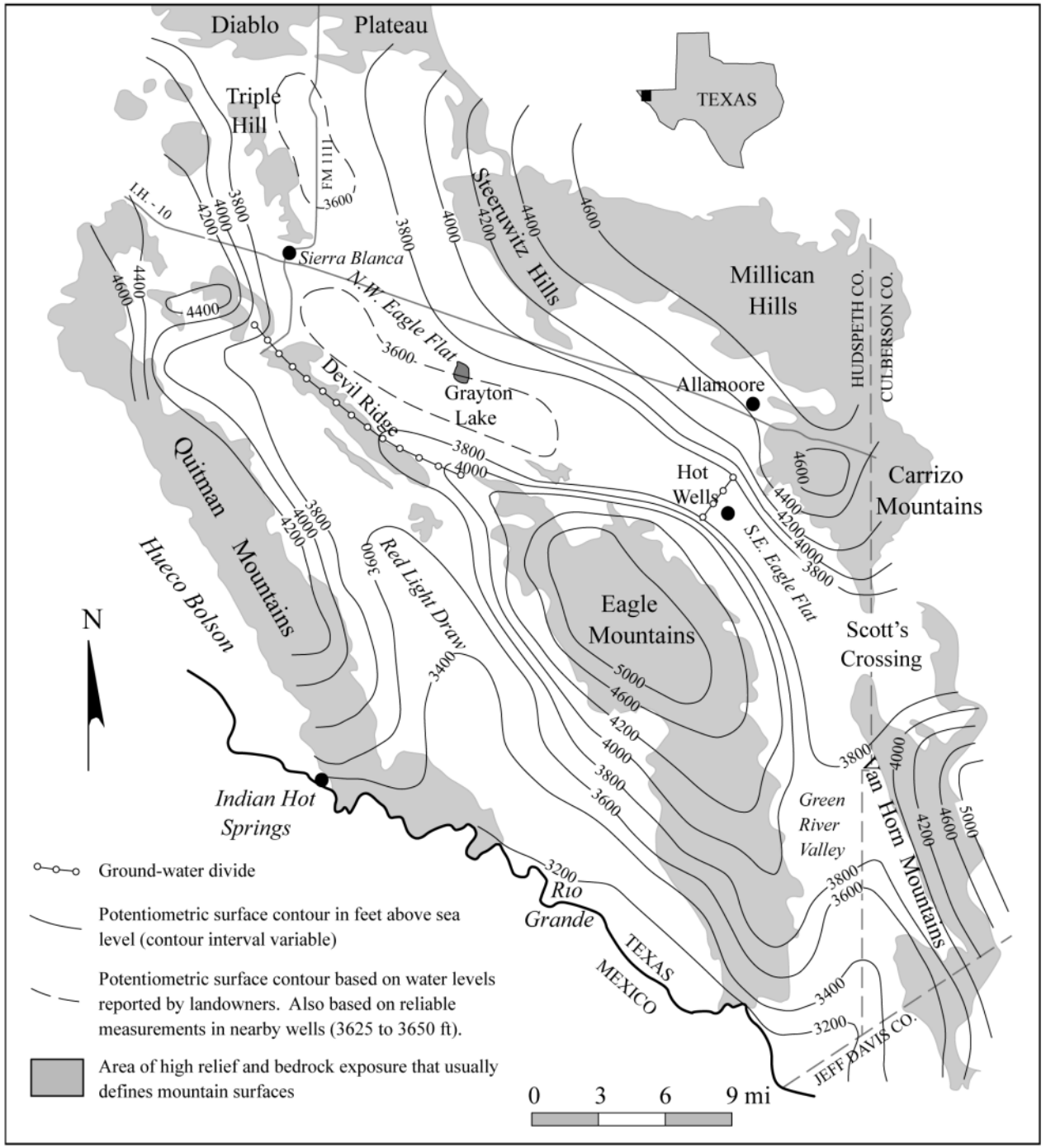


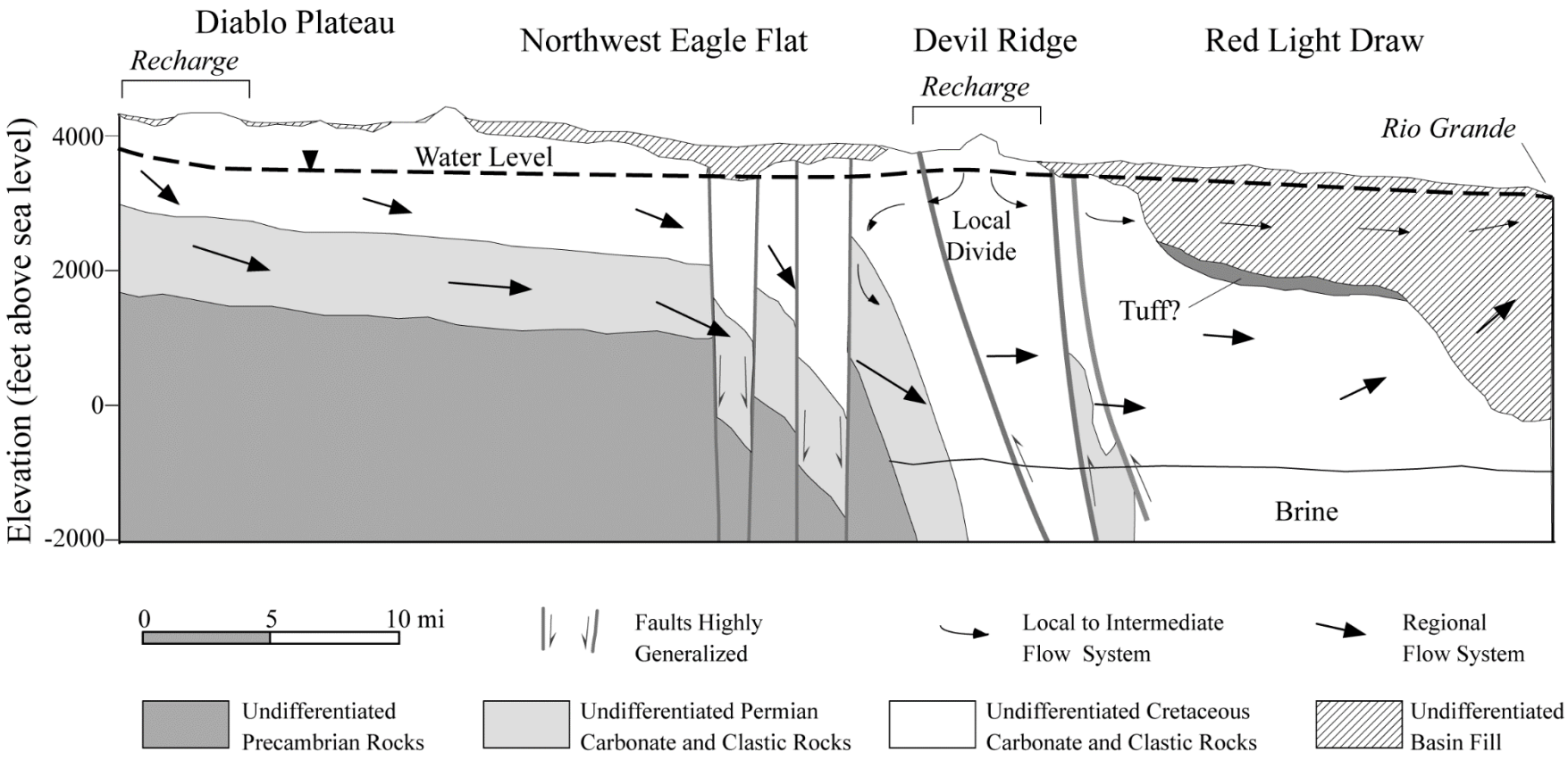
Potentiometric surface water table contours – Eagle Flat, Red Light Draw, Green River Valley and bounding mountains

Closed contours in NW Eagle Flat!

Where does it flow?

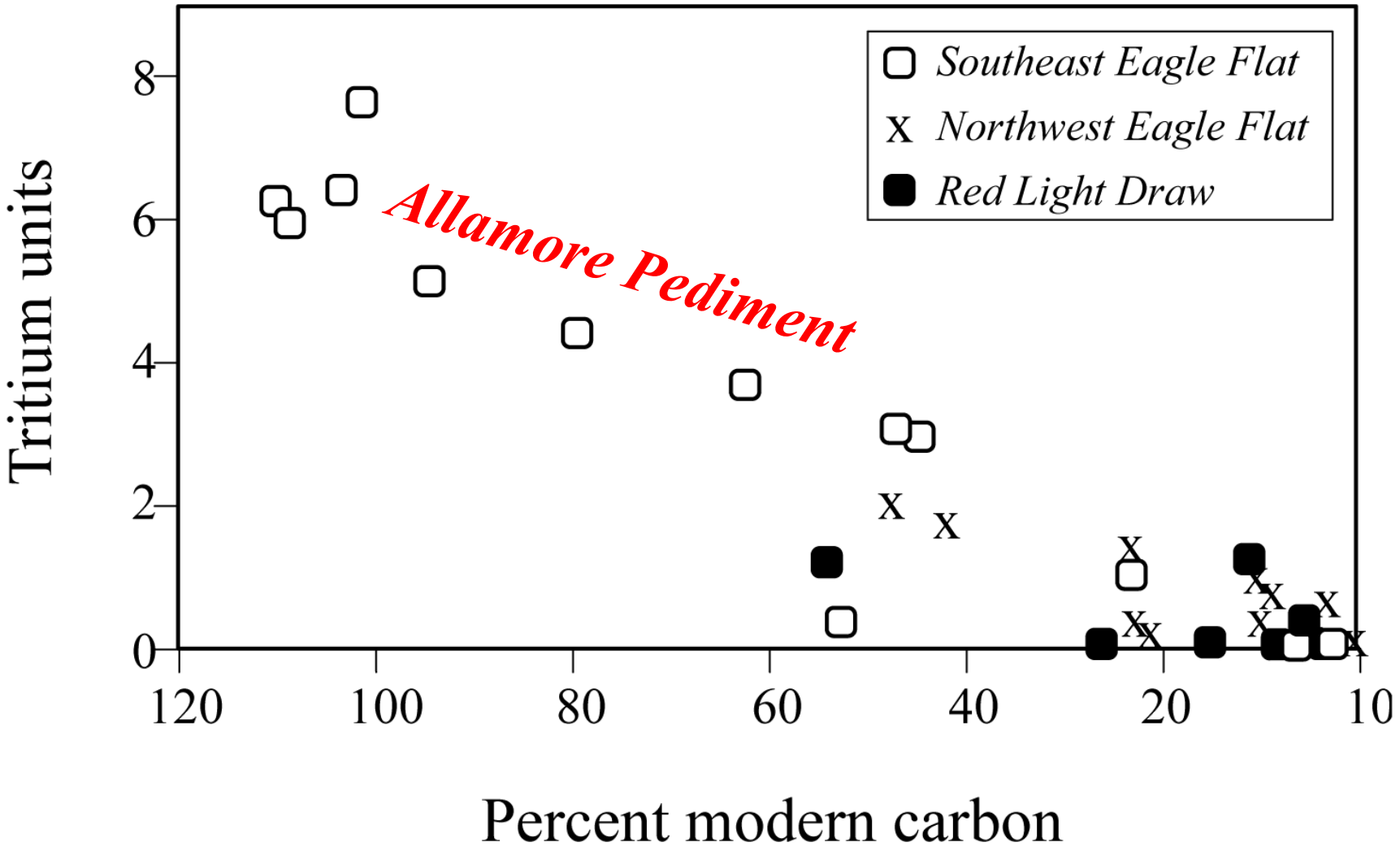
from Darling, 1997, modified from Darling et al., 1994





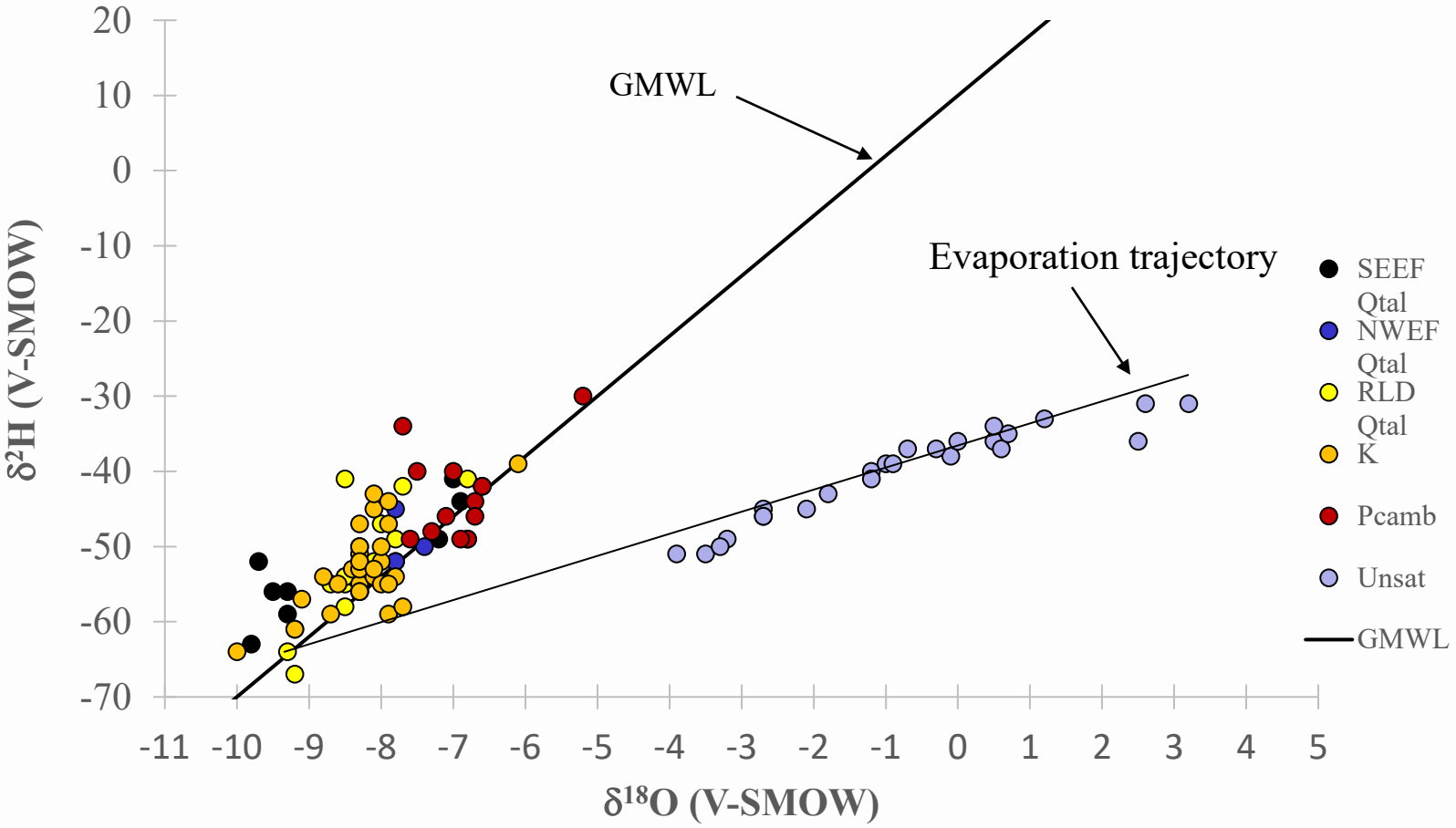
from Hibbs and Darling, 2004

Regional groundwater flow paths may move underneath local groundwater divides if permeable deposits are found at depth – ***source of recharge to Red Light Draw***



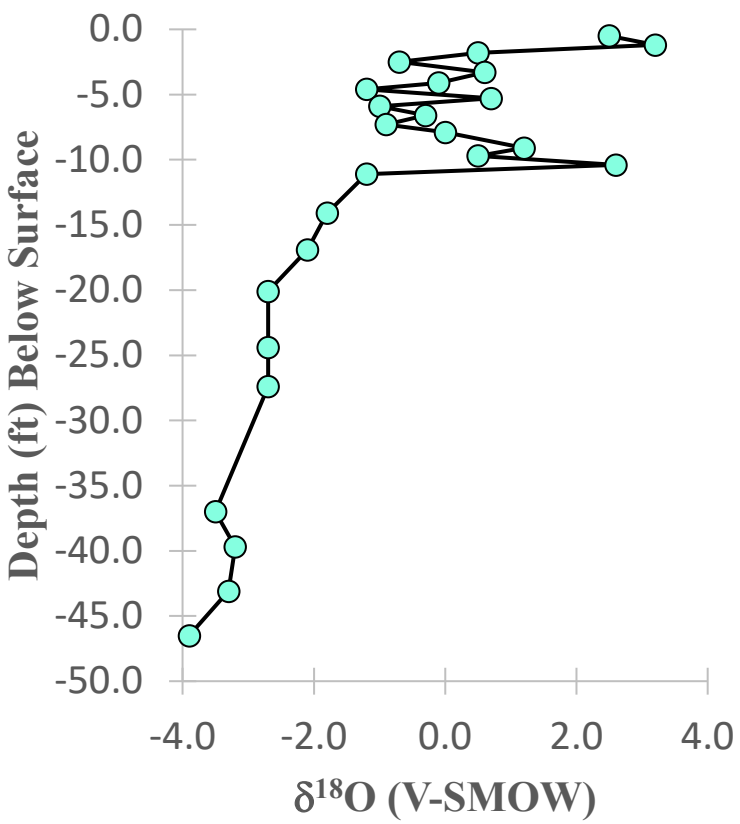
from Darling et al., 1994

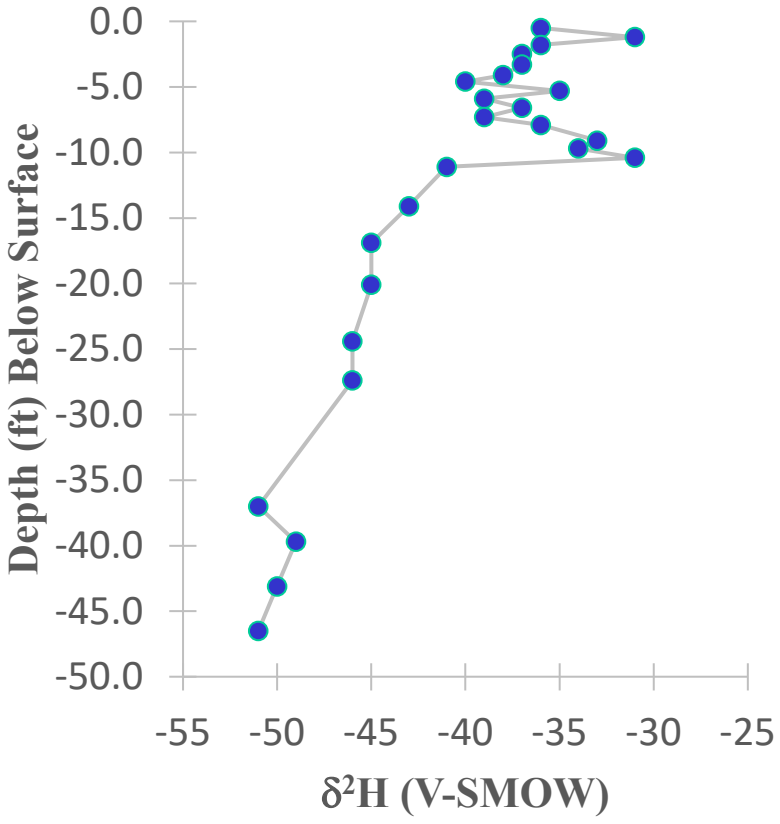
$\delta^{18}O$ and $\delta^{2}H$ – Groundwater and Unsaturated Zone



Source: Darling et al., 1994; Scanlon et al., 1993

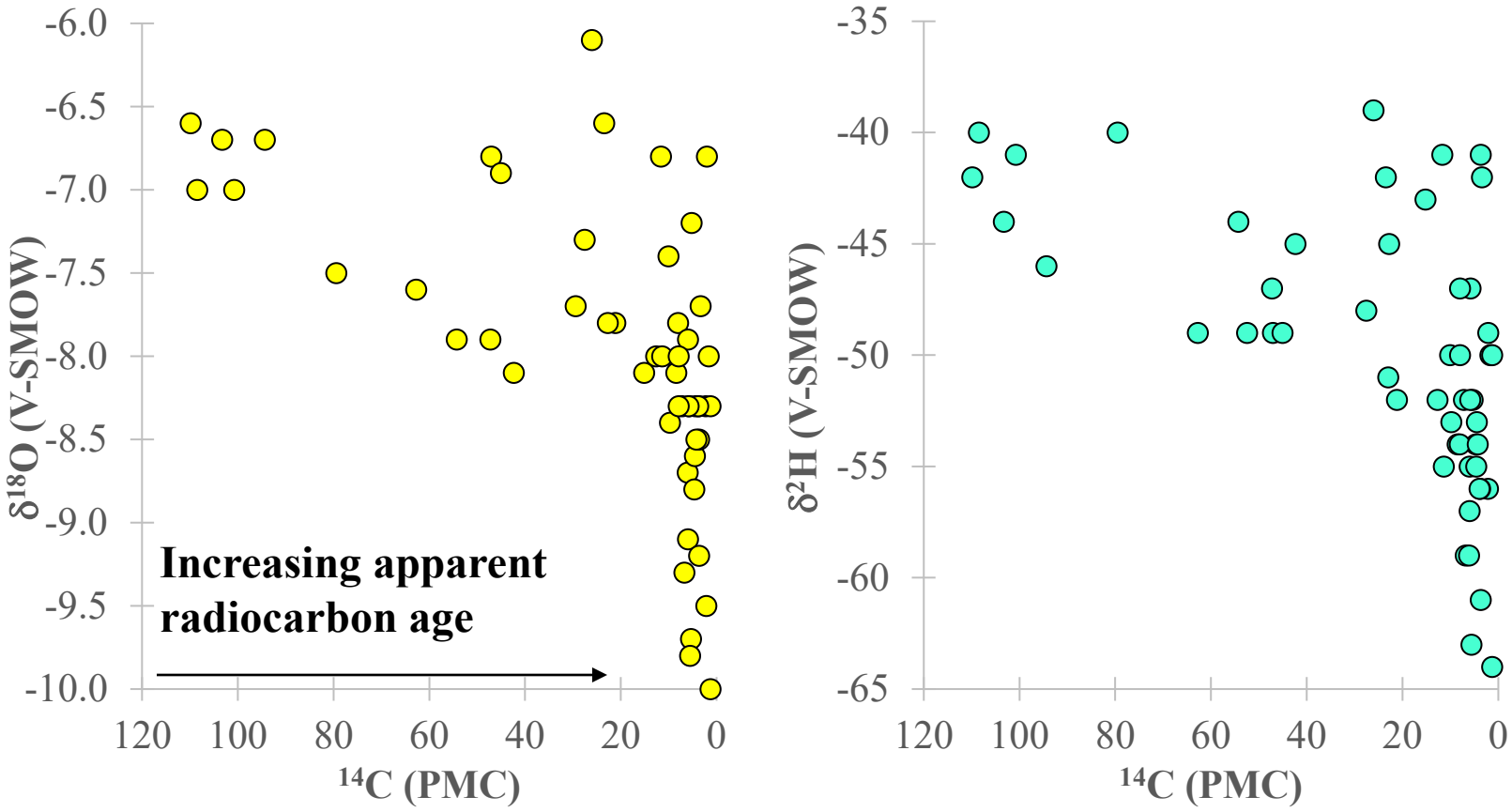
Unsaturated zone profiles of $\delta^{18}O$ and $\delta^{2}H$ – Eagle Flat Basin





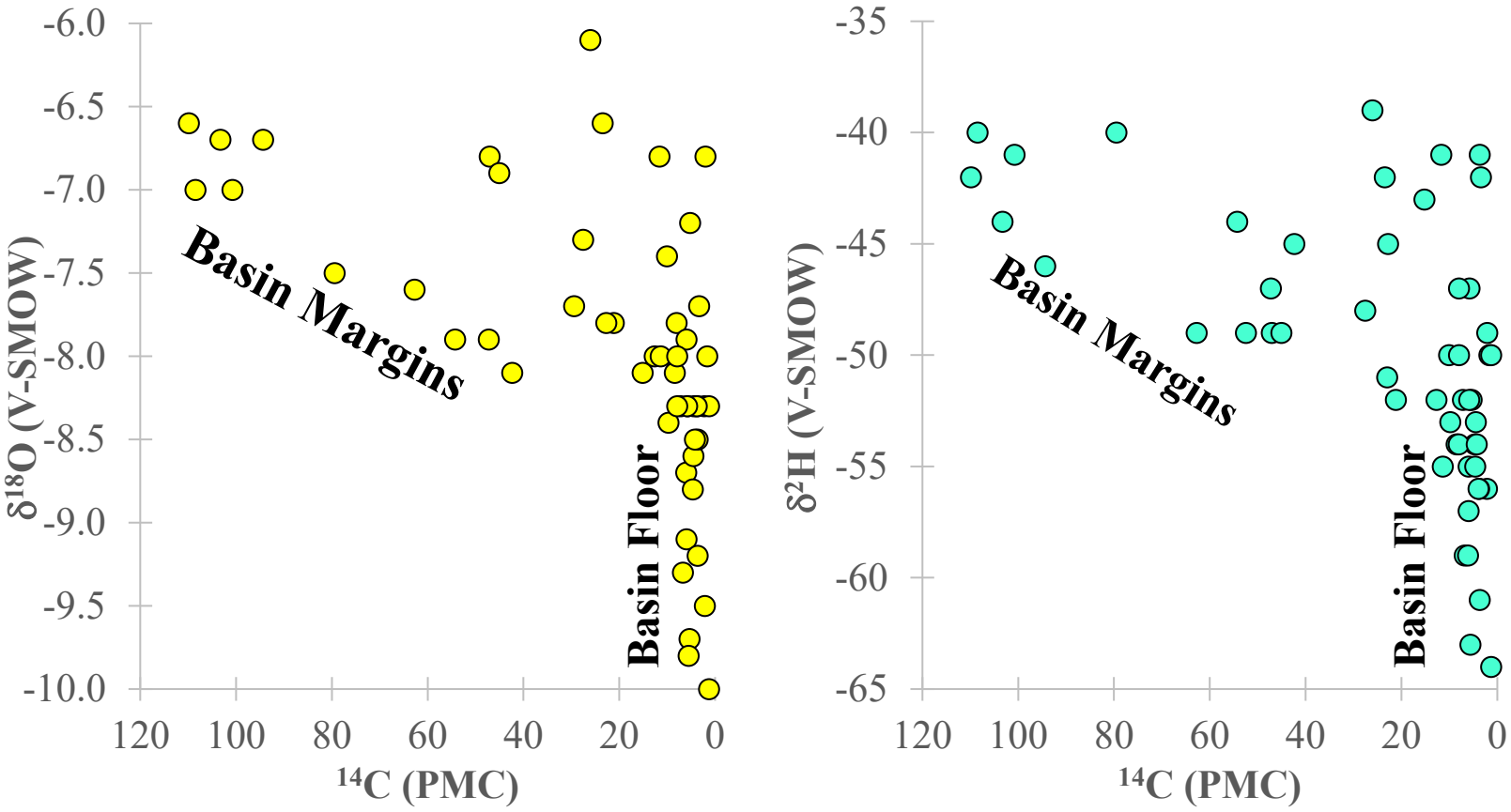
Source: Scanlon et al., 1993

Do Lower $\delta^{18}O$ and $\delta^{2}H$ Values with increasing apparent



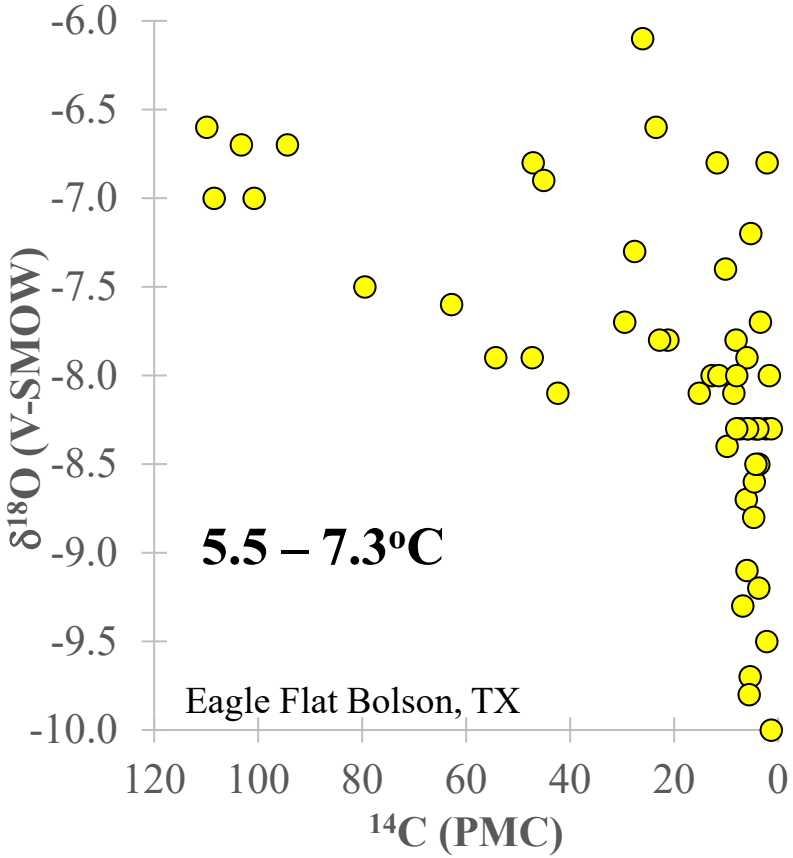
Source: Darling et al., 1994

$\delta^{18}O$ and $\delta^{2}H$ v ^{14}C

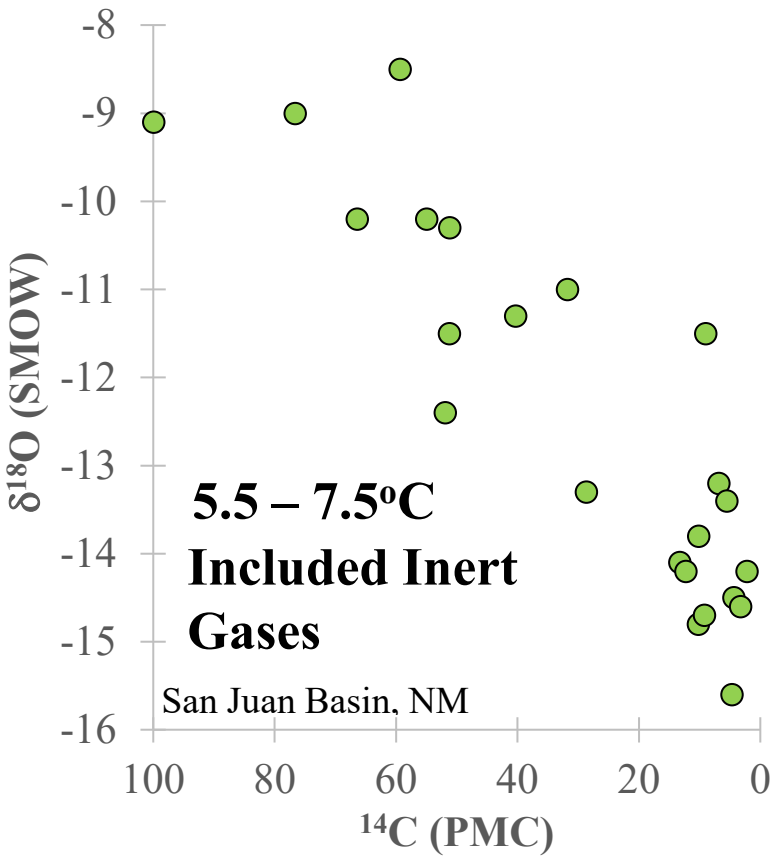


Source: Darling et al., 1994

A Similar Pattern of Decreasing $\delta^{18}O$ vs Increasing Apparent ^{14}C Age Observed in San Juan Basin Groundwater

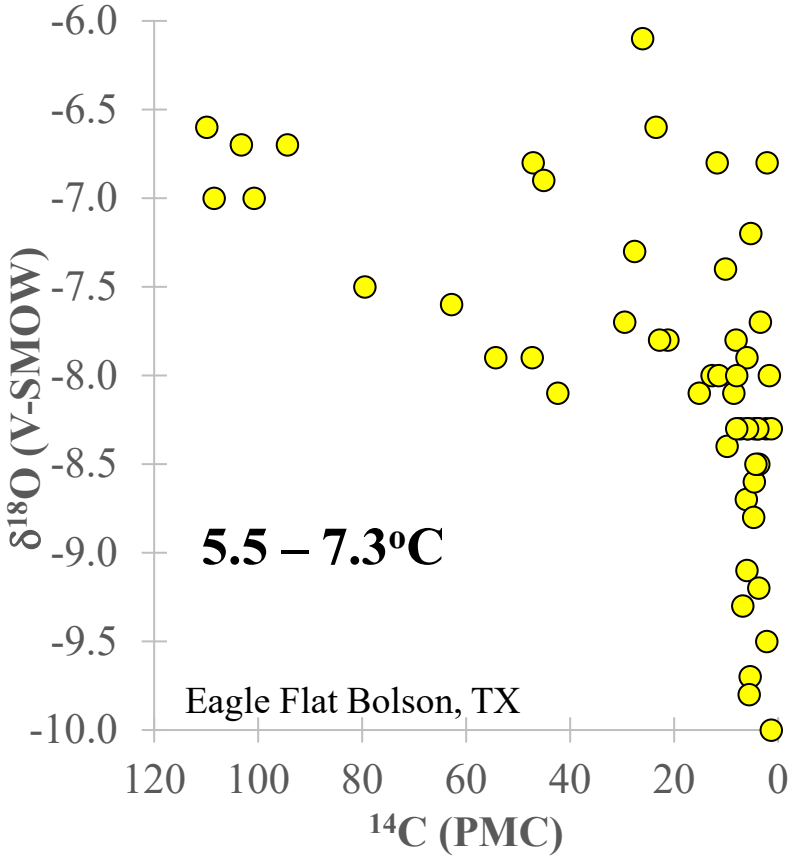


Source: Darling et al., 1994

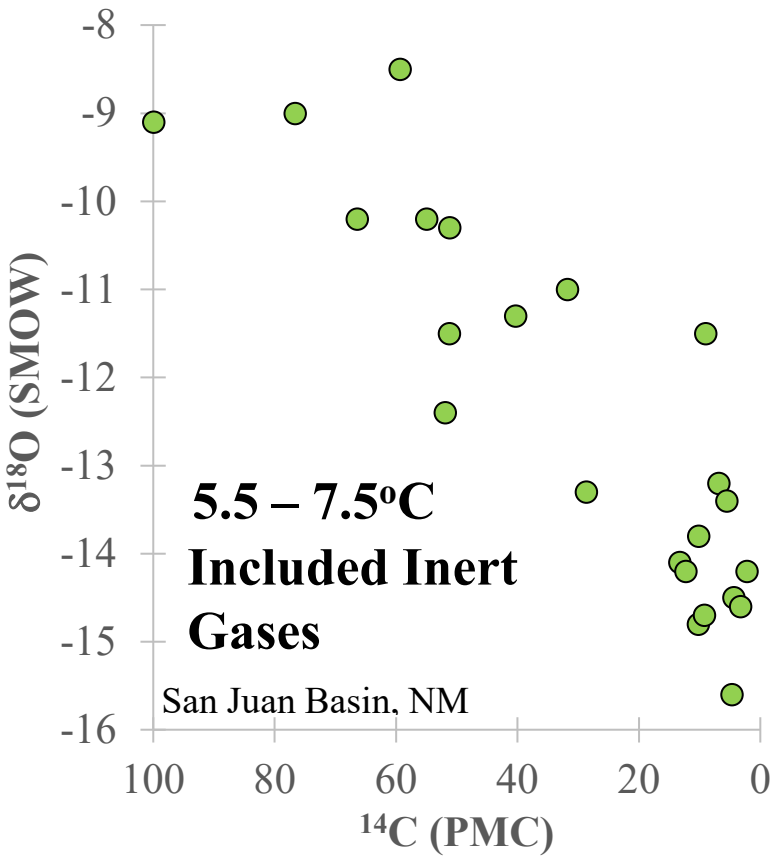


Source: Philips et al., 1986

^{14}C v $\delta^{18}O$ – Eagle Flat Bolson (TX) and San Juan Basin (NM)



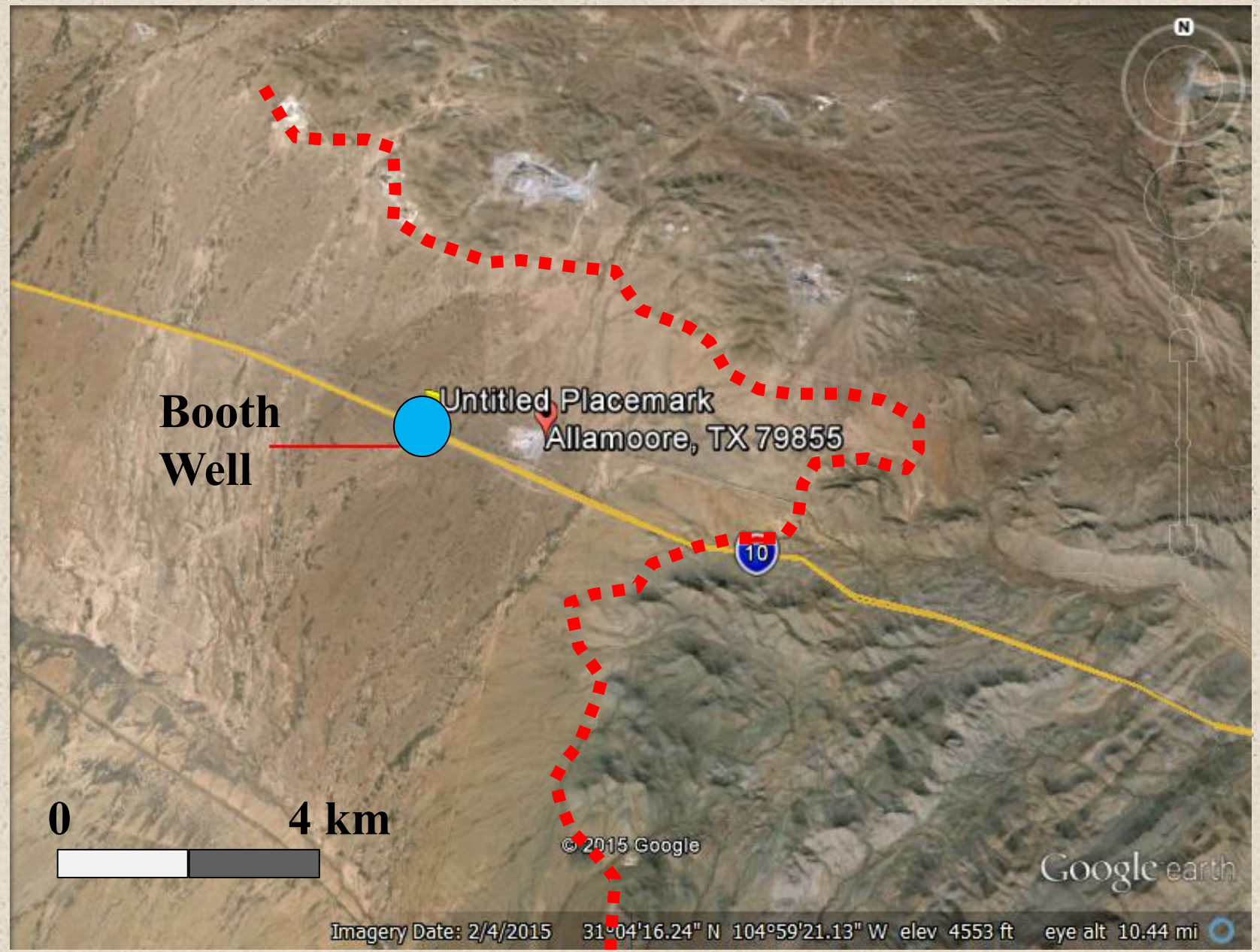
Source: Darling et al., 1994

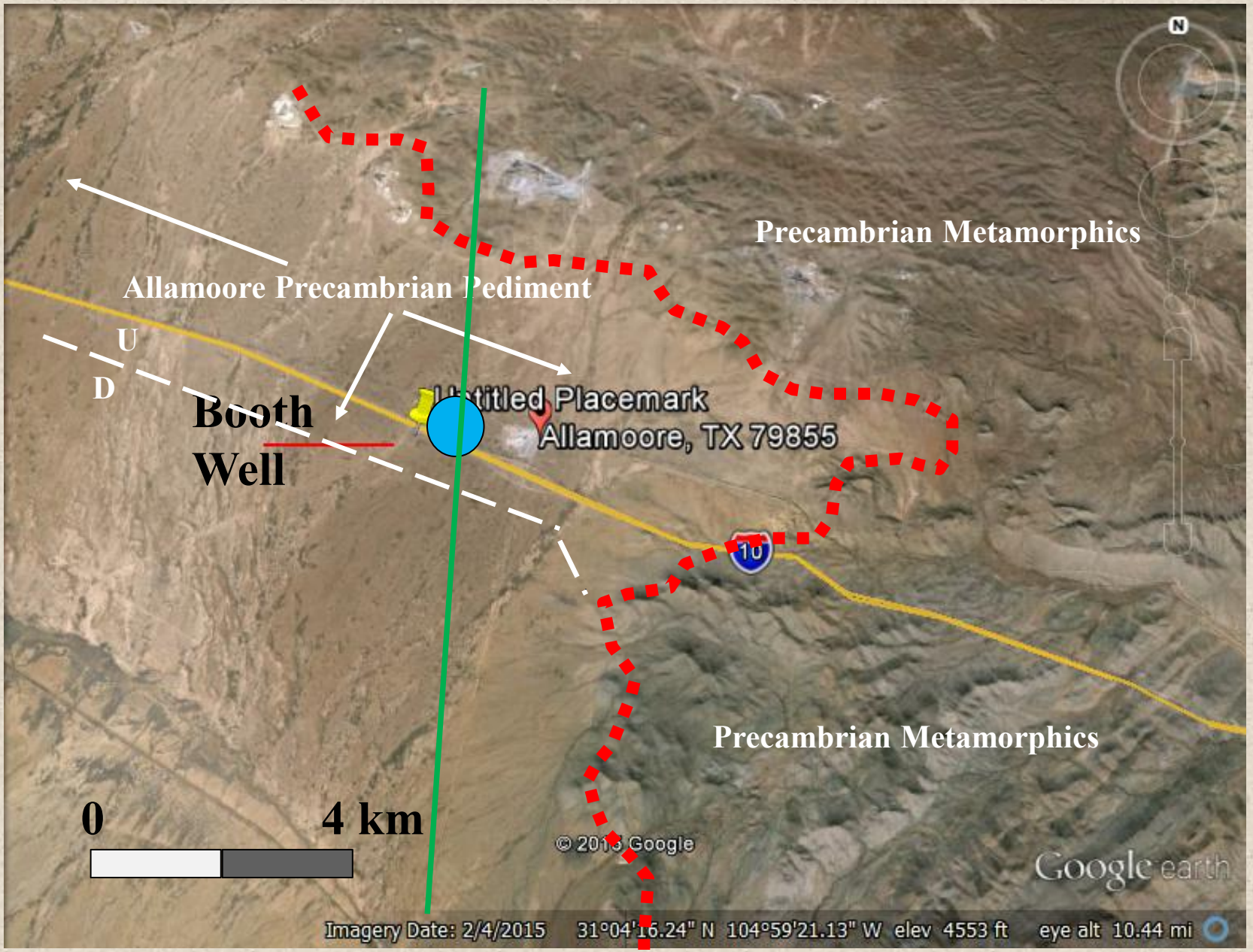


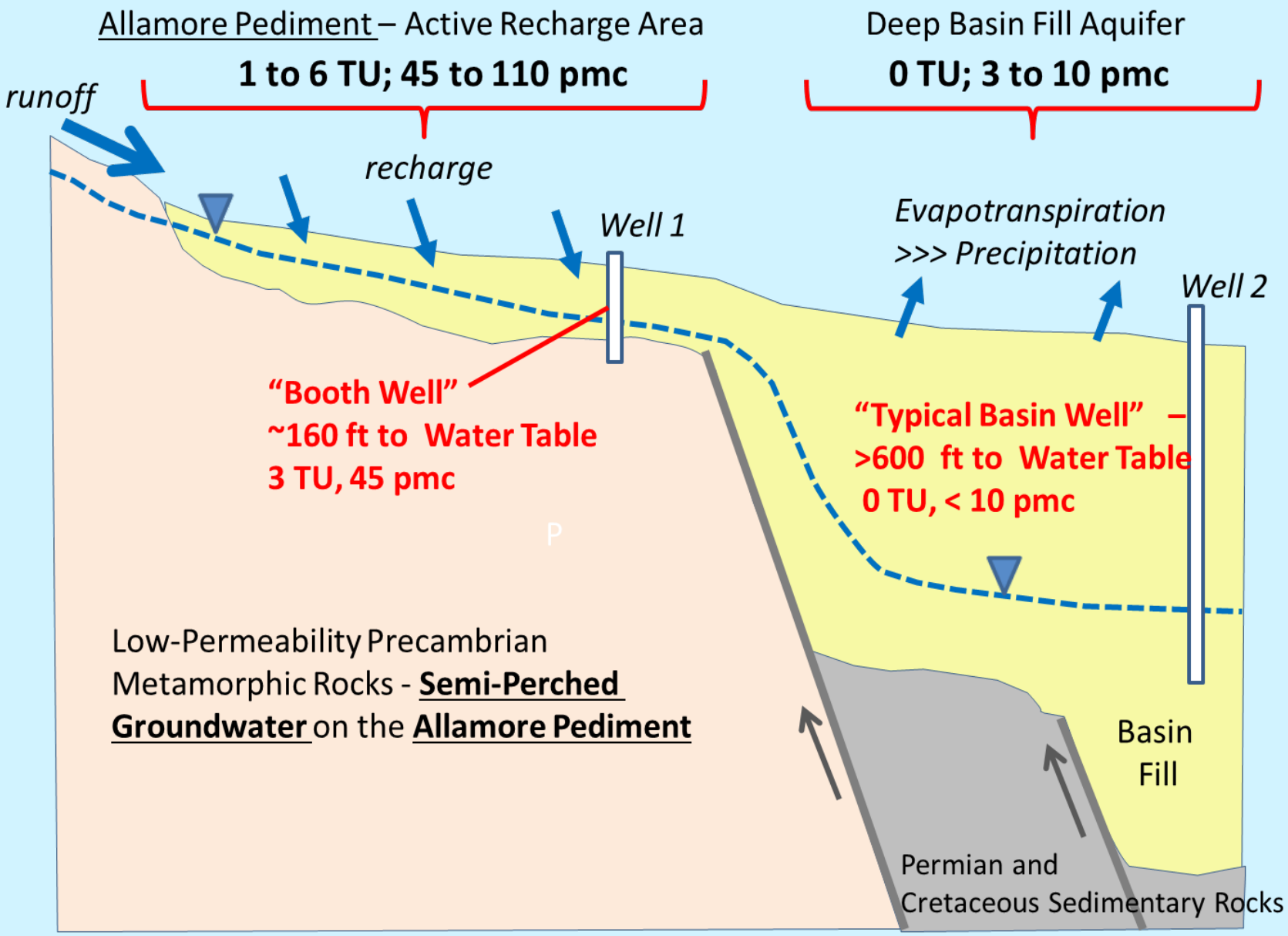
Source: Philips et al., 1986

Other Estimates of Differences in Late Pleistocene and Post-Pleistocene Temperatures

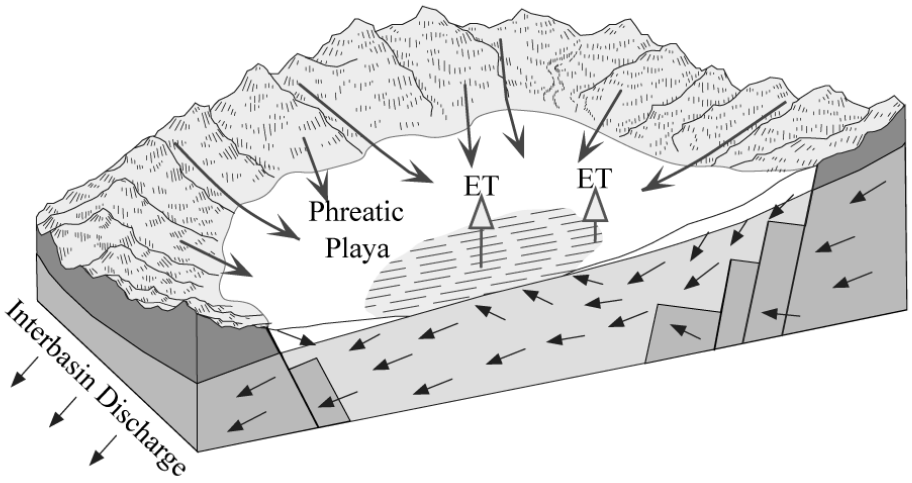
- Leopold (1951) – 6^{o}C based on relict snowlines
- Dutton (1995) – 5 to 8^{o}C based on differences in $\delta^{18}O$ of unconfined and confined groundwaters of South High Plains
- Stute et al (1992) – 5^{o}C based on concentrations of inert gases in the Carrizo aquifer of southern Texas


Booth
Well
Untitled Placemark
Allamoore, TX 79855
10
0
4 km
© 2015 Google
Google earth
Imagery Date: 2/4/2015 31°04'16.24" N 104°59'21.13" W elev 4553 ft eye alt 10.44 mi

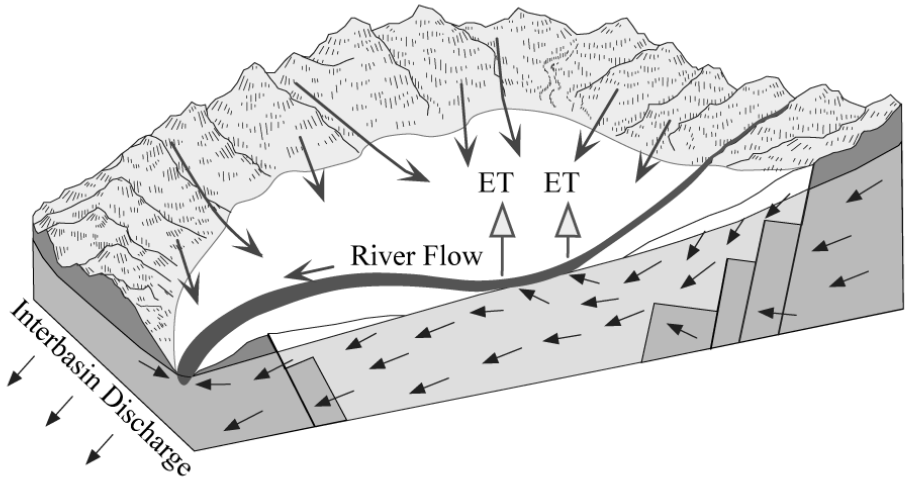

Precambrian Metamorphics
Allamoore Precambrian Pediment
U
D
Booth
Well
Untitled Placemark
Allamoore, TX 79855
10
Precambrian Metamorphics
0
4 km
© 2015 Google
Google earth
Imagery Date: 2/4/2015 31°04'16.24" N 104°59'21.13" W elev 4553 ft eye alt 10.44 mi


Allamore Pediment – Active Recharge Area
1 to 6 TU; 45 to 110 pmc
Deep Basin Fill Aquifer
0 TU; 3 to 10 pmc
runoff
recharge
Well 1
Evapotranspiration
>>> Precipitation
Well 2
"Booth Well"
~160 ft to Water Table
3 TU, 45 pmc
"Typical Basin Well" –
>600 ft to Water Table
0 TU, < 10 pmc
Low-Permeability Precambrian
Metamorphic Rocks - Semi-Perched
Groundwater on the Allamore Pediment
Basin
Fill
Permian and
Cretaceous Sedimentary Rocks

Topographically Closed, Partly Drained Basin



Topographically Open, Through-Flowing Basin



Explanation

Groundwater Flow

Surface Water Flow

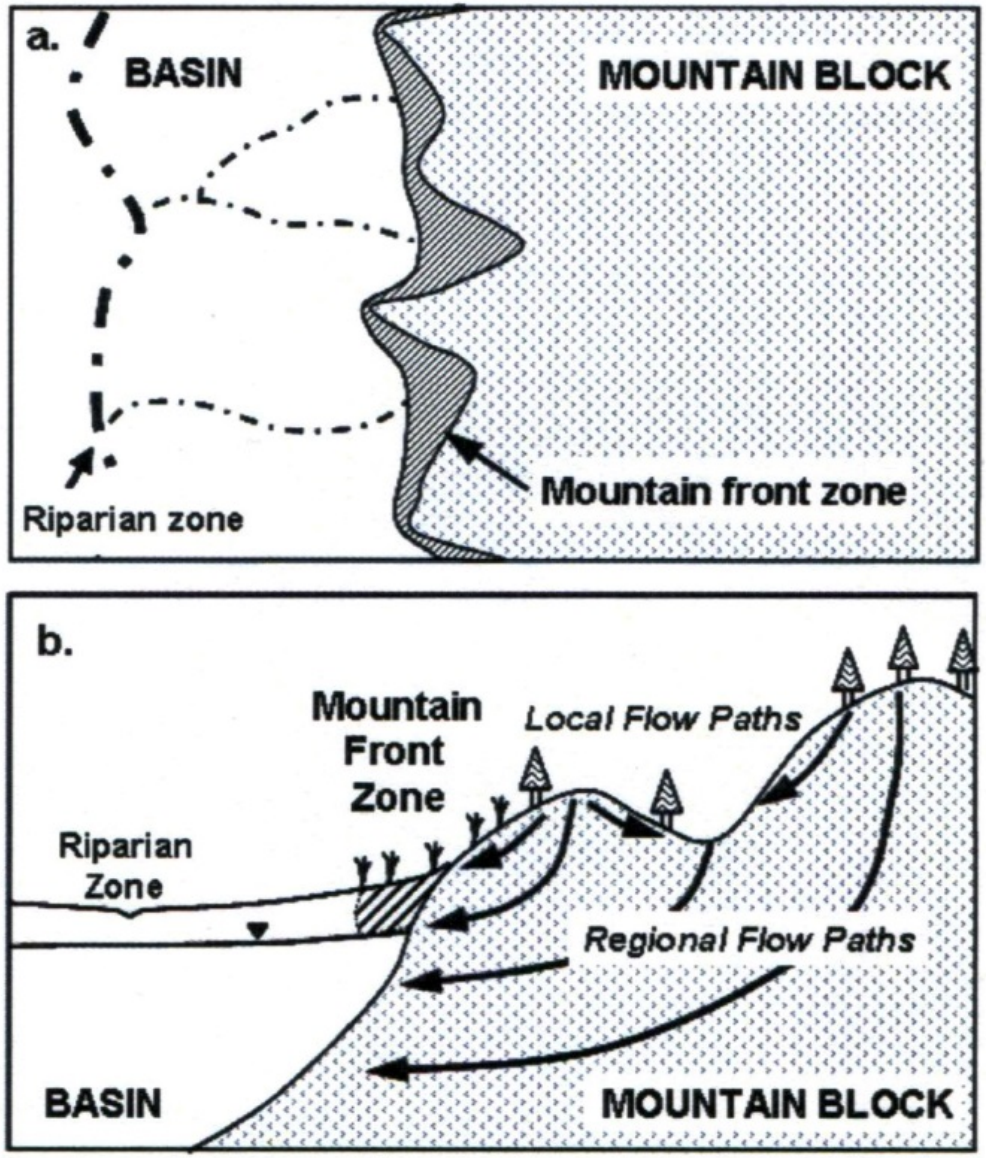
Unsaturated Basin Fill

Saturated Basin Fill

High-Permeability Bedrock

Low-Permeability Bedrock

All water passing from the mountain block and mountain front to the adjacent basin



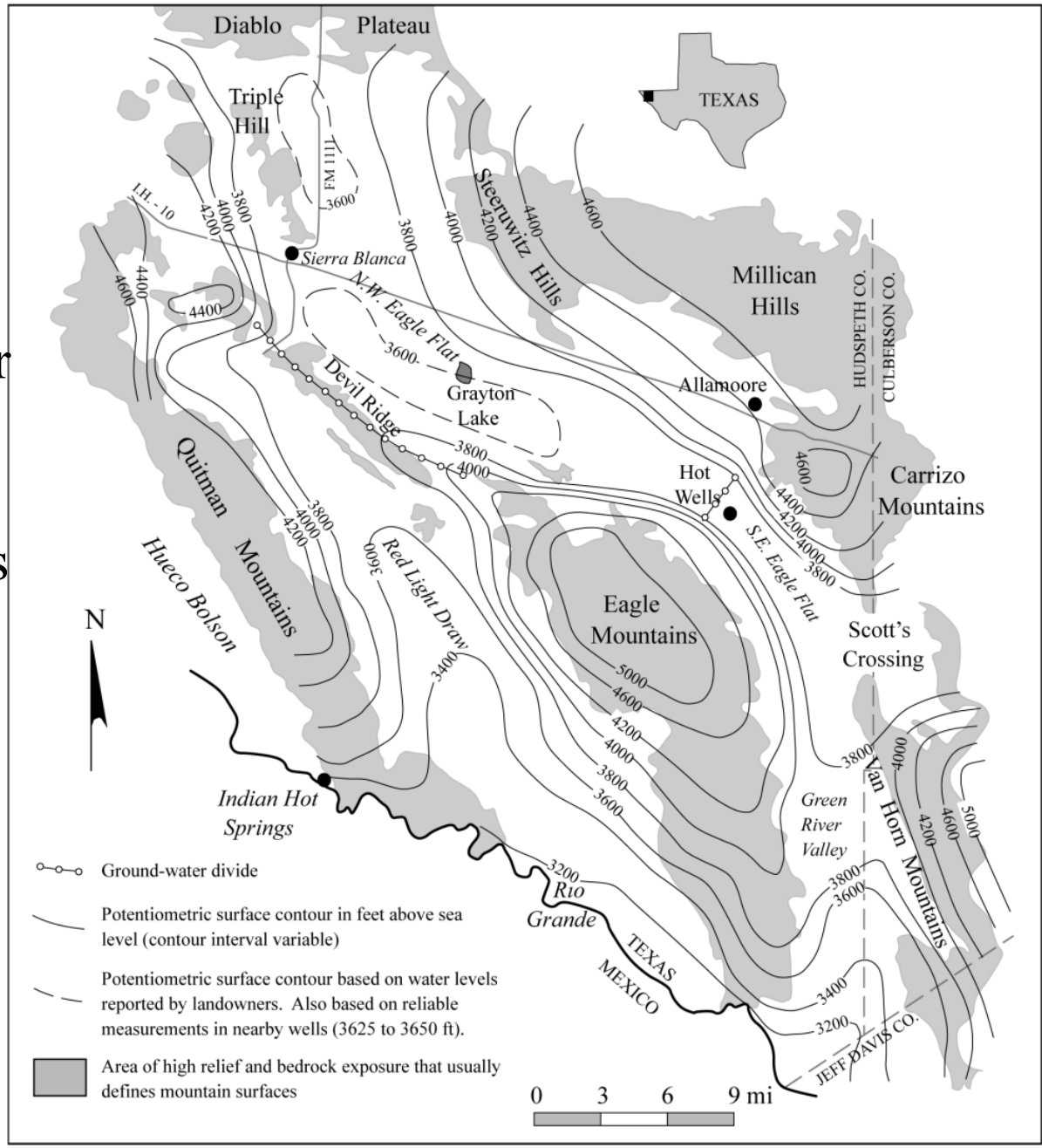
from Wilson and Guan, 2004

Northwest Eagle Flat

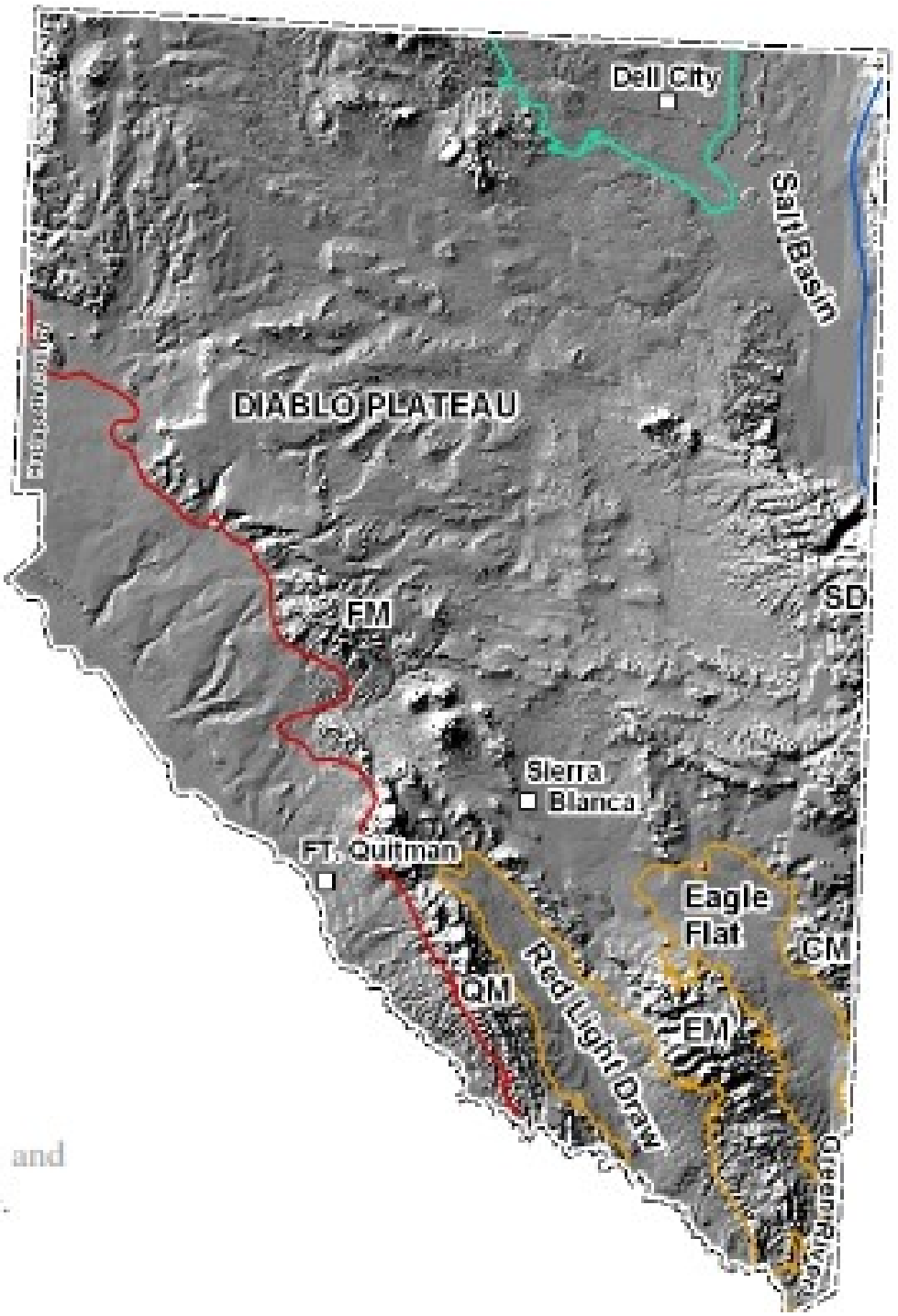
depth to groundwater
> 650 ft along basin floor

basin floor aquifer
surrounded by mountains
and groundwater divides
assumed to be barriers
to groundwater flow

where does ground
water go?



from Darling et al., 1994


Dell City
Salt Basin
DIABLO PLATEAU
FM
SD
Sierra Blanca
FT. Quitman
Eagle Flat
CM
QM
Red Light Draw
EM

, P.G., and

I, P.G.

Radioisotope Studies – Eagle Flat/Red Light Draw

negligible tritium and very low C14 along basin floor

unsaturated zone studies show upward moisture flux potential at most points

from Darling et al., 1994