Geologic Background
Wind River Formation

BY
SCOTT QUILLINAN
BRETT WORMAN
FRED McLAUGHLIN
ALAN VERPLOEG
Structure Contour of Fort Union Formation: Pavillion Field

From Seeland, 1989
Wind River Basin Stratigraphy

**Wind River Fm.** = Reservoir rocks/Surface outcrops

**Waltman Shale** and **Meeteetse Fm.** = Regional C.U.

**Cody Shale** = Source Rocks
Wind River Basin
Wind River aquifer extent

From Quillinan and Gracias, 2011
Wind River Aquifer

- Wind River Aquifer is composed of the Eocene Wind River formation
- Wells completed in the Wind River Aquifer are generally for stock and domestic, characterized by relatively low yields and poorer water quality (Morris et al. 1959; Whitcomb and Lowry, 1968; McGreevy et al., 1969; Libra et al. 1981; Daddow, 1996).
- The aquifer -lenticular SS beds and conglomerates
  - Vary widely in thickness and geometry
  - Differing tranmissivites and hydraulic isolation
  - Lenses are considered individual aquifers on a local scale
  - Often discontinuous and separated by less-permeable fine grained rocks
- Generally unconfined above 100 ft (Daddow, 1996)
Where does the water in the aquifers come from?

- Water that infiltrates the aquifer outcrop area
  - Precipitation
  - Irrigation including unlined canals and ditches
  - Losing Streams

From WSGS, 2011
Recharge for the Wind River Basin

- In general, precipitation recharges the Wind River Aq. 0.25” to 0.75” per year

From Hammerlink and Arneson, 1998; WSGS, 2011
Recharge as a percentage of precipitation

Up to 80% of precipitation may be recharging the Wind River Aquifer

From WSGS, 2011
Aquifer Sensitivity

- The Wind River aquifer has a higher sensitivity rating

Data from Hammerlink and Arneson 1998; WSGS, 2011
Potential Contaminates

- **WDEQ Water Quality Division:**
  - Known contaminated sites under the Groundwater Pollution Control Program
  - Class I, III, IV, V injection wells under the Underground Injection Control (UIC) Program
  - Wyoming Pollutant Discharge Elimination System (WYPDES) and National Pollutant Discharge Elimination System (NPDES) discharge points
  - Public Owned Treatment Works (POTWs) and septic systems (Water and Wastewater Program)
  - Concentrated Animal Feeding Operations (CAFOs)
  - Pesticides / herbicides (Nonpoint Source Program)

- **WDEQ Solid and Hazardous Waste Division:**
  - Known contaminated sites under the Voluntary Remediation Program (VRP)
  - Permitted disposal pits and other small Treatment Storage and Disposal (TSD) facilities
  - Landfills
  - Above and underground storage tanks

- **WDEQ Land Quality and Abandoned Mine Land Division:**
  - Active and inactive mines (LQD/AML)
  - Gravel Pits, Quarries, etc.

- **Wyoming Oil & Gas Conservation Commission:**
  - Class II disposal wells
  - Produced water pits
Gas Migration

Modified from USGS, 2009
Wind River Formation Depositional History

- Dominantly fluvial environments and sediments, and also contains lacustrine, swamp, soil, and alluvial fan deposits
- Abundant fluvial channels. Seeland (1978) defined the course of the paleo-Wind River as flowing through the Pavillion area.
  - Paleo-channel was established by Eocene
- The Eocene basin was at least 1km less than current elevation
- Eocene paleo-fluvial environment and climate (Fan et al., 2011)
  - low sinuosity
  - combination of gravel-bedded braided rivers (proximal to uplift) and meandering channels
  - well developed flood plains and paleosols
  - period of high precipitation (relative)
  - seasonal climate
  - fluvial gradient decreased with distance from uplifts
Wind River Formation Lithology and Source

- Variegated sands, silts, and clays
  - Sandstones are coarse- to fine-grained and often juvenile (arkosic) (Seeland, 1978; Fan et al., 2011)
- Little to no deformation (post-Laramide)
- Zircon studies indicate approximately 80% of Wind River Formation sediment is from the recycling of older (Meso- and Paleozoic) sediments, 20% from Precambrian
Depositional environment of Wind River Formation

- Fluvial Environment
- Flow of the Paleo-river was from west to east
- Variegated sands, silts, and clays
  Sandstones are coarse- to fine-grained and often juvenile

From Seeland, 1978
Fluvial deposition from the text book

From Selley, 1970; Fielding and Crane, 1987; Harms et al., 1982
Fluvial environment in the rock record

Figure 10. Detailed east-west correlation diagram across the Wind River Basin, Wyoming, showing stratigraphic units and generalized sedimentary facies within Upper Cretaceous and Paleocene rocks. Modified from Johnson and others (1996b).

From USGS, 2007
Geophysics and Lithology

Well from Pavillion Field (Doles Unit 44-15)

From Fielding and Crane, 1987
- Alternating sandstone (yellow), siltstone (orange), and shale (gray) beds.
- Indicative of fluvial deposition environment.
From Bjorklund, 1978
South-North Cross-section through Pavillion Field
West-East Cross-section through Pavillion Field
Simplified Conclusions

Recharge (from precipitation and irrigation)

0-100 ft

Lenticular sand bodies

3000-5000 ft

Gas Migration (from deeper source rocks)

Not to scale
Thank You!

SCOTT QUILLINAN
GEOLOGIST
WYOMING STATE GEOLOGICAL SURVEY
(307) 766-2286
SCOTT.QUILLINAN@WYO.GOV