# Identifying and Remediating High Water Production in Basin Centered Formations

Randal L. Billingsley
Advanced Resources International, Inc.
1401 17th St, Suite 400
Denver, CO 80202
303-295-2722

Dr. Leta K Smith Consultant Houston, TX 77043

Low-permeability formations in "basin-centered" settings are projected to be an important component of the future domestic natural gas resource base. The potential of this resource is being questioned as operators encounter high volumes of moveable water in deep basin settings. Understanding the nature of moveable fluids in these basin-centered settings is essential for developing strategies and techniques to avoid or remediate high water production. Advanced Resources International and the Department of Energy are performing a research program (DE-FC-02NT41437) to characterize the nature, distribution and flow paths of moveable fluids in the subsurface of several low permeability Rocky Mountain basins in order to improve resource characterization, develop water remediation strategies and enhance gas recoveries in these resource rich basins.

Initially, the project will focus on design and construction of a high-quality water chemistry database in the Wind and Green River basins incorporating available historical and current formation water chemistry data. Water composition data will be used to deduce depositional environments and diagenetic alterations to the formation waters and construct models describing the distribution and movements of the waters in the subsurface. The models will be used to devise strategies for the avoidance or remediation of moveable waters in the subsurface. A field demonstration of the strategies will be performed in the Wind River Basin and the results made public through technology

Final deliverables for the project will include an "atlas" of Rocky Mountain produced water compositions, a folio of conceptual models, a field demonstration with post appraisal, and a workshop.

# Project Objectives

- Build a high quality regional water chemistry database
   Existing data from public and industry sources
  - New data from targeted producing wells
- Identify and model sources and flow paths of subsurface waters using assembled pressure, temperature and chemical "fingerprints"
- Verify the model(s) through a field demonstration
- Transfer technologies to industry
- Preliminary results presented Salt Lake City AAPG
- Final results June 2004

# BACKGROUND INFORMATION

## Basin Centered Gas Paradigm

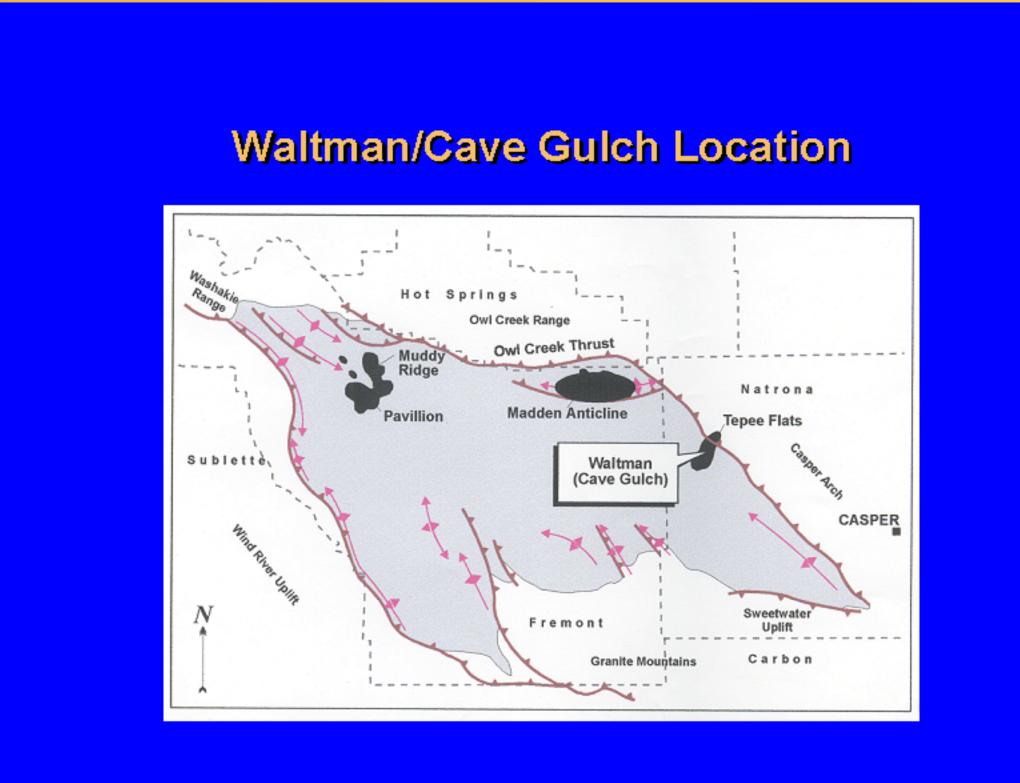
- Emerged following discovery of Elmworth field in Alberta
- Describes a laterally extensive, gas-charged hydrocarbon system where pore throats are too small to allow water to move (Law, 2002)
- Relative permeability to gas high, water low
   Reservoirs produce relatively dry gas even at high water
- saturations
- Such "Basin Centered" deposits projected to represent a major gas resource in tight formations of the Rocky Mountains

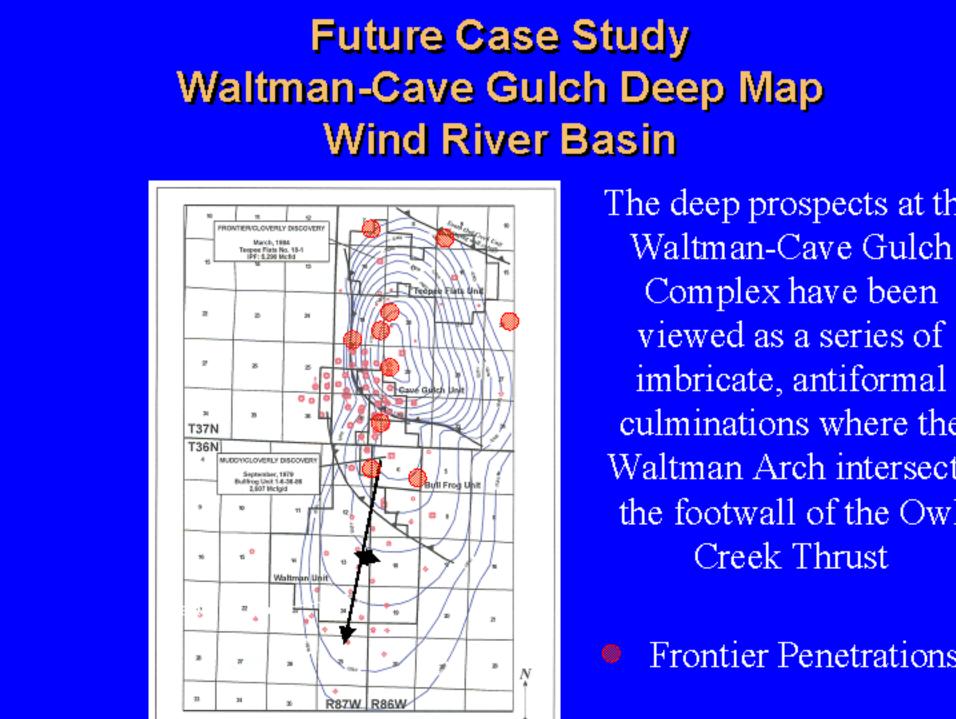
# Example of Basin Centered Gas System Piceance Basin Ornad Valley Basin Frinchis-Bullion Ornad Valley Basin Centered Gas System Prichith-Bullion Ornad Valley Basin Frinchis-Bullion Frinchis-Bullion JOHN TORNAD JOHN TORNAD Transition And Water Saturated Zones in, Williams Fork Formation, Southern Piceance Basin. Note gas is downdip from water.

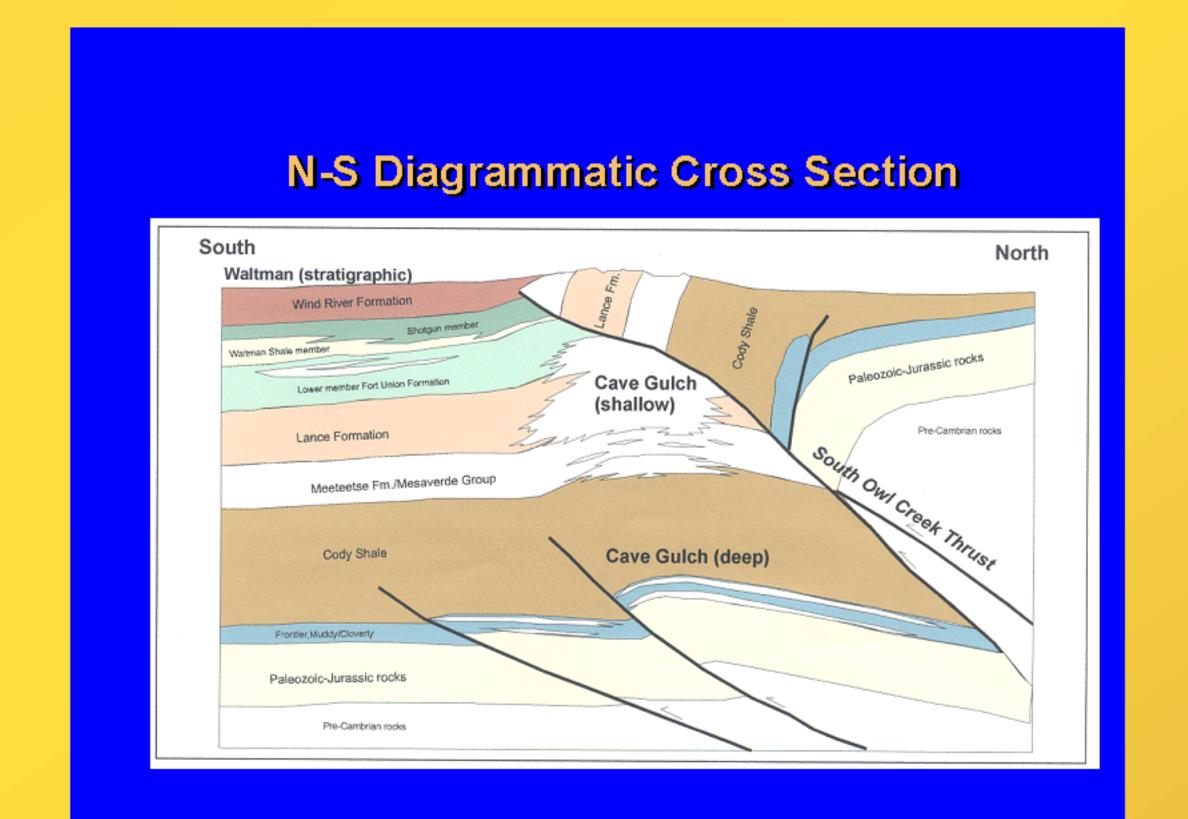
### Problems with Basin Centered Production

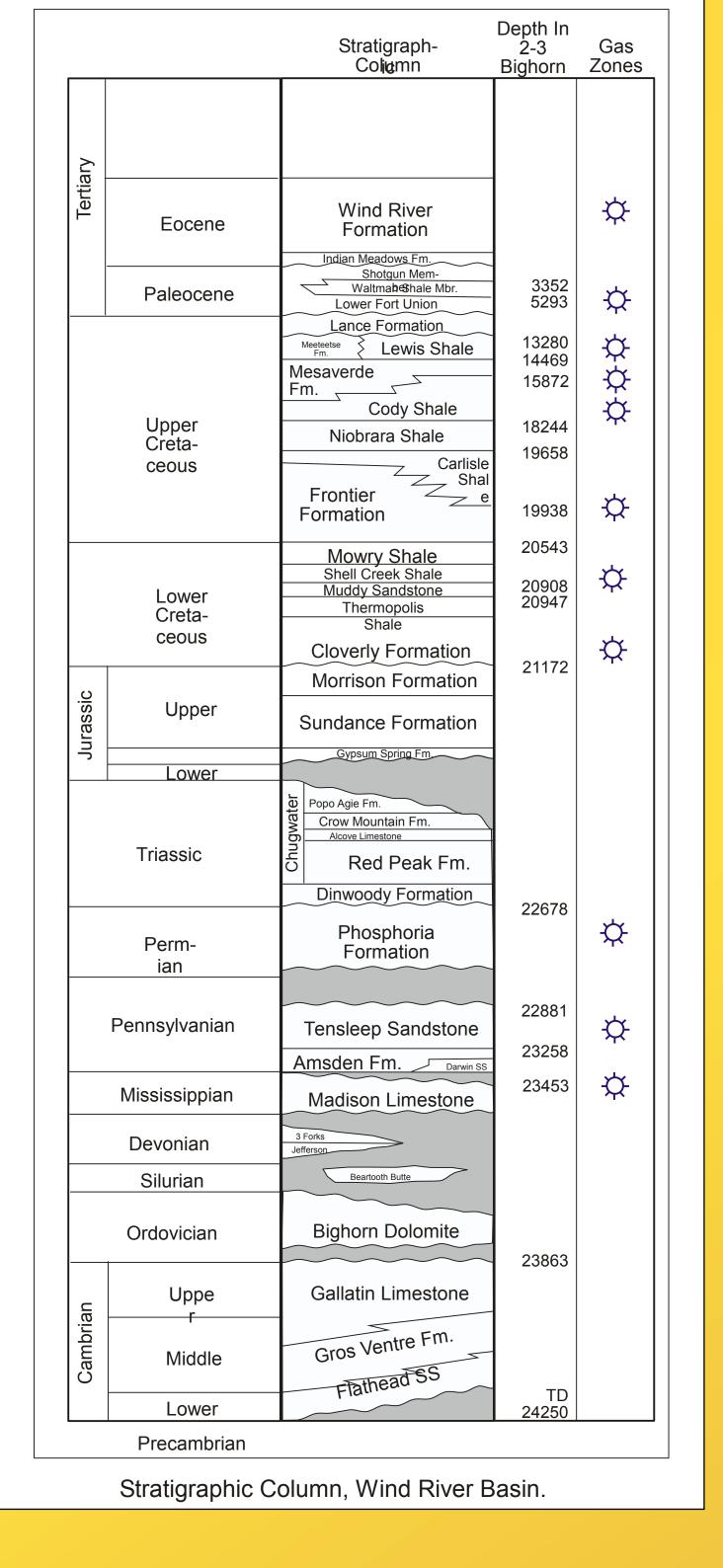
- Water production emerges as a problem
   Success in finding high porm etrocks often le
- Success in finding high perm streaks often leads to high water production, even within geopressured intervals
   Major questions
- What is the nature, origin and distribution of the water?Are water volumes finite?
- What is impact on gas in place calculations and ultimate recoverable resource?

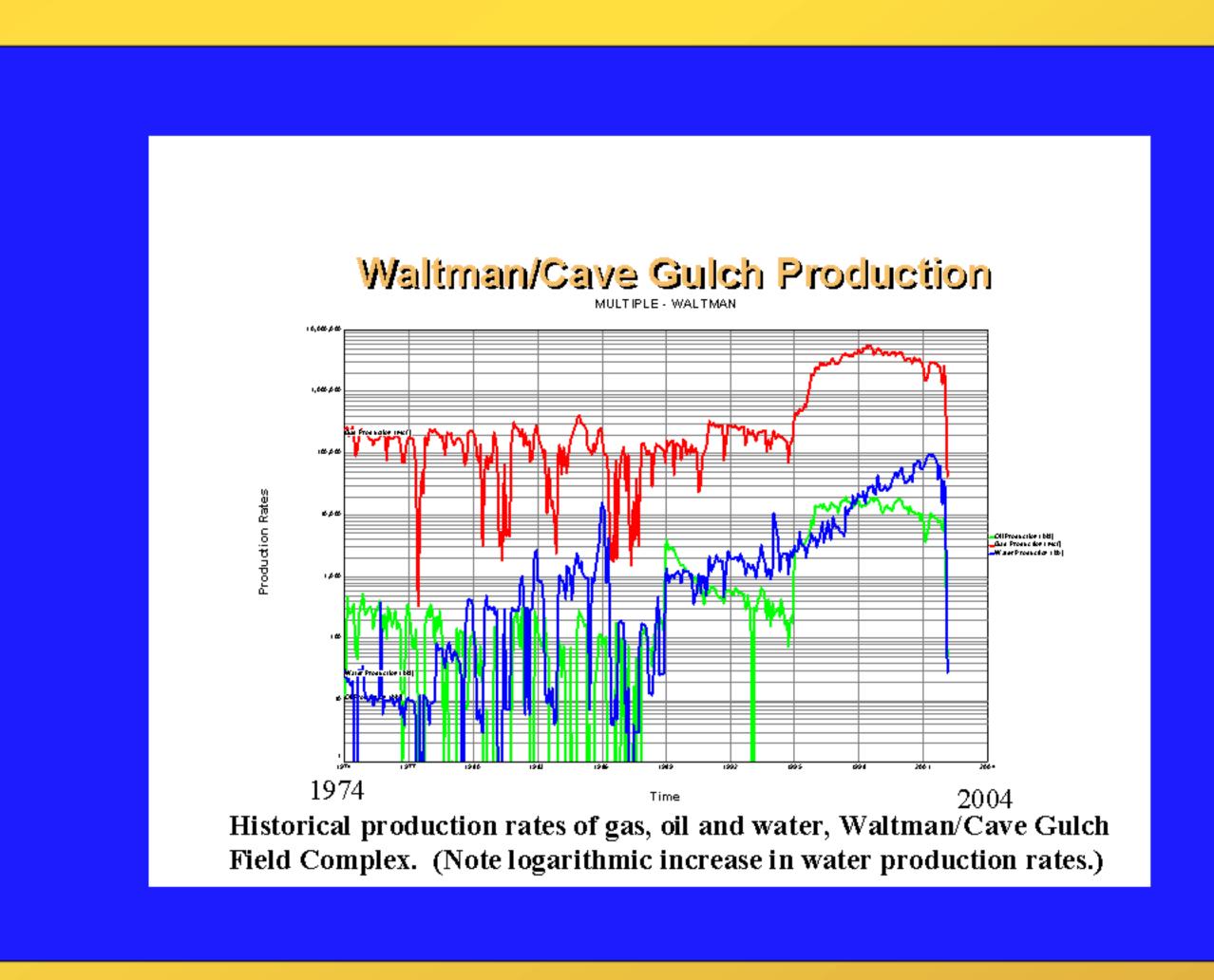
## DEEP WALTMAN/CAVE GULCH FIELDS











# Deep Waltman/ Cave Gulch Results

- Barrett's deep Frontier wells successfully encountered sufficient permeability to make commercial wells
- The actual results were noncommercial due to excessive water production from the "Basin-centered" accumulation
- Barrett decided the deep play was too risky without a better understanding of the nature and occurrence of the movable water

High water production from deep zones and increasing water from shallower zones have seriously hindered exploitation of identified tight gas resources.