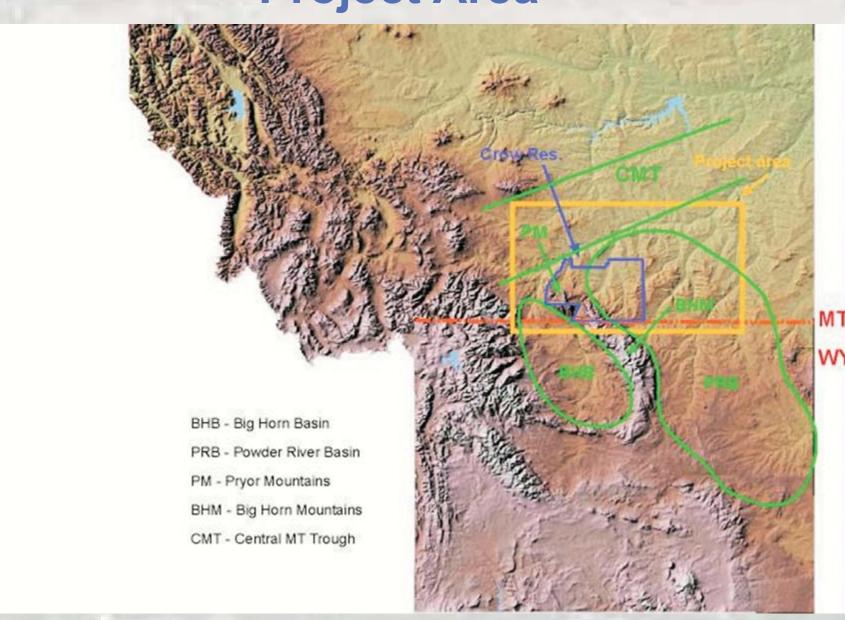
Reservoir Development in the Tensleep Sandstone, Pryor and Bighorn Mountains, South-Central MT

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1 Funding and Acknowledgements

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- > Cooperator: Crow Tribe granted access to tribal lands.

2 Introduction

The Permo-Pennsylvanian is the most prolific oilproducing system in the Northern Rockies Region. > Bighorn Basin (BHB) produced over 2 BBO.

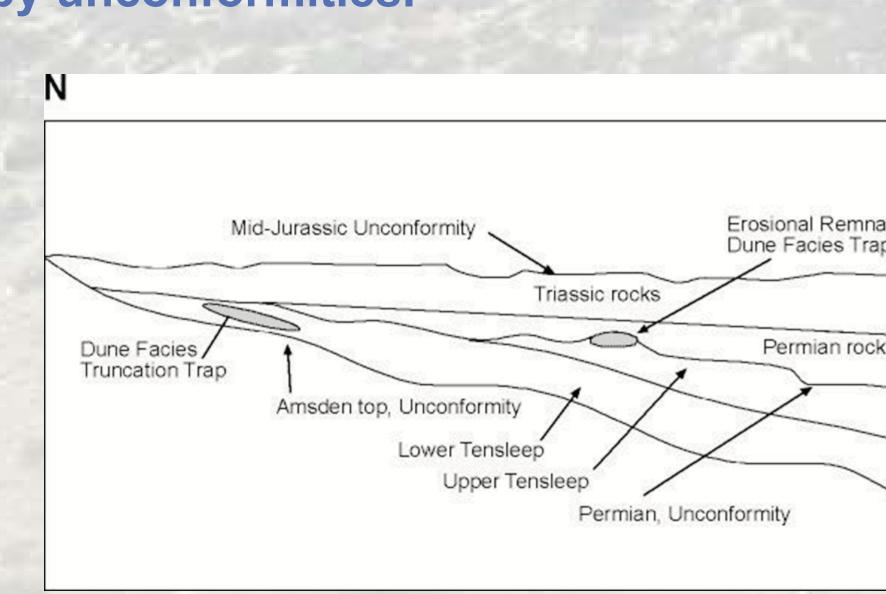
- > Powder River Basin (PRB) produced over 500 MMBO.
- > Production is stratigraphically controlled.
- > In the region most production is associated with structural highs, so exploration has focused on structural features.
- > Possibility of a major stratigraphic accumulation in south-central Montana has long been recognized, but exploration has focused on the zero-edge pinch-out.
- > Working Hypothesis: A primary regional stratigraphic trap occurs south of the zero-edge related to the truncation of reservoir facies within the depositional system and oil in the Tensleep in both the BHB and PRB represent one regional petroleum system.

3 Project Goals

- > Develop new exploration model for the Permo-Pennsylvanian system in south-central Montana.
- > Define an exploration fairway for the system.
- >Ultimately, add oil and gas reserves from new discoveries.

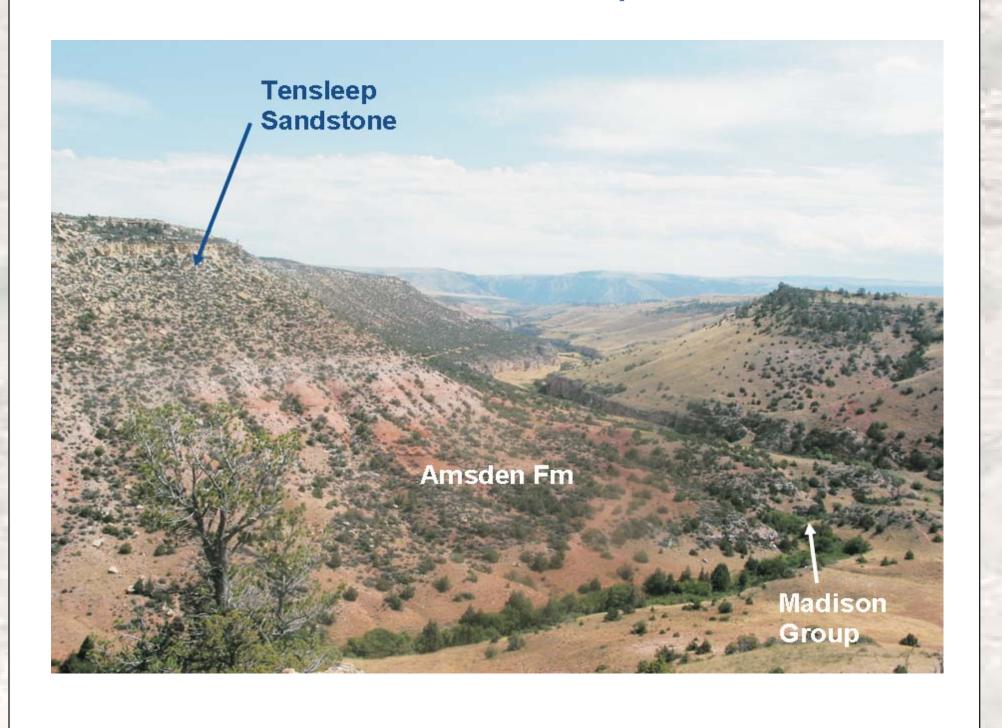
4 General Stratigraphy

- > Mississippian through Mid-Jurassic sequences represent continuous depositional across the region, but were separated by Laramide deformation into BHB and PRB.
- >Permo-Penn system is bounded by unconformities.



- > Permian Phosphoria in BHB correlates roughly with the Goose Egg Formation in the PRB.
- > Penn Tensleep Sandstone correlates, in general, with the Minnelusa Fm in PRB.
- > Reservoir facies in the Tensleep and the Minnelusa are mainly eolian sandstone.
- > The Permo-Penn system hydrocarbon source has been typed to organic-rich beds of the Phosphoria.

Stratigraphic Sequence above and below the Tensleep SS

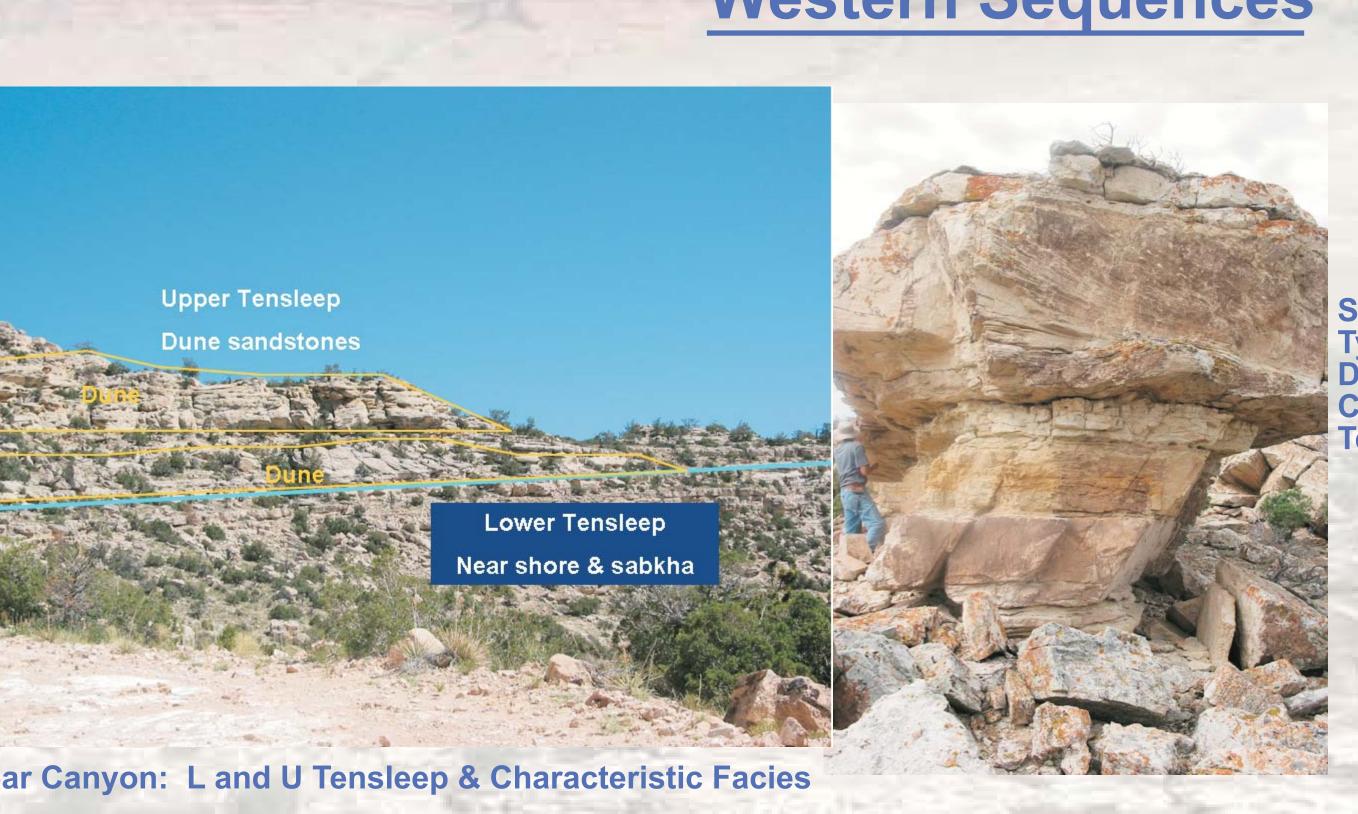


Summary of Field Relationships

- Measured sections show significant relief on unconformities bounding the Tensleep Sandstone.
- Total Tensleep thickness varies greatly.
- Sequences were deposited in near-shore marine, sabkha, and dune environments.
- In the West: Lower and Upper Tensleep
- Lower: cycles of marine ss, locally minor dune sandstone & probable sabkha sandy limestone and dolomite.
- In the East: only Lower Tensleep; rocks are similar but dune ss develops in this part of the section.



Western Sequences



Stockman Trail: Typical Marine-





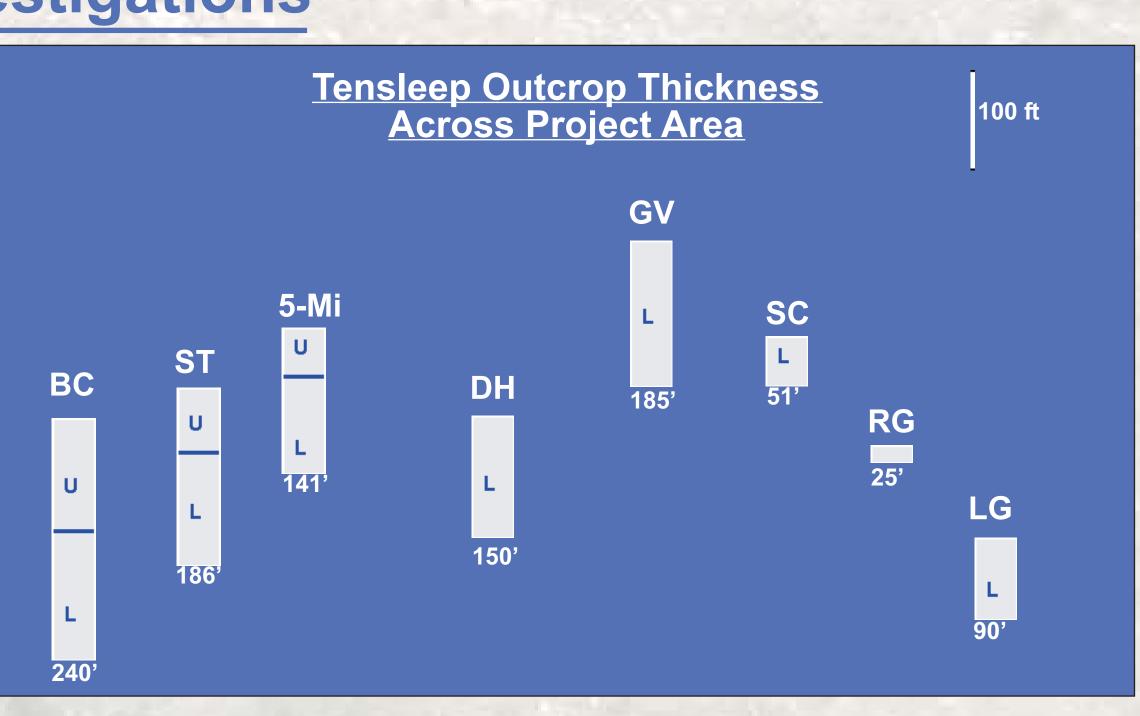
Bear Canyon: Characteristic Cross Bedding in Dune SS.



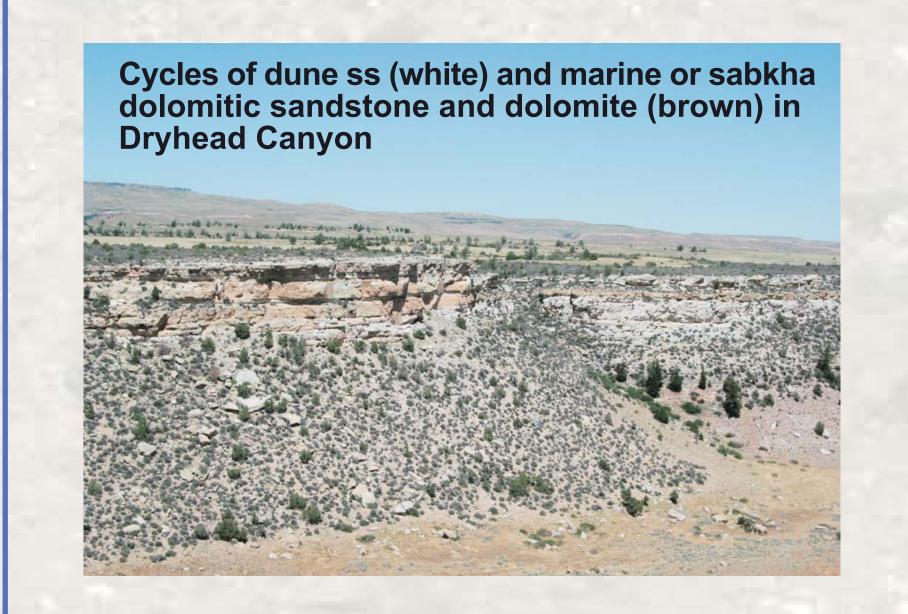
Bear Canyon: Sandy, cherty dolomitic limestone

5 Field Investigations

- > Sections were measured at 8 localities. At Dry Head Canyon the Tensleep is exposed continuously for about 8 mi. Therefore 5 sections were measured at that locality.
- > The figure to the right illustrates the thickness variations as well as the distribution of the lower and upper Tensleep sections.
- BC=Bear Canyon; ST=Stockman Trail; 5-Mi=5 Mile Cr; DH = GV= Grapevine Canyon; SC=Soap Cr; RG=Rotten Grass Cr;

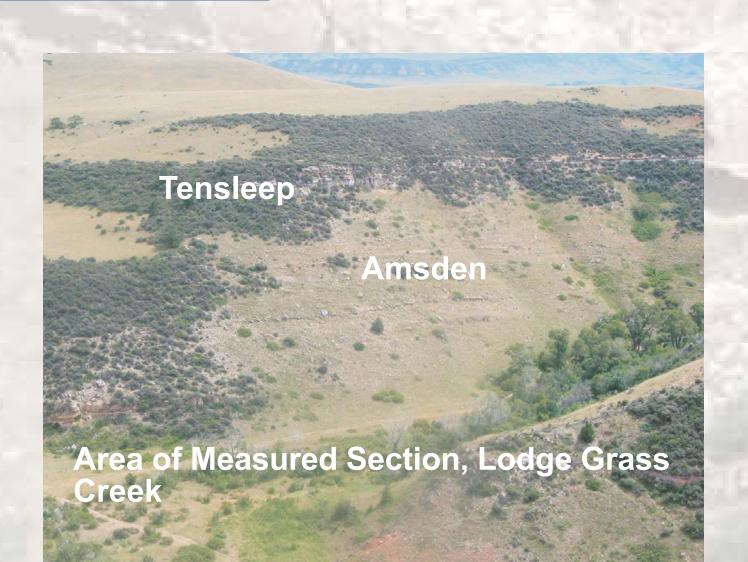


Eastern Sequences



Cycles of dune ss (white) and marine or sabkha dolomitic sandstone and dolomite (brown) in **Dryhead Canyon**





Dramatic Thinning of Tensleep West of Measured Section in Lodge Grass Creek



Regional Petroleum System

- Working hypothesis: that oil was generated and migrated before development of Laramide structural features. Therefore, oil from fields in the region should be similar and regional stratigraphic traps probably exist.
- Oil samples were acquired from existing Tensleep producing fields to test our idea.
- The chemical results confirm our interpretation and indicate: "close agreement between all samples from both a thermal maturity history and a common organic source origin" (Geoffrey Bayliss, Geochem Labs Inc).

8 Conclusions

- Stratigraphy of the Tensleep is complicated by rapid facies changes and substantial relief on bounding unconformities.
- Reservoir facies are mainly eolian sandstones that pinch out within very short distances. Therefore, well spacing as small as 10 acres may be necessary to tap all potential reservoirs in a
- Organic chemistry of oils from Tensleep fields in the region document one common petroleum system from the same organic source.