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The Deep Basin – A Hot "Tight Gas" Play for 25 Years

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History

The Deep Basin of western Canada was recognized in the late 1970's as an immense wedge of abnormally-pressured, hydrocarbon-saturated strata on the eastern flank of the Rocky Mountain Foothills (Fig. 1, 2). Canadian Hunter discovered gas in Lower Cretaceous shoreface sandstones after interpreting numerous intervals and extensive areas of bypassed gas pay on logs. The initial discoveries were given regional scope when Hunter geologists recognized marine equivalents in the Foothills to the west, thus establishing broad east-west exploration fairways through west-central Alberta and adjacent British Columbia. The subsequent exploration boom yielded numerous discoveries in the Elmworth / Wapiti and Noel / Kelly areas (Fig. 1).

Masters (1979) calculated potential recoverable gas resources of 440 TCF for the Deep Basin, assuming that advancing technology and increasing prices would make this gas economically accessible over time. Many geologists in the early 1980's thought that this estimate was wildly optimistic. Have subsequent events supported Masters or his critics?

Current Situation

Twenty-five years later, the Deep Basin remains a hot exploration area locally, but only a fraction of its resource potential has been realized. Exploration and development have been focused in the north, where Lower Cretaceous plays have been extended westward and southward. In west-central Alberta (Fig. 1), several Deep Basin plays have been pursued as if they were conventional accumulations. However, regional hydrodynamic work demonstrates that they lie within the hydrocarbon-saturated regime (Putnam and Ward, 2001). Significant discoveries are now being made further afield, such as at Hooker in the southern Deep Basin (Fig. 1).

There are no statistics for Deep Basin gas reserves, as hydrodynamic regimes have not been mapped systematically at reservoir scale. Summing up in-place gas volumes tabulated by the Geological Survey of Canada (Stockmal et al., 2001) for all play types occurring in the Deep Basin, about 77 TCF has been discovered, and another 25 TCF is expected to be recovered with future exploration. A substantial fraction of these volumes occur in conventional traps, updip from the Deep Basin, in plays that straddle its updip margins. Therefore, Deep Basin gas volumes are probably half or less of the 150 TCF that Masters (1979) envisioned to be accessible at $2.00/MCF. What accounts for this shortfall?

Reservoir Quality – The "Sweet Spot" Strategy

Canadian Deep Basin plays have historically targeted high reservoir quality "sweet spots" within much larger masses of lower-quality rock. In the Elmworth / Wapiti and Noel / Kelly areas, well-sorted conglomeratic shoreline strata with moderate porosity and high permeability are the primary exploration targets. Little gas is produced from associated fine-grained, low-permeability shoreface sandstones, although they contain far more gas in place. In west-central Alberta, most Deep Basin pools are in sandstones with well-developed secondary solution porosity, while poorer-quality sandstones are abandoned as uneconomic. Further south, there has been relatively little Deep Basin exploration, at least partly because reservoir quality "sweet spots" appear to be rare.

The "sweet spot" strategy requires single pay zones (or one primary zone and a small number of secondary targets) to have sufficient deliverability and reserves to support exploration and development economics. Looking southward to analogous basin-centered gas fields in the United States, Canadian operators are now realizing that gas can be produced economically from much tighter rocks. The American "basin-centered" approach requires much different exploration and development strategies, such as: locating thick net pay sections, possibly aggregated over several zones; performing massive frac jobs; exploiting natural fracture systems; downspacing; and directional and horizontal drilling.

Some of these strategies are now being pursued in the Canadian Deep Basin. Downspacing and directional drilling are being used successfully in the Cardium Formation in west-central Alberta, where millidarcy-quality sandstones up to 20 metres thick are widespread. The Hooker play in southern Alberta features similar reservoir quality, and is being exploited with downspacing and advanced completion technology (Fig. 1). Numerous other Deep Basin gas plays are now being drilled at two to four wells per section along selected fairways. However, the vast bulk of tight gas sand resources remain untouched.

New Deep Basin Plays

In addition to the unexploited tight sands of west-central Alberta and adjacent British Columbia, Deep Basin gas potential may exist in other areas of western and northern Canada.

In northeastern B.C., shelfal carbonates of the Jean Marie Formation contain subnormally-pressured, continuous-phase gas over large areas, encased in basinal shales. Horizontal wells accessing natural fractures have greatly enhanced the reserve base of this play in recent years. In addition, EnCana recently established several TCF of recoverable reserves within thick buildups at the western shelf margin (Sierra play), which previously were regarded as uneconomic.

In the Mackenzie Valley region of the Northwest Territories, hydrogeological analysis by Petrel Robertson Consulting suggests that there may be a Deep Basin regime within Devonian strata, with potential comparable to the Sierra play.

Summary

Masters' huge original resource estimates for the Deep Basin assumed constantly escalating gas prices and advancing technology over time. Until recently, however, gas prices have varied widely, and have hindered consistent long-term exploration and development spending. Canadian operators have relied upon the "sweet spot" exploration strategy, and have not utilized new technologies and exploration models to access tight gas as extensively as have their colleagues in the Rocky Mountain states.

Twenty-five years after the discovery of the Deep Basin, we now see ahead of us a period of escalating gas demand and prices, and the widespread availability of advanced drilling and completion technologies. Perhaps we will also see the realization of the enormous gas resources of the Canadian Deep Basin, and an expansion of this potential to new areas.

References

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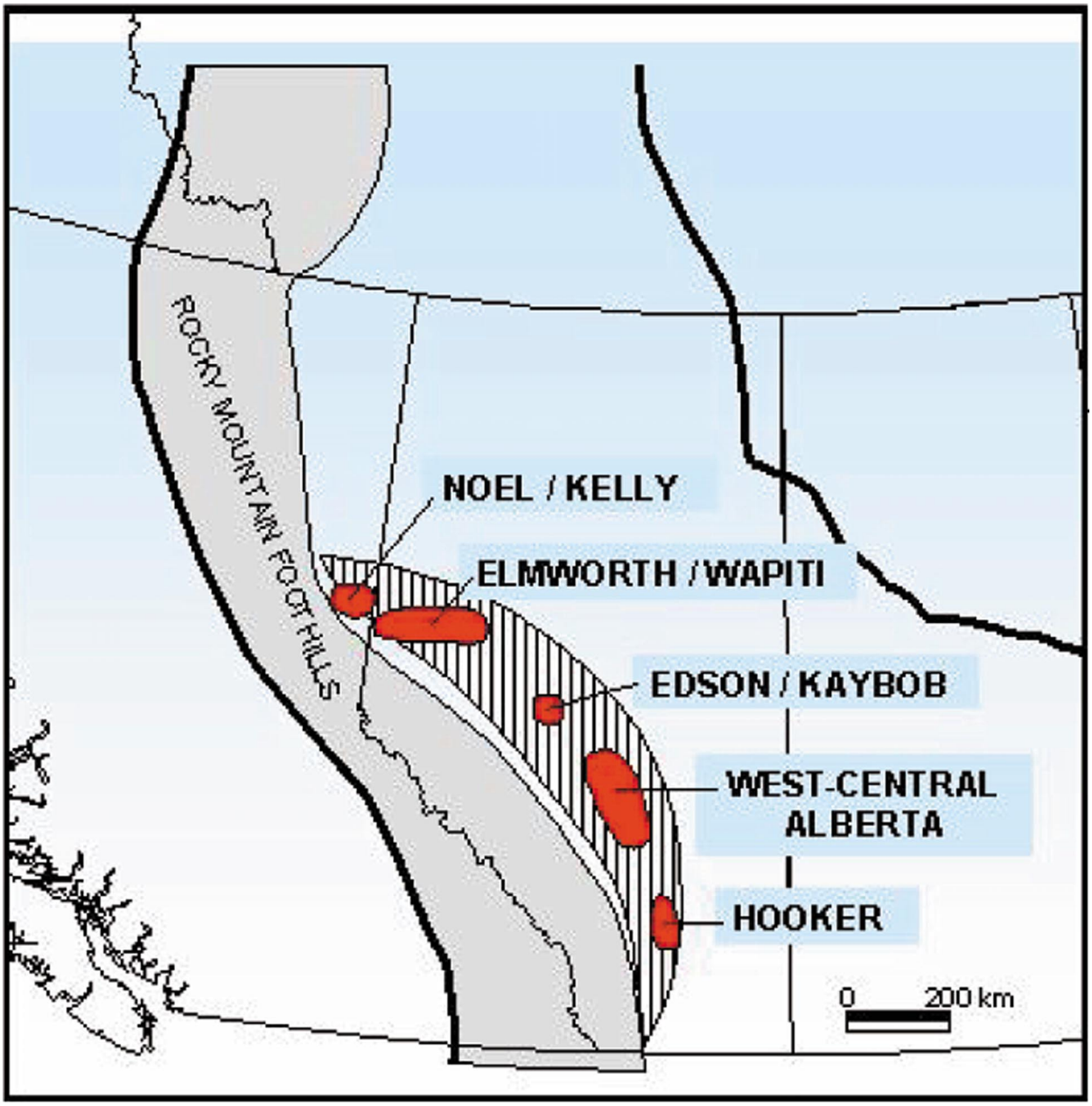

Fig. 1. Location map, Western Canada Deep Basin.

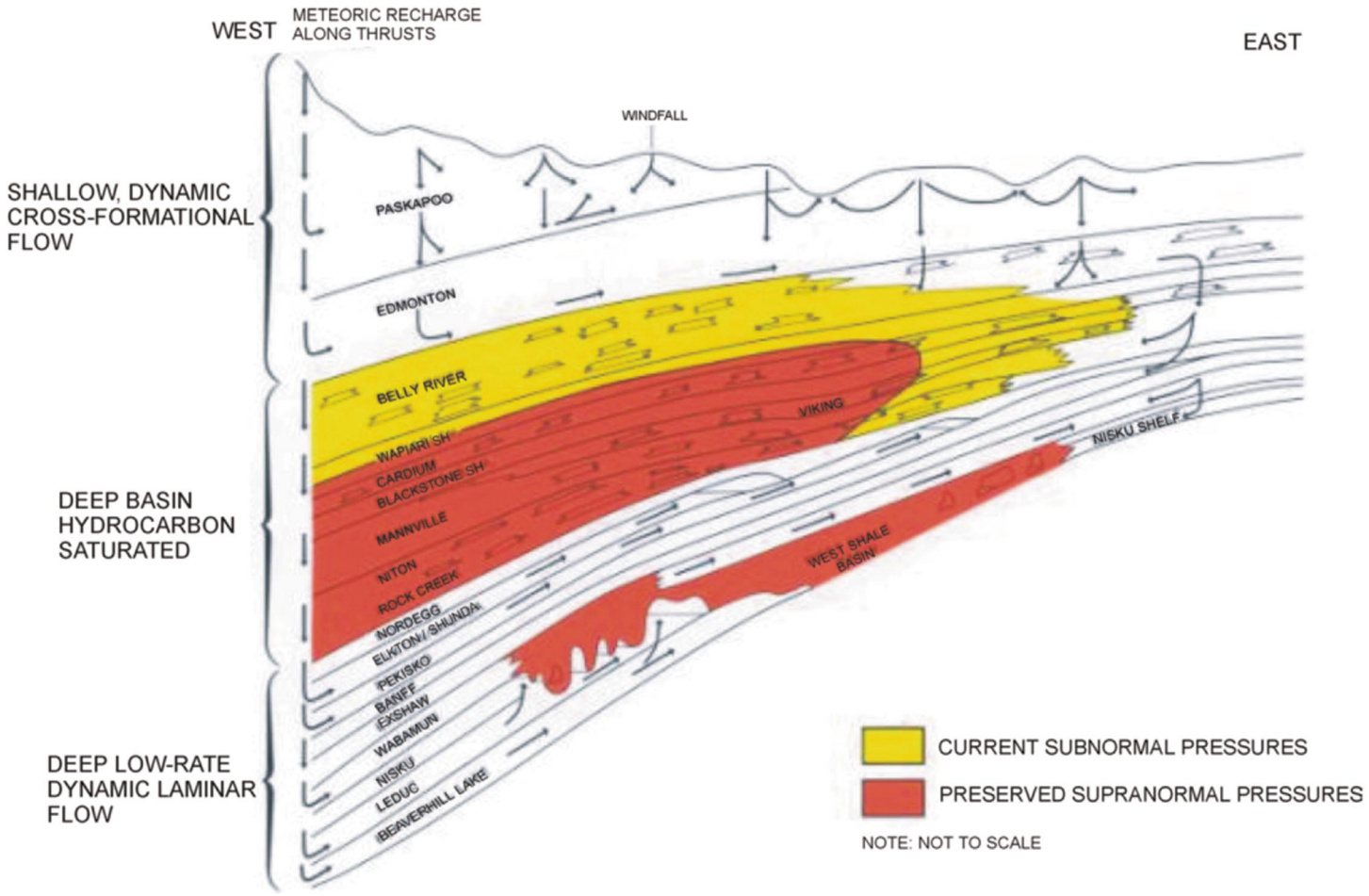

Fig. 2. Schematic hydraulic cross-section, Western Canada Basin (after Putnam and Ward, 2001).