Sunnyside Oil Sands at Bruin Point, Southwest Uinta Basin, Utah*

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Abstract

The south flank of the Uinta Basin in northeast Utah is the high Tavaputs Plateau, which dips gently northward towards the basin center and is deeply dissected by the Green River and its tributaries. Where not removed by canyon incision, bitumen-impregnated sandstones in the middle Green River Formation (lower Eocene) occur along nearly the full length of the plateau. The bituminous sandstones encompass an area greater than 600 square miles and hold an estimated 11.6 to 14.0 billion barrels (BBO) of crude oil, but the net thickness of the bituminous sandstone and the OOIP rarely exceed 70 ft and 80 thousand barrels per acre (MBO/ac), respectively. However, in an exceptional 4.5 square mile area centered on Bruin Point (elev. 10,120 ft) on the southwest basin rim, the net thickness of bituminous sandstone and OOIP are measured in hundreds of feet and MBO/ac, respectively. The estimated OOIP in just this small area is 1.16 BBO. Bruin Point is an erosional remnant of a structural-stratigraphic trap formed by the superposition of a monoclonal flexure on a thick stack of deltaic-littoral sandstones. In the 1970s-1980s, this unique area was extensively evaluated to characterize the reservoirs and delineate the oil resource. Over 120 test wells with cores were drilled and analyzed. As many as 32 stacked bituminous sandstone bodies were encountered, 17 of which hold nearly all of the oil. The sandstones were deposited in constantly shifting deltaic lobes and along inter-delta shorelines. They are encased in marsh and floodplain mudstone and littoral calcareous mudstone and bioclastites. The sandstones are poorly-sorted, fine-grained feldspathic arenites up to 115 ft thick in distributary channels, but less than 10 ft thick in beach deposits. Average porosity and permeability are 23% and 570 md, respectively, but values vary widely between, and even within, depositional settings. The bitumen at Bruin Point is heavy (8.60 API) and highly viscous (106 cp). Just 25 miles to the north, these same deltaic sandstones are the reservoirs in the greater Monument Butte conventional oil fields. Although many operators have attempted to exploit this site for liquid hydrocarbons using both in situ steam flood and mining with solvent extraction, so far only small-scale mining of the bituminous sands for road construction has been commercially successful.

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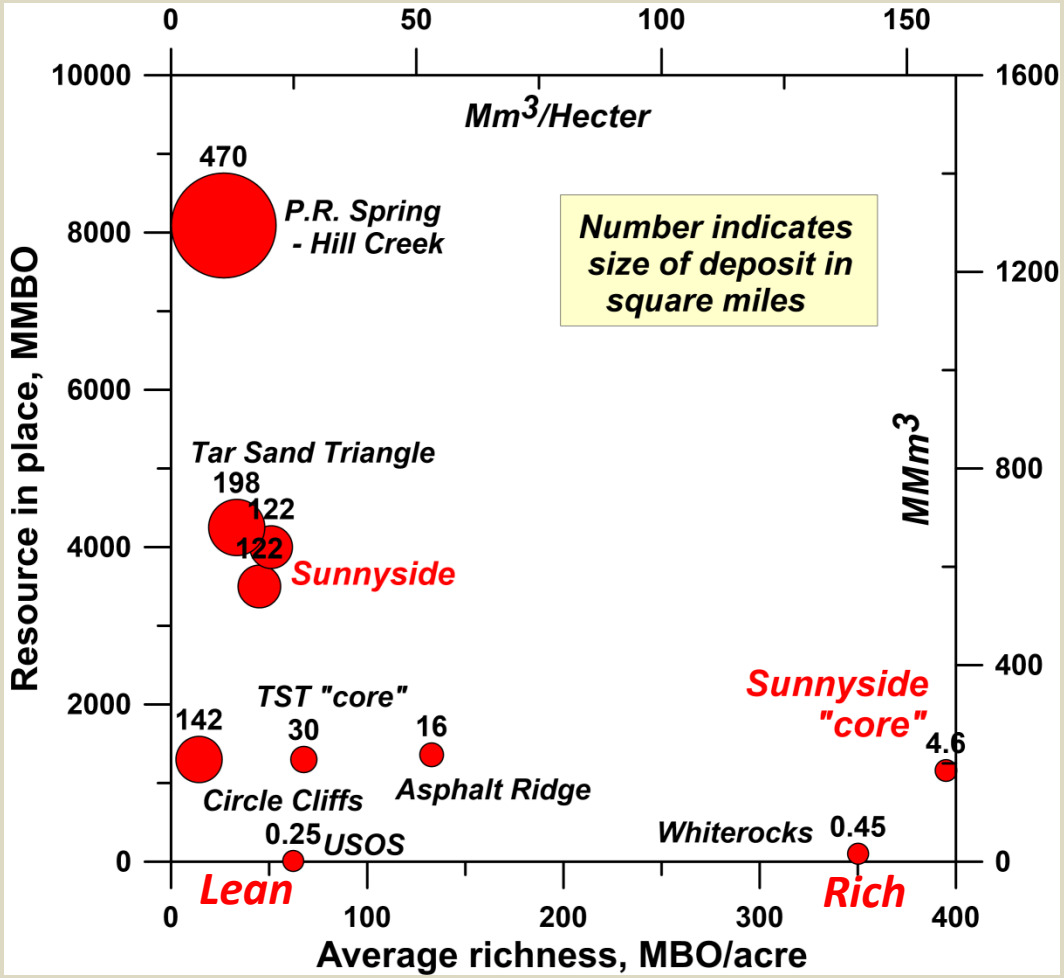
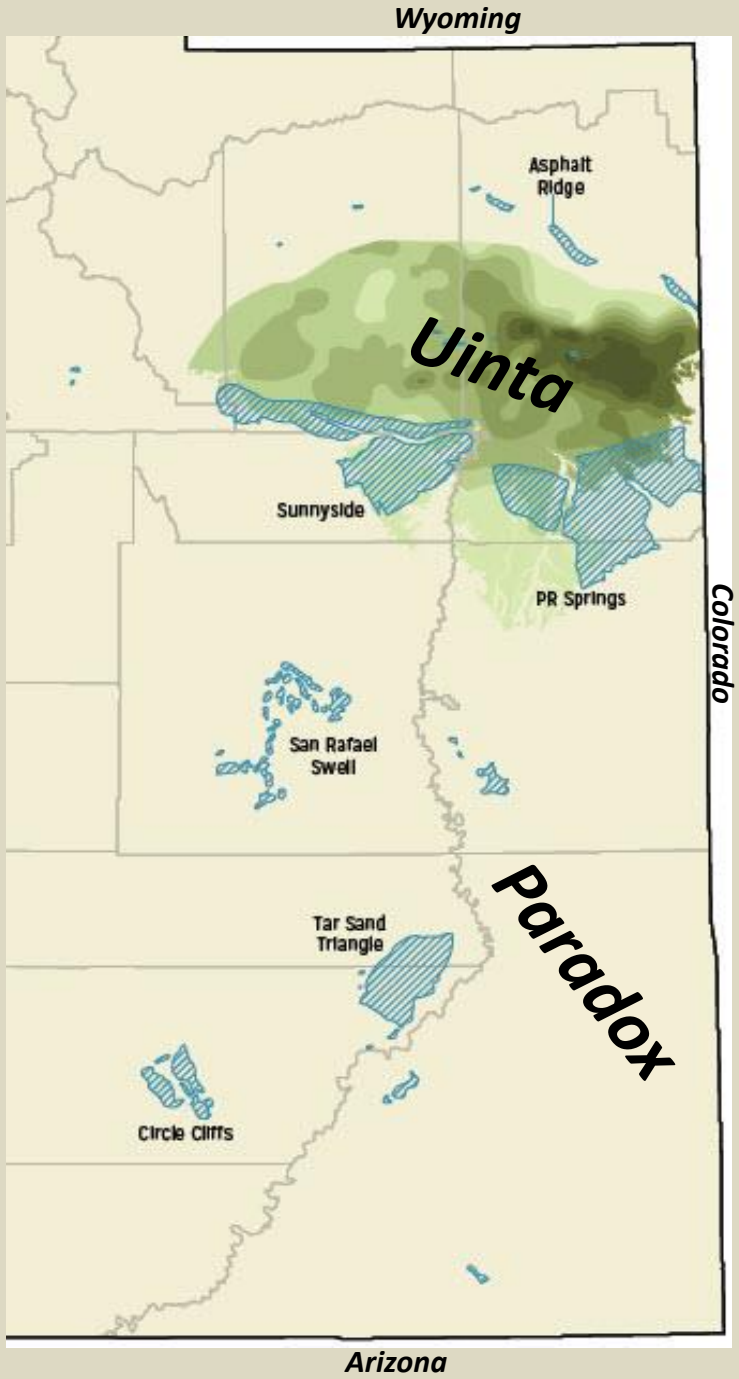
Distribution and Size of Utah's Oil Sand Deposits

Total resource greater than 16 billion barrels-in-place





Sunnyside Oil Sands at Bruin Point, southwest Uinta Basin, Utah

Oil sand deposits bordering Uinta Basin

PR Spring-Hill Creek

8095 MMB in 470 mi²

26.9 MB/acre

Sunnyside

3500-4000 MMB in 122 mi²

45 to 51 MB/acre

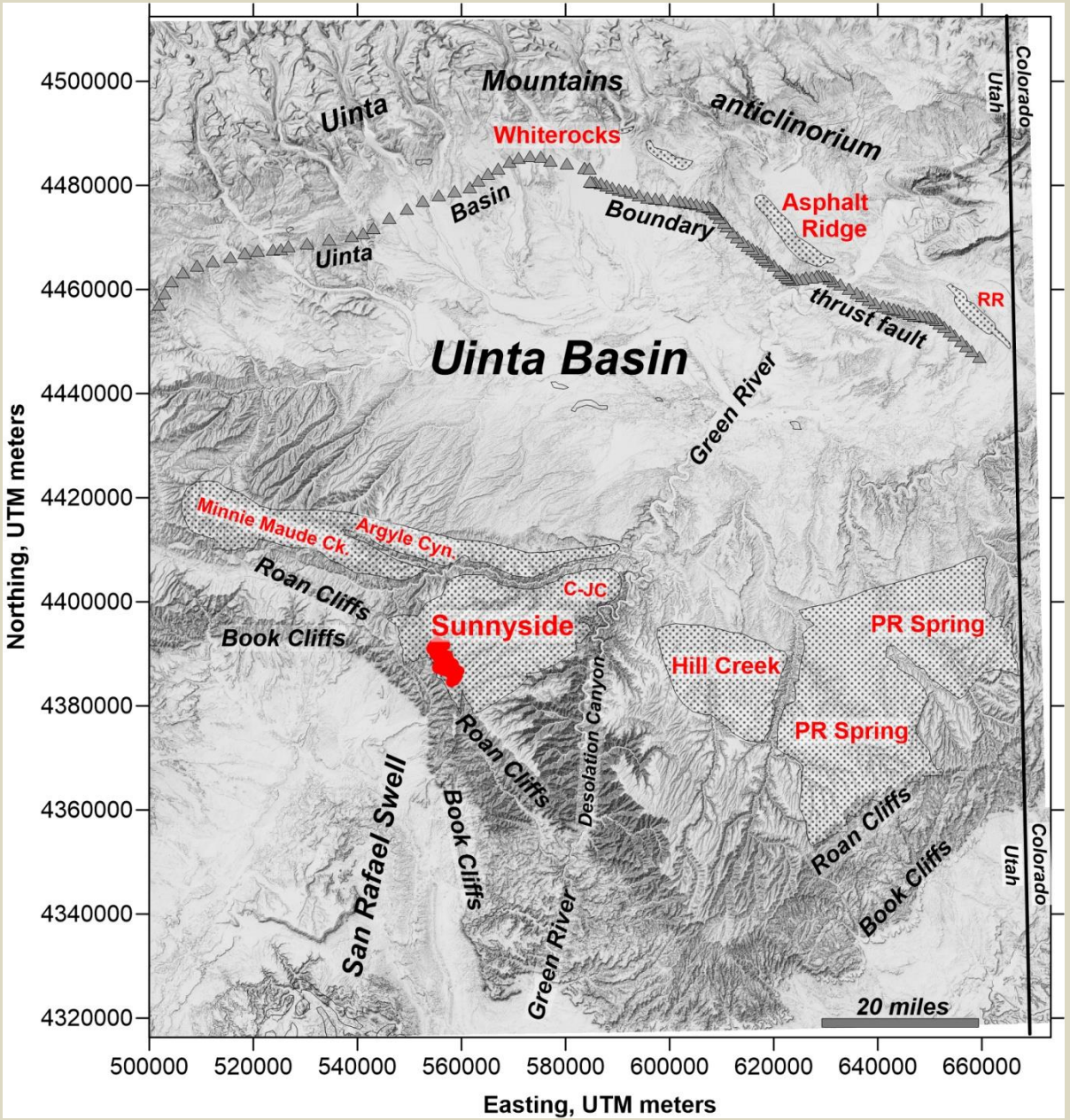
Sunnyside "sweet spot"

1160 MMB in 4.6 mi²

395 MB/acre

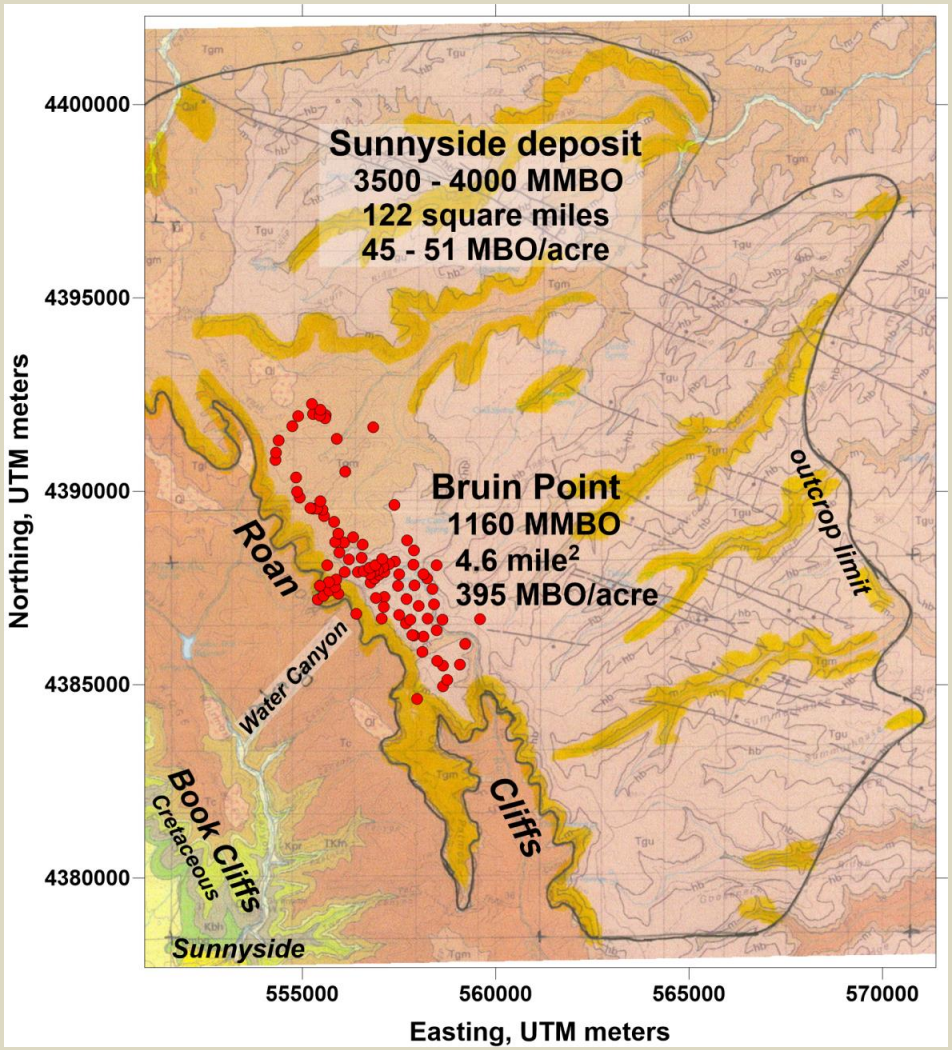
Other deposits on south flank have very small size and bitumen richness.

Large conventional oil fields down-dip in basin center.

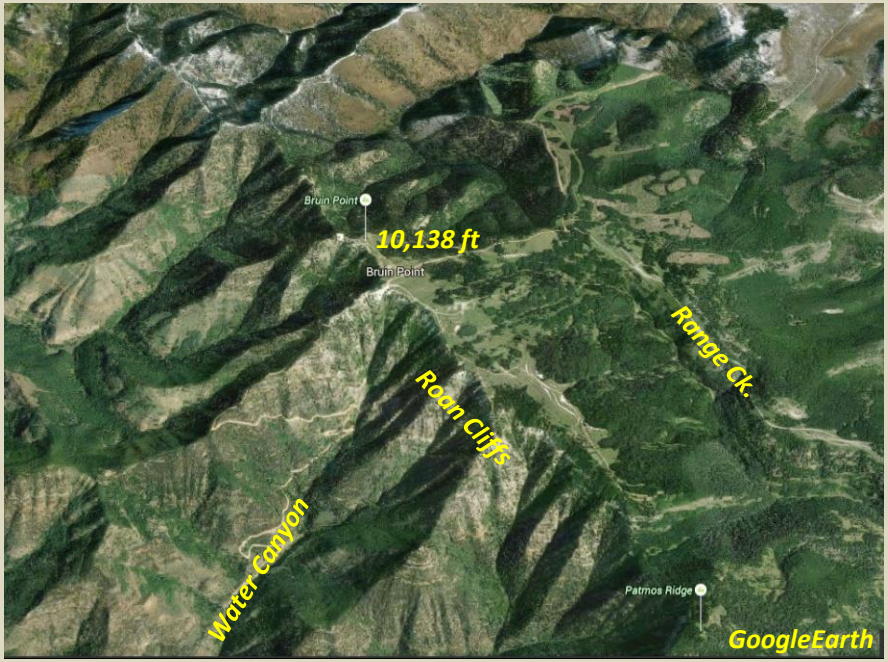


Bruin Point "sweet spot" in the Sunnyside oil sand deposit

Red dots indicate exploratory wells



Bruin Point area looking to SE



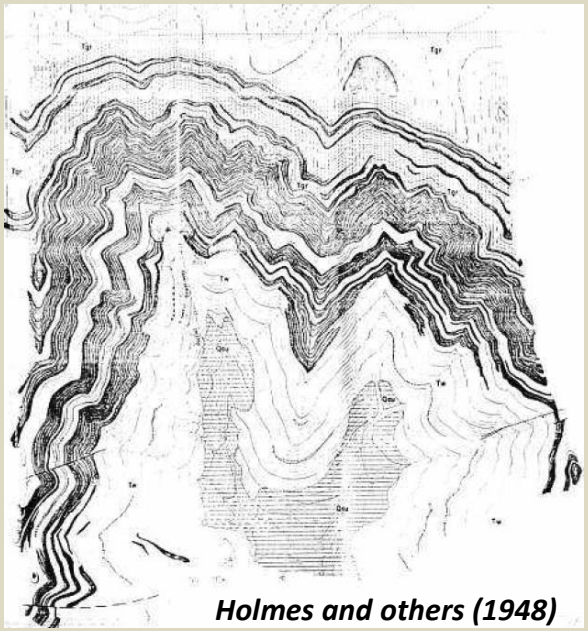
Bruin Point area looking north

Green River Formation

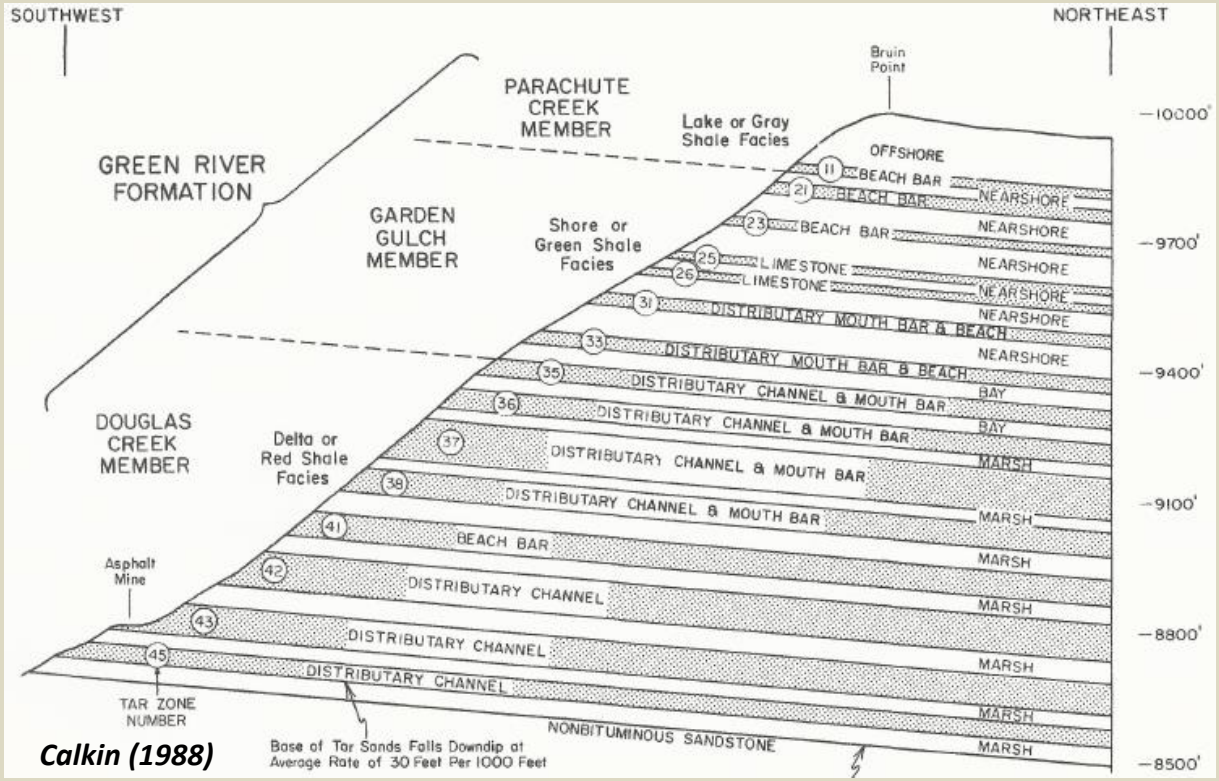
Fluvial-deltaic passing upward into open lacustrine.

Cyclic sedimentation.

Up to 32 stacked bituminous sandstone intervals.

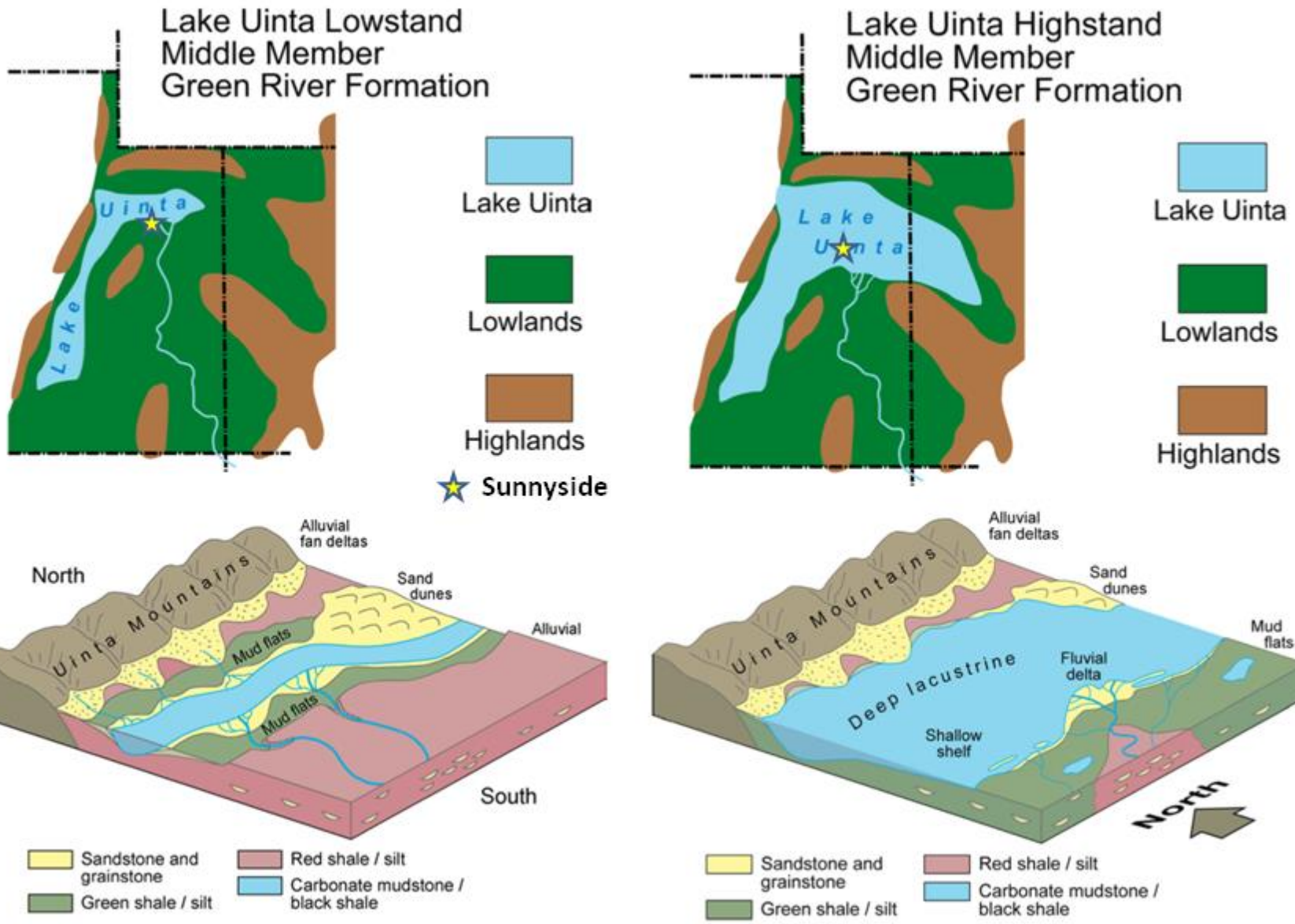


Bituminous sandstone intervals mapped in headwall of Water Canyon



Calkin (1988)

Lake level rise and fall drives facies cyclicity along the southern shoreline



Modified after Morgan et al., 2003, Utah Geological Survey Open File Report 411

Sandstone reservoir properties

Lithified fine-grained feldspathic arenite with high silt content in beds up to 115 ft thick.

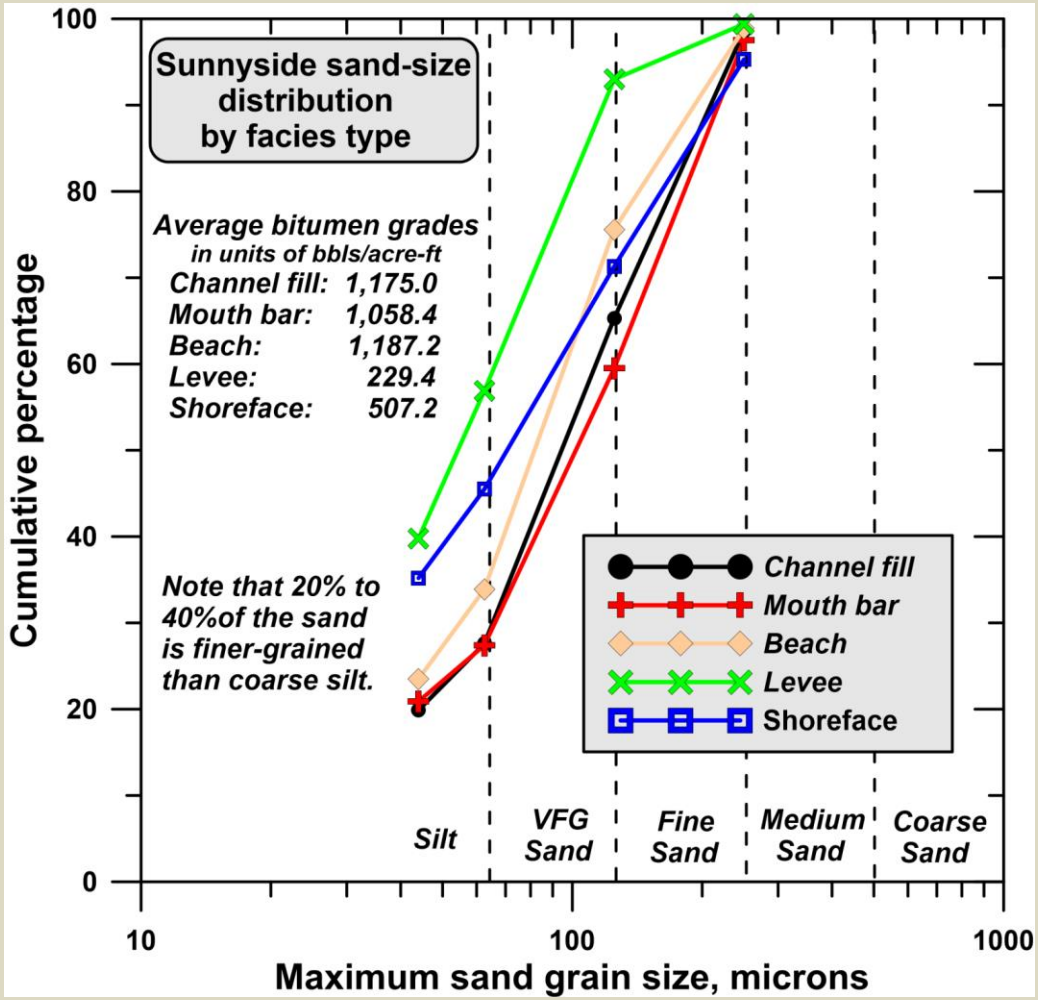
Grain-size generally related to depositional setting and average bitumen grade.

Average porosity – permeability: 23% and 570 md

Alternating sandstone-mudstone intervals

Porosity	23 ± 6.5%	(3.7–35.6%)	n = 1627
Permeability	570 ± 700 md	(0–5370 md)	n = 804
Oil saturation	51.8 ± 28.3%	(2.0–90.0%)	n = 1404
Water saturation	20.9 ± 16.1%	(0.0–97.0%)	n = 1404

Campbell and Ritzma (1979)



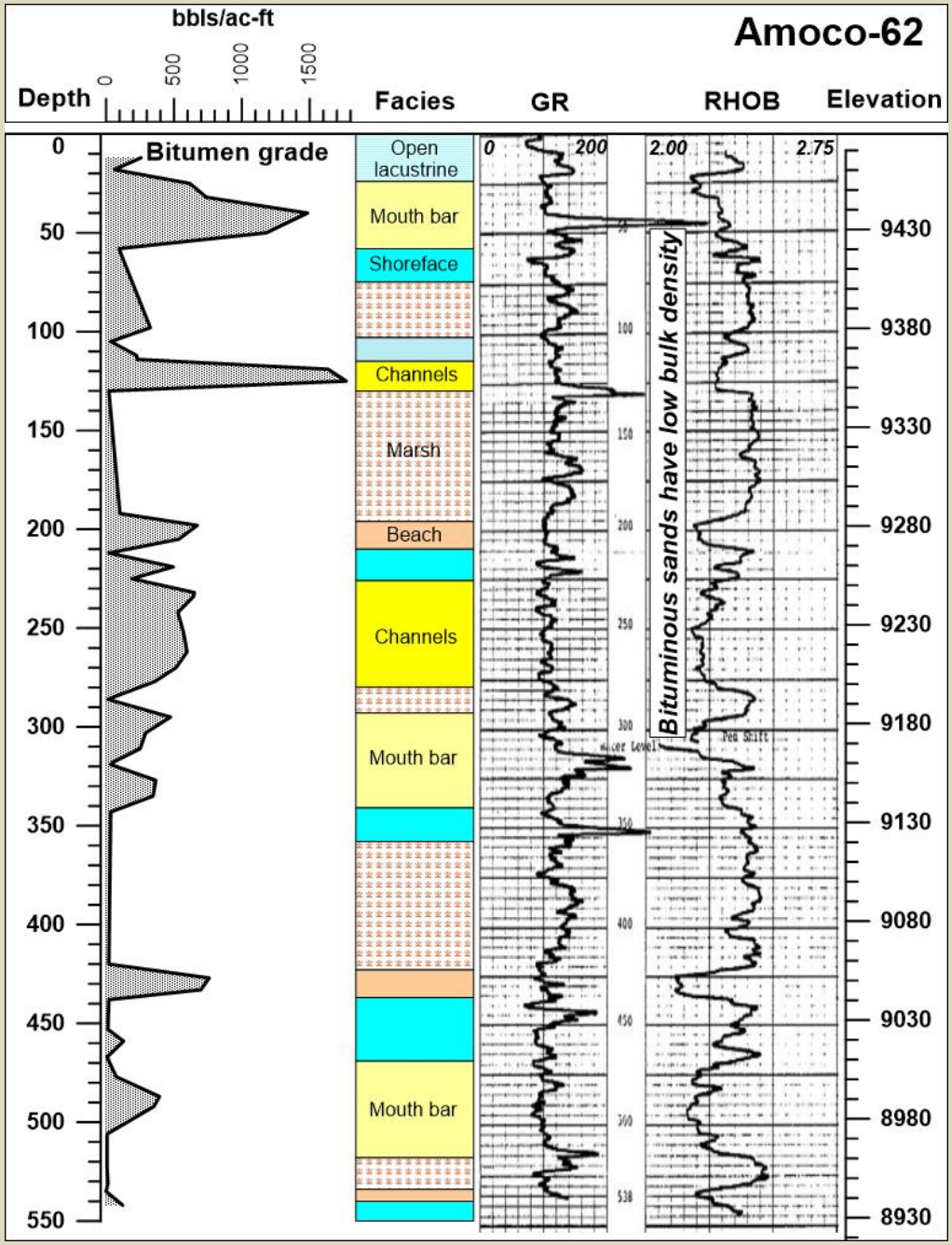
Bruin Point area core data

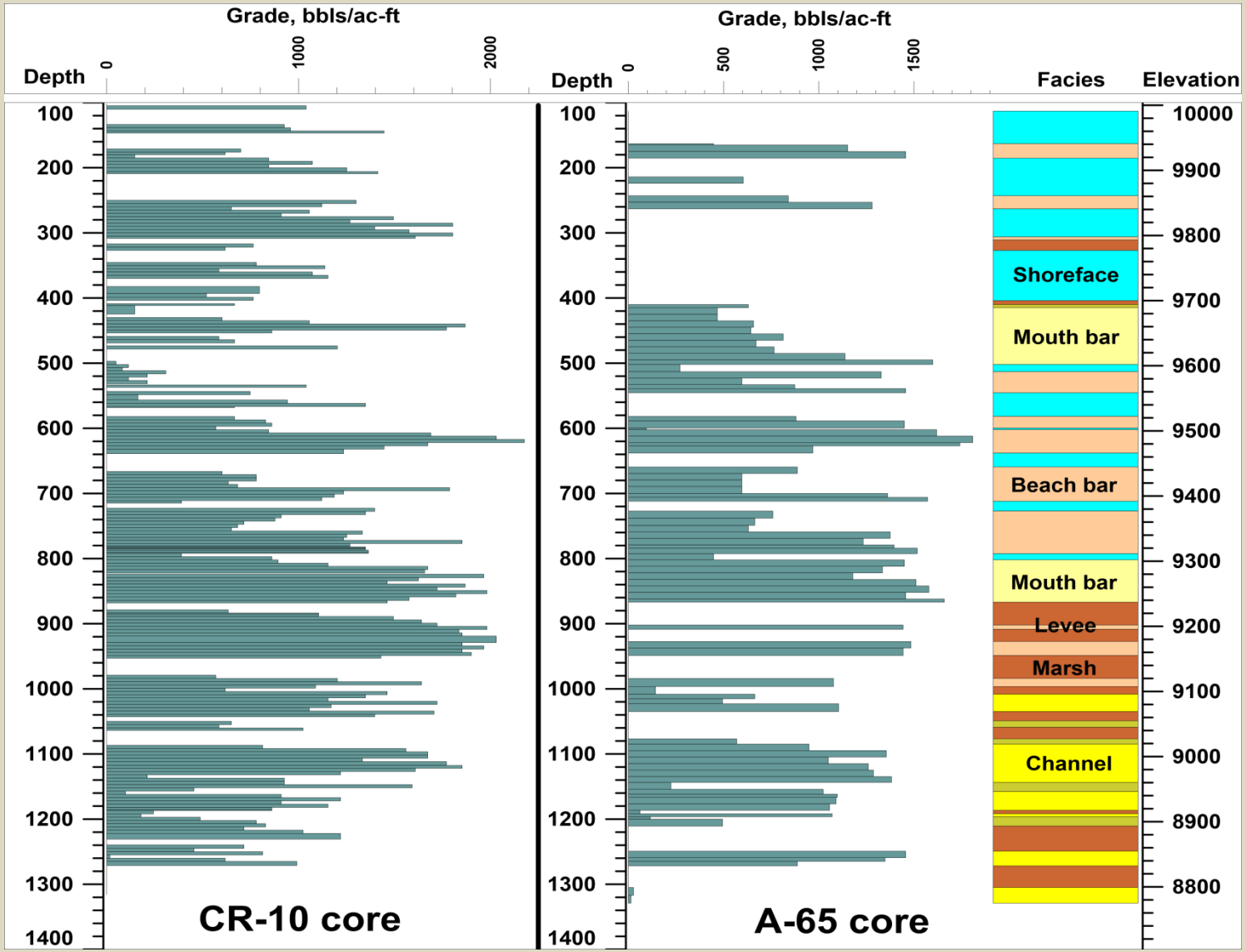
Cores taken in 1970 - 1980s

For one foot intervals record of :
Bitmen grade (gal/ton)
Depositional environment
Lithology
XRD mineralogy
E-logs

Amoco-62 core

Net bituminous sand: 362.6 ft
Net/Gross ratio: 68%
Average grade: 380.3 bbls/ac-ft
Resource: 137.9 MB/acre





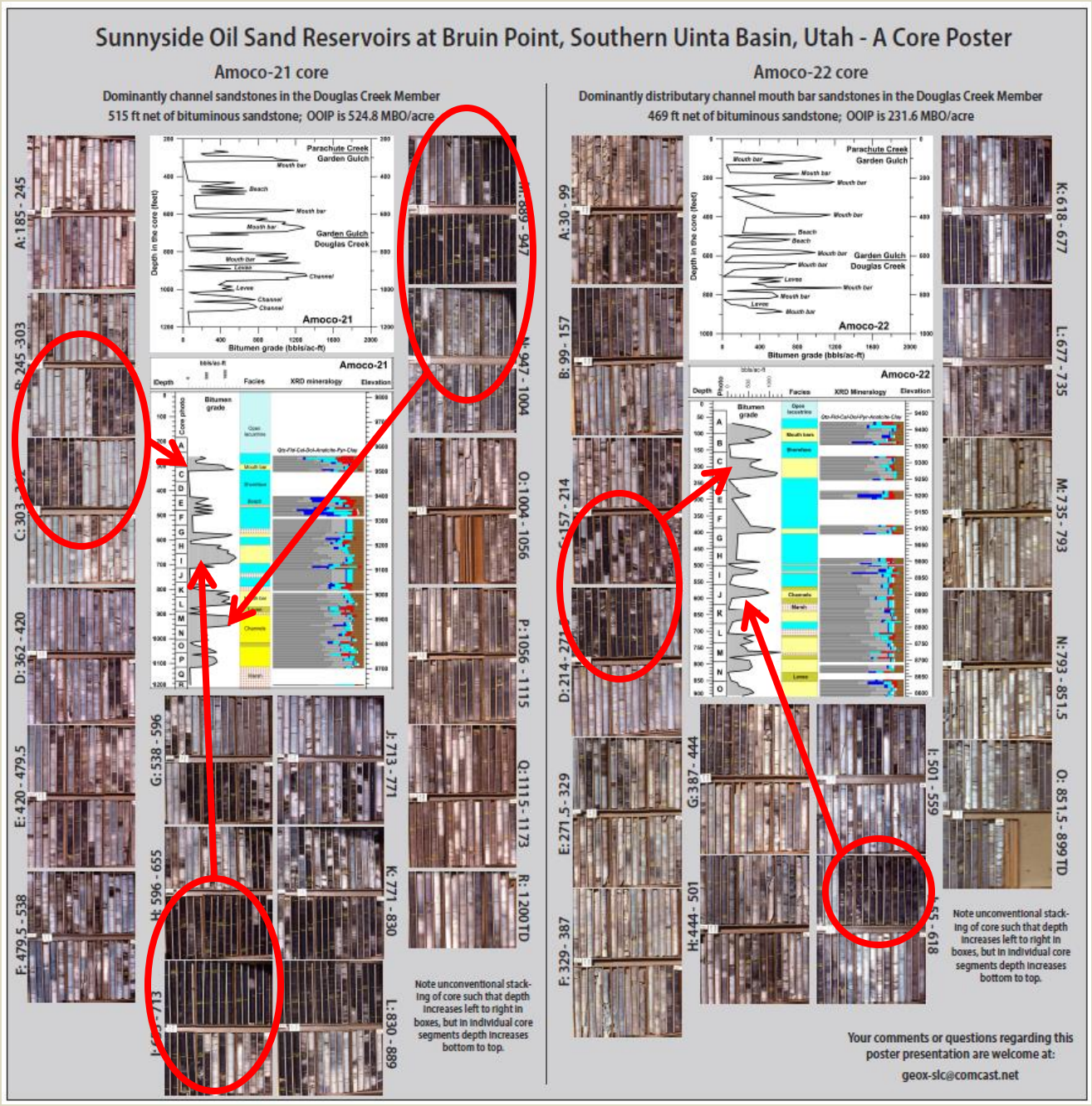
Bituminous: 923.7 ft (76%)
Avg. grade: 1079.3 bbls/ac-ft
Resource: 997.0 MB/acre

Bituminous: 696.8 ft (60%)
Avg. grade: 977.0 bbls/ac-ft
Resource: 680.8 MB/acre

Channels

515 net ft

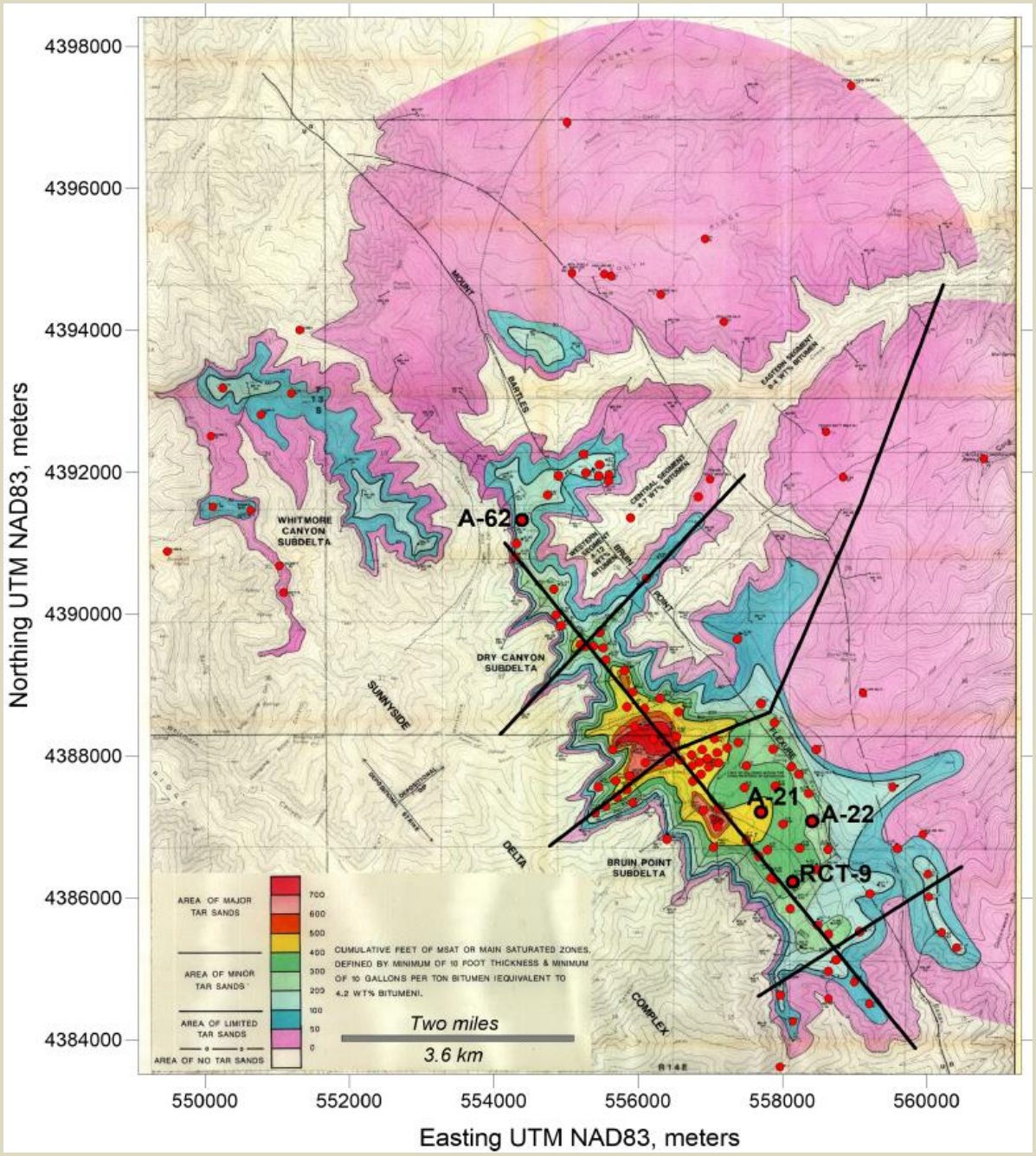
525 MB/ac



Distributory mouth bars

465 net ft

232 MB/ac



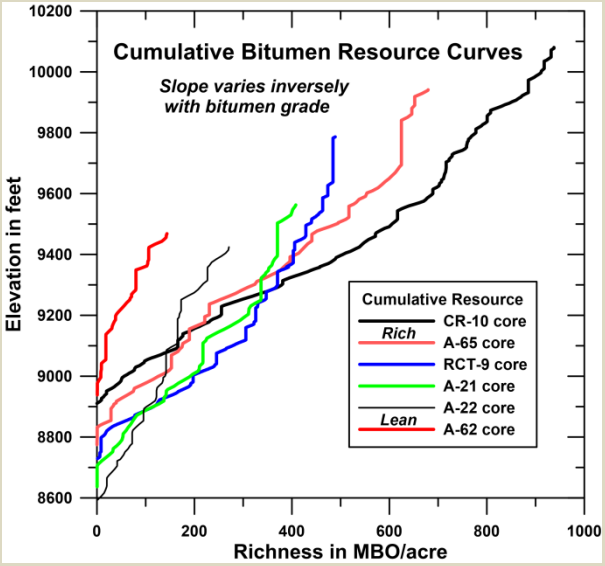
Bituminous sand net thickness

Yellow-red: >400 net feet

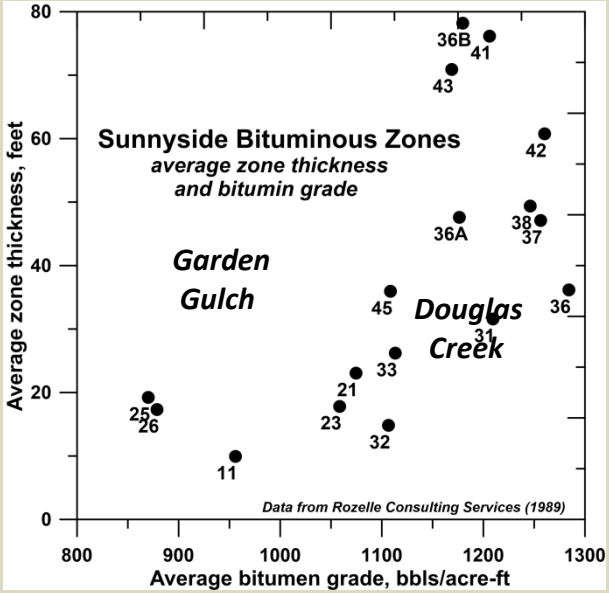
Purple: <50 net feet

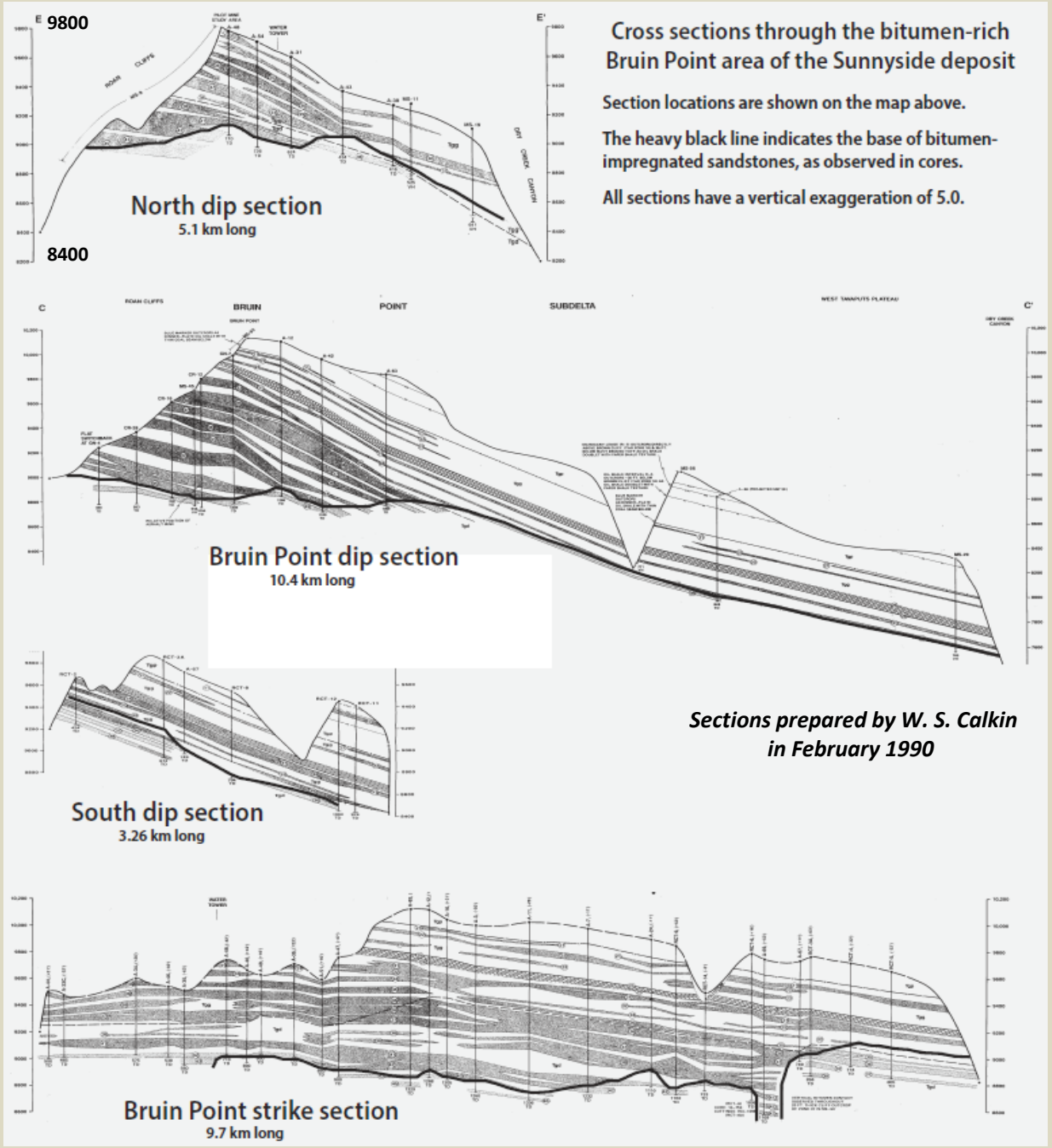
CR-10 and A-65 cores are in the small red area.

Map prepared by W. S. Calkin in January 1990



17 bituminous intervals





Cross sections through the bitumen-rich Bruin Point area of the Sunnyside deposit

Section locations are shown on the map above.

The heavy black line indicates the base of bitumen-impregnated sandstones, as observed in cores.

All sections have a vertical exaggeration of 5.0.

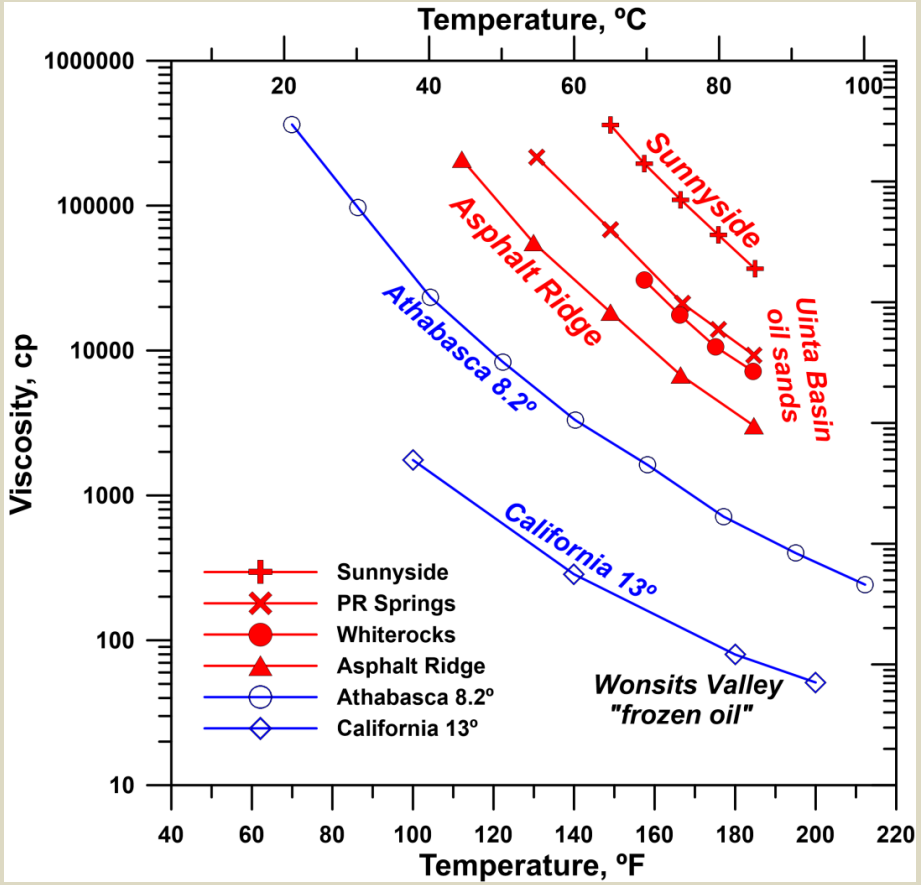
Sections prepared by W. S. Calkin in February 1990

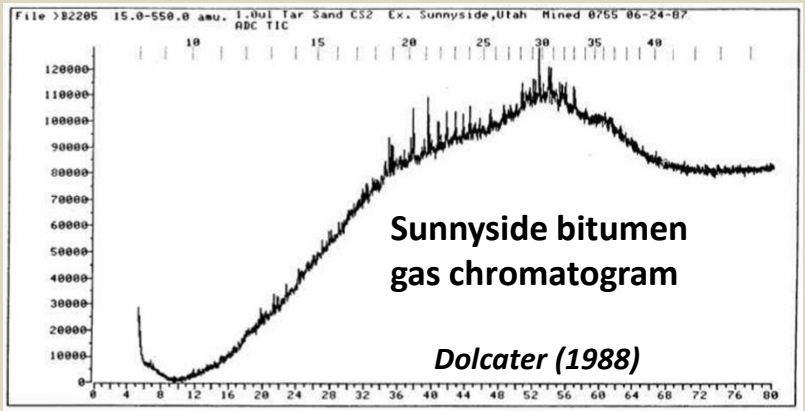
Character of Sunnyside bitumen

- The source of all Uinta Basin crude oil and bitumen is the Green River Formation, a world-class source rock.
- The viscosity of the Sunnyside bitumen is the highest in the basin. This restricts the potential for *in situ* thermal recovery strategies.
- Bitumen has low API gravity, but high molecular weight ; low saturates + aromatics and high asphaltenes.
- GC-MS analysis indicates that the oil was subjected to "*fairly extensive biodegradation*".

Property	Sunnyside Crude	Asphalt Ridge Crude
API gravity	5.5	14.4
H/C ratio	1.45	1.56
Molecular weight	588	490
Viscosity at 122°F (cp)	1,500,000	80,000
Nitrogen (wt. %)	0.90	1.06
Sulfur (wt.%)	0.50	0.44
Fractional composition		
Saturates	24.9	32.4
Aromatics	18.6	22.4
Resins	30.6	37.6
Asphaltenes	23.7	7.6

*Data from Bukka et al. (1991) and Oblad et al. (1987).





Conclusions

At Bruin Point, along the southwest rim of the Uinta basin, an area of just 4.6 square miles holds 1.16 billion barrels of bitumen.

The bitumen is in stacked fluvial-deltaic and lacustrine beach sands in the lower Green River Formation. They are encased in high-stand mudstones.

The sandstone intervals are exceptionally numerous, thick and bitumen-rich at this location. Bitumen richness averages 395 MB/acre.

However, at this location the 8.6^0 API bitumen is highly biodegraded and exceptionally viscous (10^6 cp).

Despite concerted efforts to exploit this unique resource, with major investments in the 1970s and 1980s, the only commercial success has been small-scale mining of oil sand for road construction.

Challenges to development remain the poor quality of the bitumen, the lithified sandstone reservoir, and the sensitive location of the site.