

Oil Shales in Saskatchewan

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Saskatchewan Energy and Resources

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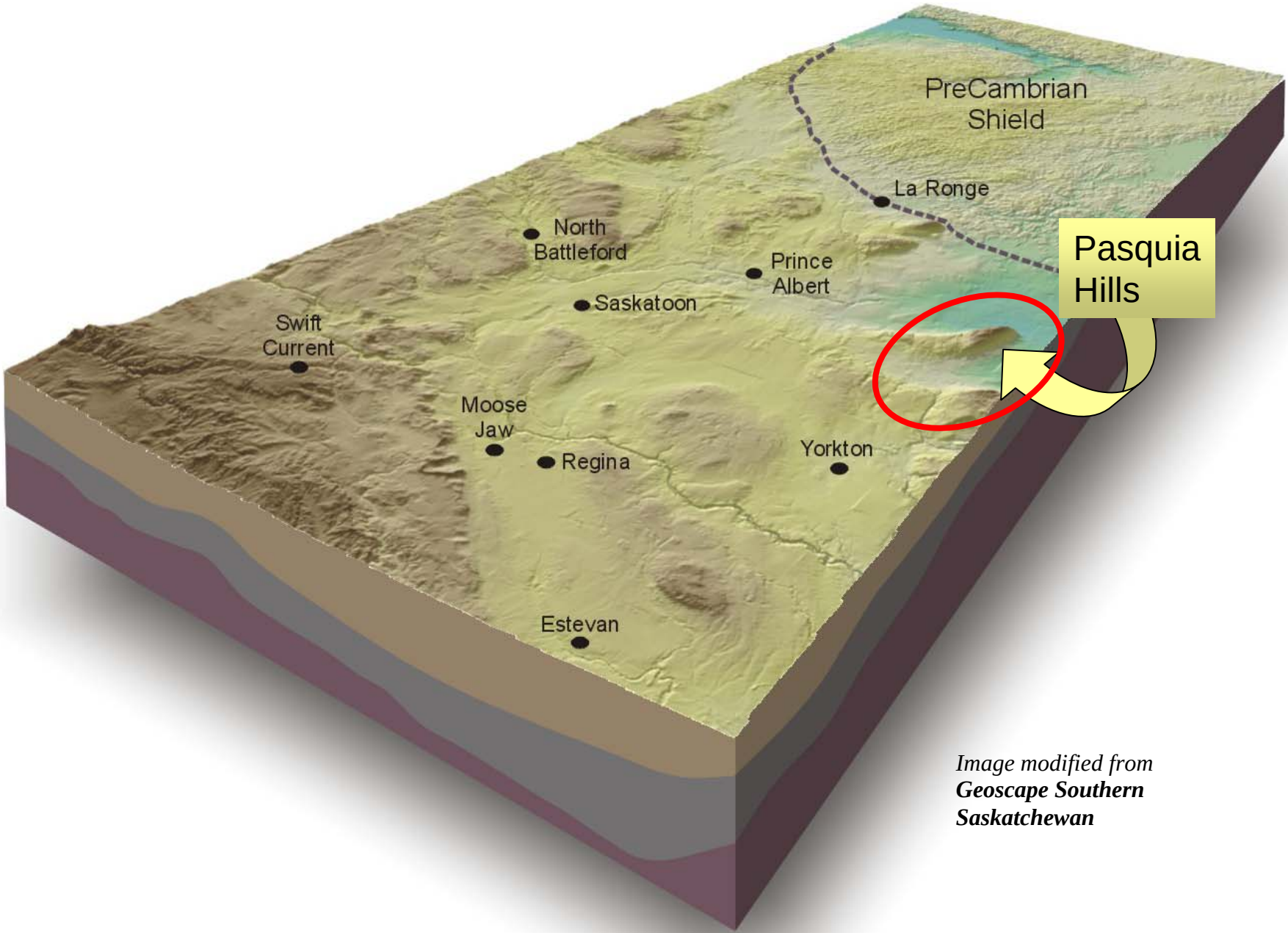
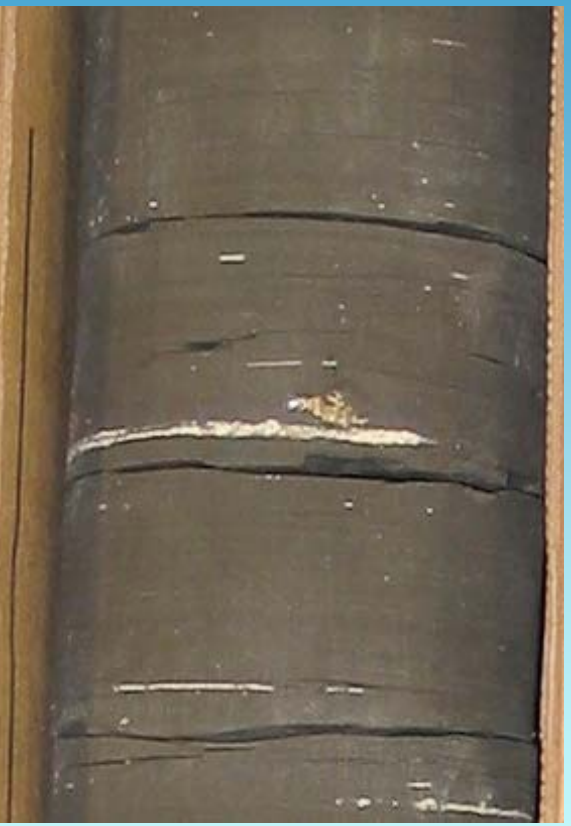


Image modified from
Geoscape Southern Saskatchewan

Oil Shales vs Oil Sands



Kerogen rich shale
Second White Specks Fm
NAL ALIDA EAST
21/10-02-006-33W1M

- Oil sands produce “bitumen” whereas oil shale produces “kerogen”
- Oil shales have a high organic content – high in kerogen
- Oils shales are immature source rock

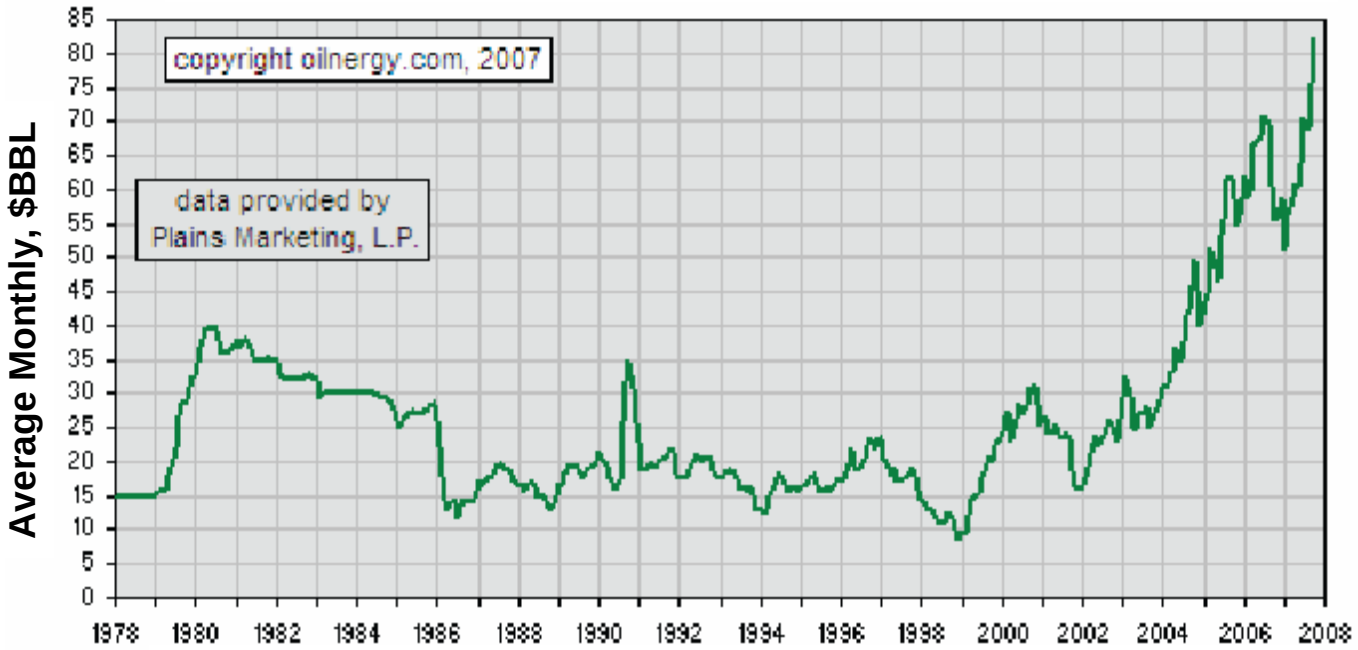
Oil saturated sand
Mannville Fm
HUSKY NEILBURG
11/11-7-46-25W3M

What is oil shale?

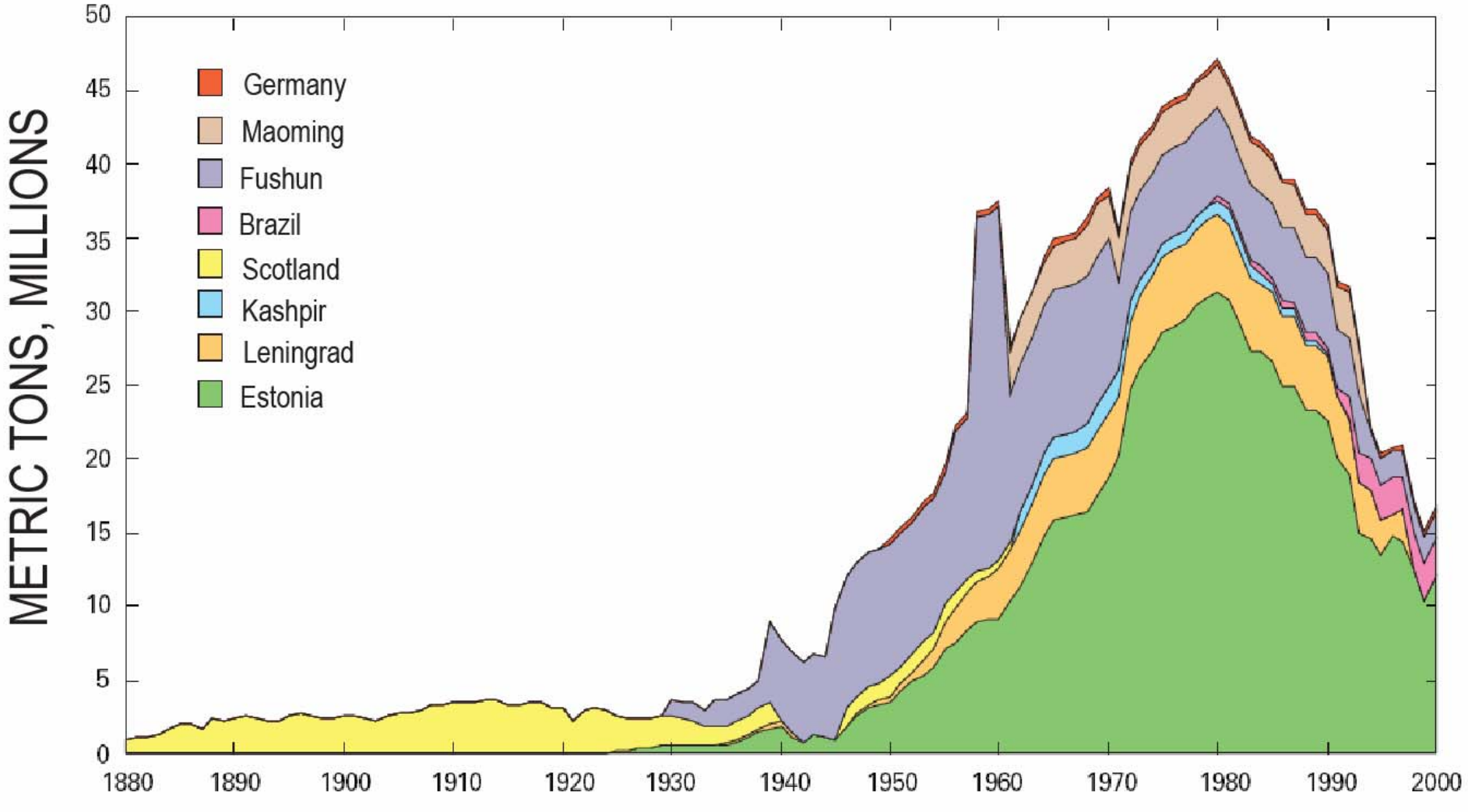
- Formed over millions of years ago by deposition of debris on lake beds and sea bottoms
- Not necessarily a shale - marlstone oil shales common
- Kerogen is richer in hydrogen and nitrogen, and therefore has a value added to the end product

After Cobban and McKinley
http://esp.cr.usgs.gov/research/fossils/ammonites.html

Plains Marketing, L.P.'s WTI Crude – Posted Price

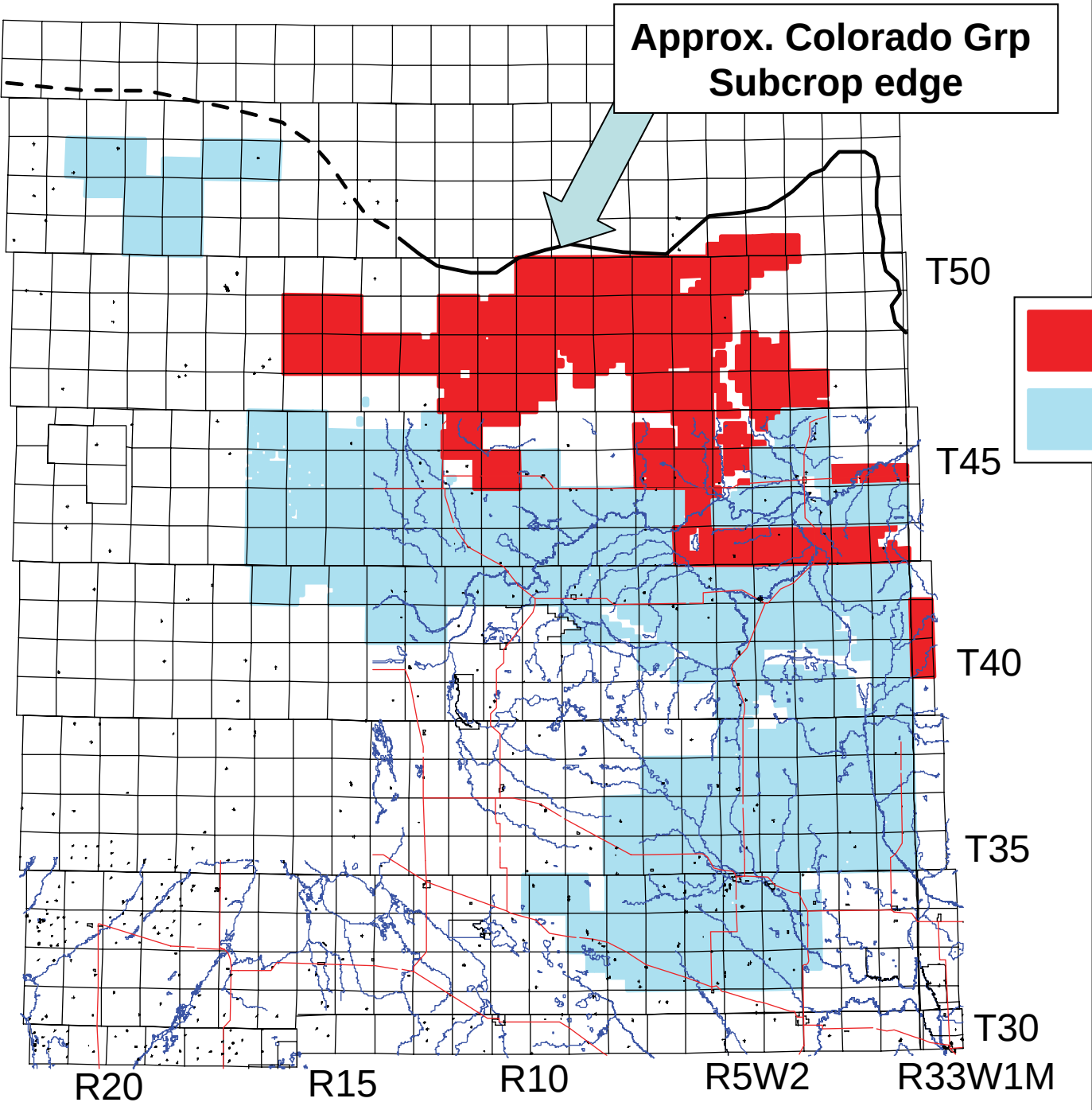


Average Monthly data from January 1978 through October 2007



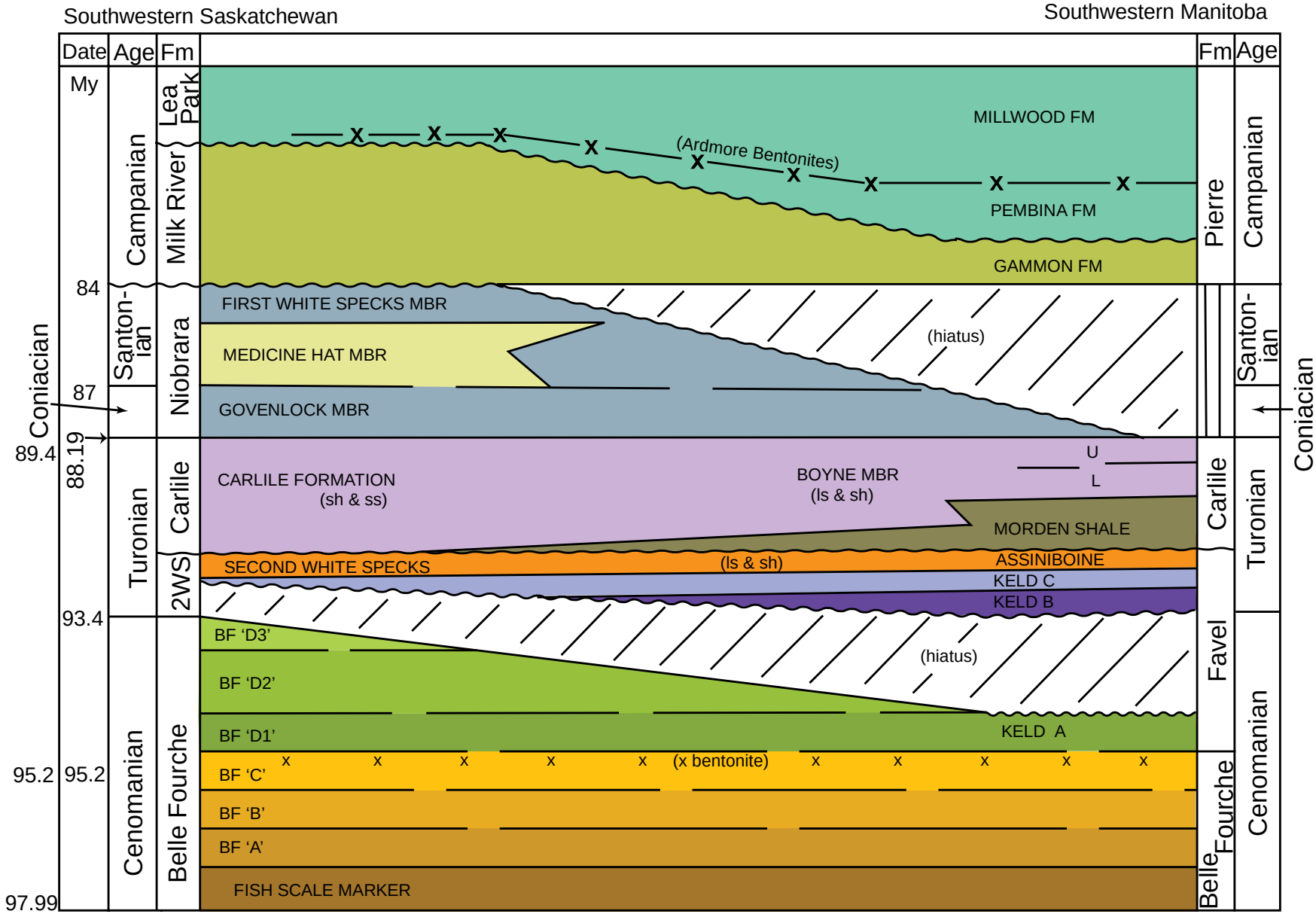
•Current all production in the world is ex-situ

Current Land Permits



Oil shale Permits

PNG Permits



References: Ridgley et al. (2002) Collum (2000) Bloch et al (1993) McNeil and Caldwell (1984)

Extraction of oil from shale

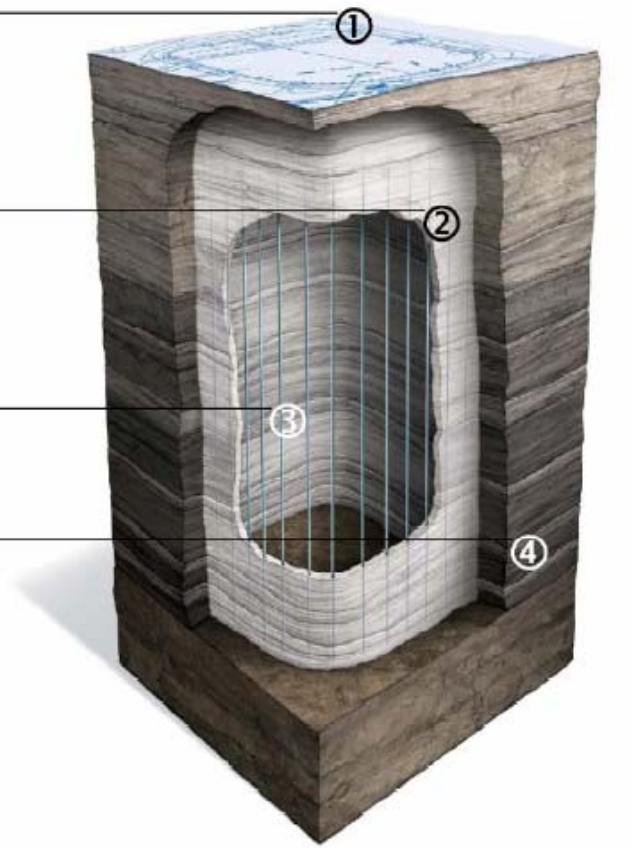
- To obtain oil, shale must be heated to a high temperature (a process called retorting)
- The resultant liquid must then be separated and collected\Traditional and current mining methods have been used to extract the shale before retorting
- An alternative but currently experimental process referred to as *in situ* retorting involves heating the oil shale while it is still underground, and then pumping the resulting liquid to the surface

Classification of oil shale processing technologies according to heating method and location[6]

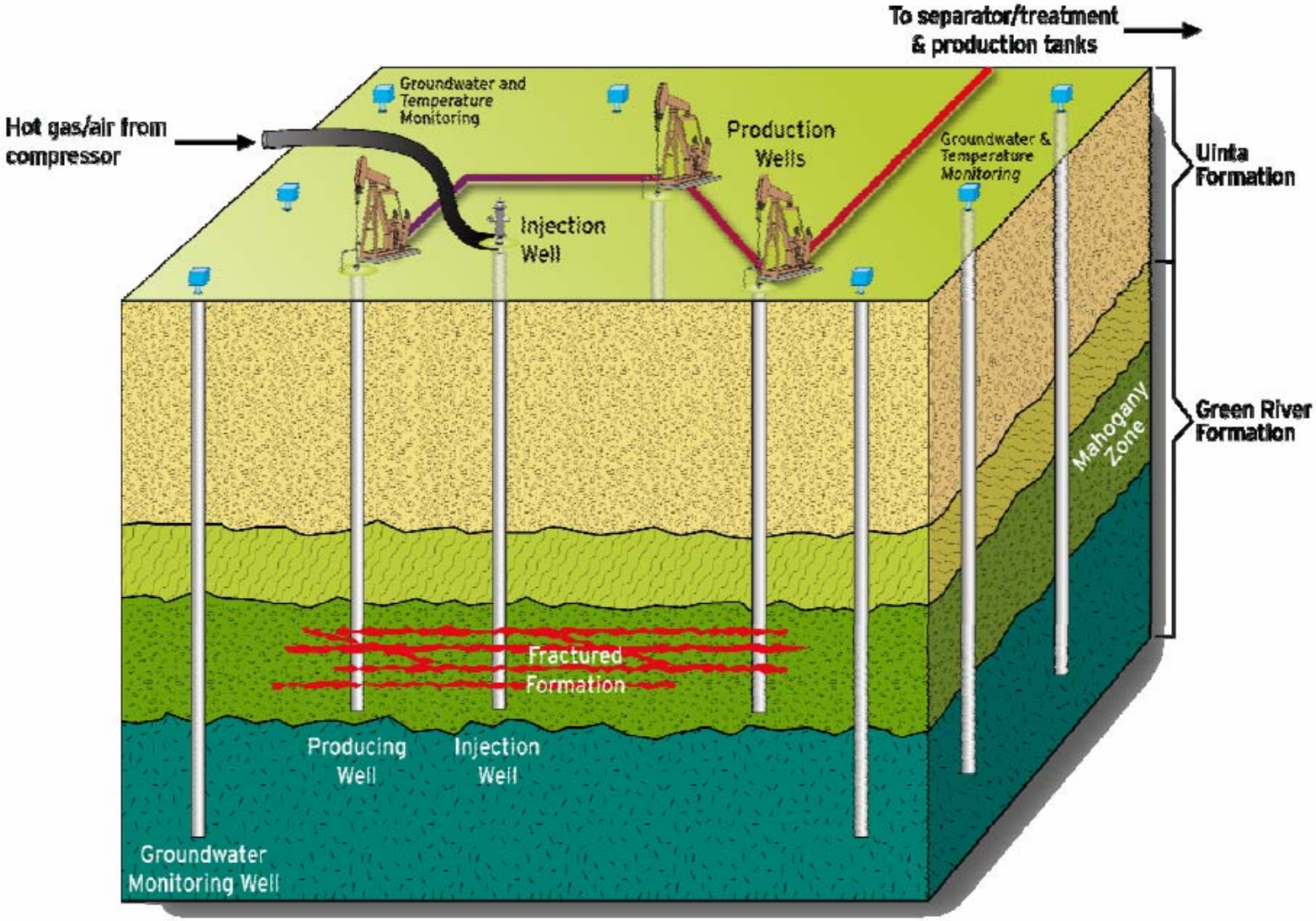
Heating Method	Above Ground (*ex-situ*)	Below Ground (*in-situ*)
Internal combustion	Kiviter, Fushun, Union A, Paraho Direct, Superior Direct	Oxy MIS, LLNL RISE, Geokinetics Horizontal, Rio Blanco
Hot recycled solids (inert or burned shale)	Alberta Taciuk, Galoter, Lurgi, TOSCO II, Chevron STB, LLNL HRS, Shell Spher	-
Conduction through a wall (various fuels)	Pumpherston, Hom Tov, Fischer assay, Oil-Tech, EcoShale In-Capsule Process, Combustion Resources	Shell ICP (primary method), EGL Oil Shale Process, IEP Geothermic Fuel Cell Process
Externally generated hot gas	PetroSIX, Union B, Paraho Indirect, Superior Indirect, Syntec process (Smith process)	Chevron CRUSH, Petro Probe
Reactive fluids	IGT Hytort (high-pressure H2), Xtract Technology (supercritical solvent extraction), Donor solvent processes, Chattanooga fluid bed reactor	Shell ICP (some embodiments)
Volumetric heating	-	ITTRI, LLNL and Raytheon radiofrequency processes, Global Resource microwave process, Electro-Petroleum EEOP

In Situ process

1. **SURFACE FOOTPRINT** – Surface facilities for the freeze wall include access points to the closed-loop pipe system, monitoring wells and groundwater wells, which will pump out the groundwater from inside the contained reservoir once the freeze wall is built.
2. **ICE WALL** – A chilled liquid would be circulated through a closed system of pipes causing the water in the surrounding rock to freeze and eventually form a wall of ice. This freeze wall will serve as a barrier to keep groundwater out of the contained reservoir.
3. **HOLES** – Shell will drill a maximum of 150 holes spaced about 8 feet apart in order to create the closed-loop pipe system.
4. **SHALE BED** – Up to 2,000 feet beneath the surface, the shale layer is a rock formation containing organic matter (kerogen). It is this organic matter trapped in the rock that results in oil and gas when gradually heated. Shell's goal is to find a way to produce this potential energy resource in an economically viable, environmentally responsible and socially sustainable manner.

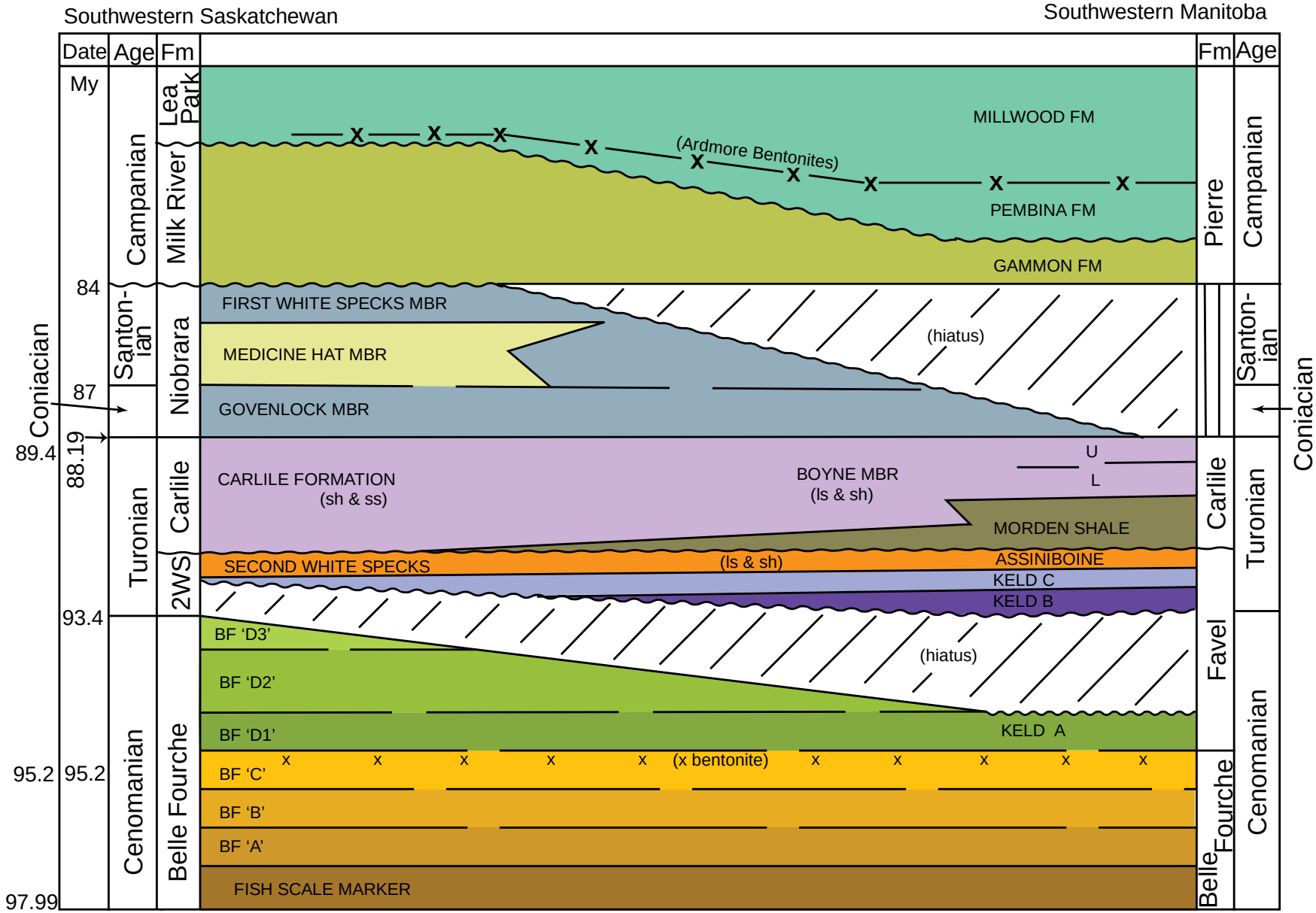


Source: http://www.co.blm.gov/wrra/WRFO_Oil_shale.htm



Fractured zone vertically and horizontally limited to 1 to 5 acre area

Source: Environmental assessment of Chevron proposed Oil Shale R&D; http://www.co.blm.gov/wrra/documents/CO1102006120EAwofigures.pdf



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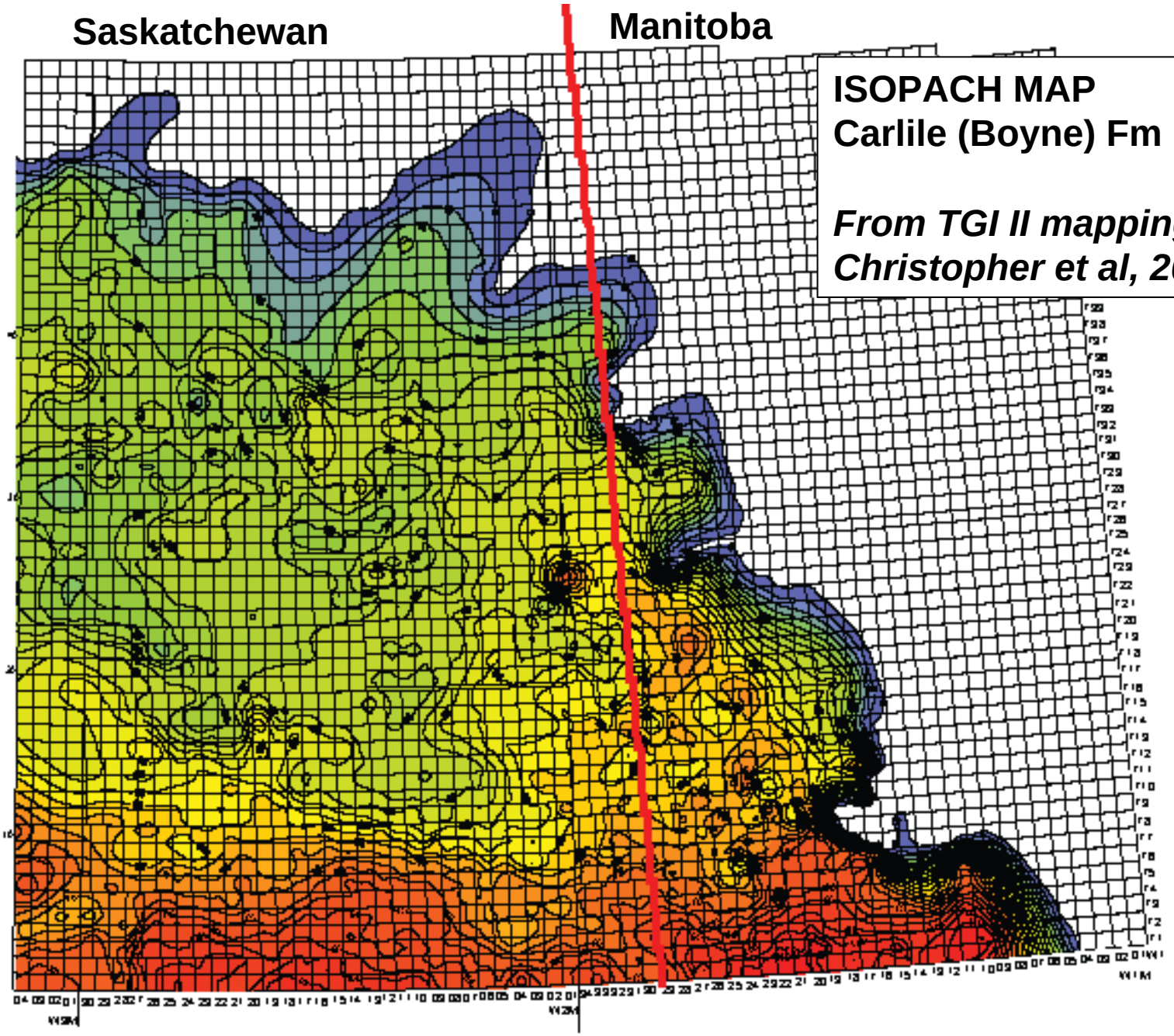
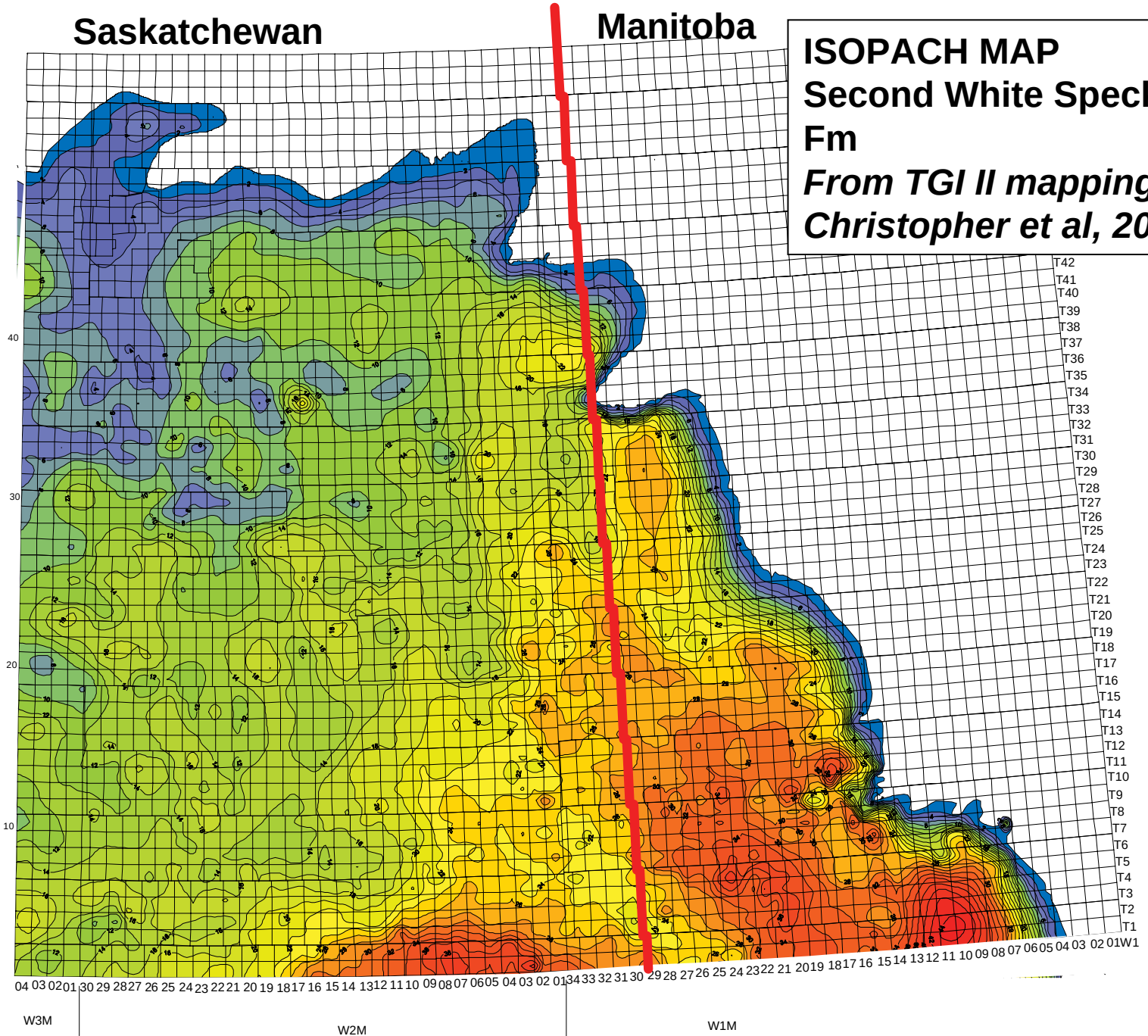
Saskatchewan

Manitoba



ISOPACH MAP
Carlile (Boyne) Fm

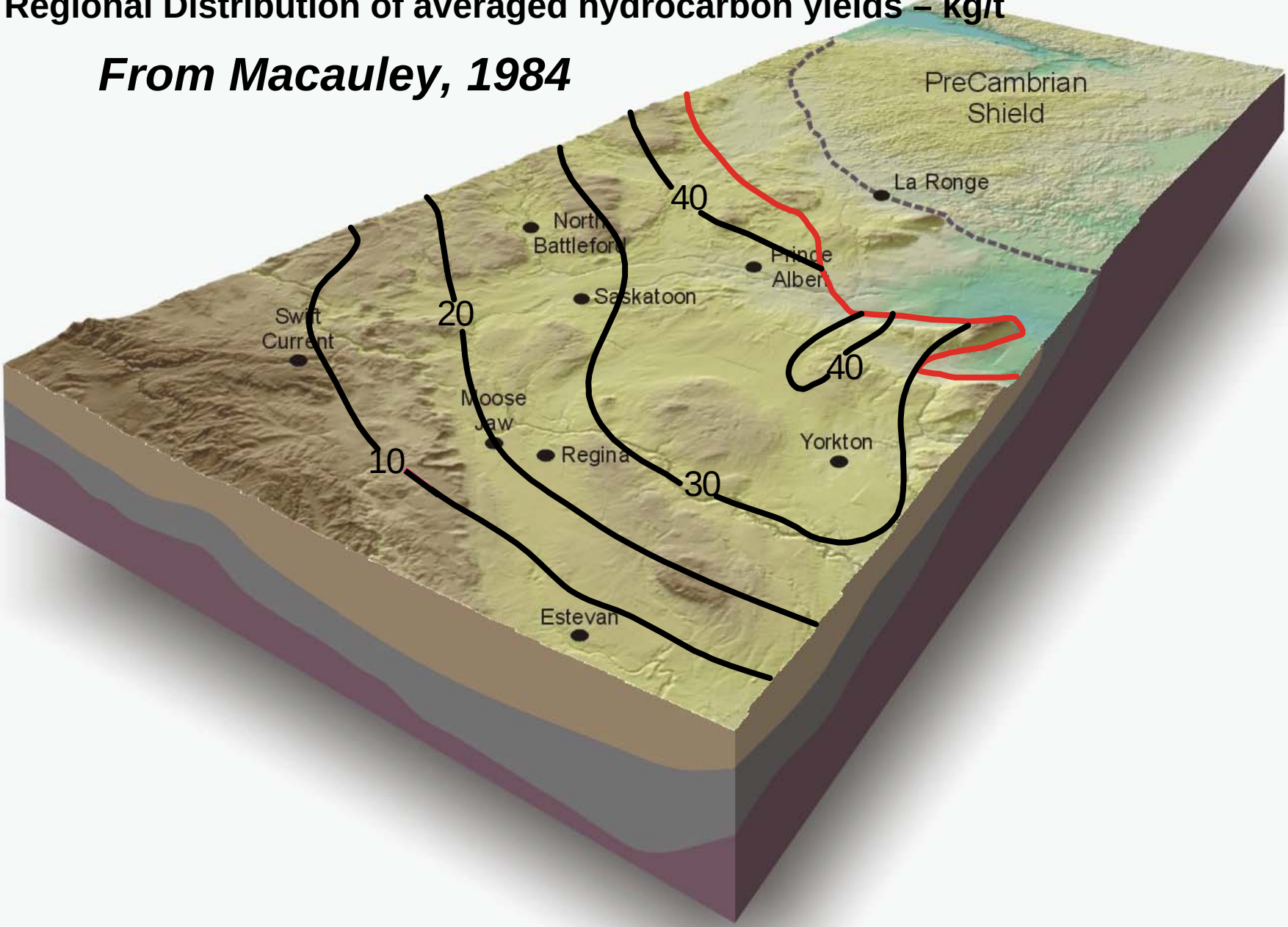
From TGI II mapping results
Christopher et al, 2006


Saskatchewan
Manitoba
ISOPACH MAP
Second White Specks (Favel) Fm
From TGI II mapping results
Christopher et al, 2006
W3M
W2M
W1M

Carlile Fm

Regional Distribution of averaged hydrocarbon yields – kg/t

From Macauley, 1984



Second White Specks Fm

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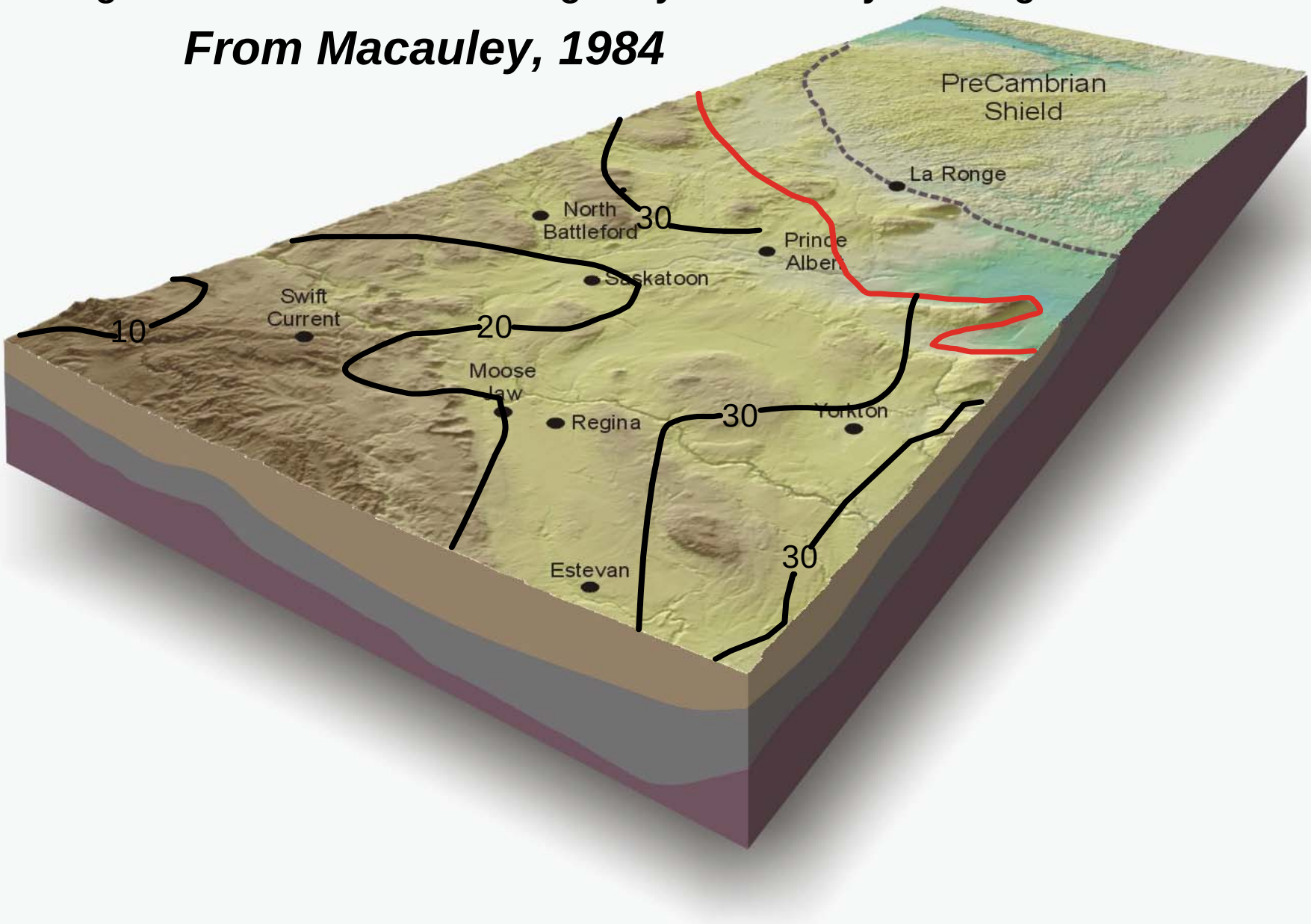

Conclusions

- Price of oil continue to remain ~ $100, exploitation of this resource is more attractive.
- Ex-situ recovery and production already occurs in Brazil, China, Estonia – is the value added of the by-products enough to make it viable in Canada?
- Once in-situ technologies develop, southern Saskatchewan has potential.

Acknowledgements

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- TGI II – GSC, Saskatchewan Energy and Resources and Manitoba Science Technology and Mines