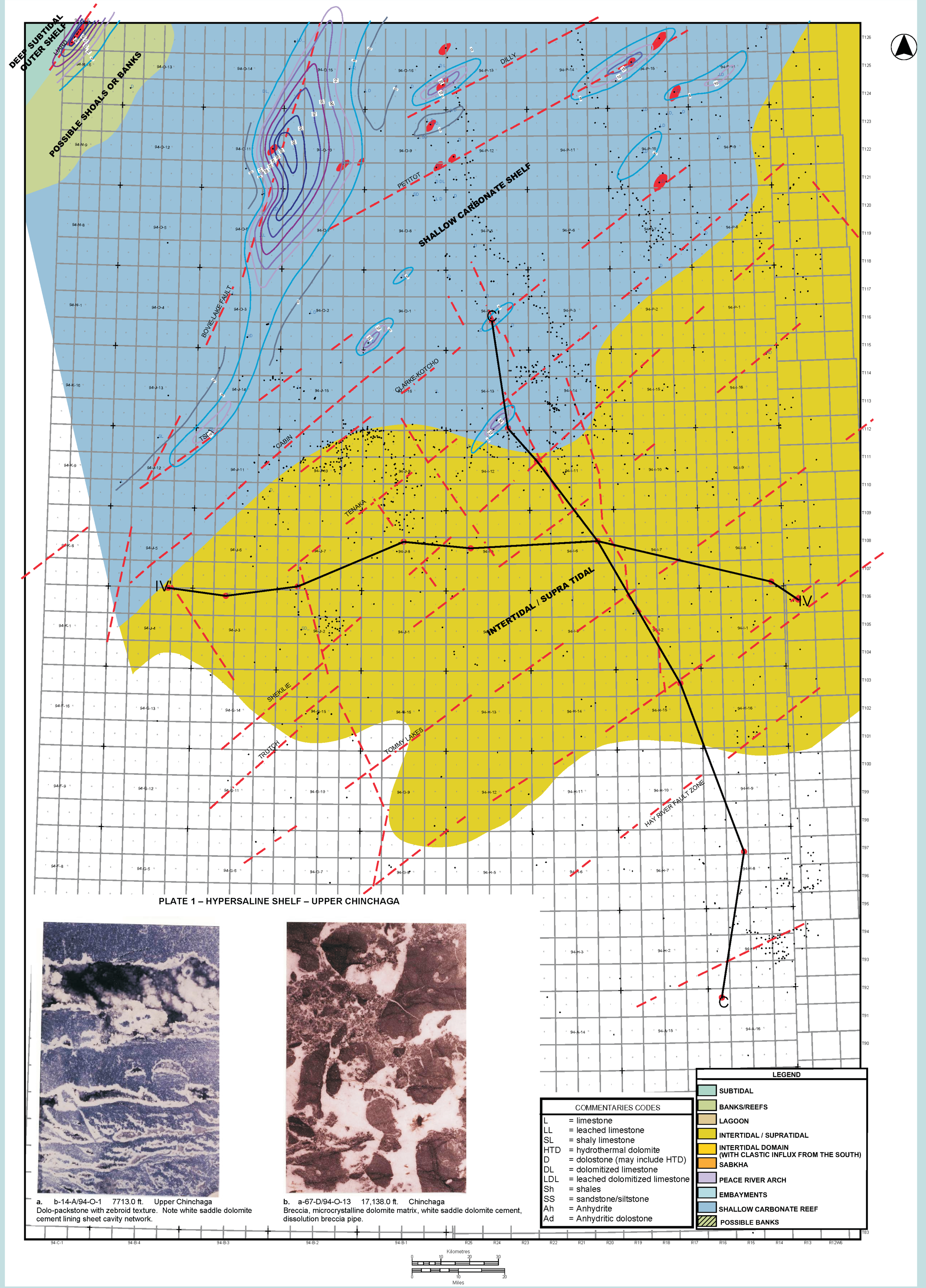

POSSIBLE SHOALS OR BANKS
SHALLOW CARBONATE SHELF
INTERTIDAL / SUPRA TIDAL
PLATE 1 – HYPERSALINE SHELF – UPPER CHINCHAGA
a. b-14-A/94-O-1 7713.0 ft. Upper Chinchaga
Dolo-packstone with zebroid texture. Note white saddle dolomite cement lining sheet cavity network.
b. a-67-D/94-O-13 17,138.0 ft. Chinchaga
Breccia, microcrystalline dolomite matrix, white saddle dolomite cement, dissolution breccia pipe.
COMMENTARIES CODES
L = limestone
LL = leached limestone
SL = shaly limestone
HTD = hydrothermal dolomite
D = dolostone (may include HTD)
DL = dolomitized limestone
LDL = leached dolomitized limestone
Sh = shales
SS = sandstone/siltstone
Ah = Anhydrite
Ad = Anhydritic dolostone
LEGEND
SUBTIDAL
BANKS/REEFS
LAGOON
INTERTIDAL / SUPRATIDAL
INTERTIDAL DOMAIN (WITH CLASTIC INFLUX FROM THE SOUTH)
SABKHA
PEACE RIVER ARCH
EMBAYMENTS
SHALLOW CARBONATE REEF
POSSIBLE BANKS
Kilometres
Miles

Fig. 5 - UPPER - CHINCHAGA PALEO-GEOGRAPHY AND POROSITY

The Chinchaga contains a wide variety of lithofacies including very fine-grained peloidal wackestones and packstones with birdseye fabrics, pebble breccias and dessication fractures.

Chinchaga carbonates produce gas at Beaver River (and to the north at Kotaneelee, Pointed Mountain, and Fort Liard), primarily from hydrothermal dolomite reservoirs and structural traps.
The Chinchaga is prospective in northernmost British Columbia where fenestral and intrafossil vug porosity has been observed in platformal facies, and hydrothermal dolomites (Plate 1) occur along several fault trends. Numerous gas shows occur in the Chinchaga (and younger formations) along the eastern upthrown margin of the Bovie Lake Fault in B.C. and the NWT, as large volumes of gas appear to have been preferentially transported along the axis of the fault, and trapped locally in areas where HTD is well developed.

Another potential play may exist where Chinchaga carbonates shale out northwestward toward the Yukon Territory. The Chinchaga carbonate platform is fully developed at Beaver River, but is absent or drastically thinned northwest of Kotaneelee and Pointed Mountain. Reefal buildups may occur along the carbonate bank edge and would offer more effective matrix porosity and permeability than the fractured reservoirs at Beaver River, Kotaneelee, and Pointed Mountain Fields. Hydrothermal dolomitization would further enhance reservoir potential on this trend.

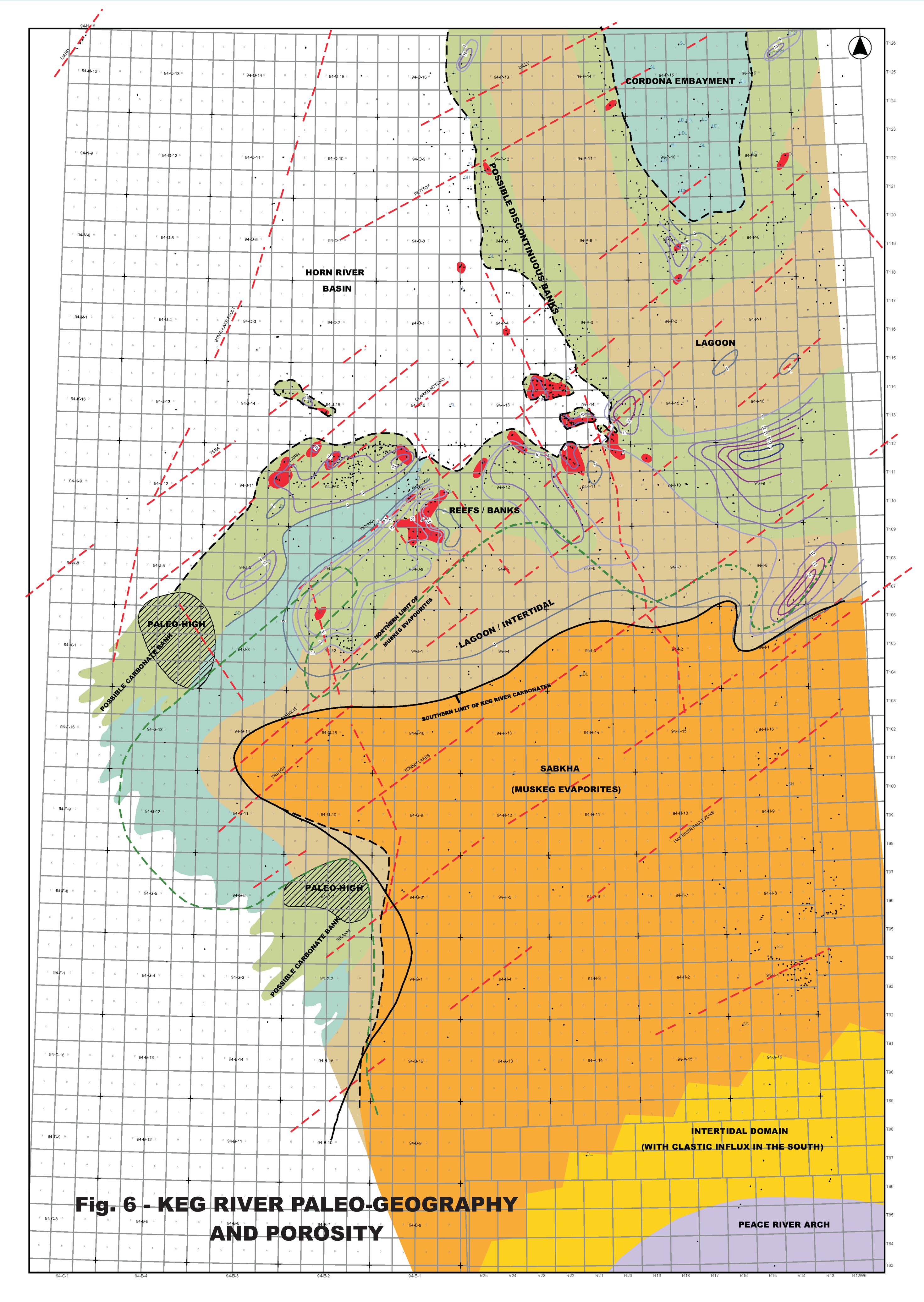


Fig. 6 - KEG RIVER PALEO-GEOGRAPHY AND POROSITY

The Keg River produces gas from isolated reefal buildups controlled by basement horst blocks, such as at Yoyo and Sierra fields, and from smaller structural/stratigraphic pools along the major basinal margins.

Sulphur Point strata are difficult to distinguish from the Keg River in many areas so their exploration potential can be assessed jointly. Generally, the Sulphur Point is regarded as a more homogeneous regional aquifer, and trapping situations may not occur as abundantly as in the Keg River.

Keg River / Sulphur Point carbonates are prospective in at least four settings:·

Faulted Platform Margins Conceptually, wherever faults cut across a continuous platform margin at a high angle, a potential structural trapping situation is set up. If the fault is deep-seated, and/or was active near the time of deposition, it may have influenced reef growth and subsequent diagenetic processes. Such traps will likely be small up to several spacing units and tens of BCF but highly productive.

Flanks of Platform and Embayments Fault lineaments and a poorly-controlled Keg River thin indicate the possible presence of a SW-NE embayment cutting across the Keg River platform. By analogy with the Hotchkiss Embayment (at Slave Point level), Keg River and Sulphur Point reef buildups along the margins may be prospective.

Discoveries of this type could range up to several hundred BCF reserves in thick buildup sections, with high productivities from dolomitized reefal buildups.

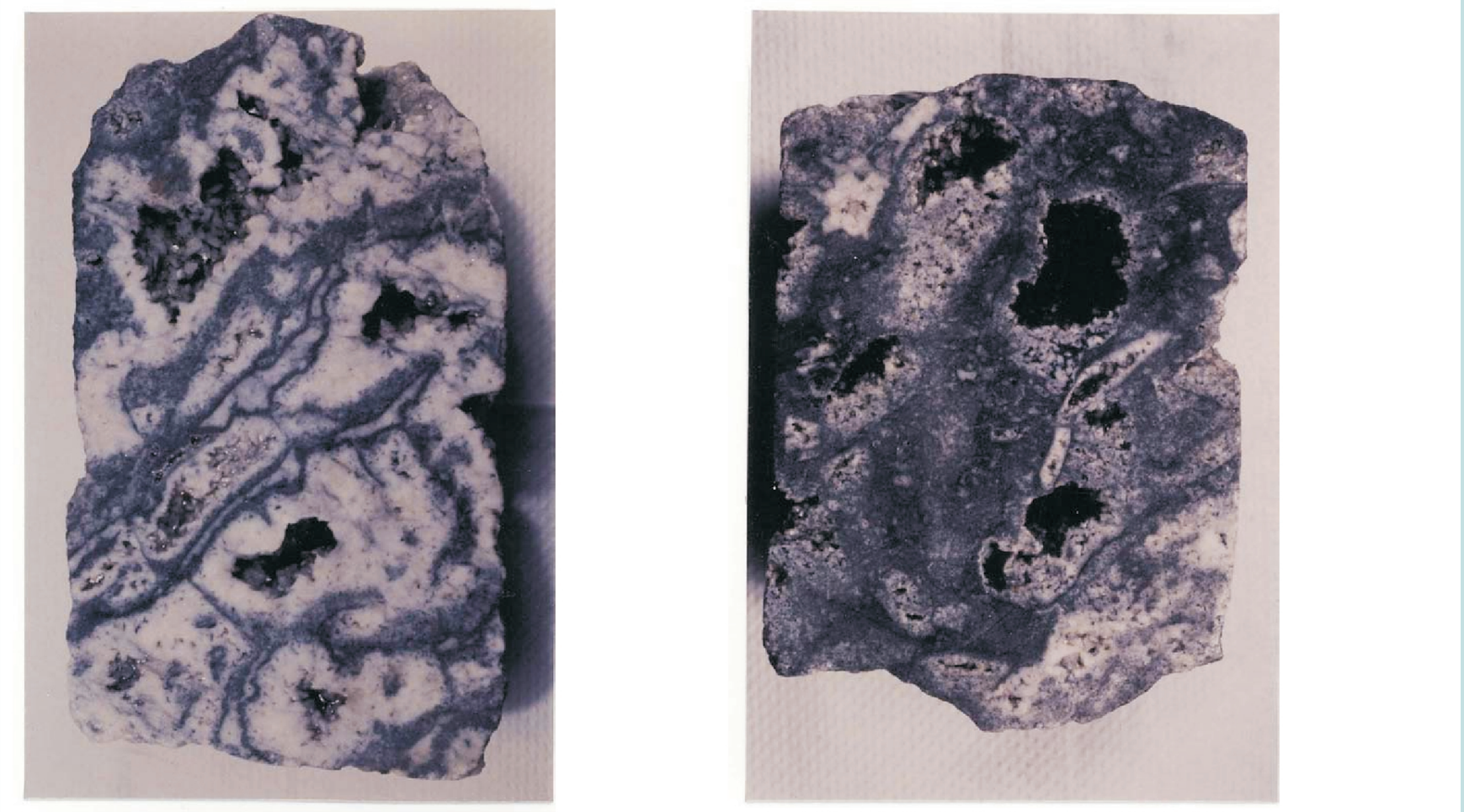
Western Carbonate Banks The restricted Elk Point (Muskeg) evaporite basin must have had a western margin. Displacement along regional SW-NE fault trends may have elevated particular structural blocks, thus influencing the paleogeography of the margin trend. Later movement, during the Antler Orogeny, may have influenced fluid movements and hence diagenetic trends.

Keg River / Sulphur Point discoveries on the western margin could range up to Clarke Lake size (hundreds of BCF to more than a TCF). Although mapping would be difficult and drilling expensive for deeply-buried targets along this play trend, high reservoir pressures would augment reserves and productivity.

Antler Structural traps The Sulphur Point occurs over a considerable portion of the platform. Because of its role as the major regional aquifer, it was not generally considered to be prospective but now, since Antler age deformation is seriously considered, the Sulphur Point can be regarded as a prospective reservoir where it occurs on structure, particularly south of the reefal front where it is sealed by Watt Mountain and or lower Slave Point (Fort Vermilion "Member") shales.

Such traps will likely be small up to several spacing units and tens of BCF but could be very productive in the vicinity of strike-slip faults.

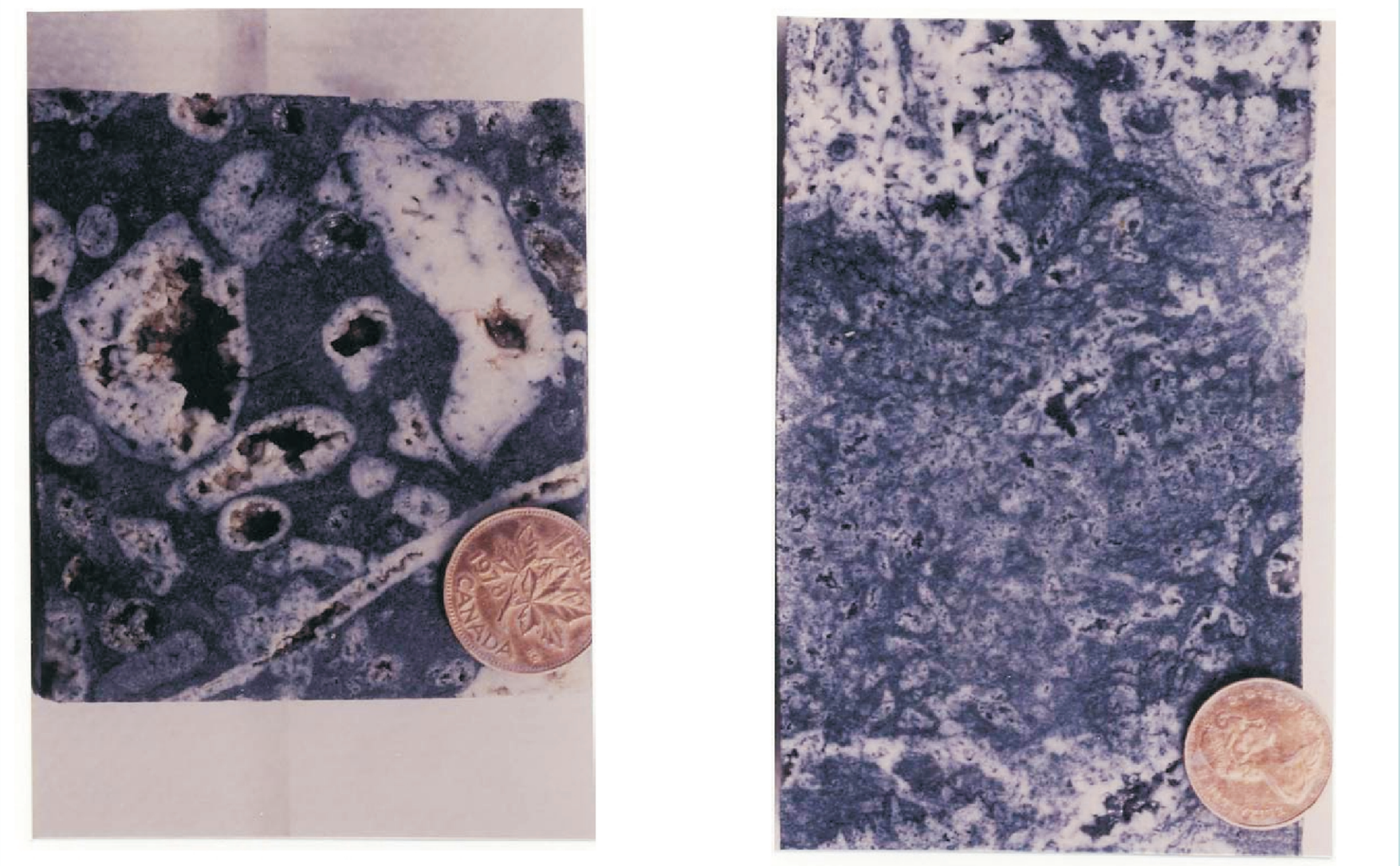
PLATE 2 – KEG RIVER – HYDROTHERMAL DOLOMITE



a. b-89-E/94-J-15 7429.8 ft. Upper Keg River
Dolomite dark grey fabric preserving with some thin rims of light grey destructive replacive cement and coarse white HTD cement infill following dissolution of stromatoporoid.

b. b-89-E/94-J-15 7432.0 ft. Upper Keg River
Dark grey fabric preserving dolomite. Skeletal wackestone with sparse crinoid. Light grey patches of bladed fabric destructive replacing fossil structures, bulbous dendroid stromatoporoid. Sparse white megacrystalline HTD cement.

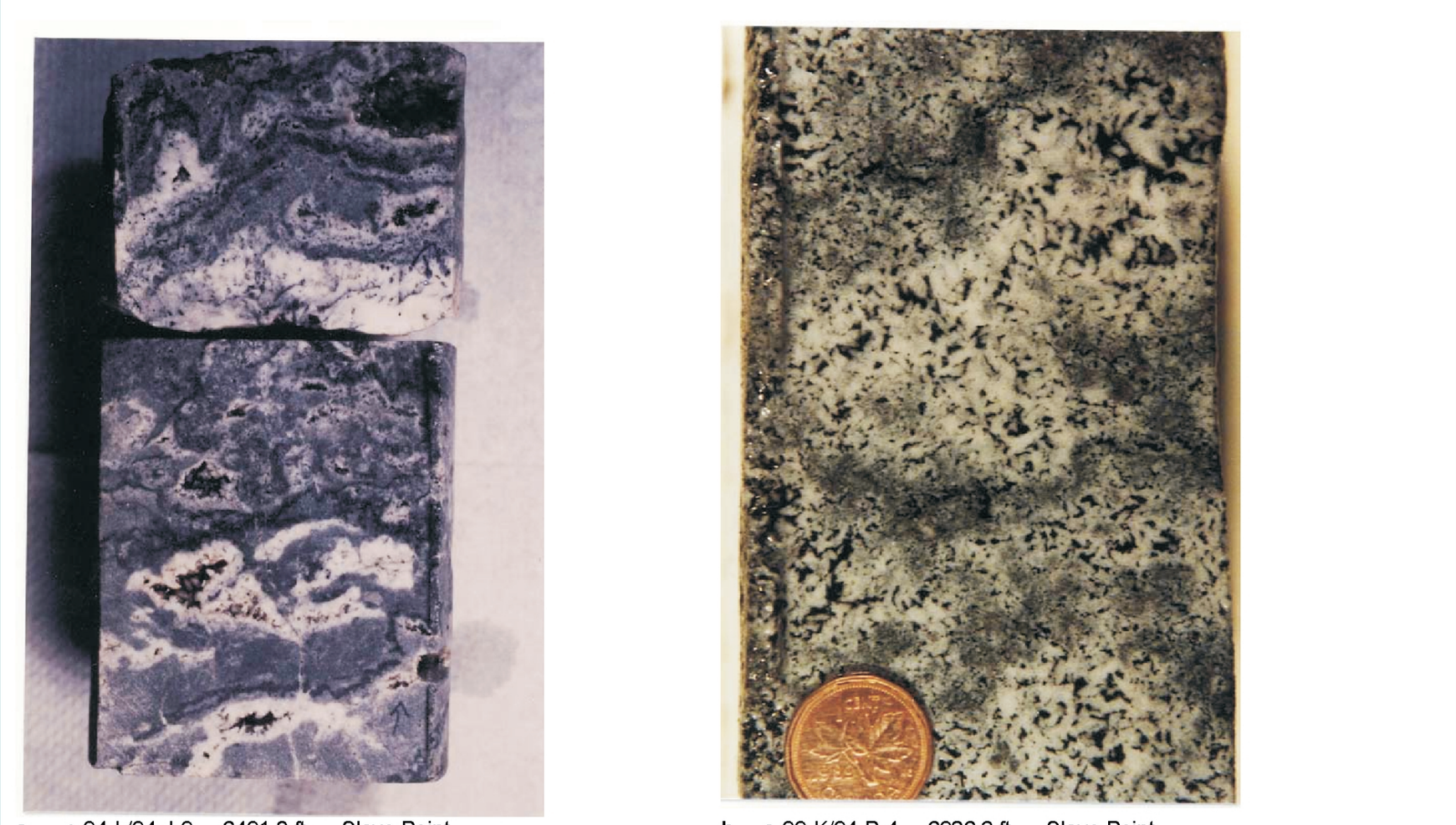
PLATE 4 – SLAVE POINT FORMATION



a. c-82-B/94-J-6 2862.3m Slave Point
Dendroid and bulbous stromatoporoid floatstone with intrafossil vuggy porosity. Course white saddle dolomite lining previously large vuggy cavities.

b. 13-35-96-12W6M 2558.1m Slave Point
Stroatoporoid –Amphipora

PLATE 5 – SLAVE POINT FORMATION – HYDROTHERMAL DOLOMITE



a. c-94-L/94-J-9 6491.0 ft. Slave Point
Bulbous to dendroid and laminar stromatoporoid floatstone. Preserved porosity in large cavities. White course dolomite lining previous intrafossil vugs.

b. a-99-K/94-P-4 6926.3 ft. Slave Point
Salt and pepper fabric is characteristic of textures associated with HTD. The dark color is interstitial bitumen.

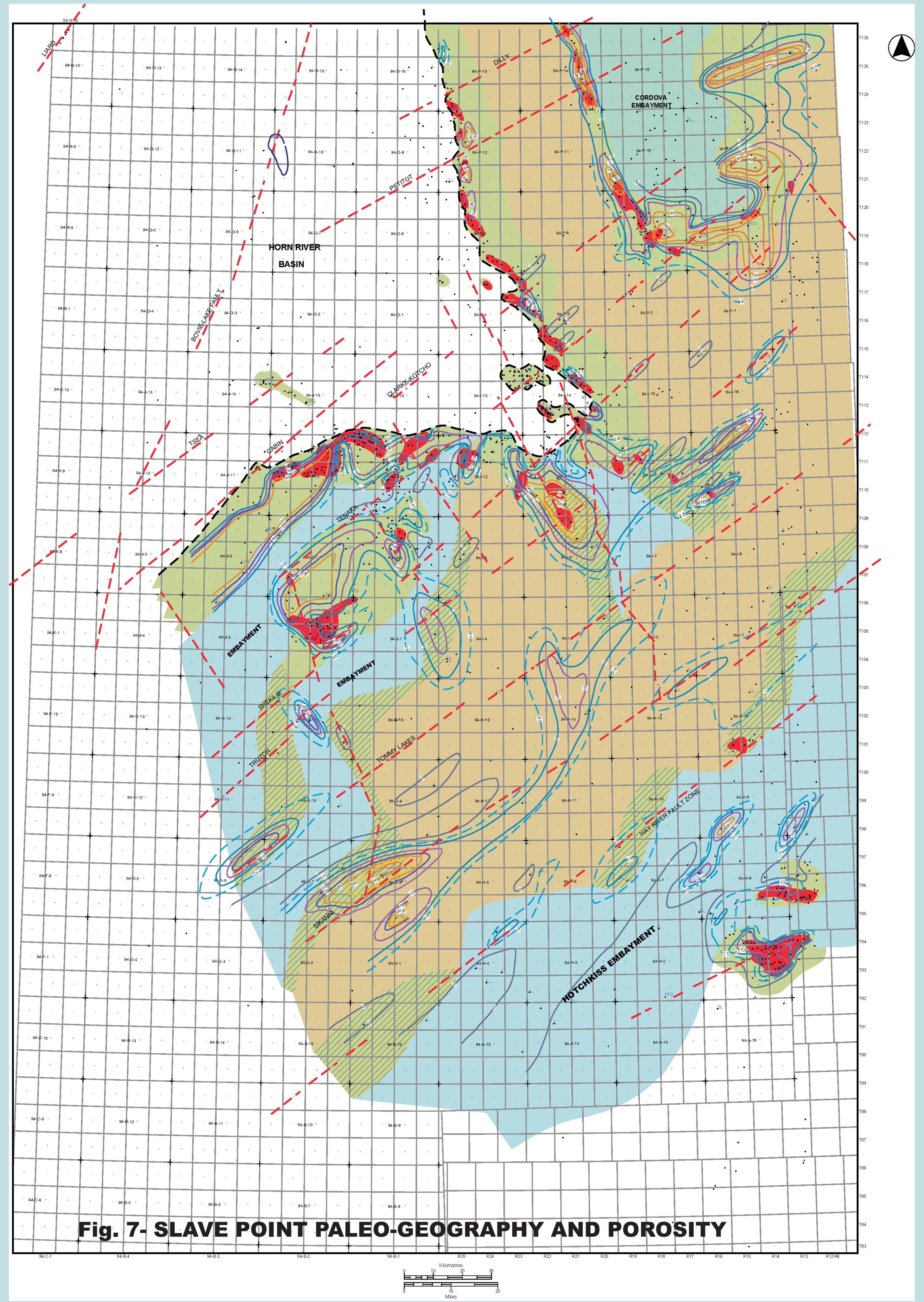


Fig. 7- SLAVE POINT PALEO-GEOGRAPHY AND POROSITY

Slave Point exploration potential is controlled by many of the same factors as Keg River/Sulphur Point potential, and hence is conceptually very similar. However, capping shales provide better seals for Slave Point reservoirs, and make seismic mapping simpler.

Slave Point carbonates produce from a variety of settings that offers considerable additional potential for substantial discoveries:

·*Barrier Buildups* The Horn River Basin and Cordova Embayment margins have been drilled fairly extensively, and it is unlikely that large buildups resembling Clarke Lake will be found along these trends in B.C. However, the postulated western margin of the Slave Point platform is essentially unknown, and may be prospective.

As for the Keg River / Sulphur Point, discoveries in this area will be difficult to map, but reserves could be on the TCF scale.

Faulted Platform Margins Deep-seated faults cross-cutting platform margins offer smaller-scale potential reserves, but high productivities where reservoirs are diagenetically enhanced.

Interior Embayment Margins The Ladyfern discovery extended prospectivity along the Hotchkiss Embayment margin westward into B.C. from Cranberry in Alberta. Slave Point buildups over paleo-highs within embayments, such as Hamburg, may also be prospective. In addition to defining the limits of the embayment, faults along the Hay River Fault Zone have linked deep hydrothermal fluids to Slave Point reservoirs. Exploration along the embayment margins should thus be guided by the presence of faults, as indicated by seismic, reactivation at higher stratigraphic levels, and basement magnetic anomalies. Ladyfern itself is coincident with a strong magnetic feature.

Other Slave Point interior embayments have been mapped in 94G and 94J, but have not been extensively explored at the Slave Point level. Several porosity anomalies in flanking wells suggest that opportunity exists for embayment margin plays to be developed. Since the Ladyfern discovery, the Hotchkiss Embayment has been the focus of relatively intense Slave Point exploration activity. Various operators have announced Slave Point discoveries as far west as 94H5, but most appear to be limited in reserve size and initial productivity. Drilling is still sparse, and potential remains for the discovery of new fields on the scale of Ladyfern.

Lower Slave Point Cycles Discrete fault-bounded areas within the Slave Point platform may develop additional cycles of reef growth, as at Adsett, given appropriate timing of movements on the faults. Detection of these cycles may be difficult without fairly extensive well control, but moderate reservoir potential may occur under the appropriate structural/diagenetic conditions.

CONCLUSIONS

This work highlights the importance of hydrothermal dolomite reservoirs as a key component of Devonian exploration potential. Dolomitization trends in the Slave Point, Sulphur Point, Upper and Lower Keg River, and Upper Chinchaga reservoirs were highlighted and used as a guide to map the porosity distribution.

Three factors are important in the genesis of hydrothermal dolomites:
1. An extensional tectonic setting, giving rise to normal and strike-slip fault motions;
2. Carbonate facies with preserved primary porosity and permeability.
3. An elevated geothermal gradient, providing a source for hydrothermal fluids.

The structural framework of the area played a major role in shaping the paleogeography and reservoir development during Devonian time.

Reactivation of deep-seated fault trends appears to have exerted control over large-scale features such as trends of platform margins and interior platform embayments, and over smaller features such as localization of isolated reefal buildups. Using regional aeromagnetic intensity mapping, surface lineaments, and offsets mapped in younger strata, we have identified regional networks of southwest-northeast and northwest-southeast faults, in addition to the Bovie Lake and the Hay River Fault Zones. Fault movements, particularly those involving strike-slip motion, have allowed deep-sourced fluids access to Devonian reservoirs, causing widespread reservoir enhancement, primarily through hydrothermal dolomitization and associated solution and brecciation.

The primary lithofacies have a significant influence on the development of HTD reservoirs. In strata with good initial effective permeability and porosity, such as reefal buildups and high-energy shoals, dolomitization enhances reservoir quality over broad areas (e.g. Clarke Lake, Adsett, Ladyfern). In contrast, where hydrothermal dolomitization occurs within lithofacies with poor primary reservoir quality, such as tight shaly limestone, reservoir enhancement may be restricted to a narrow corridor along the fault zone.

Paleogeography / porosity maps in this report highlight areas where porosity has been observed on well logs. Some of these areas correspond to known production, but others provide leads to prospectivity in new areas, and require evaluation in terms of the play types outlined above.

The Deep Devonian of northeastern B.C. has been explored thoroughly only along a few play trends, and thus offers abundant potential for high-reserve, high-productivity discoveries along a variety of established and postulated fairways.

A key recommendation that arises from this project is to carefully map and assess regional fault trends, particularly those that appear to be deep-seated, and to have been reactivated throughout Phanerozoic time. Major faults have played a large role in nucleating reef growth along major platform margins, and in determining the locations of intra-platform embayments and isolated carbonate buildups. Deep-seated faults, particularly strike-slip shear zones containing numerous small fault blocks prone to reactivation, have also promoted the movement of deep hydrothermal fluids, accelerating reservoir-enhancing diagenetic processes in carbonate reservoirs. The Hay River Fault Zone is a prime example of such a trend, but several other faults have probably exhibited similar behaviour.

Petrel Robertson