# Distribution of Presqu'ile dolomite in the Great Slave Plain, Northwest Territories

E.P. Janicki[1]

Janicki, E.P., 2006: Distribution of Presqu'ile dolomite in the Great Slave Plain, Northwest Territories; *in* Potential for Carbonate-hosted Lead-zinc Mississippi Valley-type Mineralization in Northern Alberta and Southern Northwest Territories: Geoscience Contributions, Targeted Geoscience Initiative, (ed.) P.K. Hannigan; Geological Survey of Canada, Bulletin 591, p. 179–194.

**Abstract:** This study was initiated to map out the extent and gross thickness of Presqu'ile dolomite in the Great Slave Plain of the Northwest Territories. Presqu'ile dolomite refers to a diagenetic replacive dolostone, often containing void- and fracture-filling white, coarse-crystalline sparry hydrothermal or saddle dolomite commonly associated with the Pine Point lead-zinc deposits. The lead-zinc mineralization process is still a matter of some debate; the distribution of Presqu'ile dolomite could yield some clues. It could also be useful for oil and gas exploration because of the high permeability of this dolomite.

A prominent northeast-southwest trend of thick Presqu'ile dolomite appears to be centered between the inferred Tathlina and Hay River fault zones. Presqu'ile dolomite appears to be most abundant close to surface; it does not occur below depths of 850 m. No Presqu'ile dolomite was found below the Cretaceous cover in the study area.

**Résumé :** La présente étude avait pour but de cartographier l'étendue et l'épaisseur globale de la dolomie de Presqu'ile dans la plaine du Grand lac des Esclaves, dans les Territoires du Nord-Ouest. La dolomie de Presqu'ile est une dolomie diagénétique de remplacement dont les pores et les fractures contiennent souvent de la dolomite spathique hydrothermale blanche en gros cristaux ou en selle qui est généralement associée aux gisements de plomb-zinc de Pine Point. Le processus de minéralisation en plomb-zinc suscite encore certains débats; la répartition de la dolomie de Presqu'ile pourrait fournir quelques indices. Elle pourrait également être utile pour l'exploration du pétrole et du gaz en raison de la grande perméabilité de cette dolomie.

Un important alignement nord-est–sud-ouest de l'épaisse dolomie de Presqu'ile semble centré entre les zones de failles présumées de Tathlina et de Hay River. La dolomie de Presqu'ile semble être la plus abondante près de la surface; elle est absente à plus de 850 m de profondeur. Aucune dolomie de Presqu'ile n'a été trouvée sous la couverture crétacée dans la région à l'étude.

[1]C.S. Lord Northern Geoscience Centre, P.O. Box 1500, 4601-B 52 Ave, Yellowknife, NT X1A 2R3*
* Now at Ryder Scott Company, 1200, 530-8 Ave. S.W., Calgary, Alberta, T2P 3S8, ed_janicki@ryderscott.com

# INTRODUCTION

Middle Devonian white sparry dolomite, in this area commonly known as Presqu'ile dolomite (PD), is associated with the valuable Mississippi Valley Type (MVT) lead-zinc mineralization found at the former Pine Point mining district near the south shore of Great Slave Lake, and east of the town of Hay River (Fig. 1, 3). The saddle dolomite phase of PD is often characterized as dolomite formed from the circulation of moderately warm and saline hydrothermal fluids (Roedder, 1968). However, white sparry dolomite can also form by non-hydrothermal processes, and no effort has been made here to define exact mode of origin.

The term "Presqu'ile" has traditionally been used in a variety of ways (Christie et al., 2000) including the broadly defined diagenetic replacive dolomite, stratigraphically equivalent to the Sulphur Point and lower Slave Point formations (Fig. 2), of which white sparry dolomite is only a component (though sometimes a dominant component). In the more narrow usage applied here, Presqu'ile (PD) refers to the white, sparry dolomite without time-stratigraphic connotation. Presqu'ile is also often used informally to describe the middle Devonian paleo-physiographic barrier feature (Fig. 1).

An understanding of PD distribution is important for MVT exploration because the Pine Point orebodies are associated with that type of dolomite. PD thickness can perhaps be linked to geological factors crucial for its formation such as faulting, facies changes, hydrogeological conditions, etc. Skall (1975) observed: "There is a definite relationship between Presqu'ile development and mineralization, since a relatively thick development of coarsely crystalline dolomite coincides with both Main and North Hinge alignment of orebodies".

The scope of this study was limited to determining the location, extent and thickness of white, sparry PD. Comprehensive lithological descriptions or facies analyses of the host carbonate deposits were not undertaken. No attempt was made to provide new explanations or theories on the formation of PD. To this author's knowledge, nobody has mapped the distribution of PD in a way that could be related to broad tectonic features, and that was the central purpose of this

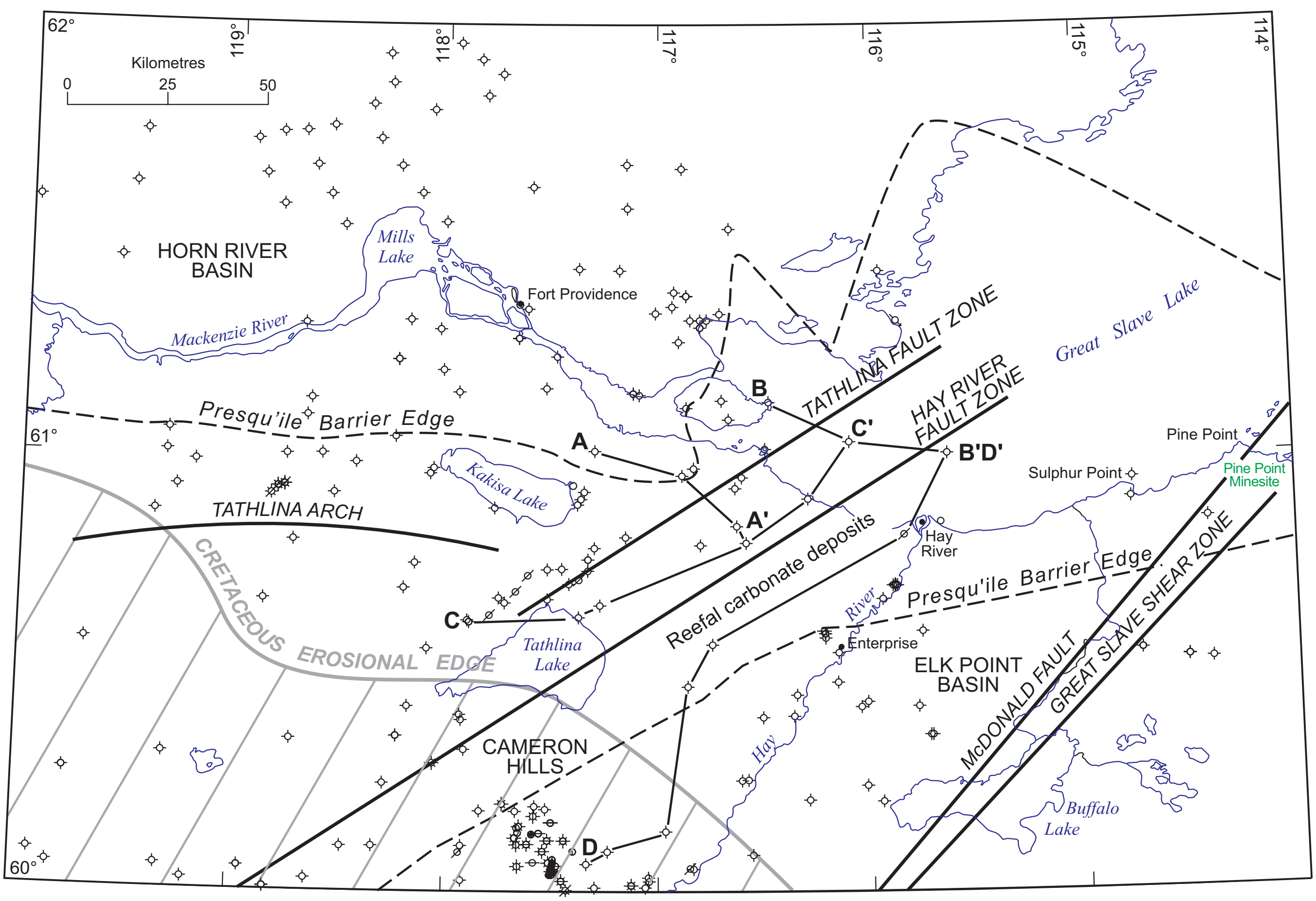



**Figure 1**. Structural and subcrop features related to the development of Presqu'ile dolomite. Cretaceous edge *after* Douglas and Norris (1994); Presqu'ile barrier edge *after* Meijer-Drees (1993); Tathlina and Hay River fault zones *after* Burwash et al. (1994); Tathlina Arch *after* Williams (1981); and McDonald Fault and Great Slave Shear Zone *after* Morrow et al. (2006). Wireline log cross-sections A–A', B–B', C–C', and D–D' are displayed in Figures 5, 6, 7, and 8, respectively.

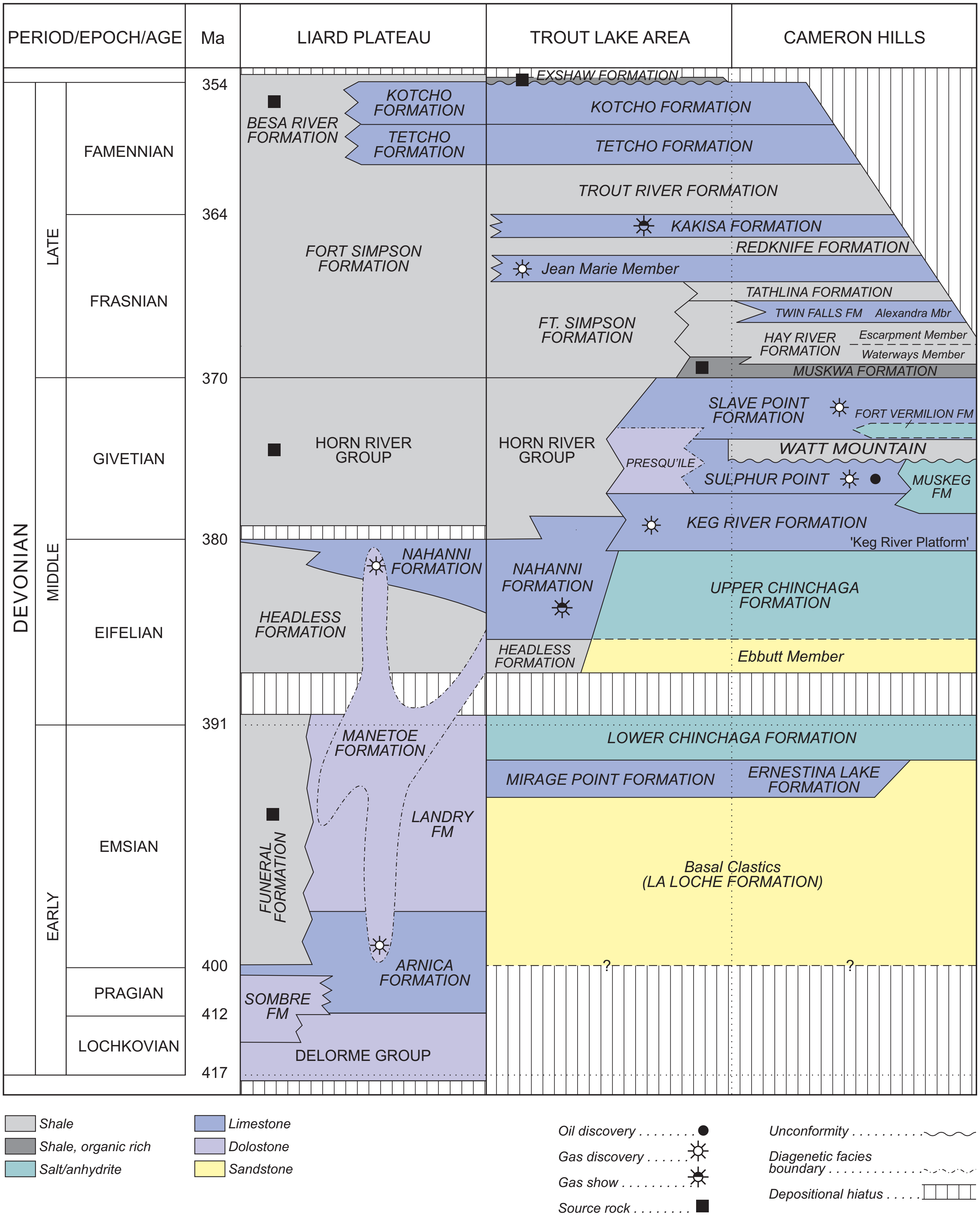



**Figure 2**. Table of Devonian formations in southern Northwest Territories. The Presqu'ile diagenetic dolostone phase interfingers primarily with Sulphur Point and Slave Point formations in the northwesterly portion of the Cameron Hills and eastern part of the Trout Lake area. *Modified after* Jones (2002).

study. Occurrences of PD have been reported in the literature (e.g. Belyea, 1971; Meijer-Drees, 1993; Williams, 1981) without being quantified or measured systematically in the same way as attempted here.

Another important goal of this study was to facilitate follow-up work on the character and distribution of PD. To make it easy to find occurrences of PD, locations, depths, and intervals have been noted on the spreadsheet (Appendix A). Appendix B provides maps showing selected (from many hundred) mineral exploration diamond-drill holes containing PD.

This study was also initiated with hydrocarbon exploration in mind. The gas productive Manetoe dolomite, which is also a white sparry dolomite developed in the Devonian Landry Formation (Fig. 2) of the Liard Plateau (Morrow et al., 1990), is highly permeable. Similarly high permeabilities could reasonably be expected for PD. In fact, drilling and test records for wells with thick sections of PD typically provide evidence for high permeability. For example, circulation was often lost during drilling across these zones, and drill-stem tests generally recovered large volumes of water (Janicki, 2006).

# REGIONAL GEOLOGY

## Structure

Much study has been devoted to the origins of PD and many different theories have been advanced. Rhodes et al. (1984), Skall (1975), Qing (1992), Krebs and Macqueen (1984), and Morrow et al. (1990) are a few of those who have proposed how PD was formed in the geological setting of the Great Slave Plain.

PD is generally found replacing limestone facies of the Presqu'ile barrier (Fig. 1), which was initiated as a carbonate shoal during the Middle Devonian and grew with slow but continued subsidence of the basement. In the early to middle Givetian a broad arching of the Keg River carbonate platform, centred approximately around the Tathlina Arch (Fig. 1), created a shallow carbonate shoaling environment, which became the Presqu'ile barrier. To the north of the barrier, in the fore-reef position, subsidence was slow (Skall, 1975) and shale of the Horn River Basin was deposited. To the south of the barrier, subsidence was more rapid, resulting in the deposition of the evaporite deposits of the Upper Elk Point Basin.

Regional dip is gradual to the southwest, with the thickest Middle Devonian section occurring in the western part of the study area south of the Tathlina Arch. In the eastern part of the study area, near Pine Point, the entire Phanerozoic section is only a few hundred metres thick. Precambrian shield rocks outcrop on the northeast shore of Great Slave Lake.

The basement beneath Great Slave Plain is highly fractured with an orthogonal grain of northeast–southwest and northwest–southeast basement-involved faults (MacLean, 2006). The tectonic forces that caused fracturing, rifting, and faulting in this area were generally tensional (Burwash et al., 1994). The large, northeast-trending fault zones (Tathlina, Hay River, and Great Slave Shear Zones) have vertical as well as dextral components to their sense of movement (see Precambrian structure contours on Fig. 1). Faults were activated and re-activated at various times during the Middle Devonian thereby creating conduits for fluid movement through the sedimentary section.

This tectonic activity led to slumping, fracturing, and faulting that localized karsting in areas where the Middle Devonian barrier was subaerially exposed to meteoric waters. The karsted and brecciated barrier rock was later preferentially altered to white sparry PD (Skall, 1975) by fluids moving along the fault zones and combining with meteoric water.

## Stratigraphy

Most PD replaces or interfingers with Middle Devonian Sulphur Point limestone, which is a fossiliferous, fine-grained, and commonly brecciated and karsted limestone within the Presqu'ile barrier. Late-stage white hydrothermal dolomite typically infills fractures and vugs within the pervasive PD. The lower Slave Point and upper Keg River formations are also sometimes partly altered to PD or transitional phases. These formation picks are ambiguous, so altered formations are not always clear. Most often, the Slave Point Formation, as defined by operator formation tops, consists primarily of unaltered fine-grained mudstone and wackestone representative of a marine shelf environment. The platformal Keg River Formation, or equivalents, is sometimes sucrosic, but not usually sparry.

You will note on Figure 2 the presence of Manetoe dolomite in the Liard Plateau region west of the study area. This dolomite has many similarities to PD but is found over a broader and lower stratigraphic level. Mode of formation is thought to be similar (Morrow et al., 1990) except that the dominant manner of faulting, which created fluid pathways, is compressive as compared with tensional block faulting beneath Great Slave Plain.

The actual formations equivalent to, or replaced by PD, can be difficult to define by old well records because a confusing array of formational names has been presented over time. The stratigraphy itself is complex because facies were diachronous in relation to the position of the Presqu'ile barrier or Tathlina Arch. Different geologists, working at different times dating back to the 1920s, have compounded the inherent stratigraphic complexity by proposing a variety of formational names, depending on which side of the barrier they were focused. Some old formational names have endured while others have largely (but not completely) been replaced. As a result, a mix of old and new stratigraphic nomenclature is extant throughout the literature, well files, and government tops. The table of formations in Figure 2 represents a current, generally accepted, summary of the stratigraphic relationships of the region.

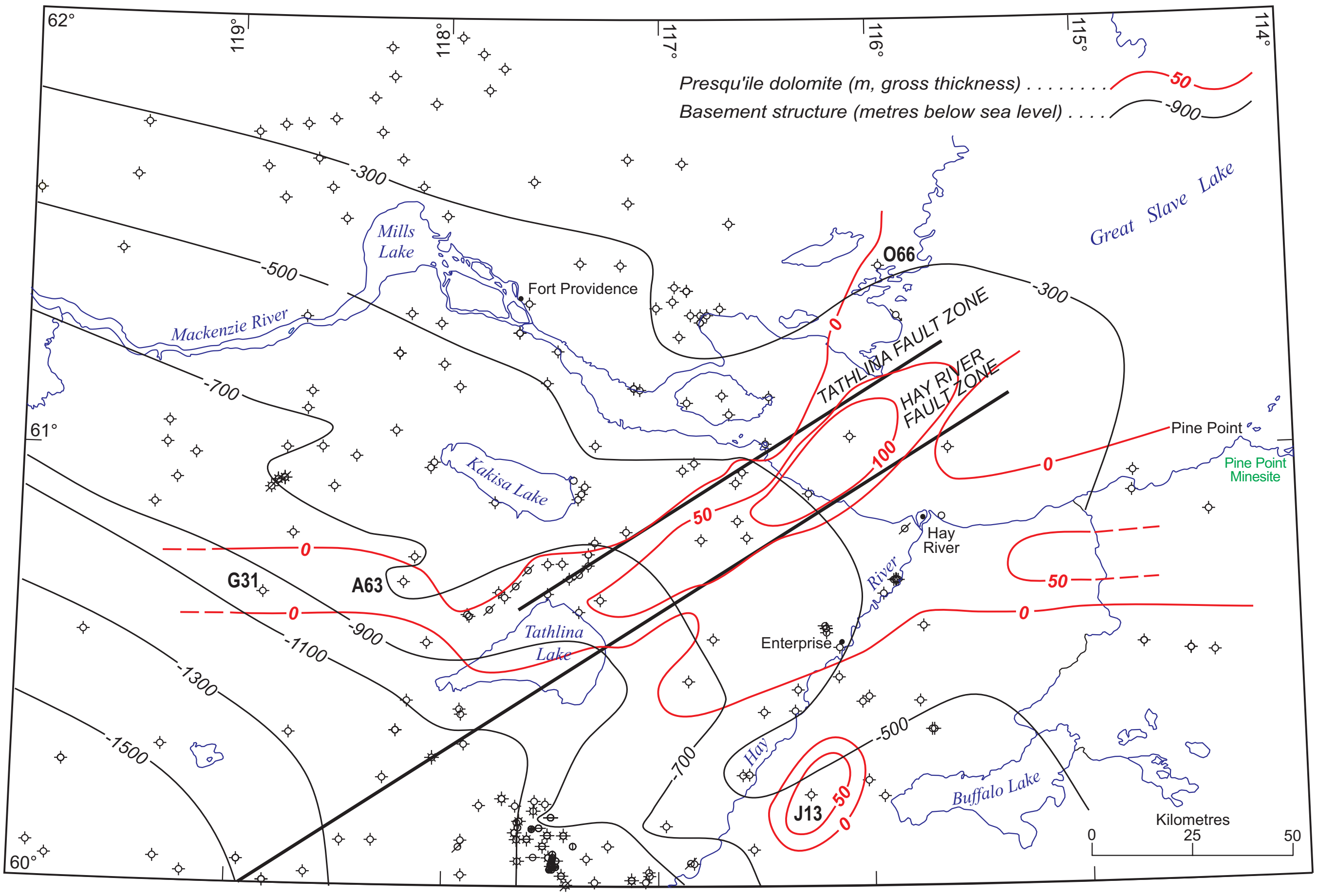



**Figure 3**. Gross thickness of white sparry Presqu'ile dolomite. Precambrian structure contours are also displayed. Appendix A contains a detailed listing of gross thickness values for all oil and gas wells examined. Appendix B provides maps showing locations and gross thickness values for mineral exploration diamond-drill holes incorporated in this figure.

As a further note, operator and National Energy Board of Canada formation picks (National Energy Board of Canada, 1992) sometimes specify "Presqu'ile" as a top whether or not white, coarse dolomite is present; a corollary is that white sparry dolomite sometimes occurs where no mention of "Presqu'ile" has been made in the tops or sample descriptions.

# METHODOLOGY

The area chosen for this study encompasses areas where previous publications (e.g. Meijer Drees, 1993 and Belyea, 1971) have reported the presence of PD. The eastern boundary coincides approximately with the former Pine Point mine site (114° W) and the limit of petroleum exploration. The study area's western boundary corresponds roughly to the Cameron Hills and does not extend as far to the similar, but stratigraphically lower, Manetoe dolomite of the Cordillera and foothills.

Information for this study was obtained from two primary sources:

- The core and sample repository at the Geological Survey of Canada, Calgary
- Sample descriptions, contained in well files, submitted to the National Energy Board

Drill cuttings were selected for viewing from wells whose sample descriptions suggested that PD might be present. Where available, core was also viewed and related to sample descriptions and observations of corresponding drill cuttings. Priority was given to locations close to Great Slave Lake and east of 118° W, which corresponds to the area closest to Pine Point and where most occurrences of PD have been reported.

Bulk percentages of PD were observed, from the shallowest occurrence to the deepest, of distinctive, white, very coarse-crystalline grains of PD. Notes were made of any mineralization and signs of oil staining or bitumen. Where available, cores containing the more obvious examples (see spreadsheet of Appendix A for locations of examined core) of PD were compared with concomitant drill cuttings so that a certain measure of visual calibration was achieved.

After drill cuttings from a number of locations had been studied, it became possible with reasonable confidence to relate wellfile descriptions to what could be expected in the actual samples. Therefore, wellfile sample descriptions alone were used to determine gross thickness for those locations whose samples were not examined. Appendix A indicates which samples or core were examined and for which locations gross intervals were based solely upon wellfile sample descriptions. The final result – the gross interval of PD (the interval between the first and last significant occurrence) – is contoured on Figure 3. Appendix A provides gross interval values for the locations studied.

Oil and gas wells in the northwest corner of the study area – beyond the northern limit of the Presqu'ile barrier (Fig. 1) – are located in the Horn River Basin where shale dominates the Devonian succession. Only a few locations were needed in that area to help define a limit for PD.

Additional data were found in diamond-drill logs prepared by mineral exploration companies on claims in proximity to Great Slave Lake. Appendix B contains claim maps showing study areas of Cominco Ltd. (1980 a, b, c) and Gulf Minerals Canada Limited (1979) that were used in this report. The study area of Westmin Resources Limited and partners was derived from a compilation of their work by Turner et al. (2002) and is also included in Appendix B. Representative diamond-drill holes were selected (of hundreds drilled) that were deep enough to have penetrated the entire stratigraphic interval potentially altered to PD and to provide a broad spacing across the mining company project areas. Additional diamond-drill hole data points were not used because their areas of concern were small compared to the much more regional perspective of this study. Gross white sparry dolomite thicknesses from the selected diamond-drill holes were incorporated with results from the oil and gas wells to produce the PD distribution map of Figure 3.

## Presqu'ile recognition

PD is distinctive by the coarse crystallinity and whiteness of the rock chips (Fig. 4a) within the sample vials. Surrounding host rocks are also somewhat distinctive by their relatively light colour, which contrasts with the darker browns and greys of the overlying, and underlying unaltered, or less altered, beds. Curved crystal faces of "saddle" dolomite Fig. 4b, c), characteristic of vug linings and fracture fills (Krebs and MacQueen, 1984), were also commonly discernable. When the sample quality was good, the gross range of PD could be determined by simply noting which sample vials were predominantly white. Where PD occurs, it is generally continuous over the gross interval and constitutes 80% or more of the sample proportion.

A transitional form of dolomite commonly occurs in proximity to sparry PD (Fig. 4d). One such example is location G36-6020-11630, where white to very light brown crystalline dolomite is developed in the Sulphur Point Formation. It does not have sparry crystals like those observed nearby at J13-6020-11615. Light brown to brown, medium- to coarse-grained sucrosic dolomite is commonly present proximal to PD in the underlying Keg River Formation. These apparently transitional forms of PD were not included as part of the gross interval despite the possible presence of mineralization.

The use of wireline logs for recognizing PD was also considered, however no consistently applicable diagnostic feature could be identified. Logging suites for the area provide limited and inconsistent log choices and the quality of many logs is poor because of the vintage of most (pre-1960s) of the wells. However, sonic logs showed some promise as tools for PD recognition. Sonic logs are widely available and when they pass through continuous and thick PD sections (e.g. J13-6020-11615 and K10-6040-11715), the acoustic responses are sometimes "spikey" as is typical for carbonate deposits with streaks of high vuggy or fracture porosity. Density logs are more ambiguous; little difference is apparent between PD and other forms of dolomite. Neutron logs showed no differences attributable to PD.

# OBSERVATIONS

## Presqu'ile distribution

PD was found mostly in the Sulphur Point Formation and rarely in the overlying Slave Point Formation or underlying Keg River Formation. In the eastern part of the study area, in the Pine Point mining region, PD is typically found in Sulphur Point or the stratigraphically lower Pine Point Formation (Keg River equivalent). Some studies (e.g. Meijer Drees, 1993) have suggested that PD can be found in the Slave Point Formation. That assertion was at least partly verified by observing sparry dolomite infilling vugs at location D50-6050-11700 in the Slave Point Formation. Possible PD was found perhaps as deep as the upper Chinchaga Formation at G15-6100-11615. As discussed previously, the actual formation being examined is often in question.

Figure 3 illustrates the distribution of PD within the study area, as based on the methodology described above. Gross PD interval values are not included to keep the presentation less cluttered, but they can be found selectively on the cross-sections (Fig. 5–8) and more completely on the spreadsheet summarizing the data (Appendix A). Gross interval values of PD range between 15 and 100 m.

The most striking feature of Figure 3 is the northeast-southwest trend of thick PD falling neatly between the Hay River and Tathlina fault zones (Belyea, 1971; Burwash, et al., 1994). The thick trend follows a northeastward swing of the Presqu'ile barrier complex front (Fig. 1) and conforms to a basement low as illustrated by the basement structure

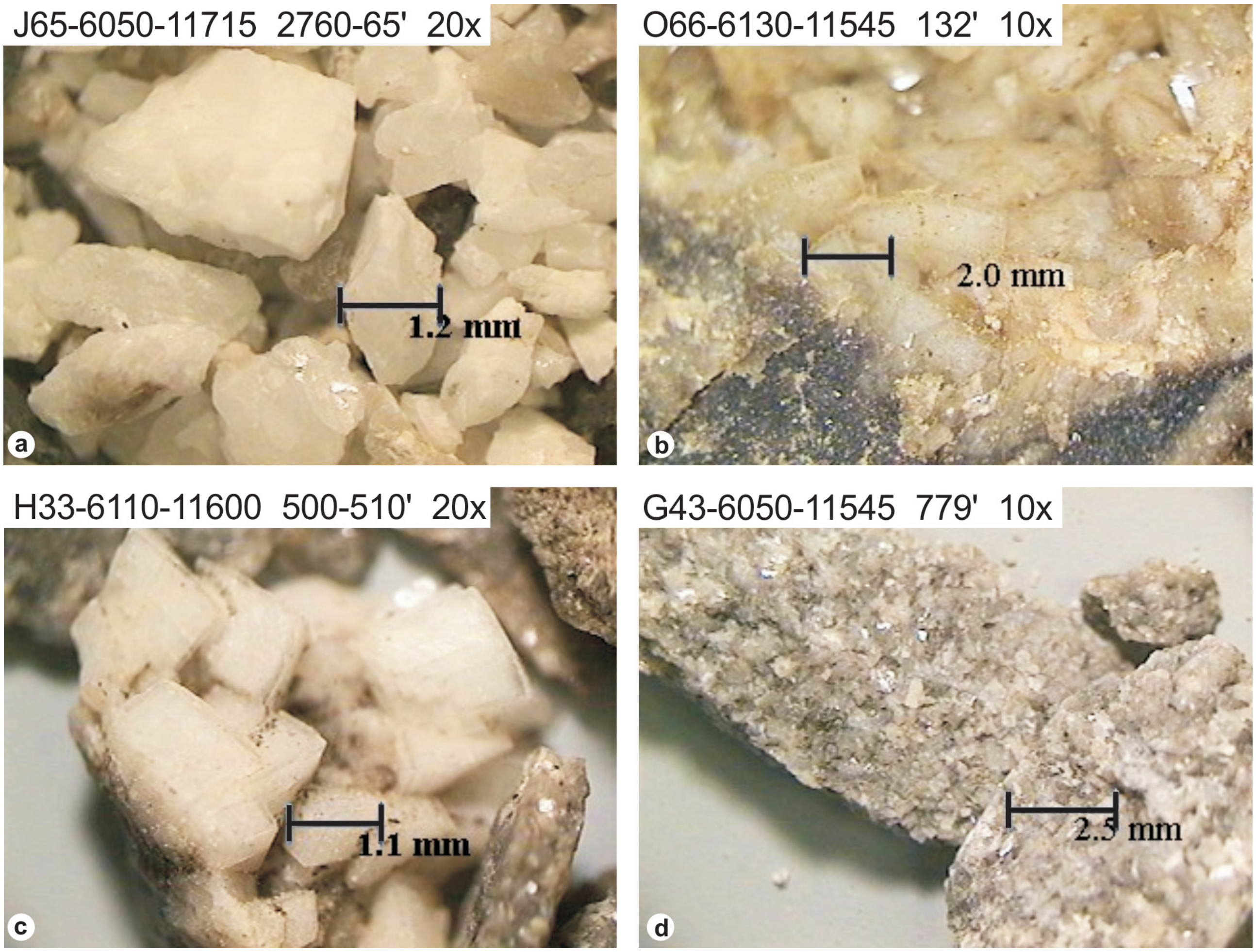



**Figure 4**. Drill cuttings and core pictures of Presqu'ile and hydrothermal dolomite. Locations, depth of occurrence, and magnifications are noted. **a**. Drill cuttings of an interval showing typical coarse and pure white crystalline Presqu'ile dolomite. **b**. Core showing hydrothermal dolomite lining a vug from Sulphur Bay on the northwestern shore of Great Slave Lake. Curved crystal faces can be seen. **c**. Larger drill-cuttings chip exhibiting curved crystal face of a hydrothermal saddle dolomite. **d**. Small core chip exhibiting a transitional form of sucrosic dolomite. Below this depth is an extensive section of white and light blue-grey sparry dolomite.

contours also shown on Figure 3. Greater PD thicknesses appear to be coincident with a graben basement structure between the two fault zones.

This PD trend likely extends to the northeast and may exist on the shores of Great Slave Lake, beyond the known occurrences studied by Cominco near Slave Point (Appendix B, Map 1) and Windy Point (mapped at surface by Douglas, 1959). Traces to minor occurrences of lead-zinc mineralization occur in brecciated and karsted dolostone at Cominco's Qito claims, however no coarse, sparry dolomite was observed there. PD occurs in a well at Sulphur Bay (O66-6130-11545, Fig. 4b) and could possibly be found farther to the north.

Cross-sections A–A' (Fig. 5) and B–B' (Fig. 6) illustrate the relationship between the major fault zones and PD in the vertical dimension. Both cross-sections, running northwest–southeast across the Tathlina and Hay River fault zones, show that PD is present between but not on either side.

Another thick PD trend, roughly coincident with known ore trends (Rhodes et al., 1984) is found to the east near the Pine Point mining district (Fig. 3). This occurrence is somewhat less thick than that found between the Tathlina and Hay River fault zones, perhaps as a result of a thinner overall Middle Devonian section in the eastern part of the map area. The actual proportion of Middle Devonian rock converted to PD may be higher in the Pine Point area than elsewhere, but this possibility was not examined. A more complete study of

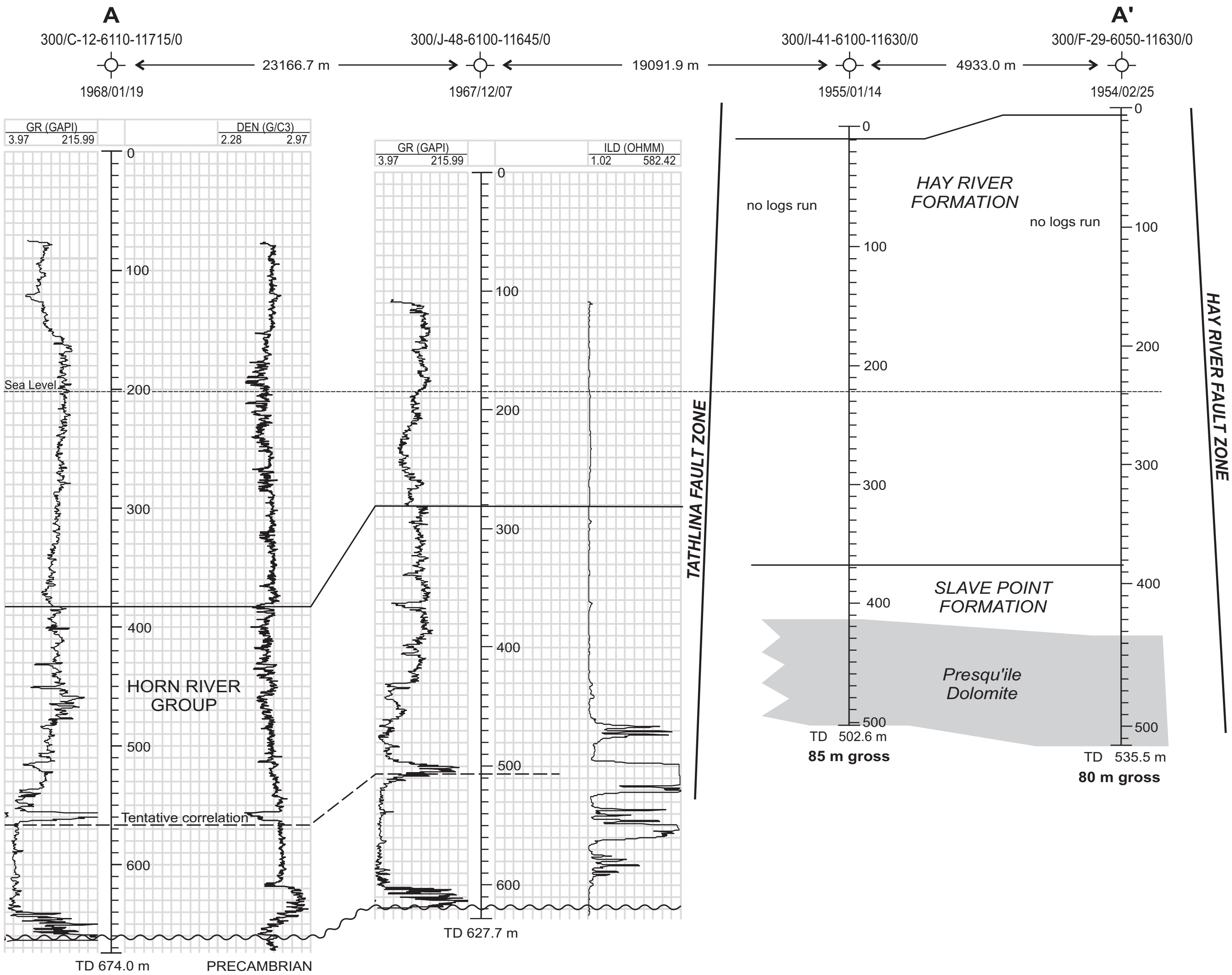



**Figure 5**. Cross-section A–A'. *See* Figure 1 for well locations. Note position of Presqu'ile dolomite between the Hay River and Tathlina fault zones. Locations C-12 and J-48 are in the fore reef zone of the Presqu'ile Barrier adjacent to the Horn River Basin.

mineral company records (Cominco, 1980a; Gulf, 1979, Turner et al., 2002) than attempted here would be needed to more precisely delineate the PD occurrence in the area.

A thinner trend of PD appears to splay off to the west of Tathlina Lake, although only two supporting data points (G31-6050-11845 and A63-6050-11800) are available (Fig. 3).

An apparently anomalous, and isolated, occurrence of PD is found to the southeast at location J13-6020-11615. Meijer Drees (1993) had also noted the occurrence of PD at this location. The shape of this anomaly, as depicted on Figure 3, was drawn to conform to a seismic low mapped on the basement surface (MacLean, pers. comm., 2003) while retaining a northeast fabric consistent with the major occurrences. More data will be needed to determine its actual shape and extent.

## Depth

The cross-sections that follow along the northeast structural trend (CC' and DD', Fig. 7 and 8, respectively) show that as the Middle Devonian strata deepen, the thickness of PD decreases, and it is not found below a depth of approximately 850 m. The thickest PD sections tend to occur at comparatively shallow depths. For example, one of the thickest sections is measured at H33-6110-11600, which is also in the shallowest well (cross-section B–B') in the study.

Cretaceous rock subcrops south of the southernmost occurrence of PD (cross-section D–D', Fig. 1); nowhere in the study area is PD found beneath Cretaceous cover.

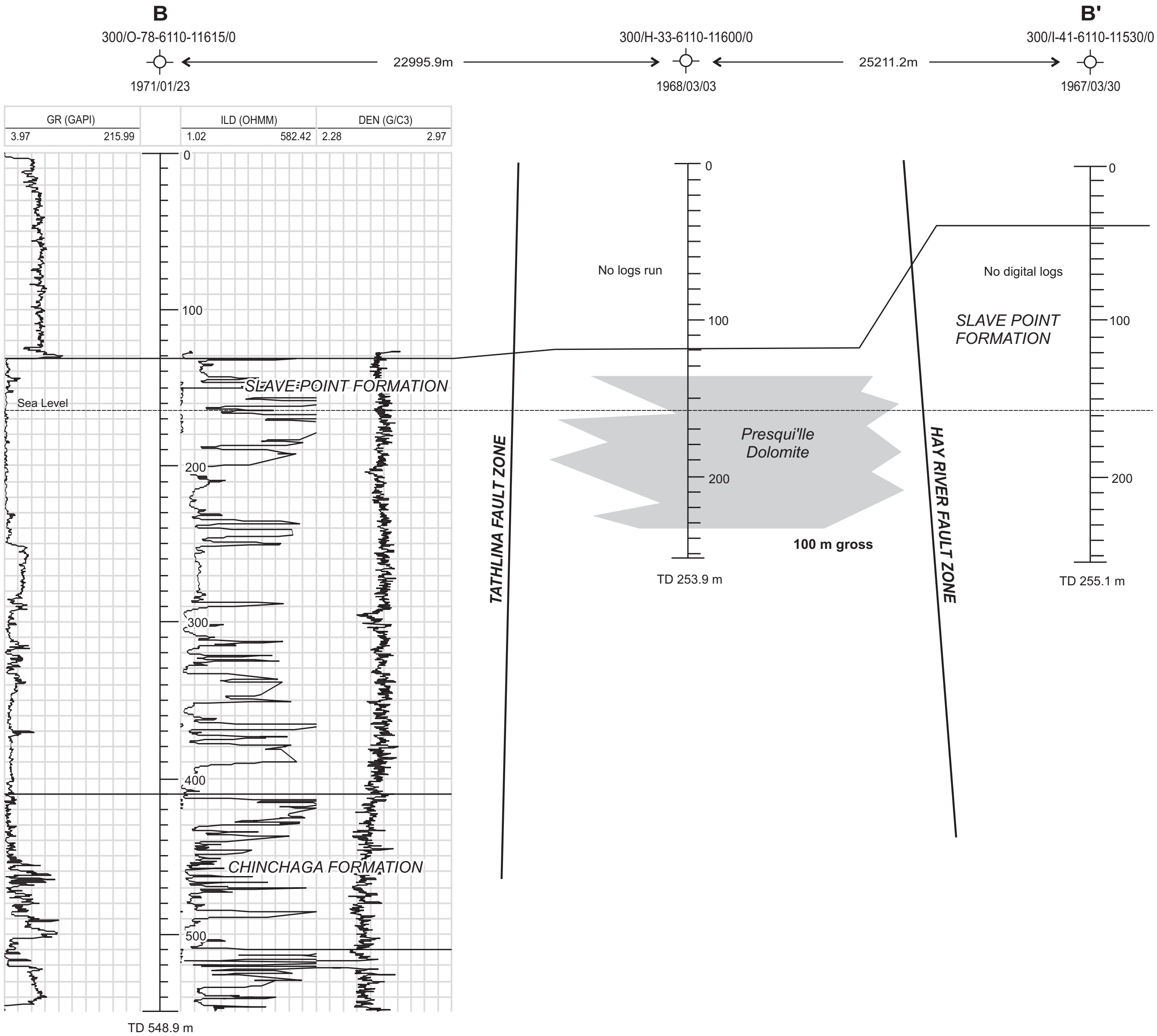



**Figure 6**. Cross-section B–B'. *See* Figure 1 for well locations. Note position of Presqu'ile dolomite between the Hay River and Tathlina fault zones.

## Mineralization

Only minor examples of mineralization, consisting mainly of pyrite, were observed in the drill cuttings of a few wells (noted in Appendix A). Some locations, in fact, displayed remarkably pure and white PD, apparently devoid of darker minerals or other constituents. This observation contrasts with the abundance of sulphide mineralization found in core along the Pine Point ore trend (Rhodes et al., 1984).

Heavy lead-zinc minerals may not have been recovered in the drilling mud systems used for oil and gas wells, therefore their absence is not conclusive. Only sparse mineralization was observed in the oil and gas cores, but few wells were extensively cored.

Much mineral exploration has occurred in areas of enhanced PD development west and northwest of the Pine Point mine property (Appendix B). Many of the diamond-drill holes on these mineral properties intersected brecciated intervals in the coarse-grained diagenetic PD and encountered significant associated lead-zinc mineralization.

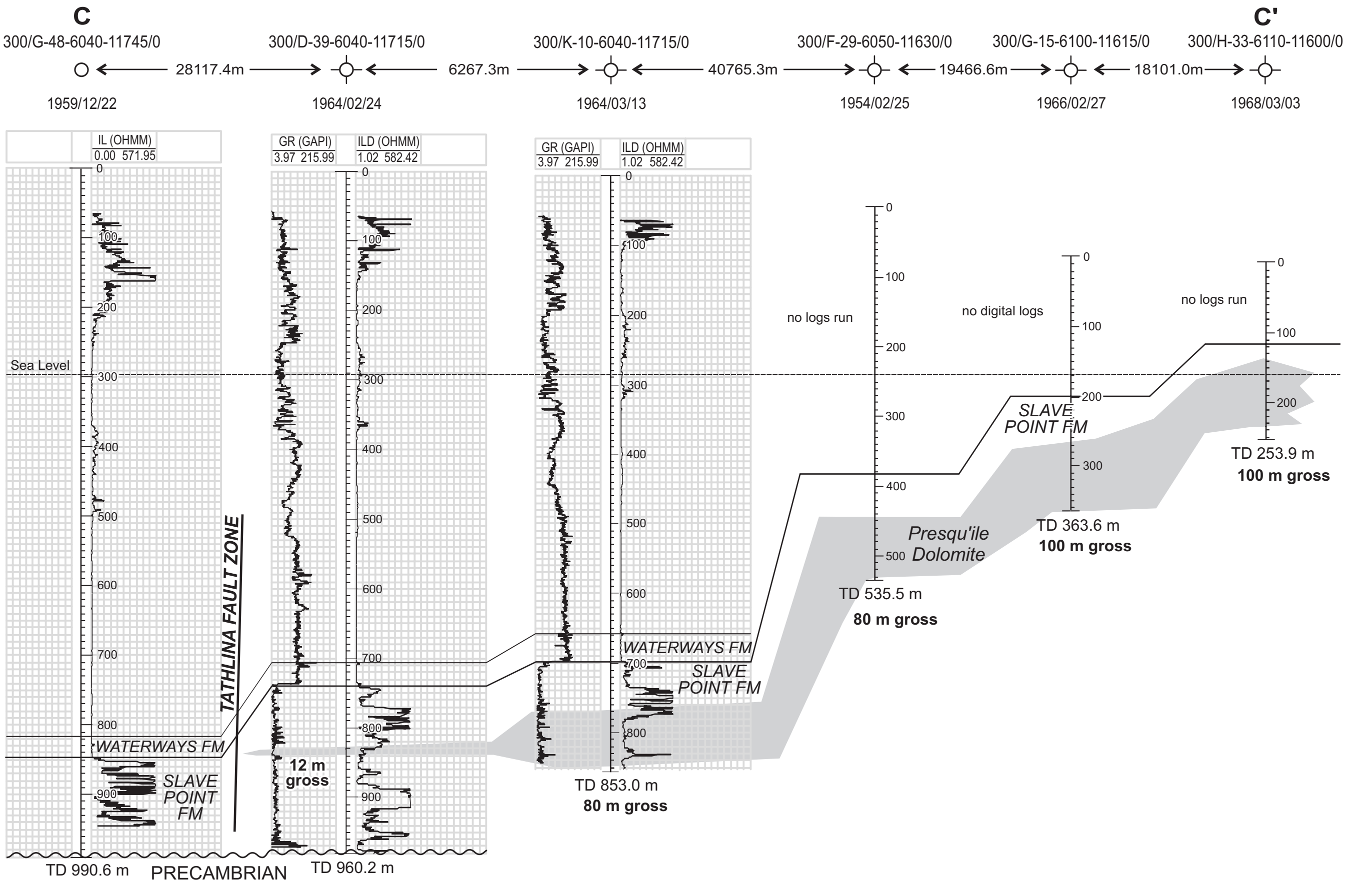



**Figure 7**. Cross-section C–C'. *See* Figure 1 for well locations. Note thinning of Presqu'ile dolomite with depth.

## Porosity and permeability of Presqu'ile dolomite

The porosity of PD was not systematically estimated during sample examination, but original wellsite estimates are available for many locations. The estimates that were made by this author are in close agreement with those original estimates. Porosity in the white sparry dolomite ranges between 12 and 16%, which is high for a carbonate. Permeability is also very good; vugs are large and, to the naked eye, commonly appear interconnected. Matrix porosity and permeability are also good to very good. Core analyses, wherever provided, consistently measured very high permeabilities – often in the range of several darcies. Prior to PD development, permeabilities were already likely to have been high (Rhodes et al., 1984) in those reefal facies most susceptible to alteration. By contrast, the overlying unaltered Slave Point and Watt Mountain formations consist largely of mudstone with poor permeability. The underlying Keg River Formation has good porosity and permeability, but probably less than that for the Sulphur Point facies which was subsequently largely altered to PD. The Keg River Formation (sometimes called Pine Point) was apparently altered into light coloured, fine-crystalline, sucrosic dolomite rather than the more sparry dolomite of the Sulphur Point Formation.

A hydrodynamic study by this author (Janicki, 2006) demonstrates extensive aquifer continuity throughout the Middle Devonian section. According to this study, neither significant permeability barriers, nor channels of especially high permeability were identified. This finding applies most directly to current hydrodynamic conditions, but is also likely at least partly applicable to the Middle Devonian setting.

## Hydrocarbon potential

Hydrocarbon discoveries in the southeastern portion of the Great Slave Plain have so far not been made in wells with extensive PD. Most activity in this region has recently been centred in the Cameron Hills, where PD is not present. Despite this, high porosity and permeability makes PD an exploration target difficult to ignore. The PD trend west of Tathlina Lake has been relatively lightly explored and the vicinity of the isolated PD occurrence (J13) has possible trapping structures (MacLean, B., pers. comm., 2003) created by a myriad of normal faults.

Little historic seismic data exists, and almost no recent seismic data has been gathered in the areas of thickest PD

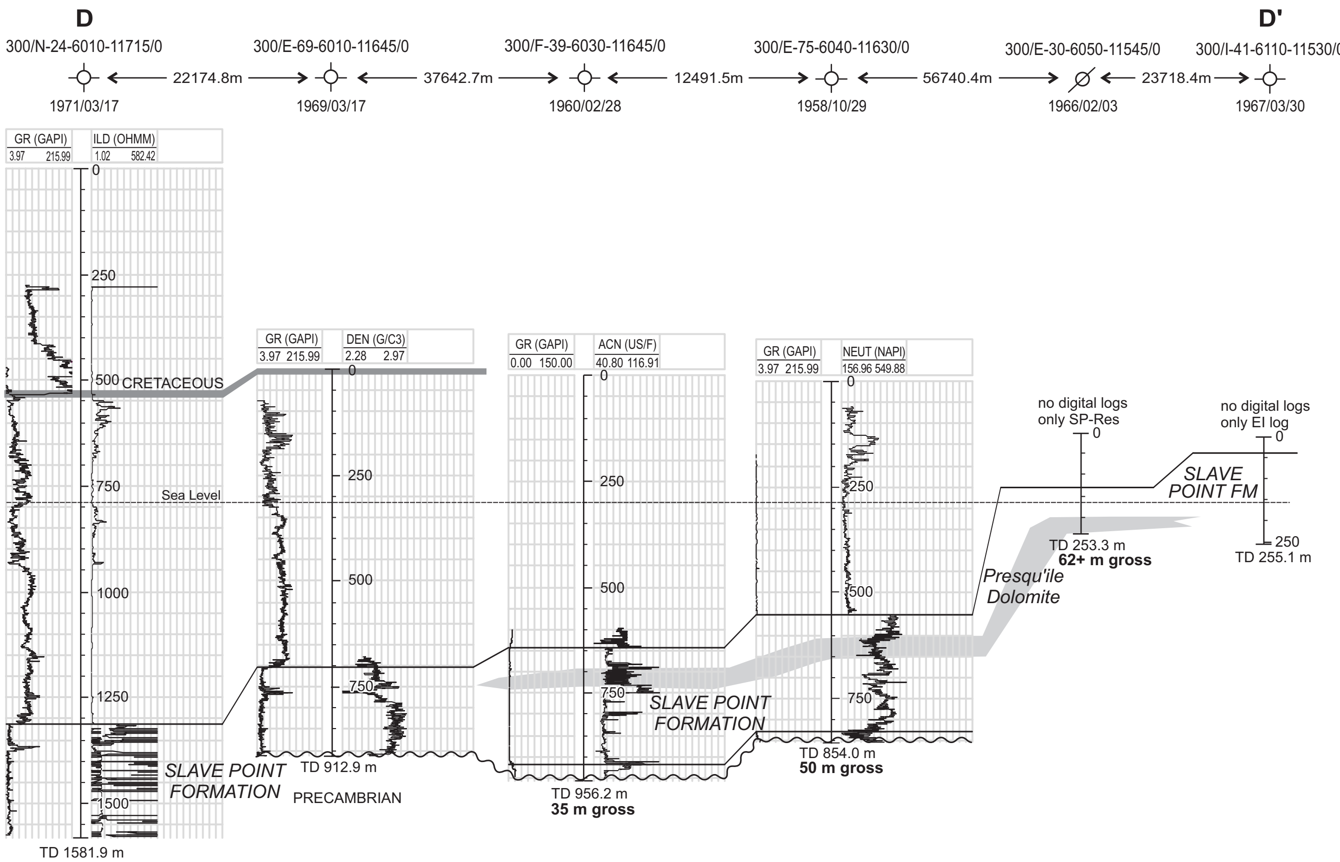



**Figure 8**. Cross-section D–D'. *See* Figure 1 for well locations. Note absence of Presqu'ile dolomite in the deepest wells and where Cretaceous cover is present.

development between the Hay River and Tathlina fault zones. Better imaging of the structures close to the fault zones coupled with new data could lead to oil and gas prospects.

## SUMMARY

Subsurface mapping, done at a regional scale, shows that the thickest occurrence of PD follows a northeast-southwest basement structural trend centred on the shore of Great Slave Lake, about 20 km west of the town of Hay River. It falls approximately between the Tathlina and Hay River fault zones. Other thick PD trends, possibly related to basement structural features, run east-west. The thick northeast trend likely continues to the northeast beyond the limits of existing exploration data. Thick PD, and perhaps mineralization, is possible northeast of Windy Point and Slave Point of Great Slave Lake.

In general, PD thins to the south and southwest and was not found below approximately 850 m of depth in the study area. No PD was found in the southwestern part of the study area where Cretaceous rock is present.

PD has not yet proven to be productive for hydrocarbons in the study area despite having high porosity and permeability. New seismic data could identify trapping structures in several lightly explored portions of the study area.

Little evidence of lead-zinc mineralization was found in core or drill cuttings containing PD.

## ACKNOWLEDGMENTS

Thanks are due to the following colleagues at the C.S. Lord Northern Geoscience Centre who supplied critical review and suggestions to improve the text: Adrienne Jones, Len Gal and Bernie MacLean. The many discussions on the topic of Presqu'ile dolomite with Allan Turner, also of C.S. Lord Northern Geoscience Centre, were especially appreciated. Peter Hannigan of the Geological Survey of Canada provided extensive critical feedback essential for improving the quality of the text, figures, and appendices.

## REFERENCES

**Belyea, H.R.**
1971: Middle Devonian tectonic history of the Tathlina Uplift, southern District of Mackenzie and northern Alberta; Geological Survey of Canada, Paper 70-14, 38 p.

**Burwash, R.A., McGregor, C.R., and Wilson, J.**
1994: Precambrian basement beneath the Western Canada Sedimentary Basin; *in* Geological Atlas of the Western Canada Sedimentary Basin, Chapter 5, (comp.) G.D. Mossop and I. Shetsen; Canadian Society of Petroleum Geologists and Alberta Research Council, p. 49–56.

**Christie, R.L., Embry, A.F., and VanDyck, G.A., (ed.)**
2000: Lexicon of Canadian stratigraphy, Volume 2, Yukon Territory and District of Mackenzie; Canadian Society of Petroleum Geologists (CD-ROM).

**Cominco Ltd.**
1980a: Assessment report, geological, geochemical and geophysical report for the Hay West Exploration Program; Department of Indian Affairs and Northern Development Assessment Report, Document Number 081224.
1980b: Windy Point Group; Department of Indian Affairs and Northern Development Assessment Report, Document Number 081333.
1980c: Assessment report for geochemical and geophysical anomalies Qito claims 2, 9 and 74; Department of Indian Affairs and Northern Development Assessment Report, Document Number 081238.

**Douglas, R.J.W.**
1959: Great Slave and Trout River map areas, Northwest Territories; Geological Survey of Canada, Paper 58-11, 57 p.

**Douglas, R.J.W. and Norris, A.W.**
1974: Geology, Great Slave, District of Mackenzie; Geological Survey of Canada, Map 1370A, scale 1:500 000.

**Gulf Minerals Canada Limited**
1979: Geological, geochemical, geophysical report for the Tathlina exploration program; Department of Indian Affairs and Northern Development Assessment Report, document number 081059.

**Janicki, E.P.**
2006b: Hydrodynamic study of Middle Devonian strata, southeastern Great Slave Plain, Northwest Territories; *in* Potential for Carbonate-hosted Lead-zinc Mississippi Valley-type Mineralization in Northern Alberta and Southern Northwest Territories: Geoscience Contributions, Targeted Geoscience Initiative, (ed.) P. K. Hannigan; Geological Survey of Canada, Bulletin 591.

**Jones, A. L.**
2002: Table of Formations; C.S. Lord Northern Geoscience Centre, NWT Open File 2002-05, poster 2 of 3.

**Krebs, W. and Macqueen, R.**
1984: Sequence of diagenetic and mineralization events, Pine Point lead-zinc property, Northwest Territories, Canada; Bulletin of Canadian Petroleum Geology, v. 32, no. 4, p. 434–464.

**MacLean, B.C.**
2006: The sub-Phanerozoic basement surface under the Great Slave Plain of the Northwest Territories, and its influence on overlying strata; *in* Potential for Carbonate-hosted Lead-zinc Mississippi Valley-type Mineralization in Northern Alberta and Southern Northwest Territories: Geoscience Contributions, Targeted Geoscience Initiative, (ed.) P. K. Hannigan; Geological Survey of Canada, Bulletin 591.

**Meijer Drees, N.C.**
1993: The Devonian succession in the subsurface of the Great Slave and Great Bear Plains, Northwest Territories; Geological Survey of Canada, Bulletin 393, 292 p.

**Morrow, D.W., Cumming, G.L., and Aulstead, K.L.**
1990: The gas-bearing Devonian Manetoe facies, Yukon and Northwest Territories; Geological Survey of Canada, Bulletin 400, 54 p.

**Morrow, D.W., MacLean, B.C., Miles, W., Tzeng, P., and Pană, D.**
2006: Subsurface structures in southern Northwest Territories and northern Alberta: Implications for mineral and petroleum potential; *in* Potential for Carbonate-hosted Lead-zinc Mississippi Valley-type Mineralization in Northern Alberta and Southern Northwest Territories: Geoscience Contributions, Targeted Geoscience Initiative, (ed.) P. K. Hannigan; Geological Survey of Canada, Bulletin 591.

**National Energy Board of Canada**
1992: Schedule of Wells North of 60°.

**Qing, H.**
1992: Large-scale fluid flow in the Middle Devonian Presqu'ile Barrier, Western Canada Sedimentary Basin; Geology, v. 20, p. 903–906.

**Rhodes, D., Lantos, E.A., Lantos, J.A., Webb, R.J., and Owens, D.C.**
1984: Pine Point orebodies and their relationship to the stratigraphy, structure, dolomitization and karstification of the Middle Devonian Barrier Complex; Economic Geology, v. 79, p. 991–1055.

**Roedder, E.**
1968: Temperature, salinity and origin of the ore-forming fluids at Pine Point, Northwest Territories, Canada, from fluid inclusion studies; Economic Geology, v. 63, no. 5, p. 439–450.

**Skall, H.**
1975: The paleoenvironment of the Pine Point lead-zinc district; Economic Geology, v. 70, p. 22–47.

**Turner, W.A., Pierce, K., and Cairns, K.**
2002: Great Slave Reef (GSR) Project Drillhole Database. A compilation of the drillhole locations, drill logs, and associated geochemical data for the Great Slave Reef Joint Venture Project; Interior Platform, Northwest Territories, Canada (NTS 85B11 to 14); NWT Open File Report 2002-1 (CD-ROM).

**Williams, G.K.**
1981: Middle Devonian carbonate barrier complex of western Canada; Geological Survey of Canada, Open File 761.

# Appendix A

## Distribution of Presqu'ile dolomite

| Location | Comments–PD gross interval | Core or samples examined? | Gross metres PD |
|---|---|---|---|
| A-05-6010-11730 | | n | 0 |
| A-47-6130-11715 | | y | 0 |
| A-52-6100-11415 | 0–5 m depth | n | 5 |
| A-60-6030-11600 | too shallow, TD in Hay River Fm | n | 0 |
| A-63-6050-11800 | 900–915 m depth | y | 15 |
| A-77-6040-11600 | no cuttings description | n | ? |
| B-05-6030-11630 | too shallow, TD in Twin Falls Fm | n | 0 |
| B-07-6040-11545 | | y | 0 |
| B-41-6150-11645 | | n | 0 |
| B-52-6100-11530 | gross PD m depth 182–198 | n | 16 |
| B-69-6110-11630 | limestone only | n | 0 |
| B-75-6120-11715 | | n | 0 |
| C-03-6040-11430 | too shallow | n | 0 |
| C-04-6100-11745 | limestone and non-porous dolomite | n | 0 |
| C-05-6100-11445 | | n | 0 |
| C-10-6120-11645 | no Presqu'ile dolomite observed | y | 0 |
| C-12-6110-11715 | | y | 0 |
| C-19-6050-11645 | gross PD depth 447–552 m – may extend into Slave Point | y | 75 |
| C-20-6120-11645 | saddle crystals mentioned, extensively cored | y | 0 |
| C-24-6010-11645 | dolomite in small vugs | y | 0 |
| C-27-6050-11715 | limestone only | n | 0 |
| C-38-6110-11645 | limestone only | n | 0 |
| C-40-6120-11545 | no sample descriptions or cuttings – drilled in 1920 | n | ? |
| C-50-6010-11730 | minor dolomite lining vugs | y | 0 |
| C-61-6130-11630 | limestone only | n | 0 |
| C-74-6040-11430 | mention of sphalerite at 277 m depth in core | y | 0 |
| D-06-6100-11830 | | n | 0 |
| D-06-6100-12030 | | n | 0 |
| D-16-6010-11630 | sucrosic dolomite only | y | 0 |
| D-34-6050-11715 | limestone only | n | 0 |
| D-39-6040-11715 | 830–842 m depth | y | 12 |
| D-44-6040-11600 | | n | 0 |
| D-47-6120-11645 | saddle crystals | y | 0 |
| D-50-6050-11700 | possible PD in Slave Pt at 580 m depth | n | ? |
| D-57-6130-11700 | | n | 0 |
| D-62-6030-11830 | no sample description | n | ? |
| D-66-6040-11600 | TD in PD 458–468+ m depth | y | 10+ |
| E-30-6050-11545 | TD in PD 216–235+ m depth | y | 19+ |
| E-33-6100-11915 | | n | 0 |
| E-55-6040-11930 | vuggy dolomite, not likely PD | n | 0 |
| E-69-6010-11645 | | n | 0 |
| E-72-6110-11615 | nearby G-38-6100-11630 has coarse-crystalline dolomite | n | 0 |
| E-75-6040-11630 | 611–662 m depth | n | 51 |

PD = Presqu'ile dolomite

**Appendix A** (cont.)

| Location | Comments–PD gross interval | Core or samples examined? | Gross metres PD |
|---|---|---|---|
| F-07-6030-11600 | anhydritic dolomite | n | 0 |
| F-25-6050-11715 | limestone only | n | 0 |
| F-29-6050-11630 | 445–528 m depth | y | 83 |
| F-35-6030-11615 | too shallow, TD in Hay River Fm | n | 0 |
| F-35-6100-11715 | anhydritic dolomite | n | 0 |
| F-39-6030-11645 | 702–737 m depth | n | 35 |
| F-43-6050-11545 | 238–275 m depth | y | 37 |
| F-46-6050-11800 | Sulphur Pt and Slave Pt are limestone | n | 0 |
| F-56-6010-11745 | Slave Pt non-porous; Keg River eroded on Tathlina High | n | 0 |
| G-07-6020-11945 | | n | 0 |
| G-15-6100-11615 | 262–360 m depth | y | 98 |
| G-43-6050-11545 | 244–269 m depth | y | 25 |
| G-19-6040-11745 | 930–942 m depth, scattered PD elsewhere | y | 12 |
| G-31-6050-11845 | 1049–1064 m depth, traces of pyrite | n | 15 |
| G-36-6020-11630 | | y | 0 |
| G-38-6100-11630 | 303–323 m depth | y | 20 |
| G-48-6040-11745 | | n | ? |
| G-56-6110-11630 | | n | 0 |
| G-63-6020-11545 | | n | 0 |
| H-33-6110-11600 | 137–238 m depth | y | 101 |
| H-34-6010-11645 | | n | 0 |
| H-36-6100-11715 | | n | 0 |
| H-38-6030-11615 | too shallow | n | ? |
| H-57-6010-11745 | | n | ? |
| I-10-6010-11730 | Keg River is fine-crystalline dolomite with poor porosity | n | 0 |
| I-16-6030-11545 | anhydritic dolomite | n | 0 |
| I-16-6010-11730 | | n | ? |
| I-41-6100-11630 | 415–500+ m depth | y | 85+ |
| I-41-6110-11530 | Keg River limestone platform | n | 0 |
| I-44-6100-11715 | euhedral dolomite- no PD | y | 0 |
| I-52-6010-11745 | | n | ? |
| I-57-6120-11730 | Keg River limestone platform | n | 0 |
| I-61-6050-11545 | | n | ? |
| I-72-6030-11530 | anhydritic dolomite | n | 0 |
| J-12-6010-11700 | | n | 0 |
| J-13-6020-11615 | 595–653 m depth | y | 58 |
| J-26-6020-11630 | | n | 0 |
| J-42-6010-11830 | | n | 0 |
| J-43-6050-11545 | | n | ? |
| J-48-6100-11645 | anhydritic dolomite | n | 0 |
| J-52-6050-11730 | | y | 0 |
| J-53-6050-11715 | 763–766 m depth | y | 3 |
| J-42-6010-11715 | | n | ? |
| J-56-6030-11800 | | n | ? |

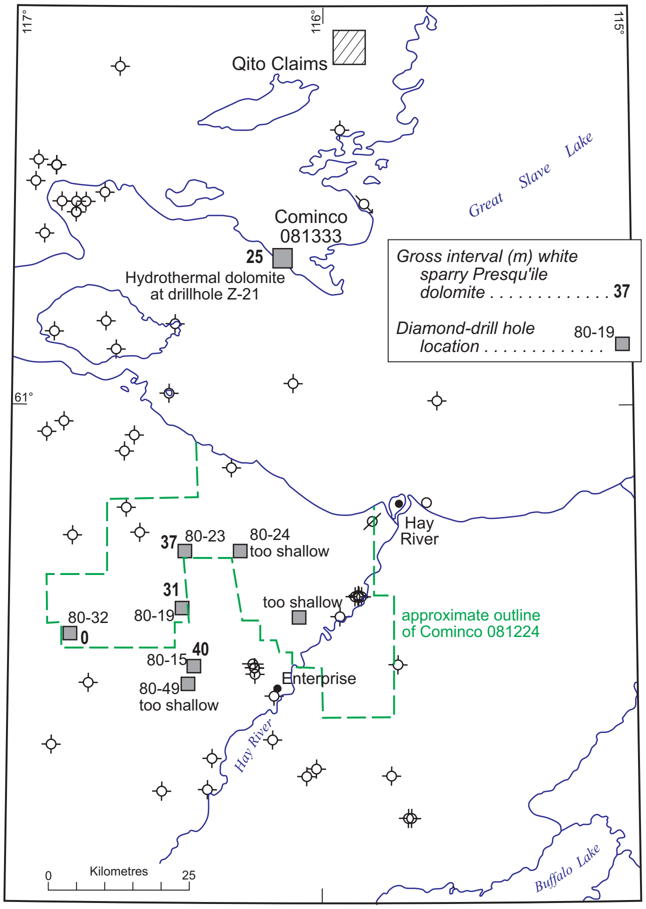
**Appendix A** (cont.)

| Location | Comments–PD gross interval | Core or samples examined? | Gross metres PD |
|---|---|---|---|
| J-65-6050-11715 | 838–878 m depth | y | 40 |
| K-10-6040-11715 | 775–855 m depth | y | 80 |
| K-48-6040-11745 | core shows brecciation, some vugs partly to fully infilled | y | 0 |
| L-05-6020-11600 | | n | 0 |
| L-10-6110-11730 | | n | 0 |
| L-42-6040-11415 | | y | 0 |
| L-50-6020-11745 | | n | 0 |
| L-66-6040-11600 | 466–486 m depth | y | 20 |
| L-69-6050-11830 | | n | 0 |
| L-71-6050-11730 | up to 5% dolomite crystals | n | ? |
| L-72-6030-11800 | mostly non-porous dolomite | n | 0 |
| M-05-6020-11815 | euhedral dolomite crystals – not PD | n | 0 |
| M-19-6020-11915 | | n | ? |
| M-29-6110-11700 | limestone only | n | 0 |
| M-31-6010-11700 | | n | 0 |
| M-39a-6110-11700 | | n | 0 |
| N-18-6020-11800 | | n | 0 |
| N-24-6010-11715 | | n | 0 |
| N-34-6050-11730 | PD discontinuous - 839–845, 871–885 m depth | y | 20 |
| O-07-6100-11445 | 22–37 m depth | y | 15 |
| O-22-6020-11730 | | y | 0 |
| O-28-6100-11800 | | n | 0 |
| O-46-6100-11630 | 319–327 m depth | y | 8 |
| O-54-6030-11745 | | n | 0 |
| O-66-6130-11545 | 18–40 m depth | y | 22 |
| O-78-6110-11615 | | n | 0 |
| P-52-6140-11630 | | n | 0 |

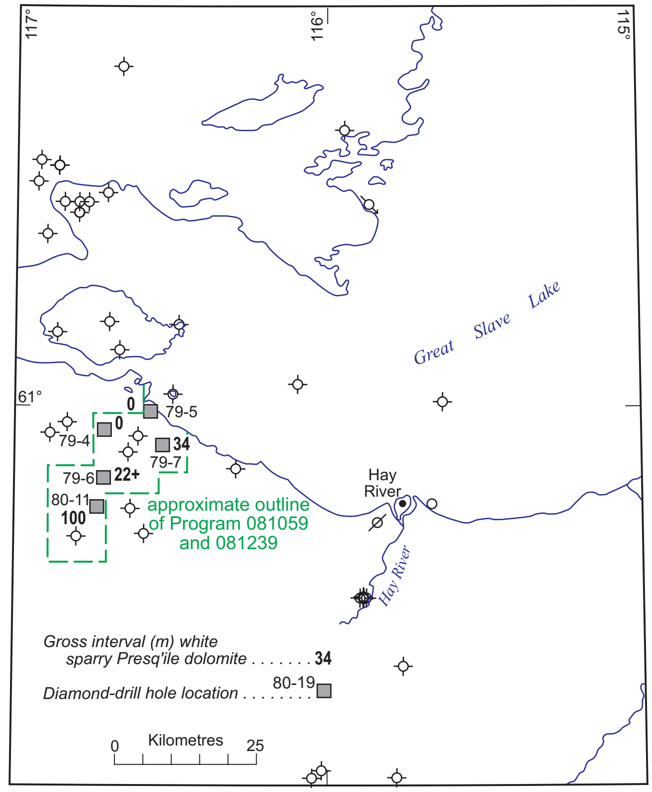
PD = Presqu'ile dolomite

# Appendix B

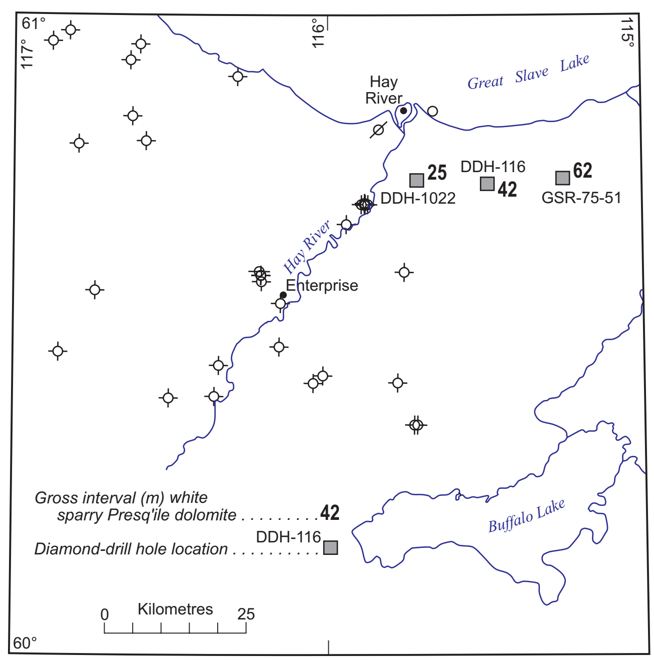
## Mineral exploration diamond-drill holes, maps 1, 2 and 3




1




2




3