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K'ágee Tu area of interest hydrocarbon assessment summary report

D.W. Morrow

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TABLE OF CONTENTS

ABSTRACT

The K'ágee Tu area of interest lies entirely within the Great Slave Plain physiographic region southwest of Great Slave Lake including the community of Kakisa. Gently southwest-dipping Devonian carbonate and siliciclastic strata that underlie this region contain three discovered gas fields with 6.4 billion cubic feet of remaining recoverable gas. Quantitative estimates indicate that the ultimate potential of the K'ágee Tu area of interest is probably less than 175 billion cubic feet of gas. Most of this potential occurs along the Presqu'ile barrier reef complex. Ultimate oil potential has been estimated at 6.0 million barrels, largely from Devonian reservoirs similar to that of the Cameron Hills Field south of the K'ágee Tu area, which produces both oil and gas.

Introduction

The NWT Areas Strategy (PAS) is a partnership process to establish protected areas in the Northwest Territories. The PAS process requires that as areas are identified, the known cultural, ecological and economic values are studied, documented and discussed. As part of this work, Non-Renewable Resource Assessments of mineral and hydrocarbon potential are conducted on areas of interest.

The purpose of this report is to present a hydrocarbon resource potential assessment of the K'ágee Tu area of interest. K'ágee Tu occupies a large region of about 8,700 km^2 southwest of Great Slave Lake and extends between 60.2° and 61.1° N latitude and between 116.5° and 119.2° W longitude (Fig. 1). The K'ágee Tu area falls entirely within the Dehcho region near its southeastern limit. The K'ágee Tu area includes Kakisa and Tathlina lakes and the small community of Kakisa on Kakisa Lake (Figs. 2, 3). K'ágee Tu falls entirely within the low relief Great Slave Plain physiographic and exploration region. It is near the community of Hay River on the southwest shore of Great Slave Lake (Fig. 1), and includes a large part of the low-lying watershed of the Kakisa River (Fig. 2). K'ágee Tu is an area rich in wildlife and it is a particularly important habitat for boreal Woodland caribou.

The north-facing, east-west trending escarpment along the northern edge of the Cameron Hills forms most of the southern boundary of the K'ágee Tu area of interest (Figs. 2, 3). The area rises abruptly from 300 metres elevation at Tathlina Lake to nearly 600 metres at the crest of the escarpment. It extends northeast to the south shore of Great Slave Lake at its function with the Mackenzie River (Fig. 2).

Geological setting

Exposed bedrock across the K'ágee Tu area consists of a gently southwestward-dipping succession of Upper Devonian strata composed of limestone or of silty and sandy shales (Fig. 4; Table 1). The Upper Devonian Hay River Formation (uDHR) shaly limestone at the northeast corner of K'ágee Tu is the stratigraphically lowest exposed unit (Fig. 4). The stratigraphy 'climbs' to the southwest through a succession of carbonate platform and shelf limestone units (Tetcho, Kakisa, and Twin Falls formations and the Jean Marie Member; Table 1), which are variably biostromal, and shaly, and which alternate with variably shaly, silty and sandy units (Tathlina, Redknife, Fort Simpson, and Trout River formations). Bedrock is either exposed at surface or mantled with a few metres of Quaternary-aged glacial drift, or by Recent (Holocene) colluvium.

In the extreme southern part of K'ágee Tu, nearly flat-lying Cretaceous strata overlie the southwest-dipping Upper Devonian succession with a regional angular unconformity (Fig. 4; Table 1) to form the Cameron Hills. This hilly upland is essentially a broad plateau formed by Cretaceous strata of the Shaftsbury, Scatter, Garbutt and Loon River formations (Dixon, 1997; Table 1). None of these Cretaceous units occur in the subsurface in the K'ágee Tu area.

A conformable succession of Lower and Middle Devonian carbonate, siliciclastic and evaporate-bearing strata (Muskwa, Slave Point, Watt Mountain, Sulphur Point, Keg River, Chinchaga, and Mirage Point formations (Table 1) underlie the Upper Devonian succession, which is exposed across the K'ágee Tu area. The basal clastics unit (or La Loche Formation sandstone) forms the base of the Devonian succession, which, in turn, rests unconformably on Precambrian bedrock (Table 1). Precambrian bedrock

was exposed in pre-Devonian time across Tathlina Arch (Meijer-Drees, 1993; Fig. 4), a large emergent land mass that extended approximately east-west across the southern Northwest Territories. Sandstones of the La Loche Formation onlap the eastern flanks of this arch in the K'ágee Tu area.

The Presqu'ile Barrier, a subsurface barrier type of reefal buildup is an extremely important subsurface feature in the northern part of the K'ágee Tu area (Figs. 2, 3, 5). It extends approximately east-west across the southern Northwest Territories approximately along the axis of the underlying Tathlina Arch. This depositional barrier separated the Elk Point carbonate and evaporate basin to the south from open marine shelf to the north. Reefal and biostromal buildups preferentially occur along the northern edge of the Barrier. North of the Barrier, open marine platform carbonates of the Lonely Bay Formation and organic-rich shales of the Horn River Group accumulated (Table 1). Muskeg Formation anhydrite accumulated contemporaneously south of the Barrier. The northern subsurface limit of these evaporates approximately coincides with the southern edge of the K'ágee Tu area.

An important petroleum reservoir, the Presqu'ile Dolomite (Table 1; Meijer-Drees, 1993; Janicki, 2006), has affected large parts of the Slave Point and Sulphur Point limestones, which have been recrystallized to coarsely crystalline porous and permeable white 'hydrothermal' dolomite.

A strongly developed set of northeast-trending subvertical faults, or fault zones, cross the K'ágee Tu area (Figs. 2, 3). The Rabbit Lake and Tathlina fault zones appear to be basement faults that have transected, or offset, the entire overlying Phanerozoic stratigraphy (Maclean, 2006; Morrow et al., 2006). Although the Presqu'ile Dolomite extends variably within strata forming the Presqu'ile Barrier across the southern Northwest Territories (Meijer-Drees, 1993), the Presqu'ile dolomite is particularly thick along and adjacent to the northeast-trending fault zones (Janicki, 2006).

Hydrocarbon Occurrences

Table 2 provides summary information concerning the volume of discovered natural gas that falls within the K'ágee Tu area. A total of about 0.18 billion cubic metres or 6.4 billion cubic feet of discovered remaining recoverable gas is apportioned between three gas fields, the Tathlina N-18 and Kakisa F-35 gas fields and part of Cameron Hills gas field (Drummond, 2004). Table 3 summarizes exploration drilling results for petroleum resources for the nine gas discovery wells drilled within and immediately adjacent to K'ágee Tu area (Fig. 2). Four of these wells are within the K'ágee Tu area. Several gas fields, the Kakisa F-35 and the Tathlina N-18 gas fields were discovered in the K'ágee Tu area in the early 60's, and the oldest gas field discovery in the Northwest Territories, the Rabbit Lake O-16 Field lies just northwest of K'ágee Tu (Fig. 1; Gal and Jones, 2003). Established reserves in these fields are $451 \times 10^6 m^3$ for Rabbit Lake Field, and $130 \times 10^6 m^3$ for Tathlina Field (Canadian Gas Potential Committee, 2001). Reserves have not been established for the Kakisa Field but Kakisa F-35, drilled in 1964, flowed roughly $28 \times 10^3 m^3/d$ (cubic meters per day) from the Slave Point Formation during DST (Gal and Jones, 2003). The Cameron Hills Field, immediately south of K'ágee Tu had a cumulative production to the end of May 2003 of $169.66 \times 10^6 m^3$ of gas, and $2{,}088.5 \times 10^3 m^3$ of oil (NEB, 2003).

PERIOD (Epoch, stage)		FORMATION / GROUP	LITHOLOGY
Quaternary		Unnamed Quaternary	Glacial drift
Unconformity			
Cretaceous	Upper	Shaftsbury (KSh- Cameron Hills)	Shale, siltstone
	Unconformity		
	Lower	Scatter (KSc- Cameron Hills)	Sandstone, siltstone
		Garbutt (KGr- Cameron Hills)	Shale, siltstone
		Loon River (KLR- Cameron Hills)	Shale (sideritic)
Unconformity			
Carbon-iferous	Lower	Banff (DCB - subsurface)	Siltstone; Silty limestone
Devonian	Upper	Kotcho (uDKoC- carbonate facies and uDKoP- shale facies)	Green shale, siltstone, sandstone, limestone
		Tetcho (uDTe)	Limestone (bioclastic and pelletal)
		Trout River (uDTR- subsurface)	Limestone, minor sandstone
		Kakisa (uDKA- subsurface)	Limestone, sandy and silty, bioclastic
		Redknife (uDR- subsurface)	Shale; calcareous and silty
		Fort Simpson (uDFS- subsurface; Hay River to Tathlina interval equivalent)	Shale (greenish-grey); calcareous and silty
		Jean Marie Member of Redknife (uDR-JM- subsurface)	Limestone; silty and bioclastic
		Tathlina (uDTa- subsurface)	Siltstone; calcareous and shaly
		Twin Falls (uDTF- subsurface)	Limestone; bioclastic
		Alexandra Member of Twin Falls (uDTF-A- subsurface)	Limestone; reefal and bioclastic
		Hay River (uDHR- subsurface)	Shale (Greenish); calcareous and bioclastic
	Middle	Muskwa of Horn River Group (mDM- subsurface only)	Shale
		Slave Point (subsurface only)	Limestone; bioclastic
		Watt Mountain (subsurface only)	Shale (greenish-grey to green)
		Sulphur Point (subsurface only)	Limestone (pelletal)
		Presqu'ile Dolomite (Pp- subsurface only but shown on map; dolomitized Sulphur Point to Slave Point)	White, coarse crystalline diagenetic dolomite (significant reservoir facies)
		Muskeg (subsurface only)	Anhydrite, tan dolostone
		Keg River, Lonely Bay (subsurface only)	Dolostone (dark crinoidal to biostromal)
		Upper Member of Chinchaga and Ebbut Member (subsurface only)	Dolostone; minor anhydrite
		Unconformity	
	Lower	Lower Member of Chinchaga and Fort Norman (subsurface only)	Anhydrite, tan dolostone
		Mirage Point and Ernestina Lake	Anhydrite, tan dolostone, evaporites
		Basal clastics and La Loche (subsurface only)	Sandstone (porous and dolomitic)
Unconformity			
Precambrian		Hottah and Great Bear domains	Metasedimentary; gneiss; granite

Table 1. Main rock formations of the Great Slave Plain in the K'ágee Tu area (see Figure 4 for formational bedrock map designations such as 'uDFS').

Drummond (2004) in a recent study assigned volumes of discovered remaining recoverable gas to these fields; 0.32 billion cubic meters, or 11.3 billion cubic feet to the Rabbit Lake O-16 Field, 0.07 billion cubic meters, or 2.5 billion cubic feet to the Tathlina N-18 Field, and 0.10 billion cubic meters, 3.53 billion cubic feet to the part of the Cameron Hills Field quarter grid that falls within the K'ágee Tu area. A conservative estimate of the volume of discovered remaining recoverable gas in the Kakisa F-35 Field could be made by assuming a year of production at the tested rate of $28x10^3m^3/d$. This indicates a total volume of 10.22 million cubic meters or about 0.4 billion cubic feet of gas for the the Kakisa F-35 Field.

Gas Field	Billion Cubic Metres	Billion Cubic Feet
Tathlina N-18	0.07	2.5
Kakisa F-35	0.01	0.4
Cameron Hills (part)	0.10	3.5
Total gas volume	**0.18**	**6.4**

Table 2. Volumes of discovered remaining recoverable gas in gas fields within the K'ágee Tu area of interest.

The Kakisa F-35 Field is developed within Slave Point reefal limestones in a primarily stratigraphic trap along the Presqu'ile Barrier edge above basement faults at Kakisa Lake (Fig. 5). Tathlina N-18 Field is developed within a structural anticlinal closure in Slave Point carbonates along Tathlina Fault Zone and similarly, Rabbit Lake O-16 Field is developed within a structural anticlinal closure in Sulphur Point fragmental limestones developed across the Rabbit Lake Fault Zone (Williams, 1977).

Well name (Grid number)	Location of well (Gas Field)	Rig Release Date	Total Depth (m)	TD Formation	Status of well
Paramount et al Cameron A-73 (6020-11730)	On southern border of K'ágee Tu (near Cameron Hills)	25-Feb-90	1585	Precambrian?	Gas
Pacific Amoco Tathlina N-18 (6020-11800)	Within a kilometer of southern border of K'ágee Tu (Tathlina)	19-Feb-73	1339.6	Precambrian	Gas
Pacific Phillips N Cameron Hills M-05 (6020-11815)	South of K'ágee Tu (near Cameron Hills)	21-Mar-71	1424.9	Precambrian	Gas Show
CPOG Chevron Gull Creek A-63 (6050-11800)	Within K'ágee Tu	28-Feb-70	945.5	Precambrian	Gas Show
Calstan Imperial Bouvier L-69 (6050-11830)	On northwest border of K'ágee Tu (Rabbit Lake?)	21-Feb-65	1018.9	Precambrian	Gas Show
Pan American-Shell Kakisa F-35 (6100-11715)	Within of K'ágee Tu beside Kakisa Lake ('Kakisa')	30-Mar-64	730	Chinchaga	Gas Show
Briggs Rabbit Lake No.3(B-07) (6100-11845)	Northwest of K'ágee Tu (Rabbit Lake)	14-Mar-57	815	Pine Point	Gas
Briggs Rabbit Lake No.1(O-16) (6100-11845)	Northwest of K'ágee Tu (Rabbit Lake)	30-Mar-55	864.4	Precambrian	Gas
Briggs Rabbit Lake No. 2(O-25) (6100-11845)	Northwest of K'ágee Tu (Rabbit Lake)	29-May-55	887	Precambrian	Gas

Table 3. Gas wells drilled within and near the K'ágee Tu area of interest.

Hydrocarbon Prospectivity

The K'ágee Tu area of interest is, as discussed previously, underlain by Devonian rocks that are prospective for oil and gas. The Canadian Gas Potential Committee (2001, 2005; see also Gal, 2005 and Gal and Jones, 2003) have previously defined hydrocarbon plays in the central Mackenzie Valley area that could potentially host oil and/or natural gas. These plays have formed the basis for a set of revised plays (Hannigan et al., 2006) and a set of previously unpublished boundaries for these revised plays are used here to outline the petroleum potential of the K'ágee Tu area of interest. Eight of these revised

plays occupy portions of the K'ágee Tu area of interest. These plays include the 'pre-mid-Devonian basal clastics', the 'Keg river Back Barrier shelf and shelf basin', the 'Keg River offshore isolated reef – Horn Plateau' the 'upper Elk Point – Presqu'ile Barrier', the 'Slave Point/Sulphur Point Barrier Reef edge', the 'Sulphur Point – Back barrier Shelf', the 'Slave Point – back Barrier shelf', and the 'Kakisa platform' plays (Figs. 6, 7, 8).

Pre-mid-Devonian basal clastics play (conceptual[1])

This play includes all prospects in structural and stratigraphic traps where transgressive basal Devonian clastic strata unconformably onlap Precambrian basement highs, such as the Tathlina Arch (Gal and Jones, 2003; Hannigan et al., 2006). Although a conceptual play here, basal Devonian clastics are prolific oil-producing reservoirs in northern Alberta, where basal Devonian sandstone beds (also known as "Granite Wash") mantle the flank of the Peace River Arch (e.g., Podruski et al., 1988). In the subsurface, basal Devonian clastic rocks are regionally discontinuous; a small portion of it underlies the northeast part area of the K'ágee Tu area of interest (Fig. 6). Potential reservoir intervals are less than 1.5 m thick, but reach a thickness of 21 m in places (Meijer-Drees, 1993). Porosity of the reservoir is generally poor to fair, although zones of porosity over 9% have been locally documented (Gal and Jones, 2003). Source rocks include organic-rich beds of the Lower Chinchaga Formation or Middle Devonian shale. Evaporitic strata of the Mirage Point and Lower Chinchaga formations could provide reasonable seal.

Keg River Back Barrier shelf and shelf basin play (established)

The established and mature Keg River back barrier shelf play (Fig. 6) includes all pools and prospects in dolomitized platformal carbonate rocks of the Keg River Formation resting south of the Middle Devonian carbonate barrier (Gal and Jones, 2003). In Alberta, the Keg River Formation is host to the Zama, Rainbow and Shekilie oil fields (Podruski et al., 1988), located approximately 200 km southwest of the K'ágee Tu area of interest. Most of this play is located in northwestern Alberta but it extends north of the 60th parallel. Only a very small portion of this play is included in the southernmost part of the K'ágee Tu area (Fig. 6). Primary source rocks for this play are organic-rich Muskeg evaporates. This play includes the Keg River reservoirs in the Cameron Hills gas fields (Fig 1; Table 2).

Keg River offshore isolated reef – Horn Plateau play (conceptual)

This play occupies only a very small part of K'ágee Tu north of Kakisa Lake (Fig. 6). It includes the platform basin shelf carbonates of the Lonely Bay Formation (equivalent to lower part of the Lower Keg River Member) that extend northward from the Presqu'ile Barrier. Potential reservoirs are isolated reef mound buildups extending upwards from the upper contact of the Lonely Bay platform. Prospectivity in this play is low for gas and very little for oil.

Upper Elk Point-Presqu'ile barrier play (established gas and conceptual oil play)

The established (immature) Upper Elk Point-Presqu'ile barrier play includes all pools and prospects in stratigraphic traps hosted in Devonian reefal and dolomitized Keg River and Sulphur Point carbonate reservoirs (particularly the Presqu'ile Dolomite) in the interval between the tight Chinchaga Formation anhydrite and Slave Point Formation lime mudstones (Hannigan et al., 2006). The play is limited to the north by the Presqu'ile carbonate barrier edge; its southern limit is defined by the edge of the Keg River and Sulphur Point back barrier shelf plays. The Upper Elk Point-Presqu'ile barrier play underlies most of the central and southern parts of the K'ágee Tu area of interest (Fig. 6). This play includes the Rabbit Lake O-16 gas field immediately northwest of the K'ágee Tu area (Figs. 2, 3).

[1] An established play has been demonstrated to exist by the discovery of hydrocarbon pools. A conceptual play does not yet have discoveries or reserves, but may exist according to geological analysis.

Sulphur Point back barrier shelf play (established)

The established and mature Sulphur Point back barrier shelf sour gas and oil play includes all pools and prospects within shelf facies carbonate rocks of the Sulphur Point Formation (Podruski et al., 1988; Gal and Jones, 2003; Hannigan et al., 2006). Most of this play is located in northern Alberta, but it extends north of the 60th parallel and occupies the southernmost part of the K'ágee Tu area (Fig. 6). This play includes the Cameron Hills gas field south of K'ágee Tu. Part of this field occurs within the K'ágee Tu area at the Paramount et al. Cameron A-73 well (Figs. 2, 3). The Sulphur Point back barrier shelf play is south of the Presqu'ile barrier. It extends northward up to the northern limit of Muskeg anhydrite which acts as an underlying impermeable play seal (Podruski et al., 1988). Structural traps dominate this play, as fractured reservoir rocks and porous grainstones form traps in antiformal closures associated with reactivated northeast-trending faults, which act as conduits for hydrocarbons (Gal and Jones, 2003; Podruski et al., 1988). This play is predominantly a gas play with subsidiary oil propectivity.

Slave Point back barrier shelf play (established)

The established and mature Slave Point back barrier shelf gas and oil play includes all pools and prospects within shelf facies carbonate rocks of the Slave Point Formation (Gal and Jones, 2003; Hannigan et al., 2006). Most of this play is in Alberta, but it also extends northward into the Northwest Territories close to the northern limit of the Presqu'ile Barrier to a junction with the Slave Point/Sulphur Point barrier edge play (Fig. 7). The Slave Point back barrier shelf play extends across most of the K'ágee Tu area except for the part north of Kakisa Lake (Fig. 7). Structural traps are dominant within this play, as fractured reservoir rocks form traps in antiformal closures associated with reactivated northeast-trending faults, which act as conduits for hydrocarbons (Gal and Jones, 2003), such as in the Tathlina N-18 gas pool developed along the Tathlina Fault zone (Figs. 2, 3; Table 2). This is mainly a non-associated gas play with low prospectivity for oil.

Slave Point/Sulphur Point barrier edge play (established)

The established and mature Slave Point/Sulphur Point barrier edge play sour gas and oil play includes all pools and prospects within a narrow ribbon a few kilometers wide of porous reefal limetones and dolomitized limestones comprised of undivided Slave Point and Sulphur Point formations (Gal and Jones, 2003; Hannigan et al., 2006). The Watt Mountain Formation shales that normally separate the Slave Point and Sulphur Point formations are very thin or absent within this play area. The well known Clarke Lake gas field of northeast British Columbia, developed in Presqu'ile Dolomite that has dolomitized porous reefal Slave Point limestone, is the archtypical example of gas pools within this play. The Netla C-07 gas field developed within porous reefal limestone west of the K'ágee Tu area is one of several discoveries north of the 60th parallel. The Kakisa F-35 gas field (Figs. 2, 3) is a discovery that occurs within the K'ágee Tu area itself. This play is highly prospective for non-associated gas, but far less so for oil. This play occupies a relatively small area across the northern part of the K'ágee Tu area of interest along Kakisa Lake (Fig. 7)

Kakisa platform play (established)

Kakisa platform is an established, but immature gas play that occupies the southwestern two-thirds of the K'ágee Tu area (Fig. 8). Some gas production occurs from pools in northeast British Columbia, but no discoveries have been made in this play north of the 60th parallel. The Kakisa Formation is generally a tight platform limestone; prospects for gas reservoirs occur where dolomitization has enhanced porosity and permeability (Gal and Jones, 2003; Hannigan et al., 2006). This play is fairly high risk with low prospectivity. Drummond (2004) assigned less than 0.25 billion cubic metres, or 9 billion cubic feet to the potential for undiscovered recoverable gas for this play in the K'ágee Tu area.

Qualitative and Quantitative estimates of Hydrocarbon Potential

In the K'ágee Tu area of interest the most prospective plays are the 'upper Elk Point – Presqu'ile Barrier', and the 'Slave Point/Sulphur Point Barrier Reef edge'plays. Gal and Jones (2003) presented a

qualitative ranking for the undiscovered petroleum potential across the entire Dehcho region. Most of the K'ágee Tu area has been assigned a high to very high petroleum potential largely because of the contribution of these plays to the total potential of the K'ágee Tu area (Fig. 9). An estimate of the total undiscovered gas potential of the K'ágee Tu area can be derived from the published estimates (Canadian Gas Potential Committee, 2005) for a Middle Devonian-Keg River/Pine Point Reservoirs play and a Slave Point/Sulphur Point Bank Margin and Interior Reservoirs play. These estimates can be interpreted to indicate an undiscovered potential of up to 220 billion cubic feet of gas in the K'ágee Tu area of interest.

Drummond (2004) recently derived an independent estimate of the remaining undiscovered recoverable gas potential of the Dehcho region based on the estimation of undiscovered petroleum potential for 20 individual plays that are approximately equivalent to those described in Hannigan et al. (2006) and used in this report. Drummond's (2004) regional map showing total undiscovered potential by quarter degree grid (Figure 9 in Drummond, 2004) across the Dehcho region can be utilized to define the undiscovered potential in the K'ágee Tu area of interest (Fig. 10). This gives a similar estimate of 4.9 billion cubic meters, or 173 billion cubic feet of gas for the undiscovered gas potential of K'ágee Tu.

Similarly, Drummond's (2004) regional map of undiscovered recoverable oil potential (Figure 12 in Drummond, 2004) indicates that about 953 thousand cubic meters or 6.0 million barrels of oil are likely to be found in the K'ágee Tu area of interest. Most of this oil potential occurs in plays approximately equivalent to the Sulphur Point back barrier shelf and Keg River Back Barrier shelf and shelf basin plays with a small contribution from a Cretacous sandstone play. However, Cretaceous strata are unlikely to have oil prospectivity in the K'ágee Tu area because it is close to surface (Fig. 4) and subject to invasion and 'water washing' by meteoric water. Dixon (1997) found that east of about 119.5^{o} west longitude, Cretaceous bedrock is deeply eroded and mantled by a very thick cover of Quaternary drift which increases the risk of breaching of potential reservoirs. Dixon (1997) also found that the most prospective basal Cretaceous sandstone reservoir facies does not extend east of this longitude and is not present in the K'ágee Tu area. Another significant risk factor is the immature level of organic maturation of Cretaceous strata across most of the southern Great Slave Plain (Stasiuk et al. (2002)), which precludes the possibility of oil generated from any nearby Cretaceous source rocks.

Conclusions

In summary, the petroleum gas potential of the K'ágee Tu area of interest is very probably between 150 Bcf and 200 Bcf. Additional gas field discoveries will likely be made, but all will be small and none will be more than a few billion cubic feet in volume. This is almost all non-associated gas that has migrated eastward updip during Paleozoic to Cenozoic maturation of primarily Devonian-aged, organic-rich, source rock shales. Oil prospectivity is low to moderate, and is based primarily on oil generated locally from Devonian source rocks that are in the oil window in the K'ágee Tu area of interest (see Stasiuk and Fowler, 2002) which generated oil in the Cameron Hills field that has survived regional eastward differential gas migration. The estimate of 6.0 million barrels of undiscovered recoverable oil may be somewhat overestimated because of the unlikely prospect of oil reservoirs within Cretaceous strata in the K'ágee Tu area.

References

Canadian Gas Potential Committee 2001: Natural Gas Potential in Canada, 2001; CDROM.

Canadian Gas Potential Committee 2005: Natural Gas Potential in Canada, 2005; CDROM.

Dixon, J. 1997: Cretaceous stratigraphy in the subsurface of Great Slave Plain, southern Northwest Territories; Bulletin of Canadian Petroleum Geology, v.45, p. 178-193.

Drummond, K.J. 2004: Oil and Gas resources and Field Size Distribution of the Deh Cho Territory (prepared for Deh Cho Land Use Planning Committee); Drummond Consulting, 148p.

Gal, L.P. 2005: Hydrocarbon potential ranking map of the Sahtu and Gwich'in settlement areas, hydrocarbon play map of the Sahtu and Gwich'in settlement areas; Northwest Territories Geoscience Office, NWT Open File 2005-04, 2 maps, scale 1:1,000,000.

Gal, L.P. and Jones, A.L. 2003: Evaluation of Oil and Gas Potential in the Deh Cho Territory; CS Lord Northern Geoscience Centre, Yellowknife, NWT Open File 2003-03, 88p.

Hannigan, P.K., Dixon, J. and Morrow, D.W. 2006: Oil and Gas Potential of the Northern Mainland, Canada (Mackenzie Corridor, and Northern Yukon); Geological Survey of Canada, Open File 5343 (CDRom).

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.

MacLean, B.C. 2006: The sub-Phanerozoic basement surface under the Great Slave Plain of the Northwest Territories, and its influence of 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, p. 149-163.

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, 222p.

Morrow, D.W., Jones, A.L., and Dixon, J. 2006: Infrastructure and resources of the Northern Canadian Mainland Sedimentary Basin; Geological Survey of Canada, Open File 5152, 1 CD-ROM.

Morrow, D.W., MacLean, B.C., Miles, W.F., Tzeng, P., and Pana, 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, p. 41-59.

Okulitch, A.V. (compiler). in prep: Bedrock Geology, slave River, District of Mackenzie, Northwest Territories; Geological Survey of Canada, Map NP-11/12-G, scale 1:1000000 (National Earth Sciences Series, Geological Atlas); Geological Survey of Canada, Open File.

National Energy Board 2003: Monthly Production Statistics from the Frontier Information Office; National Energy Board.

Podruski, J.A., Barclay, J.E., Hamblin, A.P., Lee, P.J., Osadetz, K.G., Procter, R.M., and Taylor, G.C. 1988: Conventional oil resources of western Canada (light and medium); Geological Survey of Canada, Paper 87-26, 149 p.

Stasiuk, L.D. and Fowler, M.G. 2002: Thermal maturity evaluation (vitrinite and vitrinite reflectance equivalent) of Middle Devonian, Upper Devonian and Mississipian strata in Western Canada Sedimentary Basin; Geological Survey of Canada, Open File 4341 (CD).

Stasiuk, L.D., Fowler, M.G. and Addison, G. 2002: Thermal maturity evaluation of Lower Cretaceous Manville Group and Equivalent Coals in the Western Canada Sedimentary Basin; a Compilation of Vitrinite Reflectance Data; Geological Survey of Canada, Open File 4342 (CD).

Williams, G.K. 1977: The Celibeta structure compared with other basement structures on the flanks of the Tathlina High; in Current Research, part B, Geological Survey of Canada, Paper 77-1B, p. 301-310.

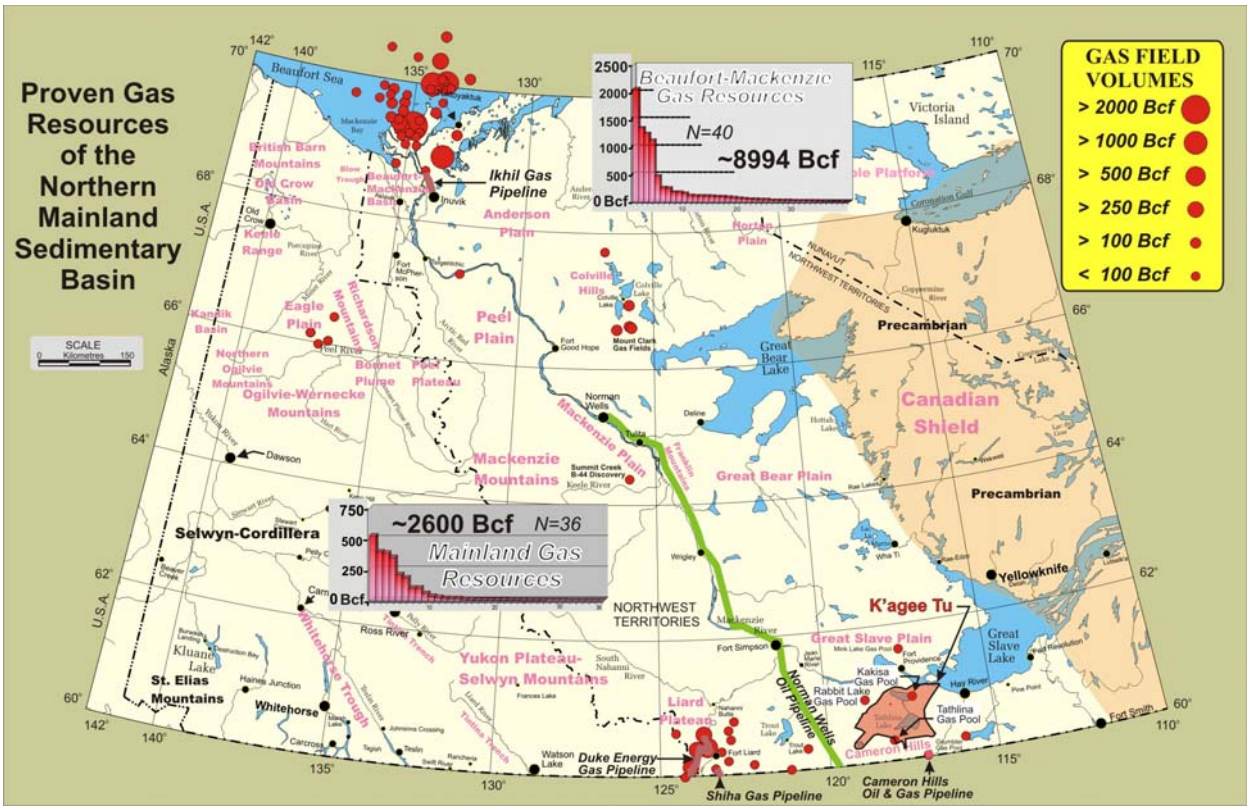

Figure 1. Discovered natural gas resources of the northern Canadian mainland (Morrow et al., 2006). The K'ágee Tu area of interest is in the southeastern part of the 'Mackenzie Valley' and contains several discovered gas pools.

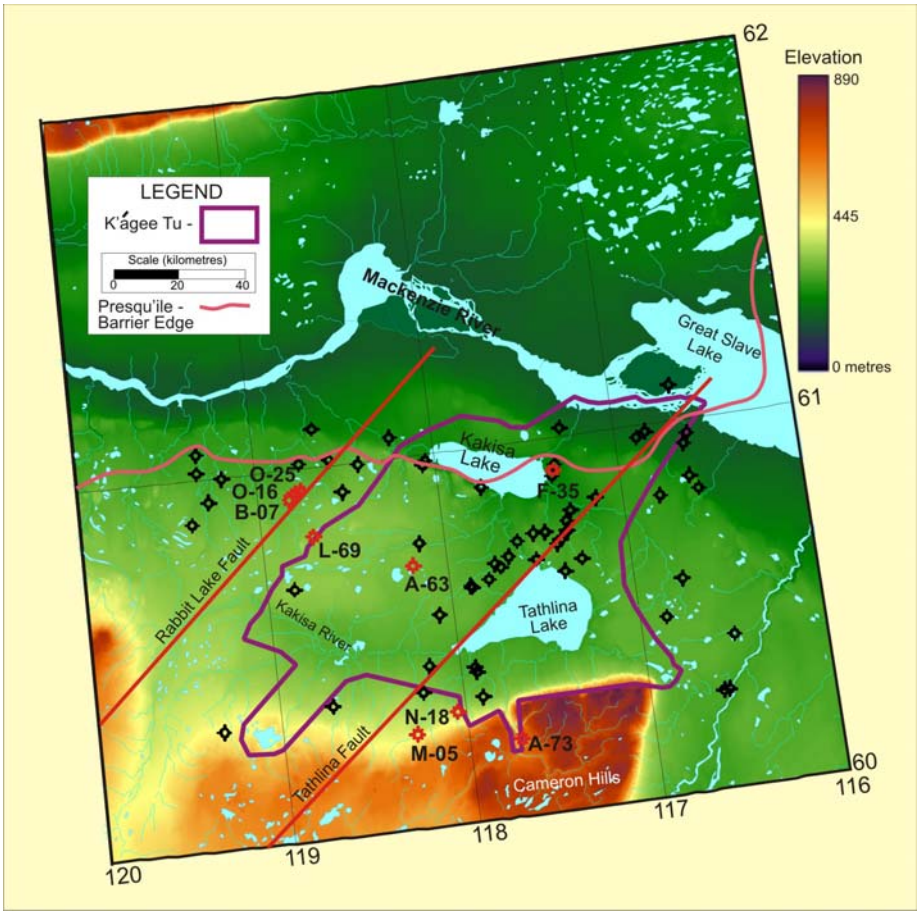

Figure 2. Elevation map of the K'ágee Tu area. K'ágee Tu area of interest falls entirely within the Great Slave Plain physiographic region. Gas wells are shown in red (Lambert Conic projection with central meridian 126^{o} longitude and standard latitudes of 62.5^{o} and 67.5^{o}). The Presqu'ile Barrier is a Devonian barrier reef complex that extends across the K'ágee Tu area. The community of Kakisa is located beside the F-35 gas field well on the east side of Kakisa Lake

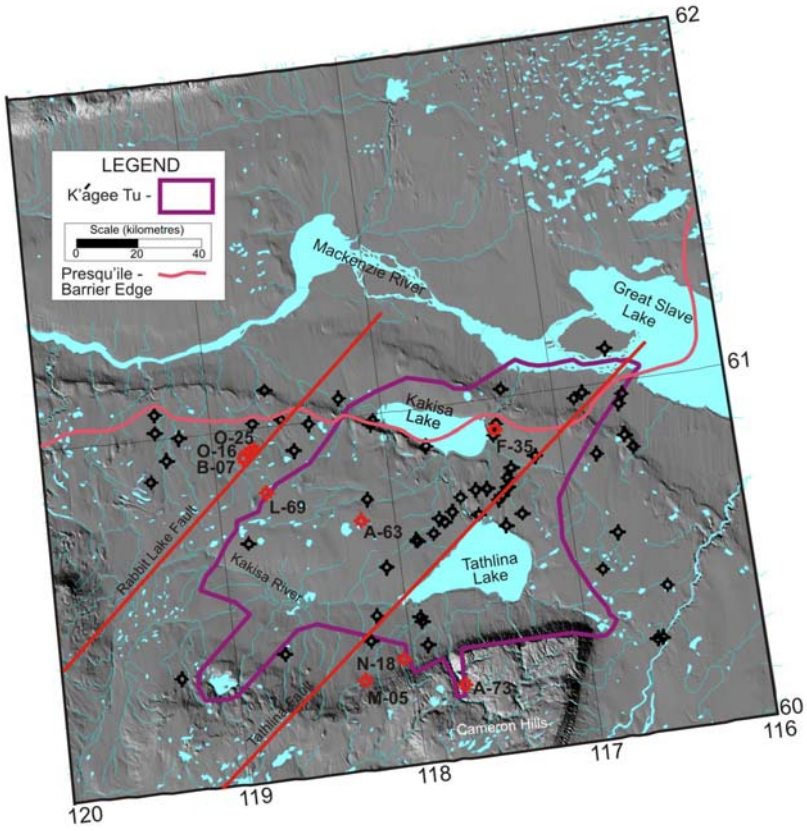

Figure 3. Shaded topographic relief map of the K'ágee Tu area of interest. The Tathlina Fault zone, which transects the K'ágee Tu area, caused the development of structural petroleum traps, such as at the Tathlina N-18 gas pool.

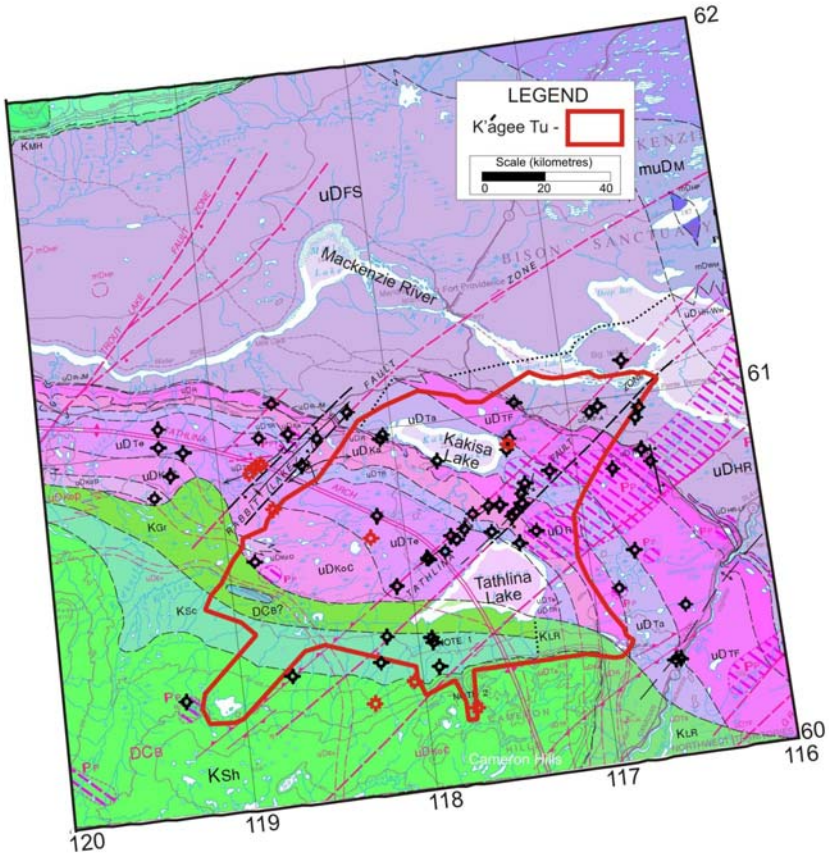

Figure 4. Map of bedrock geology (Okulitch, in prep.) across the K'ágee Tu area of interest. The axis of the subsurface Tathlina Arch is also shown, as are petroleum exploration well locations. The narrow outcrop belt of the Jean Marie Member (uDR-JM) of the Redknife Formation (uDR) has topographic expression as an arcuate narrow ridge line that is visible in the shaded topographic relief map shown in Fig. 3.

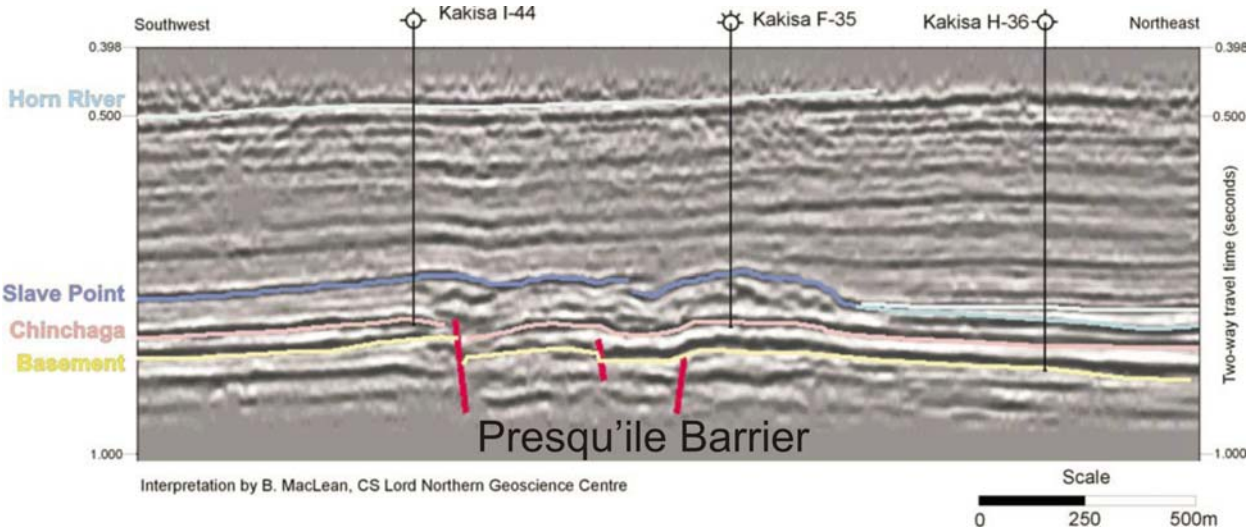

Figure 5. Interpreted seismic line (JCP-ES1-B2). This line was shot across the Slave Point edge on the east side of Kakisa Lake. A buildup at the Slave Point edge along this line was tested by the Kakisa F-35 gas discovery well (Fig. 2, 3) which found gas at the top of the Slave Point Formation in the SlavePoint/Sulphur Point barrier reef edge petroleum play. Surface mapping indicated a structural synform. Several faults offsetting the basement and at least Chinchaga Formation are indicated between the F-35 and I-44 wells. These are the northeast trending faults typical of the region. Vertical exaggeration is approximately 2.3 x.

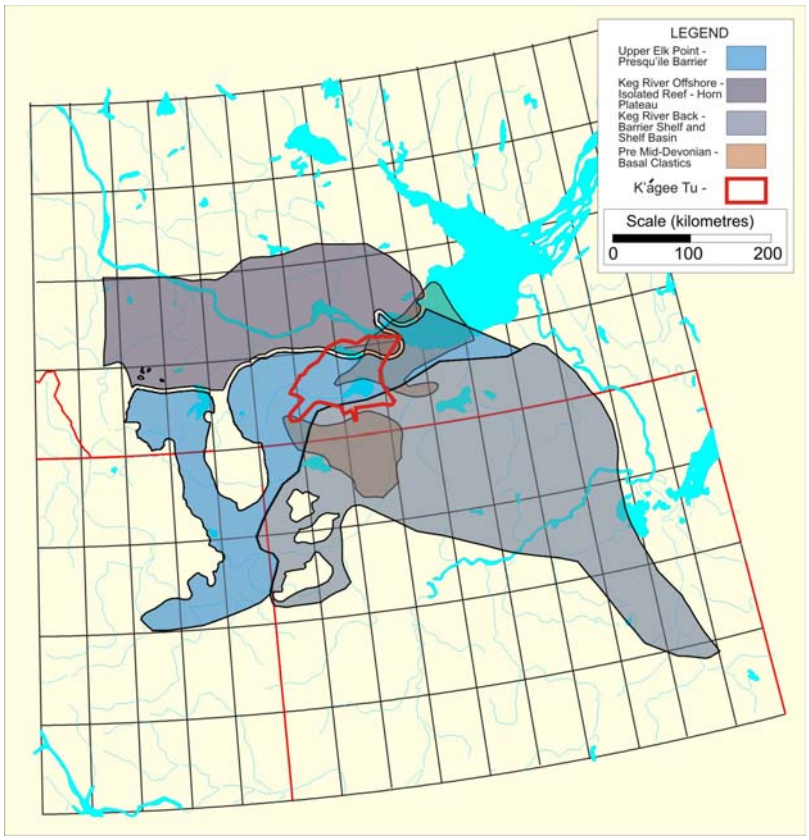

Figure 6. Lower to Middle Devonian petroleum plays that occupy the K'ágee Tu area. The upper Elk Point – Presqu'ile barrier play contributes significantly to the petroleum potential of K'ágee Tu. Other Lower to Middle Devonian petroleum plays are less significant.

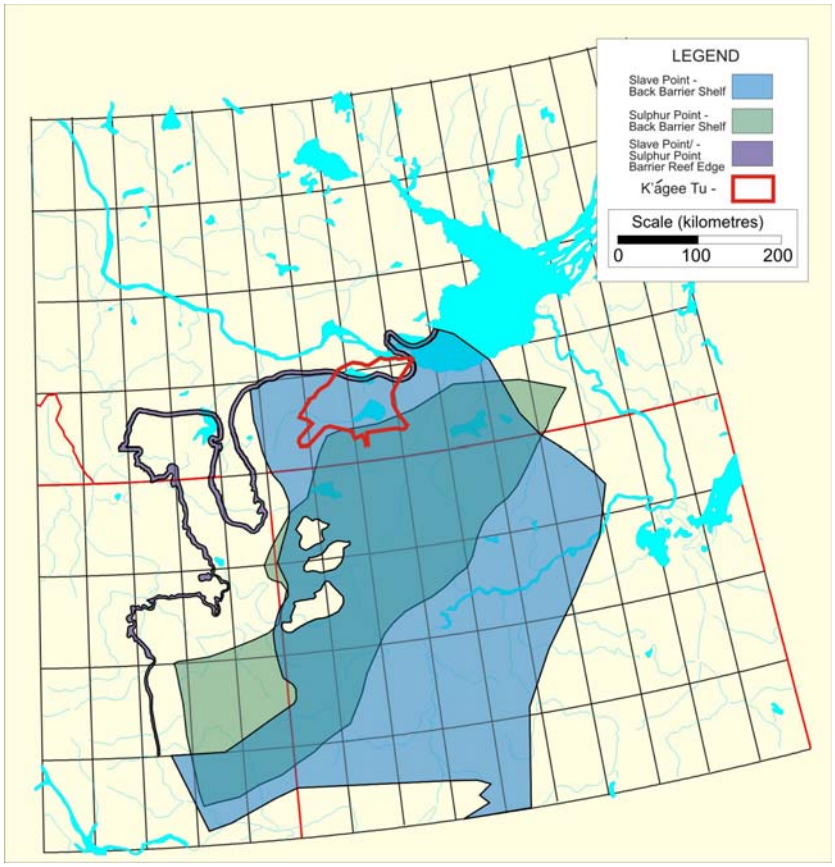

Figure 7. Middle to Upper Devonian petroleum plays that occupy the K'ágee Tu area. All of these plays contribute significantly to the petroleum potential of the K'ágee Tu area. The producing Cameron Hills Field is developed primarily within the Sulphur Point back barrier shelf play.

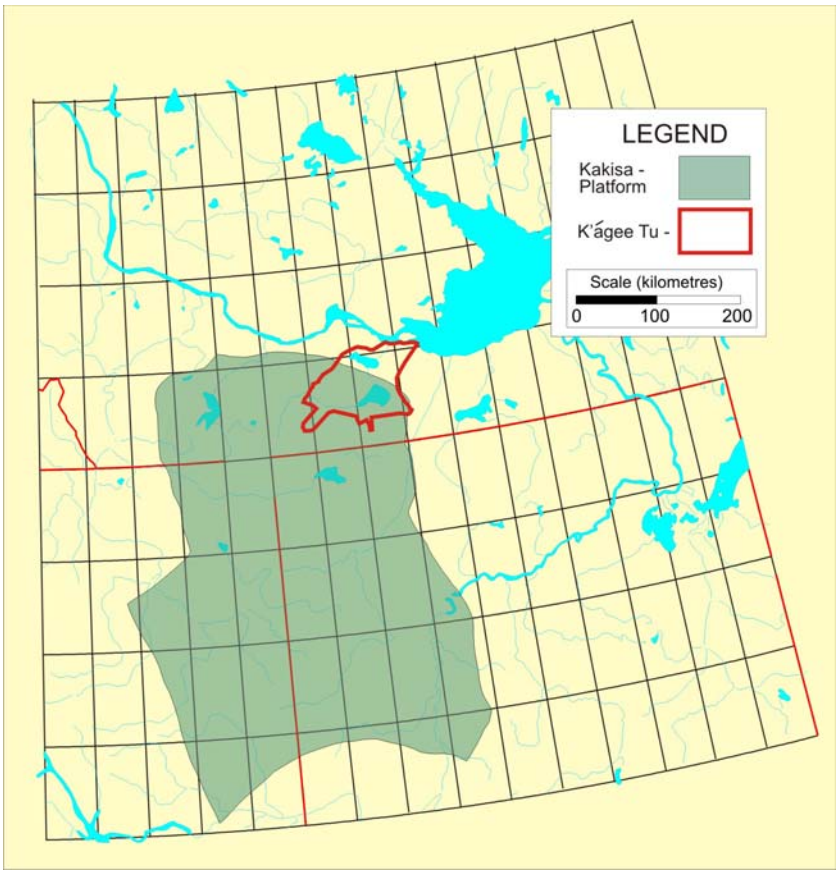

Figure 8. Kakisa platform petroleum gas play. Only a very small contribution of less than a million cubic meters of gas to the total undiscovered gas potential of the the K'ágee Tu area can be attributed to this play (see Drummond, 2004).

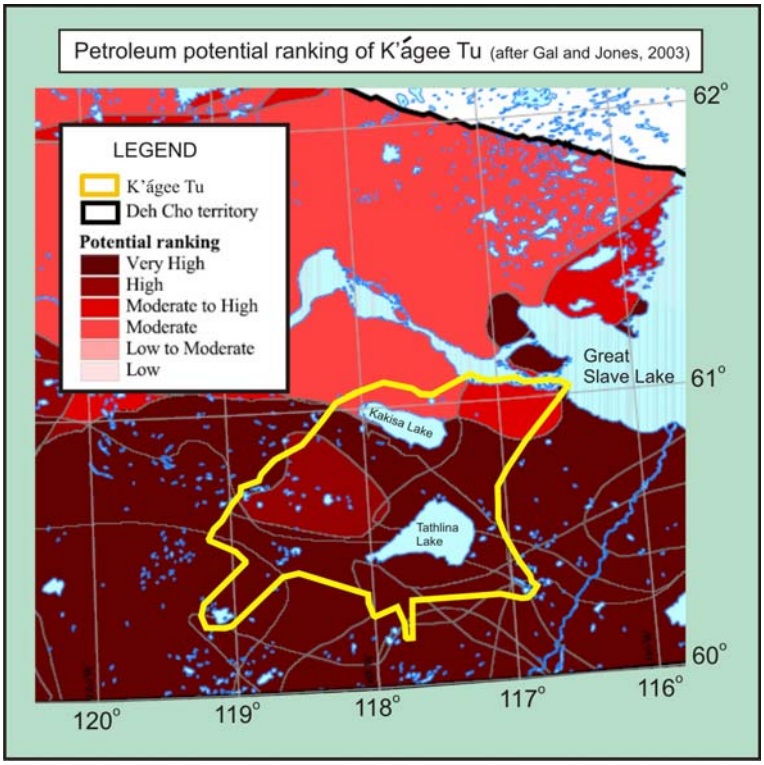

Figure 9. An earlier qualitative ranking of the potential for undiscovered petroleum across the entire Dehcho region (Gal and Jones, 2003) indicated 'High' to 'Very High' potential south of Kakisa Lake and the northern limit of the Presqu'ile Barrier reef complex and 'Moderate' to 'Moderate to High' potential north of Kakisa Lake and the edge of the Presqu'ile Barrier. Subsequent quantitative estimates of petroleum potential indicate that the K'ágee Tu area is better characterized as having moderate petroleum potential.

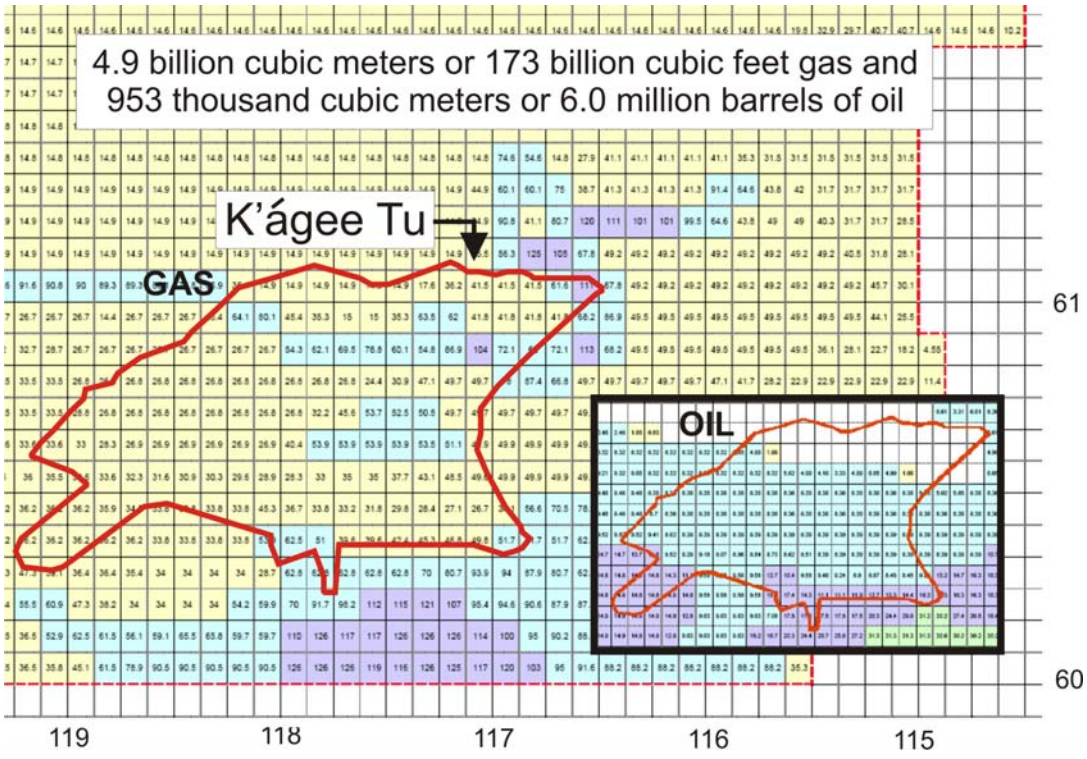

Figure 10. Estimate of undiscovered petroleum potential in the K'ágee Tu area of interest based on Drummond (2004) is about 4.9 billion cubic meters, or 173 billion cubic feet of gas. Higher gas potential exists along an east-west trend following the Presqu'ile Barrier edge immediately south of 61° latitude, such as at the Kakisa F-35 Field, and in the extreme southernmost part of K'ágee Tu around the portions of the Tathlina N-18 and Cameron Hills Field. Undiscovered oil potential is about 953 thousand cubic meters or 6.0 million barrels of oil (Oil potential map shown in inset is adapted from Drummon (2004)). Oil potential is greatest along the southern border of the K'ágee Tu area and decreases northward.