SEDIMENTARY GEOLOGY OF THE ARTEX MEMBER, BRASSEY FIELD, NORTHEASTERN BRITISH COLUMBIA

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ABSTRACT

Hydrocarbon production from the lower Charlie Lake Formation (Upper Triassic) of northeastern British Columbia occurs primarily from sandstone units such as the Artex Member. The Brassey Field is one of the more prolific fields producing from the Artex Member. At the Brassey Field, the Artex Member comprises an aeolian sand dune succession encased in an anhydritic and dolomitic interdune/supratidal package. Despite the economic importance of this member, few studies have focused on the sedimentology of this interval; consequently, the facies relationships, geological history and depositional controls of this member remain unconstrained.

Detailed core analysis and petrography augmented with wireline log correlations have aided in the development of a preliminary facies model for the Artex Member at the Brassey Field. Ten lithofacies grouped into three facies associations have been identified. These facies associations are interpreted to record deposition in aeolian sand dune, interdune/supratidal sabhka, lagoon and lake, and transgressive shoreface environments. Reservoir-quality lithofacies are limited to aeolian sandstone interval (Brassey Member) usually 1 to 3 m thick. Net reservoir thickness is a function of total sandstone thickness minus the proportion of sandstone characterized by porosity-occluding cements (primarily anhydrite). These cements are interpreted to be early postdepositional and related to dissolution of gypsum and anhydrite interbeds that interfinger with other rock types in the interdune/supratidal flat successions. The Artex Member in Brassey Field is preserved within a local topographic depression on the surface of the underlying Halfway Formation. Recognition of these hollows is critical to aid in the development of predictable models for the Artex Member sand.

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INTRODUCTION

The Middle–Upper Triassic (Late Ladinian to Carnian) Charlie Lake Formation occurs most extensively in northeastern British Columbia. It is a lithologically diverse succession of primarily unfossiliferous mixed siliciclastic, carbonaceous and evaporitic rocks. Historically, these rocks have been interpreted to represent a sabhka or back-barrier depositional environment (Arnold, 1994; Higgs, 1990). Adjacent formations consist of the older (underlying) Middle Triassic (Ladinian) Halfway Formation and the younger (overlying) Upper Triassic (Carnian) Baldonnel Formation. These units are composed of rock types that are easily distinguished from the Charlie Lake Formation and thus formation contacts are easily distinguished in drillcore and on petrophysical logs. The Halfway Formation has been described as a fossiliferous marine sandstone succession that is a temporal equivalent to the Charlie Lake Formation (Arnold, 1994; Caplan and Moslow, 1997). Consequently, the transition to the Charlie Lake Formation represents a marine-nonmarine regression that is gradational in some areas of the basin but appears to be sharp and abrupt in others. The contact between the Halfway Formation and the Charlie Lake Formation is conformable in many areas (Arnold, 1994) including the study area, although it has been argued to be unconformable in other areas. The overlying Charlie Lake–Baldonnel Formation contact consists of an abrupt shift to fossiliferous limestone and dolomite (Zonneveld and Orchard, 2002). This contact is conformable and gradational in many parts of the basin but is demarcated by an abrupt erosional surface in others (Davies, 1997a; Zonneveld and Orchard, 2002).

Triassic strata account for approximately 40% of oil reserves in British Columbia, making this unit both of economic and academic interest (Zonneveld et al., 2004). Several sand-dominated, commonly hydrocarbon-bearing members of the Charlie Lake Formation occur above the thick Halfway Formation sandstone succession (e.g., the Siphon, Blueberry and Artex members). As recognized by several authors (e.g., Dixon, 2007), facies descriptions in the Charlie Lake Formation have been lacking, mainly due to the fact that the majority of drill-core intervals have been focused on the zone below the 'A' marker, a locally fossiliferous limestone of marine derivation. Several studies have focused on the regional extent and stratigraphy of the Charlie Lake Formation sandstone bodies and the relationship of the Charlie Lake Formation to underlying strata (Higgs, 1990; Young, 1997; Dixon, 2007).

The best known of these sandstone intervals consists of the Artex Member, which occurs in the basal beds of the Charlie Lake Formation. The Artex Member produces hydrocarbons in several of parts of the basin, commonly exploited as a secondary target encountered in Halfway Formation exploration and development wells. Hydrocarbon production at the Brassey Field (Figure 1), the focus of the present study, produces primarily from the Artex Member. This field has been the focus of several investigations since its discovery in the late 1980s (e.g., Higgs, 1990; Woofter and MacGillvray, 1990). It has produced over 78 MBLS to date (Accumap, 2010).

Previous studies have focused on stratigraphic, engineering and development aspects of the Artex sands at Brassey Field (e.g., Higgs, 1990; Woofter and MacGillvray, 1990). This investigation focuses on the process sedimentology and petrography of reservoir and host-rock types and tests the premise that the Artex Member at the Brassey Field consists of a buried aeolian dune succession. A clearer understanding of the sedimentary framework of this unit is essential for petroleum exploration and development. To date, predictive facies models are lacking for this reservoir interval.

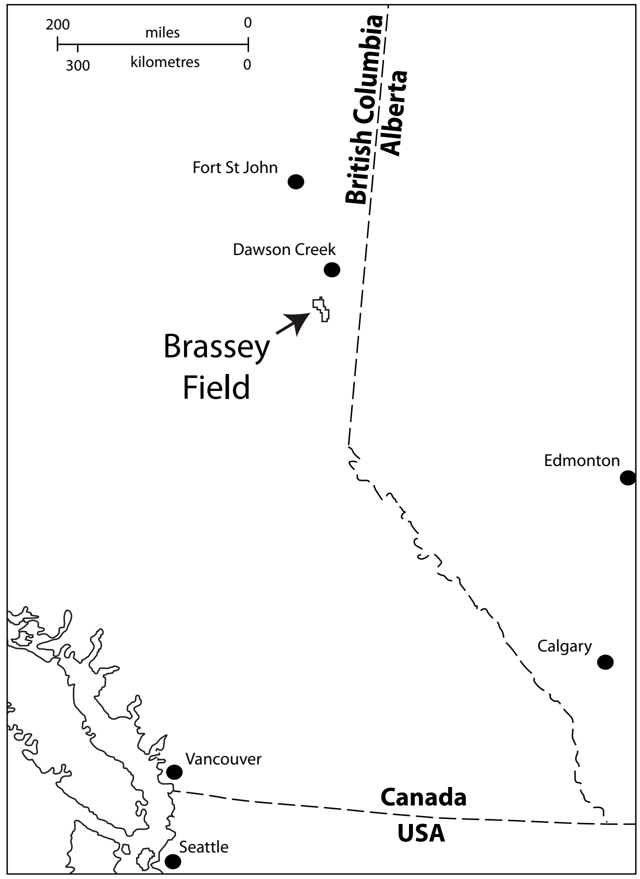

Figure 1. Location of the Brassey Field, northeastern British Columbia; modified from Woofter and MacGillvray (1990).

METHODS

Fourteen drill-cores from within and around the Brassey Field were examined in detail and sampled for petrographic analyses. Ten distinct facies and subfacies (summarized below) have been identified. The drill-cores used in this study penetrate various portions of Artex member, the reservoir unit in the Brassey Field. In order to aid in developing criteria for establishing proximity indicators and constructing a predictive facies model, the core selected represent Artex strata found in producing oil pools as well as those outside the pools.

The Wentworth scale was used to describe variations in grain size. Additionally, to describe the bioturbated strata, a bioturbation index (BI) has been used (Taylor and Goldring, 1993). This index quantifies the degree of reworking by assigning a relative number to bioturbated sediment.

Textural components often used to describe and interpret aeolian environments are typically less visible in drill-core than in outcrop because natural weathering can highlight seminal criteria such as grain-size variations in the laminae. In addition, intense internal heterogeneities, due in part to advanced postdepositional diagenesis, has affected reservoir quality and has likely destroyed some of the textures and structures useful for interpretation. Despite this, it is apparent that the distribution of the reservoir facies remains the primary control on the extent, shape and quality of the reservoir.

Facies Descriptions

Facies 1: Dolomitic bioturbated siltstone (F1)

Facies 1 is a dolomitic bioturbated siltstone with common silt or very fine grained sand laminae. This facies is characterized by a mottled or clotted texture. The 'mottling' is a result of areally variable syndepositional bioturbation (Zonneveld et al., 2001). The traces are dominated by relatively simple forms (such as *Planolites*) with variable orientations including horizontal, vertical and inclined. The bioturbation index ranges from light to moderate (BI 1–BI 3). Sedimentary structures (visible within lightly mottled intervals) include oscillatory ripples. Facies 1 is commonly interbedded with both light and dark mud beds, 3–6 cm thick. A single subfacies (F1a) was identified to further describe the variations in this facies. Subfacies F1a is

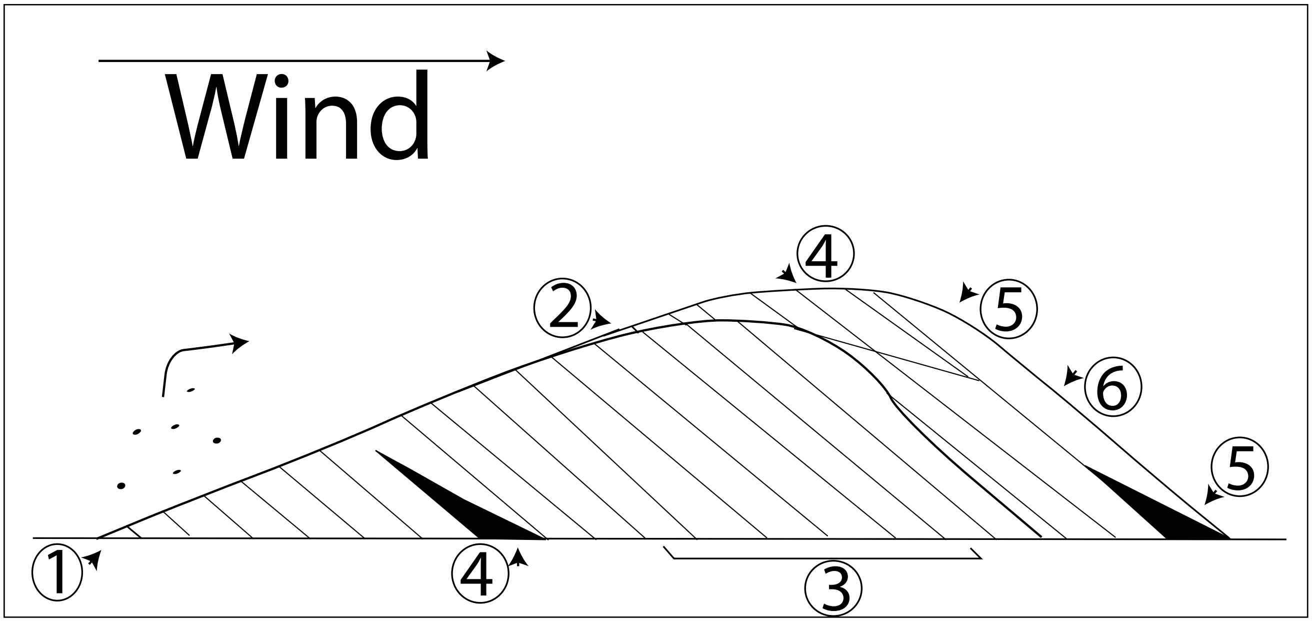

Figure 2. Simplified aeolian dune showing depositional and architectural features. The dune depicted in this schematic has undergone migration on the draa with unidirectional wind influence: 1) First-order bounding surface; showing a draa-interdune contact; 2) second-order bounding surface; dune-dune; 3) third-order bounding surfaces are aeolian laminations; 4) wind-influenced strata-spatial location of wind ripple or planar strata, found at the crest or apron of subsequent dunes, where wind influence is at its strongest; 5) location of grainfall laminae; 6) location of sandflow laminae.

a dolomitic, bioturbated siltstone with vuggy porosity. The vugs range in size from 0.4 to 1.0 cm. They are most commonly filled with calcite or anhydrite cement, but unfilled examples were also observed. Patches of moderate porosity characterize this subfacies; however, permeability is lacking.

Facies 2: Well-sorted fine- to medium-grained sandstone (F2)

Facies 2 is characterized by very fine to medium-grained sand. The cement consists primarily of patchy anhydrite and/or calcite. Cementation is the primary porosity inhibitor within this reservoir subfacies; thus the porosity ranges from nearly zero to relatively high (>15% from a visual estimation of thin sections). The pervasiveness of the anhydrite cement ranges from light to heavy. Significant variation occurs in nodule morphology with diameters ranging from about 1 to 3 cm. In this facies, the porosity is dominantly dependent on the degree of anhydrite cementation. This facies comprises the Artex Member and is the primary reservoir unit in the Brassey Field. Variability in the Artex Member sandstone has resulted in differentiation of two subfacies within this facies.

Subfacies 2a consists primarily of fine- to medium-grained, moderately to well-sorted, trough cross-stratified sand, with average foreset inclinations of ~20–25°. Low-angle (<10°) cross-strata (with identical grain-size, oil staining and porosity) occur intermittently interbedded with the steeper beds. Sedimentary structures include common oscillatory ripples. This unit is often stained with micrinite bitumen, as noted by Klein and Woofter (1989). Additionally, subfacies F2a has an erosive contact with the underlying facies. The average thickness of this unit is variable, but is usually approximately 1–3 m. This subfacies comprises the primary reservoir rock type in the Artex Member at the Brassey Field.

Subfacies 2b consists of generally massive, fine- to medium-grained sandstone. Rare examples of convolute bedding, distinguished by faint, distorted laminae, are associated with oscillatory ripples. Upon microcopy study, F2b was characterized by poorly sorted sand with a bimodal nature. Anhydrite and/or calcite cementation is more pervasive in this subfacies, resulting in poor porosity and minimal permeability.

Facies 3: Dolomitic anhydrite siltstone (F3)

Facies 3 consists primarily of dolomitic siltstone with abundant calcite-replaced anhydrite nodules. The nodules are relatively small (<0.5 cm) and are circular to subcircular. This facies displays low porosity and virtually no permeability. This facies is devoid of sedimentary and biogenic structures. It is predominantly light grey in colour but was observed to have a reddish hue in some samples.

Facies 4: Planar to low-angle fine-grained sandstone (F4)

Facies 4 is characterized by very fine to fine-grained sandstone. The bedding in this facies consists of planar laminae and low-angle crossbeds (<8°). Although difficult to discern, faint coarsening-upward trends are visible in some places. Anhydrite cement in the form of nodules (<1 cm) is common. Rare to common coarser laminae (up to medium grained) occur within this facies. The average thickness of this facies is about 20 cm (F2 is considerably thicker). It has gradational, nonerosional contacts with the adjoining facies.

Facies 5: Planar to convolute laminated dolomitic mudstone (F5)

Facies 5 is composed of grey, laminated, interbedded dolomitic mudstone. This facies is often characterized by soft sediment deformation structures, including highly convolute bedding. Dewatering structures, which exhibit fluidized mudstone that has been subjected to sudden loading resulting in a sinuous and tapered morphology, are also common. Thin-section analysis shows that microscopic dissolution seams characterized by organic residue (microstylolites) are common in this facies. This mudstone also exhibits intervals dominated by planar bedding with little to no deformation. In many examples, a thin (0.25 cm), dark, organic-rich band occurs at the upper contact of this facies. The dolomitic mudstone intervals are relatively thin (10–20 cm) and commonly overlie an erosional surface that truncates subjacent facies.

Facies 6: Laminated dolomitic mudstone and siltstone (F6)

This facies consists of parallel laminated siltstone with alternating mudstone laminae. Differential compaction of the two lithologies has resulted in an elongate lens-like appearance of the silt. Faint oscillatory ripples are sometimes visible within the siltstone, especially near the upper surface of this facies where ripples are truncated by subsequently deposited erosive facies.

Facies 7: Planar-bedded anhydrite (F7)

Facies 7 consists of planar-bedded anhydrite. It is a relatively thin facies, commonly 10–15 cm in total thickness. Thin-section analysis reveals that the anhydrite crystals have been deposited horizontally, with no biogenic structures visible. This facies has zero porosity and permeability, and likely acts as a barrier to any fluid flow within the reservoir. Contacts with the adjoining formations are nonerosive.

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Facies 8: Calcareous siltstone/limestone (F8)

This facies is characterized by fossiliferous, dolomitic bioclastic wackestone, packstone and rarely grainstone consisting of poorly sorted silt- and clay-sized grains. Recrystallized fossil debris (echinoderms, brachiopods, bivalves and gastropods) and framework grains of calcite are most visible in microscopic analysis. Dolomitized mudstone rip-up clasts are common, particularly at the base of this facies. Facies 8 is invariably characterized by an erosive base and is commonly situated on convolute-bedded mudstone (F5).

Facies 9: Massive undifferentiated siltstone (F9)

This facies is characterized by dolomitized siltstone. The siltstone is massive in nature, with no discernible bedding or internal structure. Variations in the lithology include rare mud drapes and common pyrite occurrences, with rare, poorly sorted, very fine grained sandstone laminae. Unlike F1, the sand laminae do not appear to be biogenically sorted (bioturbated), but rather occur as discrete, planar, structureless lenses. The contacts with the subsequently deposited facies are conformable.

Facies 10: Dolomitic siltstone with convolute-bedded nodules (F10)

This facies is composed of interbedded crystalline calcite (replacing anhydrite) and dolomitic siltstone. The anhydrite appears to have been deposited initially as horizontal beds that underwent subsequent disturbances resulting in contorted layers of calcite-replaced anhydrite. The facies thickness varies, but most commonly ranges between 9 and 12 cm in thickness. It is usually found above subfacies F2b (fine-grained convolute-bedded sandstone).

Facies Associations

Facies association I (FA-I)

Facies association I (comprising F2a and F4) is interpreted as an aeolian dune succession deposited within an arid coastal environment. The Artex Member and several other intervals within the Charlie Lake Formation exhibit depositional characteristics consistent with deposition in an aeolian dune setting (Higgs, 1990; Arnold, 1994; Zonneveld and Gingras, 2002; Zonneveld et al., 2004). Aeolian dunes have textures and sedimentary structures that provide evidence for the location on the dune where these facies were most likely deposited. Subfacies 2a (high-angle cross-stratified sand) provides the strongest evidence for an aeolian interpretation for this facies association. This type of deposit is unusual outside aeolian environments. Other key criteria include overall excellent sorting and well-rounded grains (Figure 4a). In addition, the nature of the anhydrite cement (i.e., mimicking primary bedding orientation) is consistent with cementation trends in other aeolian regimes (Fryberger, 1992).

Two major sedimentary processes create high-angle deposits on the lee side of sand dunes: grainfall laminae and sandflow (also known as avalanche crossbedding), which both have the ability to form cross-stratified deposits with abnormally high inclinations. The sedimentary process resulting in the texture seen in F2a is mostly likely due to the grainfall of sand grains. These deposits were created by sand grains dropping from the air, most often in the lee side of the dunes (Pye and Tsoar, 1990). This type of lamination is characterized by unsorted grains with rare grading (Brookfield, 1992). Packing is mostly loose, with an average primary depositional porosity of approximately 40%. Sandflow laminae, which are characterized by thicker, more irregular deposits, have a slightly higher porosity. Another distinguishing factor between these two processes are the angles at which the strata are deposited. In grainfall lamination, the angle of deposition is 28° or less. In sandflow deposits, angles of deposition can reach up to 35°. Based on the drillcore examined at the Brassey Field, the inclined strata have a dip of 20–25°, indicating the most likely process of deposition was grainfall lamination (Figure 3).

The spatial location of the grainfall laminae depends on the morphology of the dune. Typically, grainfall strata accumulate on the lee side of the dune just over the crest. Once the accumulation meets and exceeds the angle of repose, grains cascade down the steep dune and create an erosionally based 2–5 cm thick sandflow deposit (Pye and Tsoar, 1990). Grainfall strata commonly interfinger with sandflow laminae (Brookfield, 1992).

The planar to slightly inclined nature of sandstone beds in F4 is interpreted to be wind-ripple laminae deposited on the aeolian dune surface. These bedforms are dependent on variable wind speeds during dune deposition. When wind speeds increase and are too strong for ripple creation and migration, these tightly packed, inversely graded packages are formed. Likewise, with a decrease in wind speed it is possible to create climbing-ripple laminae. Unlike subaqueous climbing ripples, foresets in aeolian climbing ripples are difficult to distinguish because of their low relief (Brookfield, 1992). In addition, the stoss and the crest are commonly eroded during migration of the ripple, preserving only planar-laminated beds. The planar bed lamination and climbing ripples are wind-ripple deposits and are found either at the crest of the dune or near the dune apron (i.e., the basal portion of the lee side of the dune).

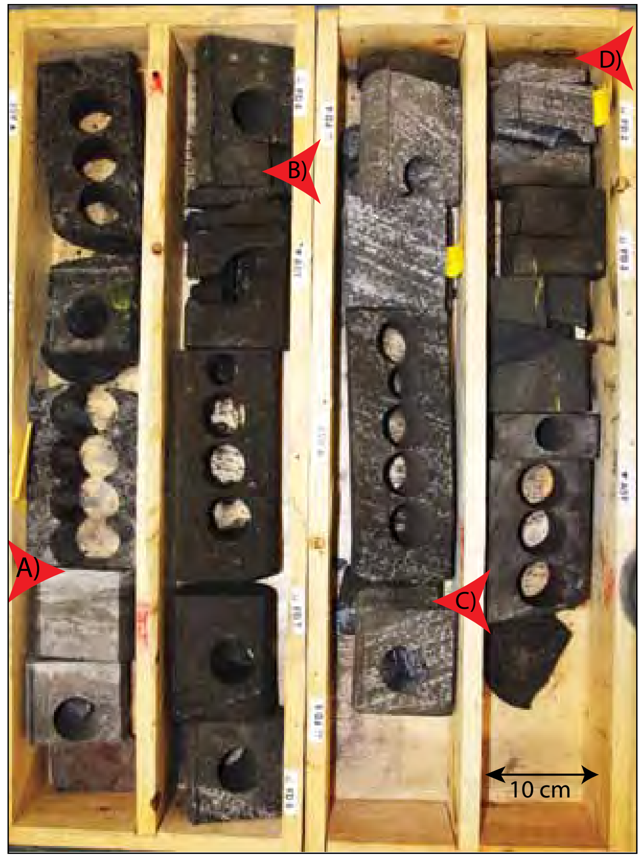

Figure 3. Drill-core from 6-1-77-19W6 showing various sedimentological features: A) Contact between the interdune/dune; interdune F1, bioturbated silt/sand; reservoir subfacies F2a sits above F1; B) F2b, massive sand; C) third-order bounding surface, reactivation surface; possibly due to wind direction variation; D) ripple cross lamination, facies F4.

Facies Association II (FA-II)

Facies association II consists of nine facies (F1, F2b, F3 and F5–F10). This facies association is herein interpreted as interdune deposits. The nature of the facies indicates that seasonal hydration, resulting in development of numerous shallow ephemeral lakes and lagoons, was commonplace (Zonneveld et al., 2004). The Lower Charlie Lake interdune area was a highly variable environment, with multiple controls on lateral lithological variability. It is proposed that the Artex sands were deposited in a sand-limited desert, which typically have interdune areas that are characterized by numerous small dunes, deflation lags and coarse sand sheets (Brookfield, 1992). It is the area where the water table directly interacts seasonally with the environment/sediment-air interface (Brookfield, 1992).

Two facies (F1 and F9) are interpreted to be subaqueous interdune deposits (i.e., ephemeral lagoon). Locally pervasive bioturbation interpreted to be syndepositional in nature, and abundant oscillatory ripples, are consistent with subaqueous deposits (Higgs, 1990). The presence of burrows in F1 and the lack of biogenic structures in F9 is attributed herein to water chemistry in the ephemeral lakes and lagoons (Zonneveld et al., 2004). Within F1, bioturbation became prevalent after a very short lag time wherein burrowing organisms are first established and, consequently, pervasive burrowing ensued. This is similar to seasonally rejuvenated ephemeral lagoons and lakes in the Coorong region of Australia (Warren, 1988). The unbioturbated mud and silt of F9 reflects deposits in which chemical conditions were simply too harsh (too saline or too acidic) for the development of infaunal populations. Locally abundant pyrite observed within F9 is consistent with sulphate-rich waters in this facies and with an evaporating ephemeral lake or lagoon succession (Higgs, 1990). In the Coorong region, increased salinity associated with seasonal evaporation results in the decimation of infaunal populations and the lagoons and lakes become devoid of invertebrate life (Warren, 1988). The mud drapes on ripples in F9 also supports interpretation of an overall low-energy environment such as a lagoon.

Facies 2b has been interpreted as slump deposits that originated on the dune and were transported into interdune areas. The poorly sorted, massive nature of the sands is consistent with slumping, most likely after the dune had been saturated with rain, although we recognize that other atmospheric (wind storms) or seismic phenomena could have also initiated the slumps. The bimodal nature of this facies (Figure 4a) is consistent with interdune deposits. Convolute, load-casted basal contacts to this facies are also consistent with sudden sediment movement onto soupy, unconsolidated substrata, likely ephemeral lagoon or lake deposits.

Sabkha deposits in the study area are represented by F3 and F10. These sabhka deposits develop in the interdune area during seasonal drying of ephemeral water bodies. The nodular morphology of anhydrite in F3 suggests that it was deposited as subsequent drying of the interdune occurred. Local red coloration of F3 (also noted by Dixon, 2007) is most likely due to incipient soil development within these areas (Zonneveld et al., 2004). The fluidized appearance of the recrystallized anhydrite observed in F10 is likely a result of periodic influxes of groundwater likely due to rain during an overall dry interval.

Mudstone and siltstone (F5 and F6) were deposited within interdune areas during intervals in which the interdune lagoons and lakes were infilled with water. Laminated mudstone included within F6 was deposited under primarily quiescent conditions. Heterolithic, flaser- to lenticular-bedded, interlaminated mudstone/siltstone reflect fluctuating energy conditions, possibly within intertidal flats on the margins of a tidally influenced lagoon. The convolute mudstone included within F5 is the result of the sudden burial of water-saturated sediment.

Seasonal desiccation of the lagoons and lakes resulted in the deposition of laminar anhydrite beds (F7). The horizontal nature of the delicate anhydrite crystals in most examples suggest that this facies was deposited during a time of seasonal dryness, when the ephemeral water body was absent. Although it is unusual in anhydrite deposits, there are several occurrences of ripples and low-angle crossbeds in this facies, which suggests aeolian reworking and redeposition.

<u>*Facies Association III (FA-III)*</u>

Facies association III consists of a single facies (F8). This facies occurs within a single horizon, near the top of the study interval, and has been informally referred to as the A-marker member of the Charlie Lake Formation. The presence of marine fossils (echinoderms and brachiopods)

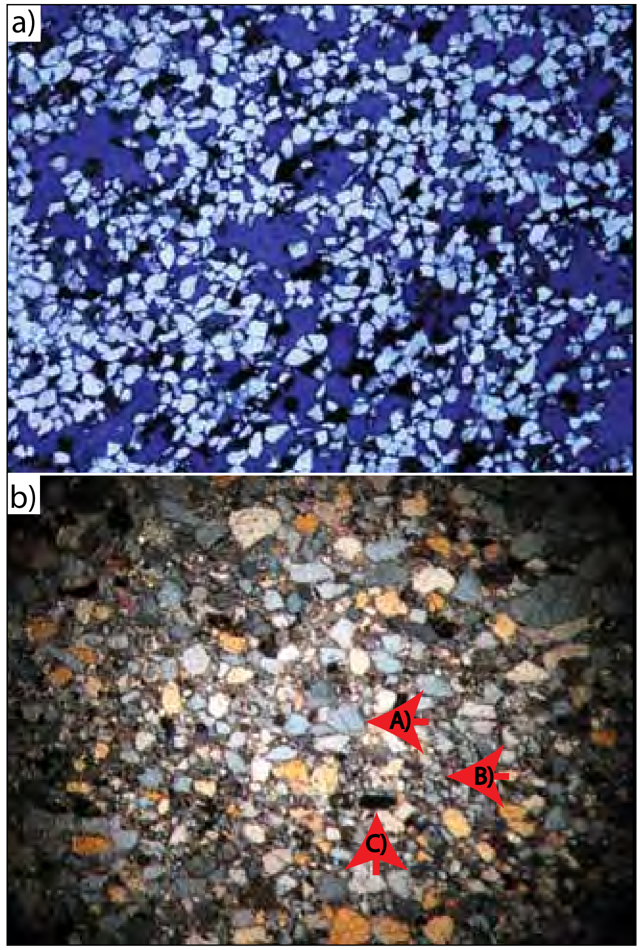

Figure 4. Photomicrographs from the Artex Member at the Brassey a) Thin-section taken from F2a, grading difficult to see but heavy minerals are at an inclined angle; postdepositional diagenesis has improved porosity; 6-1-77-19W6, 50x plane-polarized light; b) Thin section from FA-II (interdune) showing the poorly sorted, bimodal nature of the interdune area (A, B) and the presence of heavy minerals (C).

in association with fossils of facies-crossing organisms (bivalves and gastropods) reflects a marine transgression within the study area (Zonneveld and Gingras, 2002). The A-marker member occurs throughout the subsurface of northeastern British Columbia. It is thin throughout (rarely exceeding 2–7 m in thickness) and both overlies and underlies sedimentary successions deposited in marginal marine and nonmarine depositional settings, underscoring the short-lived nature of this regional marine incursion.

AEOLIAN FACIES MODELS

Aeolian facies models were among the last clastic models to be developed (Brookfield, 1992). This is due in part to the nature of climatic variations and controls in aeolian systems and to difficulties in assessing the sedimentary structures and bedforms in present-day dune systems. However, a framework has been established to help with the identi-

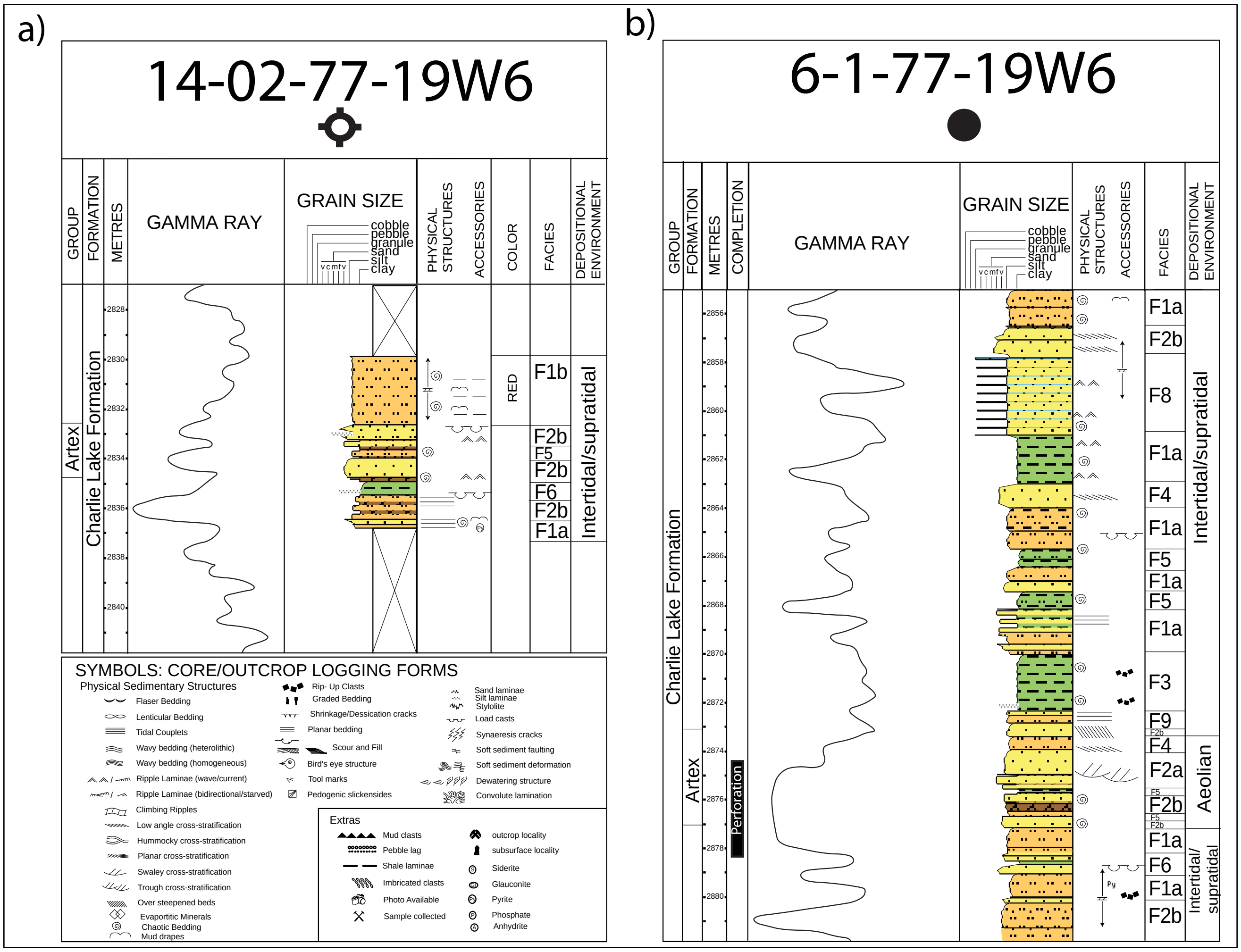

Figure 5. Core descriptions through the Brassey Field wells a) Well 14-02-77-19W6 is an abandoned well showing the lateral limits of the Brassey Field reservoir because it does not contain the reservoir facies F2a but only some intermittent F2b sands; b) well 6-1-77-19W6 is a producing well (with the corresponding gamma log) showing a full intersection through reservoir subfacies F2a.

fication and interpretation of aeolian systems. Brookfield (1992) identified several fundamental observations necessary for an aeolian dune interpretation. These include the identification of sedimentological processes that produce larger-scale bedforms found in aeolian strata that are the result of migration and amalgamation of smaller, variable-sized bedforms. The processes create unique strata, facies, grainfall, grainflow and ripple lamination. The boundaries of these strata can be assessed to deduce the nature, and possibly infer the morphology, of the dunes.

Three bounding surfaces can be identified within aeolian successions (Figure 2). The formation of first-order bounding surfaces is attributed to the migration of the draa (the largest-scale bedform identified), which varies from 10 to 450 m in height (Brookfield, 1992). The boundary of the draa is usually identified as being between interdune and dune deposits, demarcated by the contact of two dunes. Second-order bounding surfaces are formed by migration of the dune on the draa surface. Dunes are characterized by being larger than ripples but smaller than the draa on which they formed. Heights vary from 0.1 to 100 m. Second-order bounding surfaces usually form on the lee, or down wind, side of the draa. Third-order bounding surfaces represent aeolian lamination and are often reactivation surfaces. The aeolian lamination will often consist of bundles of laminae (laminae sets) formed by the erosion and subsequent reactivation of the crossbed (Brookfield, 1992). Mapping of the second- and third-order sequences is controlled by well density and distance; therefore, is not mappable in some fields, as pointed out by Woofter and MacGillvray (1990). Because of the considerable size of the draa, first-order bounding sequences should be mappable on a larger scale. In the Brassey Field, the dune-interdune contact is distinct in both drill-cores and well logs (Figures 3–5). Identification of lower-order bounding surfaces has been accomplished in parts of the Brassey Field; however, work is ongoing to substantiate the veracity of these correlations and assess their role in reservoir compartmentalization.

As mentioned above, deserts are characterized and influenced by numerous climactic conditions, including

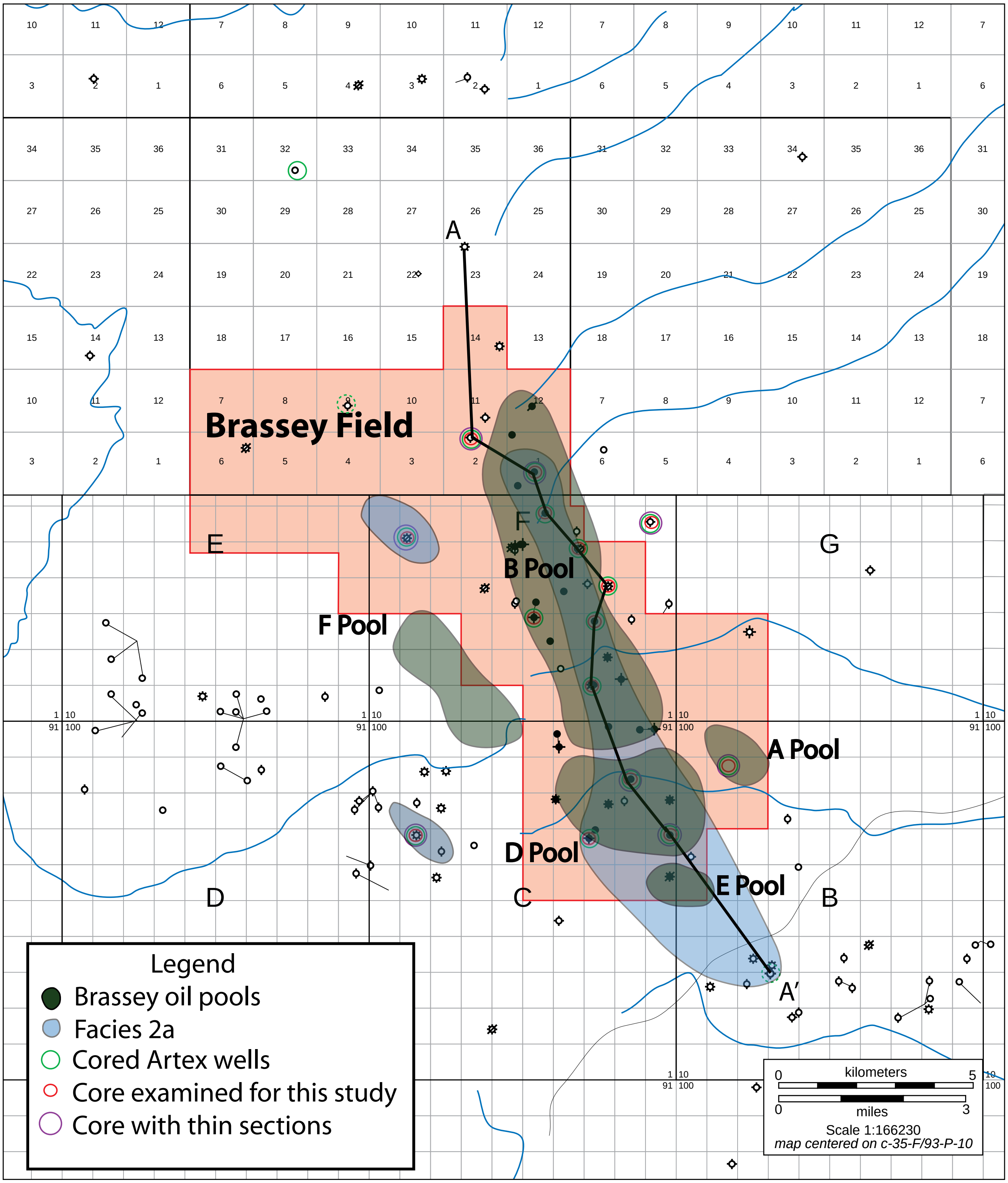

Figure 6. Facies and oil pool map of the Brassey Field.

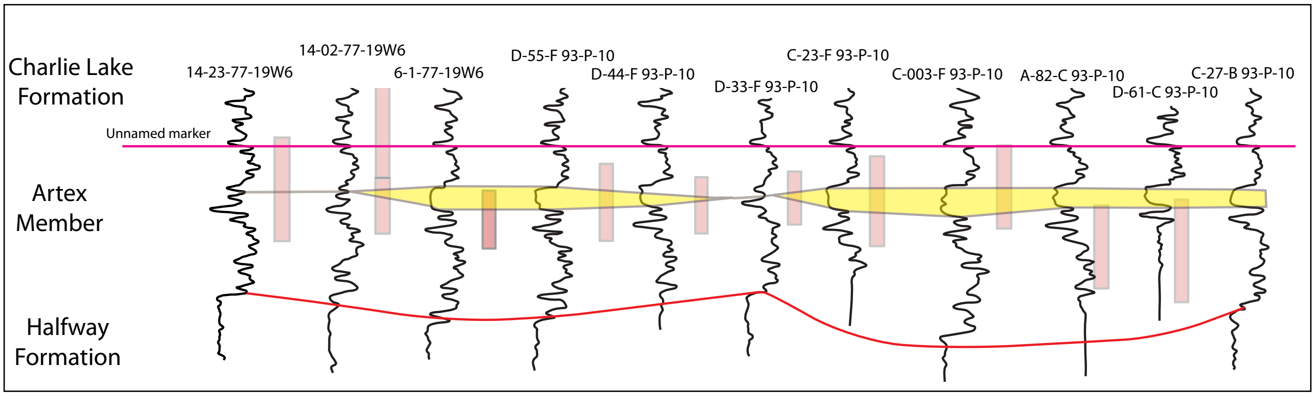

Figure 7. Northeast-southwest cross section through pools B and D of the Brassey Field. An unnamed field-wide marker is used as a stratigraphic datum (indicated by a pink line). The marker corresponds to a slightly sandier silt bed within facies F1.

sediment supply, wind strength and direction, and basin morphology. Within erg systems, several types of dunes commonly coexist, depending on local and regional wind patterns. The morphology of the dunes are related to the wind direction (Brookfield, 1992). Previous research showing sand thickness in the area around the Brassey Field has suggested a substantial erg system in which the Brassey Field was deposited (Higgs, 1990). The size and areal extent of this dune field remains conjectural (Higgs, 1990; Arnold, 1992). Dominantly unidirectional wind orientation often results in the formation of transverse and barchanoid dunes, whereas longitudinal and star dunes are more likely to form under variable wind conditions (Brookfield, 1992). Conflicting studies have postulated that the wind directions during the deposition of Charlie Lake Formation sands were both northeasterly (in the northern portion of British Columbia) and westerly (Arnold, 1994). Observation of the facies distribution (Figure 6, 7) in combination with oriented drill core data (Woofter and MacGillvray, 1990) suggests the predominant wind direction forming the dunes at the Brassey Field was from the northeast. This suggests that the dunes formed at an oblique angle to the dominant wind direction (Woofter and MacGillvray, 1990). The relationship between wind direction and the preserved shape of the Brassey Field (and its component pools) has not yet been resolved.

CONCLUSION

The Artex sands of the Charlie Lake Formation have been identified as aeolian sands. Facies mapping of the Brassey Field show that reservoir subfacies F2a coincides with the pools within the field. As proposed by Woofter and MacGillvray (1990), the primary wind direction is from the northeast and the resulting dunes formed at an oblique angle to the wind. The interdune zone was mostly likely a seasonally wet system, as suggested by some of the structures observed (i.e., dewatering structures).

A northeast-southwest cross section through the pools of the Brassey Field (Figure 7) indicates that the primary control on the deposition of these sands appears to be depressions in the topography at the time of deposition. The use of a field-wide datum as a stratigraphic marker clearly shows that no thinning of the adjacent strata occurs above or below the Artex sand reservoir facies. This indicates that reservoir predictability is dependent on paleotopography.

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