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REGIONAL SUBSURFACE STRUCTURE MAPS AND SEISMIC SECTIONS, FORT LIARD AND TROUT LAKE REGION, SOUTHERN NORTHWEST TERRITORIES

by

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ABSTRACT

Seismic time structure maps and regional seismic sections from the southwestern plains of the Northwest Territories provide a structural and stratigraphic history spanning from the Proterozoic to the present. Sectional views show a series of westward-thickening sequences ranging from Proterozoic to Cretaceous age with peneplain surfaces at the top of the Proterozoic (base Devonian) and the base of Cretaceous. Lateral facies changes and carbonate mound buildups within the Devonian section are well imaged.

Certain structural features such as the Celibeta High and the Bovie Fault are common to all maps. Post-Mississippian to pre-Cretaceous uplift of the high is documented by local erosion through the Flett Formation at the base Cretaceous Unconformity. This unconformity is itself exposed to present day erosion due to renewed uplift in Tertiary time.

Bovie Fault, which forms the eastern boundary of Liard Basin, is mapped at surface as a Laramide age feature but seismic shows it to overlie a structurally complex zone. A down-to-the-west monocline that overlies the Bovie Fault is accompanied by a pronounced increase in the rate of westward thickening of Devono-Carboniferous strata. The economically important Mattson Fomation has its easternmost limit along the Bovie Fault trend. Unlike earlier interpretations, Bovie Fault is regarded here as a slightly compressional fault with a curved fault plane and a structurally elevated eastern hanging wall. Subsidence of Liard Basin west of Bovie may have been accomplished by a downward, or a down-to-the-west, hingelike rotation of the Bovie west side footwall around a curved fault surface in Late Devonian to Carboniferous time. The Bovie trend is not offset as it crosses the Liard Line, one of three major NE trending lineaments in the study area. Other northeast trending fault zones (Rabbit Lake and Trout Lake fault zones) have some expression in the seismic structure maps shown here. Regional extensional tectonism has resulted in a widespread pattern of faults affecting the entire section up to the earliest Cretaceous.

Numerous examples of undrilled potential gas reservoirs are imaged in seismic lines of this area in both the Slave Point and Jean Marie formations. Some of these examples, which occur within the interior of the Slave Point shelf platform, may have developed where fault zones interacted with shelf sedimentation

INTRODUCTION

The area investigated in this report is bounded by latitudes 60°N and 61°30'N and by longitudes 119°30'W and 123°45'W (Figure 1; Figure 2, Location Map). This area includes the town of Fort Liard on the Liard River and extends eastward across the Interior Plains (Bostock, 1970) to a short distance east of Trainor Lake. Seismic data were obtained from paper copies of seismic lines submitted by industry to the National Energy Board following Federal Government regulations. In addition, digital well logs of wells that are located either on, or near, seismic lines were used to model the expected seismic response, or seismic character, at these well locations. Proprietary software (LogM by GMA) was used to generate synthetic seismograms from digital sonic and formation density logs of these wells (Figure 2).

Formation tops or other distinctive horizons identified on synthetic seismograms of wells were then correlated with high amplitude events on the seismic sections at approximately the same two-way acoustic travel times. A stratigraphic chart illustrating stratigraphic nomenclature and schematic stratigraphic relationships is shown in Figure 2 (Figure 2, Stratigraphic Chart). Readily identifiable markers along seismic lines include, in order of increasing seismic two-way travel time, the unconformity along the base of the Cretaceous system, the top of the Flett Formation (or base of Mattson Formation), the tops of the Kotcho and Tetcho formations, the top of the Jean Marie Formation, the top of Middle Devonian carbonates or the top of the Slave Point and the Nahanni (or Lonely Bay) formations, and the base of the Phanerozoic (Figure 2). These seismic markers coincide generally with abrupt changes downsection in acoustic impedance from lower velocity shale to relatively high velocity carbonates. This is true for the top of the Flett, Kotcho, Tetcho, Jean Marie and Slave Point/Nahanni carbonates. The other first order seismic markers occur at the angular unconformities along the base of the Cretaceous and the base of the Phanerozoic across which there is considerable divergence of intraformational, seismically-defined, bedding markers. Stratigraphic nomenclature and stratigraphic relationships for the Phanerozoic strata described in this study are the same as in Williams (1977, Tables 58.1 and 58.2).

During the course of this study, a number of lines, including lines 2 and 4 of Figure 2, were reprocessed using the original field data. The other lines shown in Figure 2 have not been reprocessed. The maximum two-way acoustic travel time represented on these lines is 3 seconds. This represents, very approximately, a vertical maximum thickness of about 7500 metres given an average seismic velocity of 5000 m/sec for the entire rock thickness represented by the 3 second two-way travel time.

SEISMIC ASSEMBLAGES

The total stratigraphic succession represented on the seismic lines of Figure 2 can be divided into three first-order structural-stratigraphic assemblages that are separated by regionally important unconformities. The lowermost assemblage is formed of Proterozoic and older strata beneath the sub-Phanerozoic unconformity. The unconformity lies at about 1.25 seconds of two-way travel time (TWT) in the north

(Figure 2, Line 2) and to the east (Figure 2, Line 7) and at up to 2.0 seconds west of the Bovie Structure (Figure 2, Line 3). The middle seismic assemblage containing Paleozoic strata is bracketed between the sub-Phanerozoic and the sub-Cretaceous unconformities at about 0.3 to 0.5 seconds TWT over most of the sturdy area (Figure 2, lines 1, 2, 3, 4, 6, 7). The assemblage is much shallower in the region of the Celibeta High (Celibeta Structure of Williams (1977)) where the sub-Cretaceous unconformity lies near-surface and is directly overlain by Quaternary strata (Figure 2, Line 5). The uppermost seismic assemblage, the post-Lower Cretaceous, includes all strata above the sub-Cretaceous unconformity including Quaternary strata.

This study is focused primarily upon the middle seismic assemblage because it contains almost all strata that are prospective for hydrocarbons. This assemblage includes all Devonian and Carboniferous strata as well as some older Paleozoic strata beneath Devonian strata in the western part of the area. This package of strata and the overlying post-Lower Cretaceous assemblage are well imaged in the available industry seismic whereas the Precambrian assemblage is less well imaged because of the attenuation of high frequency energy that occurs with increasing depth.

The Proterozoic assemblage has not been subdivided in this study although an angular unconformity within the Proterozoic, clearly shown in Line 5 of Figure 2, indicates that this might be possible. This assemblage exhibits a succession of seismic markers that define several westward-thickening and divergent wedges west of the Bovie Fault and Celibeta High (Douglas and Norris, 1959 and 1976; Figure 2, lines 1, 3, 4, 5)). These westward dipping wedges of Proterozoic strata probably form part of the Proterozoic Fort Simpson Basin that has been identified as underlying the Phanerozoic succession west of Fort Simpson (Cook et al., 1999). Interpretation of the deep (30 seconds of two-way travel time) SNORCLE (Slave Northern Cordillera Lithospheric Evolution) lithoprobe seismic line that extends eastward from near Yellowknife along the Mackenzie and Liard rivers to near Nahanni Butte (Cook et al., 1999) provides the basis for identification of Precambrian subdivisions in the much shallower industry seismic within the study area.

The Paleozoic assemblage contains well-defined seismic markers, or horizons, many of which coincide with known formational boundaries and which can be used to interpret stratigraphy and structure. Almost all of these correspond to abrupt upward lithologic transitions from Devono-Carboniferous platform carbonates to shale that are characterized by strong acoustic contrast or seismic impedance.

The most obvious marker occurs at the top of the Middle Devonian carbonates beneath Upper Devonian shales of the Muskwa, Horn River, Fort Simpson and Hay River formations (Figure 2; Figure 1, Map G). This corresponds, in different areas, to the top of the Slave Point Formation southeast of the Slave Point shale-out along the Arrowhead Salient, to the top of the Nahanni, Lonely Bay formations north and west of the Arrowhead Salient of the Presqu’ile Barrier Reef (Figure 1, map G; Meijer-Drees, 1993), and to the top of the lower part of the Keg River Formation within the Cordova Embayment (Figure 1, Map G). The top of the Jean Marie Member in the central and eastern parts of the area is the next higher well-defined marker followed by the successively shallower Devonian platform carbonate picks of the Tetcho and Kotcho formations (e.g. Figure 2, lines 2, 5).

The top of the Carboniferous Banff Formation, the next higher seismic marker, is not as well defined as the underlying Devonian carbonate-shale interfaces, but is recognizable by its contrast with the overlying Carboniferous Flett Formation. Internal reflectors within the Banff are less obvious than those within the Flett Formation (Figure 2, Line 3) and internal reflectors within the Banff display pronounced westward divergence unlike the approximately bed-parallel reflector arrays of the overlying Flett (Figure 2, Line 2).

The base of Cretaceous unconformity at the top of the Paleozoic assemblage is readily recognizable by its truncation of underlying Paleozoic strata (Figure 2, lines 2, 3, 4, 5, 6). In areas away from obvious sub-Cretaceous erosional truncation, the base of Cretaceous is not everywhere well defined seismically and must be extrapolated from areas where it is well-defined or picked with the aid of synthetic seismograms of sonic logs from wells along or very near seismic lines (e.g. Figure 2, Line 7).

MAJOR STRUCTURAL FEATURES

Large-scale structural features within the study area include Celibeta High (Figure 1, Map A and Figure 2, Line 5; Wright et al., 1994) and the Bovie Fault (Figure 2, lines 3, 4; Taylor and Stott, 1968; Douglas and Norris, 1959, 1976). Also present, but not well documented here, is a series of previously described northeast-trending basement faults, or fault zones. These include the Liard Line (Cecile et al., 1997), the Celibeta fault zone (Williams, 1977), and the Rabbit Lake fault zone (Williams, 1977; Douglas, 1974). The Celibeta fault zone has been renamed the Trout Lake fault zone in this report to avoid confusion with the term Celibeta High.

Celibeta High

We have renamed the Celibeta Structure of Williams (1977) the Celibeta High because it is a broad, domal, basement uplift rather than a local structure. It is 34 km in east-west extent as defined by the 1300 ms closing contour on the sub-Phanerozoic Unconformity map (Figure 1, Map H) and is oval in plan view with a long dimension oriented northeastward. The east-west oriented seismic Line 5 of Figure 2 clearly shows the post-depositional uplift, or doming with associated extension, of the sub-Phanerozoic unconformity and the entire Paleozoic assemblage. Seismic structure maps of the Devonian succession (Figure 1, maps D, E, F, G, H) also indicate a post-Paleozoic time of uplift for Celibeta High with all Devonian time structure maps displaying a domal uplift centred on Celibeta High.

Seismic Line 5 of Figure 2 and the structure map of the sub-Cretaceous unconformity (Figure 1, Map A) shows clearly that the sub-Cretaceous unconformity has been uplifted across Celibeta High and eroded across the central part of Celibeta in post-Cretaceous time (see also Williams, 1977). They also show that uplift and erosion of Paleozoic strata occurred before development of the sub-Cretaceous unconformity. Line 5 of Figure 2 shows definite truncation of the Carboniferous Flett Formation and the Permian Fantasque Formation eastward of Home Signal Celibeta # 7 H-50. Sub-Cretaceous truncation of the Flett Formation covers a broad area across the Celibeta High (Figure 1, Map B).

While admittedly poorly constrained to the southeast, seismic mapping supports the interpretation of Williams (1977) that Celibeta High is asymmetric with a steeper west flank (Figure 1, Map H; Figure 2, Line 5). The feature contains many syn- and post-Paleozoic north- to north-northeast oriented normal extension faults (e.g. Figure 1, Map D). Some of the post-Paleozoic extension faults form distinct grabens along the west flank of Celibeta (Figure 2, Line 5). Most of the Paleozoic-aged normal faults are downthrown slightly to the east and commonly displace the sub-Phanerozoic unconformity.

In addition to overt high-angle normal faults, the sub-Phanerozoic unconformity exhibits a highly irregular structural surface across Celibeta High (Figure 2, Line 5), unlike the rather planar aspect of the sub-Phanerozoic unconformity in areas near Celibeta High (e.g. Figure 2, Line 2). The fact that irregularities along this surface continue upsection with a progressively diminished magnitude through a succession of platform carbonates (Slave Point, Jean Marie, Tetcho, Kotcho) may indicate that there was an underlying structural, possibly fault-generated, control on these features through early Paleozoic time. There is a particularly striking example of this just slightly west of the center of Line 5 of Figure 2 where a depression along the sub-Phanerozoic unconformity is about 3 km across with an amplitude of about 120 milliseconds of two-way travel time. This depression can still be recognized at the level of the Kotcho Formation but its amplitude is greatly diminished. This graben-like depression can also be recognized some distance into the Proterozoic beneath the sub-Phanerozoic unconformity. The development of this depression could be explained as part of a graben bounded by northerly-trending normal faults with progressively diminished movement during early Paleozoic time combined with progressive sedimentary infill of the depressed area.

It is of interest that the Precambrian (Proterozoic) appears also to be arched beneath the Phanerozoic on Line 5 of Figure 2. This Proterozoic arch may have steeper flanks than those of the overlying Phanerozoic dome. This raises the possibility that Celibeta High developed partly by compressional rejuvenation of an older underlying Proterozoic arch in Cretaceous to Tertiary time.

Bovie Fault and Related Structures

The Bovie Fault, Bovie Anticline, and the Bovie Lake Thrust Fault (Taylor and Stott, 1968; Douglas and Norris, 1959, 1976) are well imaged on lines 3 and 4 of Figure 2. Along these seismic lines, the Bovie Fault is interpreted as a high angle, westward-verging, reverse fault. Bovie Fault, Bovie Anticline, and Bovie Lake Thrust Fault together extend northward from about 58°40’ to about 60°30’ north latitude as mapped on surface and as inferred from subsurface data (Wright et al., 1994; Taylor and Stott, 1968; Douglas and Norris, 1959, 1976).

The interpretation that is offered here for the development of the Bovie Fault, Anticline and Thrust Fault is essentially the same as that given in Morrow and MacLean (2000). Lines 3 and 4 of Figure 2 show the Bovie Lake Thrust Fault as a thin-skinned thrust fault with a nearly bedding plane detachment within the upper part of the Carboniferous siliciclastics of the Banff Formation (Line 4) or along the base of the overlying Carboniferous Flett Formation (Line 3). The Bovie Fault is the deeper, high angle reverse fault that is confined to strata beneath the Kotcho Formation. In the interpretation shown here, the Bovie Fault is a reverse fault with a fairly constant curvature. The top of the Middle Devonian carbonates displays about to 220 to 400 milliseconds, or about 550 to 1100 metres of vertical displacement across the Bovie Fault. The character of the Bovie Fault below the sub-Phanerozoic unconformity is uncertain because of the progressive reduction in seismic resolution with increased depth but it seems likely that Bovie Fault continues to deeper crustal depth following a path of constant curvature. The hanging wall (east side) of Bovie Fault may have been elevated by simple upward rotation of the hanging wall strata about a pivot point east of the fault. The fact that there is a noticeable reversal of the regional westward dip to an eastward dip of strata in the hanging wall (Figure 2, Line 4) is consistent with this interpretation. The geometry of Bovie Fault and the draping of upper Paleozoic strata in a monoclinal fold over this fault are consistent with the geometry of other basement-cored folds of the Rocky Mountain foreland (e.g. Cook, 1988). Cook (1988) and Erslev (1986) pointed out the requirement of a curved master basement fault to accommodate rotation of a hanging wall uplift like that displayed by the Bovie Fault.

Previously, farther south, in northeast British Columbia, the Bovie Fault has been interpreted to be a basement reactivation structure where a down-to-west extensional normal fault, which was active from late Paleozoic to mid-Cretaceous time, was reactivated by Laramide compressional tectonism as a high angle, westward-verging reverse fault (Wright et al., 1994). The Bovie Fault complex was regarded by Wright et al. (1994) as bounding the east side of Liard Basin, which contains an anomalously thick upper Paleozoic and Mesozoic sedimentary fill. Wright et al. (1994) interpreted the Bovie Fault to be a nearly vertical fault extending downwards through Precambrian strata below the sub-Phanerozoic unconformity.

As in Morrow and MacLean (2000), it is hypothesized here that post-Devonian and Carboniferous east-west contraction across Bovie Fault caused the development of a down-to-the-west flexure in the upper Paleozoic units above the upper limit of Bovie Fault itself. Eastward verging bedding plane movement occurred along Bovie Lake Thrust Fault along a detachment within the incompetent Banff Formation during the Early Tertiary Laramide Orogeny after deposition of the Cretaceous. This thrust plate may have been abruptly deflected upward across the subsurface flexure or monocline above Bovie Fault to form Bovie Anticline along the toe of Bovie Lake Thrust Fault.

Lines 3 and 4 on Figure 2 show that there is an abrupt westward increase in thickness of some Upper Devonian units across Bovie Fault. For example, the interval between the top of Tetcho to top of Kotcho increases westward from 300 m to 670 ms TWT across

Bovie Fault in Line 4 and, by a lesser amount, in Line 3. This implies that fault development began in Late Devonian time. The westward ‘drape’ of the Kotcho and Banff ‘tops’ over Bovie Fault indicates that there was substantial post-Carboniferous movement also.

The interpretation of Bovie Fault offered here does not easily explain the fact that it forms the eastern limit of the late Paleozoic and Mesozoic Liard Basin. All Paleozoic units thicken more rapidly west of Bovie Fault (e.g. Figure 2, lines 3, 4). Williams (1977) proposed the tectonic term “Bovie Hinge Line” across which upper Paleozoic and Mesozoic strata thicken rapidly westward and noted that Carboniferous, Permian and Triassic units, such as the Mattson Formation (Figure 2, Line 4), are virtually absent east of this line. Perhaps the decoupling of the uplifted east side hanging wall block from the footwall permitted greater net Paleozoic and Mesozoic subsidence west of Bovie as the hanging wall slightly overrode the Bovie Fault footwall.

Northeast-trending Basement Structures

A number of sub-parallel northeast-trending structures, which have been interpreted previously as basement faults, or fault zones, fall within the study area. These structures, from north to south, are the Beaver River Structure (Morrow and Miles, 2000), the Liard Line (Cecile et al., 1997), the Trout Lake fault zone, renamed here from the Celibeta fault zone of Williams (1977), and the Rabbit Lake fault zone (Williams, 1977). The Rabbit Lake fault zone and another northeast-trending fault zone slightly west of the study area, the Tathlina fault zone (Williams, 1977), are mapped as surface faults (Douglas and Norris, 1974). The locations of the Trout Lake and the Rabbit Lake fault zones shown on Figure 1 correspond to the long northwest faults that define the northern border of these fault zones. The Liard Line shown here corresponds to the axial trend of a linear zone defined on the basis of lower Paleozoic facies transitions (Cecile et al., 1997). These structures are all at least five kilometers wide. Only the Liard Line, the Trout Lake fault zone and the Rabbit Lake Fault Zone fall within the region of contoured seismic data within the study area (Figure 1).

Liard Line

The Liard Line has no previously documented expression on the Base of Phanerozoic unconformity or on other Phanerozoic horizons, but was inferred to exist as a linear transfer fault of crustal dimensions that controlled the orientation of lower Paleozoic sedimentary facies belts and was documented from regional aeromagnetic trends (Cecile et al., 1997). The Liard Line passes directly across the map area and may have contributed to large and consistent changes in the orientations of seismic time contours.

It is possible that the steep west-facing flank of Celibeta high on the Base of Phanerozoic unconformity (Figure 1, Map H) developed partly in response to strike-slip and/or dip slip movements along the Liard Line in Early Paleozoic time. However, the consistent overall change in direction of contours from a southeast-trend north of Liard Line to a south and southwest-trend south of Liard Line in all Devonian and Carboniferous maps

(Figures 1, maps B, C, D, E, F) is very similar to that exhibited by the Base of Phanerozoic map (Figure 1, Map H). This indicates that post-Carboniferous to Cretaceous and/or Tertiary movements are responsible for most, if not all of this regional change of contour orientations and are related to the development of Celibeta High, rather than to movements along Liard Line.

There is an indication, however, that some pre-Carboniferous Late Devonian movement contributed to changes in the orientation of some seismic contour across Liard Line. This may be discerned by a comparison of the 1800 millisecond contour line west of Celibeta on the Base of Phanerozoic map (Figure 1, Map H) with contours at approximately the same location on the other maps. Seismic contours at this location on the Middle Devonian Carbonates (1800 millisecond), and on the top of Tetcho (1300 millisecond) display similar orientations and tend to bend eastward where they pass southward across the Liard Line, like those on the Base of Phanerozoic map. Contours east of these contours bend uniformly westward where they pass southward across the Liard Line. Seismic contours at the top of Flett (e.g. at 700 milliseconds) display much less of a bend across the Liard Line than do the corresponding contours on maps of underlying surfaces (Figure 1). Also, the top of Flett has a distinctly shallower westward dip north of Liard Line than the northwestward gradients displayed by all seismic maps of stratigraphically lower Paleozoic surfaces.

Taken together these observations suggest that there may have been some pre-Carboniferous (i.e. pre-Flett) left-lateral or down-to-the-south movement across Liard Line during Late Devonian time, particularly during Kotcho to Flett time. Alternatively, these contour irregularities may relate to apparent movements across the Bovie Fault, which are of variable magnitude along structural strike.

Movement across Liard Line, either left lateral strike-slip or down-to-the-south dip slip is also consistent with the large southwest deflection of the Slave Point shelf edge along the Arrowhead Salient where it passes southward across Liard Line (Figure 1, Map G). The Bovie Fault zone of late Paleozoic age does not display any appreciable offset across the Liard Line (Figure 1). More detailed work is needed to assess whether any Liard Line-related post-Bovie movements occurred that affected the Bovie Fault zone.

Small jogs in the Base of Phanerozoic contours that fall close to, or along, the axial trend of the Liard Line (Figure 1, Map H) may be related to smaller post-Proterozoic adjustments by local unmapped faults associated with the Liard Line. The density of seismic control is not sufficient to document this possibility.

Trout Lake fault zone

The Trout Lake fault zone is documented from well data as extending from the southwest part of Celibeta High towards Trout Lake (Celibeta fault zone of Williams, 1977). It is manifested mainly as a northeast-trending fault-bounded graben on the Base of Phanerozoic surface. The single gas discovery well (H-78) is on the high north side of this fault zone. The trend indicated for the Trout Lake fault zone on Figure 1 corresponds to the north side-bounding fault of this graben, which is estimated to be about 5 kilometres wide (Williams, 1977).

Trout Lake fault zone is characterized by a cumulative vertical throw of up to 100 metres which is considerably less than the 100 millisecond, or about 250 metres, contour interval of the seismic maps shown in Figure 1. However, there is a distinct dimple, or pinching, of the Base of Phanerozoic unconformity seismic contours immediately southeast of the north side-bounding fault of this zone (Figure 1, Map H) that may reflect the influence of this fault zone. Also, the Trout Lake fault zone shows clearly on the east side of seismic Line 5 of Figure 2 as a small down-to-the-east offset on the Base of Phanerozoic. Many of the seismic maps show small jogs along, or near, the southwest side of Trout Lake that might be attributed to movements along this zone.

Williams (1977) suggested that the abrupt changes in orientation of the Slave Point shelf edge northeast of Trout Lake are on trend with this zone (Figure 1, Map G). Quaternary to Holocene movements associated with the Trout Lake fault zone may have had an influence on the development of the long northeast-directed re-entrant on the south side of Trout Lake as well as on the long and straight northeast-trending southeast side of this lake.

Williams (1977) also suggested that movements along the Trout Lake fault zone influenced the trend of the Bovie hinge line to the south in British Columbia. This implies that movements along this fault zone are contemporaneous with, or later than, development of the Bovie Fault itself. More data are needed to document the implications of this assertion.

Rabbit Lake fault zone

The Rabbit Lake fault zone has been projected southwestward across the southeast corner of the study area from the Rabbit Lake and Foetus Lake area where basement faults have been documented from well data (Williams, 1977). As mentioned previously, the northwest side of this fault zone coincides with a northeast-trending surface normal fault that is mapped for 50 kilometres from north of the Mackenzie Highway southwestward, through the entire Upper Devonian, to the northeastward limit of the overlying Cretaceous cover (Douglas, 1974). The large surface separations of Devonian formational contacts of up to 12 kilometres that are mapped across this fault are a strong indication that this fault continues southwestward beneath the overlying Cretaceous cover. The Rabbit Lake fault zone is similar to the Trout Lake fault zone in that both are characterized by a central graben about 5 kilometres wide (Williams, 1977).

Like the Trout Lake fault zone graben, the Rabbit Lake graben has a maximum documented relief of up to 100 metres on the Base of Phanerozoic unconformity surface. This elevation difference is less than the 100 millisecond (~250 metre) contour interval of the seismic maps of Figure 1. However, the both the 1200 and 1300 millisecond contours on the Base of Phanerozoic unconformity surface south of Trainor Lake display distinct and matching jogs consistent with the occurrence of a northeast-trending graben valley about 5 kilometres wide adjacent to the Rabbit Lake fault (Figure 1, Map H). Similar changes of contour line directions occur adjacent to this fault zone occur on almost all mapped Devonian and Carboniferous horizons (Figure 1).

POTENTIAL CARBONATE RESERVOIRS

A number of undrilled potential carbonate gas reservoir types are shown on seismic lines of Figure 2. Line 1 through the northwest corner of the Arrowhead Salient of the Presqu'ile Barrier (Figure 1, Map G) shows the Netla C-07 Slave Point shelf edge gas discovery well. Just behind the shelf edge gas reservoir, large carbonate mounds are clearly imaged. It is unclear whether these mounds are simply backreef shelf mounds or whether they might record a slightly younger, stratigraphically higher, second reefal Slave Point shelf edge.

Line 6 of Figure 2 shows a large, undrilled east-facing Slave Point shelf edge along the west side of the Cordova Embayment. A 3 kilometre wide shelf platform mound complex is imaged along the top of the Slave Point east of the Cordova Embayment in Line 7 of Figure 2. This mound complex is located within the Rabbit Lake fault zone (Figure 1, Map G). Movement along faults of this zone may have influenced Slave Point sedimentation across the shelf in this area and the growth of this mound complex.

Another, largely unexplored, play type is the occurrence of Jean Marie mounds near the shelf edge of the Jean Marie Formation (Figure 1, Map F). Line 2 (Figure 2) shows one of these undrilled, reefal, Jean Marie mounds. Also shown on Line 2 is the shelf edge limit of the Jean Marie limestone. West of this limit the Jean Marie seismic marker becomes indistinct, but traceable, as it dips more steeply westward and asymptotically nearly merges with the top of the Slave Point (Figure 2, Line 2).

CONCLUSIONS

This preliminary analysis of the publicly-available seismic data in the Trout Lake area of the Northwest Territories has shed light on the origin of several regional tectonic features. The area is dominated by the Celibeta High, which has been found to have at least two stages of development, an early post-Paleozoic to pre-Cretaceous episode of uplift and a later, Tertiary-aged period of uplift. The other major feature is Bovie Fault, which was confirmed to be a high angle reverse fault as interpreted previously (Morrow and MacLean, 2000). The main time of fault movement was found to span the time of deposition of the Devonian Tetcho Formation. The Bovie Fault was found to extend northward uninterrupted across the region of the Liard Line of Cecile et al. (1997).

Other northeast-trending fault zones (Rabbit Lake and Trout Lake fault zones) documented from well data by Williams (1977) received some additional verification from the maps and seismic lines presented here but the small vertical components of throw exhibited by faults in these fault zones precludes their unequivocal interpretation as seismic features.

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