THE NECHAKO BASIN PROJECT: NEW INSIGHTS FROM THE SOUTHERN NECHAKO BASIN

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ABSTRACT

The Nechako Basin is the region of south-central BC that is underlain by poorly exposed Lower Jurassic to Upper Cretaceous sedimentary sequences overlain by extensive Tertiary volcanic rocks and thick Pleistocene to Holocene glacial deposits. Jura-Cretaceous strata have potential for oil and gas.

The Nechako Basin has seen intermittent exploration for oil and gas. The Nechako Basin Project is a multi-year research program designed to generate new geoscience data and interpretations to facilitate continued oil and gas exploration. The program includes geological field reconnaissance, biostratigraphy, radiometric dating, apatite fission track thermochronometry, and Rock-Eval and thermal maturity analyses.

Work completed in the first year of the project included: reconnaissance and sampling of Jura-Cretaceous strata in the southern and central parts the Nechako Basin, new sampling and analysis of drill core and cuttings from 7 old oil and gas exploration wells, and new interpretations of well stratigraphy and regional geophysical data.

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INTRODUCTION

The government of British Columbia, through the Ministry of Energy, Mines and Petroleum Resources, is committed to realizing BC's ultimate hydrocarbon potential within its relatively under-explored portion of the Western Canada Sedimentary Basin (WCSB) and seeing oil and gas exploration within its interior and offshore basins. The government has initiated projects designed to improve the province's petroleum geology information base and to identify new energy development opportunities.

The Resource Development and Geoscience Branch (RDGB) is mandated to identify, quantify, and promote the hydrocarbon potential of onshore regions of British Columbia; In onshore regions outside of the WCSB, oil and gas potential occurs primarily within Mesozoic and Cenozoic clastic sediments of the Interior Basins. The main areas include the Whitehorse Trough and the Bowser, Sustut and Nechako basins (Figure 1). Although the Bowser and Nechako Basins have seen limited subsurface exploration, these regions remain 'frontier basins' because of deficiencies in both infrastructure and geological information.

In accordance with the goals of the Interior Basins Strategy (Hayes *et al.,* 2004), the RDGB has initiated or supported projects within these areas, leading to the capture of new energy-related geoscience information.

The Nechako Basin lies in the Interior Plateau physiographic region of British Columbia, as defined by Holland (1964). Prospective horizons for petroleum are poorly exposed Lower Jurassic to Upper Cretaceous sedimentary sequences, which are overlain by extensive Tertiary volcanic rocks and thick Pleistocene to Holocene glacial deposits. The boundaries of the Nechako Basin are variously defined (*e.g.*, Koch (1970), Hannigan *et al.* (1994)), but they are generally considered to be the Skeena Arch in the north, Highway 97 to the east, the Tyaughton Basin in the Chilcotin and Camelsfoot Ranges to the south, and the Coast Mountains to the west. Surface exposures in this area are dominated by Paleogene to Neogene volcanics, and Quaternary deposits that hide underlying geology. Although there are exposures of Jura-Cretaceous sedimentary sequences within the Nechako region, the dominance of older volcanic terranes in certain areas, together with geophysical and subsurface data, suggests that the area currently defined as the Nechako Basin is actually composed of smaller sub-basins. It is not known whether these represent separate depocentres or the remnants of one large basin.

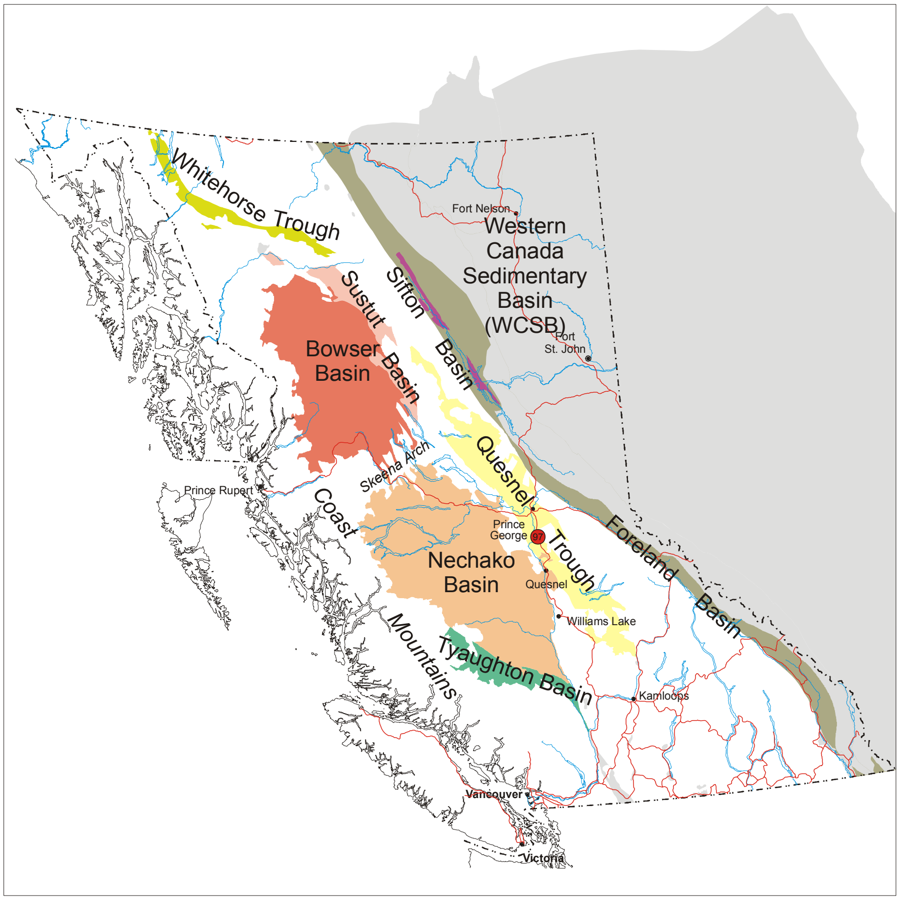


Figure 1. British Columbia's Interior basins (outlines adapted from P. Hannigan, P.J. Lee, K. Osadetz, unpublished 1993-1998).

OIL AND GAS EXPLORATION HISTORY OF THE NECHAKO BASIN (FIGURE 2)

Oil and gas exploration in south-central British Columbia began with investigation of reported oil and gas shows at surface in the Kersley area, about 55 km south of Quesnel (Hayes, 2002). One hole was drilled in 1931, and several others in the early 1950s. All penetrated 500 to 600 m of unconsolidated Quaternary deposits and Tertiary sedimentary rocks before reaching limestone bedrock (probably of the Cache Creek Group); no significant oil or gas shows were found. One hole was drilled by Northern Lights Resources in 1981 in the Kersley area, with no success (Hayes, 2002).

Honolulu Oil Corporation began exploring the Nechako Basin in 1959, concentrating in the Nazko River area (Taylor, 1960). They conducted air photo interpretation and reconnaissance surface mapping over the region, followed in 1960 with more detailed geologic investigation and the drilling of the Honolulu Nazko well a-4-L/93-B-11. The hole was dry but had spotty live oil shows and gas in one drill stem test. Limited seismic work was done: about 43.5 total line km in the Nazko area and small surveys (a few shot points each) in the Alexis Creek and Puntzi areas (Taylor, 1961). In the same year, the Hudson's Bay Oil and Gas Company drilled a 1300 m well (c-75-A/93-B-04) for stratigraphy (Williams, 1959) south of Redstone. All exploration permits were subsequently dropped (Halliday, 1969). Amoco Canada filed permits for 2.5 million acres in the Nechako Basin in 1969, conducted geological investigation, and collected magnetic susceptibility data (Halliday, 1969). An aeromagnetic survey, a seismic program, and drilling were recommended but were not conducted. Texalta Resources drilled a well (c-38-J/93-G-06) in the Punchaw area south of Prince George in 1972 (Hayes, 2002). The target Jura-Cretaceous section was not intersected; the hole penetrated 250 m of unconsolidated material over volcanic rocks of the Cache Creek Terrane. Oil staining was noted at fault contacts (well file WA 3149).

From 1979 to 1985, Canadian Hunter Exploration ran the largest and most comprehensive oil and gas exploration program that the Nechako Basin has seen, culminating in the drilling of 5 exploration wells. The company acquired 43 permit parcels late in 1979 (Province of BC News Release, January 15, 1980), and in the ensuing 2 years completed several integrated gravity and seismic surveys (3070 total line km and about 965 line km respectively). Two wells were drilled in 1980. A north-south anticline parallel to the Nazko River valley, identified by surface mapping and seismic, was tested by wells d-96-E/93-B-11 and b-16-J/93-B-11. The first hole intersected broadly similar stratigraphy to a-4-L, but the

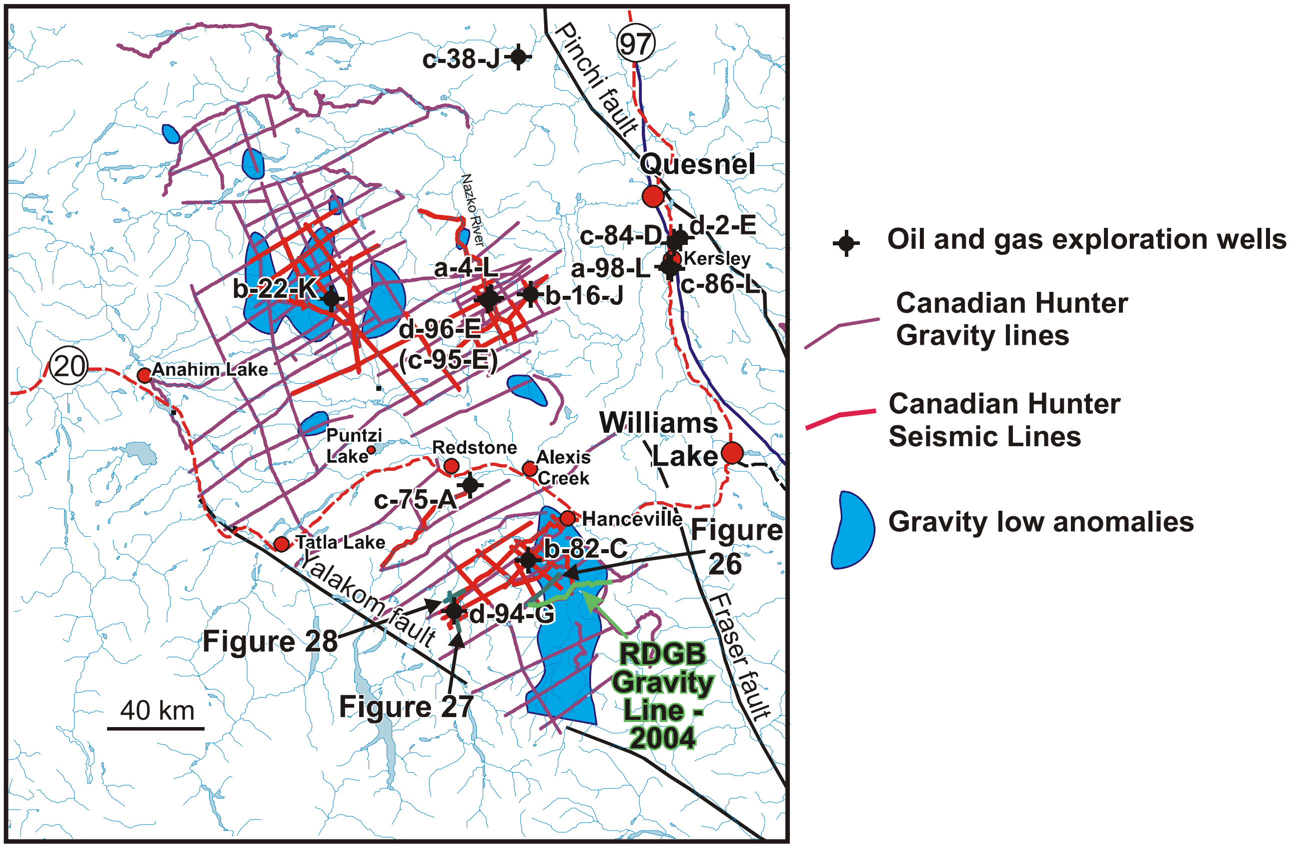


Figure 2. Oil and gas exploration to-date within the Nechako Basin.

second hole did not intersect the target strata and reached economic basement at about 1100 m. Two more holes were drilled in 1981. Well b-22-K/93-C-9 is on a seismic high (Hayes, 2002) and is also positioned over the largest and deepest gravity low (Figure 2) identified by the gravity survey in the early 1980s. The drilling intersected volcanic and volcaniclastic rocks instead of the expected sedimentary package. Well site b-82-C/92-O-14 sits on the western margin of another significant gravity low, a large north-pointing arrow-shaped feature centred in the Big Creek area south of Hanceville. The drilling pierced Tertiary volcanic rocks over sedimentary rocks of probable Albian ages. Granitic rocks intersected at 1638 metres explained the seismic high. The fifth and last well (d-94-G/92-O-12) was drilled in 1985. The well was sited on a seismically defined rollover associated with a thrust fault (Hayes, 2002) but did not intersect the expected Jura-Cretaceous sedimentary package. Fine-grained, feldspathic volcaniclastic sedimentary rocks overlie volcanic rocks at this site.

No significant physical oil and gas exploration work has been done in the Nechako Basin since well d-94-G/92-O-12 was abandoned in 1986. Several workers have compiled and evaluated existing data and discussed their implications for oil and gas exploration (*e.g.*, Hannigan *et al.* (1994); Hayes (2002); Hunt and Bustin (1997)). Julie Hunt (1992) collected and analysed new data on thermal maturity and biostratigraphy for the basin, which improved understanding of the stratigraphy of some well sections and of the oil and gas potential in the basin.

REGIONAL GEOLOGICAL FRAMEWORK (FIGURE 3)

Relatively little is known about the geological history of the Nechako Basin due to limited bedrock exposure. The assumption that Jura-Cretaceous sedimentary rocks exist beneath the Tertiary and Quaternary volcanic rocks is based on the occurrence of Mesozoic sedimentary rocks along the northern and southern fringes of the Nechako Basin. Oil and gas exploration drilling in the Nazko Valley in 1960 and 1980 confirmed that over 2000 m of Cretaceous sedimentary rocks underlie at least parts of the Nechako Basin. Rocks exposed at the northwest end of the basin in the Fawnie and Nechako Ranges are associated with Stikine Terrane and include the Hazelton, Bowser Lake, and Skeena Groups. Rocks of the Cadwallader Terrane and the overlying Jura-Cretaceous Tyaughton-Methow overlap assemblages border the southern end. The nature and location of the boundary between the Cadwallader/Tyaughton-Methow Terranes and Stikine Terrane is unknown because it is largely masked by the overlying Chilcotin basalts and Quaternary deposits, therefore interpretation of subsurface stratigraphy must include consideration of units of both Stikinia and Cadwallader affinities.

The best exposures within the Nechako region are found along the Nazko River between its confluence points with the Clisbako River and Tautri Creek. Outcrops occur in the river valley where it has incised

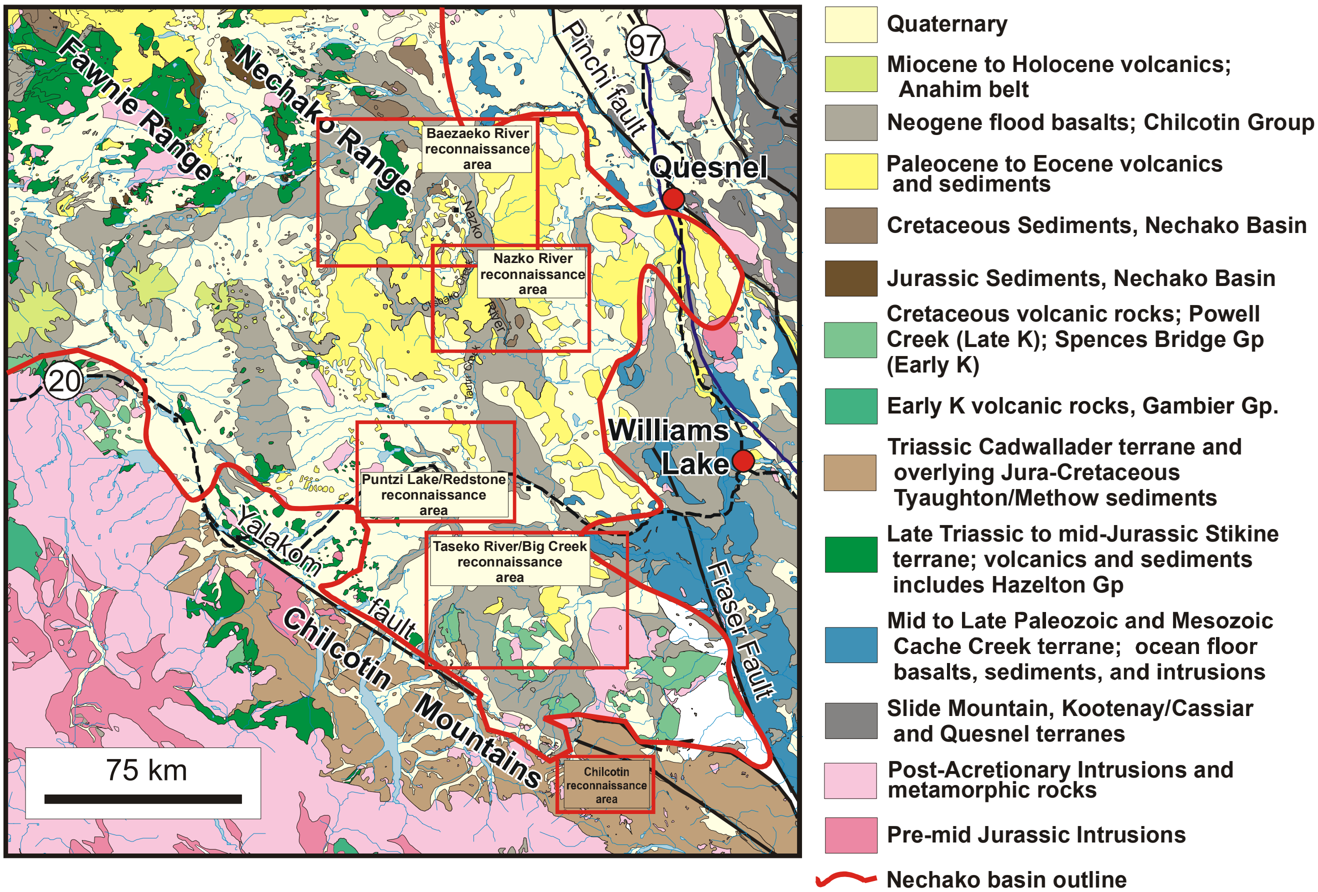


Figure 3. Regional geological framework of the southern Nechako Basin. Red rectangles outline 2005 field reconnaissance and sampling areas.

below the 1065 to 1100 m elevation level of the Chilcotin basalts—an area about 25 km long from north to south and about 5 km wide. Exploration drilling in this area and elsewhere in the Nechako region intersected various thicknesses of sedimentary rocks, but lateral correlations are not readily apparent; this is a function of the large distances between the wells but probably also reflects structural complexity in the subsurface.

THE NECHAKO BASIN PROJECT

This paper reports on a comprehensive research program for the Nechako Basin that began in 2004 with acquisition of new gravity and magnetic data along a 30 km transect (the green line on Figure 2) along Highway 20 west of Williams Lake (Best, 2004a). In addition, in 2003 a 2-year joint program was initiated between the RDGB and the Geological Survey of Canada (GSC) towards a new resource estimate of the Nechako Basin (Hayes, 2004). This has produced several products, such as a new Rock-Eval database for subsurface samples (Osadetz *et al.*, 2003), detailed subsurface sample descriptions (Thorsteinsson, *in preparation*) and a current heat flow study of the Interior basins (Majorowicz *et al.*, 2004).

In 2005, we began integrated fieldwork and sampling, regional stratigraphic correlation, thermal history studies, and radiometric and fossil dating. The project also provides technical and financial support for ongoing geophysical studies conducted by the GSC, including the positioning of 7 passive seismic stations and the initiation of a magnetotelluric survey across the Nechako Basin. The passive seismic array will provide insight into large-scale basin architecture, and the magnetotelluric survey will help image through surface basalts to distinguish volcanic from sedimentary sequences.

The current project will continue to assess the oil and gas potential of the Nechako Basin, specifically by evaluating some of the critical factors of a petroleum system: the presence of petroleum source and reservoir rocks, an appropriate thermal history, and timing of petroleum migration. This paper reports on current activities, with emphasis on regional correlations within the basin, structural style, source bed analysis, and thermal maturation. The reader is referred to Hayes (2002) and Hannigan *et al.* (1994) for our current understanding of Nechako petroleum geology.

We have begun the project by studying the Cadwallader-Tyaughton/Methow Terrane stratigraphy and structure in the Chilcotin Mountains along the southern fringe of the Nechako Basin and by re-evaluating the limited subsurface data from existing exploration wells in the context of those southern correlations. In 2006, we plan to approach the Nechako Basin from its northern boundary to assess the applicability of the Stikine Terrane stratigraphic and structural history to interpretation of the subsurface.

STRATIGRAPHY AND STRUCTURE IN THE CHILCOTIN MOUNTAINS

The Chilcotin Mountains were uplifted and incised in Neogene (specifically 2 to 14 Ma) time, exposing late Paleozoic basement and Mesozoic sedimentary and volcanic rocks (Table 1) that are expected to underlie at least part of the Nechako Basin region. The exposed rocks include Mississippian to Jurassic oceanic rocks of the Bridge River Complex, arc-derived volcanic and sedimentary rocks of the Cadwallader Terrane, and Late Jurassic to mid-Cretaceous rocks of the Tyaughton-Methow Basin. Volcanic rocks of the Powell Creek formation overlie these. The Tyaughton-Methow Basin can be considered a single entity during deposition of the Jurassic to Lower Cretaceous Relay Mountain Group. In the late Early Cretaceous, the basin was partitioned into the Tyaughton and Methow sub-basins by landforms that emerged in response to contractional deformation (Garver, 1992). The Tyaughton Basin is represented by the Taylor Creek Group and the overlying Silverquick conglomerate, and the Methow Basin by coeval but lithologically distinct Jackass Mountain Group (Schiarizza, 1996).

The Chilcotin region has been divided by Schiarizza (1996) into 3 separate domains (Figure 4) based on distinct structural styles: the south Chilcotin domain, the Methow domain, and the Niut domain. The south Chilcotin domain (Figure 5) is characterized by middle to Late Cretaceous southwest-directed contractional faults and tight folds and Late Cretaceous to early Tertiary strike-slip faults. The Methow structural domain occurs northeast of the south Chilcotin domain and is characterized by a less complex structural style—faults are more widely spaced and folds are broad and open. The Niut domain affects rocks west of Chilko and Tatlayoko Lakes that are deformed by easterly-directed mid-Cretaceous thrust faults (Rusmore and Woodsworth, 1994). The faults that characterize the Niut domain are interpreted as the easternmost component of the mid-Cretaceous contraction event that deformed the Coast Plutonic Complex (Rusmore and Woodsworth, 1991). A detailed discussion of the structural history of the Chilcotin Mountains is provided by Schiarizza *et al.* (1997).

Current understanding of subsurface geology in most of the Nechako Basin is inadequate to reliably determine the structural style in the rocks hosting prospective horizons. An understanding of the structural styles exhibited in the Chilcotin Mountains could provide working models for interpretation of the limited existing data and for the design of effective research methods.

For oil and gas prospects, the less complex structural style that characterizes the Methow domain is clearly preferable to that of the south Chilcotin domain or the Niut domain. An important question for oil and gas exploration is whether or not the closely spaced fault patterns of the south Chilcotin or Niut domains continue to the northeast beneath the area covered by Neogene basalt and Quaternary glacial deposits.

Within the south Chilcotin domain, late strike-slip faults represent closely spaced disruptions to the continuity of source and reservoir horizons as well as steep to vertical conduits to the surface that breach stratigraphic or structural traps. The southern Nechako Basin occupies the basalt and till-covered region between two major Eocene dextral strike-slip fault systems—the Yalakom and the Fraser. Post-accretionary plutons of the Coast Belt young to the northeast, reflecting their formation over the advancing east-dipping plate (Friedman *et al.*, 1995). Three large plutons within the south Chilcotin domain—the Beece Creek pluton, the Lorna Lake stock, and the Mission Ridge pluton (Figure 5)—yielded 44 Ma Ar-Ar dates (Archibald *et al.*, 1989), indicating the presence of an Eocene zone of thermal weakening (Friedman and Armstrong, 1988). This weakened thermal zone likely accommodated northerly-directed movement of outboard rocks with respect to North America that began sometime after 57 Ma and continued until at least 37 Ma (Engebretson, 1985). The resulting spatial intensity of faulting that characterized the south Chilcotin domain is therefore likely restricted to this northwest striking corridor and may not continue to the northeast beneath the Chilcotin Group basalt cover.

The extent of the influence of the characteristic Niut domain structural style is not known. Similar northeast-directed thrust faults were documented by Mahoney *et al.* (1992) in the Churn Creek area (near its confluence with the Fraser River) in the southeastern corner of the Nechako Basin.

2005 FIELD SEASON

In 2005, we examined and sampled Jurassic and Cretaceous rocks of the Chilcotin and Camelsfoot Ranges (Figures 3 and 7); these Mesozoic prospective horizons may underlie the Chilcotin basalts in much of the Nechako Basin. We sampled potential source beds for type, content, and maturity of organic matter (Rock-Eval analysis) and potential reservoir units for characterization of porosity, and collected vitrinite reflectance and apatite fission track samples for thermal history studies. We visited pre-Neogene outcrops in the southern Nechako Basin area (Figures 6, 7, and 8) to evaluate their place in the regional geological framework and to sample for biostratigraphy (palynology) and thermal history (vitrinite reflectance and fission track). At all field stations (except for those in the Chilcotin Mountains reconnaissance area), we measured the magnetic susceptibility of rock units for use in the modelling and interpretation of magnetic survey data (Figures 6, 7a, and 8; Table 5). Subsequently, we examined core and drill cuttings from old exploration

TABLE 1. SIMPLIFIED TABLE OF FORMATIONS IN THE CHILCOTIN MOUNTAINS, BRITISH COLUMBIA. ADAPTED FROM TIPPER (1963), SCHIARIZZA *ET AL.* (1997), UMHOEFER AND TIPPER (1998), AND GRADSTEIN AND OGG (2004)

Era	Period Or Epoch	Age		Group / Formation and thickness	Lithology
Cenozoic	Quaternary	**Recent**			Alluvium, river gravel, colluvium
		Neogene	Pleistocene	**Glacial deposits**	Till, outwash sands and gravels
	Tertiary		Pliocene	**Chilcotin Group**	Vesicular basalt, andesite flows, related breccia and tuff
			Miocene		
		Paleogene	Oligocene		Ootsa Lake: Felsic and intermediate volcanics and associated sediments Kamloops: Andesite, trachyandesite and latite flows.
			Eocene	**Ootsa Lake Group or Kamloops Group**	
			Paleocene		
Mesozoic	Cretaceous	**Late**	Maastrichtian		Taseko River strata: Purplish feldspathic sandstone and conglomerate, cross-bedded Powell Creek: Hornblende and feldspar phyric andesitic volcanics and volcaniclastics Silverquick: Chert and volcanic lithic pebble conglomerate, non-marine, cross-bedded, with interbedded siltstone and sandstone, silty redbeds
			Campanian	**Taseko River strata** >400m	
			Santonian		
			Coniacian	? ? ? ? ?	
			Turonian		
			Cenomanian		
		Early	Albian	**Powell Creek volcanics** >3000 m **Silverquick formation** >800 m	
				Taylor Creek Group >3000 m: Lizard Fm; Elbow-Dash Fm; Paradise Fm	Taylor Creek: Chert pebble conglomerate, black shale, siltstone, feldspathic sandstone, muscovite-rich sandstone
				Jackass Mountain group >5000 m	Jackass Mountain Group: Polylithic conglomerate, siltstone, shale and sandstone
			Aptian		
		Neo-comian	Barremian		
			Hauterivian	**Relay Mountain Group** ~2250 m	Fossiliferous brown sandstone, siltstone and shale, buchia coquina, minor conglomerate
			Valanginian		
			Berriasian		
	Jurassic	**Late**			
		Middle	Callovian		
			Bathonian		
			Bajocian	**Last Creek Formation** > 450 m **Nemaia Formation** >3000m **Bridge River Complex** Thickness unknown, at least 400 metres	Last Creek: Calcareous sandstone, siltstone, minor conglomerate and tuffs Bridge River Group: Ribbon chert, argillite, greenstone, serpentinite, blueschist
			Aalenian		
		Early			
	Triassic	**Late**		**Tyaughton Group** ~2500 m **Cadwallader Group** >3000 m	Tyaughton: conglomerate, limestone, sandstone Cadwallader: siltstone,shale, limestone, conglomerate, mafic volcanics
		Middle			
		Early			
Paleozoic	**Permian**				
	Carboniferous	**Pennsylvanian**			
		Mississippian			
	Devonian				

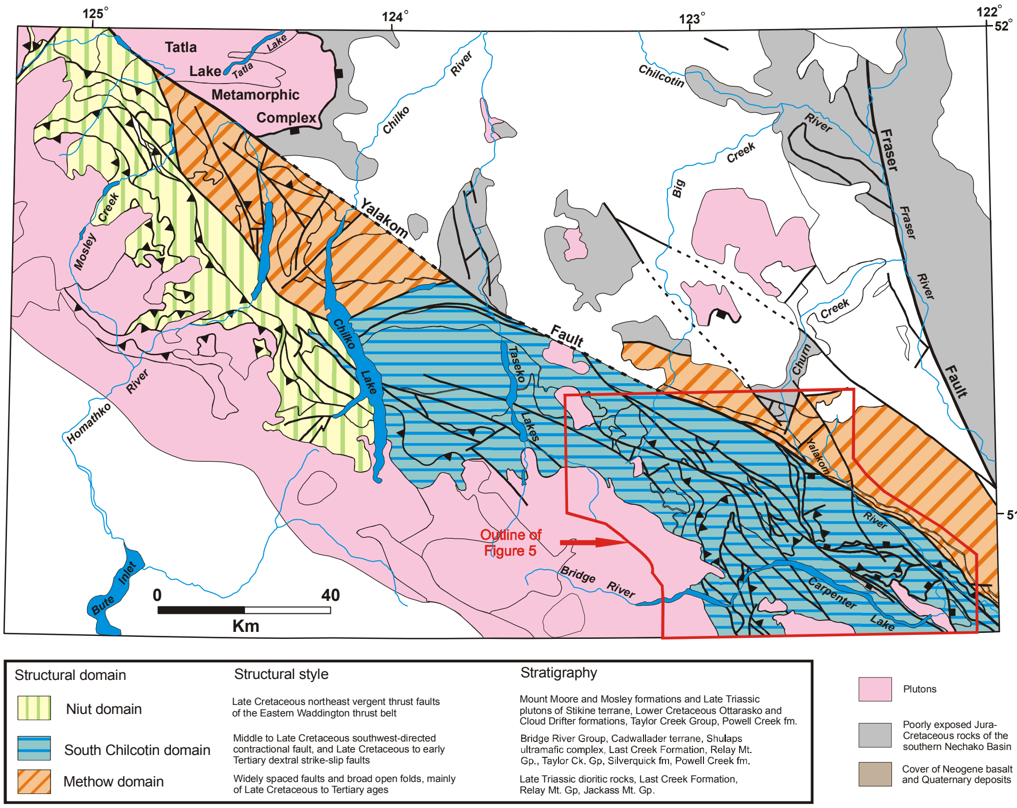


Figure 4. Structural domains of the Chilcotin Mountains (after Schiarizza, 1996).

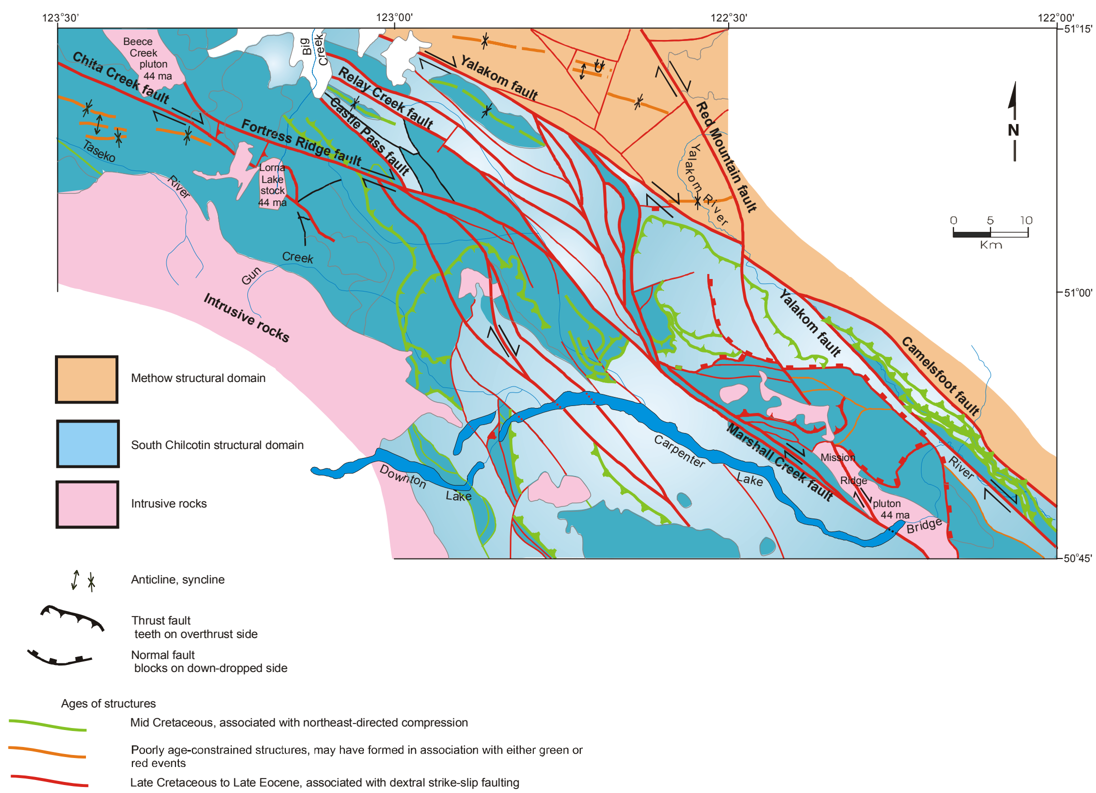


Figure 5. Structural styles in the Methow and South Chilcotin structural domains of the Chilcotin Mountains (after Schiarizza *et al*., 1997).

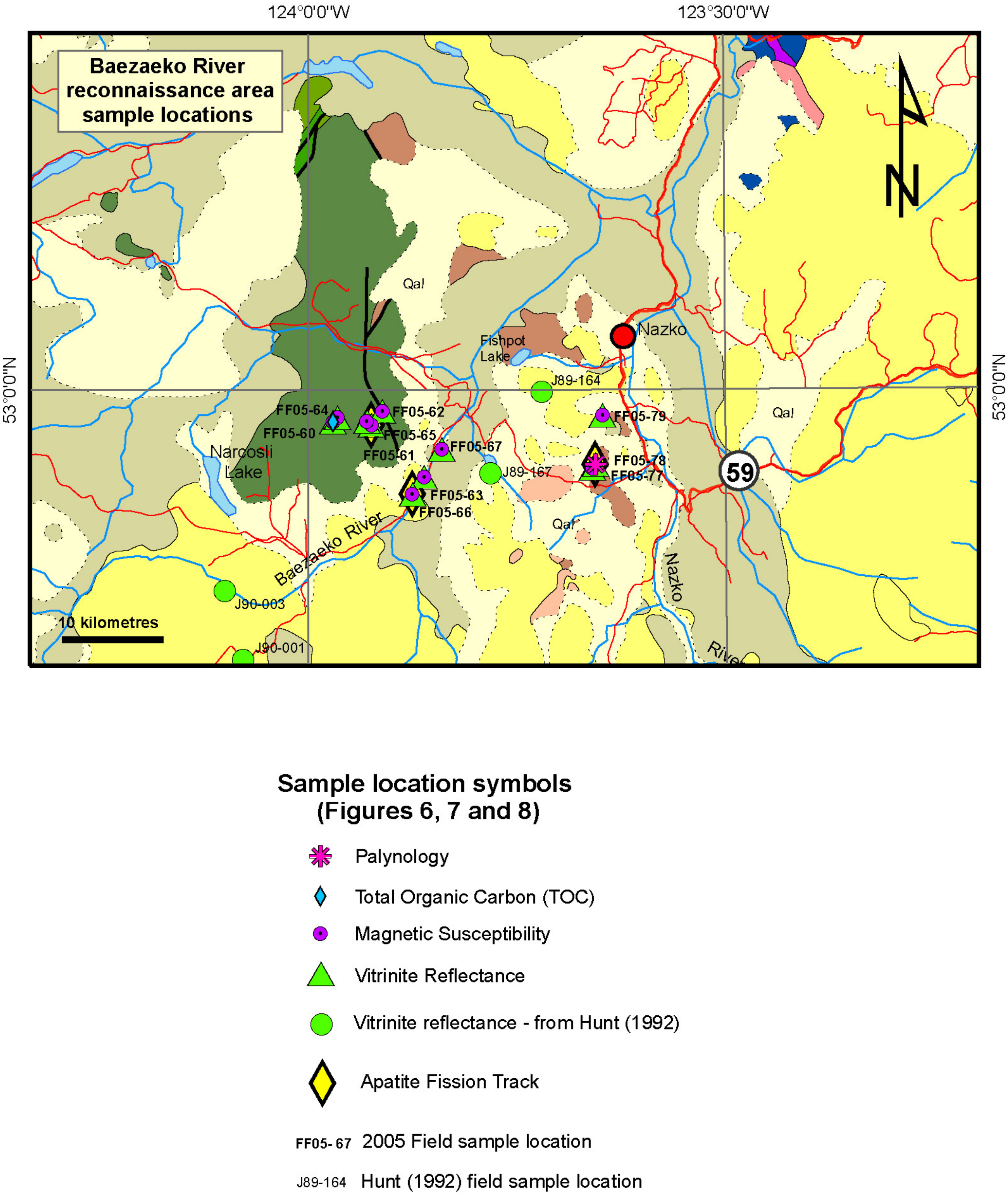
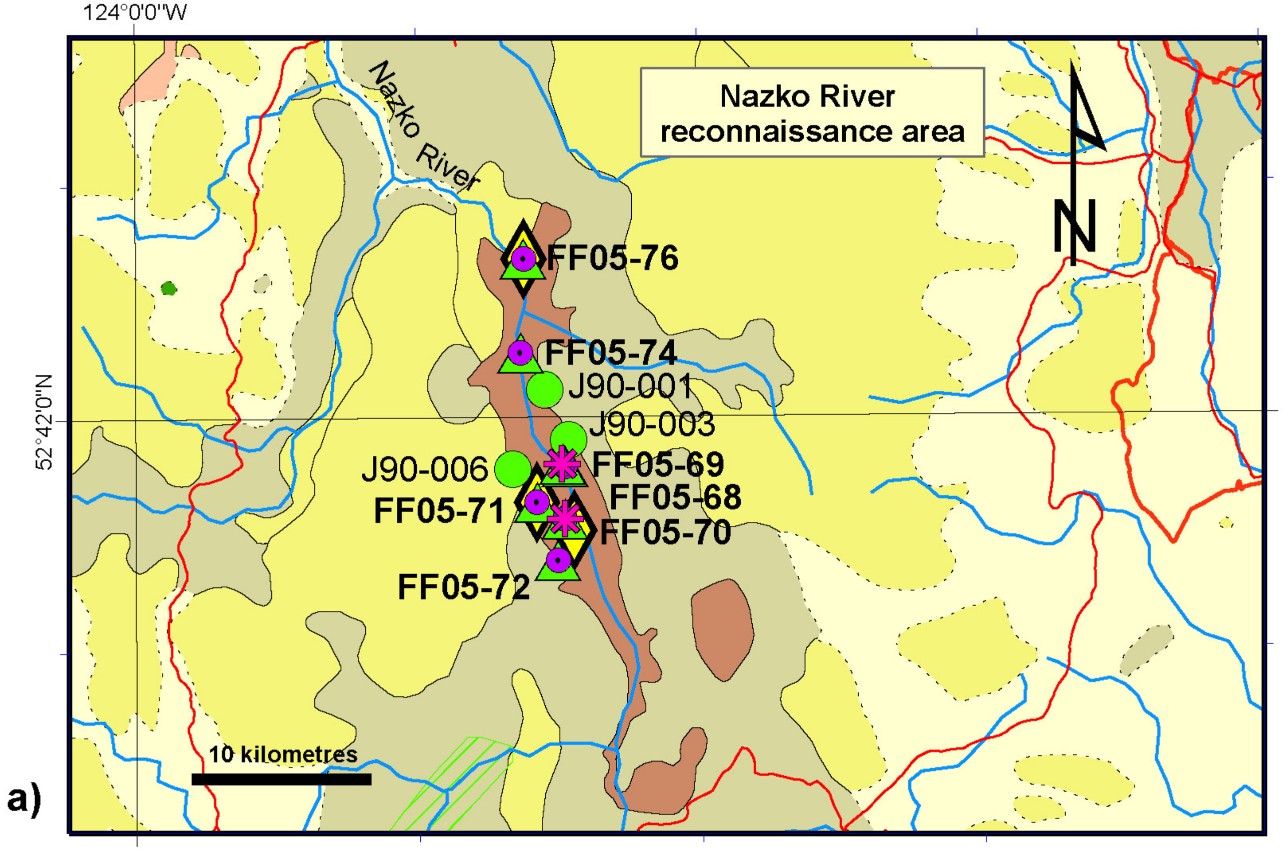


Figure 6. Reconnaissance area and sample locations for Baezaeko River. See Figure 3 for geological colour legend.



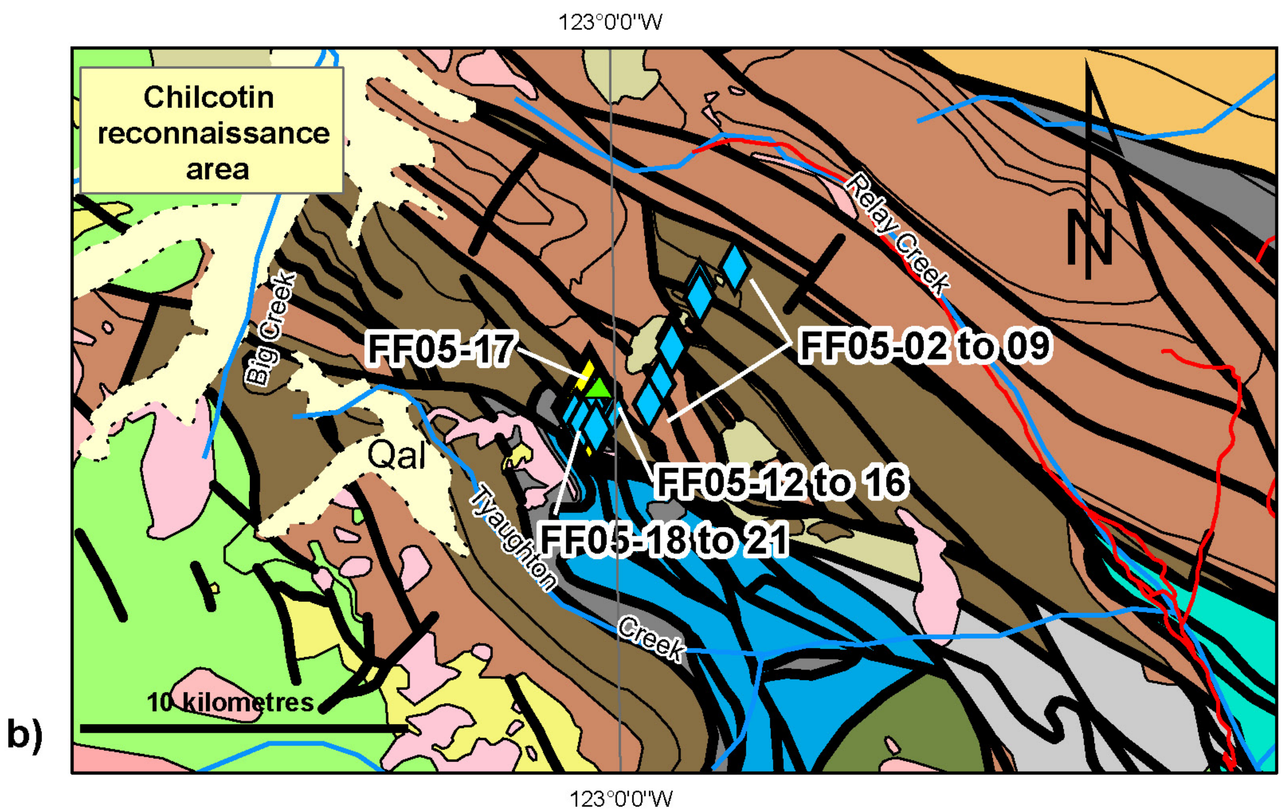


Figure 7. Reconnaissance areas and sample locations for **a)** Nazko and **b)** Chilcotin Mountains. Sample symbols are as for Figure 6. Geological colour legend for **7a)** is as for Figure 3. Geological colour legend for sampled units for **7b**): Light brown – Taylor Creek Group (samples were taken from the Paradise formation); Dark brown – Relay Mountain Group; Grey – Last Creek Formation.

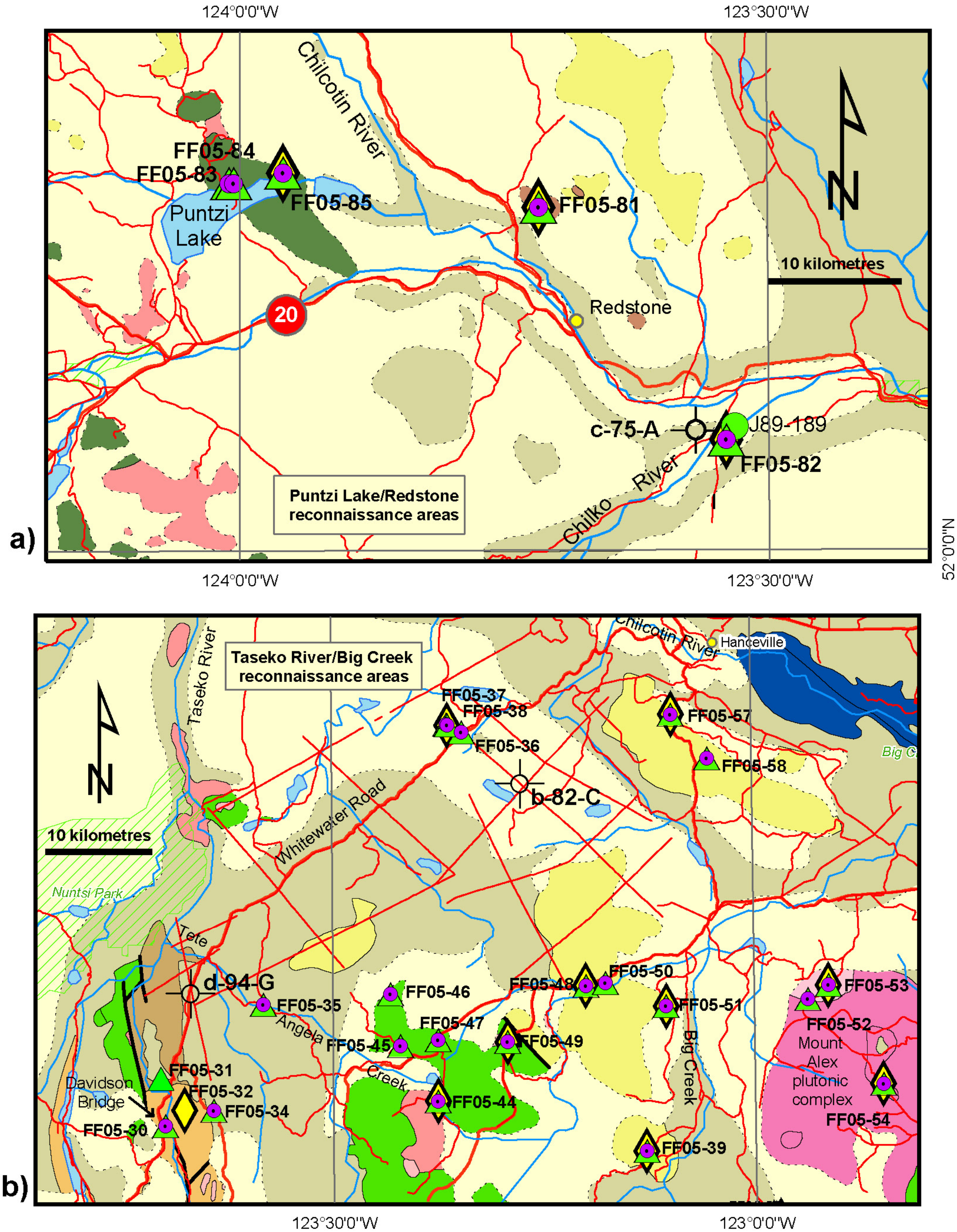


Figure 8. Reconnaissance areas and sample locations for **a)** Puntzi Lake/Redstone and **b)** Taseko River/Big Creek. Sample symbols are as for Figure 6.

wells and sampled them for vitrinite reflectance, palynology, and apatite fission track studies. The analyses of vitrinite reflectance and surface Rock-Eval samples are complete and results are discussed below. Results of palynology and apatite fission track analyses are pending and will be reviewed in a future publication.

DESCRIPTION OF TYPE AREAS IN THE CHILCOTIN AND CAMELSFOOT RANGES

We visited and sampled type sections of Last Creek Formation, Relay Mountain Group, most formations of the Taylor Creek Group, the Silverquick formation in the Chilcotin Mountains, and the Lillooet and Jackass Mountain groups along the Fraser River canyon between Lillooet and Boston Bar.

Last Creek Formation

The Early to Middle Jurassic Last Creek Formation consists of a fining-upward sequence of Hettangian to Sinemurian volcanic pebble conglomerate, sandstone, and sandy siltstone, with rare tuff bands, overlain by a markedly finer unit of Sinemurian to Bajocian calcareous black shale, minor sandstone and rare conglomerate (Umhoefer and Tipper, 1998) with a total thickness of at least 450 m. The formation is rich in ammonoid and bivalve fossils as well as woody debris. Umhoefer and Tipper (1998) interpret the lower coarse-grained part as a transgressive sequence of nearshore to inner shelf deposits, and the higher fine-grained part as outer shelf to slope deposits. Shaly intervals of the Last Creek Formation were sampled for total organic carbon (TOC) analysis to test their potential as a source rock.

Rocks that are time-equivalent and similar in lithology to the Last Creek Formation occur throughout the interior basins of British Columbia. They include the Nemaia Formation in the Potato Range and elsewhere (Umhoefer and Tipper, 1998), the Junction Creek unit in the Bridge River area (Schiarizza *et al.*, 1997), parts of the Ashcroft Formation in southwestern BC (Travers, 1978), parts of the Spatsizi Formation of the Hazelton Group in north-central BC (Thomson *et al.*, 1986), the Ladner Group near Boston Bar, the Lillooet Group near Lillooet (Mahoney, 1993), and others. Regionally, these rocks may include viable hydrocarbon source horizons (Ferri and Boddy, 2005).

Relay Mountain Group

The Relay Mountain Group comprises several sequences of fossiliferous Middle Jurassic to Lower Cretaceous clastic sedimentary rocks, which are best exposed on the ridge that includes Teepee and Relay Mountains. Umhoefer *et al.* (2002) divide the Group into 3 formal formations. The Callovian and Early Oxfordian Tyoax Pass Formation comprises marine shale and sandstone turbidites. The Teepee Mountain Formation is Late Oxfordian to Valanginian in age and consists of shallow marine clastic rocks with common *Buchia* fossils. The Hauterivian to Barremian(?) Potato Range Formation consists of marine and non-marine sandstone and conglomerate. We walked the length of the sequence exposed along the Relay Mountain/Teepee ridge and sampled all fine-grained, dark-coloured units for Rock-Eval analysis. Sandstone with woody fragments was sampled for vitrinite reflectance.

The Relay Mountain Group is a widespread and regionally important sequence in southwestern BC as it underlies Aptian and younger Cretaceous rocks of both the Taylor Creek Group (Tyaughton Basin) and the Jackass Mountain Group (Methow Basin).

Taylor Creek Group

The Taylor Creek Group includes over 3000 m of sedimentary rocks inferred to have been deposited in response to uplift and erosion of older oceanic and arc-related rocks during the accretion of the Insular Superterrane to North America (Garver, 1992, and references therein). Strata that are correlative with the Taylor Creek Group are widespread in southwestern BC and were intersected by several of the Nechako oil and gas exploration wells. These rocks clearly represent a significant component of the subsurface geology of the Nechako Basin. The Taylor Creek Group includes several shaly and conglomeratic sequences, which have potential as source and reservoir rocks respectively. Taylor Creek Group stratigraphy is more complex than is described here and is summarized in Table 1 (see Schiarizza, 1997, and Garver, 1992); lateral facies changes reflect different source terranes in various parts of the syn-tectonic basin and sub-basins.

The formations of the Taylor Creek Group sampled during the 2005 field season are the Aptian to early Albian Paradise Formation and the Albian Dash and Lizard formations. The Paradise formation is exposed on the southern flank of Relay Mountain and comprises about 80% black shale (Garver, 1992); the coarse component is mainly volcanic-rich conglomerate. Three samples of the shale were taken for Rock-Eval analysis to evaluate source rock potential.

The Dash and Lizard formations were examined along a ridge north of North Cinnabar Creek in the Taylor Creek type area. The mid-Albian Dash conglomerate is a chert-rich pebble conglomerate with lesser chert-lithic sandstone that marks the emergence and erosion of the oceanic Bridge River Terrane in Albian time (Garver, 1992). Samples of the Dash formation were collected for thin-section determination of porosity (for reservoir quality determination) and vitrinite reflectance. The middle to upper Albian Lizard Formation is a marine turbiditic sequence mainly composed of muscovite-rich lithic sandstones interbedded with shale. Shale from the North Cinnabar Creek area was sampled for Rock-Eval analysis.

Silverquick Formation

The Silverquick formation is an Albian to Cenomanian unit dominated by non-marine, cross-bedded, chert-rich pebble conglomerate with associated lesser sandstone, siltstone and shales; redbeds are common in the silty and shaly intervals. Silverquick conglomerates are distinguished from the chert pebble conglomerates of the Taylor Creek Group by their more varied clast content; in addition to chert, they contain abundant sedimentary rock fragments and intermediate volcanics and lesser greenstone, quartz, and dioritic plutonic rocks. This formation is interpreted to have been deposited primarily in a braided fluvial system (Garver, 1989). In its type area, the Silverquick formation is about 1500 m thick and is deposited on Taylor Creek Group strata on a sharp contact with an unconformity of 10° to 20° (Garver, 1992). Elsewhere, correlative rocks (the Beece Creek succession of Schiarizza 1997) may be gradational with underlying Taylor Creek Group units. The Silverquick conglomerate passes gradationally into overlying Late Cretaceous volcanic rocks of the Powell Creek formation.

Lillooet Group

The Lillooet Group is age equivalent, at least in part, with the Early to Middle Jurassic Last Creek Formation and its equivalents (Schiarizza, 1997). They are correlated with the Dewdney Creek Formation (the upper part of the Ladner Group) (Mahoney, 1993). They underlie the Jackass Mountain Group near Lillooet and are exposed in the cliffs along Highway 12 between Lillooet and Lytton. There they consist of brown to rusty brown and grey-banded siltstones and shales with lesser sandstones and conglomerates. Finer-grained intervals were sampled for Rock-Eval analysis.

Jackass Mountain Group

The Jackass Mountain Group is a Barremian to early Albian sedimentary sequence that is dominated by sandstone but also contains sections of siltstone and shale, along with the thick and distinctive conglomerates that are its hallmark (Kleinspehn, 1985). The group varies laterally but shows mappable common characteristics over time (Schiarizza *et al.*, 1997). The Jackass Mountain Group is at least 5000 m thick locally. Barremian to Aptian strata are dominantly sandy, and clast types demonstrate a mainly volcanic source; distinctive massive, dark bluish-green volcanic sandstones with abundant plant fossils are common. An abrupt transition from volcanic to plutonic clasts marks the mappable transition into the overlying Albian strata (Schiarizza *et al.*, 1997); these upper units contain abundant cobble to pebble polylithic conglomerates rich in granitoid clasts. This change in clast character is inferred to reflect the late Early Cretaceous uplift of Intermontane Belt source terrain. We examined boulder conglomerates and blue-green sandstones in the rocks along Highway #1 north of Boston Bar.

Barremian to Aptian strata of the Jackass Mountain Group contain significant shaly intervals that may have potential as source rocks; these intervals will be sampled and analyzed in 2006.

RECONNAISSANCE WITHIN THE NECHAKO BASIN

TASEKO RIVER

We examined outcrops along Whitewater Road (adjacent to Taseko River) from Davidson Bridge to Tete Angela Creek (Figure 8b) to better interpret the stratigraphy encountered in the 1985 CanHunter Redstone well (d-94-G/92-O-12). Boulder conglomerate and sandstone of the Jackass Mountain Group are exposed on the east side of the road near Davidson Bridge. A prominent section of volcaniclastic, cross-bedded sandstones are exposed at a big bend in the Taseko River (about 2500 metres north of the bridge, where Vick Creek empties into Taseko River); this section of rocks has been identified as Silverquick formation (Hickson, 1993, and subsequent workers), but they do not resemble Silverquick strata (except for the cross-bedding) and are not correlative with any of the formations described above. A hornblende Ar-Ar age of 79.93 +/- 7.41 Ma (or a range from Turonian to Campanian) was obtained from a volcanic clast at the site, implying a depositional age no earlier than Turonian (Maxson, 1996). This is consistent with U-Pb ages as young as ca. 86 Ma obtained from detrital zircons in the upper part of this section by Enkin *et al.* (in press).. Clearly the Taseko River strata, as we informally call them, are too young to correlate with the Silverquick conglomerate—they are as young as upper Powell Creek volcanic rocks, whereas the Silverquick underlies the Powell Creek section. These rocks may be correlative with those mapped as Silverquick by Mustard and van der Heyden (1997) on the south side of Highway 20 about 25 kilometres northwest of Tatla Lake; otherwise, correlative rocks have not been recognized. It is unknown whether this unit is widespread in the subsurface to the north or if it is limited in extent.

BIG CREEK

The area around Big Creek, south of Hanceville, is characterized by low relief and scarce outcrop (Figure 8b); most outcrops are found on subdued topographic highs. Andesitic to dacitic flows and breccia occur on topographic highs throughout the area; these have been correlated with the Albian Spences Bridge Group (Hickson, 1993) based on their similarity to volcanic rocks east of the Mount Alex plutonic complex, which returned a ca. 105 Ma (Albian) U-Pb age (Hickson, 1992). Volcanic and sedimentary rocks of Eocene(?) ages (Hickson, 1993; Tipper, 1978) include quartz-phyric rhyolite, olivine basalt, minor conglomerate, and sandstone and occur on subdued topographic highs. These are broadly similar to, and are correlated with, the Ootsa Lake Group. Large boulders of Chilcotin Formation basalts are common in the Big Creek area; they are not in place but sit on surficial material. The Big Creek area is the locus of a significant gravity low (discussed further below) and most likely a thick sedimentary package, which is of interest to this project for its oil and gas potential. Outcrop exposure is non-existent in the area of the gravity low, so the identity of the sedimentary package (*i.e.*, is it Jura-Cretaceous strata, Tertiary graben fill, or something else?) cannot be established by surface mapping.

REDSTONE AREA

The area around the community of Redstone (Figure 8a) is notable for the striking rim rock of Chilcotin Group plateau basalts on either side of the Chilcotin River valley from 960 to 1035 m elevation. Exposures are scarce below the rim rocks, but a few scattered outcrops of chert-rich pebble conglomerate and associated cherty sandstone resemble the Albian to Cenomanian strata of the Chilcotin Mountains. An outcrop at Gap Narrows bridge over the Chilko River is chert-rich polylithic conglomerate with large (> 1 m) crossbeds. We have tentatively correlated this with the Silverquick Formation, and it is probably the unit at the top of the nearby 1960 well c-75-A/93-B-4. Chert and muscovite sandstones with floating chert pebbles and lesser chert rich pebble to granule conglomerates underlie the westernmost part of the Sisters Hills northeast of the road to Chezacut.

PUNTZI LAKE

Rocks on the north shore of Puntzi Lake (Figure 8a) were mapped as lower Jurassic Hazelton Group by Tipper (1959 and 1969). Outcrops at the east end of the lake resemble Late Cretaceous Powell Creek volcanic rocks. A sample was taken for argon-argon radiometric dating to test this correlation. They may also correlate with the hundreds of metres of volcanic rock that were intersected by the exploration well b-22-K/93-C-09.

NAZKO RIVER

Gently dipping sedimentary rocks that resemble strata of the Lizard and Dash formations of the Cretaceous Taylor Creek Group are exposed along the Nazko River valley and on the hills between Fishpot Lake and the community of Nazko. Tan- to brown-weathering chert- and quartz-rich sandstone with floating chert pebbles is the dominant lithology. Silty and conglomeratic horizons are common, as are carbonaceous coatings on partings. On the west side of the river, near the a-4-L/93-B-11 well site, we encountered muscovite-rich grey sandstone that resembles the Lizard formation of the Taylor Creek Group. Neogene and Holocene volcanic rocks overlie the Cretaceous rocks in the Nazko River valley. West of Nazko, Taylor Creek correlative rocks sit at higher elevation than the younger volcanics. The Nazko valley likely represents the down-dropped centre of a north-striking graben active in post-Cretaceous, pre-Neogene times.

BAEZAEKO RIVER

Rocks mapped by Tipper (1959) as Hazelton Group underlie the highlands west of the Baezaeko River (Figure 6). Pale to dark grey, rusty-weathering siliceous argillite is the dominant rock type. Locally, argillite is dark grey with a dark bluish weathering colour. These sedimentary rocks are markedly more fractured and rubbly than the Cretaceous rocks. Some feldspar and pyroxene-phyric basalts are present.

GRAVITY DATA AND BASIN STRUCTURE

A Bouguer gravity map covering the southern part of the Nechako Basin is shown in Figure 9. The precursor to this map was produced by Canadian Hunter Exploration Ltd. during its exploration efforts in the Nechako Basin and submitted as part of a geological report (Salt, 1980a, b; 1981a, b; 1982a, b). The original hand-contoured line drawing was digitized by the RDGB. This allowed the production of the coloured and shaded Bouguer anomaly maps shown in Figure 9 and derivative shown in Figure 10. (The original data points from which this diagram was produced can be obtained from ARCIS Geophysical of Calgary, Alberta). The RDGB obtained gravity data along a transect across the north end of the large negative anomaly located in the southern part of Figure 9 (near line 1; Best, 2004a) and Figure 2 (green line marked RDGB Gravity Line 2004) . The new gravity profile obtained by the Branch essentially mimics the Canadian Hunter data, verifying its robustness.

The general coincidence of gravity and magnetic highs (Figure 10) suggests that the gravity highs are the reflection of underlying rocks rich in volcanics and higher density intrusions and that the gravity lows correspond to less-magnetic sedimentary sequences. This does not preclude the possibility that the gravity lows represent low-density intrusions (*i.e.*, granite) within a denser, dominantly volcanic host rock.

Simple modeling of the two prominent lows (Figures 11 and 12) in the vicinity of wells b-82-C and b-22-K suggests that they are produced by a thick package of sedimentary rocks of average density. The southern anomaly (Figure 11) may be a result of a section of sediments up to 3.5 km thick; the b-82-C well pierces the western margin of this anomaly and intersects up to 1600 m of sedimentary rocks above its termination in an intrusive body. The gross stratigraphy of this well is consistent with the gravity model over this low. The upper 1200 m of this well is probably Tertiary sedimentary material and represents a significant portion of the sedimentary section that is called for by the model.

The second prominent gravity feature (Figure 12) is a cluster of three smaller lows in the vicinity of the b-22-K well. Again, simple modeling of these anomalies suggests that they may represent one or more lenses of sedimentary rocks with a total thickness of up to 2.5 km. The top of this sedimentary sequence would be encountered at a depth of 3 to 4 km, which agrees roughly with the stratigraphy described in the well data from the b-22-K well. Age and lithology of volcanic rocks within the b-22-K well indicate that they belong to the Powell Creek volcanics, suggesting that rocks of the Silverquick conglomerate and Taylor Creek Group may underlie them at depth.

If one assumes that the Bouguer gravity lows represent sedimentary rocks, then the pattern presented in Figure 9 suggests that the configuration of the Nechako

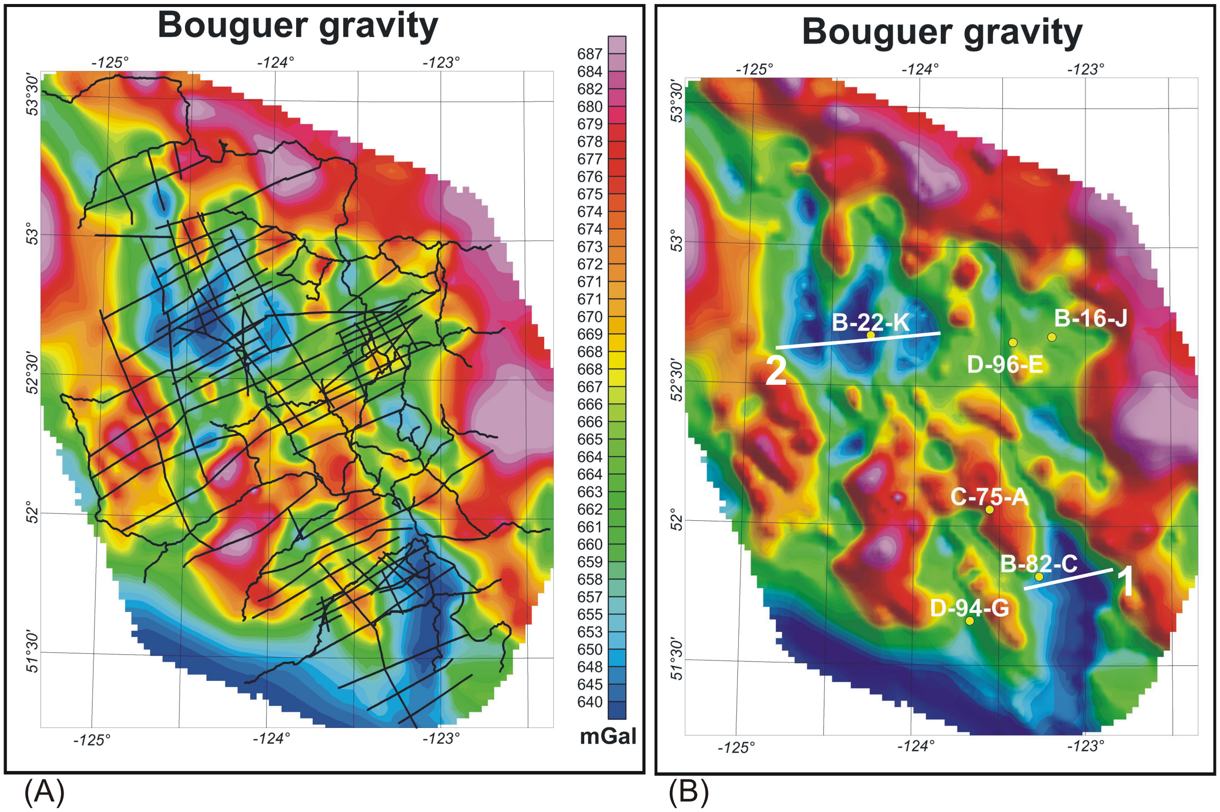


Figure 9. Bouguer gravity map of Canadian Hunter Exploration Ltd. data for the Nechako Basin produced by digitizing hand-contoured line drawing as found in Salt, 1980a,b; 1981a,b; 1982a,b. A) Coloured Bouguer gravity map showing location of data lines. B) Coloured and shaded Bouguer gravity map of the Nechako Basin (Modified from Ferri *et al.*, 2004).

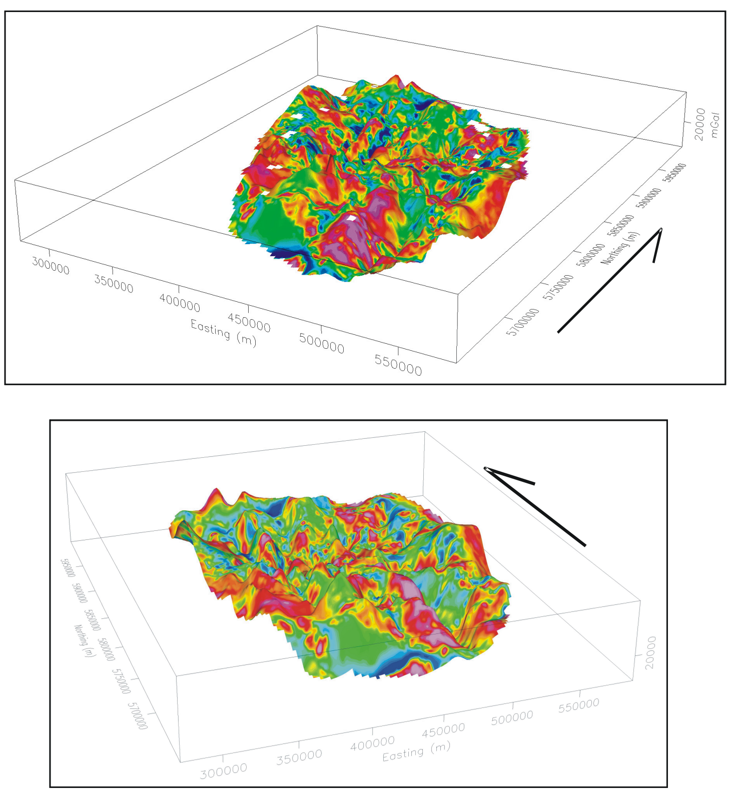
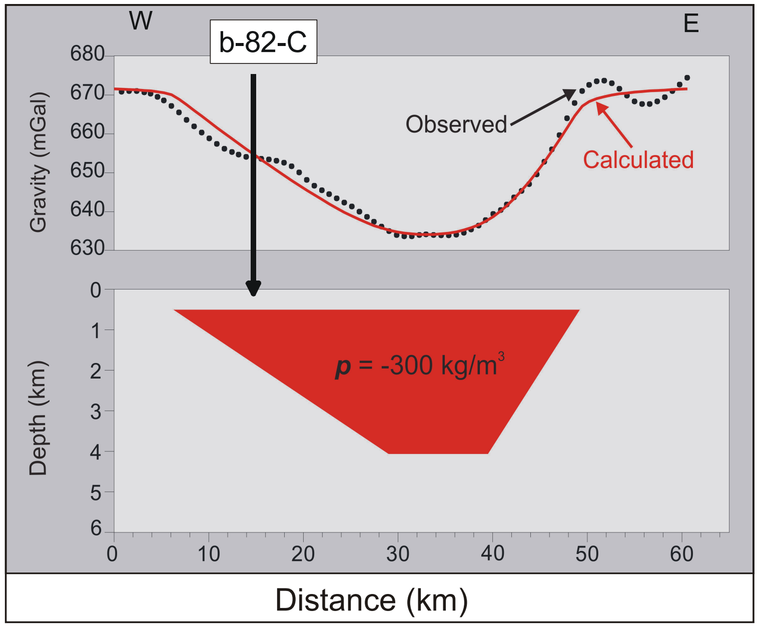
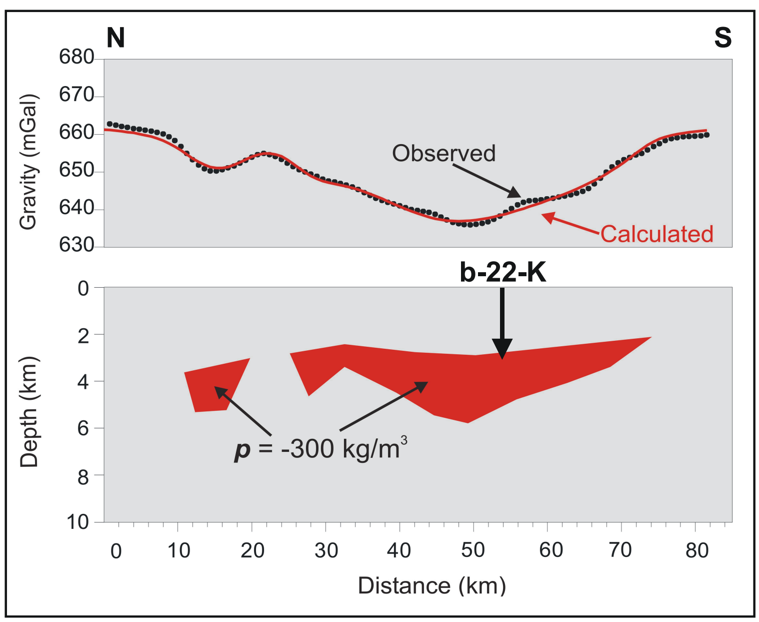


Figure 10. Magnetic field data draped over 3-dimensional rendering of Bouguer gravity map. Note that in general, zones with high magnetic values correspond to gravity highs. (Modified from Ferri *et al.*, 2004).



Line 1

Figure 11. A simple modeling exercise for the large southern anomaly through a section across line 1 in Figure A. A simple body with a density contrast of –300 kg/m^3 readily satisfies the observed gravity across anomaly 1. As illustrated here, the eastern side of the model body is required to be substantially steeper than western side. Projection of the b-82-C well geology onto the model profile suggests that the negative anomaly is due to buried sedimentary rocks more than 3.5 km thick. The average bulk density of sedimentary rocks encountered in the well is 2580 kg/m3, substantially lower than published mean values for granodiorite (2730 kg/m3) or mafic volcanic rocks (2990 kg/m3) (Modified from Ferri *et al.*, 2004).



Line 2

Figure 12. Modeling of the northern anomalies (line 2 in Figure 9) suggests that it can be produced by two simple bodies with a density contrast of –300 kg/m3. In this case, the model bodies can be more than 3 km deeper than that associated with large southern anomaly (Modified from Ferri *et al.*, 2004).

Basin is more complicated than a simple trough or depocentre and is probably composed of several smaller basins. The sharp northwest and northeast trending patterns southwest of the c-75-A well suggest structural control. The map patterns apparent on Figure 9 may be a reflection of motion on strike-slip faults and associated faults, syn-sedimentary deposition in down-thrown blocks, preservation of older sedimentary sequences, or a combination of these, produced in response to the Late Cretaceous to Paleogene right-lateral strike-slip deformation affecting this part of the Cordillera (and bounding the Nechako Basin).

Surface exposures in the Nazko River valley and results of seismic lines submitted as part of Canadian Hunter Exploration Ltd. work commitments (Focht, 1982a to 1982i) indicate that Jura-Cretaceous strata underlying these parts of the Nechako Basin are generally gently dipping. The Methow domain (described above) is probably the most applicable structural working model for the subsurface in at least the southern half of the Nechako Basin. This model predicts broad open north- to northwest-striking homoclinal folds, cut by steep northwest-striking strike-slip and associated faults at spacings in the order of tens of kilometres.

Data quality for submitted seismic lines is poor due to attenuation of returning seismic energy by surface and subsurface volcanics (Figures 26–28). In addition, most of the seismic lines within submitted reports generally follow the northwest trend of structures associated with Cretaceous shortening, so that the gentle warping seen in some of these sections (*e.g.*, Figure 27) might represent along-strike variations in structural plunge. One line (Figure 28) trends northeasterly and contains a moderately northeastward-dipping series of reflectors. Offset of reflectors within the upper parts of sections in the vicinity of the b-22-K well suggest steep normal faults of Tertiary(?) age. Given the location of the Nechako Basin between the Yalakom and Fraser/Pinchi fault zones, this area was probably affected by extensional tectonics as documented in the central Nechako Basin by Lowe *et al.* (2001) (See also Struik (1993)).

A simple, first-order cross-section through the northern and southern parts of the basin is shown in Figure 25), which is modified from Hannigan *et al.* (1994). It is possible that middle Cretaceous sediments penetrated by the d-96-E and a-4-L wells dip westward and are found stratigraphically below the volcanics penetrated by the b-22-K well. The structural geometry does not require a fault between the two wells, but neither is there evidence to preclude the existence of such a structure.

SUBSURFACE STRATIGRAPHY

The variability of the stratigraphic sections penetrated by 8 wells in the southern Nechako Basin suggests a complicated basin architecture and/or structural history for this part of the Nechako Basin. Our current understanding of the subsurface stratigraphy is hampered by a general lack of biostratigraphic control. Only the b-22-K and d-96-E wells have subsurface age constraints based on palynomorph collections (Hunt, 1992). As part of this study, samples from the a-4-L, b-16-J, b-82-C, c-75-A, and d-94-G wells have been collected and processed for palynology. Core samples were also taken from the d-96-E well to augment the current age database. Fifty subsurface samples were acquired, 17 of which were barren. Preliminary results are currently available and will be discussed in the following sections.

Canadian Hunter et al Nazko d-96-E

Palynological dates (Hunt, 1992) from the d-96-E well (Figure 13) provide an age range from Aptian to Cenomanian (late Early to early Late Cretaceous) for sedimentary rocks that occur above a dominantly volcanic sequence. This mafic volcanic sequence (from the 3324 m base to 2950m) includes minor varicoloured chert, intrusive rocks, and shale and probably belongs to the Cache Creek Group. Above this, between 2950m and 2490m, the well logs describe greenish, tight sandstone, dark shale (some bituminous) and siltstone (Cosgrove, 1981a). This green sandstone is feldspathic and contains clasts of volcanic rocks and some chert. The lithology and the Aptian to middle Albian age suggest this section may be equivalent to the lower part of the Jackass Mountain Group. Several sections of cuttings between 2510 and 2520 m and between 2592 and 2615 m contain pieces of igneous rock and limestone intermixed with greenish sandstone and shale; these are suggestive of the polymict boulder and cobble Albian Jackass Mountain conglomerate, which is characterized by abundant intrusive clasts with lesser limestone and volcanic material (Plate A). An alternative correlation for this Aptian to middle Albian section is the Paradise Formation of the Taylor Creek Group, which is time equivalent with the Jackass Mountain Group.

Late Albian to Cenomanian conglomerate, sandstone, siltstone and shale occur at depths between 2490 m and about 650 m. These rocks are time equivalent to the Taylor Creek Group (Lizard and Elbow-Dash formations) and Silverquick formation. The ‘salt and pepper’ chert-rich, micaceous sandstones in this sequence contrast with sandstones in the Aptian section in that they are cleaner, lack the green colour, are less feldspathic, and have a higher proportion of chert clasts. They are more typical of sandstones of the Taylor Creek Group and Silverquick conglomerate. Shale and siltstone are most abundant in the sections below 2100 m and between 650 and 950 m depth. A section dominated by chert-pebble conglomerate and sandstone occurs between 1720 and 2060 m. Grey, chert-rich sandstone is the dominant lithology between 960 and 1300 m. The remaining parts of the section comprise dark grey to grey and mauve siltstone and shale punctuated by sections of chert-rich sandstone and conglomerate up to tens of metres thick.

Sedimentary features observed within core are consistent with a marine depositional environment; these include mud drapes and ripple-cross laminations (Plate B). Cored sections of conglomerate and sandstone show clast content to be dominated by well-rounded chert grains with lesser volcanic clasts. Evidence of marine environments occurs in core as shallow as about 700 m. Sandstone and/or conglomerate dominated sections within this interval might represent coarser clastics described within the Lizard and Elbow-Dash formations of the Taylor Creek Group.

Late Albian to Cenomanian sandstone, conglomerate, and lesser siltstone and shale occur from 650 m to 50 m depths; this interval may correlate with the non-marine Silverquick formation.

Well logs describe Tertiary felsic volcanics in the top 50 m of this drill hole.

Honolulu Nazko a-4-L

The nearby a-4-L well (Figure 14) has gross overall similarities to the d-96-E well, although several coarse clastic sequences have 'shaled-out' to the east, suggesting abrupt lateral variation within these marine and fluvial systems. Direct correlation, particularly with the gamma ray log, is difficult and may reflect the varying amounts of mica and feldspar in the clastics, both of which would affect the response of this instrument by virtue of their high potassium content.

The lowest part of the well is equivalent to the Cache Creek Group and contains diorite in the lowest part (below 10,600 ft (3230 m)) overlain by basalt (?), tuff, chert and shale up to 7790 ft (2375 m). Greenish sandstone, shale and siltstone between 7790 and 6900 ft (2375 and 2100 m) probably correlate with the Jackass Mountain Group or Paradise formation. The succeeding sequence (from 6900 to 50 ft (2100 to 15 m)) is correlated with the Lizard and Elbow-Dash formations of the Taylor Creek Group. The Albian to Cenomanian conglomerate and (Silverquick?) sandstone at the top of the d-96-E well are absent in the a-4-L well; instead, this stratigraphic interval consists predominantly of shale, some of which has high total organic carbon (TOC) content. Conglomerate and sandstone comprise over 50% of the sequence between 1000 and 750 ft. A thick conglomerate/sandstone section is present between 5300 and 4450 ft (1615 and 1355 m)(Thorsteinsson, *in preparation*; Landreth, 1961).

Canadian Hunter et al Chilcotin b-22-K

The stratigraphy of the b-22-K well (Figure 15), located some 50 km to the west of the d-96-E well, contrasts sharply with those of the a-4-L (Figure 14) and d-96-E (Figure 13) wells. Palynology data from Hunt (1992) together with overall lithologies indicate that this stratigraphy is entirely younger than the sequence within d-96-E (compare Figures 13 and 15). The lowest 1000 m of this well are composed of maroon to greenish hornblende-plagioclase porphyry volcanic rocks resembling the Powell Creek volcanics in lithology and age. Powell Creek volcanic rocks are Cenomanian to Santonian in age and regionally conformably overlie conglomerates of the Silverquick formation. Succeeding these, between 2700 and 1550 m, are volcanics and reworked volcanics. These are in turn succeeded by approximately 1200 m of greenish claystone, shale, and minor volcanics of Santonian, Campanian, and Maastrichtian ages. The affinity of these immature sediments and volcanics is uncertain, although they are approximately age-equivalent to immature, volcanically derived sediments (herein informally named Taseko River strata) exposed along part of the Taseko River.

The upper part of b-22-K (from 1550 m to surface) contains shale and mafic volcanics of Eocene, Oligocene, and Miocene age. Eocene to Oligocene strata are correlated with the Kamloops Group and younger units (Australian Creek Formation), while uppermost Miocene basalt is correlated with the Chilcotin Group.

The sequence penetrated by b-22-K probably sits stratigraphically above the section in d-96-E, as first shown by Hunt (1992) and Hunt and Bustin (1997). Conceivably, and as suggested by simple modeling of gravity data, underlying sedimentary rocks belonging to the Silverquick formation and Taylor Creek Group are producing the large gravity anomaly below b-22-K.

Canadian Hunter Esso Nazko b-16-J

Volcanic rocks dominate the stratigraphy in this well (Figure 16), located only 15 km east of d-96-E. A sedimentary sequence in its central part is probably Tertiary in age. No stratigraphic control is available for this well; palynology samples taken from the sedimentary sequence were barren.

The basal 300 m of the well (2700 to 2395 m) are composed of basalt, probably part of the Cache Creek Group; this is overlain by approximately 700 m of light- to dark-coloured tuff and minor mafic lava. The lower 80 m of this tuffaceous succession contain shale, claystone, and sandstone intervals (Thorsteinsson, *in preparation*; Cosgrove, 1986a). Sample descriptions suggest that this tuffaceous sequence is interbedded with overlying sandstone and conglomerate of Tertiary(?) age over an interval of some 70 m. The affinity of these overlying tuffs and minor sediments is uncertain; if they truly are interbedded with the overlying sedimentary sequence, then they conceivably are Tertiary in age. The tuffs are light in colour and lack cherty lithologies, which is typical of local Tertiary rocks, but not of the Cache Creek Group.

Maroon, grey, and green polymict conglomerate, sandstone, siltstone, and lesser shale form a monotonous sequence from 1682 to 517 m (Figure 16); subrounded clasts are composed of mafic to intermediate volcanics and varicoloured chert (Plate C). These sediments appear poorly consolidated based on the caliper log, core samples, and well site descriptions. The lack of consolidation suggests a relatively young age. This sedimentary sequence bears little resemblance to rocks of the Taylor Creek Group or Silverquick formation, suggesting they are younger and probably stratigraphically above the Powell Creek volcanics. They are found below a thick section of mafic to intermediate volcanics in the upper part of the well, which likely are subsurface continuations of the Endako Group mapped at surface. This position between the top of the Powell Creek volcanics and base of the Ootsa Lake Group would bracket this sedimentary sequence within the late Campanian to Eocene.

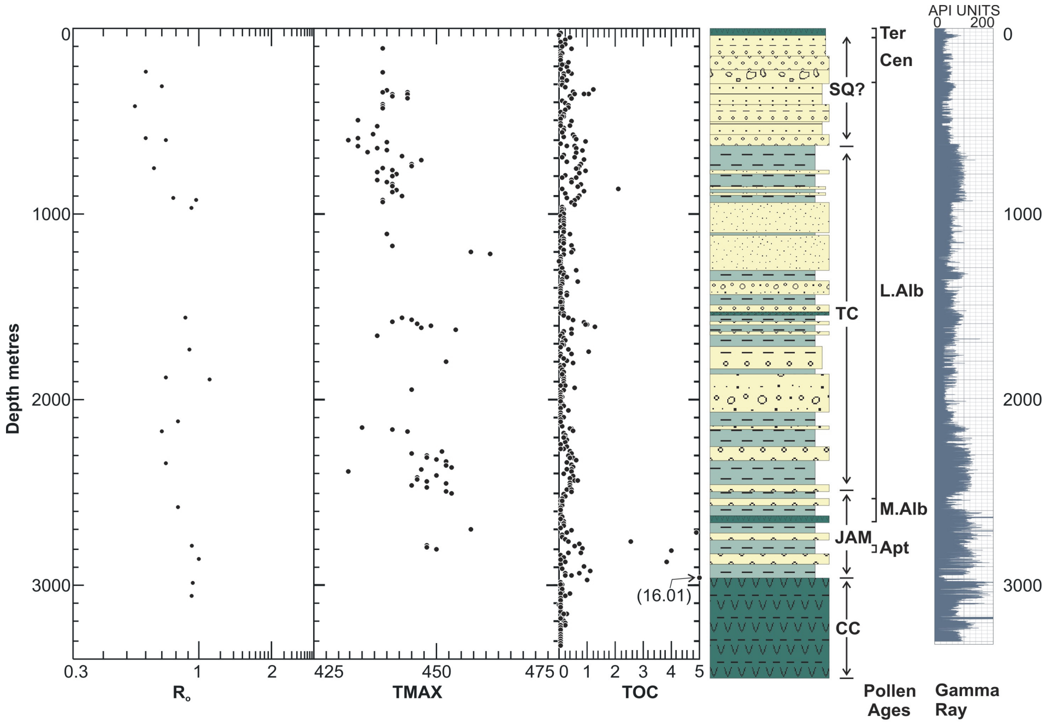


Figure 13. Simplified stratigraphic column of the Canadian Hunter et al Nazko d-96-E well plotted with the natural gamma ray log, total organic carbon (TOC), T_{max} and vitrinite reflectance values. Only T_{max} values where TOC > 0.3% were plotted. Stratigraphic column is a simplification of descriptions by Thorsteinsson (*in preparation*) and Cosgrove (1981a). Organic geochemistry is taken from Osadetz *et al.* (2003). CC: Cache Creek Group; JAM: Jackass Mountain Group; TC: Taylor Creek Group; SQ: Silverquick Formation; M.Alb: Middle Albian; L.Alb: Late Albian; Cen: Cenomanian; Ter: Tertiary.

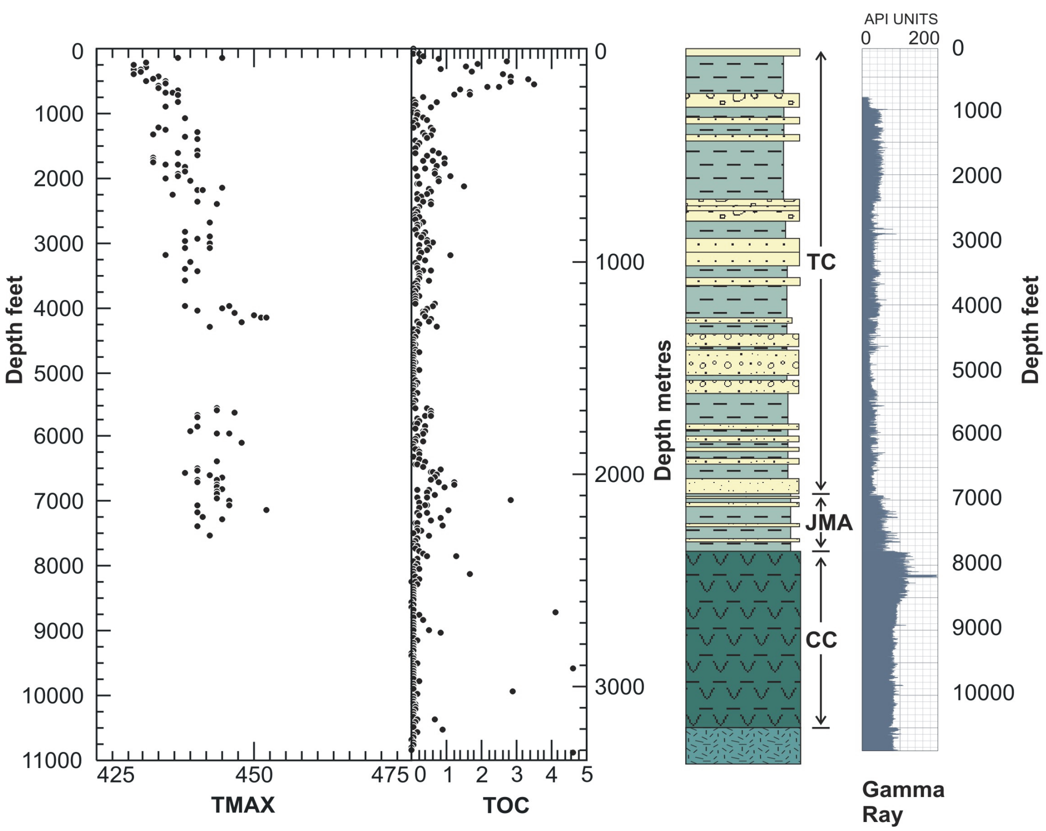


Figure 14. Simplified stratigraphic column of the Honolulu Nazko a-4-L well plotted with the natural gamma ray log, total organic carbon (TOC), T_{max} and vitrinite reflectance values. Only T_{max} values where TOC > 0.3% were plotted. Stratigraphic column is a simplification of descriptions by Thorsteinsson (*in preparation*) and Landreth (1961). Organic geochemistry is taken from Osadetz *et al.* (2003). CC: Cache Creek Group; JAM: Jackass Mountain Group; TC: Taylor Creek Group.

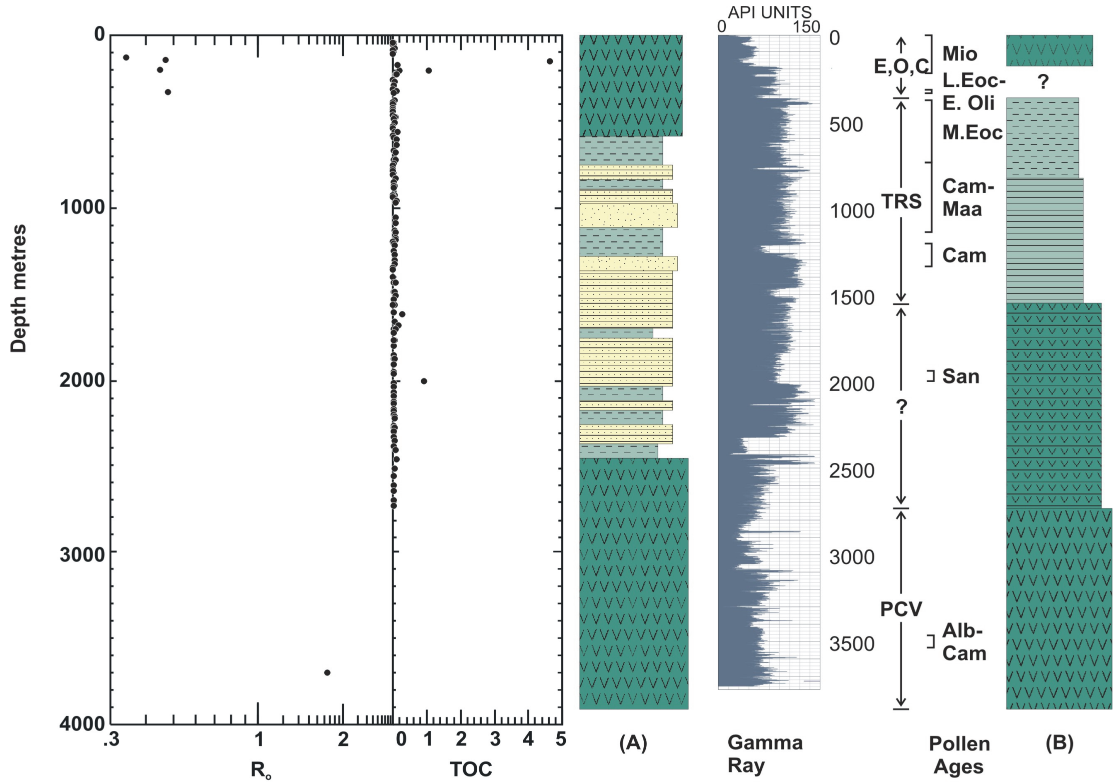


Figure 15. Simplified stratigraphic column of the Canadian Hunter et al Chilcotin b-22-K well plotted with the natural gamma ray log, total organic carbon (TOC), and vitrinite reflectance values. Stratigraphic columns are a simplification of descriptions by (A) Hunt (1992) and (B) Thorsteinsson (*in preparation*) and Cosgrove (1982). Organic geochemistry is taken from Hunt (1992). PVC: Powell Creek Volcanics; TRS: Taseko River strata; E: Endako Group; O: Ootsa Lake Group; C: Chilcotin Group; Alb: Albian; Cam: Campanian; M. Eoc: Middle Eocene; L. Eoc: Late Eocene; Mio: Miocene; E.Oli: Early Oligocene; Maa: Maastrichtian.

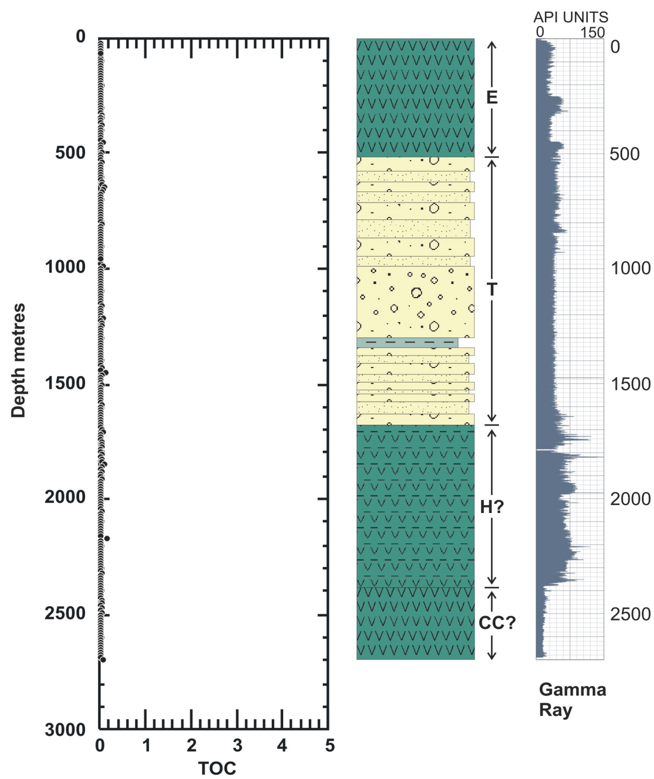


Figure 16. Simplified stratigraphic column of the Canadian Hunter Esso Nazko b-16-J well plotted with the natural gamma ray log and total organic carbon (TOC). Stratigraphic column is a simplification of descriptions by Thorsteinsson (*in preparation*) and Cosgrove (1986a). Organic geochemistry is taken from Osadetz *et al.* (2003). CC: Cache Creek Group; H: Hazelton Group; Ter: Tertiary; E: Endako Group.

Plate A. (A) Typical section of Jackass Mountain conglomerate near the Taseko River in 92-O-12/F showing the coarse nature of conglomerate. (B) Jackass Mountain conglomerate along the Trans Canada Highway, south of Lytton. Note the abundant intrusive clasts, some of which are up to boulder in size. Limestone clasts can constitute a significant proportion of clast types.

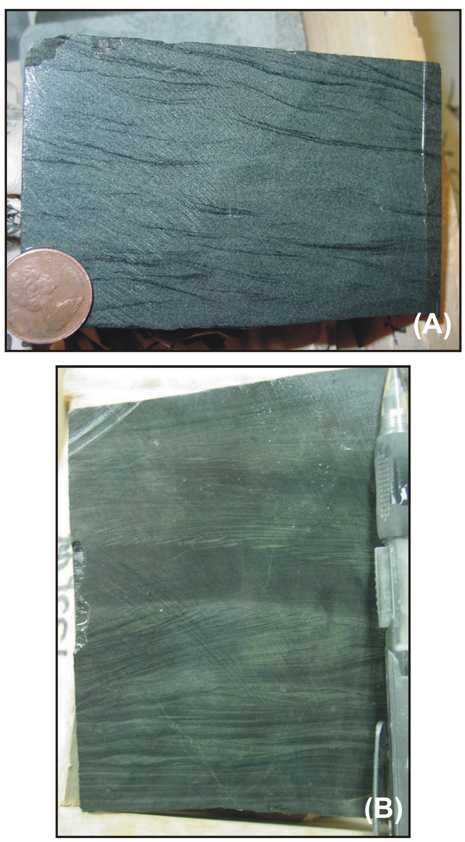


Plate B. (A) Mud drapes and ripple cross-laminations from the 959 m depth of the d-96-E well. These features suggest a tidal marine depositional environment. Similar cross-laminations are seen at the 595 m depth. (B) Ripple cross-laminations and fine mud laminations from the 1551 m depth of the d-96-E well, suggesting a marine depositional environment.

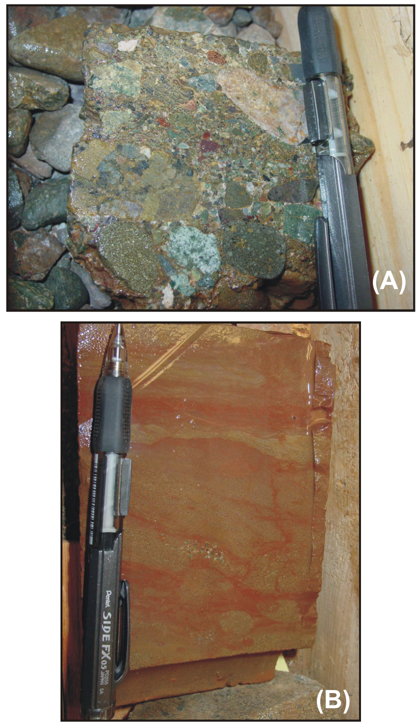


Plate C. Possible Tertiary-aged maroon conglomerate (A) and sandstone and siltstone (B) within the b-16-J well, from depths of approximately 1271 and 1273 m, respectively. Note the abundance of volcanic clasts in the conglomerate.

Canadian Hunter et al Redstone b-82-C

This well (Figure 17) intersected granite to granodiorite at a depth of 1625 m and was abandoned at 1670 m in these intrusive rocks. The upper 20 m of the igneous section has been interpreted to consist of reworked igneous material, suggesting an unconformity between Cretaceous sediments and the intrusive body (Cosgrove, 1981b). The absence of anomalous maturation values (T_{max} and R_o) that would be expected at an intrusive contact is consistent with the interpretation of this boundary as a nonconformity.

Up to a depth of approximately 1275 m, the lithologies comprise dark grey shale (some of which is bituminous and produced higher gas readings on the mud log; Cosgrove, 1981b) and interbedded ‘salt and pepper’ chert sandstones and conglomerate (Figure 17). The latter are generally much cleaner than overlying coarse clastics above 1275 m and indicate marine depositional environments (Plate D). The general character of these rocks is very similar to those of the Taylor Creek Group. This is supported by preliminary identification of palynomorphs indicating a middle Cretaceous age (A. Sweet, personal communication, 2006).

The section between 1275 and 220 m is a fairly monotonous section of poorly consolidated maroon to green or grey sandstone, polymict conglomerate, siltstone, and shale. Clearly an unconformity exists at the bottom of this section (1275 m). Conglomerate and sandstone are poorly sorted and contain abundant finer matrix material. Conglomerate is composed of sub-angular to well-rounded varicoloured volcanic, chert, and siltstone clasts. The basal part of this section contains a tuffaceous bed some 10 or 15 m thick (Cosgrove, 1981b) as well as organic-rich horizons (Figure 17). This sequence is very similar to the sedimentary section of the b-16-J well to the north, suggesting that it also is Tertiary in age. Furthermore, the well was drilled on the edge of the large gravity low (Figure 9) suggesting that this anomaly may be a reflection of a thick section of Tertiary sedimentary rocks. Palynology samples were taken within this sequence, but all were barren.

The top 220 m of the b-82-C well penetrated mafic flows and tuff, all of which fit general descriptions of the nearby outcropping Endako Group.

Hudson’s Bay Redstone c-75-A

This well was spudded just northwest of a small window of sedimentary rocks exposed at the Gap Narrows bridge across the Chilko River. The outcrops display varicoloured chert-pebble conglomerate, sandstone and minor siltstone with large cross-sets, suggesting a fluvial environment and possible correlation with the Silverquick formation.

The base of the section (Figure 18) is dominated by dark grey to grey shale, dark red siltstone, and lesser sandstone. Dark red siltstone resembles red to maroon siltstone seen in the d-96-E and a-4-L wells. These lithologies are punctuated by sections of chert sandstone similar to those seen higher in the well. These occur at

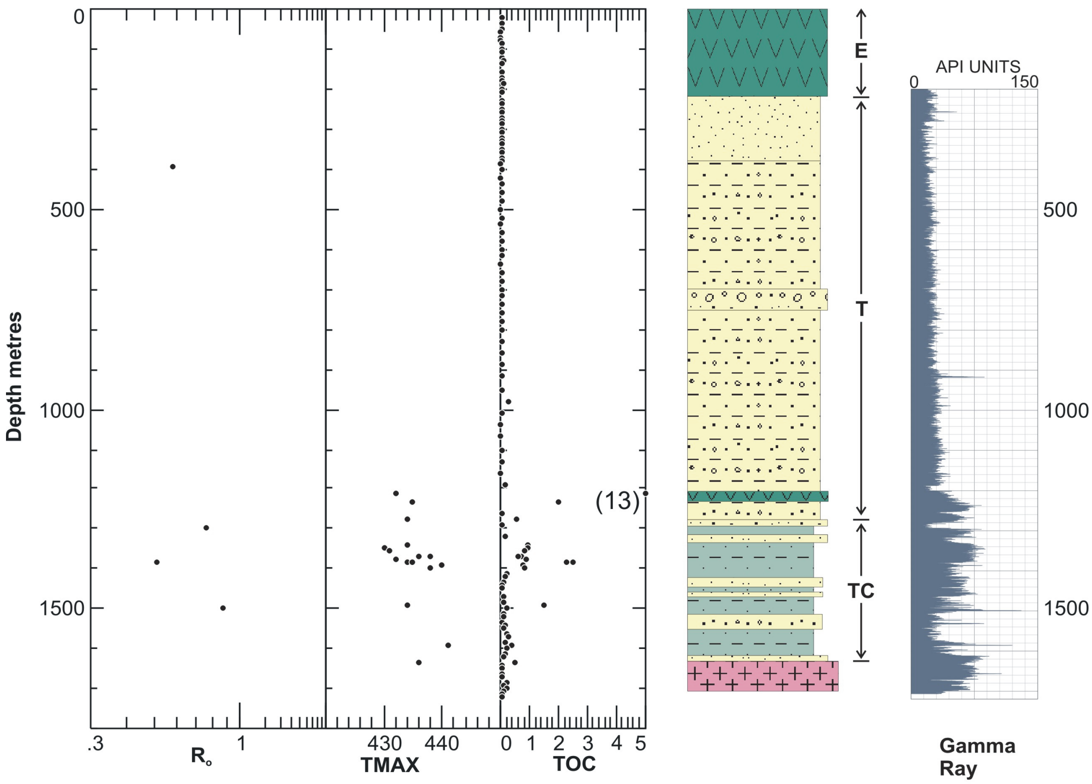


Figure 17. Simplified stratigraphic column of the Canadian Hunter et al. Redstone b-82-C well plotted with the natural gamma ray log, total organic carbon (TOC), T_{max}, and vitrinite reflectance values. Only T_{max} values where TOC > 0.3% were plotted. Stratigraphic column is a simplification of descriptions by Thorsteinsson (*in preparation*) and Cosgrove (1981b). Organic geochemistry is taken from Osadetz *et al.* (2003). TC: Taylor Creek Group; Ter: Tertiary; E: Endako Group.

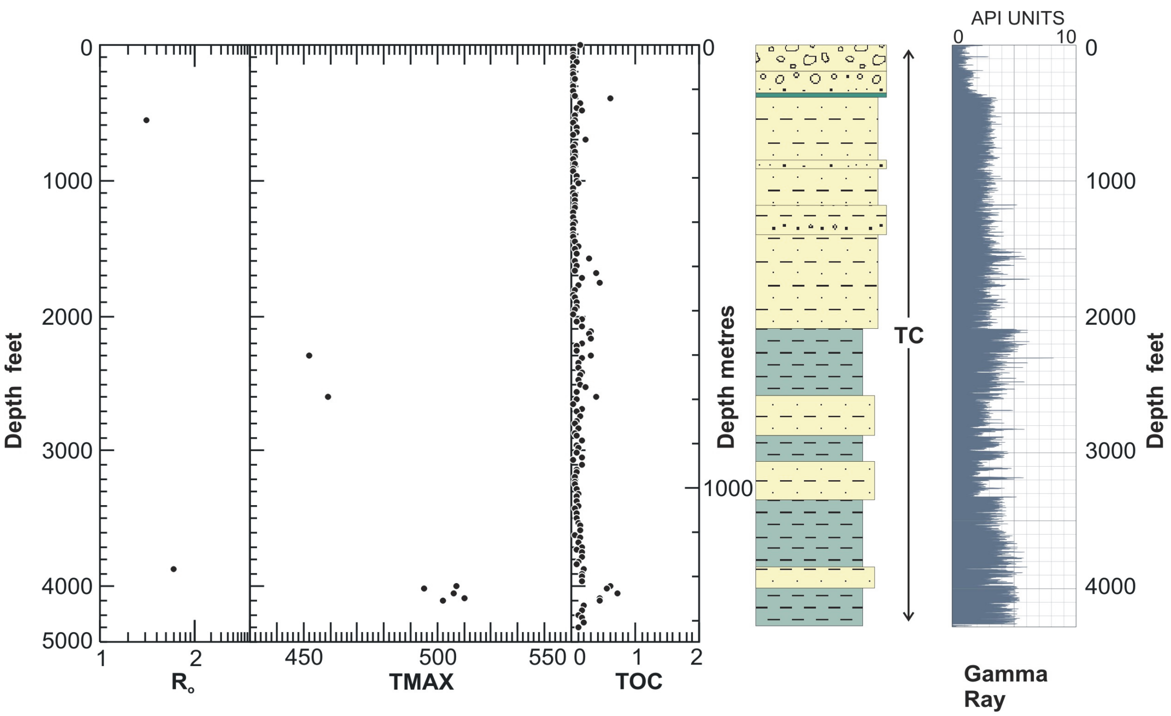


Figure 18. Simplified stratigraphic column of the Hudson's Bay Oil and Gas Company Redstone c-75-A well plotted with the natural gamma ray log, total organic carbon (TOC), T_{max}, and vitrinite reflectance values. Only T_{max} values where TOC > 0.3% were plotted. Stratigraphic column is a simplification of descriptions by Thorsteinsson (*in preparation*) and Well File 630. Organic geochemistry is taken from Osadetz *et al.* (2003). TC: Taylor Creek Group.

Plate D. Finely interbedded chert sandstone, dark grey shale, and siltstone from the 1295 m depth of the b-82-C well. Note the flaser bedding, flame structures, and associated dewatering features. Faint ripple cross-laminations are present locally. These features suggest marine depositional environments.

depths near the 4000 ft (1220 m) mark, from 3330 to 3050 ft (1015 to 930 m), and between 2880 and 2580 ft (880 and 785 m).

A tuffaceous section with interbedded chert (greenish to 'salt and pepper') sandstone and grey to dark shale comprises much of the section between 370 and 2070 ft (113 and 630 m); sandstone is feldspathic and grains are subrounded (Well Report 630). Several horizons of varicoloured chert pebble conglomerate occur in the section.

The lithologies in the top 300 ft (90 m) of the well resemble those in the surface exposures at Gap Narrows bridge. Although the surface exposures share some similarities with the Silverquick formation, the abundance of dark grey to grey shale, maroon siltstone, together with chert sandstones, suggest that they are part of the Taylor Creek Group. This is supported by preliminary palynology results from core indicating a middle Cretaceous or younger age (A. Sweet, personal communication, 2006); additional palynology collections will be taken from cuttings. If rocks in this well are part of the Taylor Creek Group, the higher thermal maturity values suggest either deeper burial or the effects of a nearby intrusion.

Canhunter et al Redstone d-94-G

This sequence (Figure 19) of thinly to thickly interbedded immature sandstone, shale, and siltstone is unique among all the sections drilled in the southern Nechako Basin. Cutting descriptions indicate a fairly homogenous interbedded succession with local dominance of sandstone, siltstone, or shale. Sandstone is grey to greenish and tends to be immature with abundant sub-angular feldspar, mafic volcanic, mafic mineral, mica, and varicoloured chert clasts (Cosgrove, 1986b). The intra-clast, authigenic clay and chlorite reflect the abundant volcanic detritus. Shale and siltstone are grey-green to dark grey and commonly silty. Carbonaceous horizons are present from 1050 to 950 m and 550 to 450 m, corresponding to increased TOC and gas levels in the mud log (Figure 19; Cosgrove, 1986b).

Volcanic rocks occur from 1976 m to the bottom at 2165 m. These are varicoloured feldspar and hornblende(?)-bearing and of an intermediate to felsic(?) nature (Cosgrove, 1986b). Of locally exposed volcanic successions, these rocks most closely resemble the early Albian to Santonian (late Early to Late Cretaceous) Spences Bridge Group.

This well was spudded in surface rocks tentatively assigned to the informally named Taseko River strata. Although the bulk of the well section is much finer-grained than its surface exposure, the immature, arkosic to lithic nature of the sandstone within the well bear some similarities to sandstone of the Taseko River strata. Sandstone that most likely correlates with surface exposures of the Taseko River strata dominate the upper 80 m of the hole. Thermal maturation levels for this well are the highest observed for any of the wells in the Nechako basin area (R_o from 0.9 to 1.5). Maturation data from nearby surface exposures of the Taseko River strata (R_o 1.2) fall within this range.

Preliminary age determinations based on palynolomorphs extracted from well cuttings suggest a middle Cretaceous or younger age, although rocks below 684 m may be older (A. Sweet, personal communication, 2006). Taseko River strata are thought to be Coniacian (Late Cretaceous) and younger.

Vieco Texacal Punchaw c-38-J

The most northerly well, the Punchaw c-38-J, was spudded in Quaternary gravels and penetrated a thin section of poorly consolidated Tertiary or Quaternary polymict (volcanic, limestone, and sedimentary) conglomerate and sandstone. At about 200 m the drill intersected sedimentary, volcanic, and igneous rocks of the Cache Creek Group (Ramsay, 1972).

SOURCE ROCK POTENTIAL AND THERMAL MATURATION

The presence of a viable source rock is the foundation of any petroleum system, and its recognition is one of the keystones in building a new petroleum province such as the Nechako Basin. To this end, the RDGB sampled and closely examined prospective strata for source rock potential. Further sampling is planned for the 2006 field season.

HYDROCARBON SEEPS AND OIL STAINING

Early in the exploration history of the Nechako Basin, indications of source rock potential were afforded by local reports of surface oil and gas seeps, many of which could not be substantiated (Hannigan *et al.*, 1994; Taylor, 1961; Perry and Bullock, 1960). Tar or asphalt was reported in the vicinity of Batnuni Lake by Tipper (1963). This locality occurs at the north end of the belt of Cretaceous strata penetrated by the d-96-E and a-4-L wells, some 70 km north-northwest of the well sites. Koch (1973) questioned the authenticity of these occurrences, citing subsequent investigations by petroleum geologists that suggest they represent recent organic material or iron-oxide deposits.

Live and dead oil staining and gas shows in drill stem tests (DSTs) were encountered over several intervals in the a-4-L and d-96-E wells (Cosgrove, 1981a). In addition, a DST in well b-82-C contained possible gas (Cosgrove, 1981b). Dead oil staining, bitumen, and bituminous shale are present in well d-94-G (Cosgrove, 1986b).

As part of a more comprehensive and robust determination of thermal maturation in the subsurface, numerous cutting and core samples were obtained for vitrinite reflectance determination (Table 4). During standard petrographic work on samples of core from well d-96-E, oil was noted as inclusions within calcite crystals and carbonaceous material and as intragranular stains (L. Stasiuk, personal communication 2006). These were seen at depths of 418, 590.5, 913, 920, 1554, 1727, 1884, and 1894 m within well d-96-E. Oil has been extracted from samples at these intervals and preliminary gas chromatograph data was obtained, although no interpretation was available when this report was published.

In addition, recent Rock-Eval analysis of cuttings from several of the wells has indicated high S_1 values from samples with high organic carbon contents (see Osadetz *et al.*, 2003). The S_1 peak is a reflection of free hydrocarbons within the sample, suggesting either the presence of unmigrated oil produced in situ by this shale (Lafargue *et al.*, 1998) or contamination from drilling fluids (*e.g.* diesel). T_{max} values from these samples were much lower than expected given the maturity levels determined by vitrinite reflectance and the higher T_{max} values in adjacent strata. This 'suppression' of T_{max} values may be a result of oil staining in the sample (L. Stasiuk, personal communication, 2006). Petrological studies are underway to determine the reasons for the high vitrinite reflectance and corresponding low T_{max} values. Any formation oil that is present will be extracted and analysed. Samples taken for further analysis are from wells (and subsurface depths) d-96-E (1740, 2710 and 2960 m); a-4-L (6980, 8700, 9930 ft); b-82-C (1208, 1380, 1383 m); and c-75-A (1690 m). Preliminary analysis of cuttings from the 27010 and 2960 m level of the d-96-E suggests that some of the material analyzed was organic material of recent origin (*i.e.* drilling additives). Further work is being performed to verify this. Oil inclusions were observed in samples from the 1740 m level of d-96-E, c-75-A and 1383 and 1380 m of b-82-C. An attempt will be made to extract these oils and characterize them.

SOURCE ROCK POTENTIAL

Julie Hunt performed Rock-Eval analysis of subsurface and surface samples from the southern Nechako Basin as part of her M.Sc. thesis at the University of British Columbia (Hunt, 1992; Hunt and Bustin, 1997). This preliminary work indicated that, in this region, subsurface samples produced T_{max} values bracketing the oil to upper gas windows. No thick, high quality source rock was recognized within the wells or at surface exposures. This work also indicated that the kerogen within the sedimentary sequences was dominantly of Type II to III affinities, suggesting that any potential hydrocarbon accumulations would be dominantly gas.

A more systematic Rock-Eval analysis of subsurface cuttings was undertaken by the Geological Survey of Canada as part of a cooperative program with the RDGB (Osadetz *et al.*, 2003). Some of these new data are shown in Figures 20 to 24. In general, the new data are very similar to those obtained by Hunt (1992); kerogen is of Type II to Type III. However there are indications of Type I to Type II material within several horizons of wells d-96-E, a-4-L, and b-82-C.

Another outcome of this recent Rock-Eval analysis was the recognition of several organic-rich horizons in the lower part of the d-96-E well, between 2700 and 3000 m, which were not sampled by Hunt (Figures 13 and 20). The original well-site geologist noted bituminous shales with source rock potential within this interval (Cosgrove, 1981a); in addition, the mud log showed increases in C1

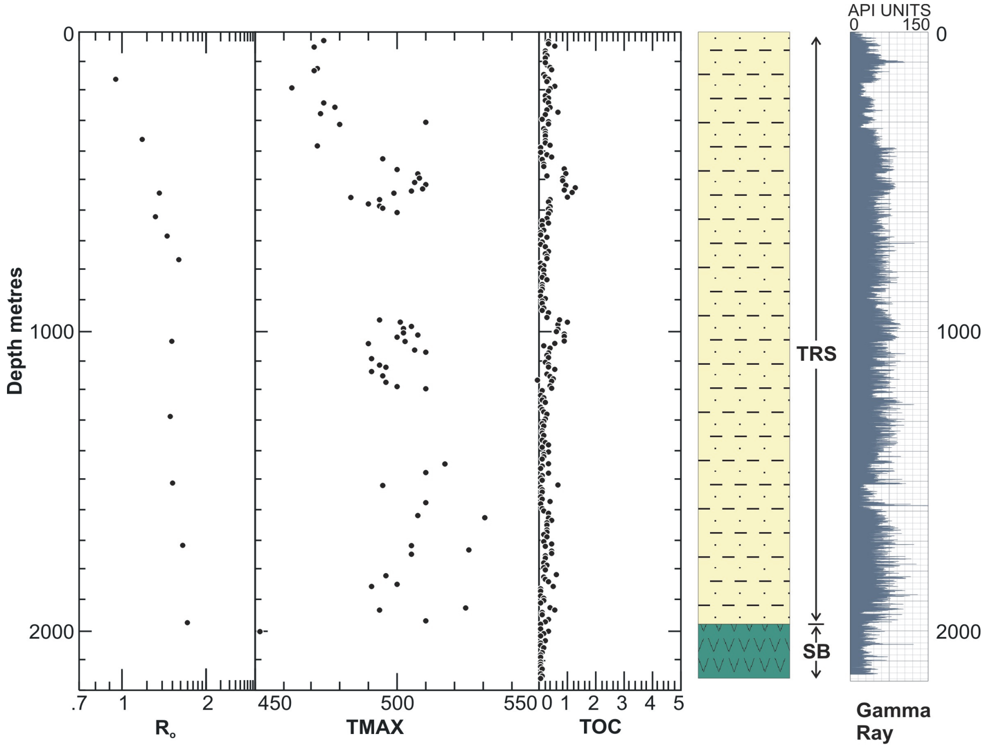


Figure 19. Simplified stratigraphic column of the Canadian Hunter et al Redstone d-94-G well plotted with the natural gamma ray log, total organic carbon (TOC), T_{max}, and vitrinite reflectance values. Only T_{max} values where TOC > 0.3% were plotted. Stratigraphic column is a simplification of descriptions by Thorsteinsson (*in preparation*) and Cosgrove (1986b). Organic geochemistry is taken from Osadetz *et al.* (2003). SB: Spences Bridge Group; TRS: Taseko River strata.

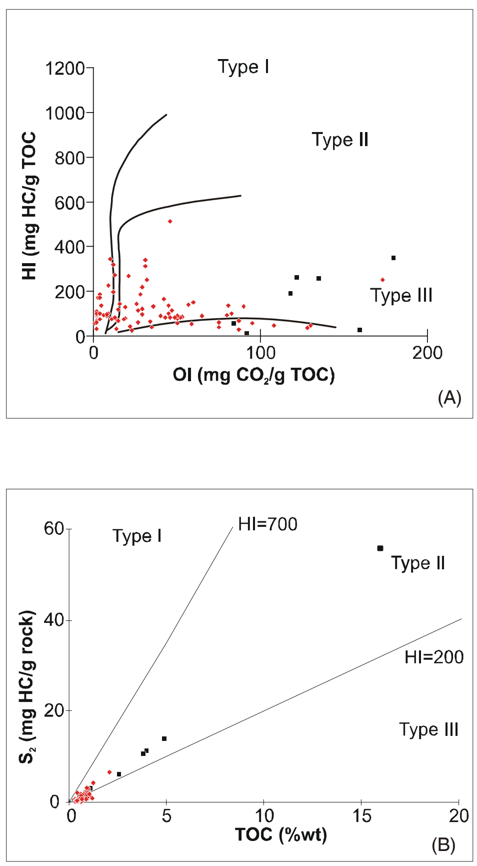
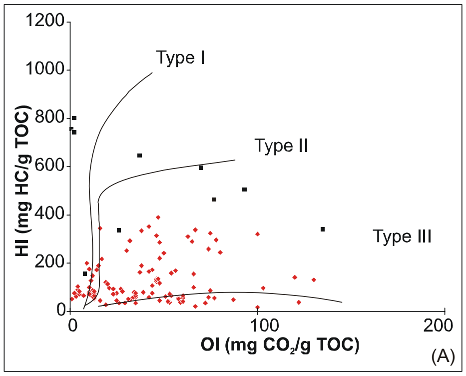


Figure 20. Graphs of Rock-Eval data of kerogen from the d-96-E well. (a) HI (hydrogen index) versus OI (oxygen index) diagram. (b) S_2 versus TOC (total organic carbon) diagram. Data points from Osadetz *et al.* (2003). Only data with TOC > 0.3% plotted. Black squares represent data from 2700 m to total depth.



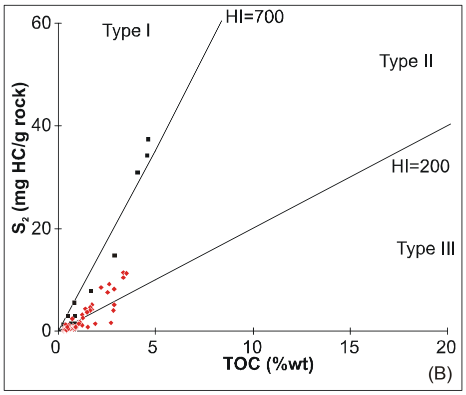
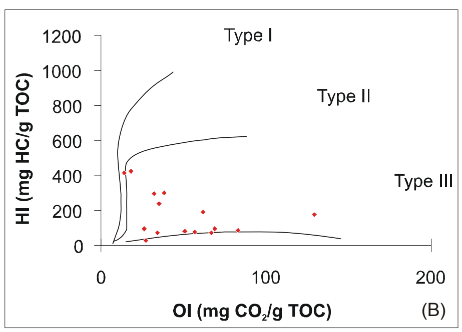


Figure 21. Graphs of Rock-Eval data of kerogen from the a-4-L well. (a) HI (hydrogen index) versus OI (oxygen index) diagram. (b) S_2 versus TOC (total organic carbon) diagram. Data points from Osadetz *et al.* (2003). Only data with TOC > 0.3% plotted. Black squares represent data from 8135 ft (2480 m) to total depth.



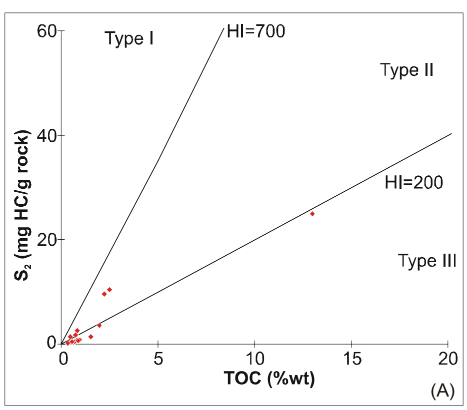


Figure 22. Graphs of Rock-Eval data of kerogen from the b-82-C well. (a) HI (hydrogen index) versus OI (oxygen index) diagram. (b) S_2 versus TOC (total organic carbon) diagram. Data points from Osadetz *et al.* (2003). Only data with TOC > 0.3% plotted.

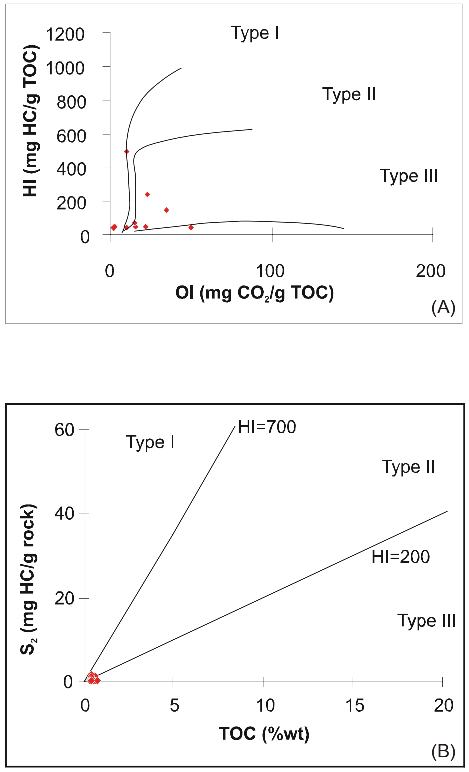


Figure 23. Graphs of Rock-Eval data of kerogen from the c-75-A well. (a) HI (hydrogen index) versus OI (oxygen index) diagram. (b) S_2 versus TOC (total organic carbon) diagram. Data points from Osadetz *et al.* (2003). Only data with TOC > 0.3% plotted.

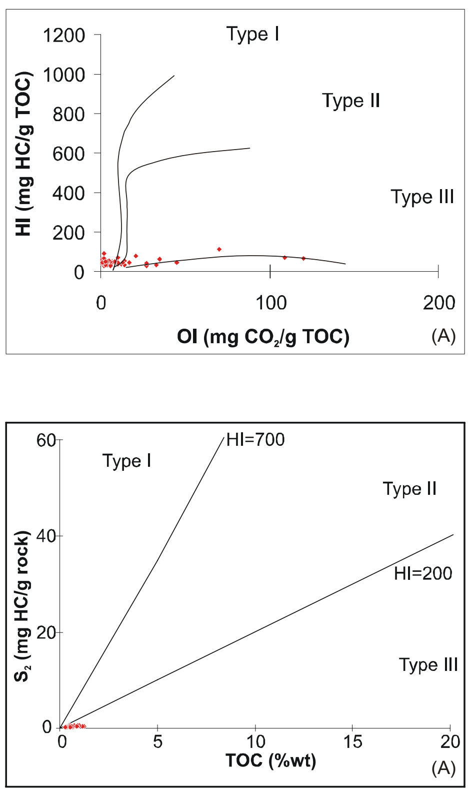


Figure 24. Graphs of Rock-Eval data of kerogen from the d-94-G well. (a) HI (hydrogen index) versus OI (oxygen index) diagram. (b) S_2 versus TOC (total organic carbon) diagram. Data points from Osadetz *et al.* (2003). Only data with TOC > 0.3% plotted.

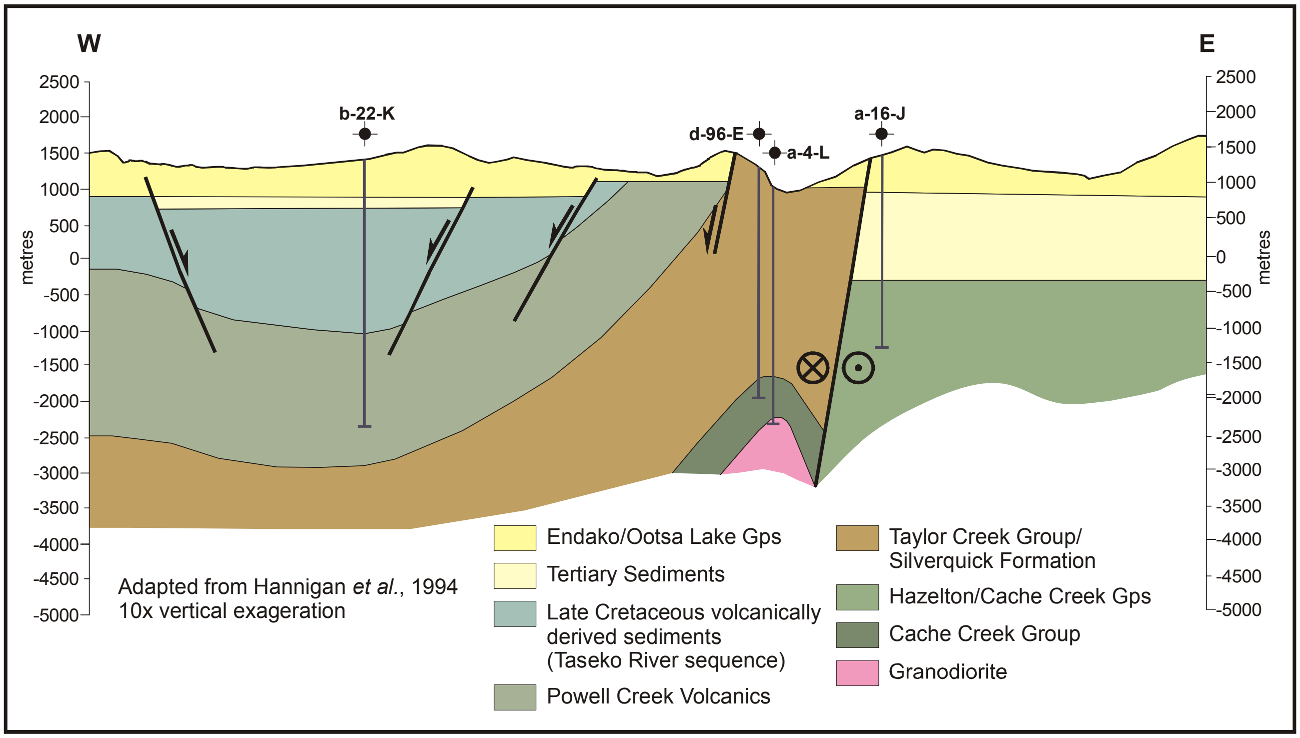


Figure 25. Simple cross-section across the southern Nechako area. Modification of a diagram by Hannigan *et al.* (1994) through the b-16-J, a-4-L, d-96-E, and b-22-K wells. In this interpretation, the general westward dip of Cretaceous strata projects under the volcanics penetrated by the b-22-K well satisfies both biostratigraphic control and gravity modeling.

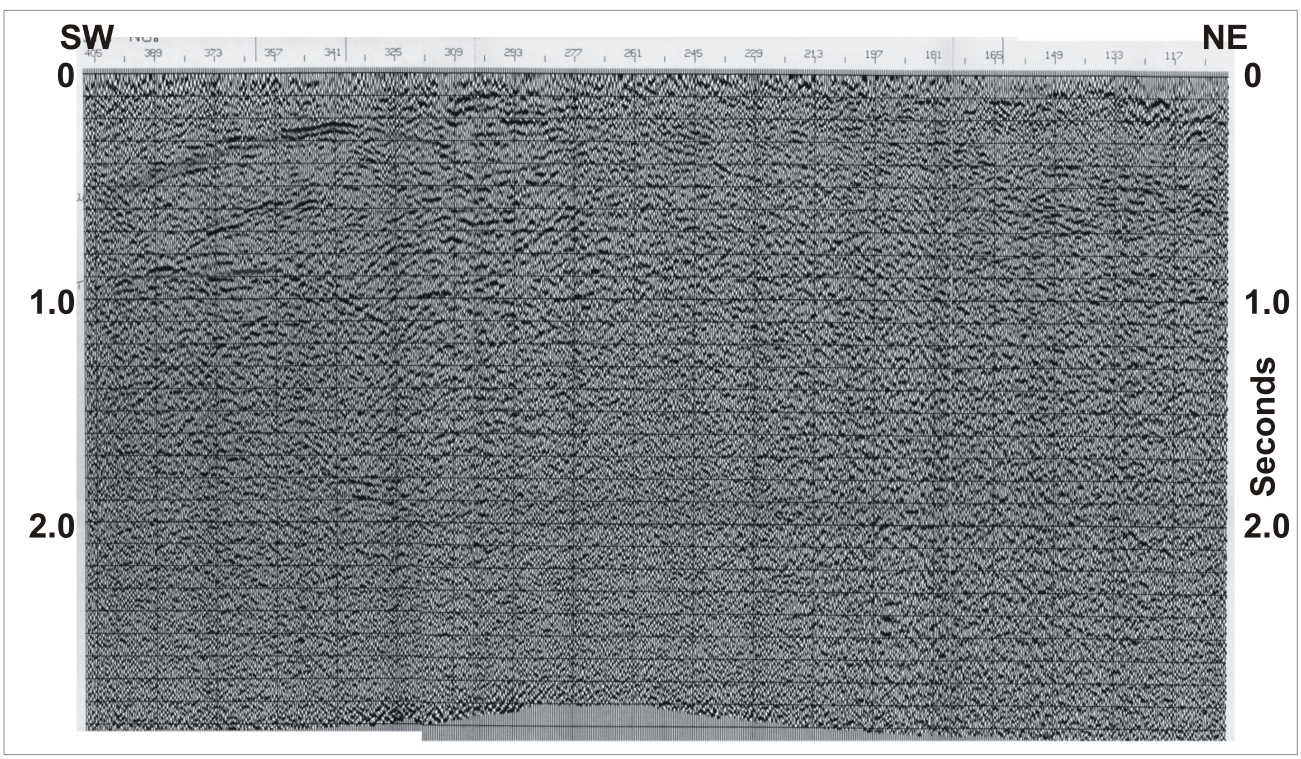


Figure 26. Seismic line across the western margin of the large negative anomaly in the southern part of the map area (Line 1, Figure 9). Seconds are two-way travel times. Line is from Focht (1982b).

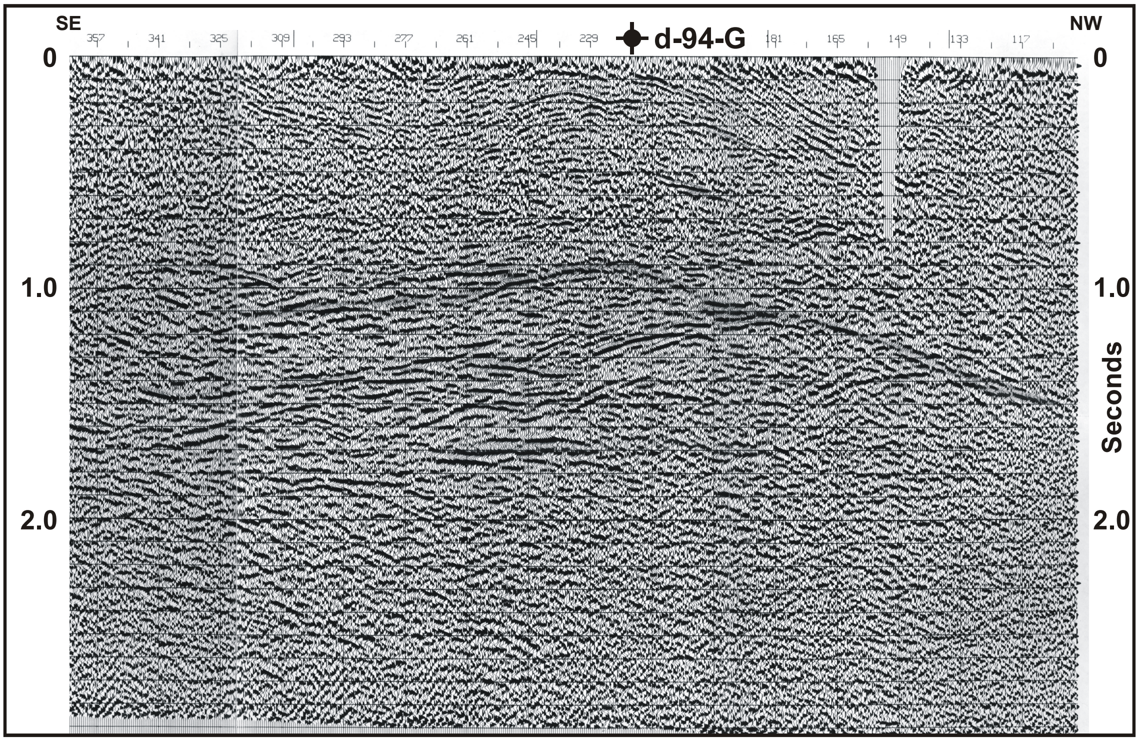


Figure 27. Northwest trending seismic line cutting through the d-94-G well. The d-94-G well is shown; the drillhole pierces a large closure in the section. Seconds are two-way travel time. Line is from Focht (1982a). See Figure 2 for location.

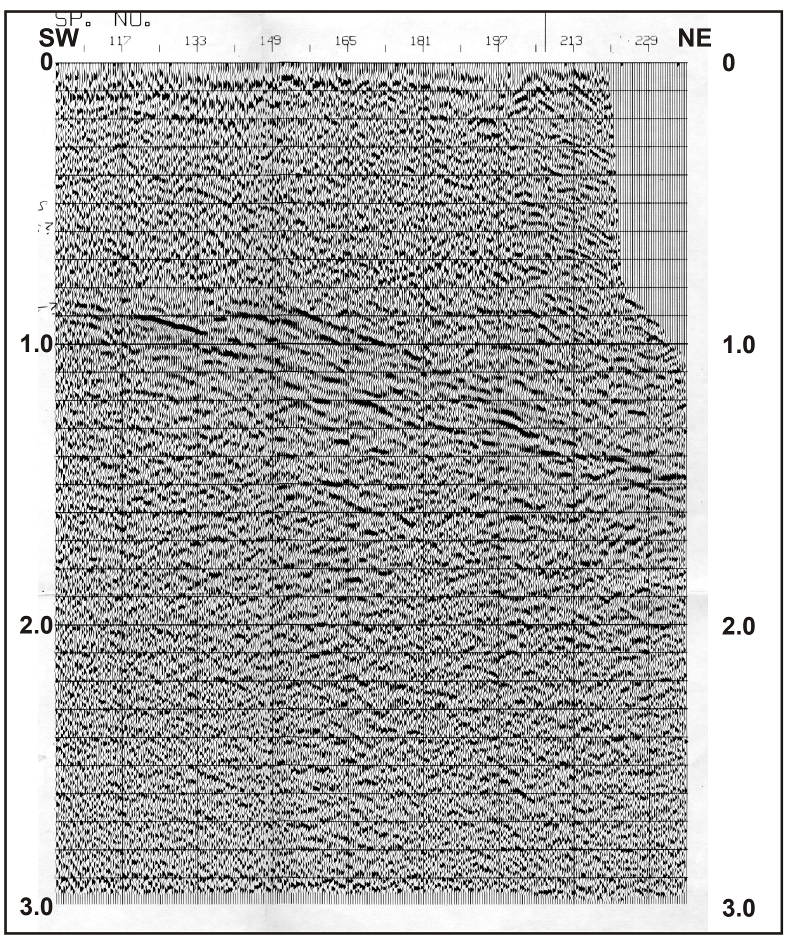


Figure 28. Northeast-trending seismic line in southern part of Nechako Basin, immediately north of the d-94-G well (see Figure 2 for location). Seconds are two way travel time. Line is from Focht (1982a). Length of section is approximately 14 km.

TABLE 2. ROCK-EVAL RESULTS FROM SURFACE SAMPLES FROM SHALY UNITS IN THE CHILCOTIN AND CAMELSFOOT RANGES

Station	Group/Formation	Rock type	Location	Easting	Northing	TOC %	T_{max} (degrees C)
				All stations UTM zone 10, NAD 83			
FF05-03	Relay Mt Gp-Teepee Mt Fm	siltstone	Relay Mt	503501	5666334	0.16	476
FF05-04	Relay Mt Gp-Potato Range Fm	siltstone	Relay Mt	502497	5665822	0.35	478
FF05-05	Relay Mt Gp-Potato Range Fm	siltstone	Relay Mt	502488	5665495	0.62	481
FF05-06	Relay Mt Gp-Unit 5 of Umhoefer et al	siltstone	Relay Mt	501698	5664338	0.82	490
FF05-07	Taylor Ck - Paradise	siltstone	Relay Mt	501689	5664115	0.31	504
FF05-08	Taylor Ck - Paradise	siltstone	Relay Mt	501655	5664066	0.40	499
FF05-09	Taylor Ck - Paradise	siltstone	Relay Mt	501309	5663026	0.42	506
FF05-11	Taylor Ck - Paradise	siltstone	Relay Mt	500966	5662427	0.47	516
FF05-12	Relay Mt Gp-Tyoax Pass Fm	siltstone	Relay Mt	499859	5662331	0.56	521
FF05-13	Relay Mt Gp-Teepee Mt Fm	wacke-siltstone	Relay Mt	499643	5662637	0.16	508
FF05-14	Relay Mt Gp-Tyoax Pass Fm	siltstone	Relay Mt	499493	5662675	0.76	511
FF05-15	Relay Mt Gp-Tyoax Pass Fm	siltstone	Relay Mt	499429	5662596	0.31	510
FF05-16	Relay Mt Gp-Tyoax Pass Fm	siltstone	Relay Mt	499321	5662403	0.43	514
FF05-18a	Last Creek Fm	siltstone	Relay Mt	498924	5662127	0.56	515
FF05-18b	Last Creek Fm	sandstone	Relay Mt	498924	5662127	0.60	517
FF05-19	Last Creek Fm	siltstone	Relay Mt	498842	5662086	0.72	513
FF05-20	Last Creek Fm	limestone	Relay Mt	499092	5661912	0.98	507
FF05-21	Last Creek Fm	siltstone	Relay Mt	499440	5661756	1.72	564
FF05-27	Taylor Ck-Lizard fm	siltstone	Taylor Basin	513203	5647338	0.33	338
FF05-64	Hazelton	siltstone	Baezaeko River	434844	5870204	0.39	336
FF05-86	Jackass Mountain	siltstone	Highway 99-Fountain	578068	5622707	0.26	608
FF05-87	Lillooet Group	siltstone	Highway 99-Lillooet	575706	5631828	1.00	310
FF05-88	Lillooet Group	siltstone	Highway 12	584825	5601877	0.36	363

TABLE 3. VITRINITE REFLECTANCE VALUES FROM SURFACE SAMPLES COLLECTED IN 2005

Station	Group/Formation	Rock type	Location	Easting	Northing	RoR %
				All stations UTM zone 10, NAD 83		
FF05-02	Relay Mt Gp-Teepee Mt Fm	siltstone	Relay Mt	503603	5666419	1.20
FF05-15	Relay Mt Gp. -Tyoax Pass Fm	siltstone	Relay Mt	499429	5662596	n/a
FF05-26	Taylor Ck.Gp – Dash fm	conglomerate	Taylor Basin	512762	5647072	1.34
FF05-31	Taseko River strata	sandstone	Taseko River	451622	5716506	1.22
FF05-64	Hazelton Gp	siltstone	Baezaeko R	434844	5870204	n/a
FF05-68	Taylor Cr- Dash?SQ	sandstone	Nazko River	471631	5836686	0.60
FF05-73	Taylor Ck Gp	sandstone	Nazko River	471588	5834194	1.00

TABLE 4. VITRINITE REFLECTANCE VALUES FROM SUBSURFACE SAMPLES COLLECTED IN 2005 FROM DRILLHOLE CUTTINGS AND CORE

Well #	Depth (m)	Sample type	%RoR
a-4-L	1356	core	0.68
b-16-J	310	drill cuttings	4.98
b-22-K	47.5	drill cuttings	n/a
b-22-K	72.5	drill cuttings	n/a
b-22-K	132	drill cuttings	0.34
b-22-K	145	drill cuttings	0.47
b-22-K	170	drill cuttings	n/a
b-22-K	205	drill cuttings	0.45
b-22-K	325	drill cuttings	0.48
b-22-K	637.5	drill cuttings	n/a
b-22-K	2500	drill cuttings	n/a
b-22-K	3696-3702.5	drill cuttings	1.76
b-82-C	830-840	drill cuttings	n/a
b-82-C	1295.1	core	0.58
b-82-C	1300	drill cuttings	0.76
b-82-C	1380-1385	drill cuttings	0.51
b-82-C	1450-1500	drill cuttings	0.87
c-75-A	172	core	1.40
c-75-A	1174	core	no data
c-75-A	1178	core	1.71
d-94-G	150-170	drill cuttings	0.95
d-94-G	355-370	drill cuttings	1.18
d-94-G	530-550	drill cuttings	1.36
d-94-G	615-625	drill cuttings	1.32
d-94-G	684	drill cuttings	1.45
d-94-G	760-765	drill cuttings	1.60
d-94-G	1030-1040	drill cuttings	1.51
d-94-G	1275-1285	drill cuttings	1.49
d-94-G	1500-1515	drill cuttings	1.52
d-94-G	1710-1715	drill cuttings	1.65
d-94-G	1970-1975	drill cuttings	1.71
d-96-E	913	core	0.78
d-96-E	920	core	0.97
d-96-E	963.5	core	0.93
d-96-E	1399	core	n/a
d-96-E	1554	core	0.88
d-96-E	1727	core	0.91
d-96-E	1884	core	0.73
d-96-E	1894	core	1.11
d-96-E	2115-2180	drill cuttings	0.82
d-96-E	2175-2180	drill cuttings	0.70
d-96-E	2342.5-2350	drill cuttings	0.73
d-96-E	2575-2580	drill cuttings	0.82
d-96-E	2780-2785	drill cuttings	0.93
d-96-E	2855-2860	drill cuttings	1.00
d-96-E	2980-2990	drill cuttings	0.94
d-96-E	3045	drill cuttings	0.93

and C2 hydrocarbons over this zone. Data points from these horizons are shown as black squares on Figure 20. Organic-rich shales within similar horizons from the nearby a-4-L well are also shown as black squares on Figure 21. Plots of TOC versus S_2 (Figures 20b and 21b) indicate HI (hydrogen index) values of approximately 350 and 700 mg HC/g TOC for samples from these horizons. Although this is encouraging, analysis of cuttings from some of these horizons (see above) suggests that the high TOC values may reflect analysis of recent organic material which may have been added to the well to facilitate drilling. Further work will be performed to correctly characterize these bituminous shales.

Palynology work by Hunt (1992) suggests an Aptian age and a terrestrial environment for well d-96-E rocks. We question the suggested non-marine environment for these fine clastic rocks because the type of kerogen present (Type II) is typical of a marine origin. The age of these rocks overlaps that of Jackass Mountain Group and possibly the lower parts of the Paradise Formation, both of which have thick sections of dark grey marine shale and siltstone in the lower parts. Resampling of these horizons is planned, together with examination of well logs, to further characterize these zones.

During the 2005 field season, surface samples for Rock-Eval analysis were obtained from shaly parts of the Last Creek Formation and Relay Mountain, Taylor Creek, and Jackass Mountain Groups for determination of source

TABLE 5. MAGNETIC SUSCEPTIBILITY READINGS FROM 2005 FIELD STATIONS

Station	UTM east	UTM north	Location name	Formation or Group	Rock type	MS reading (X 10^{-3} SI)
	All stations UTM Zone 10					
FF05-30	451542	5713086	Taseko River	Jackass Mountain Group	conglomerate	14.50
FF05-34a	455527	5714305	Taseko River	Chilcotin Group	basalt	2.50
FF05-35	459682	5722908	Taseko River	Chilcotin Group	basalt	11.10
FF05-36	476234	5744941	Taseko River	Eocene sedimentary	sandstone	0.75
FF05-37	475007	5745605	Taseko River	Cretaceous or Tertiary pluton	granodiorite	9.74
FF05-38	475060	5745563	Taseko River	Eocene sedimentary	granule conglomerate	9.47
FF05-39	491015	5710508	Big Ck.	Eocene volcanic	dacite	12.40
FF05-40	481831	5701760	Big Ck.	Spences Bridge?	volcanic breccia	0.42
FF05-41	481520	5702027	Big Ck.	Spences Bridge?	volcanic breccia	14.90
FF05-41	481520	5702027	Big Ck.	Spences Bridge?	tuff	30.50
FF05-42	481482	5702563	Big Ck.	Spences Bridge?	volcanic breccia	0.35
FF05-43	482468	5702776	Big Ck.	Spences Bridge?	volcanic breccia	0.73
FF05-44	473928	5714838	Big Ck.	Cretaceous pluton	granite	5.68
FF05-45	470911	5719402	Big Ck.	Spences Bridge?	andesite	15.60
FF05-46	470143	5723642	Big Ck.	Spences Bridge?	andesite	23.80
FF05-47	473983	5719816	Big Ck.	Spences Bridge?	andesite	14.50
FF05-48	486174	5724102	Big Ck.	Eocene volcanic	dacite	25.10
FF05-49	479689	5719593	Big Ck.	Cretaceous or Tertiary pluton	granite	11.00
FF05-50	487778	5724316	Big Ck.	Chilcotin Group	basalt	4.33
FF05-51	492762	5722331	Big Ck.	Eocene volcanic	rhyolite	1.08
FF05-52	506063	5723902	Big Ck.	Cretaceous pluton	granite	0.31
FF05-53	504383	5722776	Big Ck.	Spences Bridge?	amphibolite	56.10
FF05-54	510496	5715757	Big Ck.	Cretaceous pluton	quartz diorite	1.24
FF05-55	501888	5704608	Big Ck.	Piltz Peak plutonic complex	diorite	0.34
FF05-56	501319	5704419	Big Ck.	Piltz Peak plutonic complex	gneiss	0.14
FF05-57	493405	5746187	Big Ck.	Eocene volcanic	volcanic breccia	9.27
FF05-58	496349	5742551	Big Ck.	Eocene volcanic	volcanic breccia	16.40
FF05-60	437930	5869933	Baezaeko River	Hazelton	conglomerate	0.32
FF05-61	437572	5870194	Baezaeko River	Hazelton	gabbro	8.15
FF05-62	438840	5871012	Baezaeko River	Hazelton Group	basalt	2.34
FF05-63	442117	5865727	Baezaeko River	Eocene volcanic	basalt	7.64
FF05-64	434844	5870204	Baezaeko River	Hazelton	siltstone	0.36
FF05-65	435193	5870555	Baezaeko River	Pluton, unknown age	diorite	0.42
FF05-66	441154	5864344	Baezaeko River	Eocene volcanic	andesite	4.80
FF05-67	443575	5867884	Baezaeko River	Eocene volcanic	basalt	2.87
FF05-68	471631	5836686	Nazko River	Taylor Ck-Dash?SQ?	sandstone	0.05
FF05-69	471496	5836820	Nazko River	Taylor Ck-Dash?SQ?	siltstone	0.15
FF05-69	471496	5836820	Nazko River	Taylor Ck-Dash?SQ?	conglomerate	0.02
FF05-71	470252	5835011	Nazko River	Taylor Creek-Lizard?	sandstone	0.04
FF05-72	471246	5832206	Nazko River	Taylor Creek.	sandstone	0.06
FF05-73	471588	5834194	Nazko River	Taylor Creek	conglomerate	0.02
FF05-73	471588	5834194	Nazko River	Taylor Creek	sandstone	0.03
FF05-74	469584	5842179	Nazko River	Taylor Creek	conglomerate	0.22
FF05-74	469584	5842179	Nazko River	Taylor Creek	sandstone	0.32
FF05-76	469775	5846631	Nazko River	Taylor Creek	conglomerate	0.05
FF05-77	455689	5866203	Baezaeko River	Taylor Creek	conglomerate	0.02
FF05-78	455908	5866539	Baezaeko River	Taylor Creek	sandstone	0.07
FF05-79	456567	5870427	Baezaeko River	Taylor Creek	conglomerate	0.03
FF05-81	451001	5783484	Redstone	Taylor Creek	sandstone	0.15
FF05-82	462976	5768349	Redstone	Taylor Ck - Silverquick?	sandstone	0.23
FF05-83	430949	5785280	Puntzi Lake	Hazelton Group	tuff	0.12
FF05-84	431276	5785280	Puntzi Lake	Powell Creek?	volcanic bx	28.30
FF05-85	434471	5785920	Puntzi Lake	Powell Creek?	volcanic bx	28.30

rock potential (Table 2). Black shales and siltstones of the Last Creek Formation are part of a regional blanket of dark fine clastics deposited during a major Early to Middle Jurassic anoxic event (Ferri and Boddy, 2005). In the Bowser Basin and Ashcroft areas, time-equivalent strata (Spatsizi and Ashcroft formations, respectively) have high TOC contents and, although over-mature, may originally have been high-quality source rocks (Ferri and Boddy, 2005). Only 4 samples from the Last Creek Formation were obtained, and these had TOC values up to 1.72% and low HI values (<50 mg HC/g TOC).

Samples from the Relay Mountain Group returned low TOC values; the single sample of the Jackass Mountain Group and all of the time-equivalent Paradise Formation (of the Taylor Creek Group) samples produced TOC and HI values that are not promising for source bed potential. The dark grey to black shale and siltstone of the Paradise Formation and the base of the Jackass Mountain Group are regional in extent, however, so further sampling is required to adequately characterize them. The presence of bituminous shale in time-equivalent strata of wells d-96-E and a-4-L indicates that these horizons warrant further investigation, and they will be targeted for sampling during the 2006 field season.

THERMAL MATURATION

Vitrinite reflectance data for surface and subsurface sections are shown in Tables 3 and 4 and Figures 13, 15, 17,18, 19. In the subsurface, maturation levels from vitrinite reflectance are similar to those indicated by T_{max} values from Rock-Eval analysis of cuttings. Maturation levels could not be determined within the bulk of wells b-22-K and b-16-J due to low organic contents. Vitrinite reflectance data were obtained from only the upper part of the Tertiary strata of well b-22-K and indicate that the sediments are undermature. One sample from near the bottom of the well is in the dry gas zone. No samples could be obtained from the b-16-J well for reflectance determination. Furthermore, the low organic contents for this and the b-22-K well rendered the bulk of the T_{max} data as unreliable for thermal maturation determination. Apatite fission track analysis of samples of cuttings from these holes may provide better information on the thermal maturation history of these rocks.

Taylor Creek Group and Silverquick formation(?) rocks from wells a-4-L, d-96-E, and b-82-C returned vitrinite reflectance and T_{max} values bracketing the oil window (Table 4; Figures 13, 14, and 17). The only suitable sample from the upper Tertiary(?) part of well b-82-C yielded results within the top of the oil window. The section below this, starting at approximately 1200 m, contains material suggesting oil window conditions. Again, we anticipate that apatite fission track samples within the upper 1200 m of this well will provide more precise constraints on the thermal maturation of these rocks.

Much higher thermal maturation values have been obtained from wells c-75-A and d-94-G (Table 4, Figures 18 and 19). Reliable data from well c-75-A is lacking due to low TOC, but the available vitrinite reflectance data suggest dry gas conditions. Although the d-94-G well contains lithologies of low organic content, they are distributed evenly throughout the section and of sufficient organic content to allow thermal maturation determination. Thermal maturation data suggest conditions within the well straddled the oil and gas windows. Furthermore, both T_{max} and vitrinite reflectance data show a decrease below the 900 m and a change in thermal maturation gradient; the decrease in thermal maturation values below 900 m could be the result of a thrust repetition.

CONCLUSIONS

- Gravity and surface geological data suggest that the southern Nechako Basin is composed of several smaller sub-basins.
- Biostratigraphy and interpretation of subsurface sections suggest most wells in the southern Nechako area penetrated Cretaceous sections correlative with the Taylor Creek and Jackass Mountain groups, Silverquick conglomerate and Powell Creek volcanics. In addition, several wells penetrated thick sections of Tertiary clastics and volcanics. No rocks of the Relay Mountain Group have been recognized in the subsurface.
- Rock-Eval data indicate the potential for source bed horizons at several intervals, although further work is needed to properly characterize these horizons. No regionally persistent rich source bed horizon has yet been recognized.
- Oil inclusions occur at several horizons in the d-96-E well. These have been extracted for analysis.
- The following studies are underway: apatite fission track thermochronology, subsurface pollen biostratigraphy, reservoir porosity, surface and subsurface radiometric dating. Results will be published as they become available.

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REFERENCES

A report on Hudson's Bay Redstone c-75-A well in c-75-A/93-B-4; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Well File 630.

A report on the Texalta Punchaw c-38-J/93-G-06 well; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Well File 3149.

Archibald, D.A., Glover, J.K. and Schiarizza, P. (1989): Preliminary report on 40Ar/39Ar geochronology of the Warner Pass, Noaxe Creek and Bridge River map areas (92O/3, 2; 92J/16); *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Fieldwork 1988, Paper 1989-1, pages 145-151.

Best, M. (2004a): Gravity and Magnetic Survey, Nechako Basin Study, acquisition and processing phase; *B.C. Ministry of Energy and Mines;* Petroleum Geology Open File 2004-1.

Best, M. (2004b): Qualitative Interpretation of Potential Field Profiles: Southern Nechako Basin; *in* Summary of Activities 2004, Resource Development and Geoscience Branch, *B.C. Ministry of Energy and Mines,* pages 73-78.

Cosgrove, D.T. (1981a): Well history report on Canadian Hunter *et al.* Nazko d-96-E/93-B-11; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Well File 5439.

Cosgrove, D.T. (1981b): Well history report on Canadian Hunter *et al.* Redstone b-82-C/92-O-14; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Well File 5680.

Cosgrove, D.T. (1982): Well history report on Canadian Hunter *et al.* Chilcotin b-22-K/93-C-9; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Well File 5702.

Cosgrove, D.T. (1986a): Well history report on Canadian Hunter Esso Nazko b-16-J/93-B-11; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Well File 5544.

Cosgrove, D.T. (1986b): Well history report on Canadian Hunter Redstone d-94-G/92-O-12; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Well File 6438.

Engebretson, D.C., Cox, A., and Gordon, R.G. (1985): Relative motions between oceanic and continental plates in the Pacific basin*; Geological Society of America,* Special Paper 206, 59 pages.

Enkin, R. J., Mahoney, J. B. and Baker, J. (*in preparation*): Paleomagnetic signature of the Silverquick/Powell Creek succession, south-central British Columbia: Reaffirmation of Late Cretaceous large-scale terrane translation; *in Geological Association of Canada*, Special Volume on Major Displacements in the Cordillera.

Ferri, F. and Boddy, M. (2005): Geochemistry of Early to Middle Jurassic Organic-Rich Shales, Intermontane Basins, British Columbia; *in* Summary of Activities 2004, *B.C. Ministry of Energy and Mines, Resource Development and Geoscience Branch,* pages 132-151.

Ferri, F., Lowe, L. and Best, M. (2004): Possible Late Cretaceous to Tertiary Structural Control on Basin Configuration, southern Nechako area; *Canadian Society of Petroleum Geologists* Annual Convention, Calgary, AB, Program with Abstracts, Conference Abstract Archive CD.

Focht, G. (1982a): Nechako Basin, B.C. Project #81-152, Final Operations Report; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2378.

Focht, G. (1982b): Nechako Basin, B.C. Project #81-147, Final Operations Report; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2379.

Focht, G. (1982c): Nechako Basin, B.C. Project #81-111, Final Operations Report; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2380.

Focht, G. (1982d): Nechako Basin, B.C. Project #81-162, Final Operations Report; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2381.

Focht, G. (1982e): Nechako Basin, B.C. Project #81-235, Final Operations Report; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2382.

Focht, G. (1982f): Nechako Basin, B.C. Project #80-223, Final Operations Report; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2383.

Focht, G. (1982g): Nechako Basin, B.C. Project #80-155, Final Operations Report; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2384.

Focht, G. (1982h): Nechako Basin, B.C. Project #81-46, Final Operations Report; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2386.

Focht, G. (1982i): Nechako Basin, B.C. Project #80-254, Final Operations Report; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2387.

Friedman, R.M. and Armstrong, R.L. (1988): Tatla Lake Metamorphic complex: an Eocene metamorphic core complex on the southwestern edge of the Intermontane Belt of British Columbia; *Tectonics*, Vol. 7, No. 6, pages 1141-1166.

Friedman, R.M., Mahoney, J.B. and Cui, Y. (1995): Magmatic evolution of the southern Coast Belt: constraints from Nd-Sr isotopic systematics and geochronology of the southern Coast Plutonic Complex; *Canadian Journal of Earth Sciences,* Vol. 32, pages 1681-1698.

Garver, J.I. (1989): Basin evolution and source terranes of Albian-Cenomanian rocks in the Tyaughton basin, southern British Columbia; implications for mid-Cretaceous tectonics in the Canadian Cordillera; unpublished PhD thesis, *University of Washington*, Seattle, 228 pages.

Garver, J.I. (1992): Provenance of Albian – Cenomanian rocks of the Methow and Tyaughton basins, southern British Columbia: a mid-Cretaceous link between North America and the Insular terrane; *Canadian Journal of Earth Sciences,* Vol. 29, No. 6, pages 1274-1295.

Gradstein, F.M. and Ogg, J.G. and Smith, A.G. (2005): Geologic Time Scale 2004, *Cambridge University Press,* New York.

Halliday, I.R. (1969): Structure and stratigraphy of the Quesnel Basin, B.C.; Amoco Canada Report, *B.C. Petroleum Resources Branch* Assessment Report 1465, 9 pages.

Hannigan, P., Lee, P.J., Osadetz, K.G., Dietrich, J.R. and Olsen-Heise, K. (1994): Oil and Gas Resource Potential of the Nechako-Chilcotin Area of British Columbia; *B.C. Ministry of Energy and Mines*, Geofile 2001-6.

Hayes, B. (2002): Petroleum Exploration Potential of the Nechako Basin, British Columbia; *B.C. Ministry of Energy and Mines*, Petroleum Geology Special Paper 2002-3.

Hayes, Mark, Ferri, Filippo and Morii, Sachie (2004): Interior Basins strategy; *in* Summary of Activities 2004, *B.C. Ministry of Energy and Mines*, Resource Development and Geoscience Branch, pp. 69-71.

Hickson, C.J. (1992): An update on the Chilcotin-Nechako project and mapping in the Taseko Lakes area, west-central British Columbia; in Current Research, Part A; *Geological Survey of Canada,* Paper 92-1A, pages 129-135.

Hickson, C.J. (1993): Geology of the northwest quadrant, Taseko Lakes map area (92O), west-central British Columbia; 1:50,000 maps, *Geological Survey of Canada,* Open File 2695.

Holland, S.S. (1964): Landforms of British Columbia: a physiographic outline; *British Columbia Department of Mines Petroleum Resources,* Bulletin No. 48, 138 pages.

Hunt, J.A. (1992): Stratigraphy, Maturation and Source Rock Potential of Cretaceous Strata in the Chilcotin-Nechako Region of British Columbia, unpublished M.Sc. thesis, *University of British Columbia,* Vancouver, British Columbia, 448 pages.

Hunt, J.A. and Bustin, R.M. (1997): Thermal maturation and source rock potential of Cretaceous strata in the Chilcotin-Nechako region, south-central British Columbia, Geological Note *in Bulletin of Canadian Petroleum Geology*, Volume 45, Number 2, p. 239-248.

Kleinspehn, Karen L. (1985): Cretaceous sedimentation and tectonics, Tyaughton-Methow Basin, southwestern British

Columbia, *Canadian Journal of Earth Sciences*, Vol. 22, pages 154-174.

Koch, N. G. (1970): The Central Cordilleran Region; *in* the Future Petroleum Provinces of Canada, R.G. McCrossan (ed.); *Canadian Society of Petroleum Geologists*, Memoir 1, p. 37-71.

Lafargue, E., Marquis, F. and Pillot, D. (1998): Rock-Eval 6 applications in hydrocarbon exploration, production, and soil contamination studies; *Revue de l'Institut Français Du Petrole,* Volume 53, No. 4, pages 421-437.

Landreth, T.C. (1961): Well history report on Honolulu Nazko a-4-L/93-B-11; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Well File 634.

Lowe, C., Enkin, R.J. and Struik, L.C. (2001): Tertiary extension in the central British Columbia Intermontane Belt: magnetic and paleomagnetic evidence from the Endako region; *Canadian Journal of Earth Sciences,* Vol. 38, pages 657-678.

Mahoney, J.B., Hickson, C.J., van der Heyden, P. and Hunt, J.A. (1992): The Late Albian-Early Cenomanian Silverquick conglomerate, Gang Ranch area: evidence for active basin tectonism, *in* Current Research, Part A; *Geological Survey of Canada*, Paper 92-1A, p. 249-260.

Mahoney, J. B. (1993): Facies reconstructions in the Lower to Middle Jurassic Ladner Group, southern British Columbia, *in* Current Research, Part A; *Geological Survey of Canada,* Paper 93-1A, pages 173-182.

Majorowicz, J. A., Osadetz, K.G., Evenchick, C.A., Ferri, F. and Hayes, M. (2004): Temperature and thermotectonic histories from the Intermontane Superterrane in British Columbia; *Canadian Society of Petroleum Geologists* Annual Convention, Calgary, AB, Program with Abstracts, Conference Abstract Archive CD.

Maxson, J. A. (1996): A sedimentary record of Late Cretaceous Tectonic Restructuring of the North American Cordillera: The Tyaughton-Methow Basin, Southwest British Columbia, unpublished Ph.D. thesis, *University of Minnesota,* 190 pages.

Mustard, P. S. and van der Heyden, P. (1997): Geology of the Tatla Lake (92N/15) and the east half of Bussel Creek (92N/14) map areas; *in* Interior Plateau geoscience project: summary of geological, geochemical and geophysical studies, *B.C. Ministry of Employment and Investment,* Paper 1997-2, pages 103-118.

Osadetz, K.G., Snowdon, L.R. and Obermajer, M. (2003): Rock-Eval/TOC results for eleven Northern British Columbia boreholes; *Geological Survey of Canada,* Open File 1550.

Perry, R.G. and Bullock B.D. (1960): Preliminary Geological Report, Permit 1192, BC Report; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 904.

Ramsay, T.B. (1972): Sample descriptions for Vieco Texacal Punchaw c-38-J/93-G-6; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Well File 3149.

Rusmore, M. and Woodsworth, G.J. (1994): Evolution of the eastern Waddington thrust belt and its relation to the mid-Cretaceous Coast Mountains arc, western British Columbia; *Tectonics*, Vol. 13, No.5, pages 1052-1067.

Rusmore, M. and Woodsworth, G.J (1991): Coast Plutonic Complex: A mid-Cretaceous contractional orogen; *Geology*, Vol. 19, pages 941-944.

Salt, W.T. (1980a): Gravity Survey detailing the Honolulu Oil - Nazko Wellsite area and Reconnaissance lines in the North Chezacut area of the Nechako basin; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2394.

Salt, W.T. (1980b): Gravity Survey of the Big Creek area of the Nechako Basin; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2393.

Salt, W.T. (1981a): Gravity Survey detailing the North Chezacut area and Reconnaissance of an area north of the West Road River of the Nechako basin; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2396.

Salt, W.T. (1981b): Gravity Survey of the Chezacut - Chilanko Forks - Chilko River area of the Nechako Basin; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2395.

Salt, W.T. (1982a): Detailed Gravity Survey of the Chezacut Area of the Nechako Basin Project Number 81-156; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2397.

Salt, W.T. (1982b): Gravity Survey of the South Big Creek area of the Nechako Basin Project Number 81-164; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Geological Report 2398.

Schiarizza, P. (1996): Tatlayoko Project update (92N/8, 9. 10; 92O/5, 6, 12): *in* Geological Fieldwork 1995, *B.C. Ministry of Energy, Mines and Petroleum Resources,* Paper 1996-1, p. 77-91.

Schiarizza, P., Gaba, R.G., Glover, J.K., Garver, J.I. and Umhoefer, P.J. (1997): Geology and mineral occurrences of the Taseko-Bridge River area; *B.C. Ministry of Employment and Investment,* Bulletin 100, 292 pages.

Struik, L.C. (1993): Intersecting intracontinental Tertiary transform fault systems in the North American Cordillera; *Canadian Journal of Earth Sciences,* Vol. 30, pages 1262-1274.

Taylor, N.W. (1960): Report of Photogeological Survey and Surface Geological Study, The Nazko River Permit Area-Interior Plateau, Central British Columbia; Honolulu Oil Corporation Report, *B.C. Ministry of Energy, Mines and Petroleum Resources* Geological Report 850, 17 pages.

Taylor, N.W. (1961): A Report on the Nazko River and Puntzi Permit Areas - Interior Plateau, central British Columbia; Honolulu Oil Corporation Report, *B.C. Ministry of Energy, Mines and Petroleum Resources* Geological Report 935, 32 pages, 8 maps, and well log for a-4-L/93B-11.

Thomson, R.C., Smith, P.L. and Tipper, H.W. (1986): Lower to Middle Jurassic (Pliensbachian to Bajocian) stratigraphy of the northern Spatzizi area, north-central British Columbia, *Canadian Journal of Earth Science,* Volume 23, pages 1963-1973.

Thornsteinsson, E. (*in preparation*): Well descriptions from the Interior Basins of British Columbia; Geological Survey of Canada, Open File; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Petroleum Geology Open File.

Tipper, H.W. (1959): Geology, Quesnel map area; *Geological Survey of Canada,* Map 12-1959, 1:253,440 scale (1 inch to Four Miles).

Tipper, H.W. (1963): Geology, Taseko Lakes, British Columbia, 92O; *Geological Survey of Canada,* Map 29-1963, 1:253,440 scale (1 inch to Four Miles).

Tipper, H.W. (1962): Nechako River map area, British Columbia; *Geological Survey of Canada,* Map 1131A, 1:253,440 scale (1 inch to Four Miles).

Tipper, H.W. (1963): Nechako River map-area, British Columbia; *Geological Survey of Canada*, Memoir 324, 59 pages.

Tipper, H.W. (1969): Geology, Anahim Lake, British Columbia, *Geological Survey of Canada,* Map 1202A, 1:253,440 scale (1 inch to Four Miles).

Tipper, H.W. (1978): Taseko Lakes (92O) map area; *Geological Survey of Canada,* Open File 534, 1:125,000 scale.

Travers, W.H. (1978): Overturned Nicola and Ashcroft Strata and their relation to the Cache Creek Group, Southwestern Intermontane Belt, British Columbia; *Canadian Journal of Earth Science,* Volume 15, pages 99-116.

Umhoefer, P.J. and Tipper, H.W. (1998): Stratigraphy, depositional environment, and tectonic setting of the Upper Triassic to Middle Jurassic rocks of the Chilcotin Ranges, southwestern British Columbia; *Geological Survey of Canada*, Bulletin 519, 58 pages.

Umhoefer, P. J., Schiarizza, P. and Robinson, M. (2002): Relay Mountain Group, Tyaughton-Methow basin, southwest British Columbia: a major Middle Jurassic to Early

Cretaceous terrane overlap assemblage; *Canadian Journal of Earth Sciences*, Vol. 39, pages 1143-1167.

Williams, E.P. (1959): Geological Investigations, Redstone Project, British Columbia, Hudson's Bay Oil and Gas Company Limited, *B.C. Ministry of Energy, Mines and Petroleum Resources* Geological Report 828, 5 pages.