NECHAKO PROJECT UPDATE

Janet Riddell[1] and Filippo Ferri[1]

ABSTRACT

Evaluation of the oil and gas potential of the Nechako Basin continued for the third consecutive year. Fieldwork during the 2007 season was concentrated in the northwesternmost part of the basin and in the Skeena Arch. The Jurassic Smithers and Ashman Formations and the Early Cretaceous Skeena Group were evaluated for source and reservoir potential. Source potential is very poor in the Smithers Formation but is fair to good in the Ashman Formation and in the shale members of the Skeena Group. Thermal maturation data indicate Skeena rocks are currently in the oil window and Ashman and Smithers units are in the peak to upper dry gas zone. Results are pending for analysis of the Skeena Group coarse clastics, but indications for good reservoir quality in these rocks are lacking. Two new U-Pb dates from andesites on the southern fringe of the basin indicate that these volcanics are latest Early Cretaceous rather than Middle to Late Jurassic as previously thought.

Riddell, R. and Ferri, F., (2008); Nechako Project Update; in Geoscience Reports 2008, *BC Ministry of Energy, Mines and Petroleum Resources*, pages 67-77.

[1]British Columbia Ministry of Energy, Mines and Petroleum Resources, Oil and Gas Division, Resource Development and Geoscience Branch, PO Box 9333 Stn. Prov. Govt., Victoria, BC, V8W 9N3; e-mail janet.riddell@gov.bc.ca

Key Words: Nechako Basin, oil and gas, petroleum, hydrocarbons, Rock-Eval, source beds, thermal maturity, vitrinite reflectance, reservoir, porosity, U-Pb dates, apatite fission track (AFT) thermochronometry, Skeena Group, Hazelton Group, Bowser Lake Group, Spences Bridge Group, Smithers Formation, Ashman Formation, Powell Creek volcanics.

INTRODUCTION

Evaluation of the oil and gas potential of the Nechako Basin (Figure 1) continued for the third consecutive year. The focus of the 2007 field season was the northwesternmost part of the basin and the Skeena Arch, following investigation of the more highly prospective southern part of the basin in previous years (Riddell et al. 2007; Ferri et al. 2006). Two new U-Pb dates of volcanic rocks in the western Chilcotin have improved our understanding of the underlying basement in the southern part of the basin. We continue to build a thermal history of the Nechako region using apatite fission track (AFT) thermochronometry.

2007 FIELD SEASON

The 2-person field crew spent 2 weeks in the field during the summer of 2007 (Figure 2). We visited outcrops of Jurassic and Cretaceous clastic units in the northwestern Nechako basin and the Skeena Arch to sample units with potential as source or reservoir rocks, expanding the database compilation initiated by the work of Hunt (1992). New data presented in this report include Rock-Eval analyses for 20 shale and siltstone samples and vitrinite reflectance analyses for 24 samples.

Reconnaissance In The Northwestern Nechako Basin And Skeena Arch Areas

We conducted reconnaissance of the Jurassic and Cretaceous clastic units in the northwestern part of the Whitesail Lake mapsheet (NTS 093E) and the southwestern part of the Smithers sheet (NTS 093L), from Tahtsa Lake and Tahtsa Reach on the south to the Morice River on the north. We visited isolated outcrops in the Skeena Arch area at the

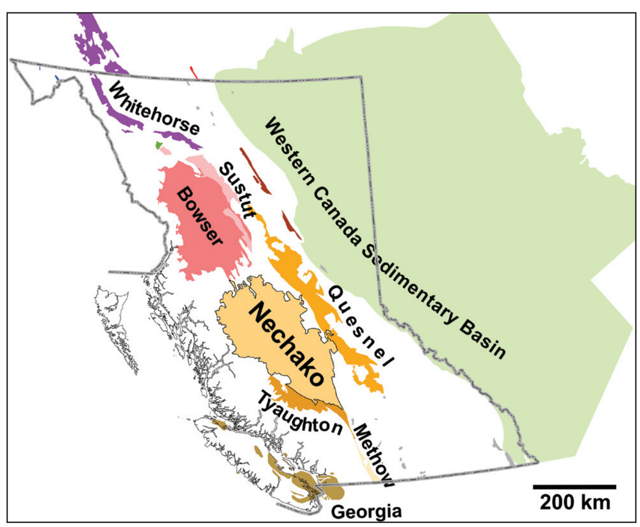


Figure 1: Sedimentary basins of British Columbia.

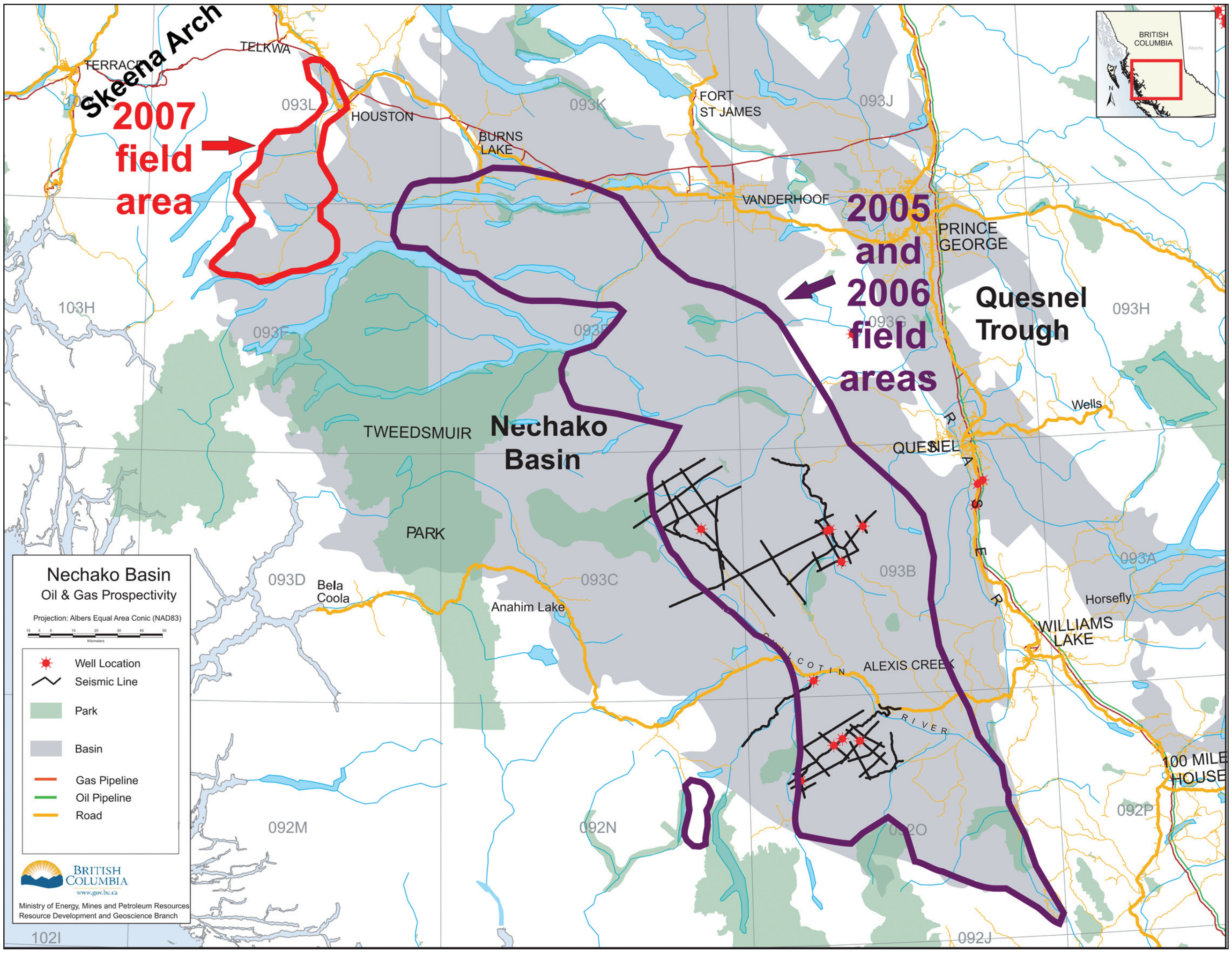


Figure 2: The 2007 field season was conducted in the northwesternmost part of the Nechako Basin.

community of Walcott, and on Ashman Ridge.

The region shares some stratigraphic elements with the Bowser Basin (Table 1). A portion of the geological map of Tipper et al. (1974) in Figure 3 shows the distribution of the major map units. Andesitic volcanics and sedimentary rocks of the Early to Middle Jurassic Hazelton Group are the oldest units in the region (MacIntyre 1985a). The Bowser Lake Group is represented by sparse exposures of the Middle Jurassic Ashman Formation. Late Jurassic to Early Cretaceous members of the Bowser Lake Group are not represented in this region. Early to Middle Cretaceous Skeena Group rocks are exposed south of Tahtsa Lake, around Collins and Nadina Lakes (Desjardins et al. 1991), and along the Morice River. Volcanic rocks of the Late Cretaceous Kasalka Group unconformably overlie the Skeena Group locally (MacIntyre 1985a). Exposures of the Paleocene to Eocene Ootsa Lake and Endako volcanic sequences are scattered and isolated in the reconnaissance area; they are more widespread and continuous further east, between Houston and Ootsa Lake (Figure 3).

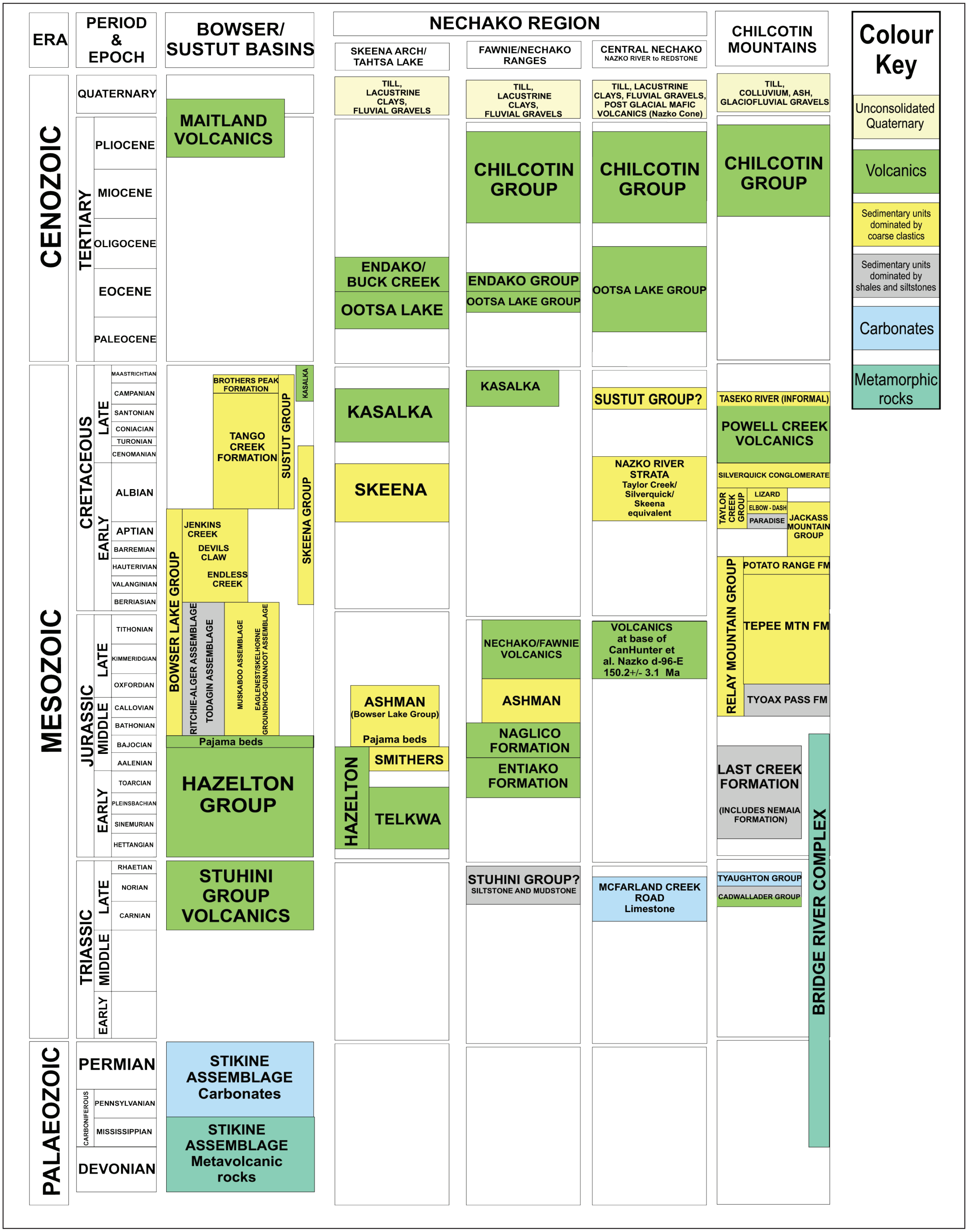
Layered rocks are intruded by granitic rocks of Late Cretaceous and Tertiary ages, which are especially abundant in the Tahtsa Lake area. Porphyry copper and molybdenum deposits, including the Huckleberry Mine, are associated with these plutons.

The Smithers Formation of the Hazelton Group, the Ashman Formation of the Bowser Lake Group, and shales and sandstones of the Skeena Group were examined and sampled for Rock-Eval analysis, reservoir quality, vitrinite reflectance, apatite fission track thermochronometry, and palynology. Clastic rocks are sparse relative to volumetrically abundant volcanic and plutonic rocks in the area.

SMITHERS FORMATION

The Smithers Formation of the Hazelton Group is well exposed in the region (Diakow 2006). We examined it on Mount Sweeney and in the Mosquito Hills north of Tahtsa Reach. It is a shallow marine sedimentary unit consisting predominantly of pale coloured grey to tan feldspar greywacke, arkosic arenite, and siltstone. Locally

TABLE 1: CORRELATION CHART, NECHAKO BASIN.



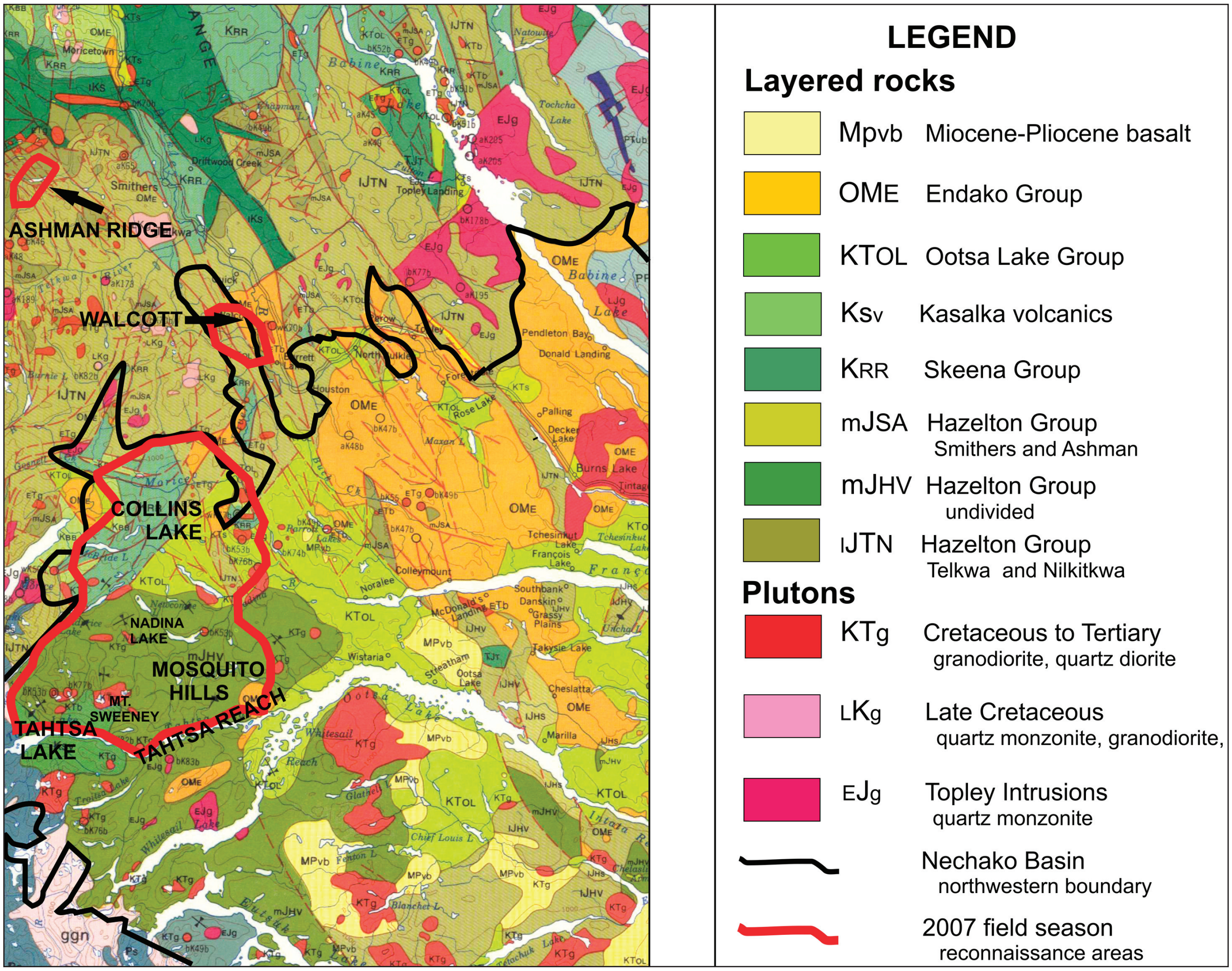


Figure 3: Reconnaissance was conducted in 2007 in the areas outlined in red. Geological map by Tipper et al. (1974); legend adapted from MacIntyre (1985).

it is rich in a distinctive Aalenian to Bajocian macrofossil assemblage that includes trigoniids, belemnites, bivalves, and ammonites. The pale colours indicate that the Smithers Formation likely has low potential as a source rock. A sample collected at Mount Sweeney contained very low levels of organic carbon (see Rock-Eval results below).

ASHMAN FORMATION

The Ashman Formation of the Bowser Lake Group, as defined by Tipper and Richards (1976), comprises mainly dark grey to black shale with lesser coarse clastics of Middle to Late Jurassic (late Bajocian to early Oxfordian) ages. Ashman Formation siltstones and shales were sampled at Walcott in the Skeena Arch; exposures in the Tahtsa Lake region were deemed to be too strongly affected by abundant Cretaceous and Tertiary plutons to provide reliable thermal and Rock-Eval data.

We also collected samples of the Ashman Formation and the underlying so-called “pyjama beds” at the top of the Hazelton Group at Ashman Ridge on the southern fringe of the Bowser Basin as part of a larger study underway by Ferri (Filippo Ferri, personal communication 2008).

Recent work in the Bowser Basin by Evenchick and others (see Evenchick and Thorkelson 2005 and references therein) has refined and redefined Jurassic and Early Cretaceous stratigraphic nomenclature and has recommended that use of the term Ashman be discontinued. A detailed discussion of the redefinition of the units at Ashman Ridge is provided by Gagnon and Waldron (2008). However, south of the Bowser Basin, in the Skeena Arch (Smithers mapsheet NTS 093L) and in the northern Nechako basin region (Nechako River mapsheet NTS 093F and north half of the Whitesail Lake mapsheet 093E) the Ashman forms a distinctive late Middle Jurassic black clastic/chert conglomerate assemblage. In these areas, the Upper Jurassic/Lower Cretaceous facies of the Bowser Basin do not exist and use of the term Ashman Formation is well-entrenched and will likely persist (T.A. Richards, written communication 2008; D.G. MacIntrye, written communication 2008).

SKEENA GROUP

The Skeena Group includes marine and nonmarine sedimentary rocks and volcanic strata (Tipper and Richards 1976) of Early Cretaceous to earliest Late Cretaceous (Albian to Cenomanian) ages. They are exposed in the southeastern part of the Bowser Basin and in the northwestern corner of the Nechako Basin. A discussion of the history of Skeena Group nomenclature is provided by Ferri et al. (2005). In the 2007 reconnaissance area, the Skeena Group is represented by the mainly basaltic Mount Ney volcanic sequence overlain by a sedimentary sequence dominated by blocky weathering sandstones with interbedded shales. The sedimentary sequences are best exposed in the areas around Collins Lake. The sandstones are fine-grained, greenish-grey and blocky weathering and generally massive or with barely discernible bedding. White muscovite flakes (1 to 2 mm-size) are almost ubiquitous in proportions ranging from 1 to 5 per cent. The most abundant clast type is green chert; also present are black chert, black lithic fragments, feldspar crystals, and rare pink chert. Plant material and carbonaceous wisps are abundant. The sandstones appear to have low potential as a reservoir unit due to their dense textures and the abundance of feldspar; however, 10 samples were collected for analysis, which has not yet been completed. The sandstones were also sampled for vitrinite reflectance and apatite fission track thermochronometry analyses.

The Skeena Group shales are exposed only in road cuts and roadside pits, where they have been quarried for local road fill. In the Collins Lake area, the shale is black, spheroidally weathered, and either brittly fractured into small pieces or soft and crumbly. Competent shale blocks with well-preserved ammonite fossils were encountered in road fill in the forestry clear cuts; however, we did not see these textures (or fossils) in place. The shales were sampled for Rock-Eval and vitrinite reflectance analyses.

RESULTS

The northwestern part of the Nechako basin has received minimal investigation of its oil and gas potential (Hunt 1992; Hayes 2003) and has seen no oil and gas exploration industry activity. Rock-Eval and vitrinite data from the Ashman Formation and the Skeena Group shales collected by Hunt (1992) and this study indicate that units with reasonably good carbon content do occur in the northwest Nechako basin and Skeena Arch areas, and some have undergone thermal maturation within the oil to gas window. However, potential source beds (the Ashman Formation, and Skeena Group shales) are thinner here than in the Bowser Basin, and the Rock-Eval data indicate that the quality of the organic material is poor. Futhermore, no promising reservoir unit has been identified by this project. Rock-Eval and vitrinite maturity data in the Tahtsa Lake/Tahtsa Reach areas are probably influenced by the abundant intrusions and volcanic rocks that post-date potential source rocks.

ROCK-EVAL

Rock-Eval analysis provides information about the amount, quality, type, and maturity of organic carbon in the sample. Of the units sampled during the 2007 field season, those from the Skeena Group and Ashman Formations contain reasonably good amounts of organic carbon but are low in oil and gas generative quality.

The Rock-Eval analyses for 20 samples collected in 2007 are presented in Table 2 and graphed on Figure 4. Total organic carbon (TOC) values for the samples from shales of the Skeena Group yielded fair to good organic carbon amounts. Results from the Ashman Formation and from the “pyjama beds” at the top of the Hazelton Group at Ashman Ridge fall mainly into the “fair” range for hydrocarbon potential, with a few in the “good” range. However, low S1 and S2 values (Table 2) for all samples indicate that the quality of the organic material is poor. Plots of various Rock-Eval data ratios on the 2 diagrams in Figure 4 indicate that kerogen from all sampled units is Type 3 (gas-prone) (Langford and Blanc-Valleron 1990; Peters 1986).

VITRINITE REFLECTANCE

Twenty-four new vitrinite samples (mainly sandstones with visible carbonaceous material) were collected; the resulting thermal maturation data are presented in Table 3 and Figure 5. Sample symbols are placed on the oil and gas window diagram of Dow (2000) based on their reflectance (%R_O) values. Note that the sample symbols are placed toward the right-hand side of the diagram, reflecting the Rock-Eval data that suggests kerogen in the Nechako region tends to be Type 3. Skeena Group rocks collected in the Collins Lake show maturity in the oil window. The values near Nadina Lake in the Skeena Group and at Ashman Ridge in the upper Hazelton and Ashman Formations show higher maturity—in the dry gas window. The high (overmature) values for thermal maturity for the Tahtsa Lake/Mosquito Hills area should be regarded with caution due to their proximity to abundant younger igneous rocks.

These new data will be used to calibrate results from new apatite fission track samples collected concurrently.

TABLE 2: ROCK-EVAL DATA FROM SURFACE SAMPLES COLLECTED IN THE NORTHWESTERN NECHAKO BASIN IN 2007. *

Sample	Formation	Area	Easting	Northing	TOC	S1	S2	PI	S3	Tmax	Tpeak	S3CO	PC(%)	RC%	HI	OICO	OI	MINC%
JR07-1	Skeena	McKendrick Ck	643196	6079027	1.01	0.02	0.02	0.52	0.60	310	349	0.20	0.03	0.98	2	20	59	0.1
JR07-2A	Ashman	Walcott	639436	6044083	1.91	0.14	0.08	0.62	0.49	312	351	0.01	0.03	1.88	4	1	26	2.0
JR07-2B	Ashman	Walcott	639436	6044083	1.17	0.04	0.02	0.61	0.63	448	487	0.02	0.03	1.14	2	2	54	0.1
JR07-9	Smithers	Mt. Sweeney	615111	5954846	0.10	0.01	0.02	0.28	0.14	348	387	0.30	0.02	0.08	20	300	140	0.5
JR07-16	Skeena	Nadina Lake	634620	5974792	0.68	0.01	0.03	0.22	0.50	495	534	0.02	0.02	0.66	4	3	74	0.1
JR07-26	Skeena	Nadina Lake	634313	5974572	0.80	0.01	0.02	0.36	0.88	421	460	0.21	0.04	0.76	2	26	110	0.1
JR07-46	Skeena	McBride Lake	613484	5988284	0.64	0.05	0.32	0.13	0.12	452	491	0.01	0.04	0.60	50	2	19	0.0
JR07-48	Skeena	McBride Lake	615350	5991769	0.58	0.04	0.26	0.14	0.20	468	507	0.02	0.04	0.54	45	3	34	0.2
JR07-51	Skeena	Collins Lake	615958	5995296	1.26	0.02	0.33	0.06	0.47	508	547	0.02	0.05	1.21	26	2	37	0.1
JR07-52	Skeena	Collins Lake	616458	5995630	1.09	0.03	0.27	0.10	0.89	516	555	0.04	0.06	1.03	25	4	82	0.1
JR07-68	Hazelton PJ beds	Ashman Ridge	573273	6078679	1.06	0.04	0.07	0.39	0.23	561	600	0.15	0.03	1.03	7	14	22	0.1
JR07-70	Hazelton PJ beds	Ashman Ridge	573286	6078735	0.65	0.04	0.07	0.32	0.18	539	578	0.02	0.01	0.64	11	3	28	0.1
JR07-71	Hazelton PJ beds	Ashman Ridge	573302	6078812	0.47	0.02	0.07	0.25	0.58	557	596	0.34	0.04	0.43	15	72	123	0.4
JR07-72	Ashman	Ashman Ridge	573309	6078862	0.59	0.02	0.05	0.29	0.30	559	598	0.16	0.02	0.57	8	27	51	0.1
JR07-73	Ashman	Ashman Ridge	573284	6078860	0.42	0.03	0.06	0.34	0.19	531	570	0.02	0.01	0.41	14	5	45	0.2
JR07-74	Ashman	Ashman Ridge	573246	6078891	0.96	0.01	0.06	0.15	0.48	598	637	0.08	0.02	0.94	6	8	50	0.1
JR07-76	Ashman	Ashman Ridge	573267	6079278	0.71	0.03	0.08	0.28	0.15	546	585	0.03	0.02	0.69	11	4	21	0.1
JR07-77	Ashman	Ashman Ridge	573278	6079476	1.06	0.02	0.12	0.13	0.98	542	581	0.51	0.06	1.00	11	48	92	0.1
JR07-78	Ashman	Ashman Ridge	573291	6079564	1.79	0.01	0.07	0.10	1.63	529	568	0.04	0.06	1.73	4	2	91	0.2
JR07-79	Skeena	Collins Lk quarry	615586	5997350	1.06	0.07	0.69	0.09	0.17	457	496	0.19	0.08	0.98	65	18	16	0.1

Standard criteria for rating potential source rocks (Peters 1986)

Rating	Total organic carbon (TOC) wt. %	S1 mg HC/g rock	S2 mg HC/g rock
Poor	0 - .5	0 - .5	0 - 2.5
Fair	.5 - 1	.5 - 1	2.5 - 5
Good	1 - 2	1 - 2	5 - 10
Very good	2+	2+	10+

**During Rock-Eval analysis, a detector senses any organic compounds generated during pyrolysis. The results provide information about the amount, quality, type, and maturity of organic carbon in the sample. Definitions are from Peters 1986. TOC: Total Organic Carbon (weight per cent), a measure of the amount of organic carbon. S1: the amount of hydrocarbons that can be distilled from one gram of rock (mg/g rock). S2: the amount of hydrocarbons generated by pyrolitic degradation of the kerogen in one gram of rock (mg/g rock). S3: milligrams of carbon dioxide generated from a gram of rock during temperature programming up to 390 oC. S1, S2, and S3 are measures of the quality of the generative potential of the source rock. Tmax: is the temperature at which the maximum amount of S2 hydrocarbons is generated, an indication of thermal maturity. HI and OI are calculated from S2, S3, and TOC analytical data and are plotted to provide an indication of kerogen type (see Figure 4).*

MAGNETIC SUSCEPTIBILITY

The field crew collected 42 magnetic susceptibility readings from all formations that we encountered during the field season (Table 4). These measurements form a contribution to a new database of physical and paleomagnetic properties that is being compiled for south-central British Columbia by the Geological Survey of Canada. See Enkin et al. (2008) for a discussion of the development of this new database, which will be used to calibrate geophysical models and facilitate accurate interpretations of old and new geophysical data.

ONGOING STUDIES

New U-Pb Dates

The project continues to acquire new geochronological data in the Nechako region. Four new U-Pb zircon ages were determined from samples of previously undated volcanic sequences that we collected during fieldwork in 2005 and 2006. The supporting data will be presented in detail in an upcoming publication, along with that of new dates described in Riddell et al. (2007). All new ages cited below are from Paul O’Sullivan (written communication 2007; see “Acknowledgements”).

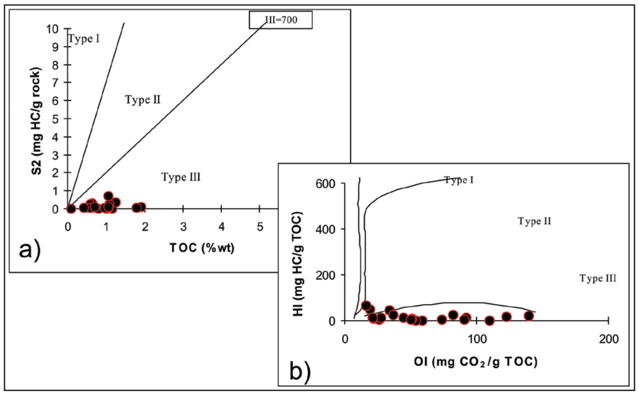


Figure 4: Graphs of Rock-Eval data for kerogen from surface samples collected in 2007 from the northwestern Nechako basin. Data points are presented in Table 2. These graphs give an indication of the kerogen type; Type I is very oil-prone, Type II is oil-prone, Type III is gas-prone. These samples fall in the Type III (gas prone) fields. a) S2 versus TOC (total organic carbon); (Langford and Blanc-Valleron 1990); b) HI (hydrogen index) versus OI (oxygen index); (Peters 1986) See Table 2 for definitions of S2, S3 and TOC. HI and OI are calculated from S2, S3, and TOC values. HI = (S2/TOC) × 100 (mg HC/g Corg); OI = (S3/TOC) × 100 (mg HC/g Corg);

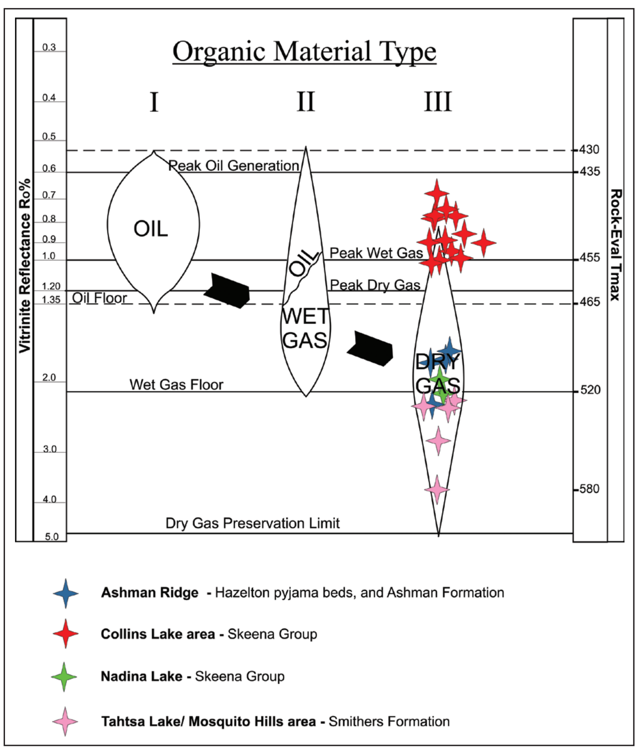


Figure 5: Thermal maturation (Ro) values from 2007 vitrinite reflectance data for areas of the northwestern Nechako basin and the Skeena Arch, plotted on a graph of the oil and gas generative window. Diagram adapted from Dow (2000). Refer to Figure 3 for sample location areas.

TABLE 3: VITRINITE REFLECTANCE DATA; SURFACE SAMPLES COLLECTED IN THE NORTHWESTERN NECHAKO BASIN IN 2007.*

Station ID	VR Ro %	Formation	Location name	Easting	Northing	Rock type
JR07-5	2.38	Smithers	Mt. Sweeney	614885	5955034	sandstone
JR07-9	2.49	Smithers	Mt. Sweeney	615087	5954494	siltstone
JR07-16	2.13	Skeena	Nadina Lake	634620	5974792	siltstone
JR07-18	2.21	Smithers	Tahtsa Reach	639801	5955840	sandstone
JR07-20	2.86	Smithers	Tahtsa Reach	637153	5955739	siltstone
JR07-24	3.81	Smithers	Mosquito Hills	644564	5963819	sandstone
JR07-26	1.98	Skeena	Nadina Lake	634313	5974572	siltstone/shale
JR07-42	0.68	Skeena	McBride Lake	614015	5986720	sandstone
JR07-43	0.74	Skeena	McBride Lake	613886	5986794	sandstone
JR07-44	0.77	Skeena	McBride Lake	613738	5986834	sandstone
JR07-46	0.79	Skeena	McBride Lake	613484	5988284	shale
JR07-47	0.86	Skeena	McBride Lake	614667	5990358	sandstone
JR07-50	0.89	Skeena	McBride Lake	614576	5993426	sandstone
JR07-51	1.00	Skeena	Collins Lake	615958	5995296	siltstone
JR07-53	0.79	Skeena	Lamprey Creek	621450	5998507	sandstone
JR07-54	0.95	Skeena	Collins Lake	612559	5993131	sandstone
JR07-55	0.99	Skeena	Collins Lake	612914	5993405	sandstone
JR07-62	1.03	Skeena	Lamprey Creek	619260	5998870	sandstone
JR07-63	0.89	Skeena	Lamprey Creek	621427	5998511	sandstone
JR07-66	1.88	Smithers	Ashman Ridge	573598	6078381	siltstone
JR07-70	1.72	Hazelton PJ beds	Ashman Ridge	573286	6078735	siltstone
JR07-72	1.85	Ashman	Ashman Ridge	573309	6078862	brown shale
JR07-75	2.28	Ashman	Ashman Ridge	573202	6078989	sandstone
JR07-79	0.90	Skeena	Collins Lake	615585	5997350	shale

**Ro% is a measure of fraction of the incident beam that is reflected coherently from the vitrinite and is an indication of thermal maturity.*

Two of the new samples were collected from the Batnuni Cone area; they each provided confirmation of expected ages. A rhyolite mapped as Ootsa Lake Group by Tipper (1962) produced a weighted mean age of approximately 49 ± 1 Ma, which falls within the time constraints for Ootsa Lake events (approximately 53 to 47 Ma) provided by Grainger et al. (2001). A tuff collected at Taiuk Creek just west of Klunchatistli Lake yielded a late Middle Jurassic age of approximately 162 ± 2 Ma, consistent with the Middle Jurassic fossil age determination of Tipper (1962) from a nearby outcrop.

Two new dates have been obtained from andesite flows exposed on the southwestern fringe of the Nechako region. Both samples are from outcrops that were interpreted as lower Middle Jurassic Hazelton Group volcanics by Tipper (1959 and 1969), Roddick and Tipper (1985), and on subsequent compilations (Massey et al. 2005 and Riddell 2006). These units are labeled lmJHz and coloured orange on Figure 6; however, the 2 new dates, marked by purple stars at Choelquoit Lake and Puntzi Lake, indicate that at least some of these rocks are too young to correlate with the Hazelton Group. The sample from the north shore of Puntzi Lake contained 2 populations of zircons; the older has a weighted mean age of approximately 152 ± 4 Ma, and the younger population is approximately 101 ± 2 Ma, suggesting that latest Early Cretaceous andesitic melts assimiliated zircons from Hazelton volcanic rocks while moving up through the crust. The sample from Choelquoit Lake produced poor quality grains; however, a weighted

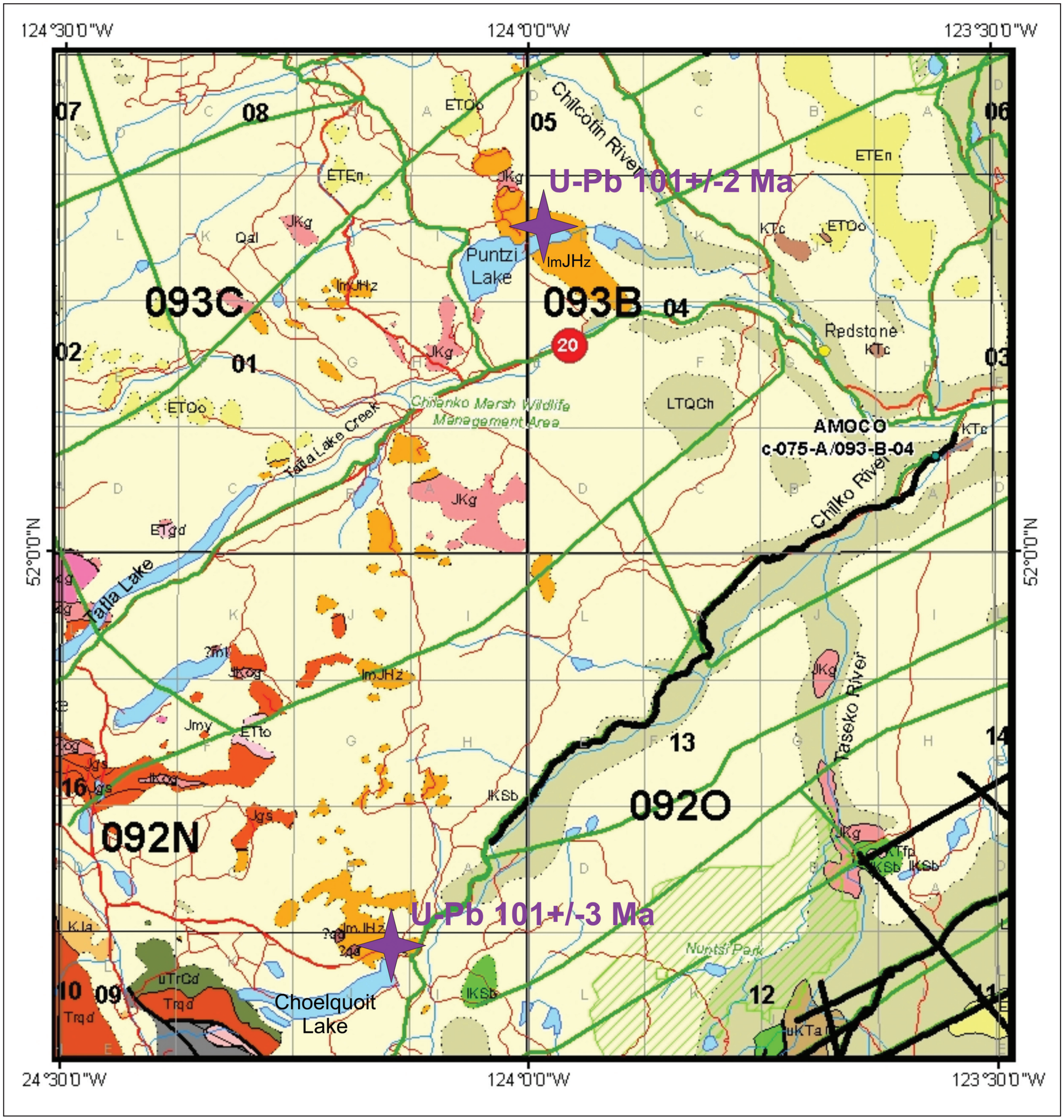


Figure 6: Locations for which 2 new U-Pb dates have been established. Base geology from Riddell (2006). The new dates indicate that at least some dark orange-coloured outcrops labeled lmJHz are latest Early Cretaceous in age—too young to correlate with the Hazelton Group. They are more likely to be correlative with the Spences Bridge volcanics or possibly the Powell Creek volcanics.

TABLE 4: MAGNETIC SUSCEPTIBILITY DATA COLLECTED IN THE NORTHWESTERN NECHAKO BASIN IN 2007. *

Station_ID	Formation	Rock type	EASTING	NORTHING	MS ($X10^{-3}$ SI)
JR07-2	Hazelton-Smithers	black limy shale	639436	6044083	0.70
JR07-3	Hazelton-Smithers	fsp sandstone	615061	5955165	0.27
JR07-4	Hazelton-Telkwa	basalt flow & bx	615277	5955359	2.10
JR07-5	Hazelton-Smithers	sandstone	614885	5955034	0.35
JR07-6	Hazelton-Smithers	conglomerate	615096	5954909	0.47
JR07-8	Hazelton-Smithers	sandstone	615127	5954784	0.21
JR07-9	Hazelton-Smithers	siltstone	615087	5954494	0.29
JR07-10	Hazelton-Telkwa	andesite porphyry	615178	5954207	13.60
JR07-11	Hazelton-Telkwa	andesite	615237	5954077	0.25
JR07-12	Endako?or Skeena volc	pyroxene basalt	632600	5966359	6.53
JR07-13	Endako?or Skeena volc	pyroxene basalt	636433	5966881	12.40
JR07-14	Endako	basalt	638375	5974277	27.10
JR07-15	Mount Ney volcs (Skeena)	basalt breccia	640587	5981921	9.50
JR07-16	Skeena	siltstone/shale	634620	5974792	0.28
JR07-17	Goosly Intrusive	quartz monzonite	642922	5956244	4.76
JR07-18	Hazelton-Smithers	fsp sandstone	639801	5955840	0.44
JR07-19	Hazelton-Smithers	fsp tuff	640039	5955754	0.16
JR07-21	Hazelton??	serpentinite	636777	5962980	6.58
JR07-22a	Hazelton??	calcareous siltstone	636903	5962897	0.27
JR07-22b	Hazelton??	pillow basalt	636903	5962897	0.42
JR07-24	Hazelton-Smithers	fsp sandstone	644564	5963819	14.30
JR07-25	Mount Ney volcs (Skeena)	pyroxene crystal tuff	634719	5974948	0.28
JR07-40	Bridge River Group	greenstone- ropy lava	515967	5656400	0.34
JR07-42	Skeena	sandstone	614015	5986720	0.27
JR07-43	Skeena	sandstone	613886	5986794	0.46
JR07-44	Skeena	sandstone	613738	5986834	0.55
JR07-45	Skeena	siltstone	612896	5987195	0.23
JR07-46	Skeena	shale/slst/sst	613484	5988284	0.23
JR07-47	Skeena	sandstone	614667	5990358	2.39
JR07-48	Skeena	siltstone/shale	615350	5991769	0.21
JR07-49	Skeena	sandstone	614099	5991516	0.26
JR07-50	Skeena	sandstone	614576	5993426	0.59
JR07-52	Skeena	shale	616458	5995630	0.26
JR07-53	Skeena	sandstone	621450	5998507	0.17
JR07-54	Skeena	sandstone	612559	5993131	0.45
JR07-55	Skeena	sandstone	612914	5993405	5.36
JR07-56	Skeena	sandstone	612977	5993456	1.19
JR07-57	Skeena	sandstone	612990	5993783	0.30
JR07-58	Skeena	sandstone	613013	5993990	0.41
JR07-59	Skeena	sandstone	613092	5994242	0.45
JR07-60	Skeena	sandstone	613118	5994303	0.33
JR07-61	Skeena	sandstone	612759	5993389	0.20

**These data form a contribution to a new database of physical and paleomagnetic properties that is being compiled for south-central British Columbia by the Geological Survey of Canada. See Enkin et al. (2008) for discussion of the development of this new database.*

mean age of approximately 101 ± 3 Ma was determined. These latest Early Cretaceous rocks may correlate with the Spences Bridge Group (bright green unit on Figure 6) or the Powell Creek volcanics.

Thermal History

Nine new apatite fission track (AFT) samples were collected in 2007 between Tahsta Reach and Collins Lake. Results will contribute to a larger AFT thermal history study of the Nechako region that will include 50 samples collected in 2005 from the Nazko River and Redstone areas (Riddell et al. 2007) and 9 samples collected in 2006 from the Fawnie and Nechako ranges and Batnuni Lake.

Reservoir Study

In contrast to many proven clastic reservoir units in the Western Canada Sedimentary Basin, the clastic units in the Nechako region tend to be mineralogically and texturally immature. Volcanic lithic fragments and detrital feldspars are locally abundant, and sorting is highly variable. Primary porosity is almost absent in surface and core samples. However, multiple factors (including early compaction that inhibited the precipitation of diagenetic products, the development of secondary porosity, and mineral leaching) conspire to create local zones of good porosity. Lithologically similar units do form productive oil and gas reservoirs in other basins; one example is the Rewan Group in the Bowen Basin of Queensland Australia (Bashari 1998).

A detailed petrographic study of samples of potential reservoir units collected during the 2005 and 2006 field seasons and from archived exploration drill cores is available as a separate report (Brown et al. in press).

CONCLUSIONS

- Rock-Eval analyses of shaly horizons indicate that the Skeena Group and Ashman Formation contain fair to good amounts of organic carbon.
- Thermal maturation data indicate that Skeena shales in the Collins Lake are within the oil window while rocks of the Smithers and Ashman formations bracket the peak to upper dry gas zone.
- New U/Pb dates of andesites near Puntzi and Choelquoit Lakes in the southern Nechako region indicate that these volcanics are late Early Cretaceous, too young to belong to the Lower Jurassic Hazelton Group. They may be correlative to either the Spences Bridge Group or the Powell Creek volcanics.
- Petrographic analysis of coarser clastics within the Nechako Basin show them to be mineralogically and texturally immature with little primary porosity. Much of the observed porosity in surface and core samples is the result of secondary porosity.

ACKNOWLEDGEMENTS

Matt Sawatzky provided excellent field support and assistance during the challenging blackfly season of 2007. We are most grateful to Don MacIntyre for answering endless questions about the geology of the Smithers, Houston, and Tahtsa Lake areas and to both Don and Jackie MacIntyre for their kind hospitality. We thank the Thompson family for logistical help and hospitality during our stay at Nadina Lake Lodge. Pat and Tania Rooney of Highland Helicopters provided safe helicopter transportation and reliable service. Jenny Wong of GSC Calgary provided prompt lab analyses of Rock-Eval and vitrinite reflectance samples. Margaret and Raymond Donelick and Paul O'Sullivan of Apatite to Zircon Labs continue to provide timely fission track and U/Pb geochronology analyses.

REFERENCES

Bashari, A. (1998): Diagenesis and reservoir development of sandstones in the Triassic Rewan Group, Bowen Basin, Australia, *Journal of Petroleum Geology*, Volume 21 (4), pages 445–465.

Brown, D., Simpson, J., Daniels, H., and Riddell, J. (in press): Two reports on petrographic analyses of clastic rocks from the Nechako region of British Columbia; *British Columbia Ministry of Energy, Mines and Petroleum Resources*; Open File.

Desjardins, P.J., Arksey, R.L., and MacIntyre, D.G., (1991): Geology of the Lamprey Creek map sheet (93L/3); in Geological Fieldwork 1990, *British Columbia Ministry of Energy, Mines and Petroleum Resources*, Paper 1991-1, pages 111–119.

Diakow, L.J. compiler (2006): Geology of the Tahtsa Ranges between Eutsuk Lake and Morice Lake, Whitesail Lake map Area, west-central British Columbia (Parts of NTS 093E/5, 6, 7, 9, 10, 11, 13, 14 and 15), *British Columbia Ministry of Energy, Mines and Petroleum Resources*, Geoscience Map 2006-5, 1:150 000 scale.

Dow, W.G. (2000): Geochemical analysis of outcrop samples from Tingmerkpuk 1998 project; *State of Alaska Department of Natural Resources*, Division of Geological and Geophysical Surveys, Raw Data File 200-3, 64 pages.

Enkin, R.J., Vidal, B.S., Baker, J., and Struyk, N.M. (2008): Physical properties and paleomagnetic database for south-central British Columbia; in Geological Fieldwork 2007, *British Columbia Ministry of Energy, Mines and Petroleum Resources*, Paper 2008-1, pages 5–7.

Evenchick, C.A. and Thorkelson, D.J. (2005): Geology of the Spatsizi River map area, north-central British Columbia; *Geological Survey of Canada* Bulletin 577, 276 pages.

Ferri, F., Mustard, P.S., McMechan, M., Ritcey, D., Smith, G.T., Boddy, M. and Evenchick C. (2005): Skeena and Bowser Lake Groups, west half Hazelton map area (NTS 093M): in Summary of Activities 2005, *BC Ministry of Energy, Mines and Petroleum Resources*, pages 113-131.

Ferri, F. and Riddell, J. (2006): The Nechako Basin project; new insights from the southern Nechako basin; in Resource Development and Geoscience Branch, Summary of Activities, *British Columbia Ministry of Energy, Mines and Petroleum Resources*, pages 89–124.

Gagnon, J-F. and Waldron, J.W.F. (2008): Ashman Ridge section revisited: new insights for the evolution of the Bowser Basin, northwestern British Columbia (93L/13); Geoscience BC Summary of Activities 2007, *Geoscience BC* Report 2008-1, pages 121–128.

Grainger, N.C., Villeneuve, M.E., Heaman, L.M., and Anderson, R.G. (2001): New U-Pb and Ar/Ar isotopic age constraints on the timing of Eocene magmatism, Fort Fraser and Nechako River map areas, central British Columbia; *Canadian Journal of Earth Sciences*, Volume 38, Number 4, pages 679–696.

Hayes, Brad (2002): Petroleum exploration potential of the Nechako Basin, British Columbia, *British Columbia Ministry of Energy, Mines and Petroleum Resources*, Petroleum Geology Special Paper 2002-3, 52 pages.

Hunt, J.A. (1992): Stratigraphy, maturation and source rock potential of Cretaceous strata in the Chilcotin-Nechako region of British Columbia; *University of British Columbia*, unpublished Master's thesis, 448 pages.

Langford, F.F. and Blanc-Valleron, M.M. (1990): Interpreting Rock-Eval pyrolysis data using graphs of pyrolizable hydrocarbons vs. total organic carbon; *American Association of Petroleum Geologists* Bulletin Volume 74, pages 799–804.

MacIntyre, D.G. (1985a): Geology and mineral deposits of the Tahtsa Lake district, west central British Columbia; *British Columbia Ministry of Energy, Mines and Petroleum Resources*, Bulletin 75, 82 pages.

MacIntyre, Don G. (1985b): Geology of the Tahtsa Lake District; Figure 2 in Bulletin 75, *British Columbia Ministry of Energy, Mines and Petroleum Resources*, 1:50 000 scale.

Massey, N.W.D, MacIntyre, D.G., Desjardins, P.J., and Cooney, R.T. (2005): Geology of British Columbia; *British Columbia Ministry of Energy, Mines and Petroleum Resources*, Geoscience Map 2005-3, 1:1 000 000 scale.

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

Peters, K.E. (1986): Guidelines for evaluating petroleum source rock using programmed pyrolysis; *American Association of Petroleum Geologists*, Bulletin Volume 70, pages 318–329.

Riddell, J.M., compiler (2006): Geology of the southern Nechako Basin, NTS 92N, 92O, 93B, 93C, 93F, 93G; *British Columbia Ministry of Energy, Mines and Petroleum Resources*, Petroleum Geology Map 2006-1, 1:400 000 scale.

Riddell, J., Ferri, F., Sweet, A. and O'Sullivan, P. (2007): New geoscience data from the Nechako basin project; in The Nechako Initiative – Geoscience Update 2007; *British Columbia Ministry of Energy, Mines and Petroleum Resources*, Petroleum Geology Open File 2007-1, pages 59–98.

Roddick, J.A. and Tipper, H.W. (1985): Geology, Mount Waddington 92N; *Geological Survey of Canada*, Open File 1163 map, 1:250 000 scale.

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

Tipper, H.W. (1962): Geology, Nechako River; *Geological Survey of Canada*, Map 1131A, 1:253 440 scale (1 inch to four miles).

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., Campbell, R.B., Taylor, G.C. and D.F. Stott (1974): Geology, Parsnip River, British Columbia; *Geological Survey of Canada* Map 1424A, 1:1 000 000 scale.

Tipper, H.W. and Richards, T.A. (1976): Jurassic stratigraphy and history of north-central British Columbia; *Geological Survey of Canada* Bulletin 270, 73 pages.