Characterization and Structural Framework of Eocene Volcanic Sequences in the Nechako Region, Central British Columbia (NTS 092N, O, 093B, C, G)

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Introduction

The Nechako region of central British Columbia (BC) is partially underlain by Jura–Cretaceous successor-basin clastic sedimentary rocks with petroleum potential (Ferri and Riddell, 2006; Riddell and Ferri, 2008). Exploration efforts between 1931 and 1986 have resulted in over 1100 km of seismic profiles, 5000 km of gravity surveys and the drilling of 12 wells. Recent surveys and interpretive efforts facilitated by Geoscience BC (i.e., Calvert et al., 2009; Hayward and Calvert, 2009; Spratt and Craven, 2009, 2010) include approximately 330 km of seismic reflection data and new magnetotelluric surveys, and have attracted interest as well as provided a greater understanding of the region.

Mesozoic stratigraphy and structures, which potentially host hydrocarbons in the Nechako region, have been subjected to widespread Eocene magmatic, thermal and structural overprinting, which have extensively modified and complicated the older geology. Variable thicknesses of Eocene volcanic strata now cover potentially hydrocarbon-bearing host rocks. Masking of the hydrocarbon prospective strata is further exacerbated by the extensive cover of Late Cenozoic subaerial Chilcotin flood basalts (Andrews and Russell, 2008) and extensive glacial sediments, typically between 10 and 50 m thick (Andrews and Russell, 2008).

Over the course of this project, the authors propose to evaluate the nature, thickness and structural framework of Eocene volcanic rocks in the Nechako region, which will lead to increased understanding of the area's Cenozoic history, contribute to improved interpretations and add value to existing seismic and magnetotelluric data sets.

In this paper, the authors present the significant outcomes of their 2010 field season, document the nature, structure and extent of the different packages of volcanic sequences currently inferred to be Eocene in age, and discuss the latter's relationships with underlying and overlying rocks.

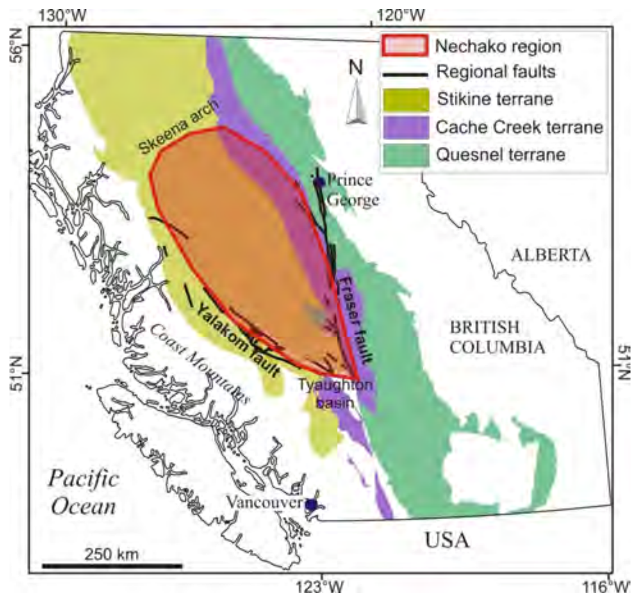

Figure 1. Location of the Nechako region in central British Columbia, and position of the region relative to the accreted terranes and regional structures.

Geological Summary and Stratigraphy

The Nechako region is underlain by the accreted Paleozoic and Mesozoic terranes of the western Canadian Cordillera, including the Stikine (island arc), Cache Creek (subduction-related accretionary-complex) and Quesnel (island arc) terranes (Figure 1; Monger and Price, 2002; Gabrielse and Yorath, 1991). The Nechako region has been defined as the area bounded to the east by the Fraser fault, to the west by the Coast Mountains and Yalakom fault, by the Skeena arch to the north and the Tyaughton Basin to the south (Figure 1; Ferri and Riddell, 2006).

Jura–Cretaceous Basin Stratigraphy

Jurassic strata are poorly exposed in the region (Figure 2). Basalt and andesitic lava flows, sedimentary rocks, lapilli tuff and rhyolite ash flows of the Early and Middle Jurassic Hazelton Group are exposed in the Tsacha Lake area (NTS

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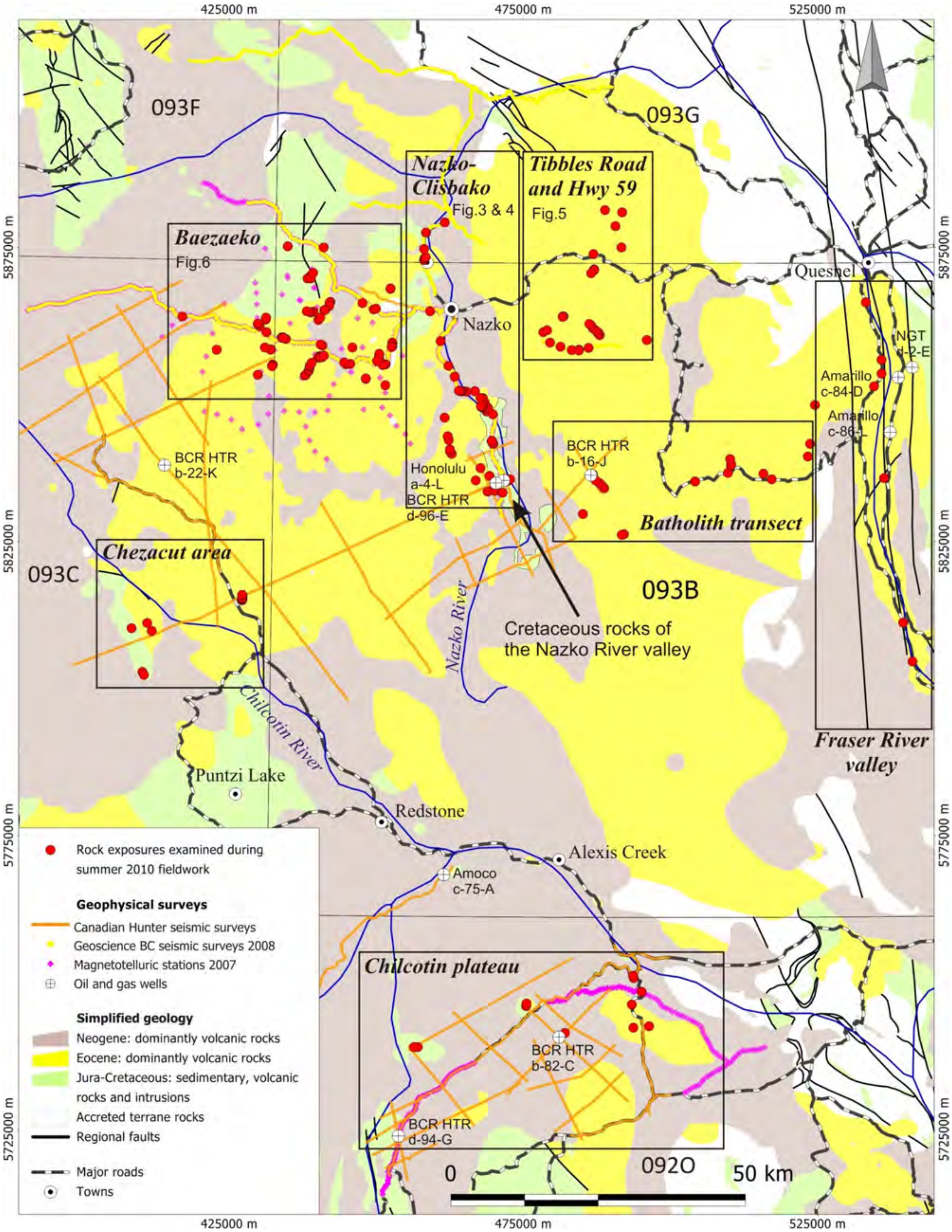

Figure 2. Simplified geology (based on Massey et al., 2005) of the Nechako region, central British Columbia, showing the distribution of documented outcrops, oil and gas wells (Ferri and Riddell, 2006), seismic lines (Calvert et al., 2009; Hayward and Calvert, 2009) and magnetotelluric stations (Spratt and Craven, 2009, 2010). Key locations and traverses illustrated in subsequent figures are also shown (UTM Zone 10N, NAD 83).

093F; Diakow and Levson, 1997). Similar units ascribed to the Hazelton Group are also identified in the western part of the Quesnel 1:250 000 map sheet (NTS 093B; Tipper, 1959). Middle to Upper Jurassic strata consist of sandstone, conglomerate, shale and minor calcareous sediments, andesitic, rhyolitic and basaltic flows associated with tuff, breccias and volcaniclastic sandstone and conglomerate (Riddell, 2006; Riddell and Ferri, 2008). In the Chilanko Forks (Mihalynuk et al., 2009) and Chezacut areas (Mihalynuk et al., 2008a; Figure 2), undated occurrences of volcaniclastic rocks, basalts, dacite tuff and breccias occur, which may be Jurassic in age as inferred by Tipper (1969).

Cretaceous rocks are sparsely exposed in the region. Thick beds of Cretaceous conglomerate and sandstone are locally exposed along the Nazko River valley as a result of tectonic deformation and tilting, but their extent outside of this narrow belt in unknown. These clastic sedimentary rocks are rich in chert clasts, but contain a variety of clasts types in variable proportions, including quartzite and volcanic rock pebbles. Feldspar crystals and muscovite flakes are locally abundant.

Eocene Volcanic Rocks

Locally thick, subaerial Eocene volcanic sequences unconformably overlie the deformed Mesozoic rocks. Eocene magmatic rocks erupted during a period of regional northwest-directed extension (Struik and MacIntyre, 2001) associated with movement along major north-northwest-trending structures, such as the Yalakom and Fraser dextral strike-slip faults. Dextral transtensional events were accompanied by extensive volcanism, which probably exploited the major extensional structures as conduits towards the surface.

Eocene volcanic rocks have been traditionally divided into the Ootsa Lake Group and the Endako Group (Souther, 1991; Anderson et al., 2000). The Ootsa Lake Group comprises flow-banded rhyolite, dacite, amygdaloidal basalt flows and minor andesite flows and tuff units (Diakow and Mihalynuk, 1986; Wetherup, 1997; Grainger et al., 2001; Riddell, 2006), locally interbedded with alternating sandstone and coarse pebble- to cobble-conglomerate beds (Diakow and Mihalynuk, 1986; Wetherup, 1997). Regional lithological variations are observed between the northern and southern part of the Nechako region (Grainger et al., 2001). To the north, on the Whitesail Lake map sheet (NTS 093E), diorite sills and dikes, andesitic and basaltic flows, and augite-phyric basalt flows are intermixed with dacitic tuff at the base, air-fall tuff, ash-flow tuff, debris flows and conglomerate. On the Nechako River and Fort Fraser map sheets (NTS 093F and 093K, respectively), rhyolitic flows and domes, tuff, pyroclastic and autoclastic breccias and minor dacitic and andesitic flows dominate. The age of the Ootsa Lake Group in the Vanderhoof area has been constrained between 53–47 Ma by U-Pb and Ar-Ar dating techniques (Grainger et al., 2001).

The Endako Group consists of andesitic basalts and basalt flows (Grainger et al., 2001). They are distinguished from the younger Chilcotin Group basalts by the presence of significant amounts (5–30%) of elongate to acicular plagioclase phenocrysts and limonite-, chlorite-, calcite- or quartz-filled amygdules (Wetherup, 1997). Whereas the Chilcotin basalts are normally horizontal, the Endako Group basalts form beds 1 to 3 m thick consisting of rarely columnar-jointed, moderately to highly vesicular lava and dipping moderately from 20 to 30° (Wetherup, 1997). West of the Fraser River, south of Quesnel, an Eocene assemblage of pyroclastic rocks, lava flows and minor sedimentary rocks has been assigned to the Endako Group (Logan and Moynihan, 2009). This assemblage includes autobreccias, monomictic and diamictic debris deposits that predominate over coherent flows, tuffs and sedimentary rocks. East of the Fraser River, locally columnar-jointed, flat-lying vesicular basalt or basaltic andesite flows interlayered with clastic units yielded a K-Ar age of 50–44 Ma (Logan and Moynihan, 2009), which is similar to the 51–45 Ma (Ar-Ar) age previously obtained for the Endako Group (Grainger et al., 2001).

Eocene and/or Oligocene Rocks

Tipper (1959) recognized a distinct mappable unit in the northern part of the Quesnel 1:250 000 map sheet, east of the Nazko River. This unit is formed of basalt, andesite, related tuff and breccias, as well as minor conglomerate, sandstone and shale. From the field relationships, these rocks were inferred by Tipper to be younger than and distinct from the Ootsa and Endako groups, but younger than the Chilcotin basalts.

Neogene Rocks

Unconformably overlying the Eocene volcanic sequences are the Neogene (28–1 Ma) Chilcotin Group flood basalts (Andrews and Russell, 2008). These are generally flat-lying to shallow-dipping, massive to columnar-jointed, olivine-phyric basalt lavas with minor pillow basalts and hyaloclastite. They cover an area possibly as large as 30 000 km^2 in central BC and have been demonstrated to be thinner than 50 m, except in paleodrainage areas where they can be over 50 m thick (Andrews and Russell, 2007; Andrews and Russell, 2008).

Mesozoic and Cenozoic Intrusions

Post-accretionary plutonic suites of the Late Triassic, Middle Jurassic, Late Jurassic–Early Cretaceous, Late Cretaceous and Eocene intrude older sequences (Struik and MacIntyre, 2001; Riddell, 2006), but few have been mapped in the central part of the Nechako region. These intrusions display a range of compositions from granite, through diorite, granodiorite, monzonite and tonalite to syenite (Massey et al., 2005), which are not included in the present study as they were not investigated.

Regional Structural Framework

Three major fault systems, north-, northwest- and northeast-trending, are recognized in the Nechako region (Struik, 1993). North-trending dextral faults form an en échelon fault system and include the Pinchi and Fraser regional faults (Struik, 1993). Their last movements are inferred to be Late Eocene to Early Oligocene in age and are coeval with the northwest-directed extension that exposed the Vanderhoof Metamorphic Complex between 55–45 Ma (Struik, 1993; Wetherup and Stuik, 1996; Wetherup, 1997).

Early Eocene northwest-trending faults, such as the regional Yalakom and Casey faults, are attributed to extension and dextral-translation processes (Struik, 1993). In the Endako region, the Casey fault presents a minimum of 4 km of horizontal dextral displacement (Lowe et al., 2001). These faults are inferred to be older than the north-trending strike-slip faults, and have accompanied the development of Early Cenozoic pull-apart basins (Struik, 1993).

Northeast-trending faults show dip-slip extensional motion (Struik, 1993) and, in the Endako region, are associated with northwest-trending faults. They show normal or strike-slip displacement and are often filled with Eocene mafic dikes (Lowe et al., 2001). Extensional deformation is confined to the Late Cretaceous, Paleocene or Early Eocene, and has the same age constraints as the northwest-trending strike-slip faults (Struik, 1993).

Considerable evidence for deformation is found within the Mesozoic to Cenozoic rocks of the Nechako region. Widespread block faulting and extension is inferred to have taken place during Eocene magmatic events (Struik and MacIntyre, 2001). In the Chezacut map area, large-scale folding rather than block faulting and rotation is proposed to explain the variable dips of Ootsa Lake Group strata, as well as penetrative, closely spaced shear fabrics (Mihalynuk et al., 2008b).

Field Investigations

Field surveys conducted in 2010 covered a large portion of the Nechako region, with emphasis in the area near Nazko and along existing seismic, gravity and magnetotelluric (MT) surveys (Table 1, Figure 2). Over 200 rock exposures were mapped, many more new outcrops were documented, and about 300 rock samples collected. Magnetic susceptibility data were also collected at each outcrop. Detailed results of the magnetic susceptibility survey will be provided in a subsequent final project report.

Numerous previously undocumented rock exposures have been identified in the Nazko–Clisbako, Baezaeko and Tibbles Road areas (Figure 2), which lent themselves to the collection of a detailed and relatively continuous lithological and structural dataset. Investigations on the Chilcotin plateau were less fruitful since outcrops are scarce and field relationships are more difficult to establish. The recently mapped Chezacut area (Mihalynuk et al., 2008a) was also investigated to correlate units from previously recognized outcrops. Additional traverses were conducted along an eastern portion of the transect that was seismically surveyed in 2009 as part of the BATHOLITHS Continental Dynamics Project (Wang et al., 2010) between Nazko and Quesnel, and along the Fraser River valley between Quesnel and Williams Lake (Figure 2) to document the regional signature of the Eocene volcanic sequences outside of the main survey areas.

Field Observations

A range of volcanic rock compositions and textures were observed over the surveyed areas. Observations made along four of the main traverses: Nazko and Clisbako valleys, Baezaeko area, Tibbles Road and Highway 59, and Chilcotin plateau are presented below. Rock types and textural interpretations corresponding to studied locations are presented in maps in the accompanying figures. Descriptions of the rock types are supported by macroscopic and microscopic samples observations. Where available, field relationships between units are illustrated using field sketches and photographs.

Nazko–Clisbako Traverse (NTS 093B and 093G)

Deformed Cretaceous clastic sedimentary rocks are exposed along the Nazko River valley, and tilting of these strata may be syn- or post-Cretaceous. They are unconformably overlain by coherent, massive to columnar-jointed, vesicular basaltic to andesitic lava flows inferred to be part of the Ootsa Lake, Endako or Chilcotin groups (Tipper, 1959; Massey et al., 2005). These volcanic rocks are exposed along the Nazko River valley on the hills forming the valley walls and to the east, along the Clisbako River (Figure 3). Fragmental units associated with the coherent lavas are mostly autoclastic flow-top breccias (Figure 3a and b). Some outcrops of inferred Eocene volcanic rocks display strong evidence of deformation, marked by intensely fractured rocks, tight folds and small-scale faults.

A commonly observed coherent unit along the Clisbako valley is made of very dense plagioclase-phyric basalt which forms massive outcrops of subhorizontal (Figure 3c) or subvertical (Figure 3d) columnar-jointed lava. To the south, this unit overlies beds of coherent, banded, aphanitic brown-black rhyolitic lava (Figure 3e). Macroscopic samples of plagioclase-phyric mafic lava from these different

Table 1. Summary of traverses and corresponding geophysical surveys carried out in the Nechako region of central British Columbia.

Traverse name	NTS area	Traverse description	Approximate length	No. of outcrops	Seismic lines (1–3)	MT surveys (4)	Oil and gas wells (5)
Nazko-Clisbako	093B; 093G	NS traverse along the Nazko River and Clisbako River valleys, from 15km north of Nazko south to the Honolulu well	46 km	66	GBC 2008-05 and GBC 2008-12; Canadian Hunter	Profile B	HONOLULU a-4-L; BRC-HTR d-96-E
Baezaeko	093B; 093C	EW traverse along the Baezaeko FSR and secondary branches	36 km	70	GBC 2008-10 ; Canadian Hunter	Profiles A, E	
		NW traverse along the Old Baezaeko Road and secondary branches	18 km	21	GBC 2008-06 ; Canadian Hunter	Profile C	
Tibbles Road / Highway 59	093B; 093G	EW traverse along the Tibbles FSR and secondary branches; continuity of units assessed along Hwy 59 to the north	18 km	24	GBC 2008-15 ; Canadian Hunter	Profile D	
Chezacut	093C	Review of several outcrops previously mapped by Mihalynuk et al. (2008)	50 km	17	Canadian Hunter		BCR-HTR b-22-K
Chilcotin Plateau	092O; 092N	Several traverses in various directions, mainly following the old CH seismic lines	20 km x 10 km	11	Canadian Hunter	Profiles F, G, H	BCR-HTR d-94-G; BCR-HTR b-82-C
Batholith transect	093B	EW traverse along the 3400 FSR	50 km	22	Batholith transect		BCR-HTR b-16-J
Fraser River Valley	093B	Review of several outcrops along the Fraser River valley between Quesnel and Williams Lake	100 km	11			NGT d-2-E; AMARILLO c-86-L; AMARILLO c-84-D

Source references for geophysical data:

(1) Geoscience (GBC) seismic lines: Calvert et al., 2009; http://www.geosciencebc.com/s/Fileaccess_OilGas.asp

(2) Canadian Hunter seismic lines: Hayward and Calvert, 2009

(3) Batholith seismic transect: Wang et al., 2010

(4) Magnetotelluric surveys: Spratt and Craven, 2009, 2010

(5) Oil and gas wells: Ferri and Riddell, 2006

Abbreviations: FSR, Forest Service Road; CH, Canadian Hunter

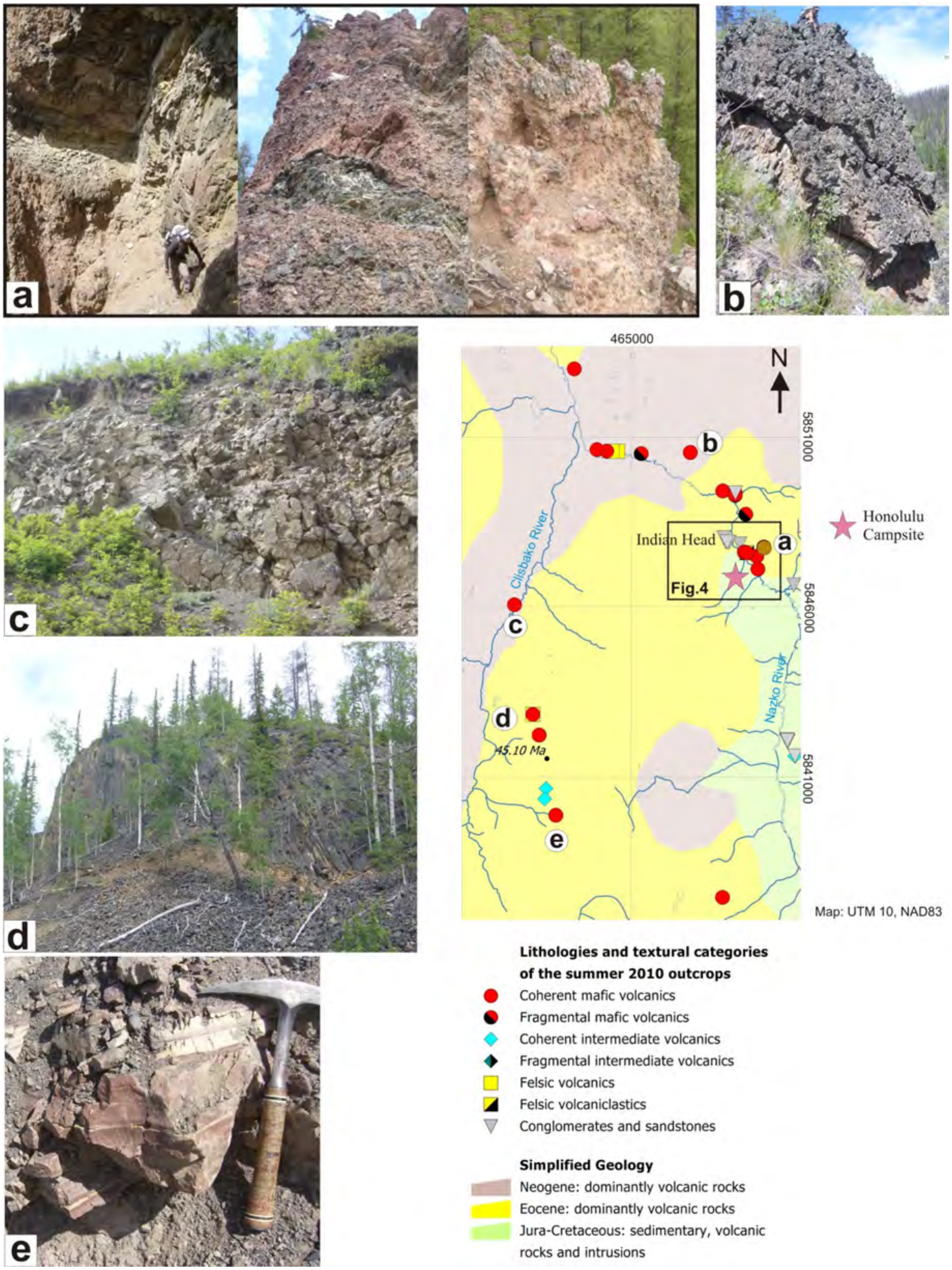

Figure 3. Nazko–Clisbako traverse, in the Nechako region, central British Columbia, showing dominant lithological and textural information for each sample locality: **a)** coherent, massive basaltic flows and associated autoclastic flow-top breccias inferred to be part of the Eocene Ootsa Lake Group (also see Figure 4c); **b)** coherent, columnar-jointed basaltic flows overlain by autoclastic breccia, assigned to the Chilcotin Group on existing maps (Massey et al., 2005; Riddell, 2006); **c)** subhorizontal columns of basalt, assigned to the Chilcotin Group on existing maps but inferred to be Eocene, based on tilting of the columns and correlation with similar outcrops; **d)** basaltic dome and subvertical columnar joints inferred to be part of the Eocene Ootsa Lake Group (Massey et al., 2005; Riddell, 2006); **e)** banded rhyolite inferred to be part of the Endako Group (Massey et al., 2005; Riddell, 2006).

locations display very similar rock composition and textures. These rocks have been assigned to the Eocene Ootsa Lake and Endako groups or to the Neogene Chilcotin Group on pre-existing maps (Massey et al., 2005; Riddell, 2006), but are believed to represent a distinct mappable unit.

West of the Nazko River, the Indian Head promontory is defined by a 90 m thick succession of Cretaceous conglomerate and sandstone dipping about 60° to the south (Figure 4a–d). East of the Nazko River, across from the promontory, folded, banded, felsic ash-tuff deposits are observed within a length of 5 km along Honolulu Road. A thin ash and tuff deposit overlying coherent massive and vesicular basaltic rocks can be seen on Figures 4e–f.

Tibbles Road and Highway 59 Traverse (NTS 093B and 093G)

East of Nazko and the Nazko–Clisbako traverse described above, a large abundance of felsic ash and tuff deposits were mapped; these are spatially associated with coherent mafic units. Both rock types are included with the Endako Group on previous compilations by Massey et al. (2005) and Riddell (2006).

North of Highway 59 (Figure 5), an outcrop of dense, nonvesicular columnar-jointed basalts forms a dome-like structure at a topographic high (approximately 2000 m asl). The base of the outcrop is made up of large, massive columns. Towards the top, the boundaries of centimetre-scale beds intersect the columnar joints pattern (Figure 5a). Similar rock units are found towards the south and are characterized by the presence of variable proportions of vesicles, but the matrix is consistently dense and aphanitic. Other mafic rock types include dark grey-purple-reddish, dense and hard, slightly vesicular to highly vesicular coherent plagioclase-bearing andesite or basalt, which are associated with autoclastic breccias. Several rock samples show fracture planes filled with very hard, mammillary silica-rich mineral, probably chalcedony.

South of Highway 59, felsic volcanic rocks dominate. Figure 5b illustrates an outcrop of a bedded light grey plagioclase-biotite-magnetite aphanitic rhyodacite interbedded with coherent massive vesicular basalt. Along Tibbles Road and transversal forestry roads, several roadside quarries provide good access to a widely recognized mappable unit of consolidated rhyolitic tuff-ash deposit (Figure 5c), which has been dated at 49.8 Ma (K/Ar whole-rock geochronology; Rouse and Mathews, 1988) at one location along Highway 59. These good quality exposures allow for the collection of structural data and observation of local compositional variations within this unit. Macroscopic samples display a white to pale pink matrix made up of ash-size compacted particles. Crystals include quartz, biotite and, possibly, some magnetite or pyrrhotite in variable proportions. Banding is observed locally, as are fiammae. Dendritic pyrolusite is commonly observed on fracture surfaces, and iron oxides and sulphides have been locally identified.

Another roadside quarry displays a sequence of several volcaniclastic deposits. Three rock types are identified:

- a brecciated unit made of angular to subangular blocks of dark grey-red highly vesicular basalts supported by a soft-weathered, light pink vesicular matrix, (Figure 5d, left photo)
- a layered, poorly sorted polymictic fragmental unit displaying angular to subangular ash- and lapilli-size felsic and mafic fragments (Figure 5d, right photo)
- a dark grey basaltic breccia, with centimetre-scale irregular fragments of light grey pumice-like lava in a silica rich aphanitic to glassy sparsely vesicular matrix

Another common rock type observed along Tibbles Road includes silica-rich massive to bedded aphanitic to plagioclase-bearing light grey rhyodacite (Figure 5e). Outcrops display typical centimetre-scale beds, brittle fractures and a ‘broken glass’ appearance. Mineralogy is characterized by the presence of 2–3% euhedral feldspar crystals, and a very hard and dense nonvesicular aphanitic matrix probably containing a high percentage of silica.

Baezaeko Traverse (NTS 093B and 093C)

The Baezaeko traverse displays a wide variety of volcaniclastic deposits, inferred to range from block and ash-fall deposits to volcaniclastic debris flows, and possibly includes some products of hyaloclastic brecciation. However, further work is required to characterize individual units and associate them with specific fragmental processes or emplacement environments. A number of coherent lava exposures have also been described, several of which are clearly identified as Chilcotin basalts. The main mappable units identified are described below but this review is not exhaustive.

A conspicuous mappable unit is a monomictic indurated red-brown breccia with angular blocks of black mafic volcanic rocks in a very fine-grained indurated aphanitic matrix (Figure 6a). The breccia is either clast or matrix supported and jigsaw-fit textures are observed locally.

Distinct from this unit is another poorly indurated unit that contains angular to subangular clasts of vesicular to nonvesicular basalt, which is similar in composition and texture to the coherent plagioclase-olivine basalt identified at several locations throughout the study area. The matrix is brown and very crumbly, probably as a result of alteration or weathering.

Another mappable unit is a thick, poorly sorted, layered polymictic volcaniclastic deposit, possibly a debris flow

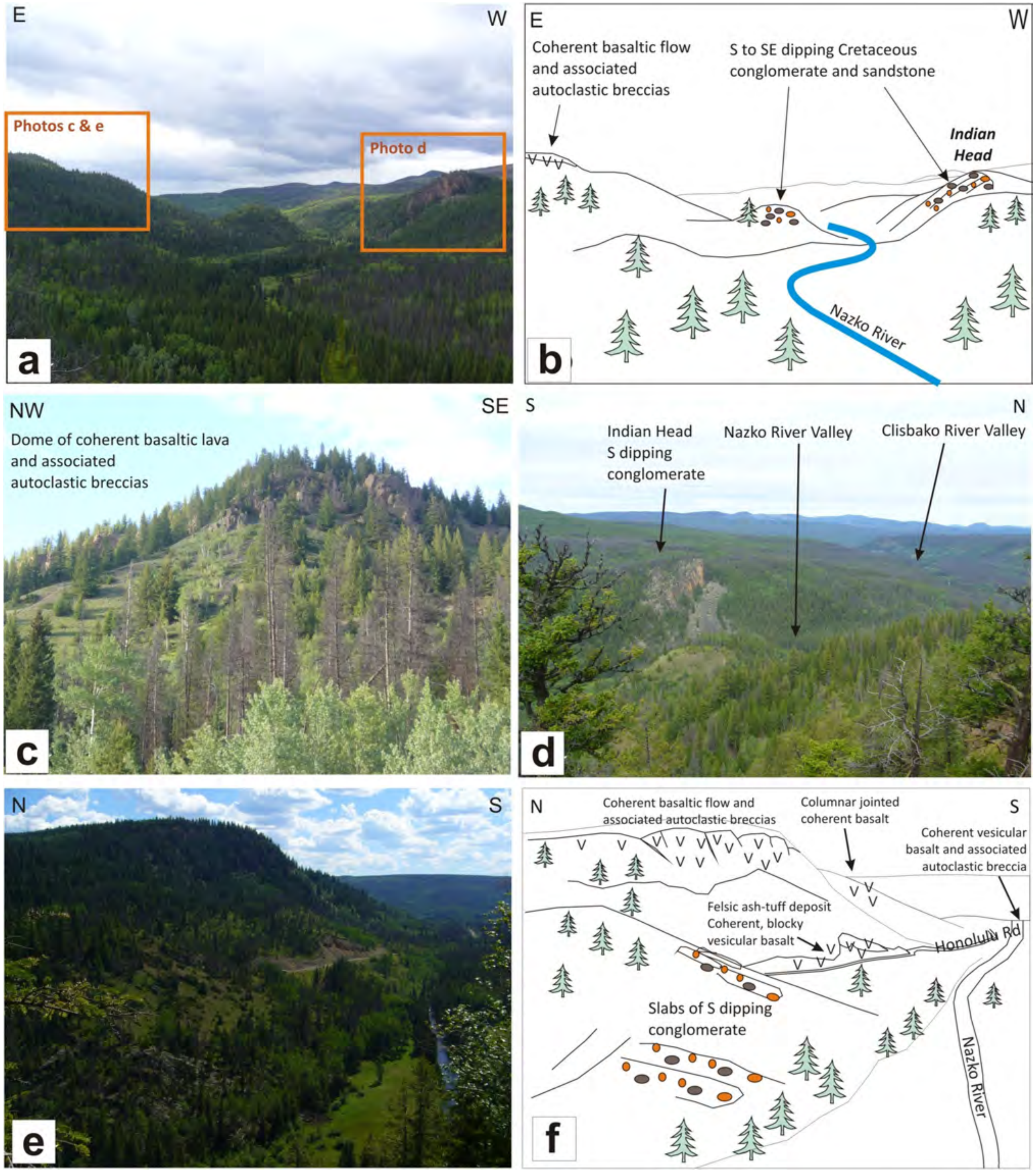

Figure 4. Stratigraphic and structural relationships in the Nazko River valley, central British Columbia: **a)** photograph and **b)** interpretative sketch of the Nazko River valley, looking south, and showing south to southeast-dipping Cretaceous conglomerate exposed at the Indian Head promontory on the western side of the Nazko River and on the eastern side of the river, and Eocene basalt flows as well as autoclastic breccias, which form the hilltop on the eastern side of the Nazko River valley; **c)** view from the campsite on Honolulu Road (see Figure 3), where inferred Eocene basaltic flows and associated autoclastic breccias form a dome dominating the Nazko River valley; **d)** south-dipping Indian Head promontory conglomerates, looking west; **e)** photograph and **f)** interpretative sketch of the Nazko River valley looking east from the Indian Head promontory, where south-dipping Cretaceous conglomerate is overlain by Eocene basalt flows and autoclastic breccias to the east, and across Honolulu Road, a thin layer of felsic ash-tuff overlies coherent, blocky vesicular basalt. Place names with the generic in lower case are unofficial.

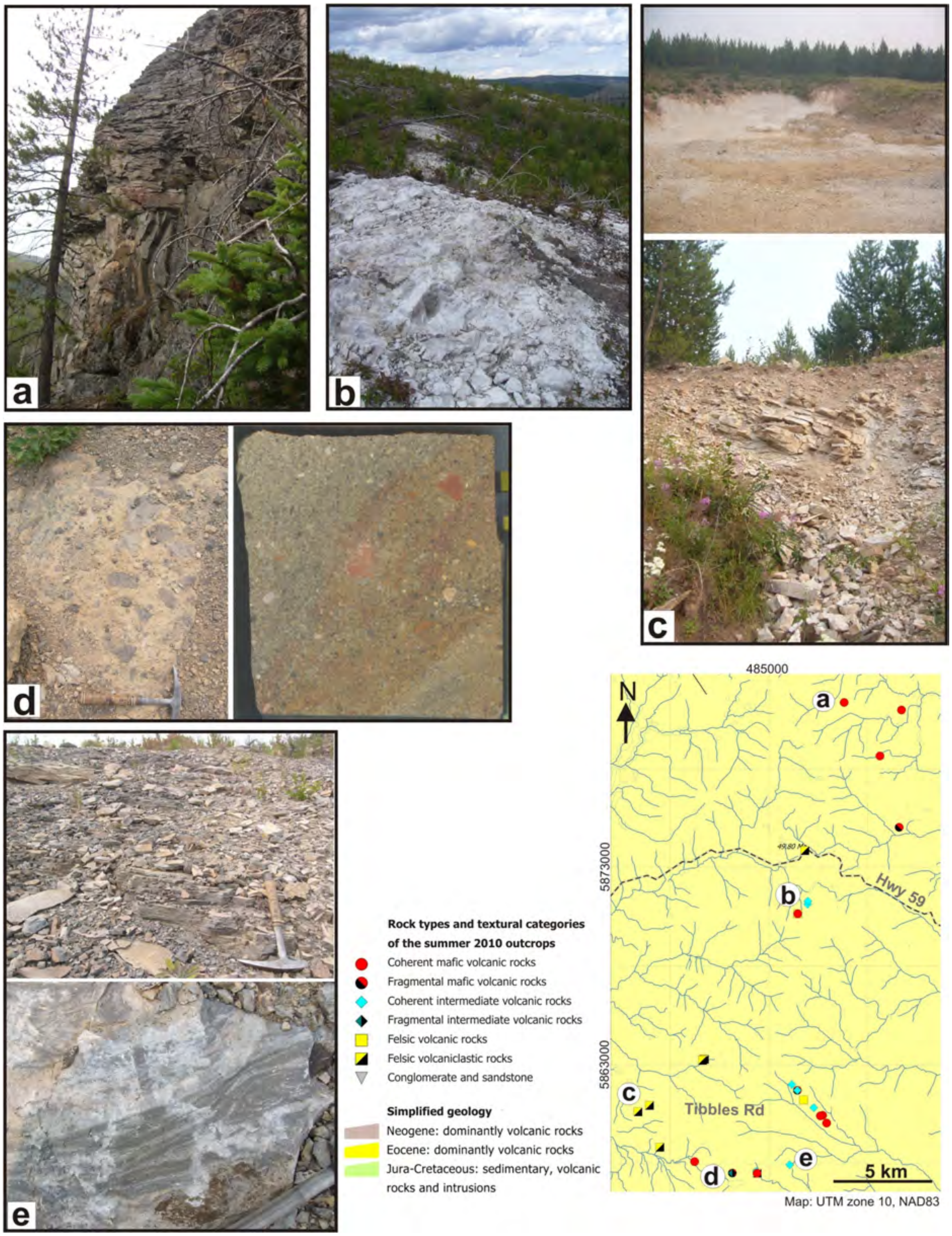

Figure 5. Tibbles Road and Highway 59 sampling locations in the Nechako region, central British Columbia, and photographs of typical exposures. All outcrops are inferred to be Eocene and/or Oligocene by Tipper (1959), and are included with the Endako Group on compilations by Massey et al. (2005) and Riddell (2006): **a)** columnar-jointed basalts; **b)** bedded rhyodacite (pale grey) interbedded with coherent massive vesicular basalt and autoclastic breccias (dark brown bands); **c)** roadside quarry (top photo) displaying bedded felsic consolidated ash-fall deposit (bottom photo); **d)** angular to subangular blocks of dark grey-red highly vesicular basalts supported by a soft-weathered, light pink vesicular matrix (left photo) and layered, poorly sorted, polymictic fragmental unit displaying angular to subangular tuff- and lapilli- size felsic and mafic clasts (right photo); **e)** bedded, slightly tilted layers of rhyodacite (top photo) overlie more massive, locally flow-banded rock of the same composition (bottom photo).

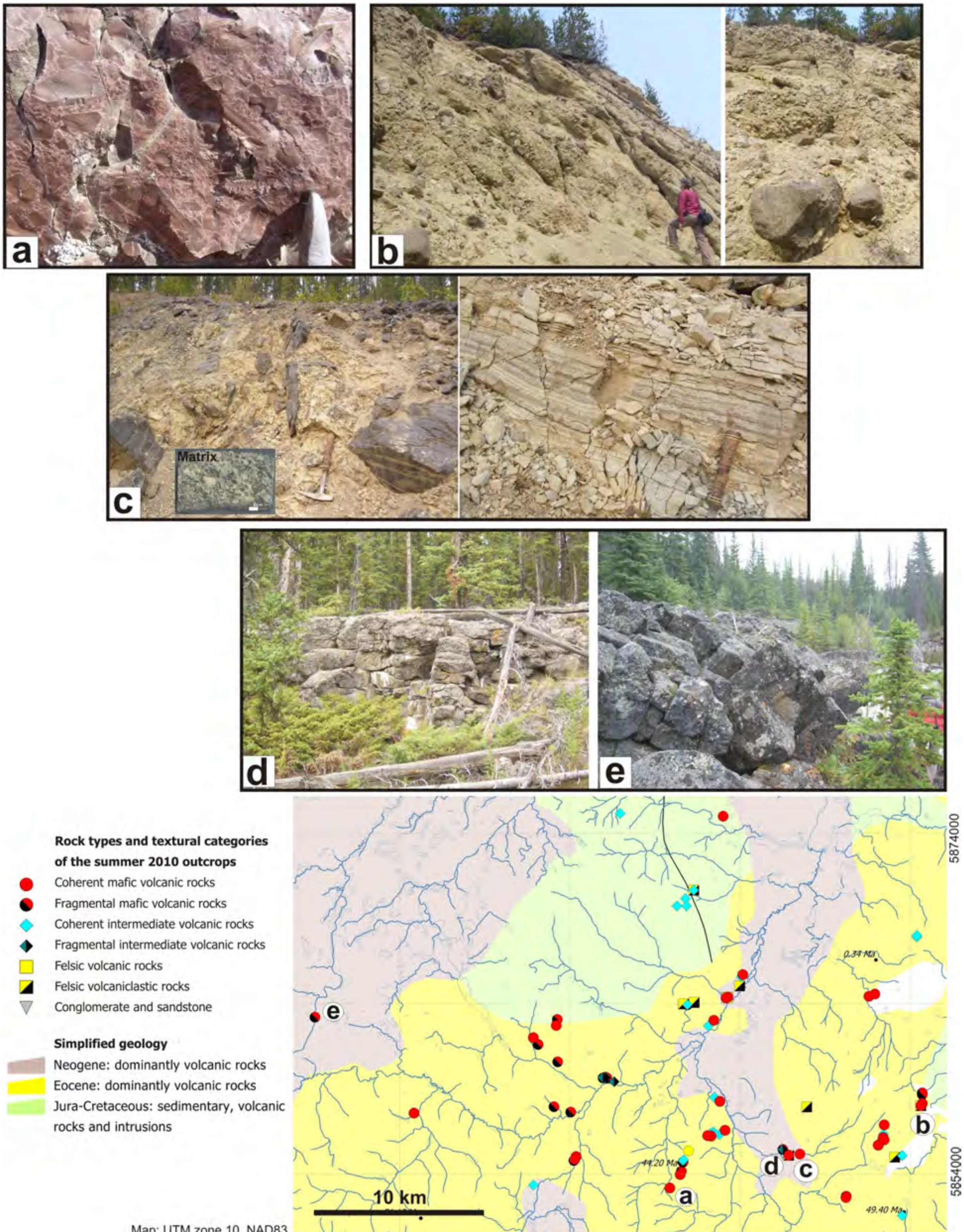

Figure 6. Baezaeko traverse sampling locations in the Nechako region, central British Columbia, and photographs of typical exposures: **a)** monomictic indurated red breccia; **b)** thick polymictic volcaniclastic deposit (left), possibly a debris flow, which displays clasts of varied sizes and compositions (right), but all of volcanic origin; **c)** roadside quarry displaying a sequence of volcaniclastic rocks, possibly a block and ash-fall deposit, with banded ash-tuff particles, which grade into lapilli-size clasts towards the top (right), overlain by a 3 m thick very chaotic, nonsorted fragmental unit comprising vesicular and nonvesicular basaltic blocks in a lapilli-tuff matrix (left); **d)** and **e)** typical outcrops of Chilcotin Group columnar-jointed basalts.

(illustrated in Figure 6b). It displays mostly rounded volcanic blocks of various sizes and compositions. About 10 km to the west, a thick sequence of volcaniclastic rocks is exposed in a roadside quarry, and is preliminarily interpreted as a block, lapilli and ash-fall deposit (Figure 6c). At the base of this outcrop, a 4–5 m thick deposit shows banded ash-tuff particles grading into lapilli-size clasts towards the top (Figure 6c, right). This sequence is overlain by a 3 m thick, very chaotic, nonsorted fragmental unit, which comprises vesicular and nonvesicular basaltic blocks in a lapilli-tuff matrix (Figure 6c, left).

Coherent mafic units assigned to the Ootsa Lake Group (Massey et al., 2005; Riddell, 2006) include dense, massive to vesicular plagioclase-phyric basalt, which locally displays a glassy matrix. Jagged autobreccia textures are often associated with this rock type. Another unit, located at the southwestern extremity of the Baezaeko traverse is composed of very dense, glassy aphanitic, brown-black, highly magnetic basalt, with dark green crystalline mantle xenoliths. Plagioclase-olivine basalts similar to the ones observed in the Nazko River valley are also recognized at several locations.

Flat-lying flows of vesicular basalt 2 to 4 m thick, which form blocky to columnar-jointed outcrops, have been previously assigned to the Chilcotin Group (Figure 6d, e; Massey et al., 2005; Riddell, 2006); these occurrences are found in topographic lows, such as rivers or along the road.

Finally, intermediate-composition volcanic rocks include bedded and banded grey-red, silica-rich, aphanitic rhyodacite such as the one observed in the Tibbles Road traverse (Figure 5e).

BATHOLITHS Seismic Transect Traverse (NTS 093B)

Along the 2009 BATHOLITHS seismic transect (Figure 2; Wang et al., 2010), coherent mafic units include massive to vesicular dark grey-purple, plagioclase-olivine–phyric to aphanitic basalts assigned to the Endako Group on previous compilations (Massey et al., 2005; Riddell, 2006). Fragmental units are associated with the coherent basalt flows. They display an ochre-orange matrix and contain blocks or ash-size particles of vesicular purple and dark grey basalt and; in some places, bedding is discernible. Coherent intermediate to felsic units are dominated by bedded, dense and highly fractured, locally slightly vesicular, light grey-green to dark grey aphanitic, intermediate dacite or rhyolite. A few occurrences of felsic, white-beige rhyolitic tuff unit were also recorded.

Chilcotin Plateau Traverse (NTS 092O and 092N)

Several traverses were conducted on the Chilcotin plateau along Canadian Hunter's seismic lines and recent MT surveys. The very few outcrops were of poor quality and too far away from each other to establish stratigraphic or structural relationships. Boulders of felsic volcanic rock (plagioclase-quartz-chlorite) occur in the vicinity of Canadian Hunter well b-82-c (Figure 2). Coherent facies recognized in this area include vesicular, blobby, mafic pyroxene-plagioclase-amphibole–bearing basalt and massive to vesicular green-purple pyroxene-plagioclase–bearing andesite. Fragmental volcanic facies include top-flow autobreccia containing blocks of angular basalt in a grey aphanitic matrix. A polymictic breccia contains angular volcanic clasts of various sizes and textures (red vesicular, grey, massive dark basalt, vesicular basalt) in a light brown-beige matrix. At the Newton gold prospect (MINFILE 092O 050; BC Geological Survey, 2010) about 24 km west of the well, Late Cretaceous to Paleogene feldspar-phyric felsic intrusive rocks are mapped (Massey et al., 2005).

Summary of Observations

The Nechako region of central BC is covered with a range of coherent magmatic and volcaniclastic rocks of various ages, compositions and textures, reflecting a long-lived and complex history of tectonomagmatic events. The Nazko and Clisbako valleys rock exposures display mostly coherent Eocene Ootsa Lake and Endako basalt and andesite flows showing typical autoclastic top- and front-flow textures, as well as minor felsic ash deposits. Several of these outcrops occur at high elevation above the valley bottom. In the Nazko River valley they overlie the deformed Cretaceous clastic rocks, which have also been intersected by two oil exploration wells drilled in the valley.

Between Tibbles Road and Highway 59, a broad felsic unit previously dated at 49.8 Ma and indicated as being part of the Endako Group on pre-existing maps is interpreted as an ash-fall deposit. Based on field observations, this unit is assumed to be continuous for up to 20 km, but it is locally interbedded with coherent mafic and intermediate lava and breccias.

In the Baezaeko traverse area, volcaniclastic units are widely present in association with coherent basaltic, andesitic and felsic volcanic rocks. The stratigraphic pattern differs considerably from that recognized in the Nazko River valley or along Tibbles Road. There is a wide variation of textures and compositions within the volcaniclastic facies, and more work is required to fully understand the different processes taking place, as well as the events and time scales with which they are associated. Chilcotin basalt outcrops normally show thick, flat beds of massive to blocky or columnar jointed, vesicular to non vesicular basalts. In this area, some of the outcrops mapped during summer 2010 have been previously dated, providing a framework for future interpretation of thermal events.

Figures 7 and 8 are preliminary maps showing the distribution of observed volcanic facies and their corresponding

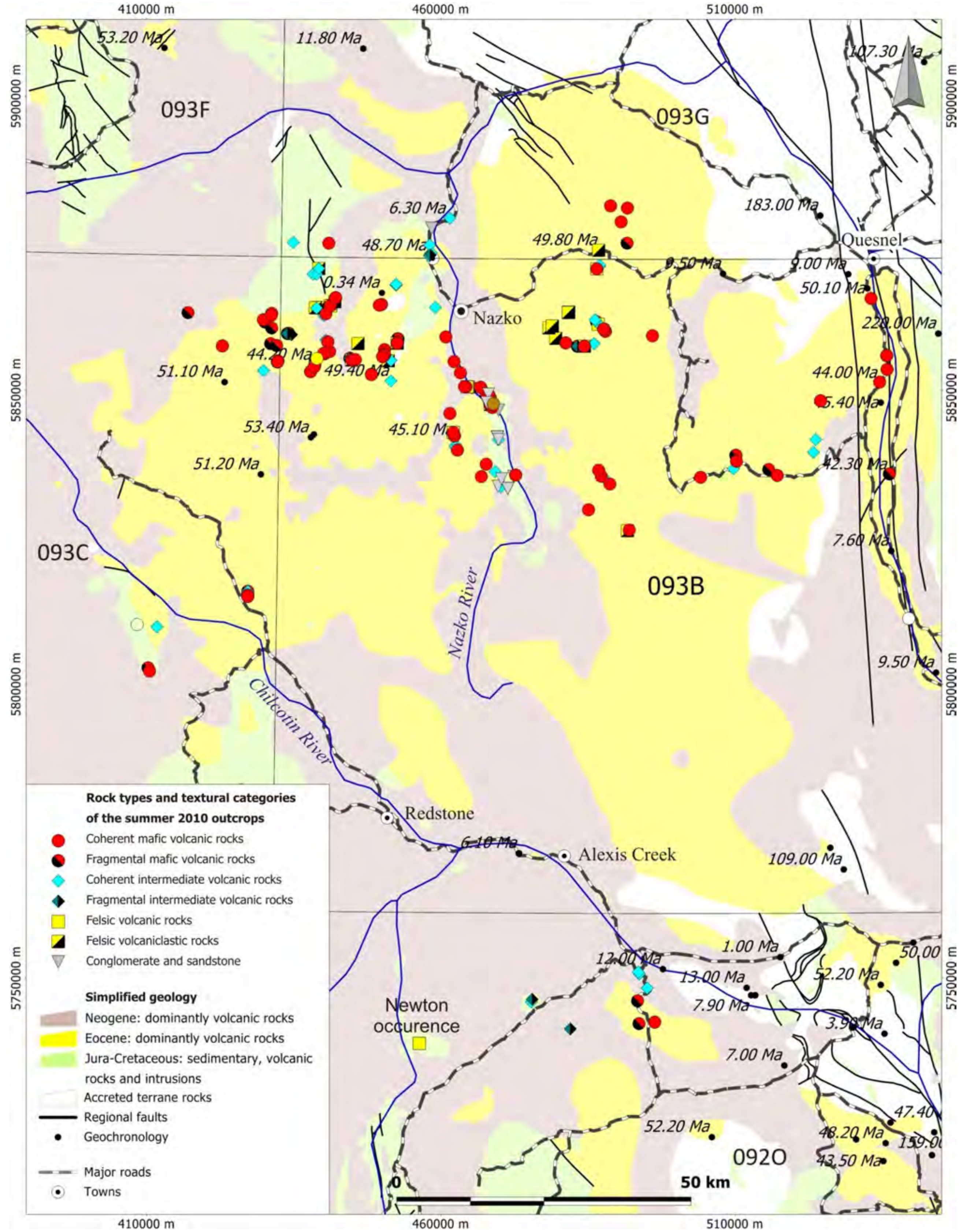

Figure 7. Regional distribution of the documented outcrops in the Nechako region, central British Columbia, and corresponding textural categories (coherent versus volcaniclastic) and rock types. Existing geochronology dates (Breitsprecher and Mortensen, 2004) are also displayed (UTM Zone 10N, NAD83).

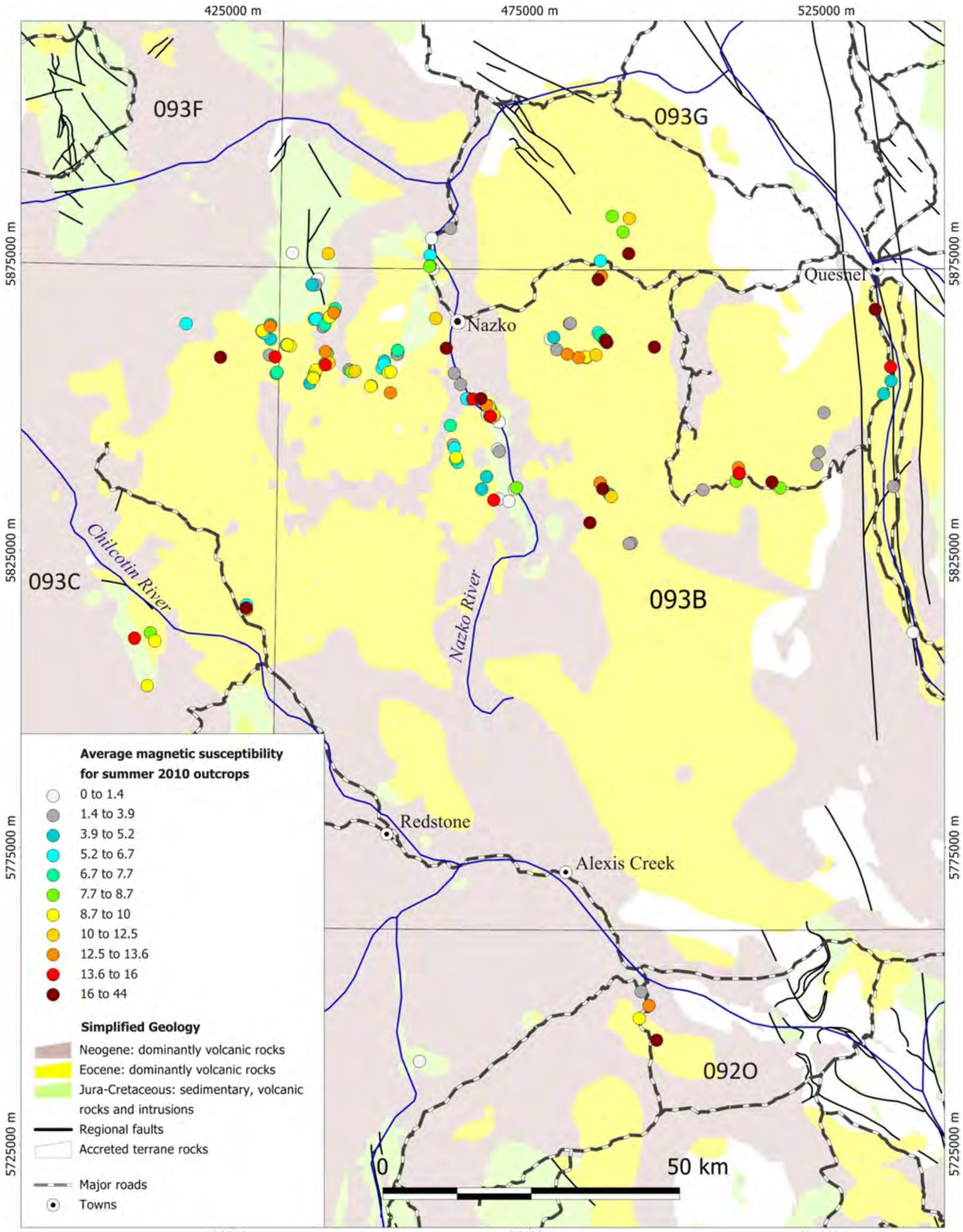

Figure 8. Distribution of the documented outcrops in the Nechako region, central British Columbia, and average magnetic susceptibility values (x 10^{-3} SI) recorded (UTM Zone 10N, NAD83).

average magnetic susceptibilities. They illustrate the spatial variability of textures, compositions and properties of the different packages of volcanic rocks collected throughout the region during the summer of 2010. This variability certainly reflects successive magmatic events and the complex tectonic evolution of central BC during Eocene times. Such observations will add value to existing geophysical datasets and lead to an improved regional scale understanding of the tectonic evolution of the region, which, in turn, will facilitate oil and gas, mineral and geothermal resource exploration efforts through this part of central BC.

Future Work

The compilation of the new field data and observations is still in progress. This critical step includes the discrimination between Eocene volcanic rocks and Chilcotin Group basalts based on composition and texture attributes, but also using field observations of the characteristics of the outcrop and relationships with adjacent units. Ultimately, an improved map of the distribution of Cenozoic volcanic units in the region will be produced. Thin-section descriptions will add value to macroscopic observations and assist in the development of a descriptive and interpretative model for the stratigraphy of the surveyed area.

The analytical part of the project will involve the processing of four rock samples for geochronology. Samples consist of felsic volcanic rocks and have been chosen to fill gaps in the existing geochronology database; samples will also be selected and processed for geochemistry and physical properties analyses.

The new observations, data and analyses will be integrated with existing datasets to develop a new set of interpretative cross-sections for the area. In particular, well data, and seismic and MT sections will be used to constrain the thickness of Eocene volcanic rocks. Structural data from the tilted Cretaceous basin strata and the overlying locally deformed volcanic succession will be used to constrain the timing and style of deformation. Subsequently, efforts will be directed towards developing a regional structural and volcanic framework for the Nechako region.

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