

A topographic and photogrammetric study of rock glaciers in the southern Yukon Territory

Amaris Page

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Department of Geography
Faculty of Arts
University of Ottawa
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2 Abstract

This research statistically examined the topographic characteristics of rock glacier locations in the Yukon Territory and tested the suitability of the Canadian air photo collection for photogrammetrically measuring rock glacier velocities. A database of more than 1500 rock glacier locations in the Yukon was compiled. The topographic characteristics of rock glaciers in a 12% sample were compared by classifying the sample by morphology (lobate or tongue-shaped) and activity (active, inactive or relict) and testing the difference between the class properties of elevation, slope, aspect and area. Tongue-shaped rock glaciers occurred at significantly higher mean and minimum elevations than lobate forms. Active rock glaciers were significantly larger than inactive and relict forms, and active forms were significantly more north-facing than inactive forms. The photogrammetry study found that it is possible to measure rock glacier movement rates from multi-temporal air photos of the quality and frequency available for the Canadian North. It was also found that thermokarst development could be tracked on multi-temporal air photos, though its presence hinders the measurement of movement. With the continued acquisition of high quality photos, the technique should prove useful for monitoring both rock glacier movement and thermokarst development.

3 Introduction

3.1 Goals of the thesis

Rock glaciers are landforms composed of sediment and ice that are found in cold, mountainous regions. Their ice content allows for internal deformation causing down-slope creep. Rock glaciers come in several varieties, depending on their origin, shape, and ice content. Rock glaciers have different shapes and origins as a result of the surrounding topography, that is its shape, its geology, and its water sources. Active (containing ice and creeping) and inactive (containing ice and not creeping) rock glaciers are examples of permafrost. Because rock glaciers of different activity levels occur in zonal patterns in many parts of the world, it has been hypothesized that the level of activity may be useful as a means from which to infer the extent of permafrost presence in an area.

This thesis addresses questions regarding the topographic characteristics of rock glacier locations in the southern Yukon Territory in order to assess their spatial spread and their subsequent usefulness as regional permafrost distribution indicators within permafrost distribution modelling. A supplemental study examines the movement of several rock glaciers in the same region to determine their level of activity and rate of flow.

Research in the Rocky Mountains of Colorado by Janke (2007) found that tongue-shaped and lobate rock glaciers (shape examples given in Figure 1) formed statistically different populations when their elevation, aspect, slope and

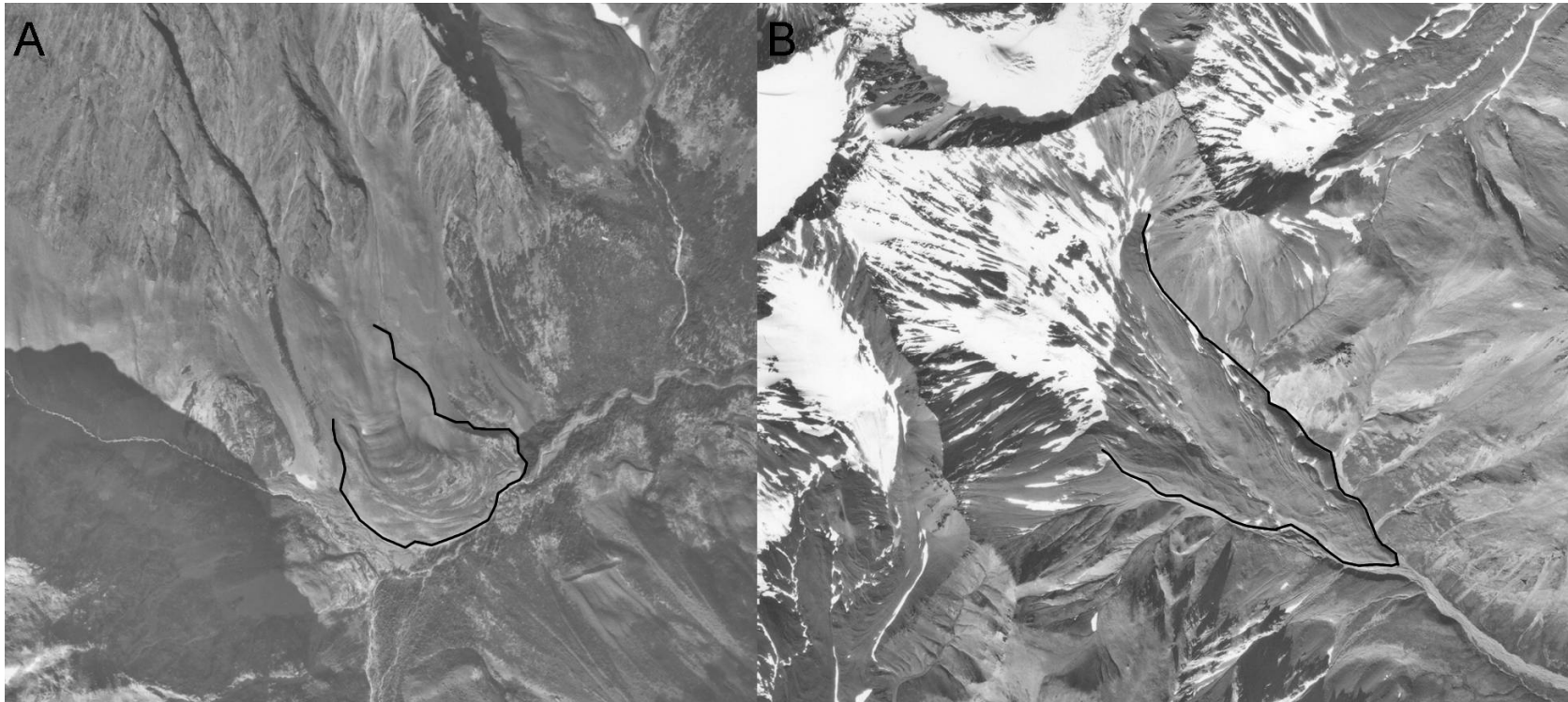


Figure 1 - Rock glacier morphologies: A: lobate; B: tongue-shaped (National Air Photo Library of Canada, A: A22355-207, B: A23794-119). Rock glacier extents indicated with the heavy black line.

area were compared. This study aims to test the relationships between the two groups using data from a higher latitude and a much larger study area.

To obtain the primary goal, a digital database of known rock glacier locations was created from existing surficial geology maps and from published (Sloan and Dyke, 1998) and unpublished research (J. P. Johnson and Hartmann-Brenner). No such database previously existed.

The purpose of the first set of results is to examine the differences in rock glacier populations as they relate to the prediction of permafrost distribution. Currently permafrost distribution in the Yukon is only understood at the most general level. Distribution modelling has the potential to provide an idea of where permafrost can and does occur at a more local scale. This is most important for environmental monitoring in an era of rapid change (indeed, even the establishment of baseline conditions), but is also useful for natural hazard assessment and infrastructure development.

The second part of this thesis deals with rock glacier movement. Very little work has been carried out on rock glacier dynamics in the Yukon Territory; the few publications include Johnson and Nickling (1979), Jackson and Macdonald (1980), Blumstengel and Harris (1988), Johnson (1998), and Sloan and Dyke (1998). These studies all included measurements taken directly on the rock glaciers over a period of time. The research outlined here attempts to evaluate whether it is possible and practical to discern rates of rock glacier movement from multi-temporal air photos. One of the sites looked at in the present study was also surveyed by Sloan and Dyke (1998), which facilitates comparison of the

techniques and provides some degree of validation for the accuracy of the photogrammetric method.

Rock glacier movement is indicative of activity (i.e. presence of ice; Haeberli, 1985) and thus of climate (and permafrost) conditions. It is unknown how climate change will affect the dynamics of rock glaciers, but using existing air photos it may be possible to determine what the rates of movement have been over roughly the last 50 years, and in some cases to see if there has been a change in the rates within the period of photo coverage. This will give a spatially diverse sample of recent rock glacier dynamics, which will be useful for comparisons with future measurements.

3.2 Research questions

The specific questions that will be addressed in this research are as follows:

Part 1

- Are lobate and tongue-shaped rock glaciers statistically different populations, according to their elevations, slopes, aspects and areas, when a random stratified sample is taken from the known population south of 65°N in the Yukon Territory?
- If so, does this indicate different origins as suggested by Janke (2007)?
- How do the results affect the possibility of using rock glaciers to indicate permafrost presence for distribution modelling?

Part 2

- Is it possible to determine rock glacier movement rates from multi-temporal air photos of the quality and frequency available for the Canadian North?
- What are the rates found and how do they compare to rates determined by other methods?
- What changes have occurred in the rates over the period of photo coverage (where photo coverage allows)?

4 Literature review

Rock glaciers have been recognized in the literature as features of mountainous landscapes in cold climate zones since at least 1910 (Capps, 1910; Moffit and Capps, 1911; Tyrell, 1910). Since then many developments have been made in their understanding, including advancements in knowledge concerning their origins, dynamics and structure, and more recently their use in modelling the distribution of permafrost. The following review discusses rock glaciers under these three specific topics. Other aspects (such as climate constraints and geological landform composition) will also be touched upon, as they influence or are influenced by the three main sections, but they will not be examined separately. The dynamics section includes a review of remote sensing techniques as used to assess rock glacier movement. The modelling section discusses only the aspects relevant to the use of rock glaciers in modelling, as modelling is covered in detail elsewhere (e.g. Etzelmüller *et al.*, 2001; Lambiel and Reynard, 2001).

4.1 Origins

4.1.1 Early theories

The origins of rock glaciers have long been a subject of speculation. In the late 1800s and early 1900s, many of the hypotheses were centred on the idea that a rock glacier was the result of some sort of mudflow or other mass movement of unconsolidated material (e.g. Bonney, 1902; Patton, 1910). Early descriptions of the landforms involve terms like “rock stream” (Cross and Howe,

1905) and “mud stream” (Bonney, 1902). These theories failed to consider that active and inactive rock glaciers are composed of ice-cemented sediments at depths of a few metres, and that their flow-indicating shapes could result from high frequency, low magnitude movement as well as from a catastrophic event (Bonney, 1902; Patton, 1910). Calling them “mud streams”, Bonney (1902) described rock glaciers in the Alps, citing landslides as their initiating event and making a plea for their distinction from moraines, a category to which he felt they would be assigned if not given adequate inspection. The next earliest coherent description of what we now call rock glaciers was given by Cross and Howe in 1905 (as cited in Patton, 1910; and Wahrhaftig and Cox, 1959), who coined both of the terms “rock stream” and “rock glacier” in reference to the landforms that they hypothesized were created during periods of glacial retreat, when weathering on newly exposed cirque headwalls caused landslides. These slides would cover the diminishing glaciers below and would be carried downslope by the glacier until all of the ice had melted away, leaving behind the rock glacier form which they imagined was a sort of moraine. They also suggested that rock glaciers could be polygenetic, and gave examples of other means of their formation while qualifying that the largest rock glaciers could only have been formed with the help of glaciers due to the volume of sediment involved (as cited in Brown, 1925). Chamberlin and Salisbury (1906, as cited in Parsons, 1939) argued that solifluction created rock glaciers through a process of deposition and movement of talus down snowbanks, slow mass movement of talus bodies possibly including ice, and glacier-like movement. Patton (1910), referring to

them as “rock streams” after Cross and Howe (1905), described rock glaciers in Colorado, arguing, like Bonney (1902), that they were formed by enormous landslides without the necessary presence of glaciers. He accounted for their absence in temperate climate zones by saying that they would be obscured by vegetation when occurring below treeline. At the time of Patton’s publication (1910), Cross and Howe (1910) changed their minds about how rock glaciers formed and agreed with Patton (1910). Moffit and Capps (1910) were the first to put forward the idea that rock glaciers contain contemporary ice and that it was responsible for at least some of their movement. They demonstrated the former by digging holes on a number of Alaskan rock glaciers, in all of which they encountered ice. Their description of the formation of the landforms followed the earlier theory of Cross and Howe (1905), except that there was never a complete melt out of ice within the rock glacier, and whether they thought the majority of it came from glacial ice or precipitation was unclear, as they recognized both as potential sources. This theory was based on the fact that small cirque glaciers headed some of the rock glaciers they encountered. They thus saw rock glaciers as successional forms related to the retreat and melt of ice glaciers. In response to the writings of Moffit and Capps (1910), Tyrell (1910) speculated that the cores of rock glaciers could be formed by the build-up of ice from the freezing of sub-talus springs which made ice bodies that he called “chrystocrenes”. His ideas were based on observations in Dawson City, Yukon, where these ice bodies were common at the base of a talus slope that bordered one end of the plain on which the city is built.

Few developments on the origins of rock glaciers occurred for many years after these original discussions. Two notable pieces of research were the digging of a tunnel up the length of one of the Colorado rock glaciers examined by Cross and Howe (1905, 1910) to the bedrock on which it sat by Brown (1925), providing a glimpse of the internal structure rarely matched to this day. This suggested that a glacier or snowbank was present under the head of the rock glacier but not under the majority of its length. The second development was the suggestion by Parsons (1939) that both glacial action and solifluction likely played a role in the formation of rock glaciers.

The rock glacier origin debate picked up with renewed vigour between the 1960s and 1980s following the comprehensive article by Wahrhaftig and Cox (1959) in which they concluded that the movement of rock glaciers results from the flow of the ice they contain, that they require steep weathering cliffs in order to form, and that they require “near-glacial” climate conditions. There were three main theories about rock glacier formation in this period: primarily glacial origin, primarily periglacial origin, and other means of formation.

4.1.2 Talus origin

Wahrhaftig and Cox (1959) provided evidence to discredit many of the early theories regarding rock glacier formation. Having accumulated survey information indicating that rock glaciers are, for the most part, constantly moving at present, they used that to rule out formation by any means that would imply settling as the only residual movement. They ignored the possibility that creep

could be initiated after a certain threshold of material accumulation had been reached. Thus they argued that landslides, talus accumulation on cirque floor snowbanks, and moraine forms could not explain the genesis of a rock glacier. They supported, therefore, the notion that rock glaciers form as a result of talus creep or solifluction.

Haeberli (1985) argued that rock glaciers could begin in scree slopes, talus cones, or sometimes in a frozen moraine. In his view, the origins of rock glaciers were poorly understood because there was a focus on studying large and well-developed features rather than smaller ones that were in earlier stages of development. He was convinced that with sufficient debris thickness, a frozen slope would begin to creep and would form a pro-talus rampart, which he considered to be the “embryonic” stage of rock glacier development. He, like some of the other researchers (e.g. Barsch, 1996; Humlum, 1982) who supported periglacial origins for rock glaciers, was adamant that their formation was entirely unrelated to glaciers: “relationships between rock glaciers and other phenomena, such as landslides or glaciers, are indirect, accidental or non-existent” (Haeberli, 1985, p.122). Barsch (1996) went so far as to declare, “the model of the so-called ice-cored (glacigenic) rock glacier has to be abolished” (p. 214, as cited in Clark *et al.*, 1998). These conclusions were based on a variety of analyses including seismic soundings, flow and density calculations, and rheological characteristics on rock glaciers others had claimed to be of glacial origin, where the authors found their test results not to be meaningfully different from those obtained from rock glaciers they considered to be of periglacial origin

(Clark *et al.*, 1998). To the outside observer lacking a personal investment in the outcome of these tests, it appears that the differences were caused by differing interpretation of the results of testing methods that lacked any real standard for their understanding, given that physical verification is rarely done due to its great cost and difficulty.

In the last 20 years, many of the hard-line periglacial origin proponents have softened their views as they and others have accumulated evidence for the roles of other processes, particularly avalanching (discussed in more detail in the “Other origins” section), in the maintenance, and possibly creation, of rock glaciers (Humlum 1996; Haeberli *et al.*, 2006; Humlum *et al.*, 2007). DC resistivity studies have also played a role in suggesting the likelihood of multiple origins for the ice found in rock glaciers (Haeberli and Vonder Mühll, 1996).

4.1.3 *Glacial origin*

Several variations exist on the argument that rock glaciers can be formed from glaciers. One of the ideas relates to the process of continued ablation of an ice glacier such that the debris it contains melts out of the ice and builds up on its surface, creating an ice-cored rock glacier. Many rock glaciers thought to be of this type have been found (e.g. Humlum, 1996; Clark *et al.*, 1998; Ishikawa *et al.*, 2001). Numerous lines of evidence have been used to support this theory, including, in the case of Humlum (1996), the exposure of the massive ice core by a meltwater channel along the majority of the length of a rock glacier, in the case of Ishikawa *et al.* (2001), the differences in DC resistivity between the glacial-

origin sample and a talus-origin sample, and in several cases (e.g. Capps, 1910; Humlum, 1996), the rock glacier observed was physically connected to an ice glacier, which formed its head.

A variation on the glacial-origin theory, that does not suggest ablation as the cause of debris build-up on the surface of a glacier, is that proposed by Shroder *et al.* (2000) following observations made in Pakistan. Their research, based on maps and remotely sensed imagery interpretation as well as site visits, found that rockfall debris (common on glaciers in the Himalayas) was building up on the surface of the glacier in question due to its inefficient transport mechanisms. The glacier studied, unlike others in the area, had not retreated over the preceding 50 years but simply did not flow fast enough to remove the debris as it was deposited.

4.1.4 *Other origin theories*

On the “other” side of the debate, Johnson (1978, 1983, 1984) was a vocal proponent of landslides and other high-magnitude events, none of which necessarily require permafrost presence in a talus slope, as formative origins for rock glaciers. His research in the southwest Yukon led him to believe that, together with glacial origins, a major origin for rock glaciers was rapid mass movement. Citing many features, such as differently-aged lobes indicating several periods of activity of a rock glacier without the evidence of any of the older lobes having reactivated upon the return of favourable conditions for formation, the lack of down-valley curvature of valley-side rock glaciers, and

morphological similarities between rock glaciers and landslide scars, he called into question the more popular talus creep origin hypothesis. He described a number of different scenarios in which catastrophic events could potentially cause the formation of a rock glacier based on the idea that slope instability caused by deglaciation, permafrost melt, melt of the remnants of a glacier encased within the talus slope, or erosion at the base of a slope could all cause massive slope failure and result in the landform known as a rock glacier (Johnson, 1984). One such scenario was that of rockfalls and landslides. It is known that weathering can be more active during deglaciation than it is today as a result of the release of pressure as the ice melts, and that with the loss of support from lateral moraines (as their ice cores melt) over-steepened slopes fail and created rock glaciers (Church and Ryder, 1972). Evidence provided to support this development includes the zonation of rock glacier distribution, which is denser in the areas deglaciated following the much larger Pleistocene glaciation than in the areas affected by the relatively insignificant Neoglacial.

Another mass movement rock glacier formation scenario not involving glaciation was that rock glaciers could be formed by a series of regressive slope failures starting at the bottom of the slope. Such an occurrence would explain the lack of a long run-out zone for the slide, as the amount of material moving at any one time would not be large and all flows except for the first would be effectively dammed by those preceding it. In this case the ridges and furrows found on many rock glaciers could be explained as being features created by the

dissipation of momentum as the slides impacted the debris left by those that came before it (Johnson, 1983; Johnson, 1984).

A related scenario involves the creation of a rock glacier following avalanching of debris-laden snow, an idea that is supported by observations that many rock glaciers have a depression between the slope at their head and the lobate form at their toe, a morphology characteristic of avalanches (Johnson, 1978; Johnson, 1983; Johnson, 1984). The avalanche hypothesis is supported by a recent publication by Humlum *et al.* (2007). Observations of rock glaciers in Svalbard led the authors to conclude that debris-laden avalanches were maintaining, and may have created the landforms. Their claims were supported by the fact that the rock glaciers occurred in known avalanche zones, as well as by the fact that a layered structure (ice-rock-ice-rock, corresponding to winter avalanches and summer ablation) was present. Haeberli *et al.* (2006) also assert that avalanching and mass wasting are the key sources of debris for rock glaciers and suggest possible correlation between the size of the rockwall supplying the sediment and the size of the rock glacier. This is a process also supported by DC resistivity findings by Isaksen *et al.* (2000) in Svalbard that indicated a layered internal structure for the rock glacier examined.

A final scenario suggested in which rock glaciers form, with the help of neither glaciers nor pre-existing talus creep, is as a result of hydrostatic pressure (Johnson, 1983; Johnson, 1984). This would occur when a seasonally frozen talus slope freezes from the surface down incorporating refrozen meltwater and creating an impermeable skin. What was otherwise free drainage would be

interrupted and hydrostatic pressure would build between the icy skin of the slope and the bedrock underneath. With sufficient pressure, the impermeable skin on the slope would give way and the water and saturated sediments would flow out from the bottom of the slope to be followed by the sediments above, which would have been undercut by the loss of support from below. This theory was based on studies of rock glacier hydrology, which demonstrated that a significant amount of drainage occurred directly from within a rock glacier to the ground below it, never forming distinct streams. It was also supported by knowledge that similar processes of pressure build-up and release occur in true glaciers. In this scenario, like the mass movement hypothesis, the ice that makes a pile of debris into a rock glacier is not necessarily present at the formation of the landform, but may come afterward with the build-up of interstitial ice.

It appears that in some cases, the origins of a rock glacier are quite clear (e.g. Capps, 1910; Humlum, 1996; Ishikawa *et al.*, 2001; Humlum *et al.*, 2007), but in others the issue has been debated for years (the Galena Creek rock glacier in Wyoming, for example; Steig *et al.*, 1998). The debate over the origins of rock glaciers seems not to be so much with the idea that they are polygenetic, which is now fairly well-entrenched, but the fact that origins can be difficult to identify in individual cases. This cannot simply be avoided because it has implications for landform dynamics, rock glacier use as a climatic indicator, and other properties of the landform.

4.2 Dynamics and structure

4.2.1 Structure

The external morphology of rock glaciers is generally now well recognized as being a lobate or spatulate debris body (Figure 1), or alternatively a tongue-shaped form (narrower at the toe than at the head), depending on the surrounding topography, and usually increasing in thickness from its head to toe. It has the appearance from afar of a flowing, viscous liquid, the surface texture often being compared to thick lava or porridge (Figure 2). The surface features include concentric or lateral ridges and furrows in some cases. Another feature seen occasionally is a smooth depression found at the head of the rock glacier, where the permafrost body has pulled away from the rockwall. This is generally a wide, shallow depression, unlike the bergschründ found on ice glaciers, which usually takes the form of a crack. An active rock glacier has a steep front sitting approximately at the angle of repose of the unconsolidated material of which it is composed (Haeberli, 1985).

Rock glaciers appear to have variable internal structure based on their origins and the processes that maintain them, though there are some characteristics that are common to all. The key common feature is the active layer, the coarse debris layer on the outside of the landform. There is general agreement that it is a few metres thick and that average grain size decreases with increasing depth to the permafrost table (Haeberli *et al.*, 2006). Some examples follow to illustrate the differences possible in the internal structure of rock glaciers.



Figure 2 – Rock glacier surface texture. Visible extent of rock glacier shown with white line. Ridge indicated by arrows.

The top, active layer of a talus-derived rock glacier is described by Barsch (1978) as being a 2 to 5 m thick blocky layer, though he states that this layer can be up to 10 m thick on an inactive rock glacier. The same layer is described by Serrano *et al.* (2006) as being 1 to 5 m thick and composed of grains averaging 10 to 15 cm in length with some boulders in excess of 6 m. Furthermore, they describe a lateral sorting of grains in this layer, with those in the middle of the landform being smaller than those at the edges.

The second layer of the talus-derived rock glacier is the perennially frozen portion. Barsch (1978) describes it as averaging 40 to 50 m in thickness, and, based on drilling results, made up of gravel to silt-sized grains (whose average size decreases with depth) cemented together by interstitial ice and containing sporadic embedded boulders and lenses of clear ice. Another example of the same layer is described by Serrano *et al.* (2006) as a “frozen body” which contains embedded boulders, and is 10 to 20 m thick based on topographic and sedimentological analysis, DC resistivity, geodetic survey, and chronology assessment.

Barsch (1978) did not include a third layer in his description of the internal structure of a talus-derived rock glacier. Serrano *et al.* (2006) did, and described it as a thinner, unfrozen layer of sediment overlying the bedrock.

An internally layered rock glacier, suggested to be an avalanche-derived landform, was described by Isaksen *et al.* (2000) following examination using DC resistivity. Its active layer is blocky and between 1 and 5 m thick. Its second, frozen layer was a 20 to 50 m thick layer of ice and debris, containing alternating

sub-layers with relatively higher and lower concentrations of debris. The sub-layers had an upward inclination near the head, approximately parallel to the surface near the middle, and towards the toe, they were angled downwards. The overall ice content was thought to be quite high and the ice was suspected of having come from a variety of different sources (Isaksen *et al.*, 2000). A third layer was present between the main frozen core and the bedrock. This third layer was less resistive than the overlying frozen core, with DC resistivity values typical of frozen, unconsolidated material, suggesting that this layer was permafrost with a low ice content (Isaksen *et al.*, 2000). Similar results were obtained by Bucki *et al.* (2004) for a rock glacier of undetermined origin in Alaska.

An ice-cored rock glacier in the Ötztal Alps, Austria, thought to be a glacially-derived form, was described by Berger *et al.* (2004). In this case, the active layer was said to be made up of an upper portion up to a few metres thick of debris that had an average diameter of 20 to 40 cm. A lower sub-layer 1.2 m thick followed this, with a distinct boundary between the two, with grains averaging less than 20 cm in diameter before the ice core was reached. Under the two portions of the active layer, there was a core of clean ice approximately 75 m thick, thought to be the remains of an ice glacier. This massive ice body directly overlaid the bedrock and no third layer was described (Berger *et al.*, 2004).

There is also limited evidence (e.g. Serrano *et al.*, 2006) for sorting of grain size lengthwise along the surface of the rock glacier with the mean grain

size increasing from the head to the foot of the landform with the long axis of grains aligned parallel to the direction of flow.

While this is not an exhaustive look at the variation that is present in the structure of rock glaciers, it is sufficient to demonstrate that the differences are large and potentially important to understanding the origins and maintenance processes that contribute to rock glacier existence.

4.2.2 Dynamics

Many of the early researchers thought that the movement of a rock glacier was essentially a catastrophic one, with the landform resulting from a landslide (e.g. Bonney, 1902; Cross and Howe, 1905; Patton, 1910). Few supporters of this model exist in more modern research, the main one being Johnson (1978, 1983, 1984), who argued for the case based on interpretation of morphology, as already discussed above. The dominant viewpoint now is that this is not generally the case. While it may be possible for rock glaciers to form following landslides onto ice bodies (e.g. Humlum, 1996; Shroder *et al.*, 2000) or following debris-laden avalanches (e.g. Haeberli *et al.*, 2006; Humlum *et al.*, 2007), there is continued movement of the rock glacier itself at low velocities that is the more important dynamic process both in terms of shaping the landform and, indeed, defining it as a rock glacier.

Rock glacier dynamics have been explored using photogrammetry and geodetic surveys since the 1960s (Haeberli, 1985). These methods are still used, but new technology has been added to the available tools with the development

of computer based analysis (e.g. Kääb and Vollmer, 2000; Jansen and Hergarten, 2006), accurate global positioning systems (GPS; e.g. Berger *et al.*, 2004), and improved remote sensing and geophysical imaging techniques (e.g. Isaksen *et al.*, 2000; Kääb and Vollmer, 2000; Shroder *et al.*, 2000; Serrano *et al.*, 2006).

Active rock glaciers creep downslope at rates, on average, between a few centimetres to up to about 1 m yr⁻¹, movement rates that are about an order of magnitude less than those of ice glaciers (Haeberli, 1985). Flow rates vary over geographic space. For example, two rock glaciers in Svalbard were measured as having velocities of between 7.4 to 10.4 cm yr⁻¹ for one and 0.4 to 2.0 cm yr⁻¹ for the other (Isaksen *et al.*, 2000). A survey of rock glaciers in the eastern Yukon gave an average flow of 20 cm yr⁻¹ (Sloan and Dyke, 1998), while an ice-cored one in the Northwest Territories was measured at 2.8 m yr⁻¹ (Jackson and Macdonald, 1980). It is commonly agreed that flow rates are influenced by air and hence ground temperatures (e.g. Brazier *et al.*, 1998; Sloan and Dyke, 1998; Kääb and Vollmer, 2000; Berger *et al.*, 2004; Roer *et al.*, 2005; Haeberli *et al.*, 2006), but the duration of temperature change which can induce flow change, and the speed at which this flow change occurs is not yet clear.

At the smaller scale, flow rates have been found to be variable over the surface of individual rock glaciers. In many cases, the upper portion of a rock glacier near its root has a higher annual velocity than its lower portion, and flow is faster towards the centre-line of a rock glacier and slower towards its margins (Isaksen *et al.*, 2000; Berger *et al.*, 2004; Janke, 2005b). This has been

established in avalanche-derived rock glaciers using central flow line velocities (Isaksen *et al.*, 2000) and ice-cored rock glaciers using transects on the upper and lower portions of the landforms (Berger *et al.*, 2004), and by using digital elevation models (DEMs) created from orthophotos over several decades (Janke, 2005b). Analyses of orthophoto data from several European talus-derived rock glaciers over decade-long periods (in several separate studies) have not shown the same pattern to exist with this genetic variation, and the margins may in fact have faster rates of movement than the central areas, reflecting both the slope of the flow and the rock glacier's thickness at the zone in question (Haeberli *et al.*, 2006).

In terms of internal dynamics, rock glaciers are widely thought to move faster at or near the surface than at depth (Haeberli, 1985; Berger *et al.*, 2004; Roer *et al.*, 2005; Jansen and Hergarten, 2006). Reasons for this continue to be debated. Among those who favour the idea of a talus-derived rock glacier, and thus study bodies they believe to be so created, the dominant opinion is that flow is primarily due to internal deformation related to creep of the frozen material, generally *en masse*. In this case, it is suggested that variations (primarily seasonal) in air temperature are affecting the flow rates of the material closest to the surface (Haeberli *et al.*, 2006). While the development of shear planes is recognized as a possible contributor to flow in talus-derived rock glaciers (Zurawek, 2002; Roer *et al.*, 2005; Haeberli *et al.*, 2006), they are thought to have minimal impact. However for those who study ice-cored and internally layered rock glaciers, shear plane development appears to be a major factor in

explaining rock glacier flow (Isaksen *et al.*, 2000; Jansen and Hergarten, 2006). Bucki and Echelmeyer (2004) and Bucki *et al.* (2005) also found shear planes to be important in the flow of Fireweed rock glacier in Alaska, which is of undetermined origin. Recent studies have suggested this is due to the development of shear planes, and the wider application of geophysical surveys has produced a growing body of data suggesting that many rock glaciers have major shear planes in their near-surface levels (e.g. Bucki *et al.*, 2004; Roer *et al.*, 2005). Similar results were obtained through the excavation of a relict talus-derived rock glacier (Zurawek, 2002). A model of rock glacier flow created by Jensen and Hergarten (2006) using a decreasing distribution of “melted” pixels from the rock glacier surface (10%) to base (1%) and a random distribution of stress at initiation, found that shear planes developed spontaneously in relation to melt zones, leading to their concentration in the upper layers of the rock glacier, which mimics their structure as observed in the field. If both melt and stress are assigned randomly at the start of the model run, shear planes still develop but at random depths.

The topic of basal sliding has engendered a debate similar to that between the relative importance of creep and shearing. In this case, however, there is little evidence to suggest that basal sliding plays any significant role in the movement of a talus-derived rock glacier and it is generally assumed to be negligible. Sliding on unfrozen sub-rock-glacial debris may be a possibility (Haeberli, 1985) but it has not been researched at all. For other (and undetermined) types of rock glaciers, basal sliding is recognized as being a major contribution to flow (e.g.

Isaksen *et al.*, 2000; Bucki and Echelmeyer, 2004). In glacially derived rock glaciers, the presence of basal sliding is considered typical (Haeberli, 1985; Bucki and Echelmeyer, 2004).

As mentioned above, air temperature is a major and undisputed control on rock glacier velocity although the exact interactions are still incompletely understood. There are, of course, a number of other controls on dynamics that, by their nature, affect all types of rock glaciers. One of these is saturation level. Some argue that supersaturation (50-90% by volume) is a virtual necessity to maintaining steady state creep (Haeberli, 1985; Haeberli *et al.*, 1999). This, however, has been contradicted by Zurawek (2002), whose sedimentological examination of a relict rock glacier found that movement was still occurring very late in the “life” of the rock glacier when its ice content was very low.

Density of the rock glacier core is another factor that has obvious impacts on potential and actual flow rates. Density is determined in large part by the relative concentrations of rock and ice, and it affects the material strength and its deformation characteristics (Haeberli, 1985). Once again there is disagreement between proponents of the talus-derived rock glacier model, who estimate rock glacier density to be about 1.5 to 2.0 g cm⁻³ (Barsch, 1978) and those who support the glacially-derived model, who estimate the density to be closer to 1.0 g cm⁻³ (Clark *et al.*, 1998). In reality, there is likely a range of densities depending on origin and a number of other factors. Lack of empirical knowledge of rock glacier densities greatly hinders attempts to model their flow.

4.2.3 Remote sensing of rock glacier dynamics

Remote sensing comprises a useful set of tools for examining rock glacier dynamics. Both airborne and space-borne remote sensing methods, in the visible spectrum and radar, have been used. Space-borne methods have been limited to radar interferometry (Stozzi *et al.*, 2004). Air photos are a far more common means of assessing changes (horizontal and vertical) in rock glaciers over time. Multi-temporal air photos have been used successfully to measure rock glacier velocities, and in some cases thinning and thickening, in Europe (Kääb *et al.*, 1997; Kääb and Vollmer, 2000; Kääb *et al.*, 2002; Frauenfelder *et al.*, 2004; Stozzi *et al.*, 2004; Wangensteen *et al.*, 2006; Roer and Nyenhuis, 2007) and in the Colorado Front Range (Janke, 2005b).

The basic task to determine velocities with any type of visible imagery is to identify distinctive features on a rock glacier surface in two or more images from different times. The distance between the original and present position of the feature can then be measured. Usually this involves the creation of elevation models (requiring a pair of stereo images from each photo date) for the production of orthoimages, and this is essential if vertical (i.e. thickness) changes are to be measured. An automated system for feature matching has been tested (Kääb and Vollmer, 2000) and was, with good imagery, found to be as good as the commonly-employed user-supervised method. However, in cases with complex terrain or when shadows were present in the image, the user-supervised method was superior.

In a comparison of methods for determining rock glacier activity Stozzi *et al.* (2004) assessed the differences between traditional geomorphological mapping, satellite-borne radar, and aerial photography. This comparison found geomorphological mapping to be subjective and variable with the range of factors the geomorphologists could choose to consider – or not to consider – and which of those were clearly visible and distinct enough to be diagnostic in any given case. They recommended the use of photogrammetric methods to improve classification. In the case of satellite-borne radar, it was found to be most useful for determining activity as well as for measuring surface velocities over large areas. Air photo analysis was best for determining three-dimensional movement on active rock glaciers. Kääb *et al.* (2002) also demonstrated the limits of multi-temporal air photo analysis when the activity of a slow-moving ($<1 \text{ cm yr}^{-1}$) Svalbard rock glacier, known to be active from long-term observations and geomorphic features, was not detected as moving using this method.

4.3 Rock glaciers in permafrost distribution modelling

4.3.1 Model building

Air temperature is widely recognized as being the main control on permafrost distribution at the regional, continental and global scale. Attempts to develop climate constraints for rock glacier distribution have been made (e.g. Haeberli, 1985; Imhof, 1996), however the latter have been found to vary depending on methods and variables used (Lambiel and Reynard, 2001) and on regional location (Brazier *et al.*, 1998; Humlum, 1998). Some authors, Haeberli

(1985) in particular, have made broad statements regarding the distribution of rock glaciers, confining their occurrence to cold, arid mountain regions below the equilibrium line of ice glaciers. The author admits that this is an oversimplification and recognizes the potential for rock glaciers and ice glaciers to exist side-by-side in transitional climatic regions. Other researchers, however, maintain that rock glaciers can form and exist in maritime climates with high precipitation levels (1000-1700 mm annually) provided that sufficient debris is available (Humlum, 1998). Based on a synthesis of antecedent studies around the world, Humlum (1998) gave approximate mean annual air temperature (MAAT) constraints for talus-derived rock glaciers of -4 to -10°C, and for ice-cored rock glaciers of -1 to -10°C. However, he also refers to a case in which maritime rock glaciers form and remain active where the MAAT is slightly above 0°C. It is clear that the type of rock glacier being considered affects the inferences that can be drawn. It is also true that there is overlap between the two temperature ranges suggested, as well as many other factors at work that account for the large range of values found over the course of spatially diverse studies.

While the use of rock glaciers to develop probable air temperature isotherms has met with limited success, the rock glaciers themselves can be useful in approximating the distribution of discontinuous permafrost due to the fact that they *are* permafrost. While active and inactive rock glaciers are some of the most visible geomorphic exemplars of permafrost in mountainous regions, there are some factors that complicate their use in modelling its distribution. The

activity level of the rock glaciers used must be taken into account. Activity is usually classified as one of three states: active, inactive, and relict (e.g. Imhof, 1996; Brazier *et al.*, 1998; Frauenfelder, 2005; Janke, 2005a). As alluded to in previous sections, active rock glaciers contain perennial ice and flow downslope, inactive rock glaciers contain perennial ice but no longer flow, and relict rock glaciers contain no ice and are not indicative of current permafrost. Because research has shown that the oldest existing rock glaciers probably developed in the Holocene (Lambiel and Reynard, 2001; Janke, 2005a), the likelihood of any relict rock glaciers being remnants of previous interglacials is very low. Relict rock glaciers can be useful to those trying to reconstruct Holocene climates, but they are of no use for mapping current permafrost distribution. It has been found in some areas that, at a regional scale, rock glacier distribution by activity is a good analogue for permafrost distribution, with active rock glaciers indicating “permafrost probable”, inactive rock glaciers indicating “permafrost possible”, and relict rock glaciers indicating “permafrost improbable” (Imhof, 1996). Some European and New Zealand research has indicated that the distribution of rock glacier occurrence by level of activity is zonal, corresponding to elevation (and other related controls on temperature), and fits well with the common permafrost distribution classifications of continuous, discontinuous/sporadic, and seasonally frozen (Imhof, 1996; Brazier *et al.*, 1998; Frauenfelder, 2005).

An additional complication in using rock glaciers to model permafrost distribution, on which consensus is generally lacking, is that of origin. Some researchers argue that rock glaciers of glacial origin are not reliable local

indicators of permafrost due to the possibility that they are the result of a surging glacier that may have significantly over-run the altitudinal boundary line for permafrost existence, and thus would have been degrading over the entirety of their existence (e.g. Humlum, 1998). Others, such as Janke (2005), consider that perennially cryotic sediment, whether in a rock glacier or elsewhere, constitutes permafrost and thus are comfortable using rock glaciers of all origins as local permafrost indicators. This makes sense when considering the definition of permafrost (earth surface material at or below 0 °C for at least two consecutive years) and the fact that it need not be in equilibrium to exist (in either a geomorphic feature like a rock glacier, or just in the ground).

Rock glaciers are local permafrost indicators, but as Imhof (1996) pointed out, while the existence of a rock glacier indicates the presence of permafrost, their absence does not indicate the absence of permafrost because the conditions needed for rock glacier development may be little related to the conditions needed for permafrost development. However, given their apparent tendency for zonal distribution and their abundance in many cold mountainous regions (excluding Scandinavia), rock glaciers do lend themselves to permafrost distribution modelling. Coupling this with good visibility and identifiability on air photos and remotely sensed imagery, they have been found useful overall as permafrost indicators for modelling projects at large scales (Etzelmüller *et al.*, 2001).

With mountain permafrost distribution modelling being a relatively new field (and with many of the variables included in modelling being poorly

understood), there are no established practices for doing it. There are, however, some commonly accepted principles. Lapse rate is the key to modelling because it is assumed that if permafrost exists at a given elevation, it is more likely to exist at higher elevations where air temperatures should be lower. For this reason, rock glaciers are usually used to establish a lower boundary of permafrost since their existence is facilitated by convective cooling of their blocky surfaces (Brazier *et al.*, 1998; Frauenfelder, 2005; Etzelmüller *et al.*, 2007).

Almost all mountain permafrost distribution models include indicators other than rock glaciers in determining where permafrost probably exists. These include the basal temperature of snow (BTS; e.g. Lewkowicz and Ednie, 2004; Lewkowicz and Bonnaventure, 2008), geophysical survey information (e.g. Haeberli and Vonder Mühl, 1996; Evin *et al.*, 1997), hydrological measurements and models, vegetation (King *et al.*, 1992), solar radiation (Funk and Hoelzle, 1992), “frost number” and similar calculated indices (Nelson and Outcalt, 1987). These variables will not be discussed in depth, but it is important to realize that rock glaciers are not used alone to predict permafrost distribution.

The use of rock glaciers in permafrost distribution modelling can be considered, in its most basic sense, a type of empirical modelling. Empirical models are useful when the goal of a model is to determine the occurrence of a phenomenon without necessarily needing to understand all of the processes that cause it (Imhof, 1996). Rock glaciers are ideal for this type of model, when used to determine lower elevational permafrost limits, since they have a strong observed tendency to occur there (Barsch, 1978). A model could therefore be

developed that uses the lowest occurring rock glaciers, and lines interpolated between them, to demarcate the lower elevational boundary of mountain permafrost. More realistically, the researcher usually tries to establish these limits in units of elevation or temperature (thereby incorporating additional variables into the model) such that they are understandable in a set of standard units and give the model potential transferability to other locations. Such a simple model, using environmentally constrained and locally variable indicators, would be useful at only the most general level (Barsch, 1978). However, with the addition of more predictive variables, this, and other similar single-variable models (like the use of a -2°C isotherm as the lower permafrost boundary; Barsch, 1978), can be improved in their predictive accuracy.

Though rock glaciers can be used alone to model permafrost occurrence, the inclusion of other variables usually means that the final model includes both empirical and process-based elements, often with sub-models within the larger whole. The mathematical form of the model depends on the relationships that exist between the variables included and can take many forms. Examples in the literature include additive (Brenning *et al.*, 2007), linear (included in countless models as lapse rate calculations; e.g. Etzelmüller *et al.*, 2001; Haeberli *et al.*, 2006), and multinomial regression (e.g. Janke 2005a; Janke, 2005c).

4.3.2 *Model verification*

Verification should be an essential step in the development of any model. It allows the assessment of the accuracy with which a process model represents

a physical process, or of the predictive capability of an empirical model. In the case of permafrost distribution models based on rock glacier occurrence, the key is to assess predictive ability. In rare examples (Etzelmüller *et al.*, 2001), this goes so far as to statistically test the confidence in the results. This, however, can only be done when the error associated with the predictive variables used is known, and in most cases it is not.

Although statistical tests are uncommon in this field, there are other ways a model can be tested. The ones most commonly used involve a comparison between the results of the model and independent indicators not included in the model (Etzelmüller *et al.*, 2001). This can be done with vegetation, where climate tolerance is known for a species (e.g. King *et al.*, 1992; Imhof, 1996), MAAT and BTS measurements (Janke, 2005c), and in many cases, there is simply no verification undertaken (e.g. Lambiel and Reynard, 2001; Janke, 2005a). Where rock glaciers have not been used in permafrost model development, they may be useful for verification. For example Imhof (1996) and Fukui *et al.* (2007), used rock glaciers to test the accuracy of the results of models created using climate-based predictive variables.

5 Study area

The area examined in this research was the southern half of the Yukon Territory, extending from 60 to 65°N and 124 to 141°W – an area of about 350,000 km² (Figure 3). Areas that lacked surficial geology maps or other maps identifying rock glaciers (about one quarter of the total area) were excluded from analysis.

Topographically, nearly half of the area is above 1000 m elevation, 8% is above 1500 m elevation, and 3% is above 2000 m (Figure 3). Several mountain ranges are present, including the Kluane Ranges, the Ruby Range, the Selwyn Mountains, the Pelly Mountains, and the Ogilvie Mountains. The Wrangell-St Elias Ranges and Icefields occupy the southwest corner of the study area and are home to extensive glaciers and Canada's highest peak, Mount Logan, at 5959 m.

All climate stations in the study area (shown in Figure 3) exhibit mean annual air temperatures (MAATs) below 0°C. The distribution of climate stations is limited, as they are few in number and none are located above 830 m elevation. Due to the limited climate data, little is known about the exact climate conditions in upper elevations, though it is known that air temperature inversions are a key influence in winter (Wahl *et al.*, 1987).

The study area covers a landmass that experiences a shift from a wetter, more maritime climate in the southwest (near the North Pacific Ocean) to a more arid climate on the inland side of the St Elias Mountains (Wahl *et al.*, 1987).

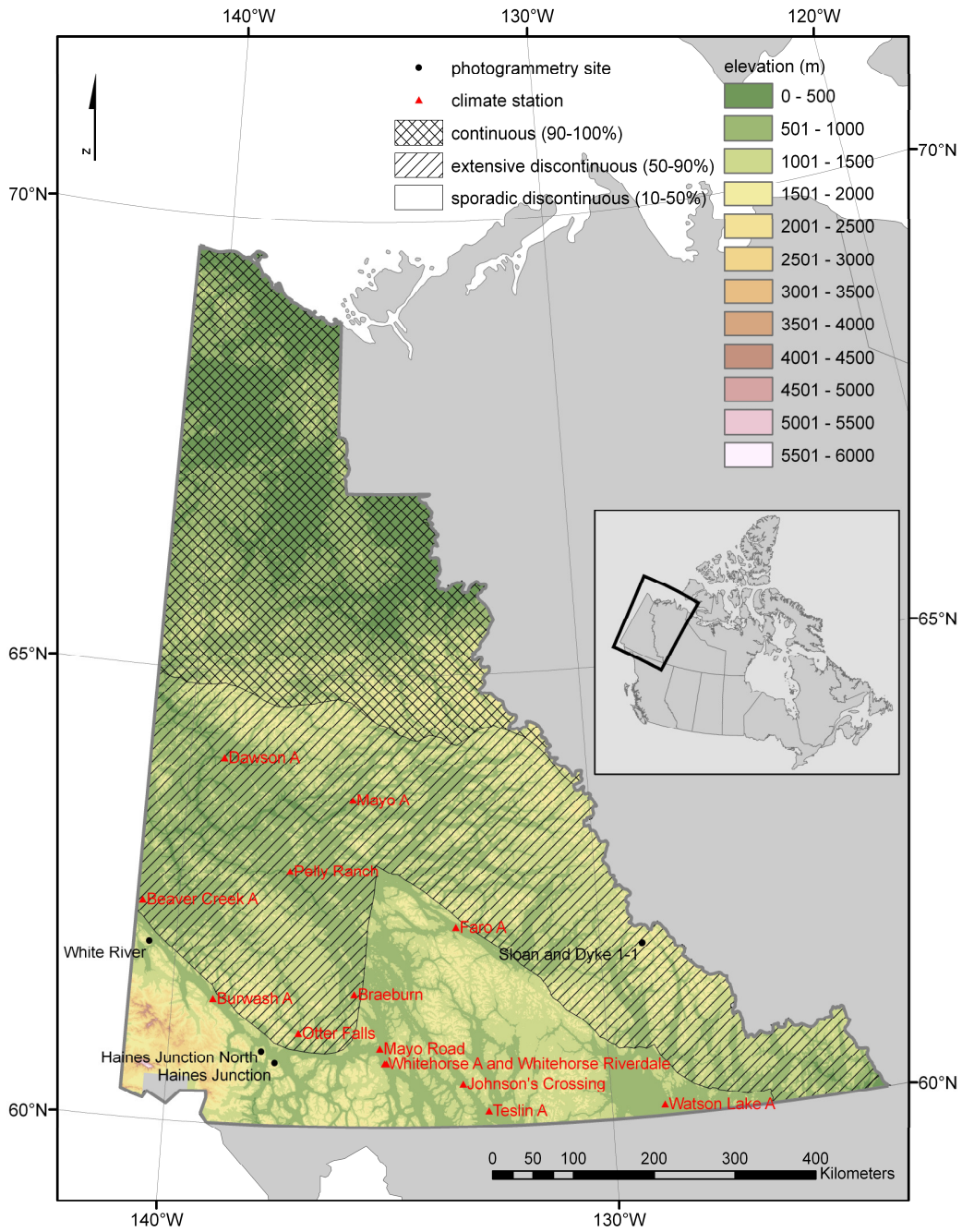


Figure 3 – Study area with elevation, permafrost extent (after Heginbottom *et al.*, 1995), weather stations (Environment Canada, 2009), and photogrammetry study sites.

Permafrost distribution (shown in Figure 3) in the Yukon is essentially continuous (underlying 90% of the terrain or greater) north of 65°N and sporadic discontinuous (10-50%) or extensive discontinuous (50-90%) south of this latitude. Rock glaciers occur widely in the mountainous areas of the study area but have not been studied as permafrost indicators in this region.

The sites examined in the second, photogrammetric, part of this study are spread across the larger study area. The White River site is located north of the Wrangell-St Elias Ranges and Icefields close to the western border with Alaska. The Haines Junction and Haines Junction North sites are located on the inland side of the Wrangell-St Elias Ranges close to the community of Haines Junction. The final site, Sloan and Dyke's (1998) 1-1 site, is located close to the eastern border between the Yukon and the Northwest Territories in the Selwyn Mountains.

6 Methods

6.1 Geostatistical examination of rock glacier location topography

For the geostatistical examination of southern Yukon rock glaciers, rock glacier locations were determined from digital versions of 51 surficial geology maps with scales ranging between 1:25,000 and 1:250,000, provided by the Yukon Geological Survey (YGS; see Appendix A). One map that had not yet been digitised (106C – Nadaleen River; Ricker, 1974) was supplied as a georeferenced image by the YGS, and the rock glaciers on it were digitised by hand. A final unpublished map of rock glaciers in the Kluane region was made available by J. Peter Johnson and Daisy-Claire Hartmann-Brenner, who had compiled it from air photo analysis. The rock glaciers shown on this map were also hand digitised. The inventory of rock glaciers from these sources totalled 1680.

The large number of rock glaciers present made it impossible to study the entire population, either on air photos or in the field. Consequently, a stratified random sample of 11.7% of the population was taken for analysis. The stratum used were those rock glaciers within 5 km of a road (possibly accessible field analysis sites) and those rock glaciers greater than 5 km from a road (inaccessible sites). 11.7% was chosen because it gave 10 potential sites for fieldwork, a number considered reasonable given the field season scheduling requirements.

The rock glaciers were classified as to morphology – tongue-shaped or lobate (Warhaftig and Cox, 1959) – and activity – active, inactive, or relict

(Haeberli, 1985) – from air photo analysis at the National Air Photo Library in Ottawa. The classifications of 29 of the original rock glacier sample were later verified in the field. Where rock glaciers were accessible, they were visited on-site, where elevation and slope were measured and observations were made of surface features and material, vegetation, stability, and other features. Where rock glaciers were visible but inaccessible (usually due to a river between the road and the rock glacier), they were photographed and observations made from a distance.

The air photo analysis and fieldwork uncovered errors in the rock glacier inventory. Twenty unmapped rock glaciers were observed in the field that were within 5 km of a road; they were subsequently added to the study group. Air photo analysis revealed that 12 landforms identified on the maps as rock glaciers were not. Most were cirque basins with incised drainage channels in their floors. These were excluded from further analysis. Other rock glaciers (12-18) were omitted from parts of the statistical analysis due to limited air photo coverage making classification impossible, or when their morphology contained both tongue-shaped and lobate elements.

Different morphology and activity groups were statistically compared for elevation, slope, area and aspect, as derived from a 30 m resolution National Topographic Database digital elevation model (DEM).

6.2 Photogrammetric examination of rock glacier dynamics

Three test sites were chosen from the above-described sample for the photogrammetric test study, based on the size of the rock glaciers present and the availability of multiple periods of air photo coverage. A fourth site was chosen from a previous study by Sloan and Dyke (1998) so it would be possible to compare the results of their surveyed measurements with those derived from the experimental photogrammetric method.

Copies of the images, scanned at 20 micron resolution, were used with the 30 m DEM to create orthophotos for each site at each time of photo coverage with PCI Geomatics' OrthoEngine. The collection of ground control points (GCPs) and tie points (TPs) during this process was complicated by the fact that camera calibration data, including fiducial mark spacing, was missing for all of the older photos as well as by the fact that the software used does not have the ability to process multiple images from different cameras at the same time. Because of this, fiducial mark spacing on the older photos had to be measured by hand and an "average" camera was calculated from the calibrations of the different photos for a site. For one site this was impossible because the fiducial marks were located in the corners on two photos and on the edges of the third photo, so the GCPs for the third photo had to be visually matched to the others in a separate session, most likely reducing the goodness of match of the resulting orthophoto with those produced from the photos with fiducial marks in the same location.

The orthophotos were then used with the CIAS software, developed by Kääb and Vollmer (2000), which probabilistically matches user-selected features

on the surface of a rock glacier in older and newer photos and measures the displacement between them. A Helmert correction was used involving matching stable points outside a rock glacier so that only relative movement is measured and errors in photo-matching have lesser effects. It was sometimes challenging to find match sites that were certain because of poor photo quality, obstructions in the photo (cloud, shadow, and snow), and the development of thermokarst. To reduce the probability of false matches, sites were selected manually and any matches with a correlation coefficient of less than 0.7 were discarded from further analysis.

The results were then exported to a GIS for display and analysis.

An additional comparative examination was undertaken in which the Sloan and Dyke site was remeasured using a georeferenced image rather than an orthophoto. For this analysis, ESRI's ArcMap was used to georectify the 1986 photo (A27020 – 248) to a Landsat image of the site (L71056017 01720010817 B50) using a third order transformation. Then the earlier air photo of the site (A12343 – 139, 1949) was georectified to the 1986 image using a first order transformation. Following this, the measurement technique was identical to that already summarised, using CIAS software with the Helmert correction and discarding measurements with feature matching correlation coefficients of less than 0.7 and those that were obvious errors.

7 Results, presented in article format

7.1 Distribution and topographic characteristics of Yukon rock glaciers

Paper intended for submission to Canadian Journal of Earth Sciences

Statement of contribution:

Amaris Page – background research, research planning, fieldwork, data compilation, analysis and interpretation, written and graphic presentation

Antoni Lewkowicz – research planning, interpretation of results, written presentation (interaction of rock glaciers with forest), editing

Panya Lipovsky and Jeffrey Bond – creators of digital surficial geology maps, editing

Amaris Page ^{1, a}, Antoni Lewkowicz ^a, Panya Lipovsky ^b, Jeffrey Bond ^b

¹ Corresponding author: apage093@uottawa.ca

^a Department of Geography, University of Ottawa
Ottawa, Ontario, K1N 6N5

Phone 613-562-5800 Ext 1067; Fax 613-562-5145

^b Yukon Geological Survey, Whitehorse, Yukon

Abstract

Existing surficial geology maps and unpublished sources were used to develop a spatial database comprising the rock glaciers located in the southern half of the Yukon Territory. Rock glaciers are present in all the main mountain ranges, but are especially numerous in the Wernecke, Ogilvie and Pelly Mountains, and in the Kluane Ranges. The highest densities were found in the Wernecke Mountains and the Kluane Ranges, reaching concentrations of up to 50-60 and 30-40 rock glaciers per 500 km², respectively. Densities in the other ranges attained maxima of 11-20 rock glaciers per 500 km² but typical values were 1-10 features per 500 km². Topographic variables (elevation, slope and aspect) were derived using a GIS for a 12% sample of the more than 1500 identified rock glaciers. Each feature in the sample was examined on aerial photographs to determine morphology (tongue-shaped or lobate) and activity status (active, inactive or relict). Tongue-shaped rock glaciers occurred at higher elevations than lobate forms, but differences in mean aspects, slopes, and areas for the two groups were not statistically significant. Active forms were significantly larger than inactive and relict forms and were also more likely to be northerly-facing. Elevations with climatic conditions suitable for tree growth overlap with those of rock glaciers so that some active features are forested while others are advancing into forested zones. Overall, rock glaciers occupy at least 320 km² and probably 540-750 km² of the Yukon Territory, which constitutes a maximum of 0.25% of the entire terrain and about 10% of the area covered by glaciers. Individual active or inactive rock glaciers can be used as point indicators (or exemplars) of the existence of permafrost but their distribution in this cold

environment does not appear to clearly demarcate a clear lower elevational limit for permafrost.

Introduction

Rock glaciers are permafrost-related landforms (Haeberli *et al.*, 2006) that are common in many of the world's cold mountainous regions. They are particularly well-studied in the European Alps (e.g. Barsch, 1978; Haeberli, 1985; Haeberli and Vonder Mühl, 1996; Imhof, 1996; Käab and Vollmer, 2000; Krainer and Mostler, 2000; Lambiel and Reynard, 2001; Berger *et al.*, 2004; Frauenfelder, 2005; Roer *et al.*, 2005; Haeberli *et al.*, 2006) but have also been examined in many other regions, including Svalbard (Isaksen *et al.*, 2000; Humlum *et al.*, 2007), Greenland (Humlum, 1996), Iceland (Etzelmüller *et al.*, 2007), New Zealand (Brazier *et al.*, 1998), central Asia (e.g. Shroder *et al.*, 2000; Ishikawa *et al.*, 2001; Fukui *et al.*, 2007), South America (e.g. Torombotto *et al.*, 1998) and Alaska (Wahrhaftig and Cox, 1959; Ellis and Calkin, 1979). Rock glacier research has examined a broad range of questions relating to landform dynamics, composition, origin, and their usefulness as regional permafrost indicators.

Research on rock glaciers in Canada has mainly focused geographically on the western Cordillera. Most of this body of work relates to case studies that discuss origins, activity, morphology and rheology (e.g. P.G. Johnson, 1978, 1980, 1981, 1984, 1992, 1998; J.P. Johnson and Nickling, 1979; Blumstengel and Harris, 1988; P.G. Johnson and Lacasse, 1988; P.G. Johnson, 1992, 1998; Evin *et al.*, 1997). A smaller number of studies have also examined rock glacier

dynamics in the region (J.P. Johnson and Nickling, 1979; Jackson and Macdonald, 1980; P.G. Johnson, 1984; Sloan and Dyke, 1998). There remains a paucity of Canadian research on rock glacier distribution. Sloan (1998) attempted to model cirque rock glacier locations in part of the Selwyn Mountains using topographic and geological variables. Harris (1981) used data from a small number of sites that included Canadian examples in an attempt to link the distribution of rock glaciers to freezing and thawing indices. Neither of these studies developed a spatial database, such as that of Janke (2007) in the Colorado Front Range, suitable for modelling rock glacier development and examining patterns in the distribution of different types of rock glaciers.

This paper is focused on the Yukon Territory where prior work has shown rock glaciers to be numerous, but the vast extent of the region has prevented any real overview of their distribution. The goal of this study is to develop a spatial database of rock glacier locations, compiled from published and unpublished sources, that can be used for a variety of tasks including landform mapping and modelling, permafrost distribution modelling and hazard mapping in relation to climate change. Following Janke (2007), a sample of the rock glaciers in the database is employed to characterise morphology, activity and topographic characteristics.

Study Area

The study area consists of the southern half of the Yukon Territory, from 60 to 65 °N and 124 to 141 °W, encompassing approximately 350,000 km². Surficial geology maps, which were the source of the majority of the rock glacier

location data, exist for about three-quarters of the region (Figure 1, also see Appendix A). The area contains several major mountain ranges, including the Kluane Ranges, the Ruby Ranges, and the Selwyn, Pelly, and Ogilvie Mountains. The Wrangell-St Elias Ranges and Icefields in the southwest of the study area include Mount Logan, which is the highest peak in Canada at 5959 m. About half of the terrain in the study area is above 1000 m asl, 8% above 1500 m asl, and 3% above 2000 m asl.

Mean annual air temperatures measured at climate stations across the southern half of the Yukon are all less than 0°C with the lowest value at Beaver Creek (Table 1). The range of monthly temperatures increases towards the north and east as the climate becomes progressively more continental. The highest of these climate stations is at 830 m a.s.l., and little is known about the climatic characteristics of the elevation zones in the mountains where most rock glaciers are found. However, because of strong and persistent winter air temperature inversions (Wahl *et al.*, 1987), both the mean annual air temperature (MAAT) and the annual range of temperatures can be expected to decrease with elevation. Precipitation varies between 280 mm yr⁻¹ and 416 mm yr⁻¹ at the climate stations, but much higher amounts occur in the St. Elias Mountains in southwestern Yukon, because of their close proximity to the North Pacific Ocean (Wahl *et al.*, 1987).

Most of the Yukon south of 65°N is underlain by discontinuous permafrost, either falling into the sporadic (underlying 10-50% of the terrain) or extensive (50-90%) discontinuous zones (Figure 2). The continuous permafrost boundary extends across the Territory just south of 65°N, such that parts of the Ogilvie

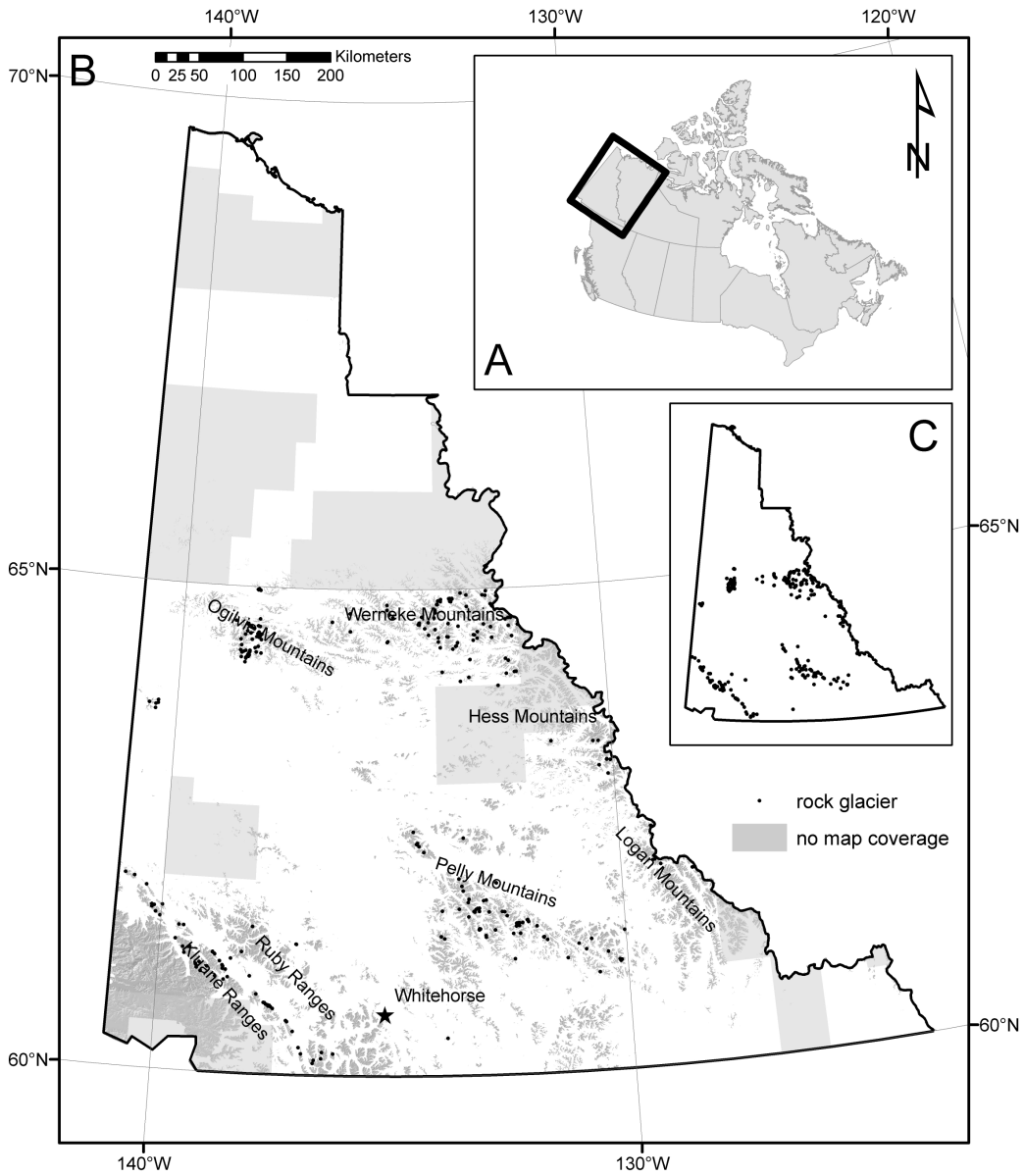


Figure 1 - A: Study area location within Canada; B: Rock glacier sites in the Yukon Territory (shown in black), compiled from published and unpublished maps. Areas not considered in the study due to lack of map coverage are shown in light grey. Elevations greater than 1500 m asl are shown with darker grey hillshade; C: Rock glacier sites included in the sample used in this study.

Table 1 - Air temperature and precipitation normals (1971-2000^a) for Yukon climatological stations (source: Environment Canada, 2009).

Station ^b	Latitude	Longitude	Elevation (m asl)	January mean (°C)	July mean (°C)	Mean annual (°C)	Mean annual precipitation (mm)
Beaver Creek A	62.41	-140.87	649	-26.9	14	-5.5	416
Braeburn ^a	61.47	-135.78	716	-21.2	13.6	-3.1	280
Burwash A	61.37	-139.05	807	-22.0	12.8	-3.8	278
Dawson A	64.04	-139.13	370	-26.7	15.6	-4.4	324
Faro A	62.21	-133.38	717	-21.5	15	-2.2	316
Johnson's Crossing	60.48	-133.30	690	-18.6	13.4	-1.5	376
Mayo A	63.62	-135.87	504	-25.7	16	-3.1	313
Mayo Road ^a	60.88	-135.18	655	-17.4	14.9	-0.7	322
Otter Falls ^a	61.03	-137.05	830	-16.4	13.1	-1.4	297
Pelly Ranch	62.82	-137.37	454	-27.5	15.5	-3.9	310
Teslin A	60.17	-132.74	705	-19.2	13.9	-1.2	343
Watson Lake A	60.12	-128.82	687	-24.2	15.1	-2.9	404
Whitehorse A	60.71	-135.07	706	-17.7	14.1	-0.7	267
Whitehorse - Riverdale	60.71	-135.03	640	-18.4	14.8	-0.2	283

^a Normals for these stations are based on fewer than 30 years of data.

^b See Figure 2 for location of stations.

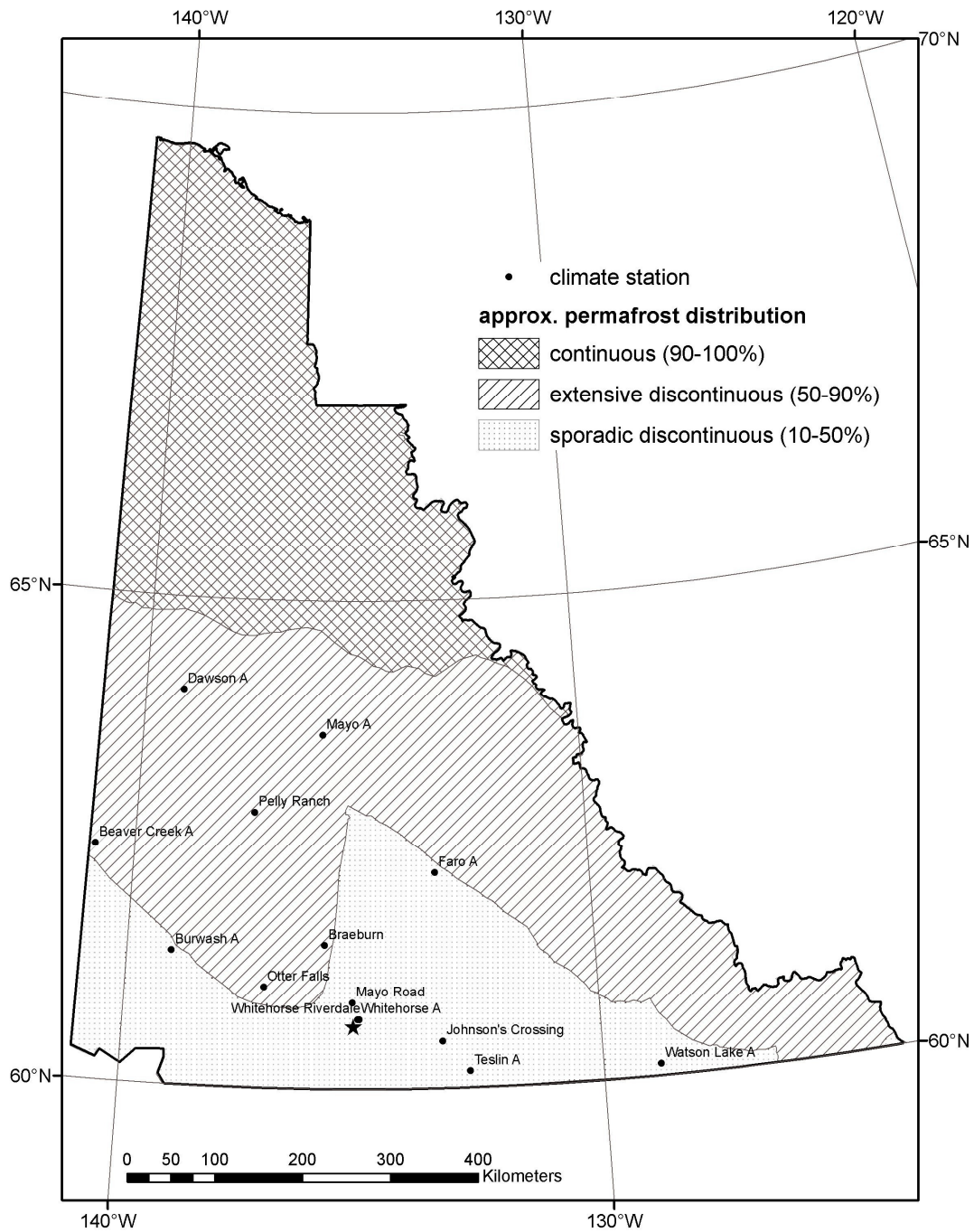


Figure 2 - Permafrost limits in the Yukon Territory (after Heginbottom et al., 1995) and location of weather stations listed in Table 1 (Environment Canada, 2009).

and Wernecke Mountains and all of the Yukon's land mass farther north lie within the continuous permafrost zone.

Methods

Rock glacier locations were primarily extracted from GIS versions of 51 surficial geology maps that were recently converted into a standardized digital shapefile format by the Yukon Geological Survey (YGS). The maps that were included in this compilation ranged in scale from 1:25,000 to 1:250,000. One map (106C - Nadaleen River; Ricker, 1974) not yet included in the YGS compilation was available as a georeferenced image, and the rock glaciers on it were digitised by hand. Additional information was obtained from an unpublished map of rock glaciers in the Kluane area produced by J. Peter Johnson and Daisy-Claire Hartmann-Brenner from aerial photo analysis from which rock glaciers were also digitised on a georeferenced scan. A total of 1680 rock glaciers were initially identified from these sources. Their locations and topographic features are included in Appendix B.

It was not possible to examine all the features identified, either using aerial photos or in the field, so a sample of 196 was extracted for further analysis. The sample consisted of a random selection of 10 (11.7%) of the 85 rock glaciers located within 5 km of a road (those potentially accessible during fieldwork), and an additional random sample of 186 rock glaciers (11.6% of the population) located more than 5 km from a road. All of the remaining rock glaciers within 5 km of a road were also classified from air photos as potential field sites. Details of this classified group are included in Appendix C.

Rock glaciers can be divided into tongue-shaped or lobate (Figure 3) features based on their morphology (Wahrhaftig and Cox, 1959; Outcalt and Benedict, 1965). Tongue-shaped rock glaciers are longer than they are wide and lobate ones are wider than they are long. The controls on morphology are not definitively known, but it has been argued (e.g. Janke, 2007) that origin – glacial or talus – controls morphology, giving rise to tongue-shaped and lobate rock glaciers, respectively. Morphology and origins are intimately tied to local topography (cirques versus valley sides), which constrains landform development. Both forms occur in the study area.

Variations in ground temperatures, ice/water content and debris input mean that rock glaciers may also differ in terms of activity (i.e. rate of deformation). Activity status and rock glacier morphology are not indicated on the surficial geology maps and these were determined for all rock glaciers in the study sample or located within 5 km of a road by examining aerial photographs at the National Air Photo Library in Ottawa. The classifications were verified for 29 features in summer 2008 by visiting 3 rock glaciers in the field and observing and photographing 26 others from a distance.

The field studies and aerial photo interpretation of the sample showed that the original inventory was not complete nor was it error-free. Several instances occurred of other landforms, mostly cirque basins with incised drainage channels in their floors, being mistakenly classified as rock glaciers on the surficial maps (12, or 6% of the total study sample); these were excluded from further analysis. 12-18 other rock glaciers were omitted from part or all subsequent analyses because the scale of existing aerial photo coverage was not adequate for

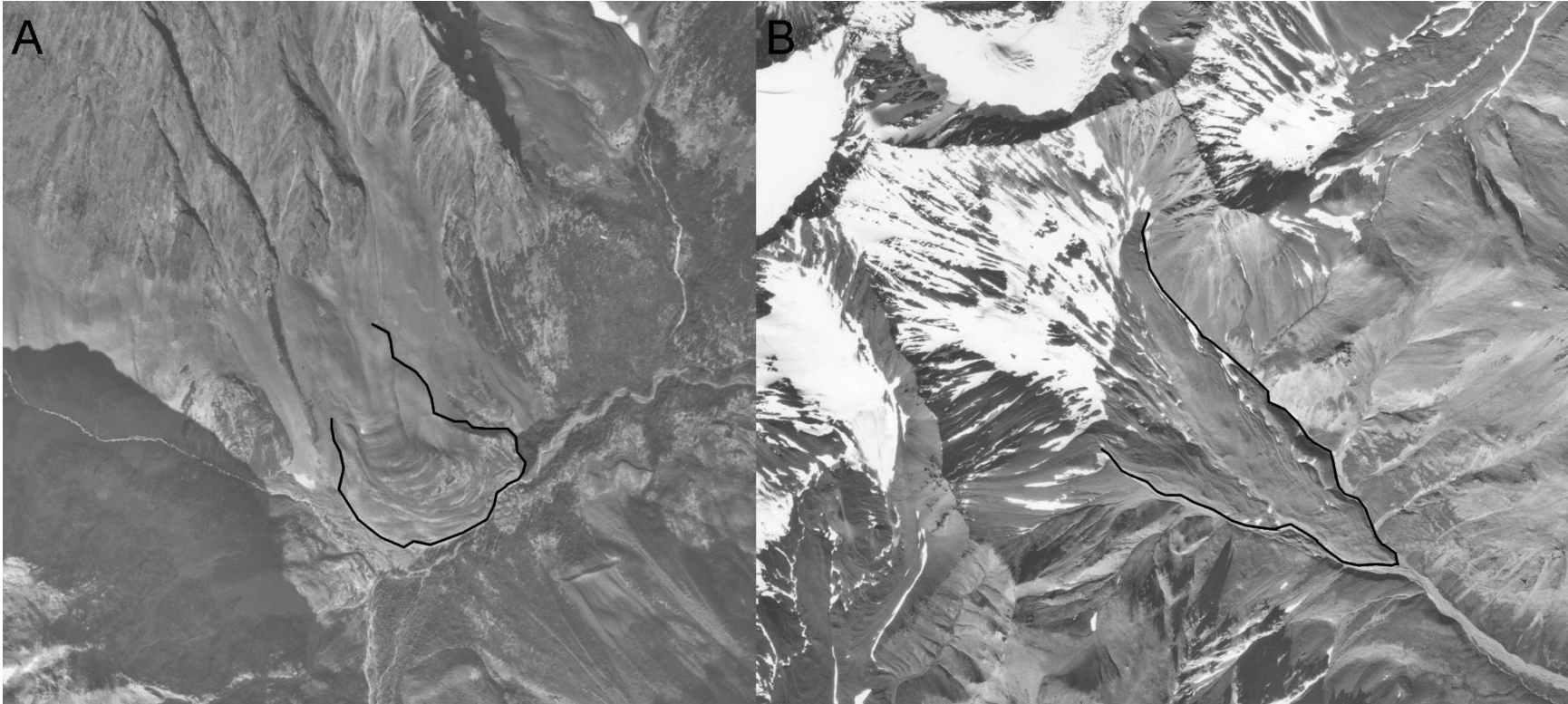


Figure 3 - Rock glacier morphologies: A: lobate; B: tongue-shaped (National Air Photo Library of Canada, A: A22355-207, B: A23794-119). Rock glacier extents indicated with the heavy black line.

classification, or because the forms exhibited both tongue-shaped and lobate elements. Twenty unmapped rock glaciers within 5 km of a road were observed in the field. These unmapped rock glaciers were subsequently included in the study sample and classified from air photos, bringing the total number of landforms classified to 273. Four of these new sites were visited, measured and described in the field and an additional 16 were photographed and observed from a distance. Totals classified for each analysis are given in the results section.

Rock glacier activity in the sample was classified on the basis of: (i) steepness of the front (near the angle of repose in an active rock glacier (Haeberli, 1985)) and its clear appearance on air photos; and (ii) appearance of the surface (i.e. pronounced ridges and furrows in active forms, smoother surfaces in inactive forms, and melt and collapse features in relict forms (Imhof, 1996)). Surface vegetation could not be used as a definitive activity indicator because there are Yukon examples of active rock glaciers with extensive forest cover (Blumstengel and Harris, 1988; Harris *et al.*, 1994). Overrun vegetation at the toe of a rock glacier, on the other hand, was considered to be a positive sign of activity. In the field, rock glaciers with stable surface boulders were considered inactive or relict, while those with unstable surface rocks were classified as active (Imhof, 1996).

Determination of morphology was based entirely on width, where tongue-shaped rock glaciers are wider at the head and lobate ones are wider at the toe. For all cases included in the study sample, it was unnecessary to distinguish morphology by considering local topographic features causing the differences in

morphology (Outcalt and Benedict, 1965), or the orientation (transverse or lateral) of ridges (Janke, 2007).

Slope and aspect of the rock glaciers in the sample were derived from a 30 m resolution National Topographic Database digital elevation model (DEM) using ESRI ArcGIS 9.2. Zonal statistics were used to calculate the mean, maximum and minimum elevation and slope for each rock glacier, employing the values underlain by each rock glacier polygon. Means were compared using *t*-tests. Area was also derived for each rock glacier in the sample from the digital map. Mean aspect and aspect variance were calculated manually by extracting the aspect values for each pixel within a given rock glacier and calculating a directional mean and a circular variance (Gaile and Burt, 1980; Davis, 1986).

Results

Rock glacier spatial distribution

As expected, rock glaciers in the Yukon occur only in mountainous areas, but these constitute a large part of the Territory's area (Figure 1). A comparison of the distribution of the known population with the topography shows that the landforms are concentrated at elevations from 1400-1900 m with the greatest number from 1600-1800 m (Figure 4), based on their mean elevations. Almost 90% of the rock glaciers fall within the highest 20% of the Yukon's land mass.

Rock glacier densities are greatest in the Wernecke Mountains and Kluane Ranges where maximum values are approximately 50-60 features per 500 km² and 30-40 per 500 km² respectively (Figure 5). Maximum densities in

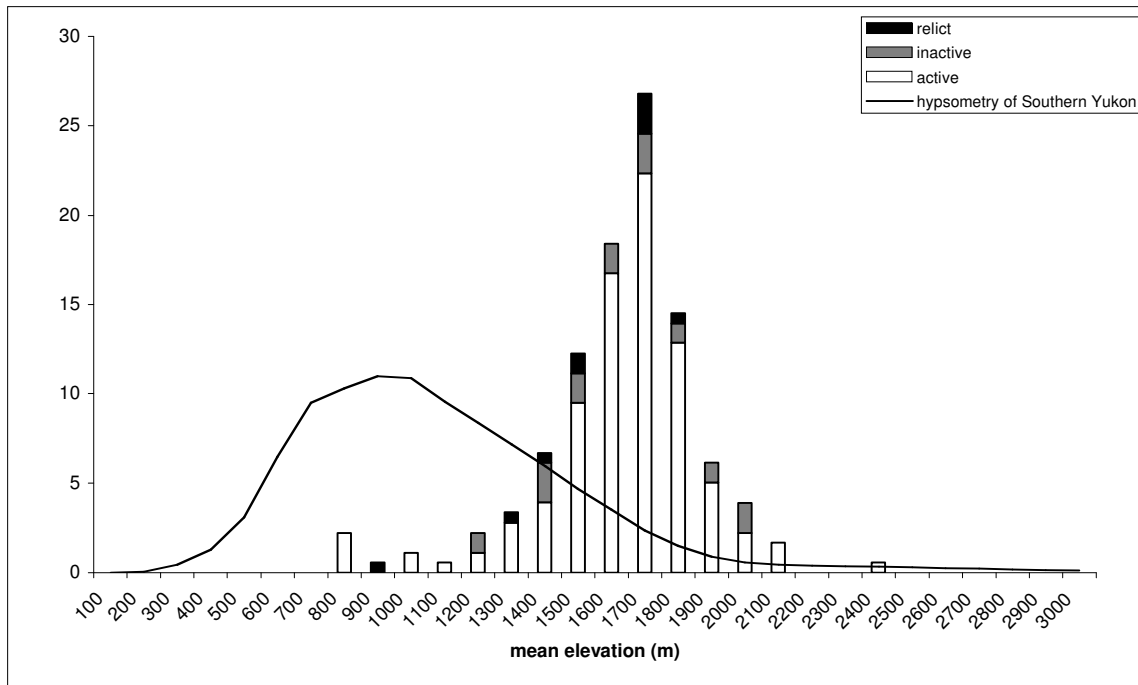


Figure 4 - Comparison of hypsometry of the Southern Yukon with the number of rock glaciers in the database by 100 m elevation band.

Table 2 - Rock glacier classification for the sample group

	Tongue-shaped		Lobate		Both		Total	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Active	105	86	37	70	6	100	148	82
Inactive	14	12	9	17			23	13
Relict	3	2	7	13			10	5
Total	120		53		6		179	

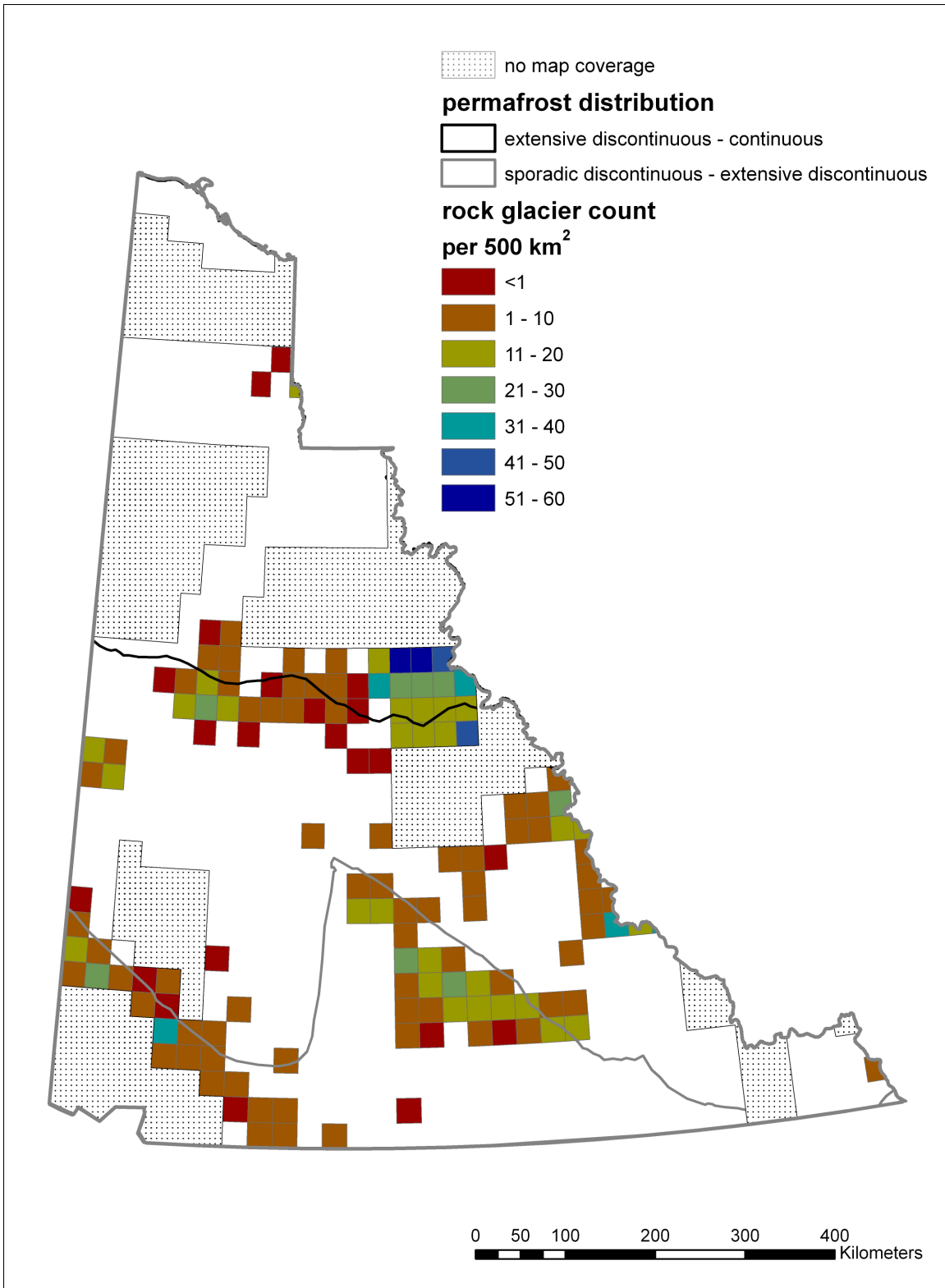


Figure 5 - Rock glacier density in the Yukon Territory per 500 km². Density was mapped per 500 km² rather than per 1000 km² because none of the map sheets exceeds 1000 km². The map sheets vary in area from 770 km² at 60°N to 660 km² at 65°N.

the other ranges are 11-20 rock glaciers per 500 km², and typical values are 1-10 per 500 km².

Rock glacier morphology

Tongue-shaped rock glaciers formed the majority in the sample (67%), with lobate forms constituting the minority (30%). The vast majority of the tongue-shaped rock glaciers are active (86%), 12% are inactive and 2% are relict (Table 2). A smaller majority of lobate rock glaciers are active (70%), 17% are inactive and 13% are relict. Tongue-shaped rock glaciers have mean, average minimum and average maximum elevations that are 90-130 m higher than lobate forms (Table 3). Of these, the mean and mean minimum values are statistically different (Table 4). Tongue-shaped rock glaciers have slopes that are 1-2° more gentle on average than the lobate forms but the difference is not significant (Tables 3 and 4). The average size of the two morphotypes in the sample is effectively identical at 0.027 km² (Table 3) and mean aspects of 343-344° are virtually the same.

Rock glacier activity

82% of the rock glaciers sampled were active, 13% were inactive, and 5% were relict (Table 5). Active rock glaciers in the sample occur most frequently with northwesterly to northeasterly aspects and at mean elevations between about 1300 and 1800 m (Figure 6A). Inactive rock glaciers show similar tendencies (Figure 6B). Relict forms (Figure 6C) are too few in number for definitive assessments. Kolmogorov-Smirnov tests showed that all distributions

Table 3 - Summary statistics for tongue-shaped and lobate rock glaciers. Elevation and slope values include standard deviation in parentheses. Mean direction includes circular variance in parentheses.

	Tongue-shaped (<i>n</i> = 120)			Lobate (<i>n</i> = 53)		
	Elevation (m)	Slope (°)	Aspect (°)	Elevation (m)	Slope (°)	Aspect (°)
Mean	1616 (±217)	23 (±7)	343 (0.52)	1500 (±292)	25 (±8)	344 (0.58)
Average minimum	1501 (±231)	7 (±6)		1370 (±288)	9 (±8)	
Average maximum	1747 (±224)	39 (±8)		1660 (±300)	40 (±7)	
Total area (km ²)		33.23			14.41	

Table 4 - Difference of means tests comparing rock glacier form and activity status in the sample.

	Lobate vs. tongue-shaped rock glaciers	Active vs. inactive rock glaciers	Active vs. relict rock glaciers	Inactive vs. relict rock glaciers
Area (m²)				
<i>t</i>	0.01	-3.96	3.00	-0.70
Probability	0.99	0.00	0.00	0.49
Mean elevation (m)				
<i>t</i>	2.58	-0.09	1.33	1.15
Probability	0.01	0.93	0.21	0.27
Minimum elevation (m)				
<i>t</i>	1.99	2.04	2.23	2.13
Probability	0.00	0.86	0.20	0.20
Maximum elevation (m)				
<i>t</i>	1.99	2.04	2.23	2.13
Probability	0.07	0.46	0.18	0.38
Mean aspect (°)				
<i>F</i>	1.09	2.29	1.28	1.79
Probability	0.37	0.01	0.37	0.13
Mean slope (°)				
<i>t</i>	-1.71	0.87	-1.31	-0.58
Probability	0.09	0.39	0.22	0.57

Note: Bold values are significant at $p = 0.05$ or better.

Table 5 - Comparison of topographic variables of active, inactive and relict rock glaciers in the sample. Standard deviation or circular variance is shown in parentheses.

Active rock glacier (n = 148)			
	elevation (m)	slope (°)	aspect (°)
Average minimum	1463 (±258)	6 (±5)	
Average maximum	1730 (±248)	40 (±8)	
Mean	1584 (±245)	23 (±7)	349 (0.52)
Total area of all active forms (km ²)	44.69		
Average size (km ²)	0.30 (±0.41)		
Kolmogorov-Smirnov	KS = 0.87	p-value = 0	
Inactive rock glacier (n = 21)			
	elevation (m)	slope (°)	aspect (°)
Average minimum	1472 (±230)	12 (±9)	
Average maximum	1691 (±228)	35 (±7)	
Mean	1580 (±226)	25 (±8)	291 (0.55)
Total area of all inactive forms (km ²)	3.27		
Average size (km ²)	0.14 (±0.11)		
Kolmogorov-Smirnov	KS = 0.99	p-value = 0	
Relict rock glacier (n = 10)			
	elevation (m)	slope (°)	aspect (°)
Average minimum	1340 (±272)	11 (±9)	
Average maximum	1602 (±271)	41 (±6)	
Mean	1466 (±273)	26 (±8)	279 (0.79)
Total area of all relict forms (km ²)	1.68		
Average size (km ²)	0.17 (±0.09)		
Kolmogorov-Smirnov	KS = 0.95	p-value = 0	

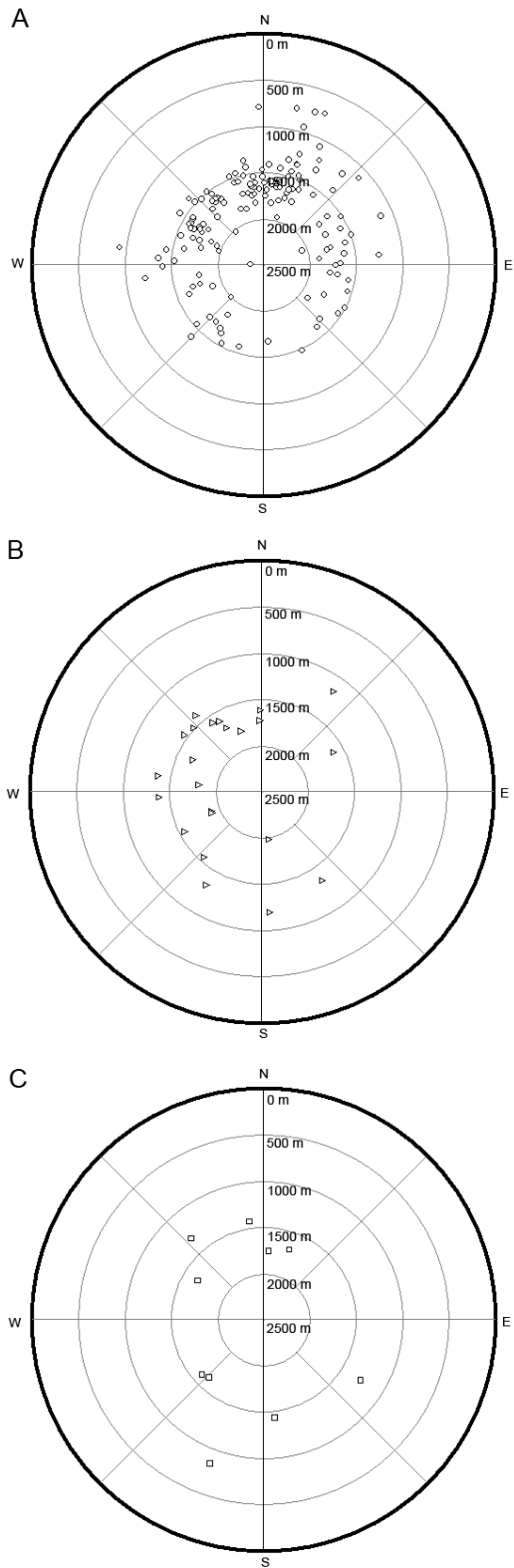


Figure 6 - Orientation and mean elevation of rock glaciers in the sample classified by activity status: A: active; B: inactive; C: relict.

were significantly different from a uniform distribution (active: KS = 0.87, p-value = 0; inactive: KS = 0.99, p-value = 0; relict: KS = 0.95, p-value = 0).

Proportionally, there were more inactive and relict forms of the lobate variety than there were of the tongue-shaped type (Table 2). Active rock glaciers have significantly larger areas (0.030 km² on average), than inactive (0.014 km²) or relict rock glaciers (0.017 km²) (Tables 4 and 5). Active rock glaciers also have significantly more northerly aspects (average of 349°) than inactive ones (average of 291°). However, mean, average minimum and average maximum elevations were all very similar for both active and inactive forms. Although the values were about 100 m lower for relict forms, the difference was not great enough to be statistically significant. Slope differences between rock glaciers of different activity status were also insignificant (Table 4).

Fieldwork

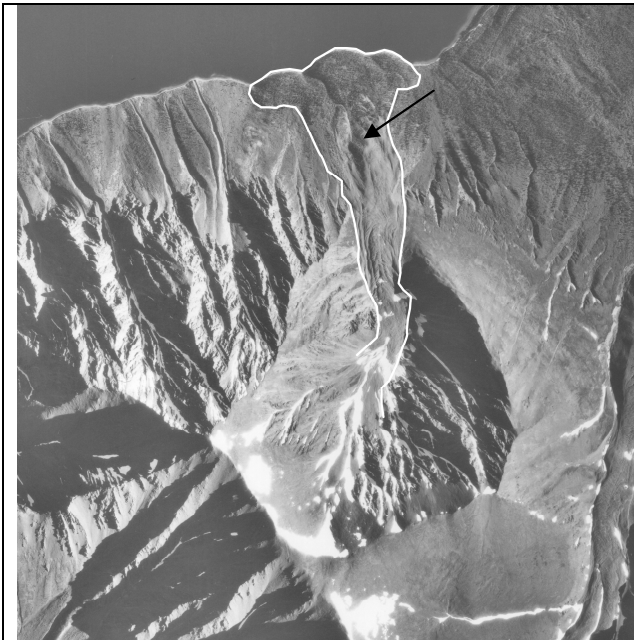
The results of the verification of classifications undertaken in the field highlighted some of the problems with the classification of rock glaciers, generally. Forty-nine percent of the rock glaciers visited or photographed in the field were assigned the same activity classification as they had been given from air photos; 29% were classified in the field as one class more or less active than the classification from the aerial photos; 22% were relict and classified as active or *vice versa*, or were not detectable in the field.

Morphology classifications were also difficult to verify in the field due to the fact that in almost all cases, except for the seven where the rock glacier was actually climbed, it was impossible to see the entire landform. The upper and

lower-most areas of a rock glacier are often out of sight when viewed from below due to the lower part being obscured by forest in front of it and the upper part lying within a cirque basin. Because of this, many of the verifications made from air photos were unverified even when the landform was observed in the field. The reliability of the morphology classifications made from air photos should be much greater, given that they are made using a bird's-eye view of (usually) the entire landform.

The number of lobate rock glaciers encountered in the field (24) was approximately equal to the number of tongue-shaped forms seen (23). Considering the number of each type present in the study sample, more than twice the number of tongue-shaped than the number of lobate forms (Table 3), the ratio seen in the field is probably partly a result of the elevation of the accessible field sites, that is at lower elevations where roads are located. The topography also likely plays a role, since roads are usually located in valley bottoms and lobate rock glaciers tend to form on valley sides. The cirques that often give rise to tongue-shaped features are usually only visible from the side on which the opening occurs, and the inside of the cirque is only visible if the opening has a steep enough angle to allow viewing from below.

An example is provided in Figure 7 of the observations from air photos and on a field visit at a rock glacier known as King's Throne. A comparison of all sites visited is included in Appendix D.



A23792 – 104 (National Air Photo Library of Canada): rock glacier extent shown by white line, upper toe shown by black arrow

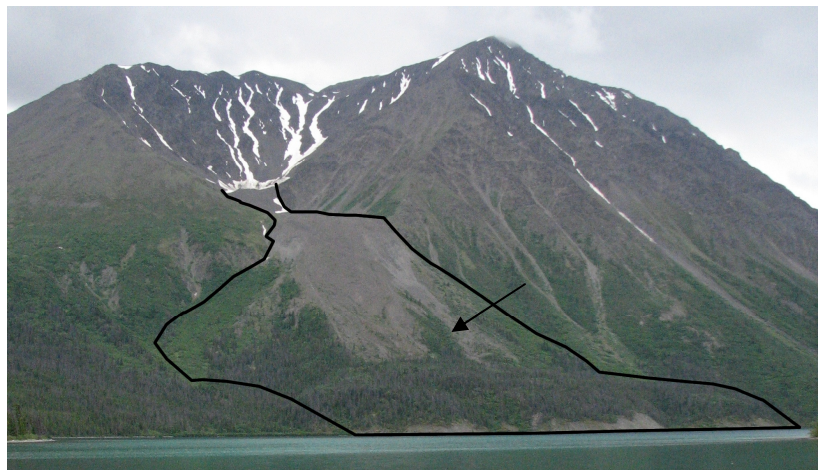


Photo 4820: Rock glacier extent shown by black line, upper toe shown by black arrow

Air photo observations:

- Active, lobate, down-valley flow, originates in a cirque, toe ends in a lake

GIS based-data:

- Mean elevation 1089 m, minimum elevation 781 m, maximum elevation 1717 m
- Mean slope 26°, minimum slope 6°, maximum slope 44°
- Mean aspect 25°
- Area 0.83 km²

Field observations:

- Elevation at road level (close to lake level) = 746 m
- 2nd toe from front (location shown with black arrows), angle 34°, elevation 817 m, grain size 2 – 50 cm with average about 10 cm (grain size about the same over the entire rock glacier), well vegetated (trees)
- Photo 4803 (middle of slope) taken at 938 m, above treeline, angle 30°
- Photo 4804 (middle of active area of slope) taken at 1118 m, angle 34°
- Top surface of rock glacier at 1251 m, photos 4805 – 4816, snow patches present, pronounced lateral ridges on surface, originates in cirque and spreads into many toes
- King's Throne from front: photos 4820, 4821

Figure 7 – Comparison of observations from air photo and field visit for King's Throne site

Discussion

Effects of errors in the database

Morphology classification errors in the sample database are thought to be negligible because all of the classification was done using aerial photographs that covered the entire extent of each rock glacier. Errors in activity classification are more likely due to the subjective nature of characterising the features that indicate status. Confidence was generally high when classifying rock glaciers as active, but inactive and relict forms were more difficult to differentiate. Thus errors are most likely to consist of misclassifications of rock glaciers between the inactive or relict groups.

Inaccuracies in the population database are believed to be more numerous. First, it is virtually certain that substantial numbers of rock glaciers exist in areas of the Territory that have not yet been mapped. For example, the highest concentrations of rock glaciers occur in the Selwyn Mountains (which include the Wernecke, Hess, and Logan Mountains) but the central section of this chain is unmapped (Figure 5). Second, the discovery of 20 additional rock glaciers, mainly in the Kluane Lake region and south along the road from Haines Junction to Haines, Alaska, during fieldwork that did not appear on the existing surficial geology maps suggests that unrecognised forms may be common, even in mapped areas. Finally, a small number of features mapped as rock glaciers appear to have other origins. Taking all these factors into account, our estimate is that there are 2500 to 3500 rock glaciers in the Yukon Territory.

Considering that the average area of all the rock glaciers in the sample database is 0.216 km² and the total number in the Yukon is in excess of 1500

(accounting for potential errors in the database), rock glaciers occupy at least 320 km² of the Territory. If the estimated range of totals is used, rock glaciers probably cover between 540-750 km², which while a very large value, still represents less than 0.25% of the Territory. In comparison, the glacierized area is an order of magnitude greater, at approximately 5000 km² (data from NSIDC, 2007).

Activity classification errors are likely to be present, however they should not present a bias in the data since, after attempting both air photo-based and fieldwork-based classification, it was decided to use only the air photo-based system due to the considerable discrepancies between the two methods. The field-based activity classifications are probably more accurate considering that surface features, matrix stability and slope are much more apparent in person than in an air photo (which is also potentially many years old, introducing the possibility of change in activity level). However, since it was not possible to visit all the sites in the study sample, the standard method had to be used.

Morphology classifications given are probably much more accurate than the activity classifications. Again in this case, it was decided to use the air photo-based class assignments. The morphology was much clearer on the air photos, where (usually) the whole landform was visible and seen at a bird's-eye view, than in the field, where both the upper and lower portions of rock glaciers were frequently obscured from view (by forest, surrounding topography, fog, and cloud, among others). Furthermore, the certainty of observing the correct feature is greater when comparing a location marked on a digital elevation model to an air photo than when comparing a location marked on a digital elevation model or

as a GPS waypoint to the topography as usually seen from the lowest point of elevation in the landscape where the roads are situated.

Distribution trends

Rock glacier density was highest in the northernmost mountain range within the study area. This may be because the area has continuous (90-100%) permafrost and thus local climate would not prevent rock glacier development in this region. However, it may also relate to the distribution of bedrock types suitable for rock glacier development.

The apparent absence of rock glaciers in some of the more southerly mountainous areas portrayed in Figure 1 may be due to two main causes. First, the southern area of the territory is thought to be underlain by sporadic (10-50%) permafrost. Consequently, climatic conditions may not favour rock glacier development or persistence at many sites. Second, we suspect that some rock glaciers are in fact present, but were not identified as such on the existing surficial geology maps.

Trends in elevation and aspect

The mean elevation of active rock glaciers in the Yukon fits in well with the known gradient in elevation for active rock glaciers in North America (Figure 8). From north to south, the mean elevation of rock glaciers increases from 990 m in the Brooks Range, Alaska (Wahrhaftig and Cox, 1959), to 1584 m in the Yukon Territory (this study) to 3526 m in Colorado's Front Range (Janke, 2007), and 3697 m in the San Juan Mountains (White, 1979). The Alaska Range (Calkin *et*

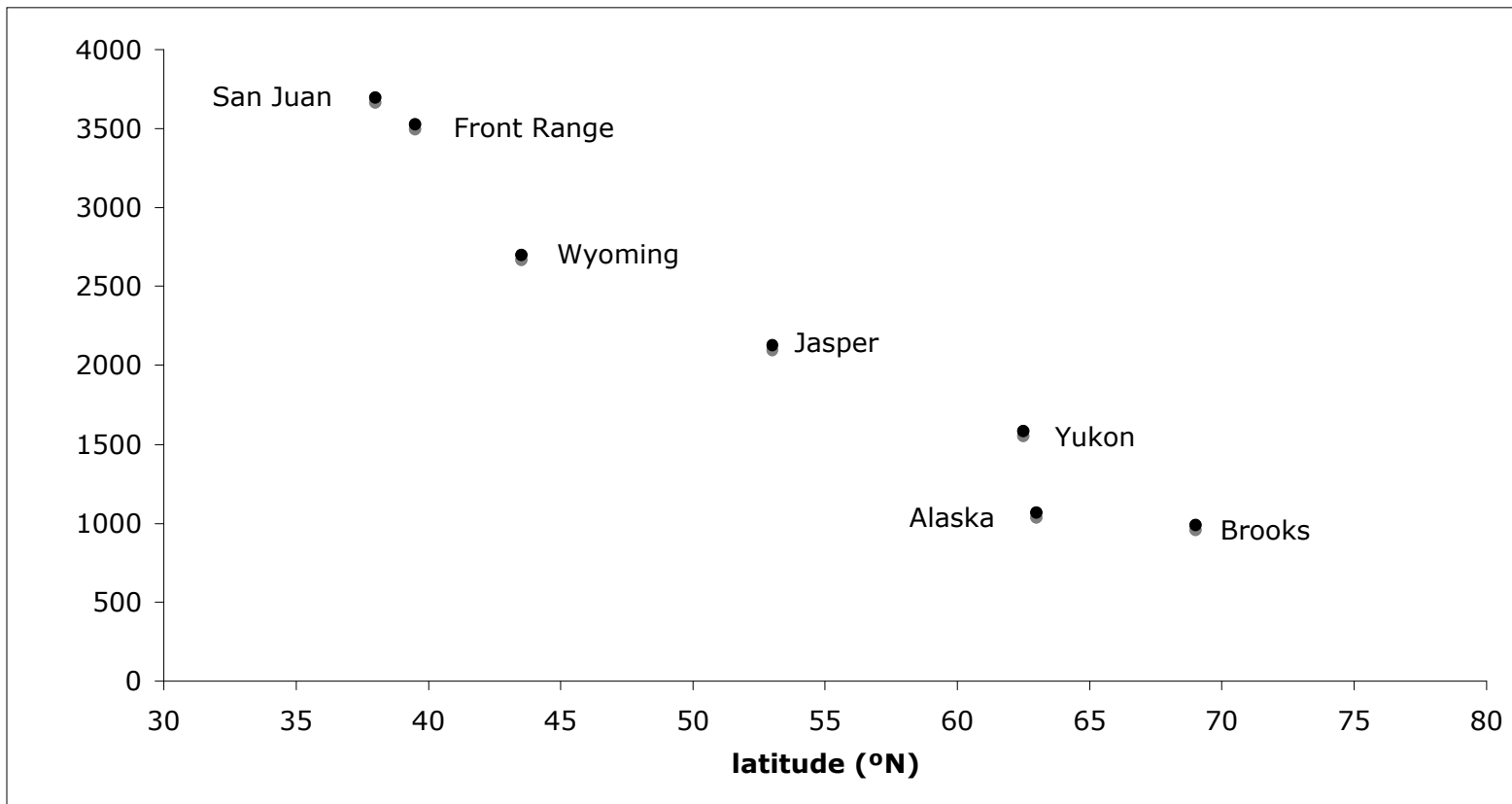


Figure 8 - Mean elevation of active rock glaciers vs. latitude in North America. Sources: Brooks Range – Warhaftig and Cox, 1959; Front Range – Janke, 2007; San Juan Mountains – White 1979; Alaska Range – Calkin *et al.*, 1987; southern Rocky Mountains – Luckman and Crockett, 1978; Absaroka Range – Potter, 1972.

al., 1987), southern Rocky Mountains (Luckman and Crocket, 1978) and the Absaroka Range in Wyoming (Potter, 1972) have intermediate values of 1070 m, 2125 m, and 2700 m, respectively.

Yukon examples also fit the rule of thumb that rock glaciers are more likely to be found with poleward facing aspects (e.g. Barsch, 1996). We hypothesized that aspect might play a less important role in determining rock glacier location with increasing latitude, and while individual rock glaciers can be oriented in any direction, Figure 9 shows that there is a clear tendency for more to occur on north-facing slopes, especially for active forms. Localised tendencies in aspect may be attributable to the orientation of mountain ranges themselves, but the Yukon results come from several ranges with differing orientations, so the 349° (NNW) mean aspect for active rock glaciers (Table 5) is likely due to a climatically-induced preference for north-facing slopes. Latitude is not significantly different between the active and inactive rock glaciers in the study sample, however it is significantly different ($p = 0.002$) between northward-facing forms (mean latitude = 62.8°N) and southward-facing forms (mean latitude = 63.8°N).

Comparison of active, inactive and relict rock glaciers

Size appears to be the best way of distinguishing between the activity groups. Active forms average about twice the size of the inactive and relict forms (Table 5). These differences may have several potential causes, including the possibility that forms which are now relict or inactive have always been either climatically marginal, hydrologically marginal, or geologically marginal, and thus

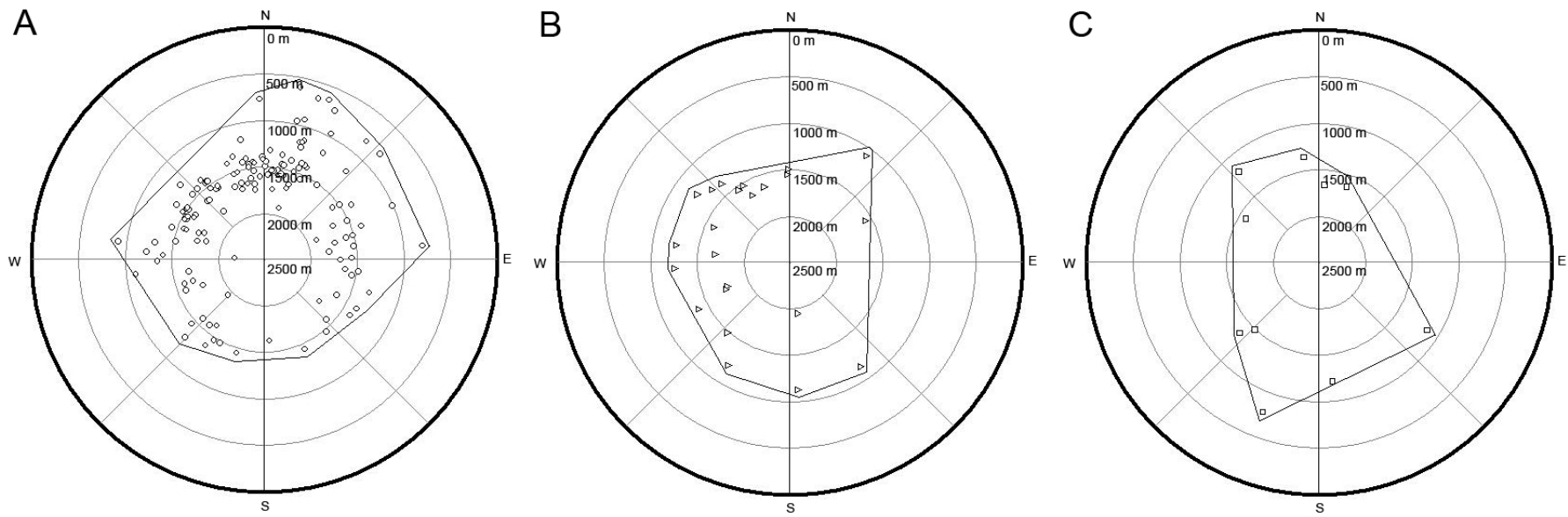


Figure 9 - Orientation and minimum elevation of rock glaciers in the sample with lines showing lower elevation limits for different activity groups: A: active; B: inactive; and C: relict.

never developed to the extent that those currently active did. Additionally, active forms may have been active longer and have, therefore, grown larger, or the active forms may be less marginal and so have grown faster. The fact that mean aspect is also significantly different between the active and inactive groups (Figure 9) lends support to the idea that north-facing slopes are more suitable to rock glacier maintenance and hence enlargement.

In contrast to the size and frequency differences, *t*-tests conducted on mean, average minimum, and average maximum elevations for active rock glaciers divided into groups facing the northern and southern halves of the compass exhibited no significant differences. Despite this, Figures 6A and 8A show that individual rock glaciers are present at lower elevations on north-facing slopes compared to south-facing ones. In contrast, inactive forms (Figure 6B) extend to their lowest elevations on southward-facing slopes. Relict forms (Figure 6C) are too few in number in the sample for the pattern to be conclusive but it is notable that the lowest one is on a slope facing SSE.

The climate of the Yukon with MAATs in valleys ranging from $\sim 0^{\circ}\text{C}$ to -5°C (see Table 1) means that large areas at higher elevations may be suitable climatically for rock glacier formation or preservation. Aspect does appear to play a role in rock glacier distribution, as the directional distribution of all activity classes was significantly non-uniform with a strong northerly component. Aspect and elevation, and by inference ground temperatures, however, are not the only influences contributing to the presence or absence of rock glaciers. Debris and water/ice input are also essential and the absence of either will mean that no rock glacier will form or that an existing one will become inactive (Haeberli,

1985). Bedrock geology also plays a major role, as the bedrock must weather to a suitable substrate for rock glacier formation. It will also affect the size and resultant form of a rock glacier (Ikeda and Matsuoka, 2006). Of the seven rock glaciers visited in the field, only one was of the “pebbly” variety (formed in shales and platy limestones) and the rest had larger “bouldery” surfaces (formed from crystalline rocks and resistant limestones; Ikeda and Matsuoka, 2006).

Topography is a further constraint on rock glacier formation, as a steep headwall is required for debris supply (e.g. Haeberli, 1985; Ackert, 1998) and a slope below it is necessary to enable flow (Sloan, 1998; Kääb *et al.*, 2009). These factors contribute to the possibility that some relict and inactive rock glaciers may have ceased activity for reasons other than climatic change.

Comparison of tongue-shaped and lobate rock glaciers

For the different morphological forms of the rock glaciers studied, elevation is the key differentiating characteristic out of the factors examined (Table 3, Table 4, Figure 10). Tongue-shaped forms frequently originate in cirque basins which are located at relatively high elevations. Lobate rock glaciers develop from talus slopes which often occur on valley sides at elevations that on average are 100-130 m lower. The same pattern was found by Ellis and Calkin (1979) and by Janke (2007) in studies of the Brooks Range and the Colorado Front Range, respectively. Similarly, Harris (1981) argued that the distribution of tongue-shaped rock glaciers relates to climatic conditions associated with glaciers while lobate rock glaciers relate to the distribution of discontinuous permafrost. In the Yukon sample, there is considerable overlap between the two

groups (see Figure 10) but both mean and mean minimum elevations differ significantly (Table 4). Like White's (1979) study of the San Juan Mountains in Colorado, no significant differences were found between the aspect and slope of the lobate and tongue-shaped samples in the Yukon. Both forms have northwest aspects and slopes of 23 - 25°. As mentioned above, geology may play a role in determining rock glacier size, since pebbly rock glaciers tend to be smaller than bouldery ones (Ikeda and Matsuoka, 2006), but this factor was not examined in the present study and the sizes of tongue-shaped and lobate rock glaciers were statistically the same.

Interaction of rock glaciers with forest

One of the aspects of rock glacier distribution in the Yukon that differentiates it from many other mountainous areas is the potential for interaction of active features with forest, either by being partially covered by forest where a suitable substrate (such as loess) is present (e.g. Blumstengel and Harris, 1988) or by extending below the treeline and disturbing forested slopes. This occurs because the northern continental climate of most of the Yukon, with cold winters but relatively warm summers and limited precipitation (Table 1), allows permafrost to persist in rock glaciers at relatively low elevations. A comparison of the elevations shown in Figure 4 with an analysis of mean July air temperatures at Yukon climate stations (Table 1) explains this possibility. July normal temperatures for 1971-2000 can be predicted using a statistically significant ($p=0.000$) multiple regression equation against longitude and elevation: $Y = 34.86 + 0.117 \cdot \text{longitude} - 0.007 \cdot \text{elevation}$ ($n=14$; adjusted $r^2 = 0.74$; standard

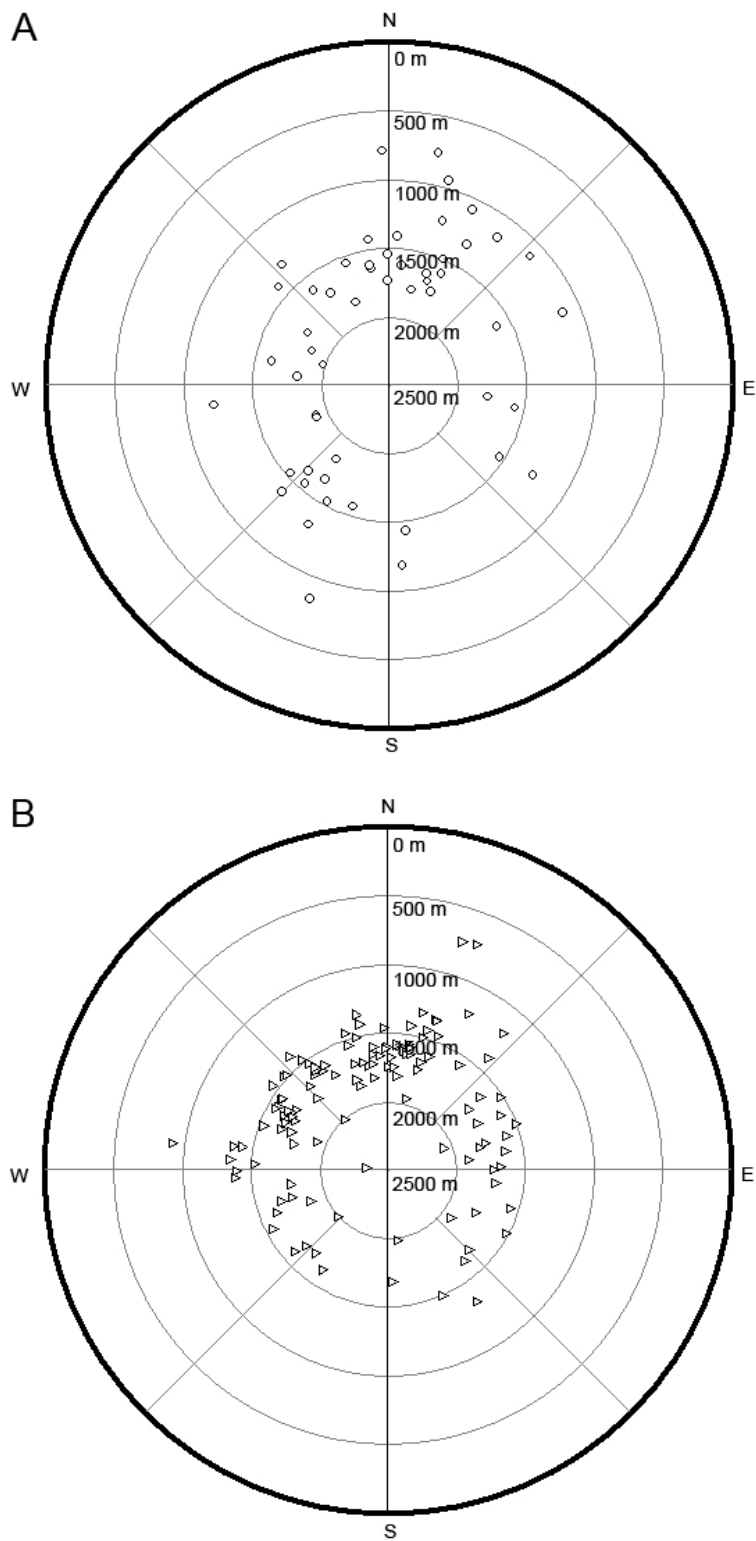


Figure 10 - Orientation and mean elevation of rock glaciers in the sample classified by morphology: A: lobate; B: tongue-shaped.

error = 0.5 °C). Surprisingly, latitude played no significant role in a preliminary investigation and so was not included in the final equation. If the generally accepted altitudinal limit of trees is taken to be where the July normal temperature equals 10 °C, this equation predicts that treeline will occur around 1200 m asl at 140 °W (i.e. longitude -140 °) in the western Yukon south of 65 °N and at 1400 m asl at 128 °W in the eastern Yukon, which corresponds closely with field observations (e.g. Danby and Hik, 2007). Figure 9A shows that many active rock glaciers extend below these elevations, so that forested rock glaciers cannot be automatically classified as inactive or relict.

Potential uses of rock glacier database

The rock glacier database compiled in this study has several potential uses in addition to mapping the landforms and examining their distribution and the topography in which they occur. The rock glaciers can be used as single point indicators of permafrost, though not of elevational limits of permafrost, since permafrost occurs in valley floors as well in higher elevational bands where rock glaciers exist. The database can be used for a deeper examination of the relationships between rock glaciers and the topography and geology in which they occur. Finally, because rock glaciers have been suspected as a potential source of landslide debris if thawed (Kneisel *et al.*, 2007), this database will provide a key input for geohazard mapping and modelling.

Conclusions

This study is the first attempt to examine the distribution and characteristics of rock glaciers across the Yukon Territory. The spatial database developed for this study is only an initial step towards more detailed analyses since fieldwork and aerial photograph examination show that it is subject to some inclusion and exclusion errors. Nevertheless, we are able to conclude the following:

1. More than 1500 rock glaciers are present in the major mountain ranges of the Yukon, and given that spatial coverage is still incomplete, the total is probably in the range of 2500-3500. The greatest spatial density occurs in the higher latitude mountain ranges, where it reaches 50-60 rock glaciers per 500 km². In total, rock glaciers occupy an area of at least 320 km² and probably 540-750 km², about one-tenth the areal extent of ice glaciers in the Territory.
2. Active rock glaciers are more numerous, larger and are more likely to have northerly orientations than inactive and relict features. All activity classes show a preferred orientation with a strong northerly or north-westerly component. Although the elevations of active, inactive and relict rock glaciers in the sample follow the typical elevational gradient from higher to lower, the differences are not statistically significant.
3. Tongue-shaped rock glaciers occur at slightly higher elevations on average than lobate forms. This fits the pattern found in previous studies in North America and elsewhere and is explained by differing origins and

- topography generating the landforms (i.e. cirque basins produce tongue-shaped rock glaciers and talus slopes produce lobate forms).
4. The average active rock glacier elevation of 1580 m calculated for a sample fits within the general pattern of decreasing rock glacier elevation with latitude for the North American Cordillera.
 5. The lower limit of active and inactive rock glaciers is about 1100 m on south-facing slopes and about 600 m on north-facing slopes. These observations illustrate the existing understanding of discontinuous permafrost distribution in the Yukon, in which permafrost can potentially be present at almost any elevation from valley bottoms to mountain peaks. They indicate that while rock glaciers may be used as single point indicators of the presence of permafrost, they may not be used to demarcate the lower elevational limit of permafrost in the Yukon as has been done elsewhere.

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7.2 Research note: Measuring change in Yukon's rock glaciers from multi-temporal air photo analysis

Paper intended for submission to the Canadian Journal of Remote Sensing

Statement of contribution:

Amaris Page – background research, research planning, data compilation, analysis and interpretation, written and graphic presentation

Andreas Kääb – research planning, technical instruction, analysis and interpretation assistance, written presentation (software capabilities and error analysis), editing

Antoni Lewkowicz – research planning, editing

Amaris Page^{1,a}, Andreas Kääb², Antoni Lewkowicz¹

^aCorresponding author: apage093@uottawa.ca

¹ Department of Geography, University of Ottawa

Ottawa, Ontario, K1N 6N5

Phone 613-562-5800 Ext 1067; Fax 613-562-5145

²Department of Geosciences, University of Oslo

Abstract

The feasibility of assessing rock glacier change, in particular horizontal displacements, using multi-temporal photogrammetric methods with the quality and frequency of air photos available for the Canadian North, was evaluated for several sites in the Yukon. Results showed that it is possible to determine general rates of flow and to observe changes in macro-features using the

examples tested. The quality of the photo scans available, problems with photo compression and photo distortion, and visual and physical obstructions (cloud cover and thermokarst) prevented the creation of detailed fields of flow vectors for entire rock glaciers. Extensive thermokarst development was observed in one case and maximum flow rates ranging between 28 and 117 cm yr⁻¹ were measured. This study shows that it should be possible to measure rates of rock glacier movement from original air photos or high quality scans.

Introduction

A small body of European (Kääb and Vollmer, 2000; Kääb *et al.*, 2002; Kaufmann and Ladstädter, 2002; Frauenfelder *et al.*, 2004; Stozzi *et al.*, 2004; Wangensteen *et al.*, 2006; Roer and Nyenhuis, 2007) and North American (Janke, 2005) research has been developed showing that multi-temporal air photos can be used to measure flow rates and thickness changes on rock glaciers. These studies have been carried out mainly with high quality air photos taken from low flying heights (often 1:15000). Some studies, however, used regular map-update air photos, similar to the ones used in this study. Other areas that have high concentrations of rock glaciers, like the Canadian northwest, do not have coverage by high quality air photos (usually 1:35000 to 1:60000) but do have coverage over large areas, often for multiple dates (between 1947 and present, with many of the photos being from the late 1940s, mid-1970s, and mid-1980s). This study was thus designed to test the possibility of using these photos to measure rates of rock glacier flow.

Little is known about rock glacier dynamics for Canadian examples. A few case studies exist that include surveyed flow rates (Hughes and Rapp, 1965 as cited by Jackson and Macdonald, 1980; Johnson and Nickling, 1979; Jackson and Macdonald, 1980; Blumstengel and Harris, 1988; Johnson, 1998; Sloan and Dyke, 1998), but no large-scale or systematic attempt has been made to measure them. However complete air photo coverage of the North exists at 1:60000 and very extensive coverage exists at a scale of 1:40000. Given that such coverage is available, it appeared worthwhile to test its usefulness for regional-scale photogrammetric monitoring techniques.

Study area

Study sites were chosen from Page *et al.*'s (in review) rock glacier inventory based on site characteristics and air photo availability. The locations chosen fall within the discontinuous permafrost zone of Canada's Yukon Territory (see Figure 1). Each site has an active rock glacier, with two lobes, except for the Haines Junction North site, which has only one. The White River, Haines Junction, and Haines Junction North sites all are located between the Kluane Mountains to the west and the Shakwak Trench to the east. The Sloan and Dyke 1-1 site (so called for Sloan and Dyke's (1998) study of the site) is situated within the Selwyn Mountains in the eastern portion of the Territory, close to the border with the Northwest Territories.

All climate stations in the southern Yukon exhibit mean annual air temperatures (MAATs) below 0°C (Environment Canada, 2004), meaning that the potential for permafrost exists. The distribution of climate stations is limited,

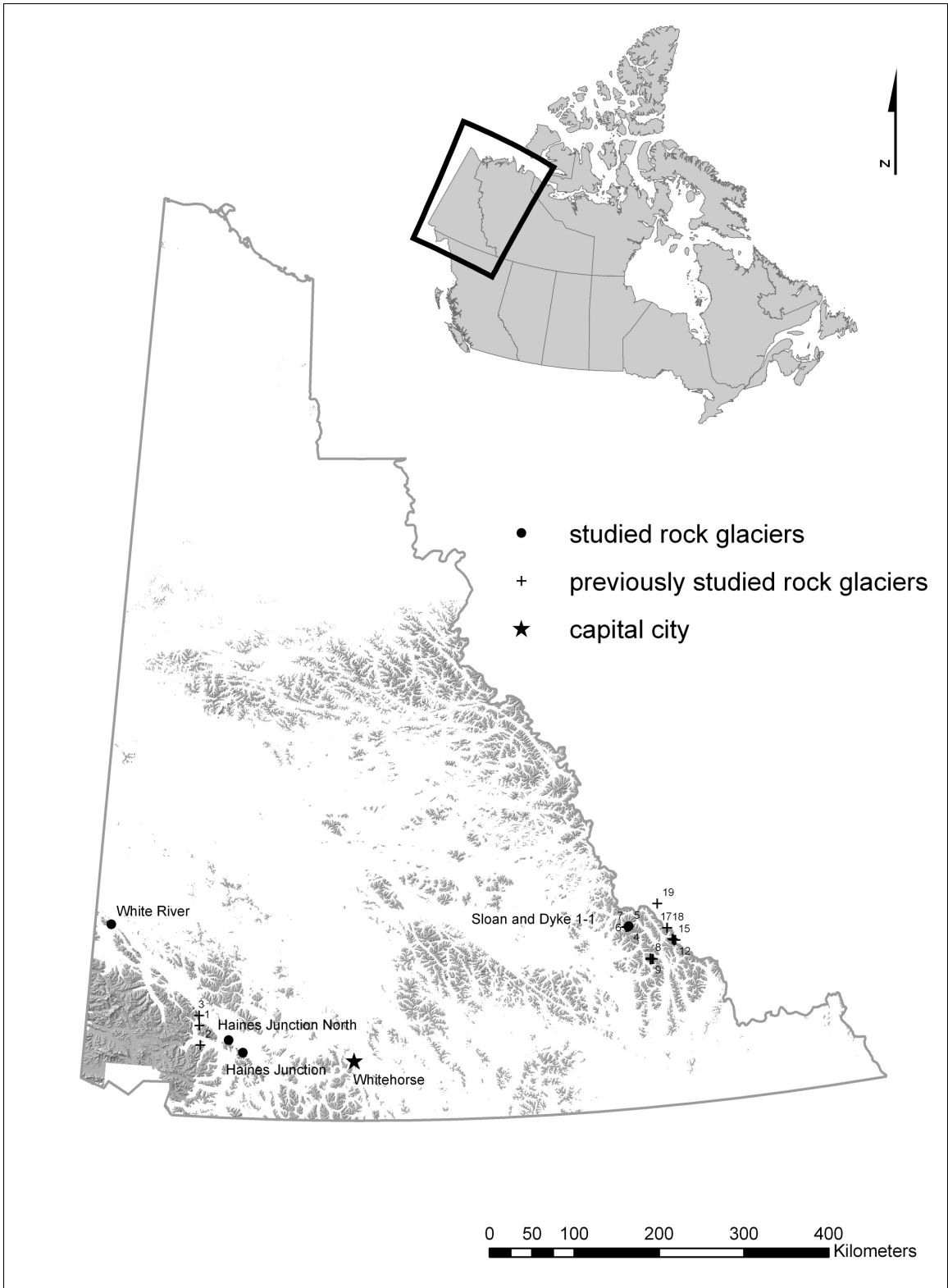


Figure 1 - Study sites and previously studied sites in the Yukon territory, Canada. Terrain with elevation above 1500 m asl shown in grey. Numbered sites have measured movement rates published in the literature (see Table 4): 1 – Slims River, 2 – Maxwell Creek, 3 – Sheep Mountain, 4-18 – Selwyn Mountains, 19 – Tungsten.

as they are few in number and none are located above 830 m elevation. Due to the limited climate data, little is known about the exact climate conditions in upper elevations: nearly half of the terrain is at an elevation of 1000 m or greater.

The study area covers a landmass that experiences a shift from a wetter, more maritime climate in the southwest (near the North Pacific Ocean) to a more arid climate on the inland side of the St Elias Mountains (Wahl *et al.*, 1987). Permafrost distribution in the Yukon is essentially continuous (underlying 90% of the terrain or greater) north of 65°N and sporadic discontinuous (10-50%) or extensive discontinuous (50-90%) south of 65°N.

The photos used for the four sites had resolutions between 1:35000 and 1:50000. The dates between pairs of photos were variable (evenly spaced photo intervals were not available), and range between 13 and 40 years. Topographic and photo information is provided in Table 1.

Methods and challenges

Photo and data acquisition

A selection of the largest rock glaciers from Page *et al.*'s (in review) inventory was chosen. This selection was then narrowed, using the resources of the National Air Photo Library in Ottawa, to those sites with at least two periods of photo coverage, aiming for sites where the separation between photo dates was approximately 30 years or greater. The best 10 of the possible sites were chosen based on visibility of the rock glaciers in the photos. Finally the three most promising sites in terms of rock glacier size and airphoto coverage and quality were chosen to be included based on preliminary analysis of the photos.

Table 1 - Topographic and photo data for studied sites

Site name	Elevation (m)	Slope (°)	Aspect (°)	Area (km ²)	Roll and photo #	Date	Resolution
White River	1401.6	18.6	69.8	2.012	A11537-87	1948	1:40000
					A27370-78	1988	1:50000
Haines Junction	1221.1	10.7	27.8	3.089	A11539-40	1948	1:40000
					A23898-134	1974	1:35000
Haines Junction North	1762.1	13.8	53.5	1.427	A11478-40	1948	1:40000
					A23794-119	1974	1:35000
					A27217-216	1987	1:50000
Sloan and Dyke 1-1a	1746.5	12.7	6.5	0.431	A12343-139	1949	1:40000
					A27020-248	1986	1:50000
Sloan and Dyke 1-1b	1656.8	18.7	12.9	0.483	A12343-139	1949	1:40000
					A27020-248	1986	1:50000

The Sloan and Dyke 1-1 site was included because it has been previously surveyed, which provides a measure against which to compare the technique being tested in this study. All of the sites have two dates of photo coverage except for the Haines Junction North site, which has three.

The photos were scanned from photographic copies of the original photos at about 20 micron resolution and saved as .jpg files. Due to the experimental nature of this study and the relatively poor quality of the available photographic copies, the .jpg files were used and not replaced with uncompressed .tif files. The jpg-compression certainly reduced the quality of the image matching described below. The photographic copies scanned were, in many cases, old, with water damage and possibly distorted by humidity. It was not the purpose of this feasibility study to rely on the original negatives, copies of which are expensive to obtain, but rather to prepare for a more extensive future study that might rely on the original photos. The times between photo pairs was variable and their use was simply based on what was available in the archive. Some of the photos contained shadows from clouds but no better images were available. A final problem encountered was that camera calibration information, aside from focal length, was missing from all of the older photos. Fiducial mark locations were measured manually and an average for each photo was used.

The multitemporal image correlation procedure used in this study is based on repeat orthoimages. Rather than creating elevation models from stereo images as would be possible in theory from the air photos available, it was decided to use an existing 30 m digital elevation model (DEM; Yukon Department of Environment, Information Management & Technology Branch, 2005) for the

creation of all orthophotos. Because of this, only horizontal rock glacier displacements were measured and not vertical changes. The DEM was generated from contours digitised from a topographic map and its quality is not perfect, as the interpolation used left the contours visible in the resulting DEM, effectively creating steps in the interpolated topography.

An additional comparison was carried out on the Sloan and Dyke 1-1 site, using georeferenced versions of the photos rather than orthophotos. This technique allowed elevation to be removed from the process of assigning geographic coordinates, since vertical movement is not being measured.

Software

The software Geomatica PCI OrthoEngine was used for the creation of orthoimages. The major challenge in using this software was that it is incapable of having more than one camera calibration per “project”, i.e. if one wishes to create two or more orthoimages at the same time, with the same ground control and tie points, all of the photos must have the same camera calibration values. This, of course, was not the case when the photos were taken 30 or 40 years apart, so the camera calibration values were averaged between the values for each different camera to create an “average camera calibration” that would be acceptable for all of the images. The combination of all multitemporal images within one photogrammetric model and a combined multitemporal bundle adjustment is a recommended measure in order to minimize distortions between the multitemporal orthoimages (Kääb and Vollmer, 2000). Errors in the “average camera calibration” relative to the correct parameters will mainly result in an

incorrectly solved flying height for the photos used, and has a lesser effect on the orthoimages computed. In fact, comparisons showed that the orthoimages from the multitemporal image blocks matched significantly better than orthoimages from separate monotemporal photogrammetric models but using correct calibration parameters. For an extended study we recommend using a photogrammetric software capable of using more than one camera model within one image block (Kääb and Vollmer, 2000).

In one case, it proved impossible to create an “average camera”, because the locations of the fiducial marks differed (corner vs. edge) on photos from the same site. Ground control and tie points were located by visually matching the locations.

For the analysis at the Sloan and Dyke site using georeferenced photos instead of orthophotos, ESRI’s ArcMap was used to georectify the newest photo (A27020 – 248, 1986) to a Landsat image of the site (L71056017 01720010817 B50) and then to georectify the older image (A12343 – 139, 1949) to the newer one.

Ground control and tie point collection and orthophoto creation

As mentioned above, ground control points and (multitemporal) tie points for the creation of the orthophotos were collected concurrently for all photos of the same study site. This way, all orthophotos for each site were created from the same photogrammetric model, ensuring the best possible match between the repeat orthoimages (Kääb and Vollmer, 2000).

Collecting sufficient ground control and tie points, as well as collecting accurate enough ground control and tie points to allow a good match between the same location in each of the resulting orthophotos, was a challenge, caused both by the poor image quality and especially by the comparatively low resolution of the DEM used. However, in the end, ground control point residuals were less than or equal to the original DEM resolution (30 m, RMSE of 30 or less) and the average ground control point residuals about half of that. While this accuracy describes the absolute georeference accuracy of an entire image block, the relative accuracy between the images is much better as ensured by the multitemporal tie points. Their accuracy was in the order of 1 m (ca. 1-2 pixels) on average.

The collection of tie points for the georeferencing process at the Sloan and Dyke site was not concurrent between the photos from the two time periods. The smallest error it was possible to obtain in georectifying the 1986 photo (A27020 - 248) to the Landsat image (L71056017 01720010817 B50), using a third order transformation, was a RMSE of 85.6, over twice what was possible with the orthophoto creation. The older photo (A12343 – 139) was then georectified to the georeferenced 1986 photo using a first order transformation resulting in a RMSE of 55.3, also higher than that obtained in the orthophoto creation. The higher errors are likely due to the fact that first and third order transformations are much lower order transformations than that used creating an orthophoto. It is a trade-off between the possibility of artificially moving features on the image (lower with the georeferencing method) and the goodness of fit between the tie points

selected for the images (higher with the orthophoto creation), both of which are potential sources of error.

Velocity measurement

Displacements between the multitemporal orthoimages were determined using the CIAS software (Kääb and Vollmer, 2000), which measures displacements by double cross-correlation between the orthophotos and georeferenced photos. The software possesses the capability to match displacements on a grid to produce a raster movement field, but due to the poor photo quality better results were achieved by having the software match user-selected points with the operator verifying that the match had been made correctly, a finding in agreement with the conclusions of Kääb and Vollmer (2000).

A Helmert correction function was used, in which stable points outside the rock glaciers were selected and matched before measuring movement, and residual co-registration parameters computed and applied to the raw displacements. This ensured that movement was measured relative to stable points and helped reduce the impact of imperfect matches between the orthophotos and georeferenced photos.

A window size must be defined for the software as it automatically finds the most similar site in one airphoto relative to the other one using this window. For high-resolution photos, a small window size is best because small features are visible, but for lesser resolution photos a large search window usually must be used because only large features on the rock glacier surface are discernible.

In this study a combination of 25 pixel (for comparably distinct features such as big rocks) and 60 pixel (for topographic features such as ridges) square windows were used. The results do not distinguish between measurements derived from the two window sizes.

One drawback to the software used is that it has no means of anomaly detection built into its matching mechanism. In other words, if a match is made between points that, for example, indicate a backward flow of the rock glacier, the software has no means to flag it as a potential error, since the user is unable to assign a flow direction. Nor is the software able to make an automatic comparison with the directions of the movement vectors already measured. Such filters have to be applied in a post-processing step (Kääb and Vollmer, 2000). However, the software provides the correlation value for each measurement.

Measurement values should be within the accuracy of the technique as they are reported or represented visually in this paper. The shortest time difference between photos is 13 years (1974 to 1987 at the Haines Junction North site), at which a rate of movement of 10 cm yr^{-1} would be detectable based on the resolution of the photo. All other photo pairings have longer time intervals and it is thus possible to detect smaller rates of movement.

Once movement vectors had been derived, all measurements for which the correlation coefficient for the feature match between the two photos was less than 0.7 were discarded. The vectors were then exported for display and analysis in a GIS.

Results

Orthophoto-based results are available for four rock glacier sites on a total of seven lobes (Figures 2-5A). And georeferenced photo-based results are available for one rock glacier site on a total of two lobes (Figure 5B).

A limited number of corresponding features between the multitemporal images were found due to the low air photo quality and the lengthy elapsed time between image dates. In one case, strong surface change due to thermokarst activity prevented measurements in the areas where thermokarst was present. Maximum rock glacier velocities at the sites examined on orthophotos range from 66 to 117 cm yr⁻¹ (Table 2). When looking at each lobe of a rock glacier separately, the lobe with the highest maximum velocity also has the highest median velocity (calculated from the 10 fastest measured values), except in the case of the White River site (Figure 2) where the north lobe has a higher maximum velocity but a lower median. This low median could be because there are fewer measurements on the north lobe than on the southern one.

Although feature matching between photos of different periods was supervised and the features were matched correctly, in some areas “upwards” flows appeared to be present. These errors are probably caused by errors in orthophotos as a result of inaccuracies in the elevation model used for their creation, or mismatches where a feature receiving high correlation values was not actually a corresponding feature. Such results are not surprising given the low photo quality and long time span between the successive images, and they were discarded as obvious errors.

In the case of the Haines Junction North site (Figure 3), where two

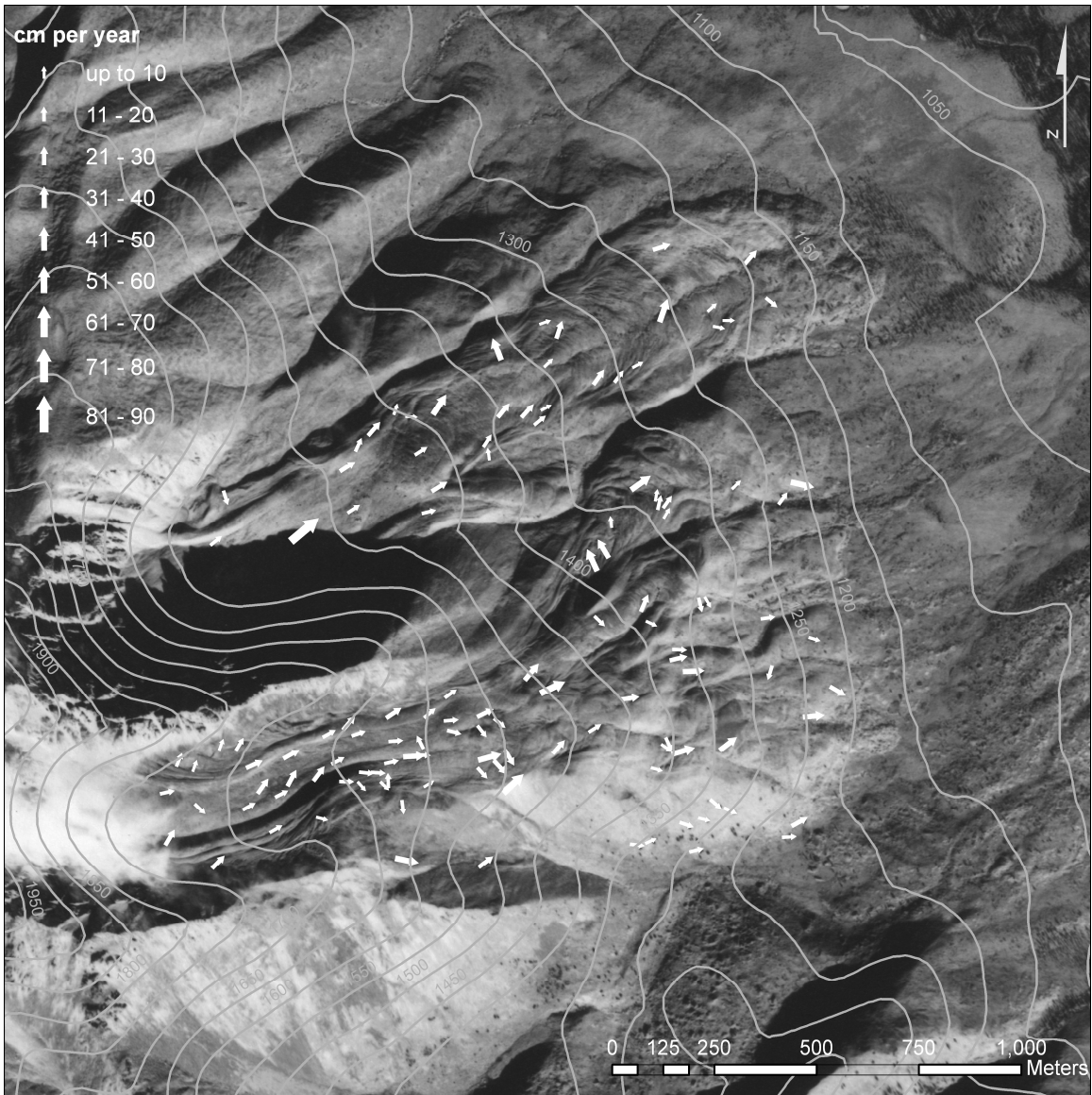


Figure 2 - White River, showing movement vectors derived from orthophotos, arrows sized relative to movement in cm yr^{-1} , 1948-1988 (photo: National Air Photo Library of Canada, A27370-78).

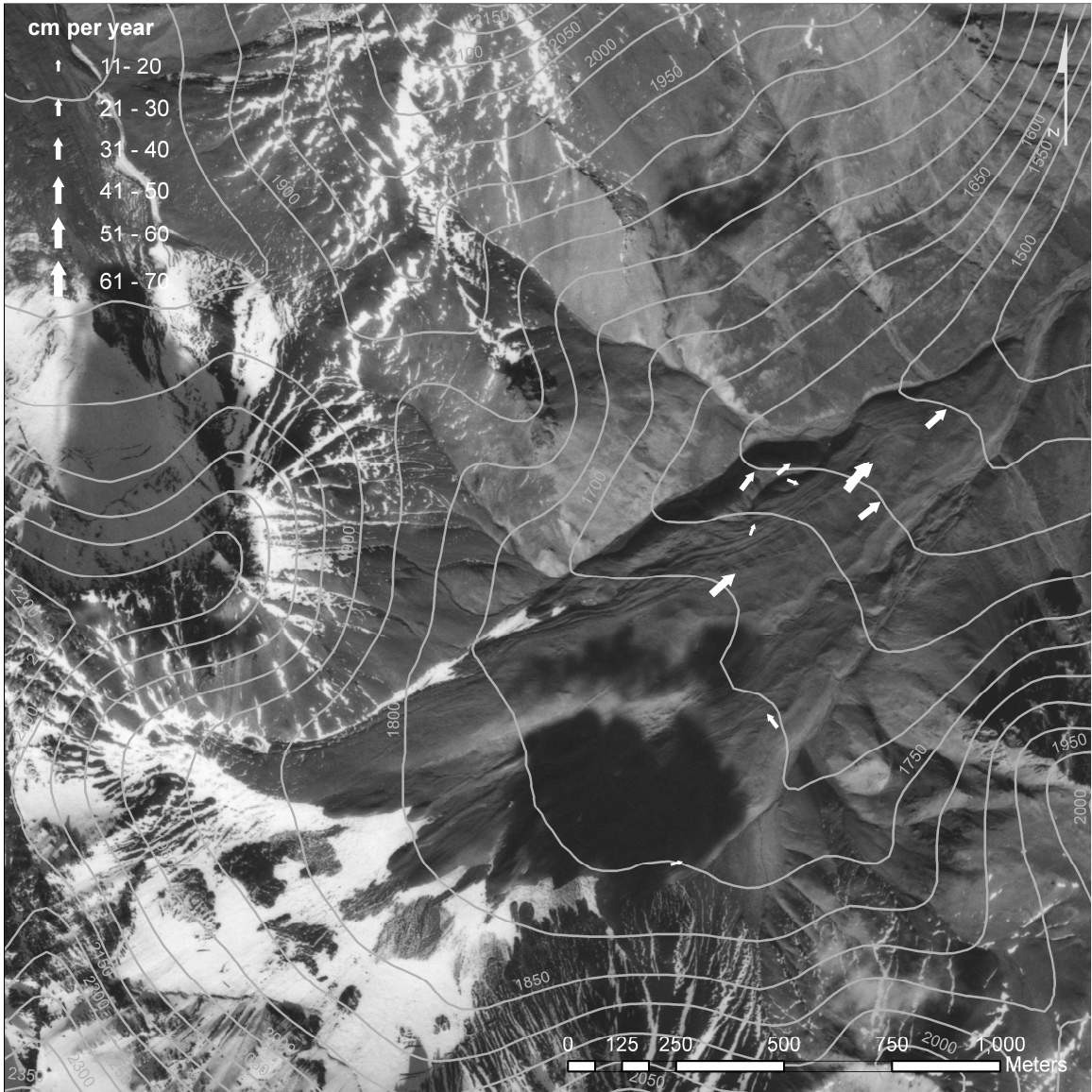


Figure 3 – Haines Junction North, showing movement vectors derived from orthophotos, arrows sized relative to movement in cm yr^{-1} , 1948-1987 (photo: National Air Photo Library of Canada, A27217-216).

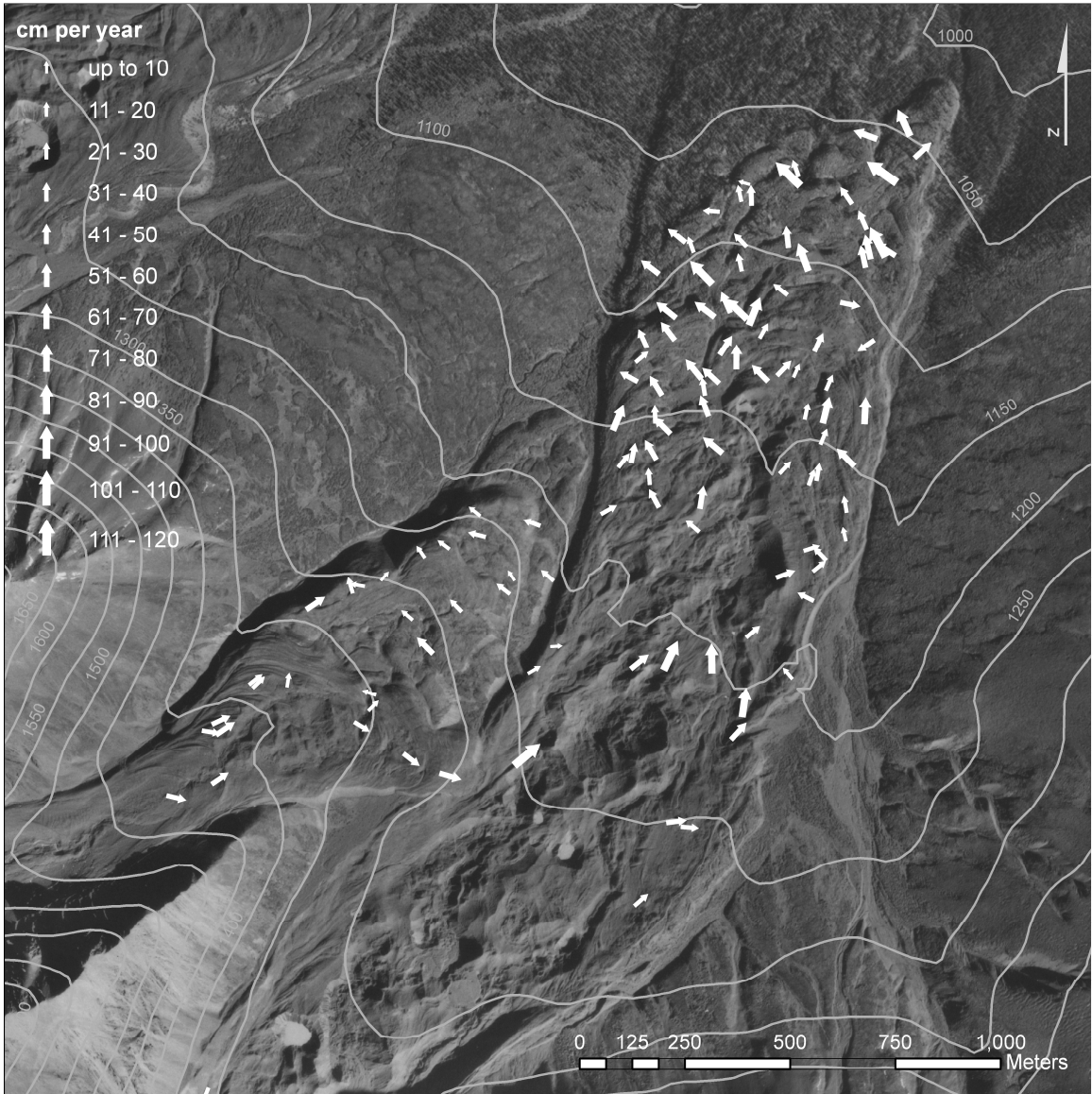


Figure 4 – Haines Junction, showing movement vectors derived from orthophotos, arrows sized relative to movement in cm yr^{-1} , 1948-1974 (photo: National Air Photo Library of Canada, A23893-134).

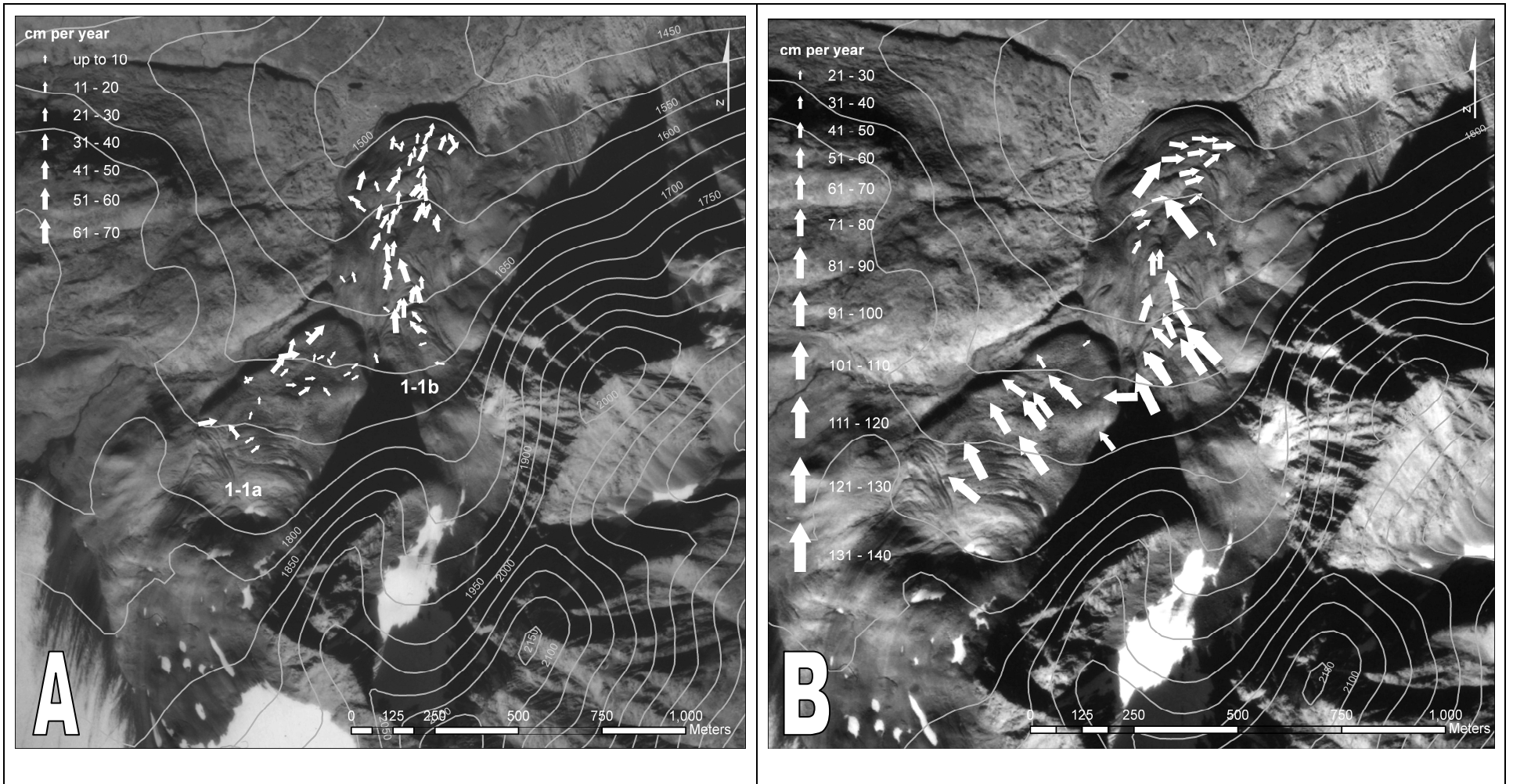


Figure 5 – Sloan and Dyke 1-1, showing movement vectors derived from orthophotos (A) and georeferenced photos (B), arrows sized relative to movement in cm yr^{-1} , 1949-1986 (photo: National Air Photo Library of Canada, A27020-248).

Table 2 - Rock glacier maximum annual velocities

Site	Lobe (<i>n</i>)	Maximum velocity (cm yr ⁻¹)	Median velocity of top 10 (cm yr ⁻¹)
Sloan and Dyke 1-1 1949-1986 GEOREFERENCED PHOTOS	both (45)	136	117
	1-1a (14)	121	95
	1-1b (31)	136	109
Sloan and Dyke 1-1 1949-1986 ORTHOPHOTOS	both (85)	66	50
	1-1a (27)	61	38
	1-1b (58)	66	47
White River 1948-1988	both (124)	83	48
	north (32)	83	28
	south (92)	58	45
Haines Junction North 1948-1987 (Coverage for 1974 also exists)	both (11)	67	39
Haines Junction 1948-1974	both (117)	117	97
	large (89)	117	97
	small (28)	58	49

different periods of photo coverage were available, the maximum velocity of 32 points measured over the 26 years from 1948 to 1974 was 86 cm yr^{-1} (Table 3). For the 13 years between 1974 and 1987, the maximum velocity measured over 33 points was 201 cm yr^{-1} . For the entire period (1948 to 1987), it was only possible to find 11 matching features, and for those, the maximum velocity was 67 cm yr^{-1} .

In addition to flow velocities, it was also possible to see the development of extensive thermokarst at the Haines Junction site. This caused problems when trying to find features to match on the earlier and later photos, but was interesting in its own right. The thermokarst was particularly evident in the mid-section of the rock glacier, in the flat area between the slope near the cirque wall and the slope of the cirque outlet. The thermokarst had begun developing at the time of the earlier photo (1948, Figure 6A) and had significantly altered the surface appearance of the entire middle portion by the time of the second photo in 1974 (Figure 6B). The presence of thermokarst indicates that at least parts of the rock glacier are (or once were) ice-rich. The lower portion of the rock glacier appears intact and shows movement typical of that expected on an active rock glacier.

The comparison between the two measurement techniques at the Sloan and Dyke 1-1 site yielded two very different sets of results. The measurements derived from orthophotos gave a maximum velocity for the two lobes of 66 cm yr^{-1} , while the maximum velocity derived from the georeferenced photos was 136 cm yr^{-1} . The rates of each lobe as measured from georeferenced photos were about twice those measured from orthophotos.

Table 3 - Haines Junction North site, changes in maximum velocity over time

	Number of points	Mean direction (°)	Maximum velocity (cm yr ⁻¹)
1948-1974	32	34	86
1974-1987	33	51	201
1948-1987	11	46	67

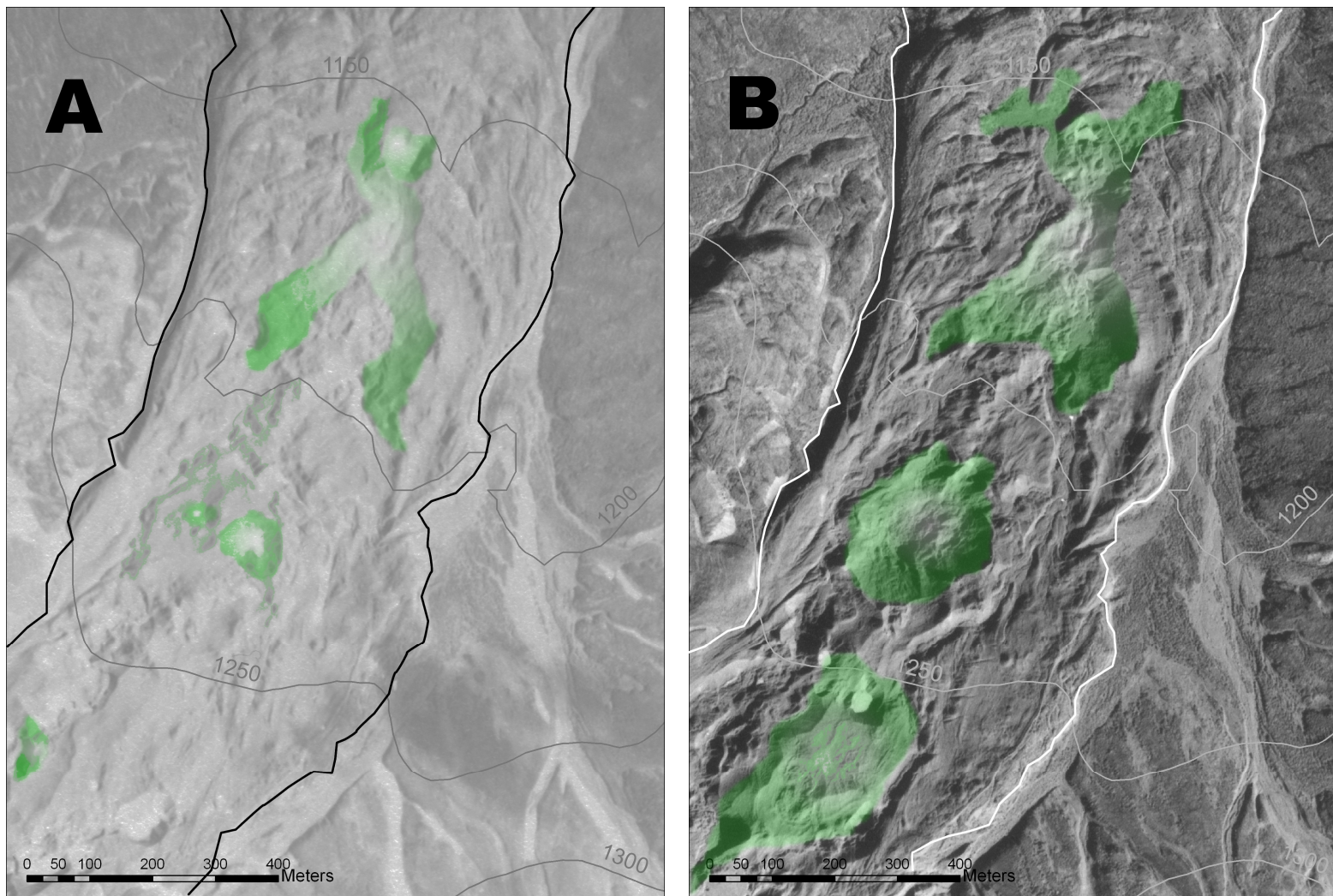


Figure 6 - Thermokarst development at the Haines Junction rock glacier site. A: 1948 photo (National Air Photo Library of Canada A1539-50; B: 1974 photo (National Air Photo Library of Canada A23893-134). Rock glacier extents are marked with heavy lines and prominent thermokarst features are highlighted in green.

Discussion

Comparison with previous measurements

The rock glacier velocities measured in this study fall within the range of values measured previously for other sites from 0 to more than 300 cm yr⁻¹ (Figure 1 and Table 4). Our measured values from orthophotos for the Sloan and Dyke 1-1 site of 61 and 66 cm yr⁻¹ for lobes 1-1a and 1-1b, respectively, are each within 20 cm of their measurements of 43 and 72 cm yr⁻¹. The comparison is not precise because their survey encompassed 12 years of change (1983-1995), while the present study spans 37 years. The orthophoto technique appears to be deriving measurements of the correct order of magnitude, though more studies comparing the results with surveyed data are needed. The technique using georeferenced photos, on the other hand, gave measurements a great deal larger than those derived from either surveying or the orthophoto method, drawing its accuracy in this case into question. That is not to say the technique is invalid for this application, just that its use necessitates similar geometries for the two photos, and this was not the case here.

Velocity change through time

A detailed examination of the two periods of photo coverage, as well as the total change, at the Haines Junction North site was undertaken to see if the apparent increase in velocity (Table 3) was reliable. The lack of any comparisons of identical features on all photo pairs (1948 and 1974, 1974 and 1987, and 1948 and 1987) made it impossible to say if the measured values were entirely accurate (i.e. total movement adding up to the sum of the two shorter increments,

Table 4 - Previously measured Yukon rock glacier velocities

# on Fig 1	Location	Movement rates	Method	Reference
1	Slims River Valley, Yukon	0-20 cm yr ⁻¹ at front 200 cm yr ⁻¹ central lower portion	field survey	Blumstengel and Harris (1988)
2	Maxwell Creek, Yukon	0.15 cm yr ⁻¹	inferred from overridden paleosols	Johnson (1998)
3	Sheep Mountain, Yukon	10 cm yr ⁻¹ lobe 1 20-30 cm yr ⁻¹ year lobe 2 60 cm yr ⁻¹ maximum lobe 2	field survey	Johnson and Nickling (1979)
4*	Selwyn Mountains, Yukon	43 cm yr ⁻¹ 1, rock glacier 1a	field survey	Sloan and Dyke (1998)
5*		72 cm yr ⁻¹ site 1, rock glacier 1b		
6		37 cm yr ⁻¹ site 1, rock glacier 2		
7		8 cm yr ⁻¹ site 1, rock glacier 3		
8		15 cm yr ⁻¹ site 3, rock glacier 1		
9		8 cm yr ⁻¹ site 3, rock glacier 2		
10		6 cm yr ⁻¹ site 3, rock glacier 3		
11		57 cm yr ⁻¹ site 3, rock glacier 4		
12		12 cm yr ⁻¹ site 4, rock glacier 1		
13		18 cm yr ⁻¹ site 4, rock glacier 2		
14		9 cm yr ⁻¹ site 4, rock glacier 3		
15		24 cm yr ⁻¹ site 4, rock glacier 4		
16		60 cm yr ⁻¹ site 4, rock glacier 5		
17		22 cm yr ⁻¹ site 5, rock glacier 1		
18	127 cm yr ⁻¹ site 5, rock glacier 2 35 cm yr ⁻¹ mean for all rock glaciers			
19	Tungsten, Northwest Territories	51 cm yr ⁻¹ maximum on surface	field survey	Jackson and Macdonald (1980)
19	Tungsten, Northwest Territories	125 cm yr ⁻¹ maximum at front 325 cm yr ⁻¹ maximum on surface	field survey	Hughes and Rapp, 1965 as cited in Jackson and Macdonald, 1980

* Re-measured in this study

etc). Table 5 shows total measured movements for the three locations at which nearby measurements were possible. The differences in maximum velocities for three comparisons were quite high, with the later interval having a very high velocity of over 200 cm yr^{-1} . Again, because the features matched on each pair of photos were different, it is impossible to state conclusively that the apparent increase in velocity over time is, in fact, an increase. Other possibilities are that velocities have been as high throughout but in locations with no distinct features, or that the high velocity is an error. It must be noted, however, that the maximum value of 201 cm yr^{-1} does not appear as an outlier, as measurements of 171 and 136 cm yr^{-1} were also made.

Impact of photo quality

The number of measurements possible on each given image pair was quite variable. There were several factors that influenced what was possible at each site. In the case of the Sloan and Dyke 1-1 site, the photo quality was quite good, and only the upper most parts of the rock glacier had shadow present that prevented measurements being taken there. At the White River site, the photo was poorer, meaning that it was possible only to identify macroforms as matchable features, such as ridges and furrows. Clouds on the photos blocked the view of parts of the rock glacier. At the Haines Junction site, the photo quality was good and many features were readily identifiable in the areas outside thermokarst development. In the areas with thermokarst development, however, changes were so extensive that identifying common features was impossible. At the Haines Junction North site, the quality of the 1948 photo was quite poor and

Table 5 - Differences between total measured displacements and sub-divided measured displacements at the Haines Junction North site

Location	Period 1: 1948-1974	Period 2: 1974-1987	Total period: 1948-1987	Difference
1*	5.0 m	1.8 m	10.5 m	-3.6 m
2	15.3 m	3.8 m	18.0 m	1.2 m
3*	5.6 m	22.2 m	20.9 m	7.0 m

*Movements were not all in exactly the same direction.

there was snow cover on much of the upper parts of the rock glacier, obscuring surface features. The 1974 photo was also taken when snow remained on the rock glacier, but the photo quality was better. The quality of the 1987 photo was also acceptable, but approximately one third of the rock glacier was covered by snow or blocked from view by clouds or their shadows.

None of the orthophotos overlaid perfectly with the other(s) for that site; in every case there were at least some areas with visually detectable discrepancies. During the creation of the orthophotos, attempts were made to ensure that these discrepancies did not affect the parts of the photos occupied by the rock glaciers.

Additionally, the possibility of tracking thermokarst development on rock glaciers (and indeed elsewhere) from multi-temporal air photo analysis was an unforeseen option. Thermokarst development impedes the measurement of surface velocities from air photos, but it is a phenomenon that is relevant to rock glacier activity.

Error analysis

The cumulative error of our orthophoto measurements may be relatively high. This includes the following main terms (Kääb and Vollmer, 2000):

- (1) Absolute orientation errors (i.e. ground control points) lead to a deviation between the airphotos and the DEM used for orthoprojection. The resulting error is similar to a vertical error in the DEM. Here, we achieved an absolute orientation better than the DEM resolution of 30 m.

- (2) Vertical elevation errors lead to horizontal distortions in the orthoimages. This effect is proportional to the elevation error and the radial distance from the image centre. We tried to minimize this effect by choosing air photos that showed the studied rock glaciers in their centre. However, we consider this error term as one of the largest in our study, potentially introducing several meters of horizontal uncertainty for locations with large DEM errors. Such DEM errors stem from erroneous air photo compilation, contour line interpolation, and, in our case, from the fact that the DEM data does not always match the date of the orthoimages. Elevation changes over time introduce DEM errors. We consider this effect to be mainly relevant for the Haines Junction rock glacier that showed strong thermokarst development.
- (3) Relative errors between the multitemporal orthoimages from errors in the relative orientation (i.e. tie points) or from air photo distortions introduce displacements that are not related to actual terrain movement. While we achieved a relative orientation accuracy in the order of 1-2 pixels for stable ground, the relative accuracy cannot be directly assessed over the rock glaciers, because their movement prevents the location of tie points on them. In addition to DEM errors we consider distortions of the photographic copies used to be the largest error contributor in our error budget. We attempted to minimize these effects by section-wise co-registering of the measurements using stable ground (see above described Helmert correction).
- (4) Lack of suitable features in the images and mismatches between non-corresponding features over time are described above.

From the error budget considerations it is clear that measurement of an individual displacement might not be significant, with potential errors of the same size or even exceeding the true terrain displacement. The displacement results of this study should therefore be viewed as a group, and general flow patterns (or median values; see Table 2) should be interpreted rather than individual measurements (see Table 5).

The error in the measurements from the georeferenced photos is also likely to be high. This method removed the errors caused by elevation but added errors in image matching that were greater than with the previous method.

Conclusions

This feasibility study shows that multi-temporal air photo analysis is a promising means of measuring Canadian rock glacier velocities in areas where multiple photo coverage exists. Indeed, even with what may be considered to be a “worst case scenario” when it comes to data quality, it was still possible to produce reasonable results. Our study showed that it is possible to measure rock glacier movement even over time periods of several decades, here around 40 years. This points to a large surface stability and coherent deformation in space and time of the rock glaciers investigated, that in turn suggests a considerable thermal stability. One site, however, showed pronounced thermokarst development and it would be interesting to investigate further whether this is due to its specific climatic or topographic settings, or changing boundary conditions.

For the Sloan and Dyke 1-1 site, where both the orthophoto and georeferenced photo techniques were tried, the orthophoto method appears to

give results more in line with the values obtained by surveying. This does not negate the potential value of the georeferenced photo technique, but illustrates that it can only be effectively applied in instances where the geometry of the photos is very similar.

Although the results are not conclusive, the preliminary measurements obtained at the Haines Junction North site indicate that the rock glacier there has been moving at speeds of up to 2 m/year over the 1974 to 1987 period.

Before using this as a definitive measurement technique, further study is needed to compare rock glacier velocities measured from photogrammetric methods to those measured from surveys done on site. A photogrammetric study of the sites already surveyed in northwest Canada would likely be the simplest and most cost-effective way to do this.

Finally, the possibility of monitoring thermokarst development on rock glaciers, and elsewhere, by photogrammetric methods that arose in this study should be explored in more detail. The sites where this is possible are not likely the best sites for measuring rock glacier velocity photogrammetrically, but may reflect parallel or related developments worth studying.

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8 Conclusions

8.1 Answers to research questions

8.1.1 Part 1: Statistical topographic comparison

The first question this research was meant to address was whether lobate and tongue-shaped rock glaciers in the southern Yukon form statistically different populations according to the topographic characteristics examined: elevation, area, aspect and slope. The research showed that lobate and tongue-shaped rock glaciers are statistically different only in elevation. Tongue-shaped forms occur at elevations about 100 to 130 m higher, on average, than lobate forms. There are no statistical differences in the area, aspect and slope of the two morphologies.

Because a statistical difference was present, the next step was to assess whether it could be indicative of the different morphologies being caused by different origins, as suggested by Janke (2007). It is possible that the statistical difference in elevation indicates different origins. It is also possible that the morphologies are more indicative of local topography, which in may be the main determinant of origin.

The final question was to evaluate how the statistical results affect the potential use of rock glaciers as regional permafrost indicators in permafrost distribution modelling. The results affect the possibility of using rock glaciers to indicate permafrost presence for distribution modelling because rock glaciers in the Yukon do not have a strongly zonal elevation gradient when it comes to their level of activity. For this reason, it is impossible to use rock glacier activity to infer

local permafrost continuity. Rock glaciers may still, however, be used as single point indicators of permafrost presence.

These findings suggest that there are many factors in addition to the ones examined in this study that affect the morphology, and particularly the activity, of rock glaciers in the Canadian North. This stands in contrast to European and New Zealand examples that found rock glaciers to have strongly zonal activity distributions. Elevation is clearly related to rock glacier morphology in northern Canada, as it is elsewhere, however the exact reason for this remains unclear. It has been hypothesized that origins may determine rock glacier morphology, and it appears true that certain types of topography favour certain morphologies, but the evidence examined in this study shows that it is not a firm rule.

8.1.2 Part 2: Experimental photogrammetric dynamics measurements

The first goal of this part of the research was to determine if it is possible to measure the rates of rock glacier movement from multi-temporal air photos of the quality and frequency available for the Canadian North. It was possible to calculate rock glacier movement rates from multi-temporal air photos from the Canadian collection. In fact, it was possible using compressed scans of poor quality photos, so the prospects for success using uncompressed scans of negatives are great.

The second task, to verify the effectiveness of the photogrammetric measurement method, was to compare the rates measured in this study to those measured previously using other methods. The rates measured in this study ranged from 0 to 2 m yr⁻¹, which fit well with earlier measurements of 0 to 3 m yr⁻¹

for northern Canadian rock glaciers. The median photogrammetrically-derived velocities measured for Sloan and Dyke's (1998) site 1-1a, 38 cm yr^{-1} , and 1-1b, 47 cm yr^{-1} , seemed reasonable compared to their measurements of 43 and 72 cm yr^{-1} , respectively, given that the measurements accounted for different periods of time.

The final goal of the research was to assess whether there had been any changes to the rates of flow between time periods of photo coverage (where multiple periods of coverage exist). This was possible at one site (Haines Junction North), however the results regarding changes in flow rates over time were inconclusive. This was the result of being unable to compare the movement of identical features on each of the image pairs due to software limitations. Different flow rates were measured between subsequent photo pairs (1948-1974 maximum: 86 cm yr^{-1} ; 1974-1987 maximum: 201 cm yr^{-1} ; 1948-1987 maximum: 67 cm yr^{-1}), but it is impossible to tell if these differences represent an increase in velocity in the 1974-1987 period, actual velocities from various different locations that have been approximately unchanged all along, or errors in measurement. It must be noted that the 201 cm yr^{-1} measurement does not appear to be an outlier.

Photogrammetric measurement of rock glacier velocities from orthophotos appears to have potential in the Canadian context. This study has shown that the process works and generates reasonable results in spite of many challenges. Measurement from georeferenced photos remains unproven by this experiment. The acquisition of suitable imagery is the main obstacle to the wider application of this technique.

8.2 Significance of the work

The database of known rock glacier locations created for the Yukon Territory as part of this study is projected to be an important tool for surficial geologists in the Territory, scientists currently studying permafrost distribution modelling, and for researchers who may undertake further work such as examining spatial relationships between rock glaciers and the factors that create and control them, or determining risk zones in geohazard mapping.

This study represents the first large-scale attempt to couple topographic characteristics with the forms and activity levels of rock glaciers in the Yukon Territory. While many of the factors examined were found to be non-significant statistically, some, like elevation and the combination of aspect and latitude, were found to be clearly related to form and activity level, respectively, of the rock glacier sample. This represents a good foundation on which future work in these areas can be based and gives some early hints as to which are the major controlling variables.

The implications of this work in the field of permafrost distribution modelling are critical. The major consequence of the findings presented here is that rock glacier activity in the southern Yukon Territory does not occur in a highly zonal elevation pattern the way it does elsewhere, and thus cannot be used to infer an associated level of permafrost distribution. As noted above however, rock glaciers are still useful for permafrost distribution modelling, since they are single point indicators of permafrost. The availability of a reasonably complete spatial database should help their use for this purpose.

The feasibility study carried out to determine if rock glacier dynamics could be measured from multi-temporal aerial photography of the quality and frequency available in Canada has achieved a positive result. Despite the fact that most of the data properties were what one might call “worst case scenarios,” it was still possible to obtain movement vectors for all the cases attempted. The movements measured where earlier surveying had been done corresponded well with the previously obtained values. Furthermore, this study revealed the possibility of tracking thermokarst development on rock glaciers through photogrammetric methods.

8.3 Need for future work

There are many prospects for future research in the areas examined by this thesis. Many of them have been alluded to already, so they will simply be summarized in this section. Firstly, the possibility remains for undertaking a similar study using the entire rock glacier population rather than a sample. Due to the amount of work that would be involved with such a large population, this would be more suited in scope to a PhD thesis. Such a study could also include comparison of factors not included in the present research, such as the influence of vegetation and potential incoming solar radiation, as well as examining relationships between factors included, but not compared, in this study, like the relationship between activity and morphology.

Secondly, there is potential for research into the role of geology in the existence of rock glaciers. This could be done fairly simply given the existence of digital versions of Yukon bedrock geology maps and the rock glacier database

created in this study. While this topic encompasses both physical geography and geology, a researcher with a strong background in geology would likely be able to get more out of such a study than a physical geographer, since he or she would be able to go deeper into the rock structure and geochemistry that make a rock type suitable – or not suitable – as a rock glacier substrate.

Finally, there are countless applications for the rock glacier database as a tool for research in areas broadly related to permafrost, climate change monitoring, and geohazards.

When it comes to photogrammetric measurement of rock glacier changes in the Yukon, there is plenty of room for expansion since the research summarized here was essentially the first of its kind, and the technique has been shown to work. A large-scale study of similar design has been suggested in order to get an idea of the rates of change of Yukon rock glaciers, which are essentially unknown. Such a study would involve a great deal of sorting through the available imagery with no guarantee that much of it would be useful. With continued future air photo acquisition, this technique would be very promising and it may also provide a means to monitor the impact of climate change on landforms like rock glaciers whose existence is to a large degree climatically determined.

9 References

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APPENDIX A - Surficial Geology Map References

Map sheet	Name	Author(s)	Scale	Date
95C 08	Babiche Mountain	Smith, I.R.	50k	2003
95C 09	Chinkeh Creek	Smith, I.R.	50k	2003
95C 16	Etanda Lakes	Smith, I.R.	50k	2003
105CDE	Whitehorse	Morison, S.R. and Klassen, R.W.	250k	1991
105F 1791A	Bruce Lake	Jackson, L.E., Jr.	100k	1993
105F 1792A	Gray Creek	Jackson, L.E., Jr.	100k	1993
105F 1793A	McConnell River	Jackson, L.E., Jr.	100k	1993
105G 1794A	Hoole River	Jackson, L.E., Jr.	100k	1993
105G 1795A	Fortin Lake	Jackson, L.E., Jr.	100k	1993
105G 1796A	Lonely Creek	Jackson, L.E., Jr.	100k	1993
105G 1797A	Rainbow Creek	Jackson, L.E., Jr.	100k	1993
105H 1674A	Dolly Varden Creek	Dyke, A.S.	100k	1990
105H 1676A	Yusezyu River	Dyke, A.S.	100k	1990
105H 1677A	Little Hyland River	Dyke, A.S.	100k	1990
105I	Nahanni	Jackson, L.E., Jr.	250k	1982
105J 1832A	Dragon Lake	Jackson, L.E., Jr., Morrisson, S.R., and McKenna, K.	100k	1993
105K 03 and 06 E	Mount Mye and Faro	Bond, J.D.	25k	1999
105K 05 NE	Rose Mountain	Bond, J.D.	25k	2000
105K 1819A	Earn River	Jackson, L.E., Jr.	100k	1993
105K 1820A	South Macmillan River	Jackson, L.E., Jr.	100k	1993
105K 1821A	Magundy River	Jackson, L.E., Jr.	100k	1993
105K 1822A	Olgie Lake	Jackson, L.E., Jr.	100k	1993
105L 1787A	Wilkinson Range	Ward, B.C. and Jackson, L.E., Jr.	100k	1993
105L 1789A	Telegraph Mountain	Ward, B.C. and Jackson, L.E., Jr.	100k	1993
105M NW	Mount Edwards	Hughes, O.L.	100k	1983
105M SE	Big Kalzas Lake	Hughes, O.L.	100k	1983
105M SW	Grey Hunter Peak	Hughes, O.L.	100k	1983
105O NE		Morison, S. R. and McKenna, K.	100k	1981
105O SE and P SW		Morison, S. R. and McKenna, K.	100k	1981
105O SW		Morison, S.R. and McKenna, K.	100k	1981
106C	Nadaleen River	Ricker, K.E.	125k	1973
106D 1172A	Nash Vreek	Vernon, P. and Hughes, O.L.	253,440	1965
115A 01-03,06-08	Frederic Lake	Rampton, V.N. and Paradis, S.	100k	1982
115A 11-14	Pine Lake	Rampton, V.N. and Paradis, S.	100k	1982
115B and G-E	Congdon Creek	Rampton, V.N.	100k	1979
115F NE	Generic River	Rampton, V.N.	100k	1979
115G-C	Burwash Creek	Rampton, V.N.	100k	1979
115H 03-06	West Aishihik River	Hughes, O.L.	100k	1989
115H 11-14	Stevens Lake	Hughes, O.L.	100k	1989
115N 09	Matson Creek	Jackson, L.E., Jr., Morison, S.R. and Mougeot, C.	50k	2005
115N 10	Borden Creek	Jackson, L.E., Jr.	50k	2005
115N 15	Crag Mountain	Jackson, L.E., Jr.	50k	2005
115N 16	Enchantment Creek	Jackson, L.E., Jr.	50k	2005
115O NE and P NW, 116B SE and A SW	North Klondike River	Thomas, R.D. and Rampton, V.N.	100k	1982
116A 1171A	Larsen Creek	Vernon, P. and Hughes, O.L.	253,440	1966
116B	Dawson	Ricker, K.E.	50k	1967
116B and 116C	Dawson	Duk-Rodkin, A.	250k	1996
116B NE and 116A NW	Upper Blackstone River	Thomas, R.D. and Rampton, V.N.	100k	1982
116G SE	Engineer Creek	Thomas, R.D. and Rampton, V.N.	100k	1982
116P	Bell River	Hughes, O.L., Pilon, J., Veillette, J., Zoltai, S.C., Pettapiece, V	125k	1973

APPENDIX B - Rock Glacier Inventory

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
61.99	-140.75	1867.06	1690	2005	1876	29.78	40.07	4.29	0.17	62.27	-129.74	1448.13	1394	1507	1451	20.45	37.02	8.54	0.06
61.97	-140.80	1850.86	1696	1994	1841	32.65	40.49	7.21	0.13	62.26	-129.73	1449.24	1406	1490	1448	22.62	32.10	12.91	0.06
61.97	-140.78	1630.84	1549	1829	1613	20.77	46.57	5.99	0.17	62.25	-129.77	1564.11	1481	1639	1561	25.53	30.13	19.98	0.03
61.95	-140.61	1222.89	899	1474	1255	18.57	40.91	0.48	1.15	62.22	-129.36	1758.25	1696	1853	1753	17.12	31.95	5.95	0.12
61.79	-140.19	1503.54	1228	1840	1489	33.37	41.34	21.44	0.26	62.21	-129.45	1695.79	1633	1727	1701	23.49	39.76	10.74	0.03
61.77	-140.18	1303.86	1173	1420	1300	23.89	43.31	8.25	0.32	62.21	-129.36	1731.11	1660	1906	1708	20.29	47.47	1.07	0.29
61.69	-140.25	1527.79	1408	1672	1518	24.14	38.11	3.84	0.24	62.21	-129.45	1661.31	1609	1706	1664	17.46	24.38	11.01	0.06
61.68	-140.23	1692.94	1568	1805	1700	16.34	31.32	3.71	0.18	62.20	-129.34	1765.02	1695	1890	1759	23.48	43.17	1.22	0.17
61.68	-140.21	1679.28	1569	1795	1682	30.05	48.93	4.10	0.21	62.19	-129.63	1677.99	1586	1766	1690	17.81	33.38	2.64	0.21
61.67	-140.19	1616.62	1493	1778	1613	28.95	38.97	14.45	0.17	62.17	-129.29	1780.04	1700	1897	1776	25.88	41.70	12.02	0.10
61.67	-140.18	1756.52	1559	1973	1746	32.79	48.66	13.52	0.21	62.16	-129.65	1691.89	1623	1845	1673	24.59	43.67	4.06	0.15
61.66	-140.21	1555.40	1489	1631	1554	18.62	38.34	5.01	0.23	62.16	-129.65	1567.31	1485	1712	1550	24.03	40.84	7.25	0.17
61.64	-140.18	1547.69	1466	1648	1544	25.36	37.12	6.06	0.15	62.13	-129.26	1486.75	1381	1621	1484	22.39	31.82	14.31	0.12
61.59	-140.13	1337.41	1177	1526	1334	34.13	42.49	20.60	0.12	62.13	-129.42	1637.45	1619	1645	1641	7.27	16.18	0.48	0.03
61.59	-140.12	1315.06	1163	1465	1317	32.91	38.53	23.32	0.11	62.11	-129.30	1351.20	1236	1486	1353	26.02	35.95	5.01	0.08
61.59	-140.10	1395.25	1223	1546	1393	37.86	41.31	31.53	0.08	62.11	-129.91	1522.82	1473	1582	1518	31.18	36.30	22.22	0.05
61.58	-140.08	1392.58	1209	1572	1388	36.50	39.99	29.02	0.11	62.11	-129.19	1847.88	1728	1995	1834	26.83	38.44	3.18	0.14
61.58	-140.07	1352.29	1230	1490	1348	35.34	41.36	25.44	0.08	62.11	-129.29	1539.70	1441	1593	1542	22.79	35.98	10.22	0.09
61.57	-140.03	1367.61	1240	1525	1364	34.50	43.48	11.65	0.09	62.10	-129.38	1615.80	1573	1650	1619	13.63	26.77	5.75	0.11
61.57	-140.02	1329.38	1210	1473	1325	32.81	41.06	10.68	0.09	62.09	-129.31	1591.85	1541	1684	1584	21.49	48.33	6.32	0.12
61.57	-140.02	1328.42	1197	1477	1330	34.84	40.35	21.47	0.06	62.09	-129.17	1707.93	1608	1863	1690	21.75	35.16	7.66	0.16
61.57	-140.01	1295.85	1219	1417	1284	28.16	40.70	13.66	0.06	62.09	-129.17	1730.22	1624	1873	1727	21.78	31.77	9.19	0.14
61.57	-139.99	1296.31	1189	1437	1285	30.58	39.70	15.02	0.07	62.09	-129.28	1773.03	1627	1923	1767	31.49	48.89	4.10	0.09
61.52	-140.79	1898.38	1783	2080	1878	23.14	37.30	10.76	0.19	62.09	-129.18	1724.73	1621	1842	1723	18.28	27.06	7.92	0.15
61.47	-140.97	1740.95	1681	1862	1722	13.68	30.79	2.43	0.14	62.07	-129.30	1686.66	1617	1778	1676	19.34	35.94	7.90	0.09
61.41	-140.75	1565.76	1510	1707	1556	15.26	30.81	0.48	0.15	62.07	-129.13	1743.50	1699	1796	1744	13.66	33.78	0.68	0.11
61.40	-139.94	1761.53	1611	1924	1745	29.53	39.79	1.97	0.13	62.06	-129.24	1750.98	1660	1856	1745	22.68	41.89	1.07	0.30
61.34	-139.84	1483.99	1366	1706	1464	21.79	36.43	10.48	0.15	62.07	-129.31	1709.67	1651	1798	1698	16.69	32.63	5.13	0.09
61.49	-139.60	1654.92	1535	1865	1638	27.15	44.17	9.76	0.26	62.06	-129.52	1646.77	1560	1783	1647	23.55	41.57	9.30	0.15
61.49	-139.55	1829.30	1670	2081	1818	32.66	40.68	23.43	0.13	62.04	-128.79	1652.51	1566	1748	1652	19.72	30.47	4.82	0.31
61.50	-139.52	1643.00	1529	1776	1635	33.16	40.80	26.49	0.05	62.02	-129.85	1491.39	1339	1653	1498	26.29	36.90	8.46	0.14
61.35	-139.66	1603.90	1354	1805	1613	37.04	43.28	27.55	0.14	62.02	-128.74	2015.26	1911	2078	2024	31.86	39.30	2.72	0.04
61.33	-139.64	1384.04	1115	1692	1367	33.10	39.66	18.66	0.20	62.02	-129.31	1301.25	1243	1377	1298	26.50	38.69	8.19	0.05
61.27	-139.34	1966.04	1925	1998	1968	8.08	15.25	4.38	0.12	62.02	-129.31	1326.45	1282	1376	1321	24.50	32.18	12.05	0.05
61.28	-139.14	1454.80	1269	1748	1414	26.94	40.05	11.58	0.23	62.01	-128.96	1714.47	1598	1825	1716	27.18	36.38	9.76	0.13
61.21	-139.10	1496.45	1395	1668	1495	11.67	27.45	1.51	1.42	62.01	-128.69	1559.83	1520	1608	1558	14.87	25.87	3.47	0.11

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
61.22	-138.94	1832.84	1553	2192	1827	29.93	43.44	10.56	0.39	62.01	-128.89	1835.15	1765	1930	1830	33.89	38.22	29.76	0.08
61.20	-138.91	2065.25	1700	2404	2072	29.29	47.49	3.05	0.61	62.01	-129.18	1509.04	1420	1617	1501	25.51	38.63	5.88	0.13
61.20	-138.91	1868.75	1791	2032	1853	21.66	40.99	5.48	0.14	62.01	-129.12	1769.08	1683	1813	1777	16.14	36.16	4.97	0.10
61.20	-138.92	1977.68	1851	2312	1939	22.82	48.26	1.97	0.36	62.01	-129.06	1721.96	1537	1972	1709	29.80	40.96	12.77	0.15
61.20	-138.98	2047.31	1938	2164	2041	22.05	35.51	6.47	0.14	62.01	-128.93	1813.88	1695	1923	1814	27.77	37.05	21.55	0.09
61.22	-139.47	1377.98	1272	1533	1369	27.50	40.99	8.46	0.16	62.00	-129.10	1505.13	1277	1769	1511	25.45	46.90	10.36	0.19
61.21	-139.45	1396.38	1303	1515	1396	17.86	36.89	9.09	0.15	62.00	-128.93	1775.31	1673	1882	1779	24.23	32.69	11.33	0.13
61.16	-139.37	1351.78	1301	1413	1348	16.93	25.30	9.33	0.12	62.00	-128.40	1716.31	1654	1837	1704	22.00	41.59	0.75	0.18
61.16	-139.35	1444.75	1382	1516	1443	19.97	23.84	15.64	0.09	62.00	-128.93	1734.77	1686	1805	1729	17.44	30.27	3.47	0.11
61.15	-139.29	1703.11	1537	1951	1680	31.46	40.79	8.77	0.27	62.00	-128.45	1640.24	1573	1727	1638	24.41	42.26	7.09	0.07
61.14	-139.26	1693.76	1541	1869	1686	25.03	36.16	10.70	0.19	62.57	-134.03	1572.54	1524	1632	1570	18.94	29.91	10.37	0.06
61.14	-139.26	1549.85	1427	1738	1544	23.85	38.38	5.10	0.38	62.57	-134.08	1622.82	1591	1653	1622	17.50	20.63	15.90	0.04
61.13	-139.24	1739.33	1552	1958	1722	31.75	41.89	5.73	0.23	62.57	-134.07	1640.00	1593	1689	1642	28.62	35.46	20.53	0.04
61.13	-139.24	1645.05	1508	1844	1627	29.42	42.58	17.99	0.10	62.56	-134.09	1694.50	1659	1728	1693	16.51	23.12	14.60	0.04
61.13	-139.24	1640.74	1491	1927	1605	29.43	40.19	14.40	0.17	62.54	-134.06	1652.51	1614	1721	1641	17.96	30.58	5.32	0.06
61.12	-139.23	1745.51	1556	1981	1736	33.52	43.25	17.87	0.10	62.54	-134.49	1694.14	1616	1808	1687	26.36	40.55	11.33	0.16
61.12	-139.23	1802.91	1586	2078	1788	36.53	45.61	23.77	0.11	62.51	-134.53	1535.36	1438	1651	1538	24.33	36.73	6.26	0.11
61.12	-139.22	1800.48	1592	2048	1780	36.89	44.75	12.89	0.10	62.51	-134.54	1614.57	1577	1681	1611	27.64	43.34	7.66	0.03
61.12	-139.22	1701.82	1480	1963	1685	33.26	45.46	12.35	0.27	62.50	-134.56	1877.13	1796	1962	1873	28.95	38.25	14.83	0.10
61.11	-139.21	1872.47	1769	2016	1862	30.21	37.32	21.21	0.08	62.49	-134.68	1714.36	1672	1765	1714	15.20	25.79	3.71	0.08
61.11	-139.21	1834.34	1754	1957	1823	30.85	37.19	26.91	0.05	62.49	-134.66	1741.03	1649	1831	1744	25.75	45.21	7.21	0.13
61.11	-139.21	1790.97	1664	1932	1789	28.76	36.56	22.01	0.10	62.49	-134.64	1694.60	1620	1785	1694	24.00	38.18	8.33	0.13
61.10	-139.20	1770.43	1568	2026	1761	29.47	36.84	12.83	0.19	62.48	-134.75	1543.90	1428	1705	1543	23.88	37.31	4.32	0.19
61.10	-139.19	1920.29	1783	2094	1909	32.28	37.39	26.98	0.06	62.48	-134.59	1600.98	1560	1643	1602	17.24	31.99	7.12	0.08
61.10	-139.19	1909.79	1764	2100	1894	33.37	37.69	28.56	0.06	62.48	-134.58	1678.35	1608	1822	1664	23.37	42.77	5.52	0.14
61.09	-139.18	1887.73	1691	2053	1909	19.66	29.88	6.73	0.24	62.47	-134.53	1593.65	1516	1677	1593	20.66	33.06	9.47	0.12
61.09	-139.17	2124.25	2026	2325	2091	26.84	41.90	3.11	0.17	62.47	-134.56	1721.49	1637	1817	1717	18.09	34.42	5.95	0.10
61.09	-139.21	1545.44	1489	1663	1540	17.15	28.22	2.57	0.14	62.45	-134.55	1579.69	1563	1598	1579	10.71	26.87	3.11	0.04
61.09	-139.21	1549.47	1474	1675	1542	20.13	33.60	5.88	0.12	62.44	-134.56	1664.18	1604	1757	1659	15.49	32.74	2.64	0.12
61.08	-139.17	2123.63	1922	2284	2123	34.12	40.52	12.96	0.14	62.42	-134.59	1733.43	1666	1801	1736	27.76	41.50	7.13	0.09
61.08	-139.17	2307.52	2120	2471	2318	33.81	42.62	23.03	0.12	62.41	-134.56	1595.86	1520	1654	1599	13.33	26.73	6.09	0.17
61.07	-139.17	2010.48	1825	2218	1995	38.24	46.66	28.51	0.08	62.39	-134.45	1696.26	1642	1780	1689	24.55	39.67	4.52	0.05
61.07	-139.17	1986.78	1803	2254	1958	32.37	42.29	21.67	0.18	62.39	-134.52	1523.97	1489	1598	1514	11.62	26.79	2.72	0.14
61.06	-139.17	1901.99	1777	2056	1889	30.11	39.99	20.92	0.06	62.38	-134.48	1678.05	1628	1727	1678	21.72	37.93	3.39	0.07
61.09	-139.19	1961.92	1777	2174	1952	36.36	39.89	32.53	0.10	62.38	-134.56	1673.22	1575	1763	1676	16.99	33.12	2.39	0.26
61.09	-139.18	1920.24	1760	2100	1909	35.88	41.87	29.56	0.07	62.38	-134.45	1640.11	1626	1671	1637	9.06	28.37	2.13	0.07

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
61.07	-139.15	2376.97	2192	2531	2372	29.21	40.78	4.39	0.17	62.36	-134.44	1789.08	1728	1882	1782	28.35	40.23	7.75	0.06
61.09	-139.13	1781.97	1705	1893	1777	18.76	36.65	2.26	0.47	62.36	-134.42	1724.17	1683	1784	1718	16.78	34.60	4.76	0.07
61.10	-139.12	2071.74	1763	2480	2053	36.48	44.65	17.37	0.32	62.31	-134.19	1671.60	1637	1746	1670	16.35	37.52	3.02	0.10
61.10	-139.12	2022.99	1829	2271	2002	35.88	42.38	6.06	0.13	62.31	-134.79	1427.64	1365	1532	1419	26.94	40.59	3.58	0.08
61.10	-139.12	1943.68	1688	2238	1939	32.59	45.56	19.78	0.13	62.31	-134.46	1572.75	1520	1649	1567	25.81	36.77	6.93	0.05
61.10	-139.12	2017.12	1858	2150	2022	29.37	39.60	10.89	0.10	62.30	-134.18	1701.06	1665	1754	1700	22.74	41.78	9.32	0.05
61.12	-139.12	1641.37	1463	1860	1645	29.98	49.25	9.51	0.35	62.30	-134.32	1719.57	1678	1755	1720	11.07	25.52	1.39	0.11
61.13	-139.12	1473.46	1409	1644	1463	14.88	37.63	1.43	0.22	62.30	-134.34	1765.43	1673	1873	1761	31.70	40.59	18.09	0.06
61.14	-139.11	1434.92	1374	1609	1412	16.71	36.94	1.39	0.15	62.29	-134.18	1726.46	1691	1777	1719	15.79	30.22	3.65	0.07
61.14	-139.11	1413.40	1367	1565	1393	14.92	32.70	1.72	0.12	62.29	-134.17	1690.59	1624	1718	1700	14.77	31.03	2.70	0.07
61.14	-139.11	1411.25	1354	1598	1385	14.80	33.70	1.01	0.13	62.29	-134.16	1779.61	1708	1859	1774	35.32	47.18	19.69	0.05
61.14	-139.11	1445.33	1349	1632	1431	20.04	29.84	4.79	0.15	62.29	-134.14	1632.23	1606	1668	1633	13.44	32.95	1.22	0.08
61.13	-139.07	1545.96	1480	1689	1518	17.90	33.00	2.72	0.15	62.28	-134.26	1538.64	1451	1630	1535	22.13	38.44	1.43	0.15
61.12	-139.07	1654.28	1570	1749	1653	27.40	34.84	16.92	0.07	62.27	-134.22	1656.49	1631	1700	1648	10.17	23.89	2.90	0.09
61.12	-139.07	1744.57	1572	1969	1737	31.53	39.72	22.11	0.13	63.56	-130.36	1434.58	1374	1527	1431	10.64	17.18	7.05	0.32
61.12	-139.06	1638.48	1579	1750	1631	17.39	35.23	2.88	0.21	63.56	-130.35	1425.80	1381	1475	1424	9.85	15.25	5.55	0.21
61.09	-139.11	2018.79	1881	2254	1988	30.95	39.35	10.22	0.12	63.49	-130.54	1668.92	1545	1828	1669	21.91	40.51	5.14	0.23
61.08	-139.09	2098.34	1928	2278	2105	30.84	44.37	8.59	0.21	63.48	-130.51	1845.15	1787	1935	1841	15.93	39.12	0.34	0.21
61.02	-139.29	1818.68	1634	2046	1818	33.96	42.95	27.37	0.16	63.46	-130.40	1588.37	1380	1705	1624	21.77	43.42	1.72	0.28
61.01	-139.28	1831.23	1658	2027	1828	33.28	40.23	24.19	0.18	63.45	-130.48	1760.10	1605	1932	1744	19.12	42.30	1.07	0.44
61.00	-139.28	1871.02	1656	2111	1860	35.71	41.71	28.88	0.18	63.45	-130.54	1595.15	1531	1670	1592	23.33	32.69	8.79	0.07
61.05	-139.16	1866.30	1728	2053	1852	24.41	31.40	15.49	0.17	63.44	-130.46	1890.83	1805	1976	1886	19.01	37.05	2.36	0.13
61.04	-139.13	1925.65	1797	2072	1924	26.33	37.67	16.48	0.14	63.44	-130.67	1179.16	1111	1303	1161	17.32	31.12	2.46	0.18
61.03	-139.09	2230.90	2097	2385	2234	22.50	33.10	11.24	0.16	63.41	-130.46	1686.60	1548	1853	1675	26.33	45.47	11.35	0.17
61.03	-139.08	2349.62	2171	2566	2335	29.45	40.51	5.32	0.29	63.41	-130.19	1856.11	1759	1944	1862	17.55	41.63	4.32	0.27
61.03	-138.90	1876.06	1789	1995	1869	28.00	36.85	13.46	0.10	63.40	-130.24	1933.64	1781	2145	1935	21.55	43.20	3.44	0.20
61.01	-138.95	2083.15	1848	2378	2056	31.95	44.11	14.31	0.21	63.40	-130.44	1863.57	1833	1906	1860	17.04	39.54	4.29	0.09
61.02	-138.96	1791.01	1651	2147	1736	21.52	45.62	7.86	0.24	63.40	-130.41	1651.18	1546	1774	1644	23.61	41.97	8.59	0.20
61.02	-138.95	1976.33	1889	2049	1980	29.31	36.06	22.47	0.05	63.40	-130.36	1781.01	1685	1848	1789	19.62	31.88	2.16	0.10
61.02	-138.95	2241.14	2163	2330	2236	32.30	38.75	24.80	0.05	63.40	-130.45	1766.36	1715	1813	1770	18.84	43.68	7.39	0.09
61.03	-138.96	1943.10	1756	2117	1950	30.39	39.38	17.58	0.19	63.39	-130.45	1772.28	1744	1822	1768	16.85	32.12	5.01	0.06
61.03	-138.96	1902.54	1749	2111	1897	31.09	41.74	13.01	0.12	63.38	-130.29	1628.62	1538	1728	1626	17.23	37.26	2.26	0.29
61.04	-138.96	2002.73	1868	2194	1986	30.42	39.53	17.36	0.10	63.38	-130.32	1740.01	1643	1805	1745	21.28	42.47	9.32	0.32
61.05	-138.96	1885.90	1723	2134	1864	33.59	47.15	17.03	0.11	63.38	-130.53	1590.66	1431	1724	1598	21.06	41.52	3.71	0.43
61.05	-139.00	1667.72	1489	2048	1625	24.73	41.95	2.90	0.42	63.38	-130.42	1727.60	1689	1770	1730	17.59	28.88	5.05	0.05
61.06	-138.95	1759.04	1575	2060	1736	33.66	49.41	18.78	0.21	63.38	-130.47	1677.68	1597	1763	1680	15.97	30.91	5.79	0.15

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
61.07	-138.94	1702.87	1571	1830	1704	19.47	34.72	6.32	0.26	63.38	-130.41	1552.43	1417	1647	1557	25.18	34.45	11.39	0.10
61.06	-138.96	1926.32	1693	2166	1928	43.10	51.07	31.05	0.24	63.38	-130.56	1545.52	1436	1639	1555	15.27	36.76	4.39	0.25
61.09	-138.95	1548.67	1477	1677	1532	25.18	41.85	13.12	0.07	63.36	-130.04	1720.99	1660	1773	1724	17.85	34.58	5.88	0.13
61.10	-139.00	2196.43	2058	2316	2205	32.77	44.35	12.11	0.19	63.37	-130.33	1757.38	1718	1794	1758	13.72	25.51	8.06	0.08
61.11	-139.01	2249.58	2068	2476	2233	31.01	40.56	16.05	0.16	63.37	-130.32	1634.50	1576	1681	1639	16.36	23.12	9.83	0.08
61.11	-139.03	1893.66	1759	2128	1885	26.59	42.17	13.90	0.17	63.37	-130.54	1673.20	1590	1799	1661	19.58	34.57	6.89	0.11
61.02	-138.81	1643.35	1546	1707	1651	24.57	35.84	13.07	0.10	63.34	-130.10	1741.06	1678	1807	1741	18.99	32.96	9.21	0.10
61.02	-138.54	1136.01	968	1320	1138	32.47	43.44	18.43	0.17	63.34	-130.11	1755.81	1670	1875	1751	20.91	38.84	5.48	0.18
61.23	-138.84	1315.96	1144	1468	1319	24.42	33.08	14.92	0.16	63.34	-130.17	1363.53	1334	1406	1361	10.68	22.16	1.22	0.12
61.30	-138.41	1547.91	1451	1662	1548	19.08	35.53	6.42	0.17	63.34	-130.16	1390.12	1377	1402	1390	8.51	13.24	3.11	0.04
61.39	-138.19	1677.66	1594	1756	1676	18.46	37.88	5.14	0.24	63.33	-130.19	1572.94	1472	1659	1582	15.22	32.22	3.02	0.21
61.43	-138.22	1588.12	1515	1757	1562	22.96	34.51	2.43	0.08	63.34	-130.70	1057.95	1008	1159	1056	9.52	26.62	4.76	0.31
61.45	-138.11	1820.81	1796	1844	1823	10.24	19.93	2.26	0.08	63.32	-130.15	1644.17	1525	1741	1649	14.77	28.99	1.07	0.22
61.46	-138.09	1900.45	1824	2028	1888	21.61	28.88	12.37	0.10	63.32	-130.16	1793.27	1642	1933	1783	18.65	44.78	1.39	0.39
61.46	-138.12	1881.93	1815	1964	1876	36.70	45.39	21.32	0.08	63.32	-130.18	1763.26	1720	1800	1765	24.51	33.59	13.58	0.03
61.47	-138.11	1737.46	1633	1867	1732	26.38	36.41	6.62	0.14	63.31	-130.20	1727.30	1582	1844	1736	19.19	43.37	1.69	0.28
61.51	-138.26	1856.24	1758	1960	1864	27.40	40.29	7.06	0.08	63.31	-130.23	1571.63	1514	1617	1576	17.11	23.48	10.66	0.08
61.51	-138.02	1755.91	1666	1802	1763	24.73	41.72	10.03	0.11	63.31	-130.18	1763.22	1697	1808	1768	10.76	23.59	1.07	0.17
61.51	-138.05	1850.87	1693	2003	1850	28.67	38.25	16.75	0.16	63.31	-130.52	1189.11	1109	1285	1183	16.18	26.98	7.92	0.23
61.66	-138.24	1484.79	1394	1745	1451	20.91	40.06	3.18	0.21	63.27	-130.23	1665.08	1454	1883	1668	29.05	48.68	10.40	0.28
61.65	-138.23	1541.45	1472	1637	1535	24.30	35.93	6.17	0.14	63.27	-130.24	1657.91	1567	1758	1660	23.36	38.59	10.20	0.08
61.64	-138.20	1553.04	1447	1675	1549	21.78	27.72	15.95	0.11	63.27	-130.21	1721.81	1611	1821	1722	22.29	40.23	9.30	0.12
61.64	-138.18	1732.22	1561	1828	1759	27.75	38.32	8.08	0.12	63.27	-130.34	1746.04	1650	1861	1747	23.27	46.47	6.53	0.20
61.64	-138.17	1766.50	1651	1832	1769	22.50	38.99	3.52	0.19	63.28	-130.80	1747.00	1660	1855	1741	22.32	30.57	12.34	0.07
61.94	-138.86	1393.56	1306	1502	1390	26.27	39.10	12.91	0.18	63.27	-130.48	1670.43	1611	1719	1672	19.30	37.67	10.07	0.14
61.95	-138.84	1466.00	1356	1571	1472	25.00	39.53	4.38	0.19	63.24	-130.26	1549.28	1418	1705	1541	24.17	43.92	5.05	0.24
61.95	-138.82	1459.38	1351	1590	1454	23.35	35.14	3.02	0.21	63.24	-130.27	1584.37	1463	1671	1597	23.80	44.54	10.16	0.20
61.95	-138.66	1339.58	1249	1476	1331	25.11	35.71	5.73	0.29	63.24	-130.34	1523.07	1487	1567	1524	18.19	22.75	11.67	0.05
60.46	-124.39	1291.49	1198	1462	1283	14.47	34.55	0.95	0.63	63.21	-130.29	1739.63	1629	1816	1747	16.41	32.95	1.07	0.23
60.29	-124.17	1235.51	1127	1361	1234	19.90	31.15	13.26	0.27	63.20	-130.31	1692.76	1579	1818	1696	24.26	40.59	11.28	0.16
63.08	-129.80	1753.41	1715	1775	1757	9.22	19.38	3.04	0.10	63.18	-130.13	1245.63	1195	1352	1239	13.65	33.38	2.70	0.09
64.98	-138.23	1027.64	958	1105	1023	26.74	31.46	21.39	0.05	63.18	-130.14	1340.46	1191	1650	1314	20.03	38.52	2.78	0.46
64.97	-138.25	1010.42	934	1188	982	26.00	38.39	10.05	0.07	63.17	-130.05	1786.02	1719	1865	1787	25.20	31.89	7.59	0.05
64.96	-138.20	941.57	918	979	939	12.03	27.26	7.65	0.06	63.16	-130.01	1791.01	1699	1849	1801	15.59	28.65	5.57	0.12
64.95	-138.09	1282.28	1230	1360	1280	13.04	29.42	4.39	0.18	63.07	-130.84	1531.29	1449	1659	1524	16.84	32.58	3.65	0.19
64.94	-138.08	1385.98	1342	1432	1388	15.25	25.46	5.40	0.09	63.16	-130.58	1599.37	1483	1713	1606	18.63	31.92	7.66	0.16

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.59	-138.17	1587.84	1551	1679	1579	18.99	46.74	1.39	0.13	63.04	-130.10	1504.41	1373	1670	1501	17.19	35.05	2.86	0.51
64.48	-138.33	1378.68	1310	1490	1370	19.99	28.38	6.85	0.18	63.04	-129.98	1740.46	1658	1795	1748	15.98	25.57	7.06	0.15
64.65	-138.60	1470.07	1393	1553	1474	15.56	29.12	3.52	0.20	63.14	-130.46	1630.08	1515	1765	1622	23.04	40.31	3.05	0.13
64.48	-138.51	1753.63	1668	1854	1751	21.38	34.35	12.44	0.19	63.13	-130.35	1688.44	1630	1722	1694	14.76	30.51	1.07	0.12
64.34	-138.39	1211.92	994	1462	1215	22.26	35.60	10.11	0.45	63.13	-130.31	1644.70	1581	1705	1646	16.15	37.32	0.00	0.12
64.34	-138.61	1589.81	1554	1623	1589	18.10	33.08	6.38	0.06	63.12	-130.39	1680.34	1550	1840	1679	24.45	42.23	1.39	0.26
64.34	-138.74	1465.34	1435	1493	1467	9.07	17.68	4.58	0.16	63.12	-130.49	1473.06	1383	1637	1457	31.15	39.90	16.42	0.09
64.27	-138.34	1397.99	1243	1521	1403	20.91	32.75	8.48	0.35	63.09	-130.03	1404.91	1346	1496	1398	15.44	29.08	5.89	0.12
64.27	-138.47	911.38	769	1225	874	18.54	33.83	10.44	0.43	63.09	-130.02	1469.68	1372	1563	1471	19.35	36.20	9.88	0.15
64.67	-138.17	1467.00	1395	1578	1460	14.90	35.49	5.99	0.20	63.11	-130.49	1650.24	1568	1771	1645	20.39	43.14	6.63	0.16
64.56	-138.56	1791.21	1696	1929	1780	25.13	39.22	5.81	0.18	63.08	-129.99	1504.83	1462	1576	1503	18.13	30.40	7.33	0.06
64.46	-138.54	1792.52	1724	1869	1795	19.63	34.85	7.37	0.13	63.08	-130.00	1560.59	1440	1713	1552	31.88	37.62	20.12	0.08
64.46	-138.34	1621.97	1501	1746	1626	27.85	43.23	8.06	0.16	63.07	-129.82	1670.89	1635	1720	1667	21.75	27.68	13.90	0.04
64.46	-138.60	1687.06	1659	1734	1680	18.29	29.13	6.06	0.08	63.07	-129.97	1634.29	1555	1727	1636	22.30	36.62	13.92	0.10
64.37	-138.65	1538.91	1482	1652	1528	28.71	47.77	2.39	0.09	63.04	-130.13	1326.08	1143	1515	1327	24.73	34.79	10.64	0.26
64.64	-138.74	1591.86	1539	1644	1591	20.35	34.02	8.84	0.08	63.42	-131.38	1570.84	1506	1665	1561	14.61	26.80	4.04	0.19
64.58	-138.54	1682.82	1615	1755	1683	19.09	32.74	10.01	0.11	63.21	-131.17	1627.61	1549	1681	1633	23.87	36.15	9.70	0.09
64.58	-138.74	1594.42	1423	1754	1590	26.80	43.01	10.31	0.41	63.41	-131.38	1696.79	1597	1821	1690	21.70	44.30	4.58	0.21
64.57	-138.30	1196.52	1189	1204	1196	3.77	4.26	3.04	0.05	63.38	-131.45	1662.27	1583	1814	1662	21.39	44.18	4.97	0.15
64.53	-138.19	1686.61	1605	1764	1687	26.43	42.33	12.05	0.07	63.37	-131.45	1567.66	1554	1588	1565	12.54	22.43	1.43	0.07
64.52	-138.38	1778.81	1619	2020	1772	30.95	54.43	13.20	0.20	63.16	-131.41	1626.65	1564	1670	1625	11.58	38.96	0.34	0.27
64.51	-138.58	1498.89	1439	1604	1494	18.47	33.79	8.94	0.12	63.15	-131.39	1548.87	1498	1585	1553	11.89	28.55	0.75	0.17
64.51	-138.51	1492.22	1460	1589	1479	16.18	38.54	3.32	0.07	63.14	-131.44	1613.63	1538	1680	1614	22.33	33.60	9.58	0.07
64.49	-138.53	1755.14	1649	1851	1762	15.55	35.04	2.90	0.29	63.14	-131.40	1453.05	1408	1525	1450	9.59	31.85	2.43	0.26
64.49	-138.24	1368.39	1260	1500	1372	26.12	41.14	8.56	0.16	61.97	-130.13	1553.06	1479	1648	1544	23.31	38.20	5.13	0.14
64.49	-138.47	1552.29	1459	1794	1525	26.85	51.84	1.69	0.24	61.96	-130.25	1630.29	1555	1763	1615	23.27	40.83	5.79	0.16
64.48	-138.18	1146.11	997	1443	1106	22.07	36.71	4.68	0.48	61.93	-130.24	1662.31	1561	1858	1652	30.98	51.26	8.84	0.10
64.48	-138.36	1316.89	1230	1407	1319	18.04	29.39	7.01	0.19	61.90	-130.21	1648.36	1472	1851	1653	25.67	40.62	10.91	0.23
64.47	-138.59	1629.41	1572	1687	1635	19.70	30.77	5.15	0.08	61.88	-130.15	1601.74	1491	1718	1591	26.54	38.69	6.92	0.13
64.47	-138.37	1507.38	1475	1555	1506	17.06	26.25	3.65	0.10	61.54	-131.80	1275.18	1193	1372	1268	14.37	27.64	5.10	0.25
64.47	-138.60	1734.55	1660	1817	1734	24.14	42.99	8.44	0.10	61.57	-131.89	1362.28	1333	1413	1352	18.77	30.33	5.88	0.05
64.46	-138.12	1438.51	1215	1560	1473	12.24	27.43	4.11	0.41	61.52	-131.89	1734.21	1666	1823	1731	25.94	36.89	15.13	0.06
64.46	-138.61	1581.64	1541	1671	1579	15.83	38.16	1.97	0.13	61.52	-131.90	1820.58	1697	1957	1818	31.67	41.32	13.52	0.10
64.45	-138.66	1736.85	1665	1783	1742	24.89	33.66	12.73	0.06	61.52	-131.71	1716.69	1626	1820	1722	21.19	36.46	6.85	0.12
64.44	-138.61	1788.85	1706	1902	1789	21.01	39.52	8.77	0.12	61.51	-131.69	1623.53	1475	1757	1624	16.22	30.09	6.14	0.37
64.39	-138.19	1532.42	1402	1644	1527	20.70	32.24	10.92	0.18	61.51	-131.72	1744.93	1650	1824	1758	22.83	35.54	12.57	0.09

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.39	-138.17	1682.61	1610	1772	1677	27.70	36.90	17.36	0.07	61.51	-131.67	1498.48	1347	1640	1488	17.17	32.98	5.76	0.37
64.40	-138.73	1562.94	1464	1704	1560	29.46	50.84	13.63	0.18	61.51	-131.73	1748.09	1623	1910	1747	34.43	41.44	24.65	0.07
64.39	-138.20	1472.56	1365	1597	1467	21.23	34.84	9.14	0.14	61.42	-130.87	1575.07	1515	1686	1572	14.93	28.83	4.90	0.12
64.37	-138.26	1235.85	1046	1436	1221	12.02	33.39	0.48	1.61	61.42	-130.02	1591.99	1515	1649	1596	17.64	31.03	7.73	0.15
64.38	-138.61	1595.42	1540	1668	1593	9.71	23.65	3.93	0.34	61.41	-130.90	1357.70	1316	1422	1354	13.67	28.56	2.39	0.14
64.34	-138.18	1546.72	1417	1684	1549	24.50	34.62	13.71	0.25	61.38	-130.76	1647.17	1560	1738	1649	21.56	31.43	11.99	0.10
64.34	-138.24	1456.93	1396	1555	1450	15.66	29.50	4.06	0.23	61.38	-130.93	1674.17	1526	1816	1684	24.96	41.68	7.83	0.15
64.35	-138.57	1674.44	1618	1739	1674	25.20	40.53	2.36	0.07	61.37	-130.96	1528.20	1455	1584	1535	9.91	17.42	3.77	0.20
64.35	-138.67	1554.33	1479	1638	1552	19.09	41.86	5.81	0.23	61.38	-130.50	1665.54	1584	1789	1658	17.75	32.36	3.11	0.24
64.34	-138.38	1224.22	1116	1342	1206	19.00	31.51	7.39	0.19	61.37	-130.94	1730.03	1662	1812	1730	17.82	33.11	3.39	0.11
64.34	-138.48	1274.91	1132	1421	1275	29.02	37.67	21.34	0.13	61.37	-130.96	1742.81	1679	1844	1732	21.95	33.75	4.90	0.09
64.33	-138.24	1637.30	1588	1704	1633	18.49	32.09	6.80	0.14	61.36	-130.97	1697.89	1611	1811	1692	25.19	36.66	6.40	0.10
64.33	-138.53	1581.37	1472	1701	1576	35.81	49.68	19.48	0.12	61.36	-130.99	1574.88	1480	1728	1563	26.15	39.83	7.21	0.09
64.33	-138.39	1379.25	1166	1603	1384	24.89	37.40	10.76	0.28	61.36	-130.54	1633.10	1520	1736	1635	22.85	28.08	9.74	0.10
64.32	-138.16	1357.91	1200	1534	1359	20.56	33.89	4.86	1.01	61.36	-130.74	1684.67	1652	1737	1678	13.99	28.57	4.76	0.09
64.32	-138.12	1497.14	1358	1609	1500	29.74	36.57	21.83	0.12	61.33	-130.74	1633.75	1591	1718	1620	15.11	32.72	3.44	0.12
64.32	-138.40	1319.84	1187	1440	1320	23.97	31.00	13.64	0.22	61.31	-130.96	1594.90	1494	1766	1579	28.78	46.33	5.55	0.11
64.32	-138.57	1541.55	1464	1611	1538	29.19	41.80	4.32	0.07	61.25	-130.86	1546.40	1451	1641	1553	15.36	38.52	5.79	0.22
64.31	-138.41	1213.41	1087	1338	1217	25.32	38.22	15.18	0.16	61.25	-130.99	1450.32	1399	1515	1445	16.89	29.60	8.33	0.11
64.29	-138.43	1202.08	1047	1341	1207	20.45	29.12	9.09	0.33	61.24	-130.79	1671.33	1593	1771	1670	29.34	41.50	18.83	0.07
64.28	-138.20	1492.42	1426	1584	1491	19.80	32.57	6.80	0.16	61.23	-130.78	1554.51	1504	1589	1557	17.40	25.30	12.98	0.04
64.31	-138.59	1601.53	1530	1709	1587	27.80	43.32	6.99	0.10	61.22	-130.94	1517.82	1429	1599	1517	21.10	36.51	11.00	0.19
64.30	-138.19	1489.04	1458	1537	1488	20.49	37.49	14.91	0.06	61.21	-130.40	1648.19	1580	1778	1639	23.05	46.21	9.72	0.11
64.30	-138.39	1547.37	1299	1707	1559	25.12	42.28	0.00	0.42	61.21	-130.44	1611.74	1495	1779	1612	26.04	41.66	7.59	0.33
64.30	-138.43	1140.33	1007	1236	1151	18.07	25.53	8.94	0.19	61.20	-130.87	1536.92	1342	1746	1533	22.56	39.76	11.77	0.31
64.28	-138.41	1455.93	1197	1670	1462	20.49	41.77	6.75	0.61	61.19	-130.40	1733.01	1676	1785	1738	11.60	26.11	0.34	0.14
64.28	-138.45	1095.30	786	1396	1097	18.64	38.98	6.28	1.49	61.18	-130.65	1645.87	1534	1762	1650	23.98	35.82	13.96	0.13
64.27	-138.29	1269.01	1122	1405	1271	24.39	35.02	13.78	0.17	61.17	-130.62	1608.76	1550	1704	1601	22.48	36.09	6.17	0.10
64.26	-138.47	943.25	762	1217	913	17.63	30.83	7.75	0.57	61.17	-130.63	1674.54	1613	1775	1671	20.57	40.95	1.39	0.15
64.26	-138.30	1086.25	1015	1218	1077	20.18	30.42	12.35	0.21	61.17	-130.26	1615.71	1564	1695	1612	19.26	39.59	6.99	0.09
64.22	-138.49	1137.62	989	1252	1146	22.93	31.44	1.51	0.34	61.16	-130.75	1552.41	1458	1653	1552	25.14	34.92	14.20	0.10
64.60	-138.21	1630.09	1528	1702	1629	15.49	34.30	4.06	0.13	61.16	-130.35	1524.93	1447	1659	1521	15.49	33.53	3.81	0.41
64.93	-133.98	1404.53	1277	1539	1405	32.99	42.40	17.35	0.08	61.14	-130.84	1736.60	1694	1793	1731	20.61	37.54	3.32	0.07
64.92	-133.92	1191.31	1084	1347	1186	30.51	43.69	9.70	0.18	61.13	-130.81	1477.97	1412	1547	1480	18.80	30.87	9.72	0.11
64.88	-133.94	1511.58	1353	1828	1448	28.19	55.41	1.97	0.20	61.13	-130.88	1567.58	1472	1685	1564	21.25	37.33	7.75	0.16
64.88	-133.93	1400.84	1339	1485	1400	17.10	28.83	3.32	0.13	61.13	-130.16	1588.20	1526	1673	1583	25.94	36.49	15.48	0.10

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.86	-133.94	1948.30	1793	2072	1952	37.85	53.29	1.51	0.16	61.13	-130.11	1587.80	1537	1650	1585	24.18	42.36	8.81	0.06
64.86	-133.97	1588.14	1452	1725	1584	32.58	38.70	26.12	0.08	61.12	-130.13	1552.42	1522	1583	1554	13.13	28.50	2.72	0.12
64.86	-133.96	1608.68	1467	1771	1604	35.45	41.50	31.11	0.06	61.12	-130.14	1559.56	1509	1610	1560	14.47	29.67	7.45	0.11
64.89	-133.82	1382.78	1150	1562	1392	26.65	38.19	14.72	0.19	61.11	-130.16	1629.17	1483	1796	1633	26.09	43.81	4.53	0.31
64.85	-133.88	1649.06	1528	1817	1644	37.94	45.55	28.46	0.10	61.11	-130.15	1639.81	1535	1720	1640	21.59	29.09	9.75	0.11
65.00	-133.81	1158.22	1055	1329	1157	26.03	36.34	16.42	0.20	61.11	-130.12	1725.11	1690	1795	1722	14.52	37.68	4.17	0.08
64.94	-133.86	911.14	819	1076	893	20.03	37.75	0.00	0.21	61.11	-130.24	1631.91	1574	1742	1625	19.23	42.41	5.71	0.13
64.89	-133.94	1559.61	1435	1679	1547	26.99	35.72	1.51	0.15	61.11	-130.12	1712.17	1646	1838	1703	25.40	47.94	10.48	0.07
64.91	-133.83	1425.59	1317	1493	1430	25.50	37.71	10.64	0.20	61.10	-130.86	1718.17	1608	1853	1707	25.92	49.10	14.55	0.09
64.90	-133.84	1636.41	1549	1722	1632	28.66	39.24	22.38	0.10	61.11	-130.11	1624.81	1576	1674	1625	16.22	32.05	9.97	0.08
64.90	-133.85	1579.66	1454	1702	1578	35.80	42.17	28.51	0.08	61.09	-130.15	1589.26	1553	1655	1584	17.26	39.34	2.46	0.13
64.89	-133.81	934.37	845	1062	933	31.45	44.54	9.70	0.08	61.06	-130.63	1566.84	1421	1751	1557	26.86	39.13	11.31	0.19
64.89	-133.85	1275.62	1209	1364	1275	25.15	35.82	8.59	0.11	61.06	-130.60	1560.94	1397	1698	1563	28.14	38.13	17.18	0.23
64.88	-133.92	1639.81	1494	1796	1656	31.52	42.69	18.31	0.17	61.06	-130.74	1638.84	1565	1726	1646	16.80	43.02	2.26	0.30
64.88	-133.85	1782.62	1638	1864	1795	36.31	56.33	1.82	0.15	61.06	-130.64	1641.81	1577	1689	1656	15.13	26.60	1.39	0.09
64.86	-133.89	1596.87	1415	1692	1633	36.21	59.19	1.07	0.11	61.06	-130.71	1467.33	1293	1568	1485	18.87	37.45	3.37	0.50
64.86	-133.88	1368.17	1323	1447	1361	21.25	41.09	2.64	0.16	61.06	-130.61	1609.07	1401	1792	1612	19.93	40.55	3.93	0.73
64.85	-133.94	1580.61	1454	1759	1573	29.50	39.24	19.28	0.11	61.06	-130.69	1549.94	1480	1655	1544	23.54	40.36	9.88	0.17
64.85	-133.93	1624.20	1491	1800	1615	31.08	38.93	24.26	0.10	61.03	-130.67	1548.15	1468	1641	1540	12.67	28.67	3.11	0.23
64.84	-133.93	1635.04	1475	1813	1623	29.39	36.71	21.68	0.11	61.03	-130.27	1534.64	1403	1639	1540	19.58	35.10	5.13	0.31
64.84	-133.91	1809.46	1575	2095	1795	31.00	39.16	20.37	0.23	61.02	-130.60	1519.86	1399	1698	1509	27.14	43.54	11.40	0.14
64.83	-133.92	1473.20	1393	1616	1458	19.84	30.52	4.43	0.15	61.02	-130.60	1639.40	1538	1745	1639	17.96	33.06	1.35	0.15
64.82	-133.91	1541.62	1331	1759	1544	33.23	47.91	7.39	0.43	61.01	-130.54	1634.54	1595	1713	1629	16.08	34.68	1.91	0.13
64.82	-133.89	1427.68	1219	1772	1392	26.48	41.04	5.73	0.39	61.01	-130.61	1650.40	1534	1809	1641	28.45	40.04	10.97	0.16
64.82	-133.77	1654.10	1491	1803	1655	31.38	47.13	1.97	0.34	61.01	-130.43	1544.95	1489	1645	1542	15.19	40.63	5.75	0.16
64.81	-133.96	1780.66	1679	1982	1758	28.28	52.34	5.48	0.24	61.01	-130.43	1560.62	1477	1683	1557	24.28	39.52	6.62	0.15
64.79	-133.99	1878.24	1788	1993	1874	37.88	51.56	23.88	0.08	61.01	-130.45	1498.99	1447	1550	1508	15.55	23.84	6.14	0.07
64.79	-133.89	1316.23	1187	1571	1280	27.41	49.19	4.26	0.36	61.00	-130.52	1494.90	1378	1668	1490	23.59	53.67	10.72	0.29
64.79	-133.92	1715.84	1570	1853	1717	47.83	57.20	25.42	0.08	61.00	-130.51	1544.16	1474	1619	1538	22.50	40.36	5.40	0.09
64.78	-133.91	1742.05	1564	1888	1749	35.64	50.49	5.43	0.21	61.50	-131.91	1776.91	1666	1899	1772	35.29	38.54	29.25	0.05
64.78	-133.92	1679.55	1536	1883	1663	35.91	54.08	2.46	0.20	61.49	-131.72	1702.75	1631	1773	1702	17.94	38.46	2.39	0.17
64.76	-133.98	1618.03	1521	1822	1616	16.84	42.73	0.68	0.39	61.49	-131.64	1519.33	1445	1606	1522	20.52	31.73	15.18	0.07
64.76	-133.92	1622.44	1570	1722	1608	17.59	38.23	4.26	0.21	61.47	-131.97	1678.78	1533	1879	1648	26.10	38.32	7.61	0.21
64.79	-133.83	1437.35	1311	1579	1441	27.28	42.66	6.42	0.28	61.47	-131.96	1766.23	1656	1878	1761	29.63	39.82	18.27	0.09
64.76	-133.86	1562.92	1448	1847	1528	27.03	55.05	0.68	0.31	61.47	-131.65	1593.68	1484	1696	1602	22.34	39.72	7.13	0.17
64.75	-133.84	1374.62	1296	1485	1370	26.42	38.53	3.72	0.13	61.46	-131.09	1640.01	1588	1712	1640	19.89	38.01	0.48	0.09

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.75	-133.84	1369.48	1278	1507	1365	16.63	36.43	6.42	0.20	61.46	-131.14	1689.73	1654	1756	1682	11.28	26.58	3.18	0.11
64.74	-133.83	1402.59	1304	1541	1396	26.51	41.70	10.68	0.16	61.44	-131.22	1703.73	1619	1822	1698	29.03	42.51	10.70	0.13
64.74	-133.82	1385.79	1230	1571	1384	31.53	38.05	20.69	0.16	61.43	-131.55	1480.73	1342	1584	1490	22.82	34.22	11.37	0.16
64.73	-133.94	1593.40	1489	1743	1590	31.76	45.76	2.88	0.26	61.43	-131.51	1653.80	1560	1736	1651	22.92	38.66	4.06	0.12
64.71	-133.98	1562.70	1360	1771	1594	32.22	53.15	5.81	0.27	61.41	-131.76	1323.99	1273	1412	1316	14.89	30.32	2.02	0.23
64.70	-133.97	1661.86	1555	1816	1658	28.93	39.08	12.81	0.12	61.42	-131.02	1755.34	1684	1844	1755	15.66	30.79	7.45	0.16
64.69	-133.99	1429.11	1254	1599	1430	34.48	40.65	25.10	0.09	61.40	-131.89	1546.46	1485	1646	1543	18.37	41.54	2.39	0.17
64.66	-133.95	1577.10	1447	1726	1571	36.81	44.54	25.53	0.22	61.40	-131.76	1518.24	1401	1696	1516	21.49	34.20	1.97	0.14
64.65	-133.68	1952.37	1734	2137	1967	35.22	47.06	15.88	0.16	61.40	-131.75	1578.12	1496	1660	1581	26.96	32.74	18.39	0.08
64.65	-133.97	1743.64	1611	1925	1739	30.20	43.60	0.48	0.31	61.41	-131.08	1696.41	1593	1836	1699	23.39	34.24	4.69	0.11
64.65	-133.95	1870.44	1736	1979	1875	34.87	47.09	2.90	0.22	61.41	-131.09	1661.89	1546	1791	1663	26.88	34.44	13.12	0.14
64.59	-133.99	1644.97	1580	1754	1636	23.55	43.54	7.21	0.09	61.40	-131.75	1547.30	1442	1662	1541	26.84	38.51	12.05	0.11
64.59	-133.97	1858.50	1677	2018	1882	31.26	42.41	3.52	0.14	61.41	-131.07	1724.71	1628	1888	1716	16.10	35.60	2.78	0.25
64.59	-133.77	1494.54	1390	1675	1475	30.87	46.96	4.50	0.16	61.39	-131.73	1416.09	1363	1457	1420	14.52	22.37	5.23	0.14
64.59	-133.74	1579.91	1484	1789	1554	29.53	51.72	1.35	0.39	61.38	-131.72	1580.38	1476	1658	1584	10.10	20.69	1.91	0.43
64.57	-133.76	1812.08	1782	1850	1812	18.36	30.84	6.49	0.06	61.39	-131.05	1491.29	1461	1549	1485	11.46	25.49	3.77	0.08
64.57	-133.71	1882.98	1631	2096	1871	29.21	50.27	5.48	0.24	61.37	-131.68	1498.59	1395	1654	1491	22.12	34.42	7.65	0.19
64.57	-133.69	1764.24	1702	1863	1762	23.24	41.80	9.83	0.14	61.37	-131.69	1574.92	1476	1705	1568	23.98	37.20	10.94	0.15
64.56	-133.71	1968.25	1786	2214	1941	35.58	57.96	5.48	0.19	61.37	-131.70	1625.35	1567	1717	1619	25.30	41.28	13.63	0.09
64.56	-133.82	1536.57	1419	1746	1514	33.05	52.19	8.81	0.17	61.38	-131.08	1692.35	1609	1760	1700	21.66	36.83	5.79	0.10
64.56	-133.80	1863.24	1752	1995	1856	24.86	44.52	9.70	0.13	61.36	-131.28	1591.15	1486	1697	1595	36.97	41.65	18.07	0.06
64.56	-133.89	1462.01	1393	1558	1443	17.38	35.51	6.92	0.14	61.36	-131.29	1538.75	1488	1601	1535	18.53	29.00	13.26	0.05
64.54	-133.87	1622.61	1547	1699	1623	21.32	35.97	7.39	0.07	61.36	-131.05	1535.74	1439	1648	1540	20.79	41.71	5.95	0.21
64.49	-133.96	1664.18	1535	1904	1628	33.32	59.75	3.58	0.17	61.35	-131.53	1543.70	1419	1673	1548	23.54	38.06	7.51	0.22
64.50	-133.92	1812.73	1651	1920	1824	30.27	40.31	4.76	0.10	61.35	-131.13	1543.39	1454	1642	1535	20.32	35.51	6.18	0.21
64.51	-133.91	1689.46	1520	1890	1677	32.83	54.44	1.07	0.29	61.34	-131.09	1667.15	1624	1748	1662	25.76	38.91	10.68	0.11
64.51	-133.87	1767.38	1625	1914	1772	33.30	42.80	13.33	0.23	61.32	-131.60	1642.16	1534	1761	1640	22.34	30.89	7.14	0.13
64.50	-133.84	1586.78	1466	1748	1572	31.21	47.78	14.66	0.22	61.32	-131.02	1506.06	1406	1559	1519	16.33	32.95	4.82	0.17
64.46	-133.92	1571.74	1457	1770	1559	33.04	46.41	16.17	0.22	61.31	-131.02	1559.67	1517	1635	1557	22.10	36.07	10.48	0.06
64.45	-133.92	1634.63	1509	1765	1629	34.31	50.31	6.72	0.32	61.30	-131.16	1652.10	1567	1771	1651	25.96	42.12	5.27	0.07
64.45	-133.91	1582.57	1525	1638	1584	21.59	32.86	5.13	0.10	61.29	-131.14	1555.43	1469	1642	1557	17.90	30.66	8.74	0.17
64.43	-133.99	1624.96	1482	1789	1623	33.00	48.60	9.70	0.17	61.26	-131.11	1550.88	1480	1639	1551	14.29	31.33	3.05	0.16
64.42	-133.90	1516.41	1384	1615	1535	23.98	39.10	0.95	0.14	61.25	-131.86	1541.43	1419	1674	1548	25.90	38.24	11.40	0.15
64.40	-133.87	1610.08	1492	1744	1612	32.47	45.05	1.39	0.24	61.25	-131.19	1545.60	1463	1653	1543	25.73	40.96	8.16	0.08
64.44	-133.77	1322.98	1212	1473	1317	36.02	46.85	19.19	0.14	61.25	-131.07	1638.58	1552	1758	1638	26.52	41.49	10.68	0.07
64.17	-133.94	1519.24	1232	1755	1522	30.37	39.38	23.49	0.28	61.25	-131.18	1476.88	1436	1566	1470	14.69	33.10	3.65	0.20

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.16	-133.93	1657.94	1479	1769	1678	33.61	45.30	0.48	0.09
64.15	-133.84	1538.07	1456	1629	1541	22.36	34.90	8.44	0.14
64.14	-133.82	1621.07	1400	1766	1631	33.47	45.75	2.05	0.27
64.13	-133.89	1641.91	1384	1826	1657	32.20	41.78	2.57	0.30
64.12	-133.95	1353.85	1267	1448	1350	33.40	39.67	25.50	0.09
64.12	-133.96	1360.80	1236	1519	1356	32.82	39.31	18.10	0.13
64.10	-133.87	1490.00	1368	1583	1481	25.31	39.16	2.72	0.12
64.01	-133.80	1403.10	1311	1455	1410	19.86	34.29	1.22	0.13
64.13	-133.61	1710.48	1593	1818	1709	25.72	38.70	4.22	0.15
64.14	-133.63	1597.40	1411	1818	1596	30.22	44.65	2.78	0.50
64.14	-133.67	1673.75	1524	1768	1683	30.91	43.36	0.68	0.21
64.15	-133.73	1541.90	1300	1768	1527	31.30	50.63	1.97	0.36
64.32	-133.73	1502.61	1307	1802	1464	22.31	40.36	2.16	0.48
64.39	-133.57	1663.27	1576	1719	1673	29.81	41.38	1.39	0.15
64.41	-133.59	1708.57	1634	1796	1707	30.76	43.59	2.88	0.12
64.42	-133.60	1765.33	1663	1912	1753	32.10	45.74	4.76	0.13
64.39	-133.75	1727.37	1524	1883	1747	39.34	54.27	2.90	0.16
64.40	-133.74	1671.83	1456	1922	1660	41.71	56.46	5.32	0.30
64.43	-133.69	1797.73	1697	1887	1803	25.59	37.89	4.82	0.23
64.45	-133.65	1775.26	1670	1901	1775	32.70	49.98	3.11	0.19
64.51	-133.68	1758.74	1683	1901	1737	26.31	41.43	2.86	0.12
64.51	-133.71	1844.20	1651	1989	1842	39.99	51.84	2.72	0.16
64.53	-133.70	1852.29	1610	2118	1851	36.40	52.30	2.46	0.42
64.52	-133.58	1519.87	1449	1629	1522	28.20	44.65	2.26	0.16
64.54	-133.67	1585.44	1535	1707	1579	21.25	52.41	2.90	0.19
64.56	-133.62	1474.07	1397	1594	1462	20.76	34.85	5.99	0.18
64.56	-133.65	1588.24	1486	1770	1577	35.31	53.51	11.77	0.22
64.60	-133.69	1549.23	1455	1786	1547	19.13	48.67	2.43	0.43
64.60	-133.65	1860.79	1719	2010	1860	42.29	50.02	27.92	0.11
64.60	-133.64	1790.38	1645	1944	1788	33.39	42.85	24.28	0.11
64.63	-133.62	1856.84	1634	2015	1852	37.01	51.40	5.72	0.20
64.74	-133.55	1551.64	1378	1709	1549	32.23	39.04	2.16	0.11
64.81	-133.49	1334.72	1172	1521	1326	28.65	38.29	8.28	0.24
64.77	-133.45	1529.94	1454	1706	1512	18.56	38.59	3.02	0.30
64.76	-133.45	1764.12	1676	1839	1766	30.04	42.04	10.03	0.11
64.83	-133.47	1606.08	1442	1741	1607	30.75	37.56	0.75	0.25

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
61.21	-131.31	1443.05	1297	1605	1439	23.04	39.96	7.75	0.31
61.21	-131.23	1438.61	1325	1572	1437	25.81	39.10	9.88	0.12
61.17	-131.27	1586.55	1522	1686	1584	22.59	37.49	6.17	0.14
61.17	-131.25	1421.28	1361	1478	1421	18.19	31.40	10.03	0.09
61.17	-131.26	1595.58	1508	1698	1592	22.62	32.55	9.76	0.08
61.16	-131.25	1613.54	1560	1658	1615	18.19	28.65	10.10	0.08
61.16	-131.24	1610.24	1575	1653	1608	14.48	30.94	1.22	0.08
62.85	-131.64	1522.56	1419	1627	1522	16.90	39.16	0.48	0.29
61.25	-138.23	1672.85	1607	1744	1676	22.91	38.16	0.95	0.12
61.23	-138.85	1208.41	1126	1289	1212	21.11	27.41	15.79	0.10
61.23	-138.99	1825.97	1695	1942	1829	16.45	28.31	7.23	0.27
61.23	-138.93	1778.46	1575	1983	1770	19.30	34.40	2.36	0.63
61.23	-138.99	1775.97	1584	2028	1760	23.49	36.73	6.62	0.30
61.21	-138.79	1060.37	954	1190	1058	19.81	36.63	6.93	0.36
61.21	-138.80	1148.67	1070	1235	1147	27.58	37.03	20.10	0.06
61.21	-138.90	1802.78	1463	2105	1813	22.70	43.95	5.72	0.81
61.19	-138.92	2026.18	1855	2423	2011	17.12	42.81	0.00	1.20
61.19	-138.90	1983.64	1862	2114	1968	20.27	38.97	1.39	0.34
61.18	-138.94	1961.09	1821	2089	1964	18.93	38.47	4.04	0.51
61.16	-138.88	1876.80	1807	1963	1871	26.18	41.02	16.03	0.07
61.15	-138.74	1485.22	1350	1699	1471	26.78	38.66	10.94	0.22
61.14	-138.69	1665.29	1389	2028	1659	26.99	43.80	7.92	0.56
61.15	-138.96	1551.70	1494	1600	1553	24.74	34.77	17.69	0.04
61.13	-138.87	1829.57	1749	1935	1822	25.23	43.67	9.30	0.22
61.10	-138.63	1735.94	1424	2045	1739	27.87	48.23	5.43	0.87
61.07	-138.62	1709.83	1521	1856	1728	21.59	40.10	5.55	0.47
61.09	-138.61	1753.82	1447	1968	1774	28.93	48.57	7.37	0.79
61.09	-138.73	1605.98	1495	1736	1597	33.56	45.22	20.47	0.11
61.09	-138.99	2005.54	1867	2163	2012	20.37	38.12	4.39	0.28
61.09	-138.69	1796.61	1675	1897	1805	25.84	42.34	11.99	0.23
61.08	-138.95	1548.67	1411	1728	1533	23.08	41.28	1.22	0.59
61.06	-138.55	1401.48	1032	1953	1335	28.01	40.23	12.30	0.38
61.06	-138.97	1571.20	1453	1754	1561	22.25	48.70	7.90	0.76
61.06	-138.99	1600.00	1489	1772	1595	19.71	35.50	9.65	0.21
61.02	-138.52	1037.91	939	1131	1036	20.69	33.13	9.74	0.14
61.04	-138.72	1654.85	1510	1888	1642	25.51	49.80	5.14	0.35

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.90	-133.46	1849.35	1706	2053	1833	34.16	44.52	4.50	0.15	61.01	-138.94	2078.79	1838	2281	2089	27.51	44.81	10.37	0.43
64.83	-133.56	1638.37	1542	1762	1628	23.95	43.33	2.05	0.22	61.00	-138.94	2008.86	1723	2303	2040	22.82	57.89	2.72	0.61
64.84	-133.54	1690.56	1489	1885	1713	27.07	39.30	7.09	0.34	60.99	-138.75	1375.71	1228	1532	1367	27.35	41.27	9.52	0.45
64.85	-133.57	1633.14	1437	1881	1626	37.02	49.27	23.20	0.19	60.99	-138.92	2067.42	1920	2210	2074	18.53	33.90	8.06	0.24
64.85	-133.63	1153.30	1046	1262	1151	32.52	39.68	24.10	0.09	60.98	-138.50	907.69	838	1021	902	17.24	36.17	0.34	0.24
64.85	-133.62	1195.94	1073	1310	1200	35.46	46.27	25.21	0.11	60.99	-138.85	1916.54	1862	1973	1920	17.71	29.03	7.21	0.09
64.85	-133.59	1155.78	1005	1378	1146	34.74	51.23	14.04	0.24	60.99	-138.81	1593.84	1539	1659	1593	21.10	32.48	4.06	0.06
64.30	-133.77	1073.23	952	1169	1072	9.46	19.41	4.38	0.64	60.99	-138.81	1583.44	1501	1681	1580	29.89	42.23	9.58	0.07
64.68	-133.50	1606.03	1476	1732	1612	32.72	42.93	2.88	0.14	60.99	-138.77	1474.96	1390	1569	1472	28.07	37.48	14.87	0.10
64.69	-133.47	1554.31	1414	1663	1555	30.20	41.17	3.05	0.15	60.96	-138.58	902.14	779	1239	859	16.89	43.65	1.72	0.78
64.86	-133.66	828.20	665	1078	812	26.10	40.49	3.05	0.40	60.96	-138.59	790.79	773	829	786	11.09	31.33	3.34	0.08
64.87	-133.63	1083.72	893	1294	1072	32.47	43.62	20.77	0.16	60.94	-138.50	1290.12	1191	1408	1287	21.83	35.79	14.62	0.12
64.88	-133.62	1338.12	1136	1514	1347	35.24	41.71	20.96	0.13	60.94	-138.41	1918.17	1860	1996	1916	20.48	32.99	13.83	0.08
64.87	-133.60	1056.29	905	1221	1049	31.41	42.05	21.77	0.09	60.93	-138.50	1399.79	1339	1499	1392	17.19	30.21	1.43	0.20
64.88	-133.60	1388.67	1246	1569	1381	36.26	44.75	25.52	0.14	60.93	-138.54	1814.24	1755	1854	1818	18.69	31.36	8.10	0.10
64.88	-133.62	1448.25	1209	1628	1467	34.79	47.14	19.18	0.26	60.93	-138.51	1638.52	1490	1836	1634	29.65	44.07	14.13	0.14
64.89	-133.61	1707.66	1514	1928	1707	40.60	55.55	27.20	0.22	60.92	-138.45	1750.94	1499	2127	1753	17.59	48.39	1.39	1.77
64.90	-133.57	1585.72	1423	1775	1592	30.18	44.00	20.06	0.14	60.92	-138.38	1754.41	1594	1947	1761	20.16	37.03	6.17	0.41
64.91	-133.57	1415.46	1357	1516	1412	25.18	44.09	1.35	0.13	60.90	-138.28	2045.35	1906	2175	2053	27.73	37.90	10.68	0.25
64.91	-133.63	1787.19	1630	1980	1798	36.99	50.42	1.07	0.28	61.99	-140.84	1735.04	1614	1839	1741	25.33	39.01	4.06	0.22
64.91	-133.65	1464.25	1341	1701	1446	33.53	50.80	8.06	0.25	61.99	-140.79	1643.24	1523	1798	1645	15.78	36.09	2.13	0.28
64.91	-133.59	1506.48	1402	1588	1509	32.65	44.94	4.06	0.24	61.64	-140.08	1683.34	1532	1854	1683	21.86	33.08	7.95	0.20
64.88	-133.58	1020.94	697	1467	1034	27.23	46.47	2.13	0.45	61.51	-140.74	2030.04	1895	2119	2042	19.21	33.19	7.72	0.20
64.92	-133.59	1394.63	1334	1414	1402	11.74	30.82	0.34	0.08	61.96	-140.63	1399.60	1067	1823	1384	18.61	39.22	0.48	2.01
64.93	-133.62	1311.03	1219	1406	1312	21.74	31.50	13.77	0.13	61.97	-140.78	1698.00	1608	1745	1708	15.84	32.78	1.69	0.09
64.94	-133.50	1782.89	1613	1925	1794	34.51	44.96	7.72	0.12	61.95	-140.68	1757.51	1699	1810	1761	16.11	25.05	8.56	0.09
64.94	-133.50	1335.42	1253	1429	1335	22.64	44.81	5.73	0.13	61.94	-140.64	1418.20	1397	1458	1412	13.59	31.47	2.02	0.04
64.95	-133.61	1011.39	831	1369	967	22.49	41.65	1.39	0.50	61.94	-140.68	1803.58	1688	1924	1800	33.08	39.38	15.82	0.06
64.96	-133.56	1518.59	1347	1667	1530	34.95	48.05	12.35	0.18	61.94	-140.62	1635.42	1583	1699	1634	20.69	34.03	8.38	0.09
64.97	-133.57	1444.97	1325	1580	1440	25.45	40.67	2.72	0.26	61.92	-140.51	898.69	836	990	889	10.49	22.50	1.39	0.42
64.97	-133.61	1643.85	1444	1851	1649	34.22	42.97	16.63	0.20	61.92	-140.62	1319.53	1139	1523	1320	25.79	39.70	8.77	0.47
64.98	-133.61	1702.95	1397	2042	1696	36.23	47.17	5.71	0.46	61.88	-140.36	1360.07	1152	1507	1376	20.56	36.72	5.81	0.29
64.99	-133.52	1743.93	1609	1890	1740	37.46	43.42	22.78	0.14	61.64	-140.04	1480.49	1411	1577	1478	17.94	31.23	9.46	0.14
64.98	-133.56	1365.84	1207	1530	1367	27.74	36.68	13.14	0.27	61.85	-140.32	1587.56	1511	1697	1586	22.17	38.50	6.99	0.12
64.99	-133.64	1464.68	1333	1638	1456	31.77	42.07	22.74	0.18	61.82	-140.25	1435.71	1212	1657	1437	24.39	40.92	13.43	0.30
64.98	-133.66	1137.98	1010	1395	1112	22.51	38.95	6.20	0.24	61.83	-140.96	1439.25	1346	1526	1438	24.74	36.77	12.36	0.25

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.96	-133.46	1783.68	1707	1931	1778	27.70	42.12	6.06	0.16	61.82	-140.28	1545.12	1481	1659	1540	22.89	41.09	7.65	0.09
64.97	-133.49	1573.37	1372	1879	1540	26.82	47.31	0.68	0.60	61.82	-140.97	1568.85	1511	1649	1565	23.83	33.76	4.58	0.09
64.99	-133.48	1842.53	1665	1990	1842	31.98	39.95	7.66	0.12	61.81	-140.23	1440.74	1277	1624	1431	25.31	44.15	10.86	0.31
64.99	-133.34	1548.40	1493	1597	1549	14.70	31.58	6.62	0.18	61.80	-140.21	1379.46	1148	1532	1403	20.98	39.33	1.07	0.37
65.00	-133.30	1385.88	1339	1434	1388	28.85	44.44	9.92	0.05	61.97	-140.82	1511.42	1436	1601	1508	17.87	37.93	4.39	0.33
64.98	-133.36	1592.34	1555	1645	1587	9.23	22.47	1.35	0.19	61.97	-140.66	1633.82	1485	1833	1615	18.21	43.32	0.34	0.41
64.97	-133.34	1644.88	1515	1860	1637	24.66	45.87	1.51	0.18	61.96	-140.71	1569.76	1427	1627	1584	13.18	32.93	0.00	0.36
64.98	-133.31	1417.01	1305	1667	1385	25.74	48.83	1.51	0.29	61.95	-140.69	1592.61	1431	1754	1576	16.19	36.98	0.75	0.90
64.98	-133.29	1695.86	1525	1811	1701	32.50	42.16	20.07	0.27	61.88	-140.37	1293.01	1173	1383	1306	20.95	32.06	9.76	0.12
64.94	-133.41	1599.35	1494	1708	1587	25.78	48.11	4.26	0.17	61.68	-140.15	1341.45	1300	1435	1336	20.42	43.59	8.06	0.09
64.94	-133.41	1823.65	1679	2014	1812	48.77	56.52	30.49	0.09	61.68	-139.96	1470.26	1389	1525	1479	17.79	28.56	7.57	0.13
64.93	-133.42	1811.38	1692	2022	1783	28.12	54.38	5.10	0.16	61.54	-139.97	1138.14	1050	1248	1129	14.50	22.61	5.48	0.21
64.92	-133.42	1820.91	1647	1960	1823	34.19	55.64	1.69	0.36	61.73	-140.11	1440.90	1207	1609	1457	18.35	40.26	3.81	0.59
64.92	-133.41	1597.51	1544	1648	1596	15.22	40.97	7.12	0.14	61.71	-140.01	1082.88	915	1454	1052	14.20	33.70	4.17	0.83
64.93	-133.37	1575.71	1454	1675	1576	38.41	46.23	15.17	0.12	61.70	-140.02	1464.24	1332	1583	1468	21.22	35.23	3.65	0.35
64.93	-133.37	1543.63	1453	1702	1522	23.30	43.11	5.75	0.16	61.69	-140.22	1397.50	1363	1447	1396	14.71	32.71	2.72	0.11
64.92	-133.35	1510.28	1492	1563	1508	10.64	29.93	0.00	0.08	61.69	-139.99	1445.48	1183	1661	1463	19.49	32.93	5.44	0.67
64.93	-133.35	1439.21	1387	1511	1436	23.52	36.98	4.32	0.10	61.67	-140.16	1610.73	1402	1799	1623	24.75	42.64	8.79	0.39
64.96	-133.37	1623.06	1484	1762	1622	33.31	43.37	13.27	0.26	61.67	-140.18	1498.06	1446	1590	1491	20.54	42.81	5.52	0.10
64.95	-133.31	2042.27	1938	2132	2045	33.37	49.95	2.43	0.20	61.66	-140.14	1657.78	1474	1838	1662	18.81	40.29	1.07	0.60
64.96	-133.29	1686.32	1567	1815	1683	35.15	49.02	20.82	0.12	61.63	-140.08	1795.68	1629	1952	1800	26.93	42.12	8.17	0.47
64.90	-133.42	1525.24	1369	1913	1468	28.36	52.17	3.84	0.50	61.63	-140.12	1675.78	1481	1901	1677	21.39	39.52	3.44	0.88
64.91	-133.39	1549.96	1485	1629	1544	30.82	36.56	25.80	0.05	61.63	-140.11	1862.82	1763	1986	1854	28.83	39.57	16.12	0.10
64.90	-133.38	1440.95	1220	1678	1445	36.15	43.43	24.26	0.24	61.63	-140.11	1848.59	1753	1956	1854	21.09	38.02	7.39	0.13
64.88	-133.42	1124.97	829	1419	1132	33.68	43.91	15.65	0.31	61.62	-140.06	1565.72	1518	1614	1565	16.58	31.69	3.39	0.17
64.88	-133.28	1153.98	926	1463	1116	30.88	42.11	15.06	0.24	61.62	-140.08	1752.63	1671	1814	1755	15.23	30.16	0.48	0.52
64.76	-133.42	1815.42	1623	2098	1797	35.10	51.99	0.68	0.32	61.61	-140.05	1602.01	1426	1848	1588	17.80	42.29	3.18	1.16
64.75	-133.43	1779.84	1639	1915	1783	30.52	43.67	8.11	0.26	61.62	-140.15	1699.41	1569	1826	1704	16.92	32.74	5.26	0.26
64.75	-133.38	1469.39	1397	1666	1439	16.35	38.95	1.91	0.26	61.61	-140.12	1576.27	1529	1666	1570	17.32	36.00	5.01	0.11
64.74	-133.39	1874.58	1781	1925	1878	24.24	36.77	1.39	0.14	61.60	-140.03	1791.83	1643	1920	1794	19.45	34.18	1.69	0.28
64.74	-133.33	1732.32	1646	1805	1735	31.79	44.37	2.26	0.17	61.54	-140.00	1154.07	1055	1231	1162	16.36	30.68	6.06	0.21
64.75	-133.32	1662.82	1558	1714	1675	29.35	42.77	8.46	0.10	61.51	-139.63	1542.18	1424	1685	1540	19.56	35.68	4.68	0.44
64.74	-133.32	1858.80	1769	1951	1852	27.99	39.52	2.16	0.13	61.50	-139.57	1537.19	1357	1699	1540	17.45	36.83	4.53	0.50
64.71	-133.35	1702.49	1620	1789	1705	22.69	34.51	5.52	0.18	61.99	-140.77	1607.75	1478	1795	1584	23.91	41.29	7.80	0.31
64.62	-133.44	1573.69	1239	2009	1568	36.24	54.17	15.91	0.35	61.87	-140.99	1376.73	1319	1458	1376	16.29	31.02	7.39	0.11
64.43	-133.37	1599.82	1477	1679	1601	26.21	35.68	2.16	0.20	61.99	-140.81	1619.21	1447	1831	1596	18.99	43.41	0.75	1.05

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.45	-133.46	1537.43	1393	1707	1530	33.93	41.99	18.23	0.13	61.68	-139.43	1070.94	894	1322	1067	27.10	51.43	13.66	0.21
64.43	-133.44	1654.15	1415	1902	1661	33.19	50.47	18.00	0.23	61.58	-138.77	1832.70	1675	2038	1832	26.63	38.85	11.98	0.19
64.43	-133.48	1468.99	1349	1595	1465	35.63	39.49	31.24	0.08	61.53	-138.75	1524.03	1465	1588	1519	36.41	39.10	33.12	0.03
64.43	-133.48	1526.32	1410	1637	1524	24.31	37.78	10.91	0.17	61.49	-139.50	1627.23	1451	1839	1617	26.95	42.53	14.28	0.28
64.42	-133.49	1813.67	1609	2095	1802	38.46	55.91	0.68	0.43	61.27	-138.96	1509.87	1357	1640	1509	26.69	35.36	17.39	0.21
64.41	-133.51	1722.54	1633	1798	1721	34.80	51.80	4.11	0.11	61.27	-139.49	2025.65	1813	2297	2036	20.95	49.03	4.52	0.69
64.42	-133.40	1528.12	1268	1752	1550	28.98	40.28	21.04	0.25	61.26	-139.45	2341.29	2167	2520	2331	19.84	41.59	1.69	0.51
64.42	-133.52	1729.04	1671	1792	1725	32.12	38.11	26.06	0.05	62.44	-133.44	1838.87	1666	1973	1843	30.48	38.77	15.04	0.13
64.38	-133.36	1504.41	1369	1620	1498	28.39	37.72	1.69	0.19	62.44	-133.47	1546.63	1469	1648	1545	15.52	21.50	7.54	0.14
64.14	-133.53	1600.77	1394	1741	1624	27.37	45.37	5.73	0.28	62.44	-133.50	1595.77	1497	1721	1597	22.91	38.16	9.33	0.11
64.06	-133.38	1322.78	1129	1493	1315	29.90	41.41	2.26	0.42	62.44	-133.49	1603.44	1518	1710	1603	19.21	37.15	8.22	0.22
64.06	-133.39	1399.46	1329	1479	1397	29.73	39.64	2.78	0.09	62.44	-133.51	1673.96	1588	1776	1663	23.71	34.93	3.18	0.10
64.05	-133.40	1422.37	1240	1656	1421	30.73	42.59	11.01	0.22	62.44	-133.52	1673.98	1540	1775	1678	28.30	38.93	3.71	0.11
64.05	-133.41	1322.57	1199	1469	1317	33.47	42.87	13.52	0.14	62.02	-133.56	1899.85	1834	1990	1894	39.43	43.66	34.97	0.04
64.08	-133.16	1752.96	1625	1856	1748	36.12	50.61	13.68	0.16	62.02	-133.73	1628.85	1546	1763	1630	22.69	39.44	1.39	0.15
64.08	-133.17	1662.74	1452	1861	1678	29.33	53.59	1.07	0.76	62.03	-133.55	1642.34	1580	1700	1645	13.22	27.95	5.75	0.17
64.09	-133.19	1464.01	1366	1625	1452	32.76	45.92	10.87	0.13	62.02	-133.55	1703.76	1662	1754	1701	13.93	24.90	7.36	0.06
64.09	-133.24	1745.56	1612	1854	1748	29.20	43.07	8.46	0.18	62.02	-133.56	1748.64	1665	1845	1745	20.53	33.61	7.65	0.09
64.09	-133.21	1701.01	1487	1865	1698	32.88	51.71	1.69	0.30	62.50	-132.30	1478.11	1433	1523	1480	13.63	26.13	3.44	0.11
64.10	-133.20	1543.28	1449	1632	1537	32.30	46.04	11.65	0.10	62.49	-132.33	1484.86	1399	1571	1488	24.01	32.93	11.20	0.10
64.11	-133.22	1673.50	1432	1811	1682	36.75	50.95	10.36	0.21	62.96	-132.43	1657.35	1593	1749	1654	30.08	43.89	15.20	0.09
64.11	-133.12	1598.62	1434	1741	1616	29.49	46.23	4.90	0.27	61.97	-133.94	1642.55	1593	1744	1634	23.54	43.01	5.81	0.07
64.16	-133.30	1661.80	1468	1791	1689	26.79	42.29	5.05	0.35	61.61	-133.44	1658.23	1593	1731	1659	30.63	41.94	12.47	0.06
64.28	-133.17	1576.27	1410	1697	1597	26.32	40.15	9.14	0.24	62.97	-132.41	1614.83	1483	1787	1616	25.27	48.10	5.32	0.34
64.34	-133.11	1659.66	1488	1824	1679	33.16	53.04	2.88	0.45	62.97	-132.47	1624.85	1521	1745	1616	28.72	39.42	11.04	0.10
64.42	-133.28	1466.09	1308	1611	1464	27.29	37.18	18.45	0.28	62.97	-132.40	1628.89	1468	1809	1629	32.49	46.99	6.47	0.16
64.62	-133.22	1894.82	1767	2051	1896	35.49	52.45	6.18	0.23	62.95	-132.12	1539.60	1441	1711	1535	22.12	44.85	4.52	0.23
64.67	-133.25	1821.18	1692	1898	1833	31.26	43.31	3.05	0.16	62.91	-132.30	1341.73	1284	1388	1345	6.93	16.08	1.91	0.28
64.70	-133.18	1626.87	1513	1759	1620	29.15	38.33	17.15	0.16	62.90	-132.31	1513.99	1391	1704	1518	19.77	42.25	3.11	0.33
64.70	-133.16	1532.87	1346	1799	1506	25.11	39.36	5.01	0.27	62.78	-132.44	1249.81	1182	1420	1225	21.05	41.13	2.70	0.15
64.69	-133.16	1611.38	1462	1828	1586	26.46	39.42	10.74	0.17	62.78	-132.44	1270.52	1181	1392	1259	29.64	41.67	12.02	0.07
64.69	-133.15	1766.18	1675	1837	1769	29.22	36.77	2.16	0.07	62.77	-132.70	1467.36	1405	1597	1444	24.40	43.17	6.89	0.06
64.70	-133.08	1795.19	1696	1915	1791	28.42	36.58	14.32	0.19	62.76	-132.74	1490.87	1459	1559	1486	10.81	28.93	3.81	0.18
64.71	-133.10	1871.24	1767	1947	1881	28.68	37.25	14.25	0.06	62.76	-132.69	1593.36	1487	1678	1597	16.72	31.35	6.06	0.23

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.71	-133.09	2030.46	1933	2105	2036	30.77	40.42	7.37	0.10	62.54	-132.34	1676.79	1603	1793	1662	30.59	45.35	15.51	0.05
64.73	-133.28	1699.79	1494	1951	1688	25.62	46.95	8.54	0.71	62.52	-132.34	1543.44	1492	1632	1537	22.27	30.29	4.11	0.06
64.74	-133.14	1891.01	1824	1947	1894	29.66	40.42	4.53	0.08	62.52	-132.35	1684.67	1616	1768	1680	21.97	29.88	10.18	0.08
64.74	-133.15	1790.46	1581	1993	1791	31.09	44.89	12.35	0.42	62.00	-133.70	1770.42	1728	1828	1766	29.03	41.41	10.43	0.04
64.76	-133.10	1655.01	1568	1767	1648	28.67	35.77	15.33	0.11	62.00	-133.71	1796.16	1743	1874	1795	35.27	43.33	23.13	0.04
64.77	-133.10	1887.34	1750	2009	1891	33.17	44.65	10.89	0.11	62.00	-133.71	1790.69	1746	1861	1784	22.59	41.93	8.29	0.09
64.78	-133.16	1692.41	1563	1829	1702	22.43	35.72	4.97	0.18	61.98	-133.49	1824.39	1728	1929	1827	23.73	38.34	13.07	0.14
64.82	-133.20	1895.13	1741	2006	1900	27.63	39.59	5.43	0.25	61.98	-133.52	1649.86	1482	1894	1650	17.26	37.20	0.75	0.47
64.82	-133.23	1987.42	1838	2078	2000	34.51	52.60	3.58	0.23	61.98	-133.96	1740.85	1668	1850	1731	27.80	41.29	2.43	0.07
64.83	-133.23	1848.66	1625	2115	1831	33.25	58.83	4.73	0.68	61.96	-133.52	1706.15	1665	1771	1704	18.22	34.92	3.18	0.14
64.85	-133.23	1683.10	1508	1834	1681	32.11	48.79	2.64	0.38	61.95	-133.58	1760.34	1700	1810	1761	19.94	34.76	6.06	0.10
64.86	-133.24	1701.15	1484	1932	1705	33.78	50.35	0.00	0.42	61.95	-133.51	1892.75	1835	1979	1894	23.74	38.11	12.69	0.07
64.92	-133.17	1933.48	1777	2085	1926	35.55	45.43	1.69	0.14	61.95	-133.57	1768.51	1668	1925	1765	25.45	46.95	3.05	0.18
64.92	-133.15	1922.58	1692	2141	1921	34.12	46.53	9.30	0.25	61.95	-133.49	1824.78	1739	1947	1820	27.64	44.23	12.21	0.11
64.90	-133.17	1894.70	1795	1955	1897	28.03	41.52	4.06	0.15	61.95	-133.64	1785.06	1646	2015	1761	25.35	43.28	1.82	0.52
64.91	-133.21	1703.99	1433	1972	1720	41.13	53.83	15.16	0.28	61.94	-133.70	1780.36	1655	1937	1781	38.63	49.89	20.78	0.11
64.91	-133.21	1502.01	1362	1674	1491	23.40	41.98	2.16	0.33	61.94	-133.35	1707.57	1641	1777	1710	17.57	27.54	8.06	0.12
64.89	-133.09	1496.94	1431	1578	1494	26.89	37.72	6.34	0.14	61.94	-133.57	1741.50	1679	1910	1716	20.99	49.03	2.05	0.17
64.94	-133.26	1823.48	1607	1984	1849	35.15	55.40	3.34	0.60	61.94	-133.45	1659.39	1528	1777	1667	20.44	46.16	3.37	0.22
64.94	-133.23	1538.89	1483	1641	1539	15.11	34.34	4.26	0.23	61.94	-133.54	1710.68	1644	1756	1717	27.95	43.34	9.02	0.04
64.95	-133.24	1777.79	1607	2034	1754	32.18	46.93	5.13	0.32	61.94	-133.94	1634.94	1559	1787	1626	21.45	41.49	5.73	0.14
64.94	-133.14	1634.21	1419	1863	1621	32.41	46.45	11.33	0.20	61.94	-133.57	1721.94	1659	1846	1705	26.81	48.89	3.93	0.05
64.95	-133.16	1784.12	1594	1923	1818	27.99	47.03	1.82	0.19	61.94	-133.52	1876.23	1787	2033	1873	31.11	43.94	5.32	0.10
64.96	-133.11	1344.67	1036	1763	1309	30.77	44.45	3.18	0.65	61.93	-133.38	1751.81	1666	1870	1753	23.06	38.93	5.43	0.13
64.97	-133.21	1506.75	1386	1618	1505	23.51	37.22	9.75	0.15	61.93	-133.59	1617.64	1520	1854	1598	27.40	50.08	2.64	0.23
64.97	-133.16	1819.74	1615	1981	1826	34.51	47.33	1.07	0.22	61.93	-133.41	1736.86	1601	1849	1737	20.19	40.54	4.38	0.38
64.97	-133.13	1813.86	1742	1884	1812	30.51	40.60	8.69	0.07	61.93	-133.63	1841.79	1712	1982	1840	32.53	47.03	12.26	0.11
64.97	-133.11	1726.08	1653	1800	1721	30.18	38.46	11.31	0.06	61.93	-133.47	1716.41	1667	1768	1716	11.70	25.56	5.76	0.14
64.98	-133.10	1526.40	1407	1619	1528	33.65	40.92	7.73	0.07	61.93	-133.58	1744.76	1610	1923	1749	24.31	44.81	8.87	0.20
64.97	-132.96	1557.67	1502	1623	1553	17.02	32.67	5.88	0.13	61.93	-133.58	1818.25	1666	1942	1822	34.05	42.64	18.91	0.08
64.98	-132.93	1393.55	1373	1430	1393	7.78	21.09	1.91	0.14	61.93	-133.60	1840.51	1741	1967	1828	27.97	47.13	10.74	0.13
64.97	-132.89	1528.57	1421	1625	1528	34.37	40.96	26.61	0.15	61.93	-133.48	1829.98	1744	1937	1820	26.95	46.17	6.49	0.12
64.92	-133.06	1668.22	1531	1777	1666	33.84	45.35	3.11	0.19	61.93	-133.57	1775.95	1696	1942	1759	28.96	42.01	10.10	0.08
64.94	-132.89	1912.48	1788	2015	1925	33.12	40.36	8.38	0.10	61.93	-133.57	1790.14	1724	1851	1789	19.08	36.44	6.76	0.10
64.92	-132.88	1228.96	1073	1424	1223	31.12	40.92	19.17	0.14	61.92	-133.53	1835.41	1782	1929	1833	17.49	39.77	4.32	0.11
64.92	-132.86	1333.71	1134	1498	1336	35.38	42.45	18.70	0.09	61.92	-133.47	1856.58	1802	1925	1854	18.46	42.25	5.95	0.08

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.91	-132.85	1303.03	1075	1518	1307	33.66	40.00	22.11	0.15	61.90	-133.37	1554.18	1546	1577	1552	9.80	27.68	0.95	0.07
64.89	-133.06	1308.22	1271	1362	1307	20.29	36.77	4.52	0.09	61.54	-133.22	1641.71	1518	1754	1657	28.86	46.89	11.80	0.07
64.88	-133.07	1831.19	1691	1924	1841	32.41	48.04	4.53	0.10	61.85	-133.51	1610.80	1537	1683	1614	16.69	35.34	5.06	0.18
64.89	-133.05	1612.29	1462	1798	1614	31.31	48.68	13.96	0.28	61.74	-133.33	1738.62	1644	1905	1733	27.57	49.55	10.89	0.10
64.87	-133.06	1913.90	1805	2011	1912	32.41	47.07	1.43	0.18	61.65	-133.20	1525.77	1475	1594	1526	25.08	48.85	9.42	0.06
64.84	-133.07	1842.25	1691	1956	1848	28.61	45.67	1.07	0.34	61.90	-133.47	1694.22	1613	1779	1698	18.63	49.50	4.07	0.22
64.84	-133.04	1734.57	1599	1866	1735	29.10	39.66	11.20	0.19	61.90	-133.57	1851.24	1764	1975	1839	38.26	46.06	16.53	0.05
64.84	-133.04	1567.47	1468	1675	1562	28.14	44.89	0.68	0.27	61.83	-133.35	1846.41	1767	1955	1846	37.87	44.76	27.90	0.04
64.85	-133.05	1533.28	1433	1676	1523	26.90	41.90	6.80	0.19	61.83	-133.35	1761.00	1714	1845	1752	24.97	39.83	10.22	0.04
64.83	-133.00	1904.25	1730	2081	1889	31.13	50.54	2.16	0.25	61.82	-133.35	1923.89	1892	1956	1925	15.12	28.76	9.74	0.03
64.90	-132.84	1173.31	923	1495	1148	29.28	42.70	13.15	0.28	61.81	-133.34	1794.99	1748	1883	1793	22.79	40.09	10.61	0.08
64.89	-132.82	1140.07	810	1587	1104	26.44	38.58	11.82	0.40	61.81	-133.35	1745.04	1669	1875	1736	27.40	43.32	10.01	0.08
64.79	-132.89	1633.46	1435	2380	1562	38.62	68.84	8.11	0.42	61.80	-133.65	1662.13	1575	1741	1670	25.54	40.45	11.65	0.08
64.78	-133.06	2068.41	1915	2223	2066	39.68	56.99	10.43	0.12	61.78	-133.37	1594.61	1538	1657	1592	14.89	29.42	4.76	0.11
64.79	-133.07	2008.52	1828	2192	1996	37.17	51.35	16.18	0.14	61.77	-133.37	1732.58	1682	1781	1734	13.88	29.54	3.77	0.07
64.78	-133.08	1998.36	1928	2070	2006	31.04	42.36	6.89	0.08	61.77	-133.38	1787.83	1707	1950	1772	28.16	48.56	9.46	0.12
64.77	-133.06	2022.10	1796	2163	2030	37.72	51.96	5.57	0.32	61.77	-133.39	1709.61	1643	1789	1710	27.29	40.58	14.62	0.09
64.75	-133.04	1903.15	1756	2037	1904	30.59	50.61	11.08	0.09	61.76	-133.35	1710.58	1630	1785	1709	23.27	34.79	13.68	0.09
64.73	-132.89	1917.67	1675	2137	1887	41.65	60.71	3.39	0.12	61.76	-133.33	1637.09	1556	1740	1633	21.64	38.34	8.08	0.11
64.74	-132.88	1629.08	1457	1799	1632	39.57	56.84	11.50	0.35	61.76	-133.58	1733.79	1707	1782	1731	19.34	35.60	5.55	0.07
64.72	-132.91	1755.97	1603	1920	1746	29.05	36.70	3.95	0.12	61.76	-133.56	1770.46	1688	1912	1757	26.82	42.72	5.75	0.11
64.72	-132.87	1774.99	1694	1960	1753	26.35	50.50	6.80	0.13	61.76	-133.57	1720.07	1683	1822	1712	18.48	39.41	5.05	0.08
64.71	-132.90	1719.49	1589	1906	1708	20.64	31.31	8.74	0.30	61.73	-133.60	1662.01	1554	1842	1654	21.19	44.43	6.89	0.27
64.58	-133.11	1713.31	1662	1782	1709	21.31	33.59	7.85	0.13	61.73	-133.47	1649.17	1556	1789	1649	27.60	56.67	9.33	0.13
64.58	-133.08	1710.18	1633	1809	1706	23.71	39.10	8.06	0.11	61.72	-133.32	1775.07	1700	1894	1767	19.55	44.59	5.32	0.14
64.59	-133.05	1694.33	1595	1827	1688	30.18	44.42	8.72	0.24	61.72	-133.13	1533.25	1468	1590	1534	19.26	25.14	8.84	0.07
64.58	-133.02	1836.45	1708	1922	1834	34.01	45.75	0.95	0.12	61.72	-133.16	1680.14	1622	1761	1673	19.16	48.28	5.95	0.12
64.59	-133.01	1773.55	1635	1884	1784	33.66	42.19	20.91	0.16	61.71	-133.19	1672.17	1607	1777	1666	22.38	43.23	3.44	0.10
64.57	-133.00	1897.99	1773	2037	1898	32.46	46.87	10.03	0.15	61.71	-133.17	1711.20	1680	1757	1710	20.51	38.31	12.05	0.04
64.56	-132.99	1781.70	1649	1908	1772	18.52	38.32	3.93	0.31	61.71	-133.56	1753.50	1607	1990	1744	34.28	53.55	17.14	0.20
64.56	-132.98	1863.53	1706	1928	1890	25.50	41.58	0.75	0.17	61.71	-133.20	1677.02	1625	1758	1666	18.17	36.41	5.81	0.08
64.56	-132.98	1803.28	1762	1843	1802	31.00	34.54	24.75	0.02	61.71	-133.28	1735.94	1655	1802	1740	22.37	33.84	14.20	0.08
64.54	-132.95	1858.03	1708	1993	1870	24.24	38.36	1.35	0.26	61.70	-133.26	1560.96	1459	1657	1563	17.12	36.04	2.72	0.17
64.53	-133.08	1698.48	1576	1802	1704	30.93	40.39	8.46	0.14	61.70	-133.27	1657.26	1621	1761	1651	17.99	48.33	4.06	0.06
64.53	-133.05	1739.46	1555	1874	1770	24.24	47.19	0.75	0.24	61.70	-133.25	1650.81	1604	1701	1649	21.36	45.53	7.54	0.10
64.53	-133.03	1710.58	1565	1885	1706	28.65	45.01	4.39	0.23	61.70	-133.93	1700.44	1563	1847	1695	37.15	48.19	20.86	0.09

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.53	-133.01	1501.99	1437	1628	1494	17.70	39.24	5.01	0.25	61.69	-133.13	1609.82	1486	1687	1630	25.96	42.86	6.06	0.06
64.52	-133.01	1782.97	1632	1890	1794	31.13	39.06	1.51	0.13	61.69	-133.24	1612.80	1571	1657	1615	11.78	22.87	4.38	0.15
64.49	-132.99	1606.44	1413	1870	1567	28.79	45.24	4.17	0.45	61.68	-133.22	1535.61	1444	1674	1527	22.87	51.96	5.99	0.43
64.48	-132.97	1666.87	1540	1820	1660	25.80	43.59	0.48	0.39	61.67	-133.16	1794.70	1686	1888	1790	32.22	52.42	2.39	0.05
64.48	-132.94	1671.86	1526	1827	1666	26.16	50.23	0.68	0.55	61.67	-133.23	1788.46	1739	1862	1779	23.20	38.25	8.41	0.06
64.47	-133.08	1644.17	1466	1956	1632	29.01	46.08	1.72	0.44	61.65	-133.21	1603.47	1541	1650	1607	20.24	30.57	8.08	0.04
64.48	-132.99	1766.37	1665	1836	1775	29.20	40.12	4.10	0.12	61.63	-133.36	1642.88	1583	1698	1651	20.70	34.84	13.04	0.04
64.35	-133.07	1674.11	1579	1740	1675	25.86	36.74	2.64	0.13	61.51	-133.13	1601.92	1489	1752	1610	24.61	44.54	8.81	0.20
64.35	-133.06	1668.86	1561	1799	1663	30.76	43.48	3.72	0.24	61.50	-133.11	1714.86	1505	1928	1723	30.73	52.33	1.07	0.62
64.36	-133.02	1601.33	1523	1677	1602	30.09	35.50	25.75	0.08	61.59	-133.34	1547.09	1519	1583	1547	10.24	21.01	3.32	0.12
64.35	-133.02	1601.34	1504	1666	1605	24.78	40.98	14.06	0.13	61.59	-133.34	1676.29	1594	1776	1670	34.62	46.78	25.85	0.05
64.35	-133.02	1769.93	1674	1860	1772	29.86	42.55	5.43	0.18	61.97	-132.74	909.18	883	939	910	11.64	22.95	7.43	0.08
64.14	-133.05	1174.97	1051	1255	1191	25.10	39.65	0.95	0.19	61.97	-132.74	905.23	876	941	908	11.24	23.85	2.39	0.08
64.10	-132.92	1448.68	1311	1557	1452	28.31	37.93	9.65	0.12	61.95	-132.70	900.10	883	924	900	8.46	19.03	0.00	0.06
64.09	-132.84	1590.17	1463	1845	1574	24.59	41.46	11.02	0.31	61.61	-132.36	1790.52	1678	1923	1790	23.74	38.75	9.32	0.15
64.08	-132.80	1741.58	1577	1858	1755	31.76	45.02	3.58	0.28	61.61	-132.34	1777.87	1659	1893	1780	28.25	46.27	17.14	0.25
64.10	-132.81	1675.39	1532	1766	1694	26.25	41.02	2.57	0.29	61.61	-132.36	1844.27	1769	1953	1831	26.62	41.69	7.37	0.06
64.08	-132.85	1782.67	1662	1865	1789	35.30	41.52	25.28	0.06	61.61	-132.38	1733.58	1628	1841	1735	21.99	40.36	7.13	0.15
64.08	-132.84	1712.28	1620	1797	1712	31.73	47.67	6.63	0.11	61.50	-132.82	1659.33	1510	1793	1664	24.12	40.04	9.90	0.38
64.27	-132.77	1447.84	1359	1552	1443	25.16	32.56	13.20	0.14	61.50	-132.81	1744.89	1648	1857	1747	26.33	40.86	11.67	0.09
64.28	-132.72	1694.87	1555	1880	1676	30.14	48.91	1.39	0.28	61.80	-132.97	1584.88	1484	1733	1570	25.99	43.06	4.82	0.19
64.30	-132.71	1617.15	1464	1831	1613	32.75	51.42	4.07	0.25	61.72	-132.77	1717.38	1621	1806	1717	28.69	33.74	22.42	0.08
64.44	-132.75	1503.36	1307	1650	1522	22.14	36.76	2.72	0.40	61.72	-132.80	1651.26	1596	1724	1648	23.34	37.72	14.76	0.06
64.43	-132.70	1663.09	1495	1865	1649	31.02	39.26	6.02	0.20	61.71	-132.68	1667.50	1547	1796	1661	30.78	47.34	18.70	0.20
64.49	-132.71	1306.17	1178	1480	1282	19.11	32.75	4.07	0.41	61.72	-132.78	1752.67	1695	1840	1746	18.59	34.73	7.13	0.08
64.50	-132.79	1655.73	1485	1828	1670	30.41	47.03	1.07	0.39	61.72	-132.92	1601.53	1512	1714	1600	19.41	35.09	8.22	0.24
64.52	-132.85	1752.13	1592	1893	1761	28.38	41.49	5.01	0.33	61.71	-132.68	1742.62	1637	1857	1733	24.04	39.98	6.80	0.31
64.53	-132.83	1542.77	1421	1694	1538	28.13	42.95	8.58	0.28	61.71	-132.79	1806.67	1738	1903	1801	22.76	37.04	12.77	0.07
64.53	-132.82	1726.81	1513	1923	1760	31.64	43.78	3.05	0.19	61.71	-132.78	1777.44	1702	1889	1768	26.22	36.86	7.23	0.13
64.52	-132.79	1538.80	1489	1645	1524	24.12	46.09	5.06	0.11	61.71	-132.89	1575.12	1519	1627	1576	14.77	20.66	5.72	0.10
64.52	-132.78	1655.02	1553	1712	1669	27.62	38.06	0.34	0.11	61.70	-132.59	1412.35	1230	1745	1387	24.27	43.91	1.07	0.50
64.64	-132.83	1591.27	1478	1693	1594	30.35	49.70	3.72	0.21	61.70	-132.68	1880.99	1803	1950	1883	20.49	34.36	10.74	0.13
64.70	-132.78	1671.05	1568	1824	1672	26.37	53.04	6.34	0.32	61.69	-132.55	1381.28	1307	1508	1369	19.99	35.55	2.64	0.22
64.75	-132.75	1351.60	1229	1734	1308	29.44	65.19	0.34	0.30	61.69	-132.69	1802.33	1630	2018	1777	28.38	38.69	14.41	0.20
64.79	-132.81	1859.83	1717	1949	1870	28.34	50.73	2.02	0.18	61.68	-132.55	1451.89	1384	1531	1451	19.00	29.24	5.23	0.09
64.80	-132.85	1483.08	1342	1707	1471	40.37	57.28	10.48	0.23	61.68	-132.65	1843.53	1789	1897	1847	12.18	29.31	2.36	0.22

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.81	-132.87	1382.11	1241	1564	1379	39.75	48.53	31.77	0.22	61.68	-132.53	1683.93	1627	1755	1683	26.24	38.54	9.65	0.14
64.81	-132.81	1489.38	1351	1663	1480	24.02	38.68	12.35	0.22	61.68	-132.63	1605.43	1454	1781	1601	24.60	52.48	7.36	0.57
64.90	-132.78	1731.45	1600	1878	1723	38.38	49.37	27.68	0.09	61.68	-132.67	1805.79	1655	1958	1803	28.08	36.99	11.55	0.31
64.90	-132.78	1651.45	1597	1709	1653	22.94	44.71	8.38	0.10	61.67	-132.58	1591.55	1553	1639	1590	18.99	29.44	9.01	0.04
64.90	-132.79	1902.36	1783	2029	1902	35.25	48.43	16.31	0.22	61.67	-132.67	1888.17	1766	2025	1889	29.69	40.25	11.85	0.14
64.90	-132.76	1624.90	1535	1777	1617	28.46	47.78	0.48	0.31	61.68	-132.92	1830.48	1714	1917	1835	30.79	39.92	8.90	0.08
64.90	-132.75	1806.54	1661	1892	1815	28.00	39.78	3.63	0.09	61.67	-132.66	1891.17	1800	2000	1884	24.37	38.33	9.39	0.16
64.91	-132.74	1562.76	1442	1732	1556	35.00	47.67	24.21	0.14	61.67	-132.65	1866.82	1789	1997	1848	22.97	38.08	5.14	0.11
64.91	-132.81	2010.53	1907	2106	2005	31.52	43.29	3.93	0.13	61.67	-132.65	1891.64	1796	2005	1887	28.77	38.95	13.93	0.12
64.92	-132.78	1878.23	1708	1980	1879	31.58	51.15	0.48	0.33	61.67	-132.69	1764.17	1670	1840	1771	21.42	38.04	6.80	0.25
64.91	-132.66	1757.09	1644	1879	1754	33.25	45.50	20.98	0.15	61.66	-132.70	1831.17	1790	1878	1832	15.31	28.58	4.06	0.13
64.91	-132.67	1833.36	1706	2001	1814	34.57	51.35	16.67	0.13	61.66	-132.67	1900.26	1840	2005	1892	24.18	46.42	4.86	0.21
64.92	-132.70	1663.47	1500	1768	1670	32.24	38.08	25.65	0.08	61.65	-132.39	1766.73	1671	1845	1772	28.73	37.67	19.36	0.07
64.93	-132.77	1760.81	1594	1833	1778	28.44	47.82	2.05	0.20	61.65	-132.64	1637.84	1515	1851	1615	27.62	45.98	7.85	0.12
64.94	-132.76	1621.53	1512	1793	1599	27.67	40.07	8.00	0.19	61.65	-132.42	1755.23	1649	1856	1765	21.59	41.92	10.72	0.14
64.93	-132.79	1783.68	1559	2006	1794	40.89	53.73	25.63	0.43	61.64	-132.60	1609.31	1509	1712	1614	25.15	38.25	12.63	0.16
64.94	-132.84	1708.38	1521	2004	1675	26.41	50.22	6.05	0.21	61.64	-132.48	1674.11	1540	1824	1676	22.64	44.25	9.65	0.24
64.94	-132.86	1567.61	1507	1624	1572	17.51	40.54	4.82	0.11	61.64	-132.58	1611.92	1554	1695	1606	23.62	34.42	7.19	0.11
64.95	-132.78	1476.90	1361	1622	1473	28.96	43.18	4.76	0.23	61.63	-132.53	1375.19	1273	1526	1364	24.44	32.43	15.50	0.13
64.96	-132.77	1302.14	1237	1392	1297	21.39	35.39	5.01	0.18	61.62	-132.37	1730.57	1632	1846	1717	33.55	44.54	18.87	0.04
64.96	-132.84	1430.84	1289	1627	1421	35.07	44.49	23.84	0.26	61.58	-132.09	1507.56	1397	1658	1500	17.21	29.32	5.73	0.19
64.98	-132.82	910.06	877	948	909	10.09	24.54	0.34	0.34	61.58	-132.09	1548.63	1424	1699	1545	21.28	35.53	7.85	0.24
64.98	-132.76	925.86	910	943	926	3.74	20.00	0.00	0.33	61.58	-132.10	1572.49	1497	1647	1573	19.45	26.97	8.41	0.13
64.94	-132.58	1798.69	1674	1937	1799	26.10	35.50	3.05	0.15	61.56	-132.08	1719.95	1611	1856	1705	35.57	47.04	20.38	0.10
64.94	-132.57	1631.62	1493	1756	1631	35.87	49.64	15.48	0.14	61.57	-132.83	1736.98	1587	1858	1746	26.76	33.72	14.31	0.12
64.92	-132.50	1785.19	1612	1966	1788	28.46	41.38	9.19	0.20	61.56	-132.21	1405.49	1184	1828	1357	21.31	48.39	0.00	0.63
64.94	-132.54	1569.32	1394	1759	1568	35.04	47.59	17.25	0.26	61.56	-132.20	1377.32	1185	1509	1394	23.93	34.95	11.80	0.13
64.94	-132.53	1393.98	1375	1437	1392	13.24	37.54	2.46	0.08	61.56	-132.27	1615.03	1503	1772	1599	19.73	40.12	3.11	0.56
64.91	-132.64	1592.08	1436	1764	1583	29.99	40.29	18.57	0.21	61.56	-132.29	1619.95	1518	1778	1599	22.66	40.63	3.37	0.40
64.91	-132.65	1595.34	1509	1660	1599	16.73	38.51	3.52	0.17	61.55	-132.30	1727.57	1545	1900	1743	23.43	49.19	3.37	0.49
64.90	-132.64	1787.11	1639	1977	1783	36.58	50.12	28.53	0.15	61.55	-132.31	1758.13	1707	1807	1759	14.69	23.83	7.09	0.08
64.91	-132.48	1887.99	1782	1932	1903	17.57	33.67	2.13	0.12	61.55	-132.33	1678.65	1588	1801	1671	19.84	38.43	6.93	0.20
64.90	-132.53	1400.94	1360	1493	1393	18.99	37.27	3.18	0.18	61.54	-132.87	1742.81	1675	1794	1746	23.48	36.43	10.70	0.12
64.89	-132.52	1699.81	1481	1826	1708	31.09	51.35	5.06	0.17	61.53	-132.29	1548.93	1482	1649	1541	26.28	42.82	1.97	0.16
64.89	-132.48	1913.79	1841	1959	1917	20.02	29.82	2.86	0.09	61.53	-132.27	1547.93	1419	1686	1549	34.64	48.75	14.07	0.17
64.88	-132.67	1770.21	1613	1971	1762	38.76	49.99	24.98	0.14	61.53	-132.34	1566.95	1461	1716	1564	22.37	42.77	2.57	0.19

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.87	-132.66	1991.27	1857	2135	1986	33.38	41.87	11.13	0.15
64.87	-132.64	1751.92	1668	1856	1741	16.74	35.47	0.68	0.30
64.86	-132.65	1908.93	1778	2040	1907	35.13	42.17	20.94	0.18
64.84	-132.65	1430.82	1306	1625	1419	25.89	46.63	5.48	0.34
64.83	-132.63	1859.37	1725	1981	1864	31.30	40.62	5.10	0.13
64.82	-132.62	1976.00	1940	2008	1977	14.01	23.28	5.01	0.01
64.82	-132.60	2003.64	1955	2061	2007	23.04	36.33	2.05	0.04
64.80	-132.60	1745.71	1481	1932	1779	33.84	42.18	22.23	0.23
64.80	-132.59	2022.19	1975	2047	2029	21.79	34.06	3.95	0.03
64.78	-132.63	943.84	871	1098	940	14.37	32.29	0.75	0.35
64.67	-132.66	1546.69	1493	1624	1536	14.71	38.92	0.75	0.17
64.67	-132.58	1774.43	1574	1985	1781	26.23	52.37	2.72	0.55
64.68	-132.55	1529.39	1427	1656	1523	31.51	36.74	24.81	0.11
64.63	-132.59	1499.88	1432	1615	1491	21.41	37.27	4.26	0.17
64.61	-132.66	1822.52	1737	1916	1822	22.74	40.23	0.95	0.15
64.60	-132.68	1859.42	1786	1976	1853	26.16	48.83	2.57	0.14
64.54	-132.67	1764.25	1672	1830	1772	31.27	44.15	5.44	0.13
64.52	-132.58	1609.72	1487	1682	1616	25.33	36.58	3.02	0.24
64.50	-132.56	1604.97	1436	1800	1587	25.52	49.50	3.65	0.30
64.50	-132.51	1705.48	1542	1920	1681	32.00	45.12	8.58	0.20
64.50	-132.65	1685.29	1582	1838	1676	29.75	43.76	18.81	0.21
64.48	-132.65	1621.70	1456	1847	1607	37.71	52.89	1.72	0.24
64.37	-132.53	1595.00	1433	1805	1584	28.94	43.86	8.10	0.24
64.31	-132.65	1489.70	1336	1670	1484	29.02	45.95	1.69	0.30
64.30	-132.65	1591.15	1435	1826	1587	36.50	53.74	19.20	0.19
64.25	-132.68	1660.44	1495	1801	1654	33.52	48.40	2.90	0.23
64.27	-132.53	1535.12	1357	1650	1544	30.03	44.34	1.35	0.17
64.26	-132.57	1631.14	1455	1829	1614	28.19	46.24	3.02	0.28
64.23	-132.55	1817.29	1711	1887	1823	27.04	37.24	3.81	0.16
64.23	-132.63	1518.97	1077	1949	1510	31.76	44.40	4.06	0.43
64.22	-132.65	1426.02	1090	1793	1433	28.43	49.89	1.72	0.39
64.22	-132.62	1603.22	1436	1890	1554	28.04	53.44	3.84	0.39
64.21	-132.59	1500.19	1377	1703	1486	26.28	41.29	5.89	0.42
64.21	-132.61	1546.99	1442	1660	1553	25.54	38.97	11.20	0.14
64.21	-132.64	1647.82	1398	1863	1676	29.45	48.51	0.95	0.55
64.12	-132.71	1505.86	1341	1588	1526	24.39	34.77	0.00	0.29

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
61.53	-132.97	1759.51	1680	1857	1758	23.16	35.76	13.07	0.17
61.52	-132.36	1601.03	1497	1702	1598	23.43	36.72	5.27	0.46
61.52	-132.34	1687.00	1585	1824	1672	32.13	45.39	14.23	0.09
61.52	-132.35	1611.17	1545	1700	1612	20.82	36.25	3.05	0.20
61.50	-133.14	1699.42	1610	1849	1682	25.68	40.74	9.37	0.13
61.49	-133.24	1597.16	1539	1687	1589	23.84	42.19	6.70	0.10
61.47	-133.74	1022.70	895	1172	1015	26.51	38.52	1.39	0.17
61.46	-133.34	1585.04	1539	1668	1573	13.57	31.16	2.64	0.15
61.43	-133.96	1734.17	1557	1886	1738	34.54	41.80	21.60	0.13
61.41	-133.88	1619.23	1542	1713	1611	21.08	32.25	11.62	0.12
61.41	-133.93	1692.14	1604	1802	1693	28.65	42.54	13.80	0.09
61.38	-133.93	1650.69	1580	1723	1644	22.78	35.85	4.82	0.08
61.38	-133.94	1663.22	1639	1741	1656	20.97	38.48	3.71	0.02
61.38	-133.93	1672.07	1634	1730	1667	15.28	32.81	4.52	0.09
61.06	-133.61	1676.58	1580	1790	1668	32.84	44.50	4.53	0.10
61.05	-133.46	1578.35	1499	1663	1582	21.18	38.13	6.20	0.22
61.38	-133.93	1677.53	1643	1709	1678	11.36	30.16	2.90	0.07
61.35	-133.17	1645.49	1534	1823	1650	23.84	51.98	7.45	0.13
61.33	-133.16	1715.64	1602	1842	1718	36.47	45.45	23.19	0.06
61.33	-133.15	1726.89	1653	1818	1722	31.65	41.10	21.03	0.02
61.12	-133.51	1580.95	1539	1644	1578	18.39	36.88	4.97	0.11
61.15	-133.61	1752.17	1679	1855	1745	27.27	35.71	13.96	0.08
61.15	-133.96	1628.25	1584	1681	1630	17.12	28.50	6.73	0.08
61.15	-133.95	1732.88	1691	1800	1730	17.60	31.75	10.46	0.07
61.49	-132.16	1685.37	1545	1837	1682	39.43	45.64	31.77	0.12
61.49	-132.79	1641.20	1504	1760	1654	22.60	38.62	3.81	0.23
61.49	-132.76	1665.45	1593	1730	1671	19.24	33.71	8.11	0.19
61.47	-132.25	1603.76	1444	1814	1604	26.92	40.31	9.01	0.29
61.48	-132.71	1639.49	1544	1740	1635	30.93	40.65	5.10	0.08
61.47	-132.72	1666.98	1577	1724	1671	29.22	37.33	2.26	0.04
61.46	-132.88	1501.56	1439	1600	1495	26.79	43.55	5.06	0.05
61.45	-132.26	1612.81	1459	1763	1612	23.63	39.71	7.01	0.51
61.45	-132.40	1511.59	1427	1609	1507	16.06	31.77	4.58	0.18
61.43	-132.19	1708.10	1612	1821	1705	23.84	35.00	12.57	0.11
61.43	-132.20	1676.49	1522	1831	1671	24.99	39.92	8.11	0.18
61.43	-132.24	1739.22	1661	1876	1735	22.20	37.71	12.52	0.14

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.00	-132.60	1465.82	1437	1525	1457	13.06	30.84	1.39	0.12	61.43	-132.25	1589.40	1513	1665	1594	15.15	39.61	3.58	0.30
64.00	-132.57	1572.75	1505	1717	1559	25.71	44.61	4.04	0.11	61.43	-132.24	1662.97	1616	1738	1659	12.31	23.15	4.06	0.14
64.00	-132.54	1791.17	1670	1861	1804	27.00	49.29	2.26	0.22	61.43	-132.39	1517.17	1458	1638	1516	20.05	39.66	3.58	0.08
64.01	-132.53	1753.18	1646	1825	1762	24.83	41.55	1.22	0.16	61.42	-132.35	1609.11	1511	1661	1619	17.53	30.08	2.72	0.13
64.00	-132.52	1660.15	1488	1799	1661	33.69	46.98	1.72	0.29	61.44	-133.00	1784.59	1721	1872	1781	25.95	36.38	14.76	0.06
64.00	-132.51	1584.37	1454	1708	1586	26.95	42.78	6.18	0.14	61.42	-132.22	1684.75	1606	1761	1689	16.19	32.93	5.99	0.18
64.13	-132.40	1694.52	1539	1777	1706	31.07	42.13	0.68	0.44	61.43	-132.96	1633.02	1506	1798	1629	29.49	36.63	13.59	0.12
64.11	-132.46	1728.17	1533	1888	1732	32.33	46.65	6.92	0.22	61.42	-132.33	1579.38	1496	1682	1568	19.81	42.42	6.32	0.12
64.12	-132.33	1580.39	1493	1671	1583	23.30	44.69	8.11	0.17	61.42	-132.40	1666.86	1531	1800	1672	28.73	38.97	13.38	0.19
64.20	-132.34	1746.18	1603	1914	1752	28.65	42.78	2.88	0.33	61.42	-132.16	1482.64	1360	1563	1495	14.84	33.04	5.15	0.23
64.18	-132.32	1763.74	1528	1975	1758	32.82	47.48	10.62	0.30	61.43	-132.92	1533.08	1441	1651	1526	31.87	39.61	13.34	0.07
64.19	-132.30	1678.53	1526	1940	1665	33.41	51.81	7.36	0.19	61.43	-132.96	1718.44	1681	1760	1722	16.21	36.23	5.13	0.07
64.19	-132.28	1696.59	1600	1789	1701	28.34	38.04	2.13	0.14	61.42	-132.87	1625.06	1562	1700	1624	21.27	34.37	9.93	0.06
64.20	-132.32	1607.15	1495	1713	1607	34.24	43.10	17.18	0.14	61.41	-132.36	1500.36	1391	1615	1498	18.50	39.13	4.52	0.20
64.20	-132.33	1683.31	1549	1900	1667	33.27	50.49	6.85	0.15	61.42	-132.99	1524.76	1438	1639	1516	30.54	40.36	3.20	0.22
64.19	-132.36	1791.48	1654	1889	1796	33.81	47.07	5.60	0.13	61.39	-132.94	1579.41	1539	1624	1574	27.01	33.20	12.30	0.02
64.20	-132.39	1641.63	1447	1873	1657	23.38	46.72	0.48	0.39	61.39	-132.94	1579.15	1497	1745	1564	16.66	43.97	3.32	0.23
64.20	-132.41	1530.26	1348	1828	1479	29.14	47.86	1.69	0.39	61.38	-132.77	1639.39	1594	1702	1634	17.57	33.80	5.14	0.09
64.20	-132.41	1693.35	1507	1819	1702	32.83	53.31	2.36	0.33	61.37	-132.85	1688.35	1657	1747	1683	19.72	36.00	4.38	0.06
64.19	-132.44	1661.27	1491	1916	1637	27.99	50.52	10.80	0.29	61.36	-132.71	1650.08	1524	1783	1650	28.08	39.41	9.63	0.10
64.21	-132.44	1400.00	1147	1801	1361	24.34	52.56	6.89	0.59	61.32	-132.42	1459.56	1373	1518	1465	20.84	26.84	13.69	0.08
64.24	-132.44	1724.93	1570	1886	1713	33.67	54.35	0.75	0.19	61.30	-132.26	1416.69	1303	1516	1418	27.15	36.94	15.18	0.23
64.27	-132.36	1476.02	1410	1606	1469	24.74	42.96	3.11	0.23	61.20	-132.29	1069.94	1064	1079	1070	4.10	7.39	2.39	0.06
64.27	-132.34	1713.27	1551	1998	1692	34.24	48.38	7.33	0.15	61.19	-132.39	1246.35	1175	1290	1253	12.44	21.19	7.54	0.14
64.29	-132.31	1748.96	1568	1925	1751	34.25	43.63	3.44	0.15	64.31	-136.61	1371.54	1317	1503	1363	16.37	42.14	4.79	0.32
64.28	-132.46	1524.83	1463	1711	1515	22.13	48.35	4.76	0.20	64.85	-135.17	1442.39	1278	1672	1437	27.48	43.05	0.00	1.03
64.46	-132.37	1561.60	1440	1827	1524	30.07	54.02	5.72	0.15	64.85	-134.25	1711.65	1618	1842	1695	37.13	49.72	28.05	0.06
64.55	-132.42	1879.96	1674	1998	1896	33.52	46.19	1.01	0.26	64.84	-135.14	1417.62	1287	1691	1378	21.01	44.71	0.75	0.81
64.57	-132.42	1753.72	1677	1881	1741	19.03	49.26	3.39	0.26	64.84	-134.10	1519.57	1445	1597	1524	22.33	41.65	9.09	0.15
64.57	-132.43	1998.52	1715	2280	2012	40.66	61.87	3.39	0.34	64.81	-136.11	1450.10	1372	1543	1448	26.89	34.46	14.85	0.12
64.70	-132.35	1591.44	1515	1680	1589	16.60	28.55	7.13	0.29	64.75	-136.02	1463.43	1389	1529	1470	13.17	26.07	0.75	0.15
64.68	-132.31	1669.67	1378	1993	1659	21.61	43.89	5.06	0.70	64.73	-136.08	1286.46	1209	1384	1283	21.04	32.82	8.59	0.18
64.67	-132.26	1553.46	1482	1689	1548	25.52	43.89	5.24	0.12	64.73	-136.05	1377.13	1294	1510	1383	15.36	55.05	1.39	0.41
64.69	-132.29	2022.10	1874	2104	2035	33.06	44.88	1.51	0.23	64.71	-136.16	924.08	882	1034	914	9.23	24.51	0.34	0.38
64.69	-132.28	1877.01	1826	1969	1876	21.12	40.33	1.22	0.20	64.66	-136.27	1515.18	1421	1710	1490	28.29	44.89	0.95	0.22
64.69	-132.30	1834.71	1723	2064	1817	24.93	39.99	1.97	0.30	64.66	-136.44	1429.32	1355	1568	1431	17.36	50.47	5.43	0.15

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	#VALUE!	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.71	-132.29	1845.83	1628	2082	1834	24.41	37.71	3.32	0.52	64.66	-136.50	1371.24	1308	1429	1372	16.73	37.36	4.58	0.18
64.72	-132.34	1640.99	1554	1748	1635	15.40	38.26	4.11	0.32	64.60	-136.48	1458.13	1362	1657	1439	22.63	41.34	4.76	0.29
64.76	-132.32	1618.51	1441	1815	1618	33.93	42.60	18.57	0.17	64.58	-136.23	1447.12	1378	1584	1436	24.87	49.42	0.48	0.22
64.79	-132.38	2043.79	1986	2089	2045	22.50	36.17	5.44	0.05	64.57	-136.00	1362.04	1337	1386	1362	6.87	16.73	2.13	0.13
64.71	-132.08	2064.70	2050	2080	2064	12.50	18.91	7.37	0.01	64.57	-136.01	1426.82	1394	1473	1427	11.32	22.71	2.02	0.14
64.71	-132.17	2014.82	1929	2067	2018	32.67	42.60	4.32	0.04	64.54	-136.10	1553.57	1478	1699	1548	23.41	43.39	8.71	0.16
64.71	-132.11	1946.60	1916	2030	1928	19.02	31.69	0.95	0.02	64.54	-136.12	1593.82	1530	1695	1587	27.17	47.51	1.39	0.18
64.71	-132.23	1563.63	1470	1707	1549	26.88	41.94	12.89	0.18	64.49	-137.70	1490.23	1451	1543	1492	15.75	22.87	1.51	0.17
64.72	-132.25	1655.92	1522	1767	1661	30.65	40.32	12.11	0.22	64.49	-137.69	1670.77	1556	1811	1665	30.42	41.46	20.92	0.13
64.70	-132.24	1734.43	1625	1823	1734	27.94	39.95	11.35	0.10	64.45	-137.69	1648.24	1521	1792	1646	14.87	37.25	0.75	0.43
64.70	-132.25	1842.84	1785	1863	1851	17.66	45.38	0.34	0.16	64.45	-137.64	1523.10	1454	1609	1527	16.33	35.29	1.01	0.25
64.70	-132.24	1797.96	1706	1880	1796	18.78	30.01	9.14	0.11	64.44	-137.57	1578.60	1460	1767	1559	24.03	46.40	1.69	0.30
64.69	-132.24	1898.91	1807	1960	1897	16.55	32.15	5.48	0.14	64.43	-137.79	1668.16	1531	1795	1667	21.25	40.30	1.01	0.48
64.70	-132.04	1998.87	1923	2074	2002	28.26	39.26	5.13	0.06	64.43	-137.71	1824.65	1588	1981	1839	34.72	51.85	5.44	0.43
64.70	-132.06	2052.25	2047	2060	2049	10.74	20.25	3.32	0.00	64.42	-137.87	1702.20	1557	1915	1678	26.75	49.57	1.72	0.75
64.70	-132.16	1899.17	1814	2061	1901	26.39	49.26	1.22	0.42	64.43	-137.50	1532.68	1397	1713	1529	19.26	46.22	0.75	0.87
64.69	-132.18	2059.80	1909	2274	2045	42.88	57.82	21.24	0.24	64.42	-137.57	1699.52	1554	1849	1701	22.69	39.31	7.95	0.21
64.68	-132.11	1966.14	1794	2200	1952	34.35	50.74	9.75	0.22	64.41	-137.90	1696.65	1550	1911	1685	31.25	48.87	6.20	0.40
64.67	-132.11	1825.45	1721	2024	1794	26.55	47.48	3.52	0.19	64.42	-137.10	1357.82	1225	1518	1358	14.53	29.51	6.28	0.76
64.65	-132.05	1760.64	1570	1961	1767	42.22	52.48	12.83	0.24	64.42	-137.51	1608.47	1407	1807	1601	24.01	37.69	9.58	0.43
64.65	-132.08	1325.00	1278	1440	1310	15.13	32.28	0.00	0.25	64.39	-137.75	1638.50	1469	1881	1627	33.01	48.11	8.84	0.74
64.65	-132.13	1761.29	1630	1881	1763	34.45	40.35	6.18	0.16	64.38	-137.59	1534.29	1426	1738	1507	27.48	46.42	0.75	0.28
64.63	-132.18	1801.82	1683	1961	1794	21.76	44.40	1.43	0.39	64.37	-137.70	1599.75	1454	1713	1604	33.90	42.03	26.86	0.24
64.63	-132.21	1705.73	1562	1914	1688	26.90	39.54	6.80	0.32	64.38	-137.62	1511.78	1418	1624	1502	30.31	47.22	14.23	0.21
64.62	-132.25	1721.93	1518	1971	1710	28.22	43.16	1.51	0.40	64.36	-137.20	1518.21	1436	1698	1497	23.00	40.90	1.22	0.19
64.61	-132.24	1785.49	1572	2014	1798	23.25	40.55	2.43	0.53	64.34	-136.45	1481.07	1377	1670	1458	15.48	33.83	5.71	0.47
64.60	-132.21	1861.06	1726	1970	1859	29.36	44.41	0.95	0.14	64.30	-137.06	1502.14	1431	1562	1505	13.54	32.01	5.48	0.21
64.59	-132.20	1871.38	1736	2032	1858	33.01	43.28	19.30	0.08	64.29	-136.38	1438.25	1366	1534	1425	15.90	27.95	5.99	0.17
64.58	-132.03	1680.21	1550	1956	1656	19.38	45.84	3.02	0.51	64.20	-137.36	1387.83	1262	1566	1374	22.90	34.36	12.34	0.21
64.60	-132.07	1555.14	1412	1701	1549	28.75	39.55	13.36	0.23	64.44	-136.54	1472.69	1373	1556	1474	22.87	35.13	8.29	0.19
64.61	-132.05	1476.06	1335	1664	1464	22.81	32.03	13.78	0.28	64.99	-134.04	729.19	605	991	705	23.98	51.22	3.37	0.30
64.62	-132.02	1754.98	1559	1966	1740	31.60	46.78	2.13	0.36	64.96	-134.25	1364.46	1244	1436	1374	20.65	43.15	3.11	0.33
64.56	-132.01	1777.09	1692	1909	1773	21.76	38.97	5.26	0.29	64.94	-135.45	1589.08	1448	1735	1583	36.30	55.21	23.91	0.26
64.48	-132.05	1553.48	1500	1623	1552	20.52	42.11	3.93	0.15	64.90	-134.03	1458.12	1381	1555	1459	26.33	42.31	8.41	0.24
64.51	-132.26	1769.58	1619	1935	1777	42.06	48.90	22.65	0.08	64.88	-134.23	1499.63	1370	1610	1507	25.29	50.31	4.04	0.28
64.50	-132.20	1647.14	1542	1863	1627	31.43	49.04	4.50	0.21	64.87	-134.15	1659.57	1488	1872	1655	38.77	55.82	6.09	0.20

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.51	-132.17	1611.96	1495	1767	1603	23.87	42.47	8.59	0.25	64.84	-135.05	1541.81	1475	1651	1534	21.22	38.27	2.46	0.32
64.49	-132.28	1652.21	1572	1787	1644	28.45	50.78	8.65	0.38	64.84	-135.10	1352.99	1278	1471	1343	28.51	40.83	15.81	0.09
64.46	-132.17	1216.06	1150	1341	1204	20.42	33.61	2.88	0.14	64.84	-135.09	1437.31	1369	1509	1440	33.47	38.90	26.12	0.07
64.36	-132.02	1191.46	1122	1350	1164	15.51	29.69	2.70	0.28	64.83	-135.08	1382.66	1325	1451	1381	29.97	36.83	21.52	0.07
64.35	-132.03	1667.99	1533	1818	1662	32.14	42.92	1.82	0.29	64.83	-134.07	1578.28	1452	1803	1564	22.95	41.89	5.32	0.32
64.35	-132.05	1764.30	1659	1840	1772	29.82	48.69	2.43	0.12	64.83	-134.17	1524.30	1416	1732	1509	32.88	55.12	7.09	0.28
64.35	-132.06	1617.84	1578	1677	1621	17.18	38.21	2.72	0.10	64.83	-134.15	1676.36	1550	1847	1658	30.69	55.31	6.39	0.14
64.35	-132.12	1416.88	1215	1643	1431	27.33	38.66	1.51	0.41	64.82	-134.01	1633.58	1581	1689	1633	19.35	39.36	4.38	0.16
64.32	-132.15	1680.55	1586	1777	1677	26.03	37.17	10.76	0.12	64.80	-134.02	1552.25	1374	1669	1561	15.54	45.19	2.72	0.92
64.34	-132.11	1484.41	1378	1610	1484	23.13	35.26	9.47	0.22	64.79	-135.14	1591.87	1537	1667	1590	19.89	39.41	2.72	0.19
64.34	-132.09	1604.62	1487	1804	1591	29.70	39.33	11.49	0.24	64.79	-134.14	1484.64	1389	1552	1490	27.02	49.07	4.82	0.15
64.23	-132.26	1597.34	1527	1763	1565	17.21	41.04	3.77	0.26	64.78	-134.14	1489.55	1373	1560	1493	23.13	38.00	0.68	0.14
64.23	-132.19	1669.24	1452	1926	1658	36.34	49.26	4.38	0.15	64.75	-134.13	1538.87	1487	1630	1536	20.17	42.28	3.37	0.20
64.25	-132.19	1565.61	1385	1710	1577	26.79	42.11	7.43	0.20	64.74	-134.24	1702.40	1584	1845	1695	34.11	42.99	22.12	0.23
64.27	-132.23	1849.84	1740	1922	1865	31.12	42.16	2.90	0.09	64.74	-135.08	1668.45	1579	1823	1655	32.48	45.12	7.36	0.22
64.25	-132.21	1693.01	1502	1967	1687	38.86	49.94	23.31	0.49	64.73	-134.06	1649.02	1550	1743	1649	27.83	50.86	3.18	0.29
64.25	-132.27	1489.88	1450	1546	1484	14.82	29.70	4.86	0.10	64.73	-134.17	1628.51	1493	1807	1621	32.09	44.02	22.06	0.22
64.25	-132.26	1597.46	1546	1671	1590	14.41	36.62	0.00	0.34	64.73	-134.32	1399.45	1366	1444	1399	12.05	19.63	2.46	0.16
64.24	-132.11	1661.59	1581	1729	1670	25.32	36.53	2.02	0.13	64.73	-134.41	1546.94	1457	1695	1526	26.59	50.73	3.44	0.36
64.24	-132.13	1618.71	1487	1775	1606	30.79	44.56	4.68	0.29	64.73	-135.73	1704.84	1610	1791	1709	27.84	35.93	16.23	0.11
64.20	-132.04	1719.82	1601	1861	1719	31.81	40.38	16.05	0.30	64.73	-134.39	1533.22	1464	1624	1527	25.97	43.11	3.84	0.16
64.18	-132.14	1757.93	1638	1856	1767	27.96	46.62	2.13	0.37	64.72	-134.26	1639.10	1545	1774	1624	25.57	52.15	5.13	0.22
64.18	-132.12	1725.01	1616	1800	1735	31.29	42.23	1.51	0.15	64.72	-135.03	1425.61	1358	1622	1419	25.94	57.37	4.50	0.20
64.10	-132.25	1487.20	1418	1621	1471	22.10	34.34	2.57	0.18	64.72	-134.31	1517.86	1444	1640	1513	15.86	36.54	0.75	0.32
64.10	-132.24	1562.64	1464	1712	1551	23.13	40.17	8.08	0.27	64.72	-135.70	1537.22	1423	1758	1496	22.66	39.00	1.69	0.43
64.09	-132.23	1880.94	1814	1928	1883	28.81	42.00	3.18	0.14	64.71	-134.07	1794.74	1722	1880	1789	23.55	45.84	2.16	0.20
64.08	-132.23	1435.21	1253	1576	1449	29.15	40.36	16.18	0.20	64.71	-135.00	1612.97	1532	1727	1609	22.88	37.94	4.39	0.14
64.09	-132.19	1232.04	1127	1383	1222	26.35	35.64	15.47	0.16	64.71	-134.01	1578.39	1551	1651	1572	14.54	36.41	4.39	0.10
64.10	-132.18	1291.04	1164	1467	1282	34.92	43.02	16.80	0.12	64.71	-134.42	1532.64	1432	1722	1516	21.88	50.67	2.05	0.62
64.10	-132.19	1667.08	1591	1741	1665	25.55	36.55	3.47	0.13	64.70	-135.76	1385.45	1333	1455	1386	14.41	37.40	0.95	0.28
64.11	-132.22	1717.23	1599	1817	1717	30.52	44.49	0.68	0.28	64.70	-134.22	1489.43	1447	1566	1484	11.72	36.21	1.07	0.26
64.11	-132.19	1560.31	1382	1728	1580	31.45	38.51	3.58	0.15	64.70	-135.72	1465.85	1425	1542	1462	20.26	38.01	2.39	0.20
64.16	-132.25	1654.55	1315	1889	1694	30.21	47.53	2.43	0.41	64.69	-135.80	1456.63	1350	1667	1451	22.48	46.12	3.93	0.30
64.17	-132.24	1541.42	1213	1849	1552	24.54	42.05	0.75	0.48	64.69	-135.69	1564.44	1372	1777	1544	30.10	51.34	3.37	0.34
64.17	-132.24	1525.51	1335	1783	1513	29.69	41.16	11.58	0.38	64.69	-134.33	1437.29	1359	1535	1433	14.99	54.01	0.95	0.50
64.17	-132.19	1621.86	1437	1922	1568	31.15	56.48	1.22	0.31	64.69	-135.82	1499.21	1389	1712	1494	24.03	52.63	5.88	0.30

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.17	-132.17	1776.07	1676	1862	1778	29.86	47.62	3.72	0.17
64.17	-132.16	1622.73	1550	1755	1615	22.79	40.99	3.77	0.24
64.16	-132.11	1717.42	1585	1861	1719	31.88	43.49	5.96	0.21
64.16	-132.09	1705.46	1611	1768	1706	27.25	36.25	2.02	0.10
64.16	-132.09	1688.24	1589	1766	1697	27.59	36.10	2.13	0.10
64.15	-132.11	1836.47	1708	1924	1839	27.21	40.39	1.69	0.21
64.14	-132.10	1555.21	1491	1628	1554	20.38	32.10	5.44	0.20
64.13	-132.03	1763.49	1670	1946	1740	22.96	48.32	2.46	0.23
64.15	-132.05	1721.06	1631	1841	1719	17.50	40.59	3.02	0.25
64.15	-132.03	1487.88	1463	1553	1482	12.68	27.47	0.95	0.18
64.16	-132.05	1619.91	1525	1742	1613	32.13	47.24	7.33	0.16
64.16	-132.04	1485.82	1411	1653	1471	22.63	43.68	4.53	0.16
64.16	-132.03	1484.77	1426	1586	1481	16.79	32.43	3.20	0.15
64.15	-132.14	1613.35	1484	1729	1617	28.96	38.22	22.56	0.13
64.15	-132.13	1633.69	1486	1858	1629	24.05	38.63	3.44	0.55
64.14	-132.14	1835.19	1623	1948	1852	31.55	51.51	1.39	0.24
64.13	-132.28	1185.91	1154	1263	1180	9.94	28.76	1.07	0.28
64.13	-132.21	1276.38	1234	1377	1264	11.71	28.25	1.22	0.36
64.13	-132.12	1740.48	1615	1850	1740	34.90	43.67	19.03	0.11
64.12	-132.07	1628.21	1496	1820	1618	23.24	40.54	2.13	0.46
64.09	-132.12	1618.25	1490	1737	1630	26.13	44.72	2.36	0.27
64.01	-132.04	1297.63	1149	1432	1299	28.08	38.11	12.91	0.26
64.00	-132.02	1637.02	1551	1734	1633	31.48	38.98	14.51	0.13
64.69	-139.41	925.46	853	1064	907	16.43	40.11	0.34	0.25
64.66	-138.58	1515.96	1446	1643	1502	24.07	50.97	4.82	0.25
64.44	-138.70	1815.04	1672	2040	1796	33.20	56.09	2.39	0.25
64.40	-138.58	1695.76	1612	1841	1699	17.34	57.43	4.73	0.25
64.40	-138.59	1679.23	1585	1791	1684	22.79	42.12	8.28	0.25
64.36	-138.59	1592.98	1472	1743	1589	23.45	46.09	3.52	0.42
64.27	-138.58	1518.34	1387	1687	1505	24.22	38.42	8.72	0.25
65.16	-137.81	987.28	845	1181	974	30.44	43.73	15.07	0.26
65.16	-137.81	836.37	818	868	837	6.69	21.19	0.00	0.23
65.10	-137.81	1330.34	1244	1429	1327	20.92	38.61	3.77	0.24
65.05	-137.77	1196.92	1068	1292	1199	22.29	36.19	6.93	0.25
65.05	-138.02	1068.45	994	1191	1064	14.33	31.18	7.72	0.35
65.02	-137.84	1392.35	1319	1502	1385	13.79	36.46	4.72	0.45

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
64.69	-134.21	1616.16	1553	1726	1611	16.40	42.24	3.63	0.24
64.69	-135.67	1449.51	1362	1608	1432	21.39	44.06	1.07	0.26
64.69	-134.24	1758.89	1596	1947	1761	28.47	54.99	1.82	0.51
64.68	-134.19	1759.36	1658	1965	1750	23.23	49.69	1.91	0.58
64.68	-135.08	1637.30	1551	1820	1616	21.62	38.12	0.95	0.25
64.68	-134.26	1690.67	1625	1800	1682	23.04	39.16	8.85	0.16
64.67	-134.22	1825.48	1658	1981	1824	36.35	58.03	2.36	0.22
64.67	-135.85	1523.35	1444	1651	1511	25.25	39.82	9.90	0.14
64.67	-135.17	1617.51	1465	1786	1613	26.91	42.69	1.01	0.28
64.66	-135.81	1526.29	1390	1675	1535	34.78	53.16	3.11	0.32
64.66	-134.15	1674.67	1567	1801	1668	25.45	49.26	4.53	0.30
64.66	-134.33	1466.08	1392	1566	1462	16.95	32.74	2.72	0.40
64.66	-135.89	1514.69	1390	1818	1472	31.67	53.90	4.72	0.16
64.66	-134.22	1578.06	1492	1710	1580	14.62	38.71	3.39	0.38
64.66	-134.42	1627.09	1442	1866	1625	30.99	41.86	6.85	0.20
64.66	-134.45	1695.03	1484	1831	1712	34.69	49.27	2.72	0.12
64.66	-134.37	1433.00	1383	1509	1427	16.70	32.86	2.16	0.22
64.65	-134.22	1697.63	1597	1851	1691	30.10	44.43	8.94	0.21
64.66	-135.23	1534.10	1386	1697	1532	24.85	39.04	9.11	0.35
64.65	-134.45	1658.23	1556	1777	1650	23.68	47.08	5.32	0.22
64.65	-134.04	1652.08	1600	1733	1649	15.96	33.51	6.93	0.15
64.64	-134.23	1395.53	1350	1447	1395	6.63	21.68	0.95	0.33
64.64	-134.39	1912.39	1767	2068	1914	33.47	43.70	10.78	0.25
64.64	-134.37	1690.82	1581	1861	1677	24.08	44.40	5.43	0.36
64.63	-134.18	1706.05	1643	1785	1704	19.81	38.01	4.53	0.28
64.63	-134.06	1627.87	1437	1818	1631	30.50	44.64	7.06	0.37
64.63	-134.14	1640.65	1558	1813	1635	21.68	49.98	4.43	0.29
64.63	-134.19	1679.58	1562	1838	1671	21.42	53.40	3.20	0.57
64.63	-134.08	1572.65	1470	1731	1563	29.29	51.84	3.81	0.38
64.62	-134.32	1478.50	1381	1567	1478	26.62	46.27	6.70	0.28
64.62	-134.14	1629.42	1521	1767	1627	32.26	46.05	8.81	0.15
64.62	-134.38	1487.93	1434	1516	1494	8.24	22.56	0.34	0.31
64.62	-134.22	1598.48	1484	1747	1591	19.00	41.69	3.77	0.44
64.62	-134.40	1465.98	1407	1556	1462	20.84	35.74	7.95	0.13
64.61	-134.41	1454.58	1402	1539	1451	12.71	33.91	3.02	0.21
64.61	-134.17	1591.51	1562	1645	1585	10.99	27.37	2.70	0.21

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
62.17	-129.26	1852.09	1735	1997	1826	35.88	54.14	4.86	0.05	64.60	-134.24	1413.18	1322	1557	1416	19.77	39.37	1.07	0.35
62.09	-129.29	1845.69	1789	1903	1839	36.50	43.25	31.49	0.04	64.60	-135.40	1415.05	1392	1462	1414	10.45	32.15	2.64	0.18
62.07	-129.53	1535.51	1460	1637	1540	16.22	35.93	1.97	0.31	64.58	-134.07	1661.10	1594	1723	1662	29.11	37.58	19.21	0.10
62.07	-129.16	1769.57	1722	1810	1770	20.75	33.43	10.65	0.06	64.57	-135.95	1610.59	1445	1778	1609	30.39	41.45	1.22	0.22
62.13	-129.42	1638.79	1601	1682	1637	14.48	27.14	6.53	0.05	64.57	-134.15	1475.44	1337	1611	1480	21.97	38.00	1.07	0.46
62.25	-129.76	1584.47	1485	1701	1579	30.63	41.24	17.78	0.05	64.57	-134.11	1707.12	1629	1829	1700	28.27	49.89	2.90	0.21
62.12	-129.25	1624.56	1534	1767	1600	20.96	35.76	6.99	0.16	64.54	-134.20	1386.96	1329	1424	1392	10.82	24.77	2.57	0.19
62.12	-129.25	1656.61	1566	1818	1634	20.82	33.86	3.11	0.15	64.54	-134.22	1472.32	1356	1604	1474	24.03	40.51	7.54	0.23
62.70	-129.62	1597.20	1504	1744	1579	25.98	38.92	9.02	0.09	64.54	-134.13	1440.86	1371	1523	1440	21.48	37.36	4.17	0.32
62.27	-129.58	1463.03	1389	1540	1463	20.30	27.32	9.72	0.08	64.53	-134.15	1495.52	1448	1623	1486	21.00	41.56	0.48	0.21
62.88	-129.83	1586.63	1521	1631	1596	15.13	22.23	2.13	0.11	64.52	-134.22	1600.44	1552	1676	1597	22.84	39.27	5.40	0.13
62.85	-129.96	1584.60	1568	1599	1585	15.84	23.68	11.24	0.03	64.51	-134.22	1437.13	1324	1524	1452	18.38	31.84	4.53	0.20
62.84	-129.95	1661.96	1621	1747	1652	19.15	44.65	5.10	0.12	64.47	-135.12	1351.58	1187	1559	1347	20.47	44.91	3.34	0.96
62.75	-129.89	1672.90	1619	1734	1674	17.33	30.78	7.45	0.07	64.46	-135.13	1391.60	1264	1544	1393	23.55	34.09	7.36	0.21
62.70	-129.63	1707.63	1601	1831	1698	32.78	40.15	24.52	0.06	64.42	-134.82	1425.41	1376	1498	1432	10.36	23.87	0.48	0.18
62.59	-129.68	1514.11	1441	1589	1517	22.23	28.47	11.37	0.06	64.36	-135.39	1421.04	1350	1534	1416	22.76	37.20	2.13	0.23
62.48	-129.31	1624.63	1572	1692	1622	26.60	32.92	16.17	0.08	64.30	-135.78	1463.27	1349	1687	1434	18.46	35.74	1.22	0.55
62.47	-129.28	1439.06	1358	1539	1439	18.57	34.18	1.22	0.23	64.23	-135.12	1421.11	1166	1721	1421	25.13	40.83	4.68	0.91
62.46	-129.29	1522.27	1458	1666	1495	19.84	34.25	2.26	0.12	63.84	-140.99	1385.34	1217	1526	1395	10.30	30.82	0.95	2.70
62.46	-129.27	1555.92	1430	1748	1547	23.39	38.54	5.73	0.38	63.79	-140.93	1088.12	950	1246	1088	13.43	23.91	8.41	0.61
62.46	-129.25	1590.67	1555	1645	1588	16.02	29.26	4.86	0.08	63.79	-140.89	1052.91	871	1213	1061	11.14	15.35	7.51	0.63
62.31	-129.96	1018.47	1006	1036	1018	5.42	11.99	1.69	0.08	63.78	-140.90	995.33	811	1180	1005	10.75	17.46	6.38	1.49
63.67	-140.48	941.02	763	1092	949	13.20	21.62	8.06	0.76	63.82	-140.83	1148.19	1022	1271	1152	14.12	23.28	5.01	0.53
63.67	-140.49	980.57	877	1097	976	12.53	17.03	9.19	0.51	63.74	-140.81	964.17	803	1136	962	10.54	19.79	2.70	1.49
63.66	-140.50	980.80	898	1055	982	11.63	16.12	9.46	0.37	63.71	-140.71	1286.72	1198	1359	1289	13.49	20.56	9.14	0.14
63.77	-140.55	1419.63	1391	1443	1421	15.18	18.59	12.30	0.04	63.72	-140.69	1286.30	1123	1462	1290	10.36	21.73	4.26	1.70
63.77	-140.54	1328.13	1172	1511	1317	13.86	26.11	5.71	0.62	63.73	-140.70	1120.13	1000	1235	1124	10.70	22.87	3.63	0.82
63.78	-140.53	1259.63	1050	1537	1242	14.54	25.52	7.97	1.07	63.72	-140.62	1385.21	1317	1463	1387	9.08	19.31	5.96	0.39
63.78	-140.50	1173.42	915	1526	1145	18.62	28.26	9.26	1.64	63.73	-140.60	1340.36	1315	1369	1341	6.45	12.65	2.88	0.11
67.83	-136.65	793.69	727	895	785	23.06	34.35	2.57	0.28	63.72	-140.59	1207.70	1085	1350	1212	6.00	22.75	1.51	1.05
67.73	-137.20	965.15	879	1079	954	15.38	33.90	1.22	0.72	63.71	-140.58	1342.63	1209	1451	1342	19.97	26.51	11.08	0.14
67.57	-136.32	1123.48	1054	1154	1129	8.87	25.68	0.48	0.31	63.75	-140.68	1264.33	1200	1333	1265	8.07	12.36	3.37	0.37
67.54	-136.33	1460.24	1365	1619	1444	26.90	37.69	12.35	0.17	63.74	-140.67	1340.37	1306	1395	1338	12.17	22.05	6.65	0.11
67.54	-136.33	1372.98	1304	1468	1371	22.41	36.74	8.85	0.17	63.75	-140.65	1418.40	1390	1457	1420	7.62	24.15	1.39	0.33
67.53	-136.41	1081.90	1000	1177	1081	20.91	32.90	5.71	0.30	63.77	-140.65	1223.88	1107	1378	1197	10.97	25.51	3.20	0.85

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
67.54	-136.39	884.13	818	980	884	16.26	39.68	1.97	0.39
67.56	-136.39	809.95	731	892	807	15.76	33.02	1.22	0.77
64.95	-137.86	1502.77	1419	1585	1503	27.32	38.00	5.48	0.15
64.84	-137.79	1249.84	1188	1309	1251	20.45	31.64	11.78	0.08
64.83	-138.11	1251.18	1250	1254	1251	1.35	3.05	0.00	0.03
64.82	-138.15	1316.28	1283	1349	1316	9.43	15.48	4.90	0.13
64.70	-138.70	1314.71	1215	1386	1323	17.62	33.02	5.10	0.13
64.66	-138.14	1563.57	1503	1623	1560	13.60	29.65	1.22	0.31
64.61	-138.46	1565.34	1404	1690	1577	30.36	41.87	20.78	0.14
64.62	-138.44	1604.66	1520	1681	1604	23.12	37.15	12.91	0.13
64.58	-138.37	1473.85	1354	1663	1457	22.84	41.66	10.44	0.22
64.60	-138.53	1625.10	1494	1773	1625	28.63	40.06	17.69	0.17
64.59	-138.55	1569.17	1483	1713	1564	22.86	41.75	10.92	0.12
64.55	-138.45	1407.71	1326	1599	1378	21.25	43.00	4.10	0.19
64.54	-138.46	1406.28	1341	1497	1402	15.57	33.38	7.33	0.13
64.59	-138.09	1714.99	1646	1811	1714	33.67	48.67	3.58	0.14
64.50	-138.71	1840.13	1778	1925	1841	25.13	35.32	2.88	0.09
64.52	-138.12	1357.02	1225	1561	1356	19.64	37.20	1.91	0.58
64.51	-138.05	1565.62	1496	1661	1555	14.82	28.71	3.63	0.13
64.54	-138.00	1473.08	1389	1547	1467	15.69	25.05	7.57	0.11
64.52	-137.98	1652.67	1496	1822	1647	15.95	30.92	0.48	0.51
64.53	-137.96	1544.12	1306	1782	1571	18.07	36.95	1.22	1.13
63.87	-134.99	1354.53	1313	1456	1339	16.13	35.43	4.58	0.07
63.79	-134.42	1487.39	1446	1526	1486	12.32	19.33	2.78	0.25
63.19	-134.23	1386.53	1357	1436	1382	11.19	20.72	1.91	0.22
63.12	-134.00	1544.20	1499	1589	1544	15.92	24.91	3.52	0.12
63.09	-135.61	1664.11	1546	1744	1675	25.72	38.81	6.28	0.12
63.11	-135.63	1677.83	1609	1742	1678	22.36	40.97	6.18	0.12
63.14	-135.76	1677.22	1629	1741	1677	15.75	34.91	3.44	0.17
63.15	-135.83	1745.34	1666	1894	1737	25.48	44.03	3.47	0.21
62.04	-140.78	1415.10	1324	1541	1408	23.69	35.27	12.64	0.12
62.03	-140.85	1450.97	1393	1553	1443	21.24	26.30	15.52	0.03
62.02	-140.85	1631.79	1552	1750	1624	30.33	45.42	13.66	0.07
62.01	-140.82	1338.62	1250	1465	1327	27.26	39.29	7.39	0.08
62.00	-140.78	1322.91	1272	1377	1322	13.03	31.03	0.68	0.24

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
63.76	-140.63	1314.09	1255	1382	1319	8.61	21.34	2.43	0.22
63.76	-140.61	1433.36	1322	1540	1438	14.67	24.90	8.25	0.20
63.79	-140.59	1102.09	912	1299	1094	12.34	22.01	1.69	1.12
63.77	-140.56	1385.39	1282	1534	1374	15.92	26.88	8.65	0.25
63.77	-140.44	1067.28	864	1308	1054	21.24	29.71	13.92	0.49
63.77	-140.45	1107.81	975	1251	1100	19.22	26.73	13.15	0.32
63.75	-140.44	1146.81	1042	1237	1146	13.29	21.78	8.84	0.29
63.75	-140.46	1253.59	1136	1358	1258	15.72	25.13	11.04	0.33
63.75	-140.48	1299.03	1205	1391	1301	14.60	24.30	10.16	0.32
63.75	-140.49	1314.59	1264	1358	1316	14.56	30.89	10.46	0.15
63.75	-140.50	1313.81	1223	1386	1316	22.00	28.00	14.67	0.12
63.74	-140.48	1392.82	1371	1414	1392	9.36	12.54	6.89	0.08
63.74	-140.49	1413.33	1373	1462	1410	10.26	14.43	6.85	0.15
63.73	-140.50	1340.48	1241	1450	1339	11.96	22.38	8.05	0.43
63.73	-140.47	1228.36	1167	1294	1225	14.30	20.01	10.48	0.15
63.72	-140.48	1245.36	1139	1371	1244	14.78	25.14	9.42	0.34
63.72	-140.49	1265.68	1187	1343	1269	12.05	17.46	8.48	0.28
63.71	-140.50	1226.08	1103	1318	1235	12.66	20.36	7.73	0.34
63.69	-140.50	961.30	903	1018	959	12.19	19.18	7.83	0.26
63.68	-140.48	936.07	815	1033	944	12.92	20.89	8.70	0.58
63.68	-140.47	915.40	766	1047	914	14.97	20.91	7.83	0.55
60.16	-136.64	1693.32	1632	1802	1687	18.36	47.82	0.68	0.15
60.13	-136.61	1551.18	1511	1629	1543	16.93	32.77	2.39	0.12
60.13	-136.66	1558.19	1517	1615	1556	18.87	34.22	3.32	0.08
60.05	-136.61	1614.20	1542	1664	1632	14.70	30.19	3.58	0.09
60.05	-136.63	1690.02	1563	1852	1679	28.92	48.48	8.11	0.14
60.06	-136.66	1522.52	1513	1554	1520	9.29	27.99	0.95	0.06
60.28	-136.47	1789.11	1747	1867	1778	18.83	32.58	6.32	0.07
60.28	-136.36	929.97	848	1044	922	17.69	34.75	7.45	0.19
60.24	-136.37	1766.55	1706	1818	1773	16.02	28.31	2.16	0.07
60.25	-136.37	1811.64	1730	1894	1813	29.96	37.85	16.03	0.11
60.24	-136.48	1803.91	1725	1940	1797	19.21	44.27	1.97	0.23
60.23	-136.45	1812.25	1799	1860	1809	10.25	36.41	2.86	0.06
60.22	-136.40	1764.79	1698	1830	1762	29.68	36.59	14.52	0.07
60.21	-136.41	1705.75	1695	1730	1706	7.83	30.03	0.00	0.08

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
61.99	-140.85	1534.93	1454	1651	1534	20.19	39.88	6.26	0.18
61.83	-137.83	1315.75	1203	1414	1332	16.35	32.68	3.84	0.22
61.19	-138.95	2137.34	2069	2254	2131	23.04	42.12	2.46	0.15
61.17	-138.95	1799.94	1706	1904	1797	26.36	37.91	9.02	0.09
61.17	-138.95	1775.29	1706	1857	1769	27.01	37.62	9.44	0.09
61.34	-137.06	914.96	914	915	915	0.17	1.35	0.00	0.04
61.35	-137.07	915.54	914	920	915	1.02	2.78	0.00	0.06
61.16	-137.75	1662.16	1580	1742	1659	30.27	42.54	9.47	0.17
61.07	-137.56	1517.80	1449	1616	1517	20.81	36.06	1.39	0.21
61.00	-138.04	1513.36	1423	1595	1510	22.76	31.89	9.72	0.06
60.84	-137.86	1368.43	1307	1491	1351	13.69	31.11	4.26	0.42
60.99	-136.29	1669.29	1586	1766	1663	27.25	38.25	20.00	0.07
61.00	-136.30	1652.50	1573	1729	1649	23.92	34.73	15.07	0.08
60.28	-136.96	1149.84	1077	1211	1149	19.41	24.63	15.53	0.10
60.22	-136.91	1303.50	1113	1576	1306	26.84	43.73	12.20	0.30
60.29	-136.71	1719.64	1660	1773	1728	26.78	35.97	5.05	0.09
60.16	-136.63	1801.77	1722	1877	1804	26.56	41.99	9.43	0.08

latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	area in km2
60.20	-136.50	1686.80	1637	1777	1679	22.02	44.01	0.75	0.07
60.17	-136.49	1779.34	1694	1963	1764	23.85	47.86	0.75	0.39
60.17	-136.47	1814.00	1748	1901	1813	18.25	25.58	10.37	0.12
60.20	-136.37	1851.88	1712	1897	1857	15.62	44.89	1.22	0.33
60.22	-136.24	1575.57	1523	1610	1580	12.90	24.47	2.36	0.09
60.23	-136.27	1973.34	1860	2059	1977	28.45	37.28	2.72	0.11
60.21	-136.28	1700.85	1627	1791	1700	19.52	37.89	3.37	0.18
60.12	-135.40	1483.53	1132	1842	1498	29.40	45.74	9.75	0.26
60.12	-135.42	1327.46	1031	1858	1289	28.07	52.81	5.32	0.83
63.14	-135.62	1709.59	1598	1806	1710	19.26	37.46	5.05	0.16
61.97	-140.74	1433.14	1382	1526	1421	20.85	38.22	3.02	0.12
60.27	-136.68	1679.64	1652	1700	1682	20.38	32.40	7.25	0.03
60.27	-136.68	1783.73	1735	1839	1780	25.86	33.84	3.95	0.02
60.25	-136.64	1689.24	1626	1749	1685	16.63	30.26	4.97	0.13
60.24	-136.68	1692.91	1624	1796	1686	26.49	41.06	4.32	0.11
60.20	-136.65	1726.69	1668	1782	1728	14.72	34.27	0.48	0.19
60.20	-136.66	1701.26	1603	1795	1714	30.04	43.67	1.22	0.06

APPENDIX C - Studied Rock Glaciers

activity - original geology map	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	mean aspect (directional mean)	area in hectares	Amaris' ID code	activity - air photo	morphology - air photo	comments - air photo
active	64.98	-138.23	1028.37	958	1105	1023	26.85	32.74	21.39	109.58	5.00		3 inactive	lobate	talus
active	64.97	-138.25	1011.76	934	1191	982	26.09	38.39	10.05	119.83	7.18		4 relict	lobate	talus, just scree?
active	64.96	-138.20	942.01	918	979	939	12.13	27.26	7.65	359.84	6.14		5 active	lobate	talus
dormant	64.59	-138.17	1587.47	1551	1679	1578	18.85	46.74	1.39	314.46	12.52		8 inactive	tongue	cirque
active	64.34	-138.39	1211.06	994	1452	1213	22.24	35.60	10.11	303.59	45.02		12 active	tongue	cirque
dormant	64.34	-138.61	1589.81	1554	1623	1589	18.10	33.08	6.38	341.38	6.10		13		no RG
active	64.27	-138.47	910.81	769	1223	872	18.57	33.83	10.44	296.50	43.11		16 relict	lobate	talus, vegd, just scree?
unknown	64.67	-138.17	1467.07	1395	1578	1462	14.88	35.49	5.99	358.54	19.92		17 active	tongue	cirque, @least 2 lobes
unknown	64.46	-138.34	1622.96	1501	1746	1627	27.86	43.23	8.06	359.22	16.37		20 inactive	tongue	cirque, 3 melt lakes
active	64.64	-138.74	1592.10	1539	1644	1592	20.26	34.02	8.84	204.35	8.32		23		no photos available
active	64.57	-138.30	1196.38	1189	1204	1196	3.78	4.26	3.04	317.35	4.59		26 relict	lobate	talus, just scree?
unknown	64.53	-138.19	1686.14	1605	1764	1685	26.59	42.33	12.05	294.77	6.89		27 inactive	tongue	talus, 2 lobes
unknown	64.52	-138.38	1777.69	1619	2020	1770	30.64	54.43	13.20	315.81	19.67		28 active	tongue	cirque
active	64.51	-138.51	1492.22	1460	1589	1479	16.18	38.54	3.32	321.99	7.16		30 active	tongue	cirque, dv
active	64.49	-138.24	1368.60	1260	1500	1372	26.08	41.14	8.56	331.11	15.69		32 active	tongue	cirque
dormant	64.48	-138.18	1145.25	997	1443	1105	22.05	36.71	4.68	268.84	47.89		34 active	lobate	talus
active	64.46	-138.12	1438.07	1215	1560	1473	12.24	27.43	4.11	173.88	40.69		39 relict	lobate	talus, multilobe
active	64.46	-138.61	1581.73	1541	1671	1579	16.09	39.45	1.97	324.53	13.47		40		photos missing
active	64.39	-138.19	1532.40	1402	1644	1527	20.67	32.24	10.92	272.56	18.21		43 active	tongue	cirque, multilobe
active	64.37	-138.26	1235.37	1046	1436	1220	12.01	33.39	0.48	247.37	161.08		47 relict	tongue	cirque
active	64.34	-138.38	1223.21	1112	1342	1206	19.09	31.51	7.39	278.41	18.78		53 active	lobate	talus, no veg
unknown	64.34	-138.48	1274.79	1132	1421	1275	29.04	37.67	21.34	122.11	13.26		54 relict	lobate	talus, just scree?, no veg
active	64.33	-138.24	1635.51	1588	1697	1631	18.11	29.69	6.80	248.60	13.81		55 active	tongue	cirque, dv
active	64.33	-138.53	1577.79	1472	1701	1573	35.82	49.68	19.48	299.49	12.50		56 active	tongue	cirque
unknown	64.33	-138.39	1379.94	1166	1603	1384	24.89	37.40	10.76	301.33	28.24		57		no RG visible in cirque
active	64.32	-138.12	1497.04	1358	1609	1500	29.69	36.57	21.83	312.93	11.86		59 inactive	tongue	cirque, 3 tongues, drainage
unknown	64.32	-138.40	1320.21	1187	1440	1324	24.01	31.00	13.64	307.78	22.42		60 active	tongue	cirque
active	64.32	-138.57	1541.21	1464	1611	1538	29.19	41.80	4.32	321.64	7.01		61 active	tongue	cirque, lumpy
unknown	64.31	-138.41	1214.34	1087	1338	1218	25.33	38.22	15.18	279.13	16.49		62 active	tongue	cirque
active	64.29	-138.43	1201.20	1047	1341	1206	20.43	29.12	9.09	287.73	32.66		63 active	lobate	talus
unknown	64.30	-138.39	1546.81	1299	1707	1557	25.09	42.28	0.00	283.56	41.90		67 active	tongue	cirque
active	64.30	-138.43	1137.96	1007	1236	1150	17.99	25.53	8.94	277.10	18.88		68 relict	lobate	talus, vegd, just scree?
unknown	64.28	-138.41	1455.41	1197	1660	1461	20.50	40.36	6.75	283.03	60.63		69 active	tongue	cirque
unknown	64.28	-138.45	1094.15	786	1390	1096	18.57	38.98	6.28	295.90	149.37		70 relict	lobate	talus, vegd, just scree?
dormant	64.26	-138.47	942.54	762	1217	913	17.59	30.83	7.75	285.06	56.77		72 relict	lobate	talus, vegd, just scree?
dormant	64.22	-138.49	1135.60	986	1252	1144	23.12	31.44	1.51	295.05	33.91		74 relict	lobate	talus, just scree?

activity - original geology map	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	mean aspect (directional mean)	area in hectares	Amaris' ID code	activity - air photo	morphology - air photo	comments - air photo
unknown	64.60	-138.21	1630.09	1528	1702	1629	15.49	34.30	4.06	8.08	12.57		75 active	tongue	cirque, multilobe
active	64.90	-133.84	1577.98	1454	1689	1576	35.88	42.17	28.51	141.24	8.37		90		no RG
dormant	64.88	-133.92	1638.32	1494	1796	1656	31.39	42.69	18.31	223.81	17.40		93 relict	lobate	talus, cv
active	64.88	-133.85	1782.89	1638	1864	1795	36.29	56.33	1.82	116.23	15.08		94 active	tongue	cirque, dv
active	64.85	-133.94	1581.50	1454	1759	1573	29.59	39.24	19.28	197.08	11.09		97 active	lobate	talus, cv
active	64.84	-133.92	1632.93	1475	1813	1623	29.47	36.71	21.68	212.51	11.40		99 active	tongue	talus
dormant	64.79	-133.99	1877.14	1788	1982	1874	37.71	50.36	23.88	293.85	8.31		106 active	lobate	huge lumpy 10 converg talus
active	64.76	-133.98	1617.98	1521	1809	1616	16.83	42.73	0.68	281.50	38.81		111 active	lobate	talus, cv, steep front
unknown	64.65	-133.68	1952.30	1734	2137	1967	35.23	47.06	15.88	291.89	16.32		124 active	tongue	covergence of 2 glaciers
active	64.59	-133.99	1647.10	1580	1761	1636	24.13	44.47	7.21	326.90	8.82		127 active	tongue	cirque, dv
active	64.50	-133.92	1813.56	1651	1920	1825	30.31	41.45	4.76	341.28	10.10		140 inactive	tongue	cirque, melt lake
active	64.46	-133.91	1573.52	1457	1773	1559	33.06	46.41	16.17	10.04	22.21		144 active	tongue	steep sides & f, ridged surface
dormant	64.40	-133.87	1610.95	1492	1744	1612	32.35	45.05	1.39	350.06	23.49		149 active	lobate	talus, cv
unknown	64.15	-133.84	1536.75	1456	1629	1540	22.26	34.90	8.44	228.74	14.05		153 active	lobate	ridges at toe, steep front
active	64.39	-133.57	1662.91	1576	1719	1673	29.84	41.38	1.39	134.36	15.17		165 active	tongue	steep front
unknown	64.51	-133.68	1760.24	1683	1911	1738	26.54	41.43	2.86	63.47	12.15		172 active	tongue	
unknown	64.51	-133.71	1845.41	1651	1989	1847	40.08	51.84	2.72	337.52	15.48		173 active	lobate	talus, smooth surface
active	64.88	-133.62	1338.70	1136	1514	1347	35.24	41.71	20.96	145.68	12.52		200 inactive	tongue	talus, no cirque here
active	64.87	-133.60	1056.68	905	1221	1054	31.67	42.05	21.77	156.01	8.52		201		alluvial fan
active	64.88	-133.60	1390.66	1246	1569	1383	36.32	44.75	25.52	125.70	13.82		202		no RG
dormant	64.90	-133.57	1586.73	1423	1775	1592	30.19	44.00	20.06	54.79	13.78		205		no RG
dormant	64.91	-133.57	1414.71	1356	1516	1412	24.88	44.09	1.35	327.98	13.37		206		no RG
dormant	64.91	-133.63	1788.15	1632	1980	1800	36.88	50.42	1.07	96.74	27.48		207 active	lobate	multilobe, ridges @ convergence
dormant	64.91	-133.65	1464.32	1341	1701	1444	33.48	50.80	8.06	342.60	24.96		208 active	tongue	
active	64.96	-133.37	1622.91	1484	1762	1621	33.45	43.37	13.27	139.43	25.94		242 active	tongue	cirque, dv
dormant	64.62	-133.44	1574.80	1239	2009	1568	36.20	54.17	15.91	298.86	34.48		258		no RG
unknown	64.45	-133.46	1537.17	1393	1707	1529	33.97	41.99	18.23	329.25	13.09		260		no photos available
unknown	64.42	-133.49	1815.11	1617	2095	1805	38.44	55.91	0.68	8.57	43.09		264		no photos available
dormant	64.41	-133.51	1723.03	1633	1798	1721	34.86	51.80	4.11	166.20	10.76		265		no photos available
active	64.05	-133.41	1320.18	1195	1469	1315	33.17	42.87	13.52	318.29	14.04		273 relict	lobate	glacial
active	64.09	-133.21	1700.64	1487	1865	1698	32.88	51.71	1.69	97.29	30.35		278 active	tongue	both cirque/talus inputs
dormant	64.28	-133.17	1575.54	1410	1689	1595	26.37	40.15	9.14	300.94	23.77		283		no RG
dormant	64.82	-133.23	1987.19	1838	2078	2000	34.49	52.60	3.58	287.20	22.56		302 active	lobate	2 lobes
dormant	64.94	-133.23	1538.21	1483	1641	1538	14.95	34.34	4.26	208.52	22.89		313 active	lobate	talus, cv, 2 lobes
active	64.56	-132.98	1863.61	1706	1928	1890	25.43	41.58	0.75	342.42	17.40		360 active	tongue	cirque, multilobe, in cir
	64.53	-133.08	1697.91	1576	1802	1704	30.98	40.39	8.46	220.35	14.21		363 active	tongue	talus, lat ridges
	64.53	-133.05	1739.82	1555	1874	1771	24.19	47.19	0.75	297.87	24.41		364 active	tongue	2 lobes, south active for sure
	64.49	-132.99	1607.24	1413	1880	1569	28.78	45.24	4.17	24.49	45.10		368 active	lobate	cirque, huge, multilobe

activity - original geology map	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	mean aspect (directional mean)	area in hectares	Amaris' ID code	activity - air photo	morpho logy - air photo	comments - air photo
	64.47	-133.08	1645.27	1466	1956	1633	29.04	46.08	1.72	11.43	43.41		371 active	tongue	cirque, dv
	64.64	-132.83	1591.03	1478	1693	1594	30.11	49.70	3.72	300.19	20.53		397 active	tongue	cirque
	64.93	-132.77	1760.85	1594	1833	1779	28.42	47.82	2.05	74.94	20.30		415 active	tongue	cirque, dv
	64.94	-132.84	1709.54	1521	2004	1676	26.44	50.22	6.05	303.62	20.94		418 active	tongue	cirque, multilobe
	64.98	-132.76	925.82	910	943	926	3.78	20.00	0.00	277.06	33.34		424 active	tongue	cirque, long
	64.92	-132.50	1784.54	1612	1966	1788	28.44	41.38	9.19	302.57	20.25		427 active	lobate	talus, lobe 1 runs over lobe 2
	64.84	-132.65	1431.06	1306	1625	1419	25.95	46.63	5.48	278.98	34.21		441 active	tongue	talus, cv
	64.82	-132.62	1979.44	1940	2008	1988	15.61	23.28	5.01	171.12	0.98		443 inactive	tongue	talus, dv
	64.82	-132.60	2001.19	1949	2061	2006	24.47	36.33	2.05	226.15	4.08		444 active	tongue	cirque, dv
	64.61	-132.66	1822.38	1737	1916	1822	22.71	40.23	0.95	6.05	14.89		452 active	tongue	cirque
	64.50	-132.64	1685.29	1582	1838	1676	29.75	43.76	18.81	2.06	21.18		458 active	tongue	cirque
	64.00	-132.54	1790.89	1670	1861	1803	26.94	49.29	2.26	261.17	22.18		476 active	tongue	cirque
	64.12	-132.33	1580.25	1493	1671	1583	23.31	44.69	8.11	303.17	17.12		482 active	tongue	cirque, multilobe, dv
	64.27	-132.34	1709.63	1551	1977	1686	33.83	48.38	6.42	299.28	14.45		497 active	tongue	cirque, melt lake @ bottom
	64.68	-132.31	1669.67	1378	1993	1659	21.63	43.89	5.06	214.96	69.54		505 active	lobate	talus, cv
	64.69	-132.24	1899.27	1807	1960	1897	16.45	32.15	5.48	83.10	14.12		522 active	tongue	cirque, dv
	64.69	-132.18	2061.45	1909	2274	2047	42.79	57.82	20.01	69.09	23.89		526 active	tongue	cirque, multilobe
	64.61	-132.24	1786.55	1574	2014	1799	23.24	40.55	2.43	12.60	53.14		535 active	lobate	talus
	64.62	-132.02	1755.66	1559	1966	1740	31.67	46.78	2.13	23.62	36.28		541 active	lobate	talus, poss PTR, cv
	64.51	-132.17	1612.06	1495	1763	1603	23.89	42.47	8.59	0.08	25.09		546 active	tongue	cirque, dv
	64.25	-132.27	1489.22	1450	1546	1483	14.81	29.70	4.86	312.16	10.31		562 active	tongue	cirque, multilobe, dv
	64.14	-132.10	1555.96	1491	1630	1555	20.37	32.10	5.44	27.51	20.34		588		no photos available
	64.14	-132.14	1835.61	1623	1948	1855	31.55	51.51	1.39	216.31	23.88		597 active	lobate	multilobe, talus, cv
	64.40	-138.59	1680.33	1585	1796	1685	22.95	42.12	8.28	115.91	24.57		609		photos missing
	64.27	-138.58	1518.66	1387	1687	1505	24.20	38.42	8.72	118.14	24.57		611 active	tongue	huge, cirque
	62.12	-129.25	1624.46	1534	1767	1600	20.92	35.76	6.99	5.34	15.46		624 active	lobate	talus, cv
	62.47	-129.28	1439.89	1358	1539	1439	18.68	34.18	1.22	9.52	22.50		635 active	tongue	cirque
	62.46	-129.25	1590.76	1555	1645	1588	16.06	29.26	4.86	324.67	7.90		638 inactive	tongue	cirque, dv
	62.11	-129.30	1355.24	1236	1495	1355	26.42	37.21	7.37	17.77	8.03		654 active	tongue	cirque
	62.07	-129.13	1743.42	1699	1796	1743	13.45	33.78	0.68	16.79	10.95		665 active	tongue	cirque, multilobe
	62.00	-128.40	1716.40	1654	1837	1704	21.99	41.59	0.75	19.95	17.60		683 active	tongue	talus, multilobe
	62.00	-128.45	1640.27	1573	1727	1641	24.02	42.26	7.09	358.08	7.30		685 active	tongue	cirque, multilobe
	62.51	-134.54	1614.57	1577	1681	1611	27.64	43.34	7.66	325.16	3.21		693 active	tongue	cirque
	62.39	-134.45	1696.62	1642	1780	1689	24.58	39.67	4.52	343.14	5.19		707 active	tongue	cirque
	62.38	-134.48	1678.42	1628	1727	1679	21.76	37.93	3.39	176.83	7.40		709 active	tongue	cirque
	62.36	-134.42	1724.39	1683	1784	1718	16.57	34.60	4.76	352.18	7.34		713 active	tongue	cirque, dv
	62.30	-134.32	1719.50	1678	1755	1720	11.08	25.52	1.39	331.17	10.79		718 inactive	tongue	cirque, dv, melt lake

activity - original geology map	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	mean aspect (directional mean)	area in hectares	Amaris' ID code	activity - air photo	morphopho logy - air photo	comments - air photo	
	63.38	-130.29	1628.24	1538	1728	1625	17.09	37.26	2.26	81.45	28.70		743	active	tongue	cirque, dv
	63.38	-130.42	1727.60	1689	1770	1730	17.59	28.88	5.05	90.14	4.91		746	active	tongue	cirque
	63.18	-130.13	1245.44	1195	1345	1239	13.69	32.54	2.70	349.18	8.61		778	active	lobate	talus
	63.18	-130.13	1341.24	1191	1650	1314	20.02	38.52	2.78	347.59	45.74		779	active	lobate	talus
	63.17	-130.05	1786.33	1719	1865	1787	25.21	31.89	7.59	28.15	5.00		780	active	tongue	cirque, multilobe
	63.13	-130.31	1644.36	1581	1705	1646	15.77	37.32	0.00	328.29	12.16		788	active	tongue	big, cirque
	63.04	-130.13	1324.20	1143	1513	1323	24.66	34.79	10.64	304.91	25.85		798	active	tongue	talus
	63.41	-131.38	1696.79	1597	1821	1690	21.70	44.30	4.58	253.25	20.98		801	active	tongue	cirque, dv
	61.52	-131.90	1818.99	1697	1957	1817	31.45	41.32	13.52	275.82	9.61		816	inactive	lobate	talus, cv, shallow slope
	61.42	-130.02	1594.53	1519	1660	1599	17.63	34.21	7.73	74.50	15.32		823	active	tongue	cirque, multilobe or incised
	61.36	-130.74	1684.98	1652	1737	1678	14.04	28.57	4.76	17.61	8.73		834	active	tongue	cirque
	61.25	-130.86	1547.17	1451	1641	1555	15.33	38.52	5.79	323.54	22.31		837	active	tongue	big, cirque
	61.21	-130.40	1648.74	1580	1778	1640	23.15	46.21	9.72	9.22	10.95		842	active	tongue	cirque
	61.13	-130.16	1588.20	1526	1673	1583	25.94	36.49	15.48	351.48	9.47		855			no RG, small lakes in cirque
	61.12	-130.13	1552.51	1522	1583	1554	13.23	28.50	2.72	340.00	12.22		857	active	lobate	talus, poss also tongue too
	61.11	-130.15	1638.53	1535	1720	1639	21.54	29.09	9.75	322.56	10.92		860	active	tongue	cirque, dv
	61.01	-130.61	1650.32	1534	1809	1641	28.41	40.04	10.97	297.35	16.30		879	active	tongue	cirque, dv
	61.40	-131.76	1520.24	1401	1696	1516	21.52	34.20	1.97	57.61	13.67		899	active	tongue	cirque, dv
	61.40	-131.75	1578.86	1496	1660	1581	27.02	32.74	18.39	303.92	7.98		900	active	tongue	cirque
	61.40	-131.75	1546.58	1442	1662	1541	26.81	38.51	12.05	289.43	10.78		903	active	tongue	small, cirque
	61.37	-131.68	1500.00	1396	1659	1492	22.23	34.42	7.65	22.94	18.96		908	active	lobate	talus, cv
	61.31	-131.02	1506.90	1406	1559	1519	16.19	32.95	4.39	70.62	16.49		919	active	tongue	cirque
	61.17	-131.27	1587.16	1522	1686	1584	22.67	37.49	6.17	64.44	13.97		930	active	tongue	cirque
	61.25	-138.23	1672.85	1607	1744	1676	22.91	38.16	0.95	356.38	11.55		936	active	tongue	cirque
	61.23	-138.84	1209.19	1126	1294	1212	21.15	27.41	15.79	53.85	9.76		937	inactive	tongue	forested, talus
	61.21	-138.79	1061.15	954	1195	1058	19.83	36.63	6.93	62.25	35.83		941	inactive	lobate	forested, multilobe, talus
	61.21	-138.80	1150.03	1070	1235	1147	27.71	37.03	20.10	55.19	5.57		942	inactive	lobate	forested, talus
	61.14	-138.69	1665.96	1389	2028	1659	26.99	43.80	7.92	35.78	55.67		949	active	tongue	cirque
	61.10	-138.62	1736.35	1424	2045	1740	27.86	48.23	5.43	0.96	87.02		952	active	tongue	cirque
	61.07	-138.62	1710.85	1521	1856	1729	21.64	40.10	5.55	45.53	46.56		953	relict	tongue	talus, just scree?
	61.09	-138.61	1753.97	1447	1968	1774	28.82	48.57	7.37	0.83	79.02		954	active	tongue	cirque
	61.08	-138.95	1548.87	1411	1728	1534	23.09	41.28	1.22	123.29	58.73		958	active	lobate	talus, cv
	61.06	-138.55	1401.48	1032	1953	1335	28.01	40.23	12.30	64.65	38.13		959	active	tongue	cirque
	60.98	-138.50	907.75	838	1021	902	17.28	36.17	0.34	343.29	23.74		968	active	lobate	talus
	60.99	-138.77	1475.36	1390	1569	1475	28.07	37.48	14.87	338.35	9.56		972	active	both	cirque and talus
	60.96	-138.59	790.97	773	829	787	11.12	31.33	3.34	358.04	8.19		974	active	lobate	vegd, talus
	61.99	-140.84	1735.22	1614	1843	1741	25.32	39.01	4.06	350.04	21.57		983	active	tongue	talus, cv

activity - original geology map	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	mean aspect (directional mean)	area in hectares	Amaris' ID code	activity - air photo	morphopho logy - air photo	comments - air photo
	61.96	-140.63	1400.56	1067	1823	1385	18.64	39.22	0.48	69.81	201.22		987 active	tongue	cirque, 2 coalescent RGs
	61.88	-140.36	1360.76	1155	1522	1376	20.55	36.72	5.81	18.35	29.30		995 active	tongue	cirque
	61.69	-139.98	1446.20	1183	1661	1463	19.45	32.93	5.44	16.41	67.16		1016 active	tongue	cirque, multilobe
	61.67	-140.16	1610.36	1402	1799	1623	24.69	40.68	8.79	320.98	38.74		1017 active	lobate	talus
	61.61	-140.12	1575.61	1529	1666	1570	17.25	36.00	5.01	298.68	10.58		1028 active	tongue	cirque, 2 lobes
	61.49	-139.50	1627.07	1451	1839	1617	27.08	42.53	14.28	20.41	28.19		1039 active	tongue	cirque
	61.27	-139.49	2025.64	1813	2297	2036	20.90	49.03	4.52	319.59	68.91		1041 active	tongue	cirque, poss real glacier
	62.44	-133.44	1840.36	1666	1973	1846	30.46	38.77	15.04	33.39	13.23		1043		no RG
	62.02	-133.55	1703.30	1662	1754	1699	14.03	24.90	7.36	347.26	5.68		1052 active	tongue	cirque
	61.95	-133.49	1824.78	1739	1947	1820	27.64	44.23	12.21	352.01	10.67		1083 active	tongue	cirque, multilobe
	61.90	-133.47	1693.76	1613	1779	1697	18.59	49.50	4.07	300.78	21.62		1111 active	tongue	cirque
	61.81	-133.34	1794.30	1745	1883	1790	22.61	40.09	10.61	285.41	7.62		1116 active	tongue	cirque
	61.78	-133.37	1594.56	1538	1657	1592	14.80	26.34	4.76	5.90	11.30		1119 active	tongue	cirque
	61.72	-133.13	1533.25	1468	1590	1534	19.26	25.14	8.84	42.29	6.82		1131 inactive	tongue	cirque
	61.72	-133.16	1679.44	1622	1761	1672	18.99	48.28	5.95	337.59	11.54		1132 active	tongue	cirque
	61.71	-133.56	1751.83	1598	1990	1742	34.14	53.55	17.11	290.96	20.40		1135 active	tongue	cirque
	61.71	-133.20	1677.75	1625	1758	1666	18.31	36.41	5.81	317.35	7.92		1136 active	tongue	cirque
	61.70	-133.93	1698.80	1557	1847	1688	37.15	48.19	20.86	327.26	8.69		1141 active	lobate	cirque, dv
	61.69	-133.13	1609.82	1486	1687	1630	25.96	42.86	6.06	321.16	6.10		1142 active	tongue	cirque
	61.69	-133.24	1613.25	1571	1657	1615	11.77	22.87	4.38	61.26	14.82		1143 inactive	lobate	talus, cv, shallow front, vegd
	61.68	-133.22	1535.64	1441	1674	1527	22.91	51.96	5.05	352.97	43.11		1144 active	both	c&t, 1-2 tongue, 2-3 lobate
	61.63	-133.36	1642.88	1583	1698	1651	20.70	34.84	13.04	52.30	3.68		1148 active	tongue	cirque
	61.51	-133.13	1601.89	1489	1752	1609	24.47	44.54	8.81	328.69	19.62		1149 active	tongue	cirque, multilobe
	61.50	-133.11	1714.95	1502	1928	1724	30.62	52.33	1.07	335.36	61.98		1150 active	tongue	multicirque, multilobe
	61.97	-132.74	909.61	883	939	910	11.61	22.95	7.43	50.31	7.82		1153		no photos available
	61.97	-132.74	905.44	876	941	908	11.33	23.85	2.39	48.51	8.44		1154		no photos available
	61.80	-132.97	1586.63	1484	1733	1575	26.20	43.06	4.82	42.56	18.79		1162 inactive	tongue	cirque
	61.68	-132.63	1605.76	1454	1781	1601	24.58	52.48	7.36	353.57	56.94		1179 active	tongue	cirque/hanging val, cv
	61.67	-132.58	1593.16	1557	1639	1592	19.29	29.44	9.01	10.66	4.45		1181 active	tongue	cirque, dv
	61.68	-132.92	1830.40	1714	1917	1835	30.77	39.92	8.90	285.66	8.03		1183 active	tongue	cirque
	61.63	-132.53	1373.32	1270	1521	1359	24.34	32.43	15.50	278.56	12.61		1196 inactive	tongue	cirque
	61.58	-132.09	1508.28	1397	1661	1500	17.28	29.32	5.73	15.15	19.02		1198 active	tongue	cirque, 1198/1199/1200
	61.58	-132.09	1547.78	1424	1688	1545	21.21	35.53	7.85	352.28	24.26		1199 active	tongue	cirque, 1198/1199/1200
	61.58	-132.10	1574.06	1497	1647	1576	19.63	26.97	8.41	24.21	12.56		1200 active	tongue	cirque, 1198/1199/1200
	61.56	-132.07	1718.74	1611	1856	1704	35.42	47.04	20.38	295.69	10.15		1201 active	tongue	cirque, snow in June30/92
	61.56	-132.20	1405.01	1184	1828	1358	21.34	48.39	0.00	178.09	62.70		1203 inactive	tongue	cirque
	61.56	-132.20	1375.47	1179	1508	1392	23.84	34.95	5.40	163.96	13.32		1204 inactive	tongue	cirque

activity - original geology map	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	mean aspect (directional mean)	area in hectares	Amaris' ID code	activity - air photo	morphopho logy - air photo	comments - air photo	
	61.56	-132.27	1616.08	1503	1772	1600	19.81	40.12	3.11	1.55	55.25		1205	active	tongue	cirque
	61.56	-132.29	1620.09	1518	1782	1599	22.64	40.63	3.37	8.93	39.92		1206	active	tongue	cirque
	61.55	-132.31	1759.55	1707	1810	1759	14.90	25.87	7.09	22.88	8.26		1208	active	tongue	cirque
	61.55	-132.33	1677.97	1586	1801	1671	19.83	38.43	6.93	295.63	19.55		1209	active	tongue	cirque
	61.53	-132.29	1548.93	1482	1649	1541	26.28	42.82	1.97	14.93	16.18		1211	active	tongue	cirque
	61.53	-132.27	1547.74	1419	1686	1550	34.41	48.75	14.07	358.75	17.27		1212	active	lobate	talus
	61.53	-132.34	1566.49	1461	1716	1564	22.46	42.77	2.57	320.09	19.16		1213	active	tongue	cirque, @least 2 small lobes
	61.52	-132.34	1684.03	1585	1821	1671	31.96	45.39	14.23	309.09	9.07		1216	active	tongue	cirque
	61.50	-133.14	1699.37	1610	1840	1682	25.73	40.74	9.37	291.62	12.47		1218	active	tongue	cirque, multilobe
	61.43	-133.96	1736.26	1557	1886	1744	34.57	41.80	21.60	358.69	13.07		1222	inactive	lobate	cv, 2 melt lakes
	61.41	-133.88	1619.02	1542	1713	1611	21.03	32.25	11.62	328.89	11.58		1223	inactive	tongue	cirque, shallow front, vegd
	61.49	-132.79	1641.07	1504	1760	1654	22.66	38.62	3.81	18.13	23.04		1239	active	lobate	talus
	61.45	-132.26	1612.88	1459	1763	1612	23.71	39.71	7.01	323.93	50.84		1245	active	tongue	cirque, multilobe
	61.45	-132.40	1511.84	1427	1609	1507	15.98	31.77	4.58	346.87	17.94		1246	active	tongue	cirque, dv
	61.44	-133.00	1783.61	1721	1872	1781	25.47	36.38	9.88	314.68	6.39		1254	active	tongue	cirque
	61.42	-132.99	1524.32	1438	1639	1516	30.52	40.36	3.20	330.79	22.27		1264	active	tongue	cirque
	61.19	-132.39	1246.35	1175	1290	1253	12.44	21.19	7.54	17.62	13.77		1273	active	lobate	talus, cv, 3 lobes
	64.84	-135.14	1416.07	1287	1691	1378	20.96	44.71	0.75	311.43	80.46		1277	active	lobate	talus, multilobe
	64.75	-136.02	1464.10	1389	1529	1472	13.19	26.07	0.75	21.06	14.96		1280	active	tongue	cirque, d-v
	64.66	-136.44	1428.87	1355	1568	1431	17.35	50.47	5.43	351.49	14.78		1285	relict	lobate	talus
	64.57	-136.01	1426.54	1394	1473	1427	11.26	22.71	2.02	349.17	14.11		1290	active	tongue	talus, cv
	64.79	-135.14	1592.80	1537	1677	1590	20.13	39.41	2.72	4.51	19.44		1331	active	tongue	cirque, dv
	64.74	-135.08	1667.65	1579	1823	1654	32.35	45.12	7.36	300.54	22.03		1336	relict	tongue	cirque, dv
	64.72	-134.30	1517.69	1444	1634	1513	15.66	36.54	0.75	316.44	31.57		1345	active	both	cirque and tals, dv and cv
	64.71	-135.00	1611.61	1532	1727	1607	22.65	37.94	4.39	296.69	14.38		1348	active	both	cirque and talus
	64.71	-134.01	1578.92	1551	1651	1572	14.80	36.41	4.39	100.23	9.55		1349	active	lobate	talus, cv
	64.66	-134.15	1675.12	1567	1801	1668	25.52	49.26	4.53	88.66	29.94		1368	active	tongue	cirque, multilobe
	64.66	-134.37	1433.40	1383	1509	1427	16.75	32.86	2.16	301.73	21.52		1374	active	both	cirque
	64.64	-134.39	1913.91	1767	2068	1915	33.49	43.70	10.78	127.24	25.14		1380	active	tongue	cirque, 3 lobes, dv
	64.64	-134.37	1688.67	1581	1861	1676	23.80	44.40	5.43	226.46	35.82		1381	active	tongue	cirque, multilobe
	64.60	-134.24	1413.17	1322	1557	1416	19.87	39.37	1.07	2.84	34.94		1394	active	lobate	talus, cv, 2 RGs
	64.53	-134.15	1494.78	1448	1623	1485	20.86	41.56	0.48	156.15	20.64		1403	active	tongue	cirque
	64.47	-135.12	1352.39	1187	1559	1347	20.57	44.91	3.34	348.57	95.88		1406	active	tongue	cirque, multilobe
	64.46	-135.13	1391.12	1264	1544	1393	23.51	34.09	7.36	266.66	21.17		1407	inactive	tongue	cirque, lacks ridges
	63.75	-140.65	1418.42	1390	1457	1420	7.65	26.90	1.39	319.14	32.93		1427	inactive	tongue	cirque
	63.77	-140.44	1067.58	864	1308	1055	21.25	29.71	12.73	340.62	49.10		1433			no RG
	63.75	-140.44	1147.49	1042	1239	1147	13.28	21.78	8.84	7.70	28.92		1435			photos missing

activity - original geology map	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	mean aspect (directional mean)	area in hectares	Amaris' ID code	activity - air photo	morphology - air photo	comments - air photo	
	63.74	-140.49	1413.27	1373	1462	1410	10.27	14.43	6.85	154.52	14.72		1441		photos missing	
	63.69	-140.50	962.18	909	1022	960	12.14	19.18	7.59	91.40	26.42		1447		no RG	
	64.61	-138.46	1563.90	1404	1690	1574	30.39	41.87	20.78	242.38	13.62		1471	inactive	tongue	cirque
	64.62	-138.44	1604.66	1520	1681	1604	23.12	37.15	12.91	300.07	12.55		1472	inactive	tongue	cirque
	64.58	-138.37	1473.69	1354	1657	1459	22.83	41.66	10.44	317.92	21.70		1473			no RG in cirque
	64.54	-138.46	1406.03	1341	1497	1402	15.52	33.38	7.33	269.24	12.55		1477	active	tongue	talus, 3 lobes
	64.52	-138.12	1356.97	1225	1561	1357	19.54	37.20	1.91	273.70	58.35		1480	active	tongue	cirque
	61.34	-137.06	914.96	914	915	915	0.22	1.72	0.00	257.47	4.09		1503			lake
	61.35	-137.07	915.54	914	920	915	1.02	2.78	0.00	347.84	6.36		1504			lake
	61.00	-138.04	1513.36	1423	1595	1510	22.76	31.89	9.72	184.78	5.89		1507	inactive	tongue	cirque, winter photo
	60.28	-136.96	1149.17	1077	1211	1149	19.41	24.63	15.53	263.85	10.12		1511	relict	lobate	talus, forested
	60.22	-136.91	1301.75	1113	1558	1302	26.75	43.73	12.20	224.95	29.85		1512	active	tongue	cirque
	60.16	-136.64	1694.21	1632	1802	1692	18.44	47.82	0.68	19.72	15.43		1521	relict	lobate	forested, talus
unknown	60.13	-136.66	1558.61	1517	1615	1556	18.51	34.22	3.32	342.47	7.94		1523	active	tongue	cirque
active	60.24	-136.48	1804.77	1725	1940	1797	19.34	44.27	1.97	76.26	22.53		1531	active	tongue	cirque
active	60.17	-136.49	1778.95	1694	1963	1764	23.82	47.86	0.75	253.71	38.68		1536	active	tongue	cirque
active	60.22	-136.24	1575.57	1523	1610	1580	12.90	24.47	2.36	34.77	8.57		1539	active	tongue	cirque
active	61.68	-140.21	1677.66	1569	1790	1678	30.02	48.93	4.10	290.90	21.12		1554	active	tongue	cirque, dv
active	61.66	-140.21	1555.08	1489	1631	1554	18.64	38.34	5.01	221.16	23.24		1557	inactive	lobate	talus, cv
dormant	61.57	-140.02	1327.76	1210	1473	1322	32.43	41.06	9.05	210.57	8.98		1565	inactive	lobate	talus, big, cv
active	61.49	-139.60	1655.16	1535	1865	1639	27.25	44.17	9.76	352.75	26.53		1574	active	tongue	cirque, dv, debris-cov glac
active	61.35	-139.66	1602.75	1354	1805	1613	37.03	43.28	27.55	228.58	14.00		1577	relict	tongue	cirque, dv, forested
active	61.27	-139.34	1966.25	1925	1998	1968	8.09	15.25	4.39	15.10	11.59		1579	active	tongue	cirque, dv
active	61.21	-139.45	1395.56	1303	1515	1395	17.78	36.89	9.06	225.64	15.26		1588	active	lobate	talus, poss PTR
dormant	61.10	-139.19	1919.25	1783	2094	1909	32.25	37.39	26.98	248.55	5.65		1605	inactive	lobate	talus, cv
active	61.06	-139.17	1898.15	1777	2045	1887	29.93	38.44	20.92	247.60	6.49		1615	active	tongue	cirque, dv, debris-cov glac
unknown	61.09	-139.18	1918.21	1760	2100	1909	35.88	41.87	29.56	246.41	6.57		1617	inactive	lobate	talus, cv
dormant	61.12	-139.12	1640.69	1463	1860	1643	29.95	49.25	9.51	350.55	35.43		1624	active	lobate	talus, cv, had trees
dormant	61.03	-139.08	2348.51	2171	2566	2334	29.40	40.51	5.32	273.61	29.02		1642	active	tongue	cirque, dv, debris-cov glacier
dormant	61.23	-138.84	1317.89	1152	1468	1319	24.52	33.08	15.13	57.22	16.29		1662			not RG, dr chans in cir floor
unknown	61.51	-138.02	1756.31	1666	1804	1763	24.61	41.72	10.03	3.76	10.80		1671	relict	tongue	cirque, dv
	60.55	-137.21	1115.22	823	1700	1032	16.49	38.51	3.52	47.33	179.92	Beside KT	active	lobate		
	61.18	-138.45	843.56	781	971	828	27.62	40.20	3.63	200.78	5.68	CultusBay RG	relict	lobate		
	60.45	-137.09	1261.81	802	1767	1340	17.27	40.28	3.32	84.93	80.09	Dezadeash	active	both		
	60.70	-137.62	1558.12	1325	1803	1560	23.85	41.29	3.37	107.56	90.43	HJ	active	tongue	debris-covered glacier	
	60.71	-137.59	1200.38	824	1648	1172	11.46	27.43	1.01	40.53	290.56	HJ2	active	tongue	debris-covered glacier	
	60.69	-137.57	1221.08	973	1501	1237	10.74	34.44	0.00	27.80	308.85	HJ3	active	tongue	debris-covered glacier	

activity - original geology map	latitude	longitude	mean elevation	minimum elevation	maximum elevation	median elevation	mean slope	maximum slope	minimum slope	mean aspect (directional mean)	area in hectares	Amaris' ID code	activity - air photo	morphology - air photo	comments - air photo
	60.68	-137.52	1404.34	1209	1626	1415	12.66	27.02	0.75	42.62	79.10	HJ4	active	tongue	debris-covered glacier
	60.56	-137.24	1088.77	731	1717	1058	26.14	44.07	5.81	25.17	83.02	King's Throne	active	lobate	
	64.97	-138.26	1170.00	1089	1264	1168	29.19	31.13	26.57	35.89	3.86	N of 4	inactive	lobate	
	64.96	-138.19	952.12	935	1000	947	15.52	33.94	6.26	15.91	2.95	Neighbour to 5	active	lobate	
	60.71	-137.63	1330.98	971	1688	1338	20.91	42.99	6.05	13.07	86.20	NHJ1	active	tongue	debris-covered glacier
	60.72	-137.67	1334.22	1193	1431	1341	25.34	46.59	12.34	28.63	20.23	NHJ2	active	lobate	
	60.73	-137.70	776.31	608	1055	749	27.83	45.06	13.21	11.71	27.84	NHJ3	active	lobate	
	60.73	-137.71	759.74	676	962	729	17.05	37.82	3.11	18.38	25.30	NHJ4	active	tongue	
	60.74	-137.72	737.88	651	814	736	15.27	27.41	6.02	21.90	15.41	NHJ5	active	tongue	
	60.39	-133.85	1137.75	1013	1240	1142	15.67	27.00	4.90	67.08	63.45	Possible RG	active	lobate	
	60.82	-137.88	1762.06	1501	2054	1749	13.79	38.81	1.07	53.49	142.66	S of 1508	active	tongue	
	64.52	-138.21	1190.49	1125	1300	1171	15.52	29.15	0.68	176.14	18.19	TombLeft	inactive	lobate	
	64.51	-138.15	1465.47	1274	1648	1464	23.33	37.39	3.11	306.20	53.42	TombRight	inactive	tongue	
	61.80	-133.03	1205.37	1101	1334	1203	27.84	36.04	20.82	263.60	15.44	Unmked RG	active	lobate	

APPENDIX D - Comparison of field and air photo observations

Amaris' ID code	activity - field	morphology - field	comments - field	activity - air photo	morphology - air photo	comments - air photo	activity same	activity same w/in one class			
3	relict	tongue	visit #1: possibly a RG, looks detached from talus but could be due to surface collapse, visit #2: lots of veg: lichens, juniper, lab tea, cranberry, cloudberry, willow, etc., minimal surface morphology (i.e. ridges)	inactive	lobate	talus		1	lobate	lobate	24
4	inactive/relict		melt depression on surface between fronts 1 and 2	relict	lobate	talus, just scree?	1	1	lobate	tongue	23
5	active			active	lobate	talus	1	1	lobate		
12	inactive	tongue	on right side of same cirque as 189	active	tongue	cirque		1	tongue		
16	active	tongue	lateral ridges, doesn't have much of a headwall	relict	lobate	talus, vegd, just scree?			lobate		
26		tongue	not a RG, photos are of supposed location	relict	lobate	talus, just scree?			lobate		
27			visit #1: should be visible in better weather, visit #2: can't find a rock glacier here, could photos 4919, 4920 show what was marked as a rock glacier? I don't think it is; the headwall is more like a hill and there are two types of rock, red and grey; I think the "rock glacier" is just a grey rock outcrop.	inactive	tongue	talus, 2 lobes				tongue	
32	active		visit #1: veg is lichens, visit #2: large, heavily ridged surface but has low veg on surface and low toe angle; Blackstone River is between road/campground and rock glacier	active	tongue	cirque	1	1	tongue		
34	inactive		visit #1: possibly somewhat active; veg is lichens and short veg, few trees; at km post 68, visit #2: upper front has veg on sides with patches on surface and front, the middle front has patchy veg throughout and huge clasts, the lowest front is fully vegetated and the road runs along the bottom edge of the front. There are many smaller fronts in between formed by very strange troughs leading me to suspect that the upper front is a rg, the middle "front" is actually a series of frontal (push) moraines, and the lower front was a creeping ice-cored moraine which is now relict. active, 2nd visit actually climbed it and saw rhizocarpon geographicum on whole thing - maybe inactive?	active	lobate	talus			1	lobate	
39	inactive		think morphology is entirely due to rock fall, lower part has veg and is fan-shaped, flow is diagonal, upper has some volume and no veg, surface morphology is present but not pronounced (ridges and troughs), upper is tongue shaped	relict	lobate	talus, multilobe			1	lobate	
53	inactive	tongue		active	lobate	talus, no veg			1	lobate	
54	inactive		lower is well-treed, upper slope of RG has meltwater/drainage channels (therefore inactive?), talus slope is veg'd too therefore likely inactive	relict	lobate	talus, just scree?, no veg			1	lobate	
57	inactive		very wide, talus slope and just below are unveg'd, lower part is veg'd			no RG visible in cirque					

Amaris' ID code	activity - field	morphology - field	comments - field	activity - air photo	morphology - air photo	comments - air photo	activity same	activity same w/in one class
60	inactive	tongue	veg and meltwater channel to left of RG, can't see veg on upper part of RG, it is somewhat lumpy with more volume at the top than the bottom, lower part is vegetated, looks fairly flat and inactive despite lack of veg on upper	active	tongue	cirque		1 tongue
62	active		flat surface, talus above is veg'd - can it still be active?	active	tongue	cirque	1	1 tongue
63	active		quite lumpy, toe has a few trees on it and upper has low veg - can it still be active?	active	lobate	talus	1	1 lobate
70	inactive	tongue	trees at toe, low veg on rest, surface ridges present but not pronounced	relict	lobate	talus, veg'd, just scree?		1 lobate
74	relict	tongue		relict	lobate	talus, just scree?	1	1 lobate
954	active	tongue		active	tongue	cirque	1	1 tongue
959		tongue	is a scree slope	active	tongue	cirque		tongue
968				active	lobate	talus		lobate
987	active	tongue	above White River RV park	active	tongue	cirque, 2 coalescent RGs	1	1 tongue
1131		lobate	not a RG, photos are of supposed location	inactive	tongue	cirque		tongue
1149	active	tongue	this is a "debris-covered glacier"	active	tongue	cirque, multilobe	1	1 tongue
1150	inactive/relict	upper = tongue, lower = lobate/fan-shaped	if this is a RG, it is inactive/relict, highly veg'd	active	tongue	multicirque, multilobe		1 tongue
1162		wide tongue	in cirque, cross-cirque flow, looks talus-derived, can only see side profile, front looks steep-ish but is veg'd, upper talus unvegetated	inactive	tongue	cirque		tongue
1473		wide tongue	not a RG, it is a ridge running down the centre of a small cirque, there are bedrock outcrops on its surface			no RG in cirque		tongue
1511	inactive/relict	wide tongue	inconclusive - can't see toe, bottom area is vegetated and doesn't have a pronounced front, could be inactive/relict rock glacier, possibly a landslide, but not an active rock glacier	relict	lobate	talus, forested	1	1 lobate
1512		lobate	landslide	active	tongue	cirque		tongue
Beside KT	active	tongue	active upper, fully veg'd lower	active	lobate		1	1 lobate
CultusBay RG	inactive	lobate	upper slope (above where lower slope has been modified by the road) = 30, large platy schist, 3-300cm, avg - 50cm, well lichenized, well-developed soil on sides, trees on surface, possible collapse features on surface, waypoint taken on road surface, lobate-ish - very short, maybe 50m from front to back, road cuts straight across toe (no deformation and very little rock fall), toe ends in Klauane Lake, surface about 50-60m above lake surface	relict	lobate			1 lobate
Dezadeash	active	tongue	upper part is active - bent over trees, no lichens, rocks with impact marks, elev = 831m, middle front = 7007m, old bottom front = 679m, road = 650m	active	both		1	1 both

Amaris' ID code	activity - field	morphology - field	comments - field	activity - air photo	morphology - air photo	comments - air photo	activity same	activity same w/in one class		
HJ	active	tongue	vegetated front area, upper is unvegetated, highly ridged, and has a lot of volume	active	tongue	debris-covered glacier	1	1	tongue	
HJ2	active	tongue		active	tongue	debris-covered glacier	1	1	tongue	
HJ3	active	tongue		active	tongue	debris-covered glacier	1	1	tongue	
HJ4	active	tongue		active	tongue	debris-covered glacier	1	1	tongue	
King's Throne	active	lobate	2nd front from bottom elev = 817m, well-veg'd, 938m no more trees, top surface = 1251m	active	lobate		1	1	lobate	
N of 4	inactive	tongue	front is vegetated with low plants and trees so it is probably inactive, lots of rhizocarpon geographicum on front, this is a pebbly rock glacier with a platy matrix, possibly slate or shale; active, 2nd visit I said inactive because of veg	inactive	lobate		1	1	lobate	
Neighbour to 5	inactive/relict	tongue		active	lobate				lobate	
NHJ1	active	tongue		active	tongue	debris-covered glacier	1	1	tongue	
NHJ2	active	tongue		active	lobate		1	1	lobate	
NHJ3	active	lobate		active	lobate		1	1	lobate	
NHJ4	active	tongue		active	tongue		1	1	tongue	
NHJ5	inactive	lobate		active	tongue				tongue	
Possible RG	relict	tongue	treed	active	lobate				lobate	
S of 1508	active	lobate	ridges on toe	active	tongue		1	1	tongue	
Tomb Left	active	tongue	vegetated front with cracks (where movement has occurred?), cracks on sides and near top like a bergschrund, only upper talus is unveg'd, landslide-derived?	inactive	lobate				lobate	
Tomb Right	active	lobate	shape due to topo? Veg on surface but not on front, crack at top like a bergschrund - active? Landslide-derived?	inactive	tongue				tongue	
Unmked RG	active	lobate	upper part is active at least	active	lobate		1	1	lobate	
							sum	24	38	
							% of total	48.97959184	77.55102041	