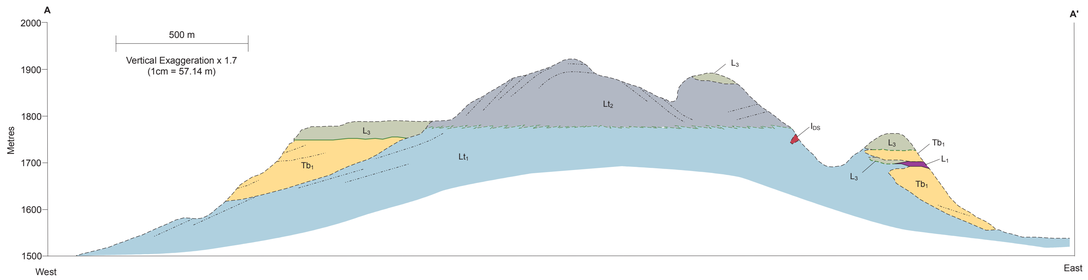

Figure 1. Cross-section A-A'.

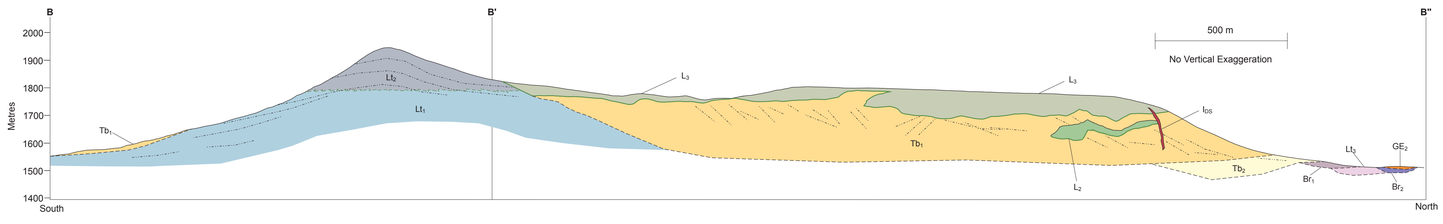

Figure 2. Cross-section B-B'-B".

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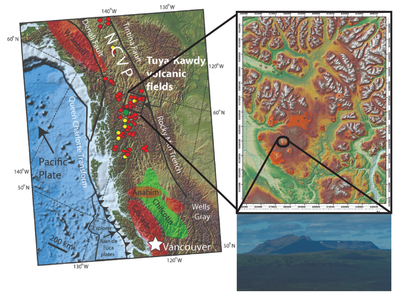


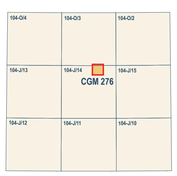
Figure 3. Regional map of the northern Cordilleran volcanic province (Edwards and Russell, 2000; Edwards et al., 2010). Highlighted is the volcano, informally named Kima'Kho, located within the Tuya-Kawdy volcanic field (right). Note photograph highlights explosive cone (left) and classic flat plateau of effusive lavas overlying pillow-bearing tuff breccias (looking west).

Abstract

This volcano, informally named Kima'Kho, is one of more than 30 Pleistocene volcanoes on the Tuya-Kawdy plateau of northern British Columbia that record interactions with the Cordilleran ice sheet. This basaltic glaciovolcano features deposits resulting from explosive and effusive eruptions at 1.9 Ma and hosts multiple passage zones (transition surfaces between subaqueous and subaerial deposits (Russell et al., 2013)). Lithofacies include explosive lapilli tuff cone-forming deposits dominating the southern flanks of the edifice, which are partially overlain to the north by lava-fed deltas comprising lavas and tuff-breccia. Late-stage intrusions are identified by geological field relationships and $^{40}Ar/^{39}Ar$ geochronology. Explosive and effusive deposits show textural and stratigraphical indicators that delineate 'passage zones'. Six prominent passage zones record depth fluctuations of ~160 m in the englacial lake. Based on estimates of maximum lake depths, the reconstructed minimum ice thickness is ~440 m.

Résumé

Ce volcan, connu sous l'appellation non officielle de Kima'Kho, compte parmi plus de 30 volcans du Pléistocène situés sur le plateau Tuya-Kawdy, dans le nord de la Colombie-Britannique, qui conservent les traces d'interactions avec l'Inlandsis de la Cordillère. Ce volcan basaltique sous-glaciaire exhibe des dépôts résultant d'éruptions explosives et effusives s'étant produites il y a 1,9 millions d'années et renferme plusieurs zones de passage (des surfaces de transition entre des dépôts subaquatiques et des dépôts subaériens (Russell et al., 2013)). Les lithofaciès comprennent des dépôts coniques de tufs à lapillis formés par des éruptions explosives qui dominent sur les flancs sud de l'édifice volcanique et qui sont en partie recouverts au nord par des deltas de lave constitués de coulées et de tuf bréchique. Des intrusions tardives ont été reconnues grâce aux relations géologiques sur le terrain et à la géochronologie Ar/Ar. Des indicateurs texturaux et stratigraphiques à l'intérieur des dépôts d'éruptions explosives et effusives délimitent des « zones de passage ». Six grandes zones de passage rendent compte de variations de la profondeur d'environ 160 m dans le lac intraglaciaire. Selon les estimations de la profondeur maximale du lac, l'épaisseur minimale de la glace reconstituée serait d'environ 440 m.



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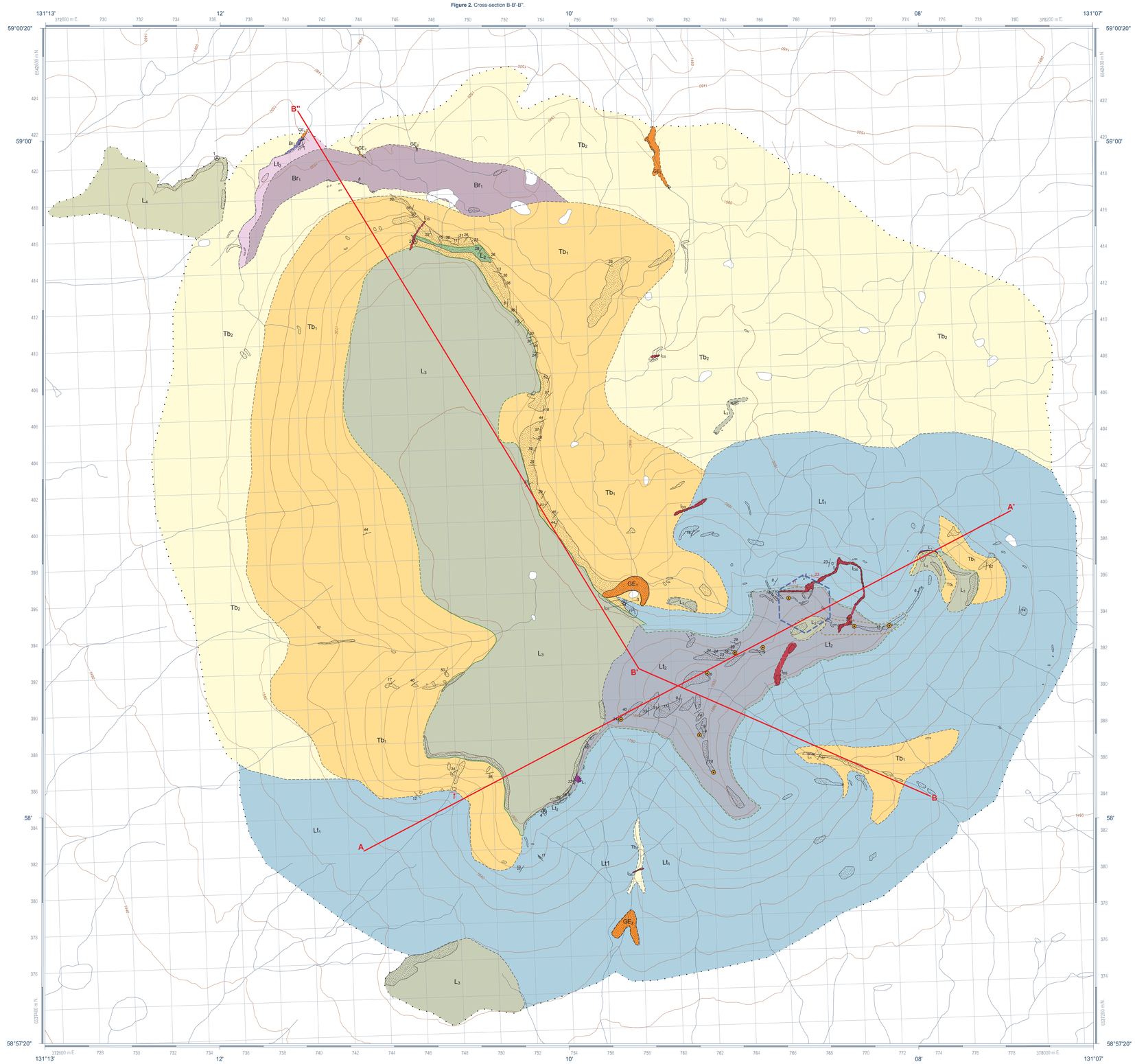
CANADIAN GEOSCIENCE MAP 276

BEDROCK GEOLOGY

(GLACIO-) VOLCANO WITHIN THE TUYA FORMATION, AT KAWDY MOUNTAIN

British Columbia

1:10 000



Glacial and Erosional Deposits

GE1-2 **Post-eruptive, glacially eroded deposits and mass wasting of volcanic edifice:** Glacial and/or mass wasting deposits; 1 - Unconsolidated, poorly sorted, angular blocky, clast-supported talus of basalt debris from overlying lava in northeastern cirque; 2 - Massive to crudely bedded, matrix-supported polymict, normally graded, sub-angular to rounded silty glacially transported moraine.

Coherent-Extrusive

L4 **Olivine-phyric, massive, columnar basalt lavas:** Dark grey, moderately olivine-phyric, fine-grained, moderately vesicular, basalt: subhedral, embayed olivine phenocrysts (8% vol; 0.1–1.5 mm), trachytic groundmass displaying abundant plagioclase (0.05–0.2 mm) with minor olivine (<1%), clinopyroxene (<2%) and oxides (1%); outcrop features massive curving-to-planar vertical columns ~50–80 cm diameter with elongate vesicles (<5% vol.), flaggy jointing, and bears rare white, crystalline, altered xenoliths.

Coherent-Intrusive

Ios **Plagioclase-olivine-phyric, weakly vesicular basalt sills and dykes:** Grey to dark grey, variably olivine-phyric (8–15% vol., 0.5–3 mm) or olivine-plagioclase-phyric (5–10% combined volume [OI 30–60%, Pl 70–40%], 0.5–5 mm), fine-grained, weakly vesicular basalt; Groundmass dominated by sub-ophitic plagioclase laths (0.1–1 mm) in pyroxene with subordinate olivine (0.1 mm) and oxides (0.2 mm). Outcrops vary from linear, centimetre- to decimetre-thick, vertical to horizontal intrusions and large scale, irregular plug-like intrusive masses, tens of metres across. Common features include columnar and radial joints, fine-grained peperitic and glassy, sometimes locally pillowed margins, and associated black, glassy to aphanitic, poorly consolidated highly vesicular to scoriaceous lapilli-sized clasts along margins.

Coherent-Extrusive

L3 **Moderately olivine-plagioclase-phyric, massive, columnar basalt lavas:** Grey, moderately olivine-plagioclase-phyric weakly to moderately vesicular aphanitic basalt: isolated skeletal anhedral olivine with overgrowths (35% vol., 0.5–2 mm), and euhedral oscillatory zoned plagioclase (2–5% vol., 1–5 mm), both showing variable resorption features and commonly glomerocrystic. These massive, columnar jointed lavas vary laterally in dominant phenocryst and groundmass size (Southern lava fine-grained groundmass, plagioclase laths 0.1–0.2 mm; Northern lava fine- to medium-grained plagioclase ~0.5–1 mm and sub-ophitic texture).

L2 **Weakly olivine-plagioclase-phyric, massive, basalt lava:** Grey, weakly olivine-plagioclase phyric, fine-grained, moderately vesicular basalt: isolated euhedral olivine (3% vol., 1–3 mm) and plagioclase (2% vol., 1–3 mm) phenocrysts, groundmass dominated by plagioclase laths (0.2–0.8 mm) and sub-ophitic pyroxene (0.5–1 mm) with minor olivine (~<0.2 mm), and irregular stretched vesicles (3% vol., ~0.2 mm). Occurs as massive, weakly columnar jointed lava flows.

L1 **Densely piled pillow basalts:** Grey to black, vitreous, variably olivine-plagioclase-phyric, weakly radially vesicular, variably glassy selvaged, densely packed intact pillow basalts +/- minor fine-grained intra-pillow ash matrix (peperite). Pillows are generally elongate and convex upwards (30 cm–2 m).

Volcaniclastic-Effusive Units

Tb2 **Massive to weakly bedded, poorly sorted, vitriclast bearing, palagonitised tuff breccia:** Orange-brown moderately palagonitised, weakly bedded, poorly sorted, fine-grained (0.2–0.1 mm) sideromelane rich matrix-supported basalt lithic-bearing tuff breccia. Basalt fragments (20% vol., 1–40 cm) are angular to subrounded, dense to weakly vesicular, and occur both randomly dispersed and concentrated in channelised lenses <80 cm wide. Interbedded with rare horizons of fine-grained, well sorted ash tuff with angular ash to lapilli-sized glass shards.

Tb1 **Weakly to well bedded, pillow bearing, palagonitised tuff breccia:** Orange-black, moderately to heavily palagonitised, vitreous fine- to medium-grained matrix-supported, pillow and lithic-bearing basaltic tuff breccia. Pillow morphology varies from circular and elongate coherent whole pillows (0.2–1 m) to ~50 cm wide sheet flows that both conform with and crosscut bedding. Lithic clasts are of variably vitreous to aphanitic, dense- to moderately-vesicular, angular (1 cm–60 cm, 30% vol.) basalt.

Volcaniclastic-Non-Primary Units

Br1 **Massive, poorly sorted accessory lithic bearing breccia:** Tan to beige, massive, crystal- and lithic-rich, matrix-supported (80% vol., <0.2 mm), poorly sorted, vitriclast-bearing breccia. Lithics range petrologically, including accessory lavas and are angular to subrounded (5% vol., 0.5–5 mm). Fresh sideromelane juvenile, vesicular clasts are intact and angular (3% vol., 0.5–1 mm). Variably palagonitised, blocky, vitreous, crystal-bearing pillow rinds are present in low abundance (<2% vol., 1–3 mm).

Br1 **Massive, vitriclast bearing, lapilli ash breccia:** Grey, unaltered, massive, lithic- and vitriclast-rich, matrix-supported, lapilli breccia. Ash matrix (60% vol. <0.1 mm) consists of blocky, curvilinear sideromelane shards (90% total) and curved, intact, bubble junctions (10%). Vitriclasts are variably vesicular with some showing elongate, <0.05 mm tube vesicles and irregular boundaries. Lithics are consistent with juvenile extrusive lithologies and likely represent lava fragments, though most are angular and thus represent limited transportation.

Volcaniclastic - Pyroclastic Units

Lt3 **Crudely bedded, moderately well sorted, scoriaceous ash and lapilli:** Black-brown, weak to moderately palagonitised, well sorted, crudely stratified, crossbedded, lapilli clast-supported, poorly consolidated, highly vesicular.

Lt2 **Massive to crudely bedded, poorly sorted lapilli tuff:** Beige-tan, unaltered to lightly palagonitized, poorly sorted predominantly ash matrix-supported massive to locally crudely bedded, lapilli tuffs, with subrounded to angular lapilli to block (<30 cm) sized dense to moderately vesicular, basalt clasts, locally cross-bedded, discontinuous, moderately sorted, clast-rich horizons, and isolated to densely packed horizons of armoured lapilli.

Lt1 **Massive to well stratified, moderately well sorted lapilli tuff:** Grey-tan, weak to moderately palagonitised, moderately well sorted, ashy matrix-to-clast-supported lapilli tuffs. Outcrops vary from massive and homogeneous to well laminated (1–10 cm) laterally continuous beds commonly defined by centimetre-scale horizons and lenses of variably vesicular, aphanitic to vitreous lapilli clasts. Increased sorting and crossbedding are present in some poorly consolidated, black-brown, scoriaceous, moderately sorted lapilli tuffs, which also display partially disaggregated ashy accretions around lapilli.

- Outcrop examined
- Defined geological contact
- Inferred geological contact
- Passage zones; defined transition between subaqueous to subaerial deposits
- Passage zones; inferred transition between subaqueous to subaerial deposits
- Extent of mapped pleistocene volcanic deposits
- Region of decimetre-sized ballistic clasts
- Inferred vent location
- $^{40}Ar/^{39}Ar$ age and sample number (*see* Table 1)
- Armoured lapilli
- Bedding strike and dip
- Contact strike and dip
- Strike and dip of dyke cooling joints
- Lines of cross-section
- Apparent dip in cross-sections (shown in cross-section figures only)

Number	Sample	Easting	Northing	Elevation (m)	Age (ka)	Age Error
1	MT-14-102	373599	6542041	1522	1531.4	13.8
2	MT-14-132	374670	6541549	1712	1986.1	30.2
3	MT-14-106	375754	6539534	1753	1880.4	19.3
4	MT-14-153	375277	6538402	1773	1982.2	35.4

Table 1. $^{40}Ar/^{39}Ar$ radiometric age.

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Geological Survey of Canada
Canadian Geoscience Maps

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Authors: M. Turnbull, J.K. Russell, B.R. Edwards, and L. Porritt

Geology by M. Turnbull, with contributions from J.K. Russell, B.R. Edwards and L. Porrit, 2015

Geological compilation by M. Turnbull and B.R. Edwards, 2015

Geology conforms to Bedrock Data Model v. 4.0.0

Geomatics and cartography by R. Cocking

Joint initiative of the Geological Survey of Canada and the University of British Columbia, conducted under the auspices of the Cordillera Project as part of Natural Resources Canada's Geo-mapping for Energy and Minerals (GEM) program

Map projection Universal Transverse Mercator, zone 9. North American Datum 1983

Base map at the scale of 1:50 000 from Natural Resources Canada, with modifications. Elevations in metres above mean sea level

CANADIAN GEOSCIENCE MAP 276

BEDROCK GEOLOGY

(GLACIO-) VOLCANO WITHIN THE TUYA FORMATION, AT KAWDY MOUNTAIN

British Columbia

1:10 000

250 0 250 500 750 1000m

Magnetic declination 2016, 20°06'E, decreasing 18.5' annually.

This map is not to be used for navigational purposes.

Title photograph: Kima'Kho volcano, northwestern British Columbia. Photograph by B.R. Edwards. 2016-002

The Geological Survey of Canada welcomes corrections or additional information from users.

Data may include additional observations not portrayed on this map. *See* map info document accompanying the downloaded data for more information about this publication.

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CANADIAN GEOSCIENCE MAP 276

BEDROCK GEOLOGY

(GLACIO-) VOLCANO WITHIN THE TUYA FORMATION, AT KAWDY MOUNTAIN

British Columbia