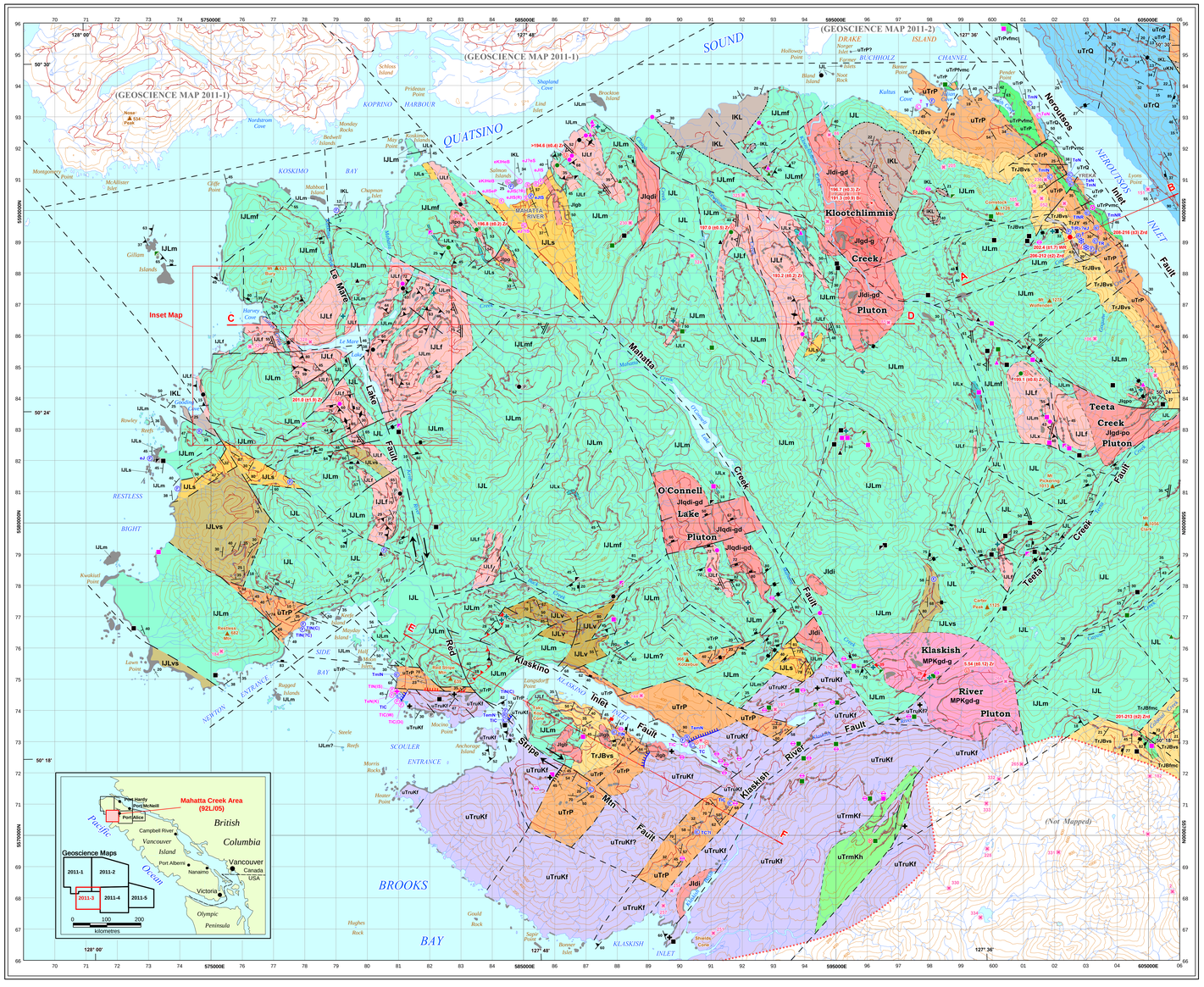


BC Geological Survey

GEOSCIENCE MAP 2011-3

Geology, Geochronology, Lithogeochemistry and Metamorphism of the Mahatta Creek Area, Northern Vancouver Island

NTS 092L/05

G.T. Nixon, J.L. Hammack, J.V. Hamilton, H. Jennings, J. P. Larocque, A.J. Orr, R.M. Friedman, D.A. Archibald, R.A. Creaser, M.J. Orchard, J.W. Haggart, H.W. Tipper, E.T. Tozer, F. Cordey and C.A. McRoberts

PALEONTOLOGY by
M.J. ORCHARD, E.T. TOZER, H.W. TIPPER and J.W. HAGGART (Geological Survey of Canada)
F. CORDEY (University of Lyon, France)
C.A. McROBERTS (SUNY, Cortland)

GEOLOGY by
G.T. NIXON, J.L. HAMMACK, J.V. HAMILTON, H. JENNINGS, J.P. LAROCQUE and A.J. ORR
(BC Geological Survey)

GEOCHRONOLOGY by
R.M. FRIEDMAN (The University of British Columbia)
D.A. ARCHIBALD (Queen's University)
R.A. CREASER (University of Alberta)

0 2 4
kilometres
Scale 1:50 000

LAYERED ROCKS

UPPER CRETACEOUS
NANAIMO GROUP EQUIVALENTS (IN PART)
Campanian to ?Maastrichtian

uKN — Grey to greenish grey and brown, medium to coarse-grained, arkosic to lithic wacke, pebble to cobble conglomerate, siltstone and minor coal; locally fossiliferous

LOWER CRETACEOUS
Upper Valanginian to Barremian
LONGARM FORMATION EQUIVALENTS

IKL — Greenish to brownish grey, thinly bedded to massive sandstone, siltstone, mudstone, pebble conglomerate and minor coal; locally fossiliferous

UPPER TRIASSIC TO LOWER JURASSIC
BONANZA GROUP
Lower Jurassic (Hettangian to Upper Sinemurian)
LE MARE LAKE VOLCANIC UNIT

IJL — Undifferentiated basaltic to rhyolitic flows and pyroclastic rocks (mainly subaerial); includes ash-flow and rare airfall tuff and reworked equivalents, minor pillow lava, pillow breccia, hyaloclastite and rare pyroclastic surge deposits, locally intercalated with marine to non-marine volcanic conglomerate, sandstone, siltstone, mudstone, impure limestone and debris-flow deposits

IJLm — Dark grey-green, basaltic to andesitic flows with minor intercalated volcaniclastic and sedimentary lithotypes similar to unit IJLvs; locally includes minor pillow lava/breccia; may include minor rhyolitic flows and pyroclastic rocks

IJLmf — Mainly bimodal basaltic and rhyolitic flows and pyroclastic rocks with subordinate, intercalated volcaniclastic and sedimentary lithotypes similar to unit IJLvs

IJLf — Medium grey, rhyolitic to dacitic flows, flow domes and/or pyroclastic rocks, including flow and pyroclastic breccias, welded to non-welded crystal-lithic lapilli tuff and rare airfall tuff; aphanitic to feldspar-phyric; may include thin interbedded sedimentary deposits and minor basaltic to andesitic flows

IJLx — Dark grey-green, plagioclase-megacrystic (0.8-2cm), variably amygdaloidal basaltic to andesitic flows; locally intercalated with aphanitic and plagioclase-phyric flows; texturally similar to plagioclase-megacrystic Karmutsen basalt in unit uTruKf

✚ — Small outcrop of plagioclase-megacrystic basaltic to andesitic flows of unit IJLx; texturally similar to plagioclase-megacrystic Karmutsen basalt in unit uTruKf

IJLv — Dark grey-green, basaltic to andesitic volcanic breccia of epiclastic and pyroclastic origin, and variably reworked lithic-crystal tuff; locally includes fine-grained sedimentary interbeds

IJLs — Grey-green sedimentary strata including impure limestone, calcareous to non-calcareous mudstone, shale, siltstone, sandstone and tuffaceous equivalents; may include minor intercalated tuff and volcaniclastic breccia

IJLvs — Interbedded volcaniclastic and sedimentary strata; includes lithic and crystal-lithic lapilli tuff and reworked equivalents, pyroclastic and epiclastic volcanic breccia, sandstone, siltstone, mudstone, impure limestone, and minor debris-flow and phreatomagmatic deposits; may include minor lava flows

Upper Triassic (Rhaetian) to possibly Lower Jurassic (Hettangian)
VOLCANICLASTIC-SEDIMENTARY UNIT

TrJBvs — Interbedded volcaniclastic and sedimentary strata (predominantly submarine): buff to grey-green, thin to very thickly bedded, calcareous to non-calcareous, volcanic breccia, lithic and feldspathic wacke, siltstone and limestone, locally coralline; lithic-crystal tuff, lapilli tuff and reworked equivalents; and minor vitric tuff, pebbly sandstone, siltstone, and volcaniclastic debris-flow deposits; may include black carbonaceous shale, mudstone, siltstone and limestone (locally coralline) equivalent to unit TrJY

TrJY — Yreka shale-limestone unit: black carbonaceous or graphitic shale passing upward into black to medium grey, thin to medium-bedded, variably carbonaceous, silty limestone with shale partings, concretionary limestone, mudstone and siltstone; locally fossiliferous; may be included in unit TrJBvs where not mapped separately (or pass laterally into coarser-grained clastic deposits)

TrJBfmc — Dark grey-green basaltic flows and minor volcaniclastic breccia and lapilli tuff; aphanitic to coarsely clinopyroxene-plagioclase±olivine-phyric

Upper Triassic (Carnian to Rhaetian)
PARSON BAY FORMATION

uTrP — Medium grey to black, thinly laminated to medium bedded, impure limestone, calcareous to non-calcareous mudstone, siltstone and shale intercalated with variable proportions of grey-green lithic feldspathic/tuffaceous wacke, minor crystal-lithic tuff and reworked equivalents, volcaniclastic breccia and debris-flow deposits, and rare vitric tuff, pebbly sandstone and conglomerate; shale locally yields abundant thin-shelled bivalves (Halobia sp., Monotis sp.); limestone locally contains rare algal structures; may include coralline limestone (Sutton limestone equivalent in part; see below) near the top of the succession

❄ — Sutton limestone equivalent: thin (<10m) unit of pale to medium grey, massive reefoid limestone near the top of the Parson Bay Formation; contains silicified corals and other fossils; likely equivalent in part to Sutton limestone in the Cowichan Lake area, southern Vancouver Island

uTrPvmc — Dark grey-green, basaltic tuff-breccia, lapilli tuff and reworked equivalents; aphanitic to coarsely clinopyroxene-plagioclase±olivine-phyric; may include minor limestone, wacke, siltstone and mudstone

uTrPvmo — Dark grey-green basaltic flows and lesser volcaniclastic breccia and lapilli tuff; aphanitic to coarsely clinopyroxene-plagioclase±olivine-phyric

uTrPvfmc — Dark grey-green tuff-breccia, crystal-lithic lapilli tuff and lesser basaltic flows; aphanitic to coarsely clinopyroxene-plagioclase±olivine-phyric; may include minor limestone, wacke, siltstone and mudstone

LAYERED ROCKS (cont'd)

UPPER TRIASSIC
VANCOUVER GROUP
Upper Triassic (Carnian to Lower Norian)
QUATSINO FORMATION

uTrQ — Medium to pale grey, thinly bedded to massive micritic limestone and locally bioclastic limestone; minor silica replacement and chert nodules; rare laminated interbeds, oolitic layers and algal structures; locally fossiliferous; unit is very thin (<40m) on the west coast of northern Vancouver Island

Upper Triassic (Carnian; possibly Middle Triassic (Ladinian) at the base)
KARMUTSEN FORMATION
Upper Karmutsen Formation: Flow Member

uTruKf — Dark grey-green, aphanitic to plagioclase-phyric and minor plagioclase-megacrystic basalt flows, commonly amygdaloidal and locally exhibiting laminar flow features (vesicle trains) and pipe vesicles; may include minor pillow lava and hyaloclastite

✚ — Small outcrop of dark grey-green, plagioclase-megacrystic (1-2cm) basalt flow; commonly amygdaloidal and locally exhibiting trachytoid texture; intercalated with aphanitic or plagioclase-phyric basalt near the top of the succession

▼ — Thin (0.5-5m) beds of pale to medium grey, micritic to rarely bioclastic limestone intercalated with basalt flows near the top of the flow succession

Middle Karmutsen Formation: Hyaloclastite Member

uTrmKh — Dark grey-green, massive to medium bedded, basaltic hyaloclastite breccia, including pillow-fragment breccia, and medium bedded to laminated hyaloclastite sandstone; may locally pass laterally into pillowed basalt flows

uTrmKf — Dark grey-green, variably amygdaloidal basalt flows; typically aphanitic

INTRUSIVE ROCKS

TERTIARY (LATE MIOCENE; ca. 5.5 Ma)
KLASKISH PLUTONIC SUITE

MPKgd-g — Pale greenish to pinkish grey, medium-grained, equigranular biotite-hornblende granodiorite, biotite-hornblende-quartz-plagioclase porphyry and granite-granophyre (gd-g)

EARLY JURASSIC (ca. 196.7 Ma)
ISLAND PLUTONIC SUITE

Jl — Dark grey-green to pale pinkish grey, medium to coarse-grained, equigranular granitoid rocks and porphyry; includes gabbro (gb), hornblende±biotite-bearing diorite (di), quartz diorite (qd), granodiorite (gd), granite (g), hornblende±biotite-plagioclase porphyry (po) and quartz-plagioclase±biotite porphyry (qpo); combined codes indicate a range of common rock types (qd-gd, quartz diorite - granodiorite)

Jlgd-g — Pale pinkish grey, medium to coarse-grained, equigranular biotite-hornblende granodiorite-granite core of the Klootchlimmis Pluton

Minor Intrusions
LATE TRIASSIC TO EARLY JURASSIC

✚ — Dark grey-green, plagioclase-megacrystic basaltic dike/sill coeval with similar lavas (IJLx) in the Le Mare Lake volcanic unit

○ — Dark grey-green, clinopyroxene-plagioclase±olivine porphyry coeval with mineralogically similar lavas in the lower part of the Bonanza Group (units TrJBfmc/uTrPvmc/uTrPvfmc/uTrpvfmc)

Selected References

Carruthers, A. H. and Stanley, G. D., Jr. (2008): Late Triassic silicified shallow-water corals and other marine fossils from Wrangellia and the Alexander terrane, Alaska and Vancouver Island, British Columbia; in Blodgett, R. B. and Stanley, G. D., Jr., editors, The Terrane Puzzle: New Perspectives on Paleontology and Stratigraphy from the North America Cordillera; Geological Society of America Special Paper 442, pages 151-179.

Hopkin, E. K. (2009): Late Carnian (Late Triassic) conodont and ammonoid paleontology of Wrangellia; unpublished M.Sc. thesis, The University of British Columbia, 108 pages.

Janousek, V., Farrow, C. M. and Erban, V. (2006): Interpretation of whole-rock geochemical data in igneous petrology: introducing Geochemical Data Toolkit (GCDkit); Journal of Petrology, Volume 47, pages 1255-1259.

Jeletzky, J. A. (1976): Mesozoic and ?Tertiary Rocks of Quatsino Sound, Vancouver Island, British Columbia; Geological Survey of Canada, Bulletin 242, 243 pages.

Muller, J. E. and Roddick, J. A. (1983): Geology, Alert Bay - Cape Scott, British Columbia; Geological Survey of Canada, Map 1552A, scale 1:250 000.

Muller, J. E., Northcote, K. E. and Carlisle, D. (1974): Geology and mineral deposits of Alert Bay - Cape Scott map area, Vancouver Island, British Columbia; Geological Survey of Canada, Paper 74-8, 77 pages.

Stanley, G. D., Jr. (1989): An Upper Triassic reefal limestone, southern Vancouver Island, British Columbia; Canadian Society of Petroleum Geologists, Memoir 13, pages 766-755.

Steiger, R. H. and Jäger, E. (1977): Subcommission on geochronology: convention on the use of decay constants in geo- and cosmochronology; Earth and Planetary Science Letters, Volume 6, pages 359-362.

Streckeisen, A. and LeMaitre, R. W. (1979): A chemical approximation to the modal QAPF classification of the igneous rocks; Neues Jahrbuch für Mineralogie Abhandlungen, Volume 136, pages 169-206.

Wilson, P. R. (1955): The geology and mineralogy of the Yreka copper property, Quatsino Sound, British Columbia; unpublished M.Sc. thesis, The University of British Columbia, 81 pages.

MAP SYMBOLS

- Geological contact, defined
- Geological contact, approximate
- Geological contact, inferred
- Steeply dipping fault, defined
- Steeply dipping fault, approximate
- Steeply dipping fault, approximate, right-lateral offset
- Steeply dipping fault, inferred
- Reverse fault, defined (teeth on upper plate)
- Reverse fault, inferred (teeth on upper plate)
- Unconformity, defined
- Unconformity, approximate
- Unconformity, inferred
- Thin (<40m) tectonic sliver of Quatsino limestone adjacent to fault
- Thin (<40m) unit of Quatsino limestone in stratigraphic contact
- contact with Karmutsen and Parson Bay formations
- Thin (<10m) unit of Yreka shale-limestone (TrJY) truncated by fault at top of Parson Bay Formation
- Limit of mapping
- A — B Line of vertical cross-section
- Outcrop examined
- Outcrop too small to show at map scale

Structure

- 30 Bedding, inclined, vertical
- 14 Volcanic flow lamination, inclined, vertical
- 30 Eutaxitic foliation/welding, inclined
- 64 Plutonic flow lamination, inclined, vertical
- 56 Dike, inclined, vertical
- 70 Tertiary dike, inclined, vertical
- 27 Axis of minor fold, inclined
- 17 Axial plane of minor fold, inclined
- 17 Lineation, inclined, horizontal (slickenfibres on steeply dipping fault)

Fossils

- TRN Macrofossil locality (fossil age code below; identification by E. T. Tozer, H. W. Tipper, J. W. Haggart and C. A. McRoberts)
- TC(W) GSC Macrofossil locality (fossil age code below)
- TC Conodont locality (fossil age code below; identification by M. J. Orchard)
- TxN GSC Conodont locality (fossil age code below; identification by M. J. Orchard)
- T Radiolarian locality (fossil age code below; identification by F. Cordey)

Fossil age designation
T Late Triassic; J Jurassic; K Cretaceous
e early; m middle; l late

Late Triassic: C Carnian; N Norian; R Rhaetian
Jurassic: S Sinemurian; P Pliensbachian
Cretaceous: H Hauterivian; B Barremian
Ammonite Zone: (Di) Dilleri; (W) Welleri; (K) Kerri; (R) Rutherfordi; (C) Cordillerarius; (S) Suessi
l lower
(no label indicates age indeterminate; combined codes indicate age/zone range)

Geochronology

- 196.7 (±0.3) Zr — U-Pb zircon date (Ma, 2 sigma error); Zrd, detrital zircon (determined by R. M. Friedman)
- 202.4 (±1.7) WR — Re-Os whole-rock isochron date, carbonaceous shale-mudstone (Ma, 2 sigma error; determined by R. A. Creasor)
- 181.3 (±0.9) Bi — $^{40}Ar/^{39}Ar$ date (Ma, 2 sigma error); Bi, biotite (determined by D. A. Archibald)

Metamorphism

- Hornblende hornfels facies: hornblende+plagioclase±epidote±quartz
- Upper greenschist facies: actinolite+chlorite+albite±epidote±quartz ±calcite
- P Prehnite-pumpellyite facies mainly: pumpellyite±prehnite+chlorite+albite ±epidote±quartz±calcite

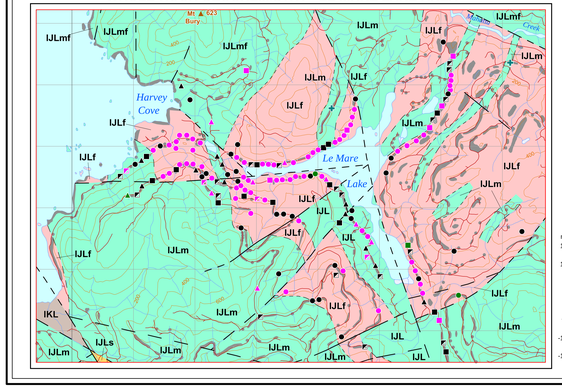
Mineralization

- 52 MINFILE locality (092L 052)

Topography

- Lake
- Flooded land (swamp)
- Stream or river
- Contour (100m)
- 639 Spot height (m)
- Road (gravel)

WHOLE-ROCK GEOCHEMISTRY - LE MARE LAKE AREA



Approximate mean magnetic declination February 2011 for centre of map area: 18 degrees 25 minutes east, decreasing annually 12.3 minutes per year

Base Map Information

Base map produced from digital TRIM (Terrain Resource Inventory Management) 1:20 000-scale topographic database, British Columbia Ministry of Natural Resource Operations.

North American Datum 1983 (NAD83). Universal Transverse Mercator Projection (Zone 9). Elevation in metres above mean sea level. Contour interval 100m.

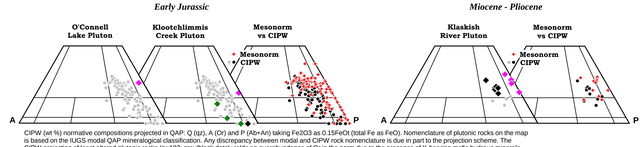
Data Compilation
G. T. Nixon, M. C. Kelman, K. A. Johnston and R. D. M. Rayner

Digital Cartography
G. T. Nixon

WHOLE-ROCK GEOCHEMISTRY LEGEND

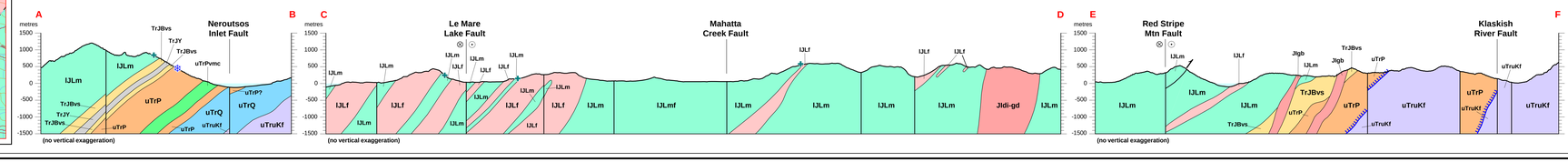
Classification SiO_2 wt %	(MgO>12 wt %) Picrite < 53	Basalt < 53	Basaltic Andesite >53 < 57	Andesite >57 < 63	Dacite-Rhyolite > 63	Plutonic Rocks
Volcanic Rocks						*Major Intrusions*
Least altered	■		◪	▲	●	◆
Alkali metasomatized	■		◪	▲	●	◆
Severely altered *	■		◪	▲	●	◆

* High proportions of veinlets and/or amygdule fillings, or pervasive fine-grained alteration, commonly involving chlorite, epidote, albite, calcite, quartz, sericite, prehnite, zeolites and clay minerals, and less commonly actinolite, potassium feldspar and pumpellyite.



CIPW (wt %) normative compositions projected in QAP: Q (qz), A (Or) and P (Ab+An) taking Fe2O3 as 0.15FeOt (total Fe as FeO). Nomenclature of plutonic rocks on the map is based on the IUGS modal QAP mineralogical classification. Any discrepancy between modal and CIPW rock nomenclature is due in part to the projection scheme. The CIPW projection of least altered plutonic rocks (n=107; grey/black dots) yields an overabundance of Or in the norm due to the presence of K-bearing mafic hydrous minerals (biotite, hornblende) relative to the mesonorm (red crosses); the latter produces a bias towards tonalite in the granitoid rocks (not a common rock type) whereas the CIPW projection shows bias towards quartz monzodiorite (much less common than quartz diorite).

ag, alkali-feldspar granite; g, granite; gd, granodiorite; m, tonalite; aps, alkali-feldspar qz syenite; qs, qz syenite; qm, qz monzonite; qmd/qmg, qz monzodiorite/qz monzo-gabbro; qd/qgb, qz diorite/qz gabbro; as, alkali-feldspar syenite; sy, syenite; mz, monzonite; md/mg, monzodiorite/monzogabbro; ddgb, diorite/gabbro



Notes

All isotopic dates are calculated using the decay constants recommended by Steiger and Jäger (1977); recent estimates of K decay constants would increase the $^{40}Ar/^{39}Ar$ age by ca. 1%.

Geochemical analyses in the Le Mare Lake area (see inset) were generously provided by Minnova Inc.

Acknowledgments

We sincerely appreciate the warm hospitality shown to us by the residents of northern Vancouver Island. We thank Dave Heberlein, Cam DeLong and the crew of Minnova Inc., for freely sharing geological information, donation of whole-rock chemical analyses and memorable "New England crab bakes" at Gooding Cove. Western Forest Products Inc., and Le Mare Lake Logging Ltd., kindly provided maps of logging roads in the area. Critical reviews by L. J. Diakow, N. W. D. Massey, J. L. Nelson and P. Schiarizza greatly improved the final cartographic product. Sadly, two of our co-authors, Drs. E. T. Tozer and H. W. Tipper of the Geological Survey of Canada, passed away recently; their contributions to invertebrate palaeontology will be sorely missed.

Recommended Citation

Nixon, G. T., Hammack, J. L., Hamilton, J. V., Jennings, H., Larocque, J. P., Orr, A.J., Friedman, R. M., Archibald, D. A., Creaser, R. A., Orchard, M. J., Haggart, J. W., Tipper, H. W., Tozer, E.T., Cordey, F. and McRoberts, C.A. (2011): Geology, geochronology, lithogeochemistry and metamorphism of the Mahatta Creek area, northern Vancouver Island; BC Ministry of Energy and Mines, Geoscience Map 2011-3, 1:50 000 scale.