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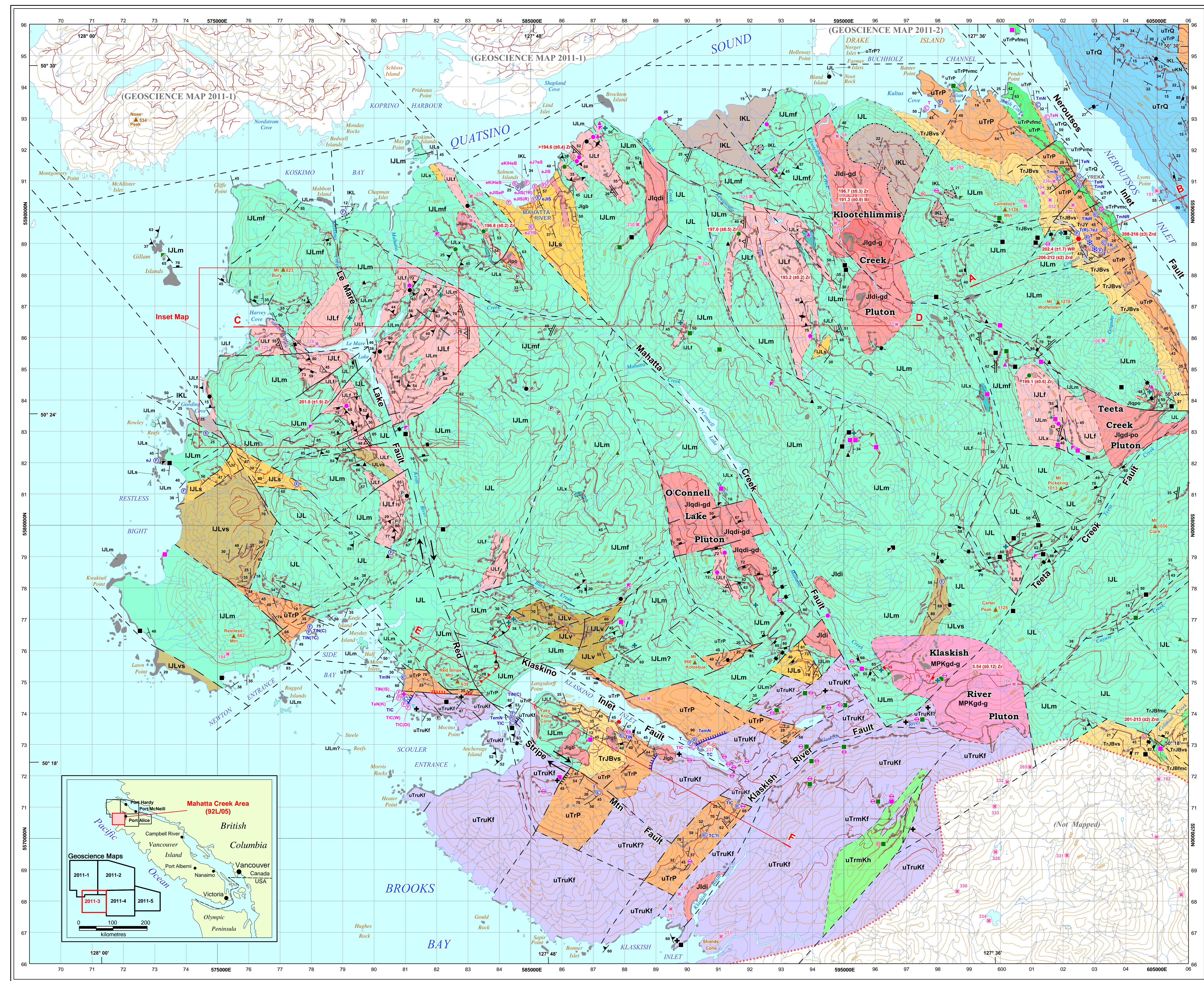
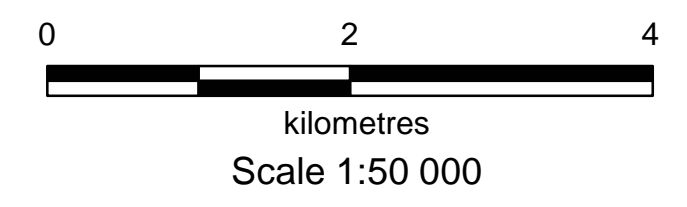
Geology, Geochronology, Lithogeochemistry and Metamorphism of the Mahatta Creek Area, Northern Vancouver Island

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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. LAROQUE and A.J. ORR (BC Geological Survey)

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



LAYERED ROCKS

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

LOWER CRETACEOUS
Upper Valanginian to Barremian
LONGARM FORMATION EQUIVALENTS

UPPER TRIASSIC TO LOWER JURASSIC BONANZA GROUP
Lower Jurassic (Hettangian to Upper Sinemurian)

- uTrQ** Grey to greenish grey and brown, medium to coarse-grained, arkosic to lithic wacke, pebble to cobble conglomerate, siltstone and minor coal; locally fossiliferous
- IKL** Greenish to brownish grey, thinly bedded to massive sandstone, siltstone, mudstone, pebble conglomerate and minor coal; locally fossiliferous
- 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 lithologies similar to uTrQ; locally includes minor pillow lava breccias; may include minor rhyolitic flows and pyroclastic rocks
- IJLmf** Mainly bimodal basaltic and rhyolitic flows and pyroclastic rocks with subordinate, intercalated volcaniclastic and sedimentary lithologies similar to uTrQ
- IJLf** Medium grey, rhyolitic to dacitic flows, flow domes and/or pyroclastic rocks, including flow and pyroclastic breccias, welded and flow-welded crystal lapilli tuff and rare airfall tuff; aphanitic to felsophic phytic; may include thin interbedded sedimentary deposits and minor basaltic 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 uTrKf
- IJL+** Small outcrop of plagioclase-megacrystic basaltic to andesitic flows of unit IJLx; texturally similar to plagioclase-megacrystic Karmutsen basalt in unit uTrKf
- 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** Intersbedded 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 breccia-like deposits; may include minor lava flows

LAYERED ROCKS (cont'd)

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

QUATSINO FORMATION
Upper Triassic (Carnian; possibly Middle Triassic (Ladinian) at the base)

- uTrKf** Dark grey-green, aphanitic to plagioclase-phyric and minor plagioclase-megacrystic basaltic flows, commonly amygdaloidal and locally exhibiting laminar flow features (vesicite trans) and pipe vesicles; may include minor pillow lava and hyaloclastite (vesicite trans) 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 trachyoid 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 basaltic flows near the top of the flow succession
- uTrMh** Middle Karmutsen Formation: Hyaloclastite Member
Dark grey-green, massive to medium bedded, basaltic hyaloclastite breccia, including pillow fragment breccia, and a medium bedded to locally trachyoid texture; may locally pass laterally into pillow basalt flows
- uTrMf** Dark grey-green, variably amygdaloidal basaltic flows; typically aphanitic

INTRUSIVE ROCKS

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

EARLY JURASSIC (ca. 196.7 Ma)
ISLAND PLUTONIC SUITE

- MPKgd-g** Pale pinkish grey, medium-grained, equigranular biotite-hornblende granodiorite, biotite-hornblende-quartz-plagioclase porphyry and granite-granophyre (gd-g)
- Jl** Dark grey-green, plagioclase-megacrystic basaltic dike/fill coeval with similar lavas (IJL) in the Le Mare Lake volcanic unit
- Jl+** Dark grey-green, clinopyroxene-plagioclase-olivine porphyry coeval with mineralogically similar lavas in the lower part of the Bonanza Group (units uTrBm/uTrPm/uTrKf/uTrMf/uTrMh)
- Jl-g** Pale pinkish grey, medium to coarse-grained, equigranular biotite-hornblende granodiorite-granite core of the Koochichimnis Pluton

Minor Intrusions
LATE TRIASSIC TO EARLY JURASSIC

- +** Dark grey-green, plagioclase-megacrystic basaltic dike/fill coeval with similar lavas (IJL) 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 uTrBm/uTrPm/uTrKf/uTrMf/uTrMh)

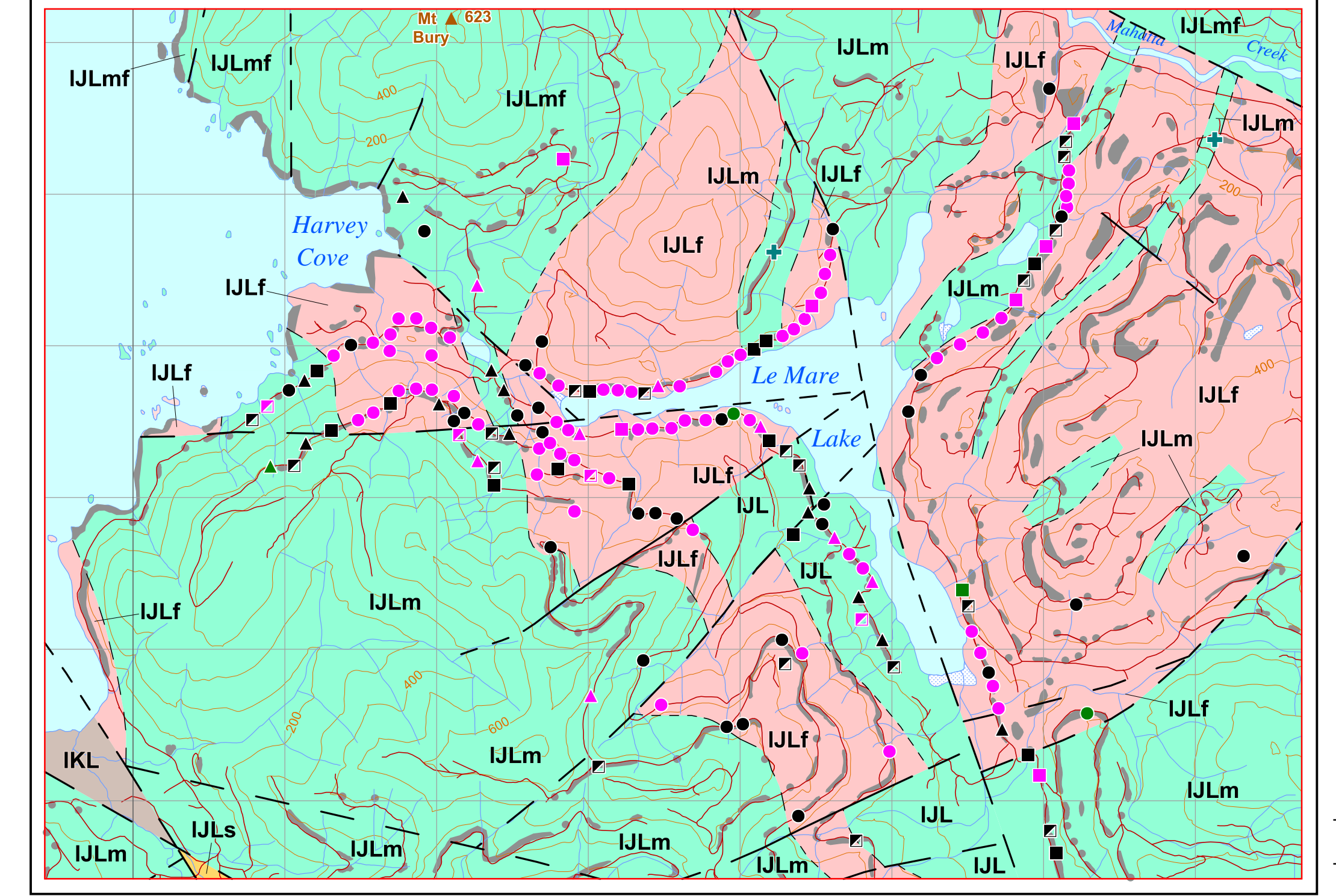
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MAP SYMBOLS

- 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)
- Uniformity, defined
- Uniformity, approximate
- Uniformity, inferred
- Thin (<40m) tectonic siver of Quatsino limestone adjacent fault
- Thin (<40m) unit of Quatsino limestone in stratigraphic contact with Karmutsen and Parson Bay formations
- Thin (<10m) unit of Yelka shale-limestone (TrY) truncated by fault at top of Parson Bay Formation
- Limit of mapping
- Line of vertical cross-section
- Outcrop examined
- Outcrop too small to show on map scale
- Structures**
- Bedding, inclined, vertical
- Volcanic flow lamination, inclined, vertical
- Eutaxitic lamination, inclined
- Plutonic flow lamination, inclined, vertical
- Dike, inclined, vertical
- Tertiary dike, inclined, vertical
- Axis of minor fold, inclined
- Axis of major fold, inclined
- Lineation, inclined, horizontal (slickensides on steeply dipping fault)
- Fossils**
- Macrofossil locality (fossil age code below; identification by E. T. Tozer, H. W. Tipper, J. W. Haggart and C. A. McRoberts)
- GSC Macrofossil locality (fossil age code below)
- Conodont locality (fossil age code below; identification by M. J. Orchard)
- GSC Conodont locality (fossil age code below; identification by M. J. Orchard)
- Radiolarian locality (fossil age code below; identification by F. Cordey)
- Fossil age designation**
- T. Late Triassic; J. Jurassic; Cr. Cretaceous
- e. early; m. middle; l. late
- Late Triassic:** C. Carnian; N. Norian; R. Rhaetian
- Jurassic:** S. Sinemurian; P. Pleniabachian
- Cretaceous:** H. Hauterivian; B. Barremian
- Ammonite Zone:** (D) Diller; (W) Wellet; (K) Kent; (R) Ruedemann; (C) Cordilleran; (S) Silesites
- I. lower (no label indicates age indeterminate; combined codes indicate age zone range)
- Geochronology**
- U-Pb zircon date (Ma, 2 sigma error); ZrL, detrital zircon (determined by R. M. Friedman)
- Re-Os whole-rock isochron date, carbonaceous shale-mudstone (Ma, 2 sigma error; determined by R. A. Creaser)
- ⁴⁰Ar/³⁹Ar date (Ma, 2 sigma error); Bt, biotite (determined by D. A. Archibald)
- Metamorphism**
- Hornblende hornfels facies: hornblende-plagioclase-epidote-quartz
- Upper greenschist facies: actinolite-chlorite-albite-epidote-quartz-scalcite
- Prehnite-pumpellyite facies mainly: pumpellyite-actinolite-chlorite-albite-epidote-quartz-calcite
- Mineralization**
- MINFILE locality (092L 052)
- Topography**
- Lake
- Flooded land (swamp)
- Stream or river
- Contour (100m)
- Spot height (m)
- Road (gravel)
- 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 ⁴⁰Ar/³⁹Ar age by ca. 1%.
- Geochemical analyses in the Le Mare Lake area (see inset) were generously provided by Minova Inc.

WHOLE-ROCK GEOCHEMISTRY - LE MARE LAKE AREA



WHOLE-ROCK GEOCHEMISTRY LEGEND

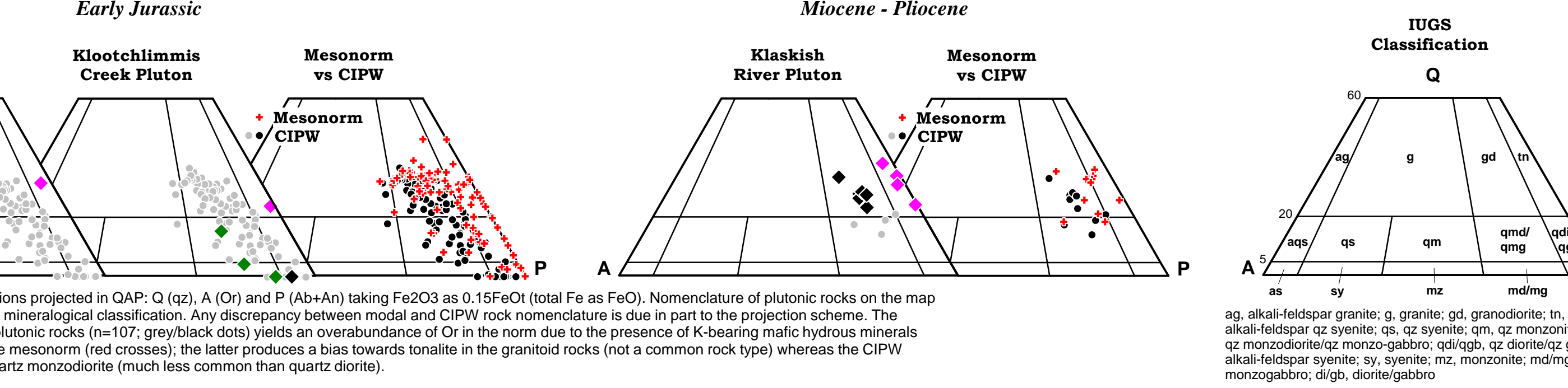
Classification	(MgO+12 wt % SiO ₂ wt %)	Basaltic Andesite	Andesite	Dacite-Rhyolite	Plutonic Rocks
Volcanic Rocks	≤ 53	53-57	57-63	> 63	Major Intrusions
Least altered	■	■	■	■	■
Alkali metasomatized	■	■	■	■	■
Severely altered	■	■	■	■	■

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

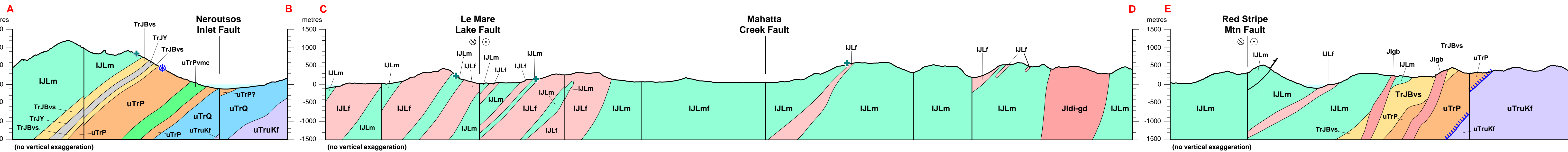
Base Map Information
Base map produced from digital TRIM (Terrain Resource Inventory Management) 1:250,000-scale topographic database, British Columbia Ministry of Natural Resources Operations.
North American Datum 1983 (NAD83) Universal Transverse Mercator Projection (Zone 9). Elevation in metres above mean sea level. Contour interval 100m.

Digital Cartography
G. T. Nixon

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



CIPW (wt %) normative compositions projected in QAP: Q (qtz), A (An) and P (Ab+An) taking FeO as 0.15FeO (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 (in 107, grey/black dots) yields an overabundance of Q or in the norm due to the presence of K-bearing micric hydroxyl 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 monzonite (much less common than quartz diorite).



Acknowledgments
We sincerely appreciate the warm hospitality shown to us by the residents of northern Vancouver Island. We thank Dave Heberlein, Cam Dalving and the crew of Minova 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. Schaefer greatly improved the final geochronology 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 paleontology will be sorely missed.

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