Volcanic evolution and refinement of stratigraphy hosting porphyry systems in the southern Nicola arc

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Introduction

Here we present the refined Nicola Group volcano-stratigraphy between Merritt and Princeton (Fig. 1). This segment of the Middle to Late Triassic arc bridges important porphyry copper camps of Copper Mountain, Highland Valley and the Iron Mask. Refinements are based on more than 50 new isotopic age data sets as well as new fossil collections selected from >8800 field stations. Nearly a third of the age dates were from detrital zircons (DZ), key to distinguishing similar-looking sedimentary successions, but some of these ages acquired by laser ablation ICP-MS lacked resolution required by the new stratigraphic framework. As shown here, that problem was addressed through reanalysis of the youngest zircons identified by LA-ICP-MS, by high precision thermal ionization (TIMS) techniques. From these isotopic and field data arise a 6-stage Nicola arc history.

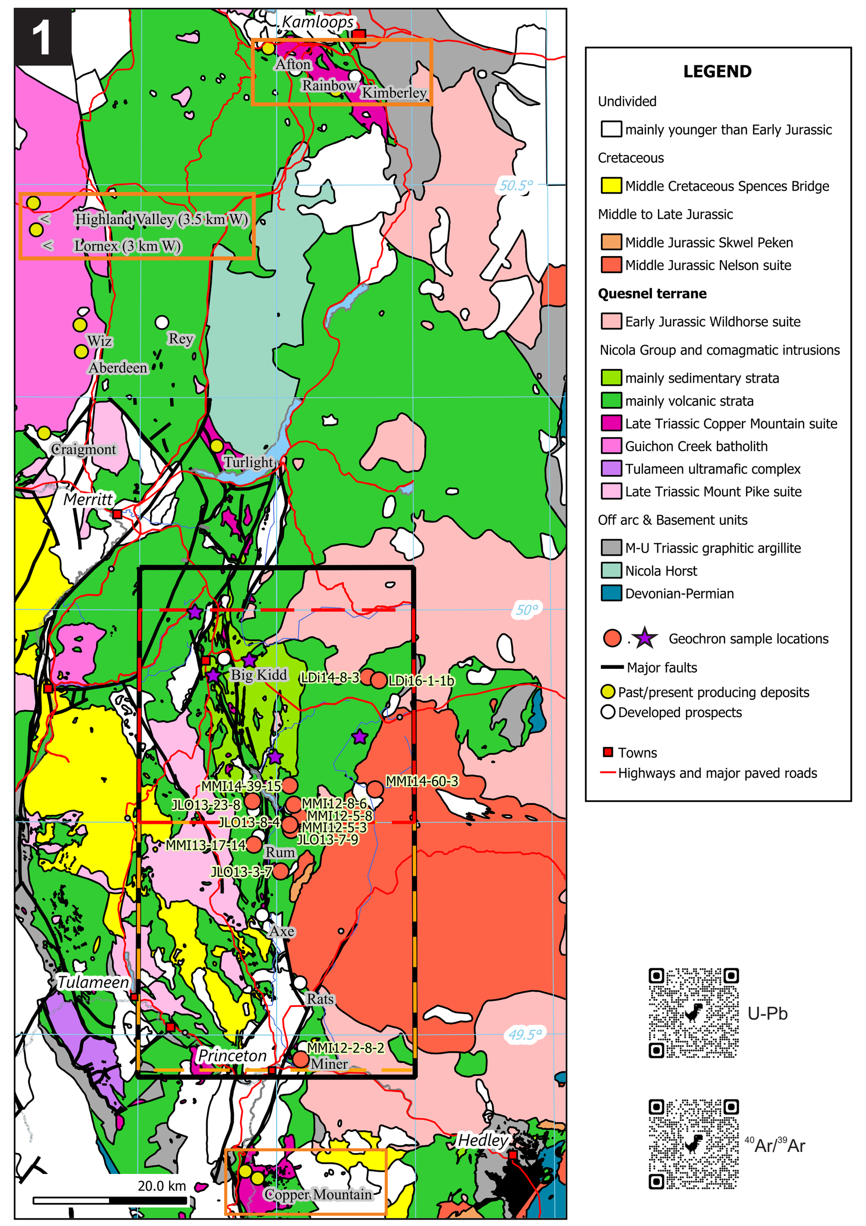


Fig. 1.
Orange boxes: major porphyry copper camps
Black box: Geoscience map GM2020-01 (Fig. 2).
Purple stars: U-Pb data sites Geofile 2025-15
Orange circles $^{40}Ar/^{39}Ar$ sites Geofile 2025-16
(available @QR code upper and lower, respectively).

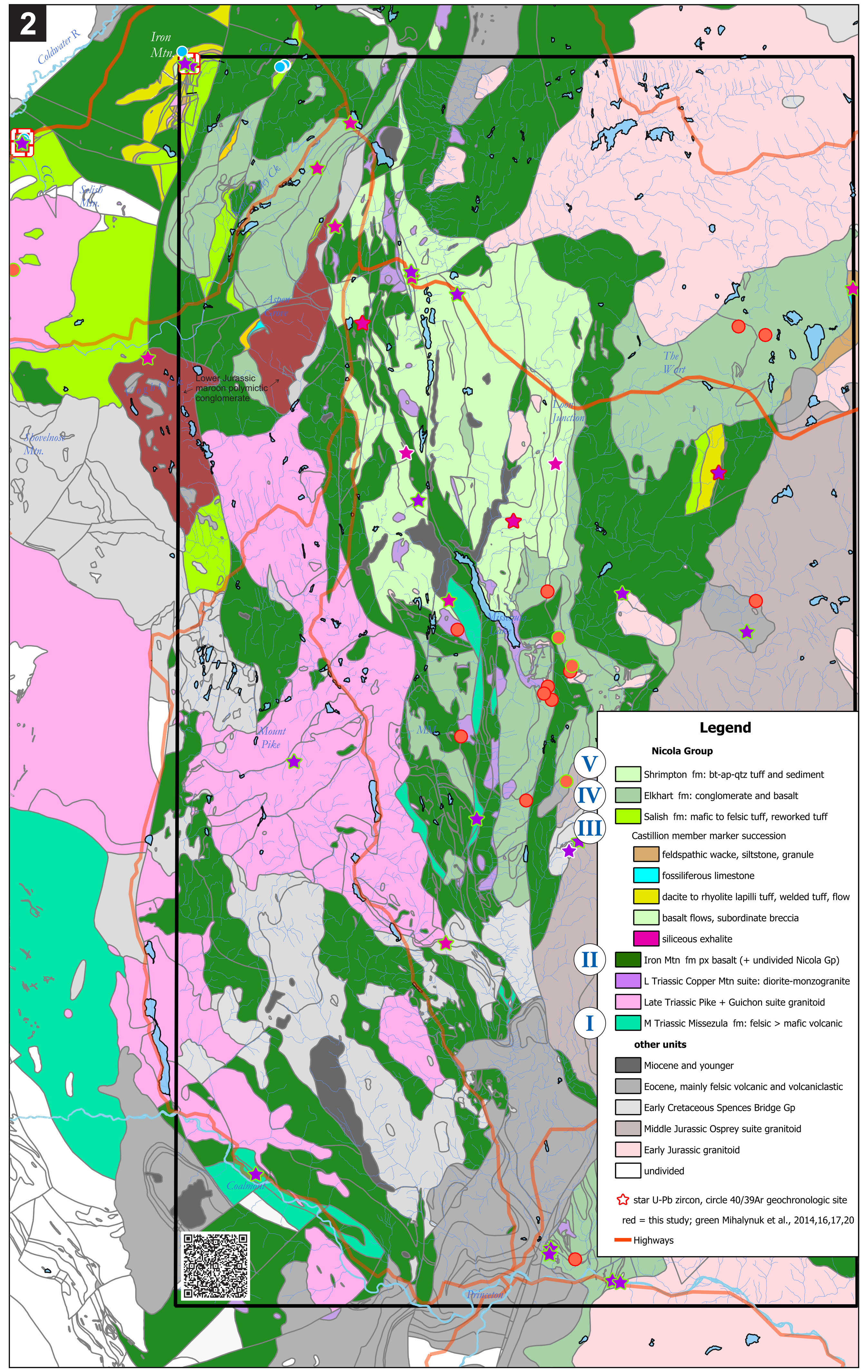


Fig. 2.
Five stages of Triassic Nicola arc growth
Black box: Geoscience map GM2020-01
(scan QR code for the digital release).

Stage I: 240 - 237 Ma
Arc initiation

Missezula fm.
-bimodal, but mostly felsic (dating bias?)
-crosses the arc width
-basement contact uncertain

Stage II: 237 - 224 Ma
Major submarine arc growth

Iron Mountain fm. (& basal, epiclastic Missezula fm.)
-augite porphyry breccia and flows, mostly submarine = hallmark Nicola Gp. unit
-most voluminous unit
-spans the arc width

Stage III: 224 - 222 Ma
Arc emergence, maturation

Selish fm.
-Arc emergence. Limestone common as the arc reaches sea level. Arc has thickened and matured and felsic intrusions and widespread ash flow is characteristic
-spans the arc width
most voluminious unit (Figs. 3, 4)

Stage IV: 222 - 208 Ma
Arc growth, late deep incision

Elkhart fm.
-arc incision produces widespread conglomerate and finer-graned strata derived from all levels of the pre-existing Nicola arc, along with pyroxene and hornblende-phyric volcaniclastics and flows
-felsic magmatism not common

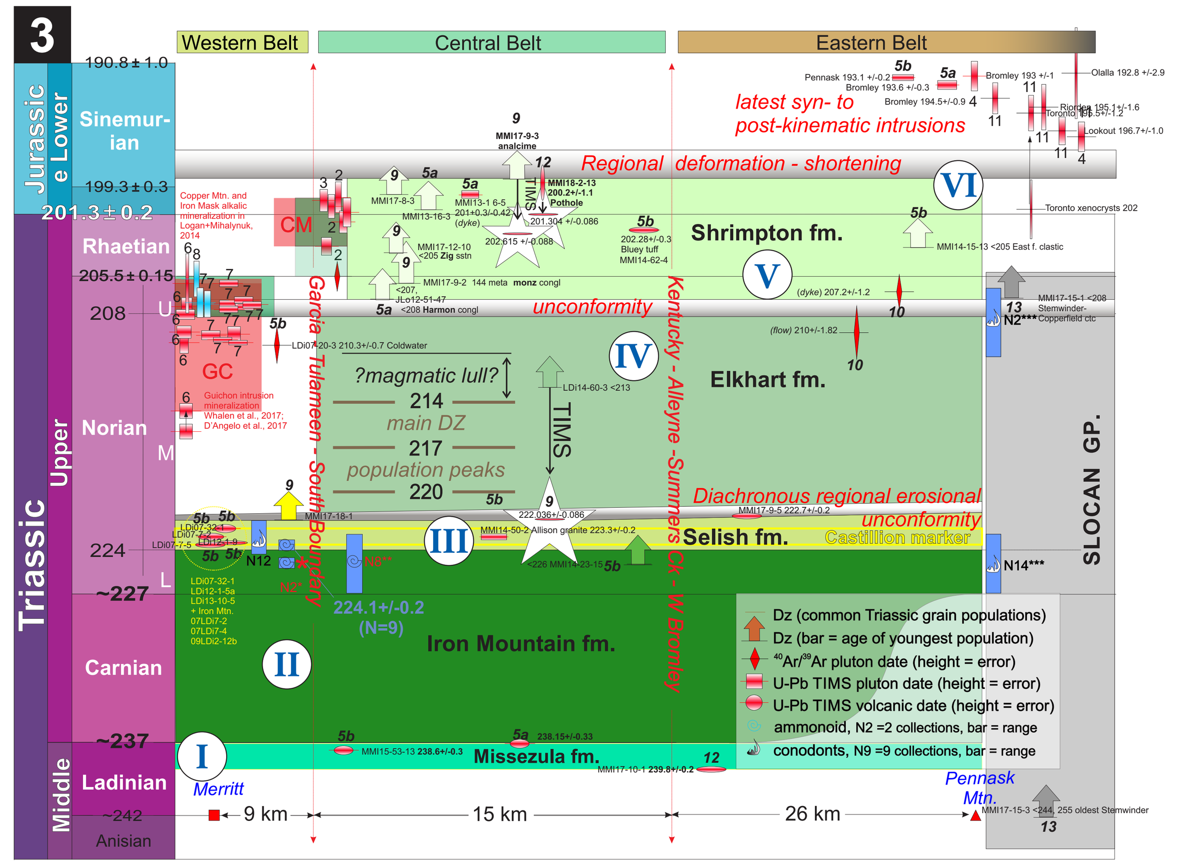
Stage V: 208 - 201 Ma
Arc disturbance, mineralization

Shrimpton fm.
-abrupt change to biotite-apatite-quartz-phyric volcanism along with ultrapotassic analcime-porphyritic basalt flows
-reworked flows common
-coeval mineralization, both calc-alkalic and alkalic porphyry coppoer deposits

Stage VI: 201 - 200 Ma
Arc quiescence

upper Shrimpton fm.
-turbiditic sandstones with ash beds of decreasing thickness and frequency (?re-established by 197Ma)

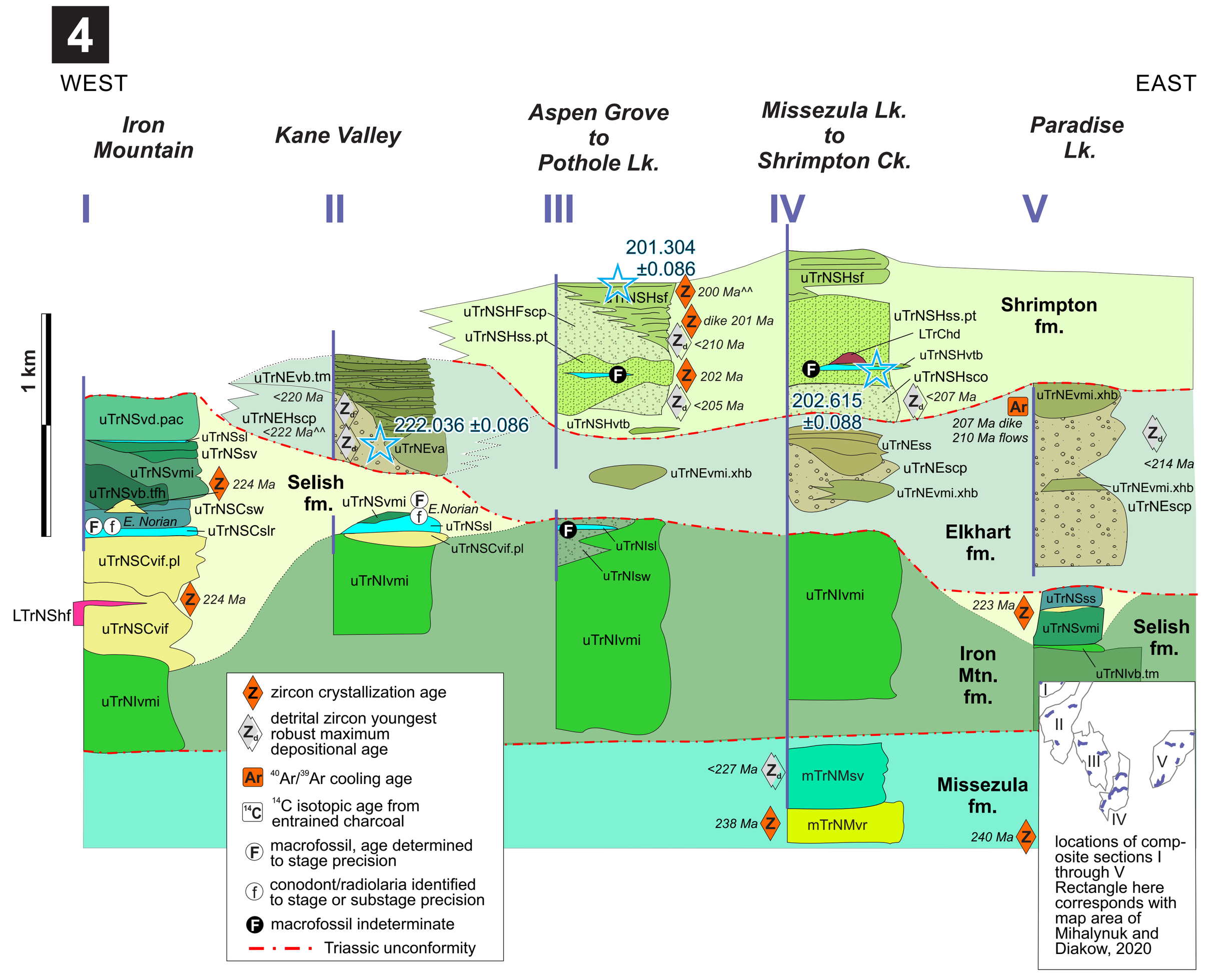
Volcano-stratigraphy



Fossil data sources: * Preto (1979); ** Monger (1989); *** Ray (1994); others in Orchard et al., submitted 2025
Isotopic age data sources: 1 = Logan et al., 2007; 2 = Mihalynuk et al., 2010; 3 = Logan and Mihalynuk, 2014; 4 = Parrish and Monger, 1992
5a = Mihalynuk et al., 2015; ***5b*** = Mihalynuk et al., 2016; 6 = Whalen et al., 2017; 7 = D'Angelo et al., 2018; 8 = Ash et al., 2007;
9 = Mihalynuk et al., 2025 (QR code, Fig. 1); ***10*** = Gabites and Mihalynuk, 2025 (QR code, Fig. 1); 11 = Mortensen, 2014; ***12*** = Mihalynuk et al., 2020; ***13*** = in preparation; for references see Mihalynuk and Diakow, 2020 (QR code, Fig. 2)
Data enumerated in ***bold italic*** were produced as part of SNAP.

Figure 3. A time-space plot showing the distribution of new and recently published geochronological age constraints for the southern Nicola arc along with new formation nomenclature. Also included are age data from coeval strata in the Hedley area, here correlated with the Slocan Group.

Figure 4. A stratigraphic correlation chart showing the distribution of age data within stylized stratigraphic sections.



Detrital zircon age refinement

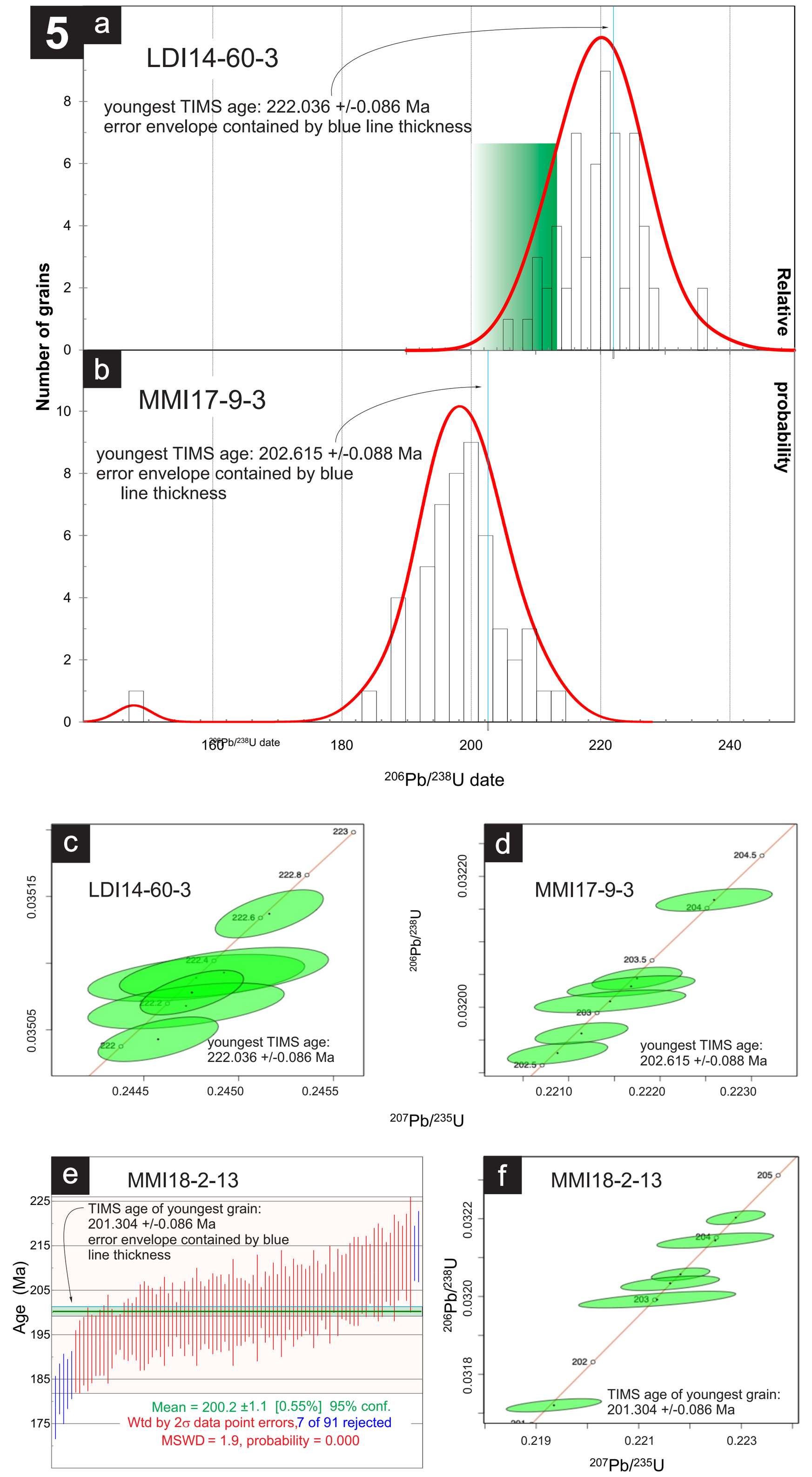
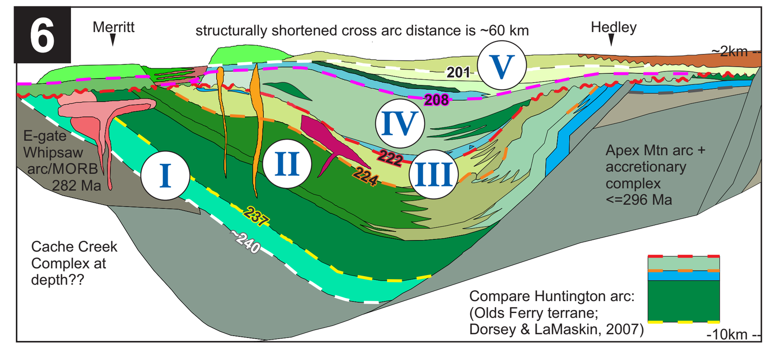


Figure 5. Refinement of detrital zircon ages originally determined by Laser Ablation, LA-ICP-MS. Young grains identified by LA are reanalyzed by TIMS to obtain very precise ages

Figure 6. Nicola arc cross section showing evolution of stages to create a copper porphyry laden district. Complications from contractional deformation are omitted.



Why it matters

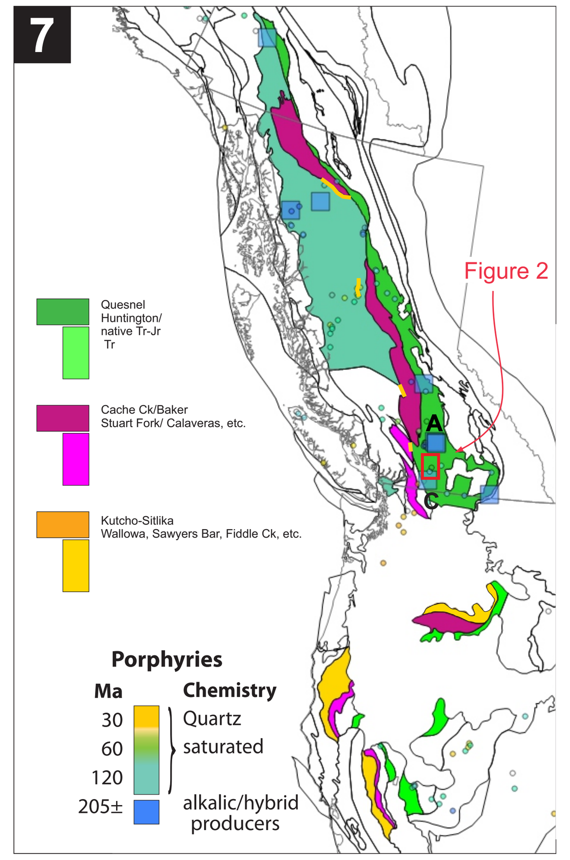
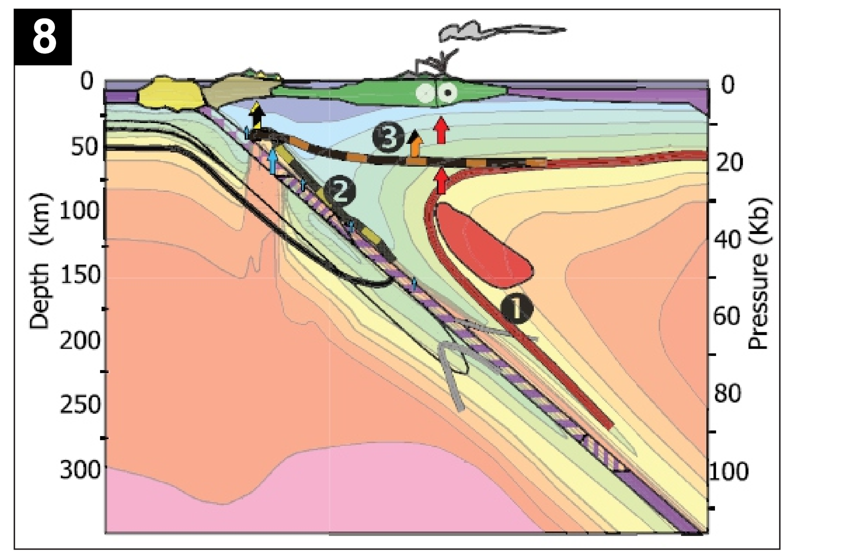


Figure 7. Nicola arc is a key part of a prolific Late Triassic Cu-Au±Ag-Au-Mo mineralizing event, mostly ~205 ±5 Ma. Southern Nicola arc is historically the most important part of the belt, including the Iron Mask (Afton @A) and Copper Mountain (@C) alkalic porphyry deposits, and the calc-alkalic Guichon Creek complex (Highland Valley) -see Fig. 1.

Arc disturbance Cu-Au porphyries

Figure 8. Disruption of Nicola arc may have arisen from collision of the Kutcho-Sitlika arc. Inevitable rupture of the subducting plate leads to generation of magma endowed with metal as hot asthenosphere influx causes fusion of metal-laden, metasomatized mantle wedge (cf. Logan & Mihalynuk, 2014, Economic Geology, 109, 827-858).



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