Cryptic magmatic skarn of the Merry Widow deposit, Vancouver Island, Canada

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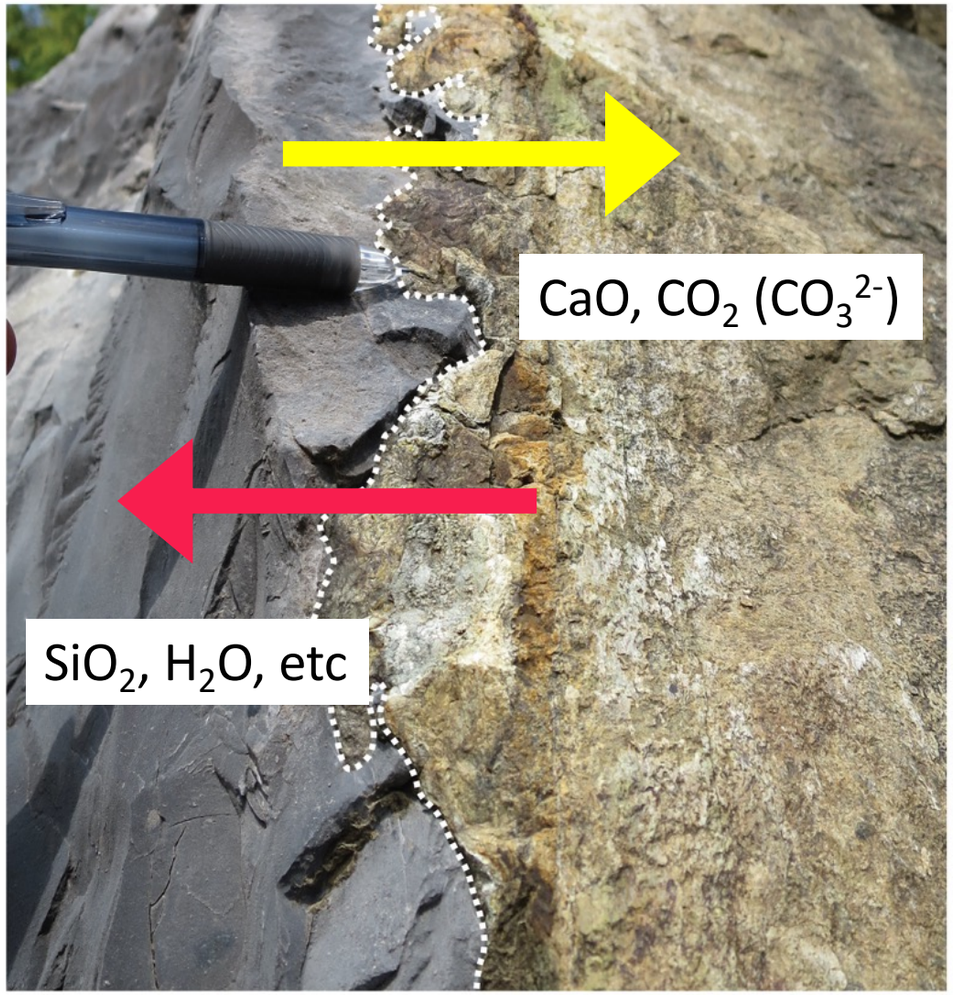
Mafic cumulates along the margin of the Merry Widow pluton, Vancouver Island, Canada

Magma-carbonate interactions

Reactive, volatile-rich chemical exchanges between limestone and magma



limestone | silicate melt

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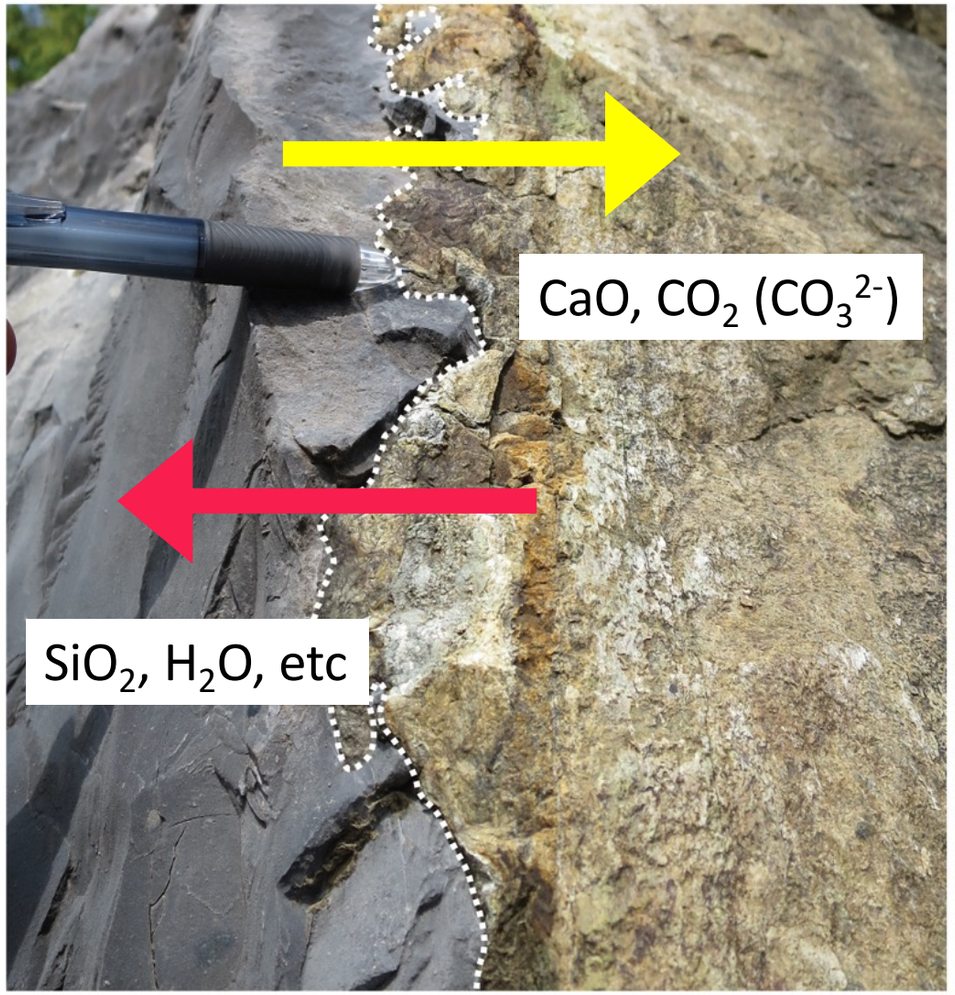
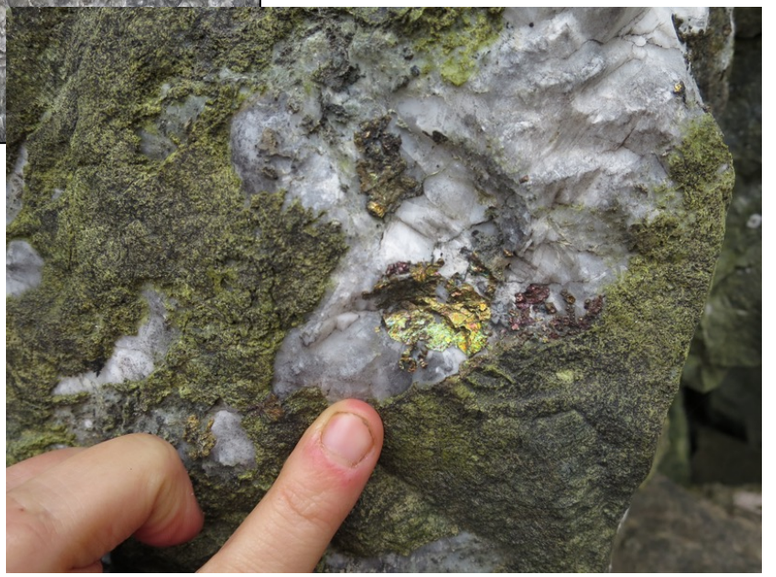


limestone | silicate melt

Reactions, fluid mobilization is much **more** obvious in the carbonate



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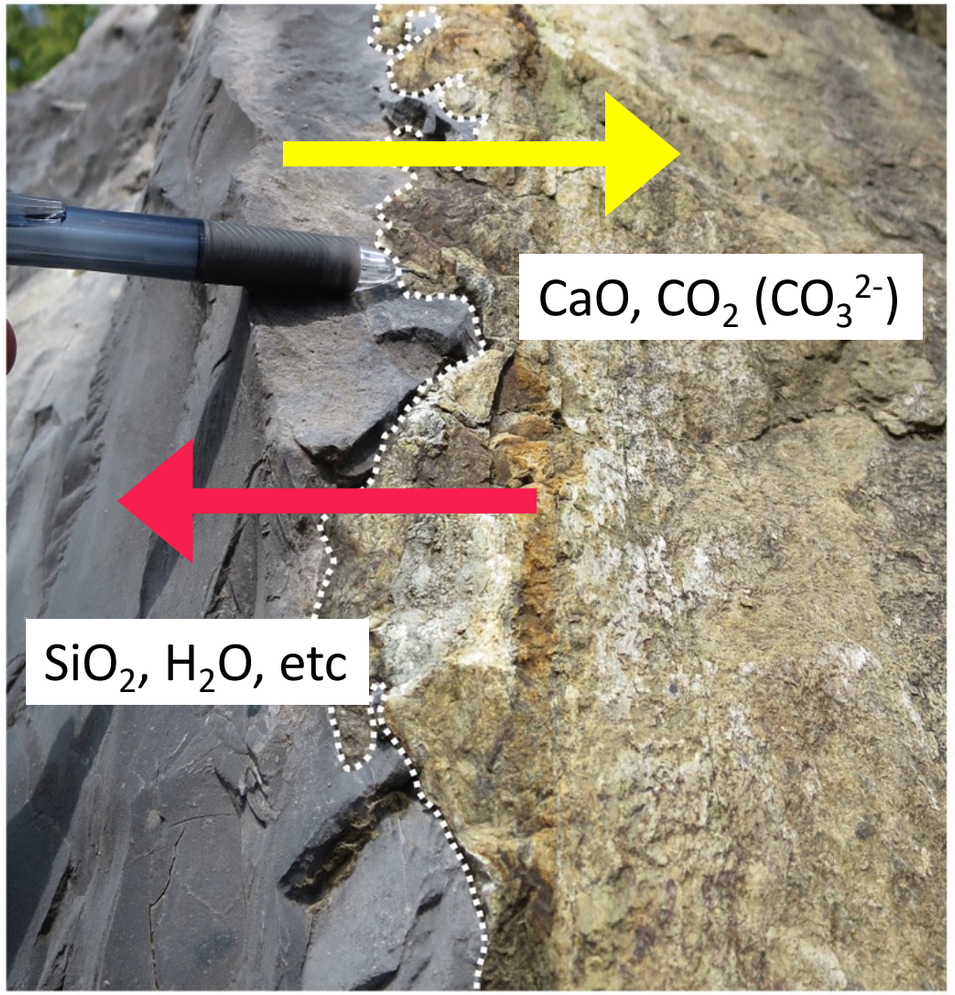
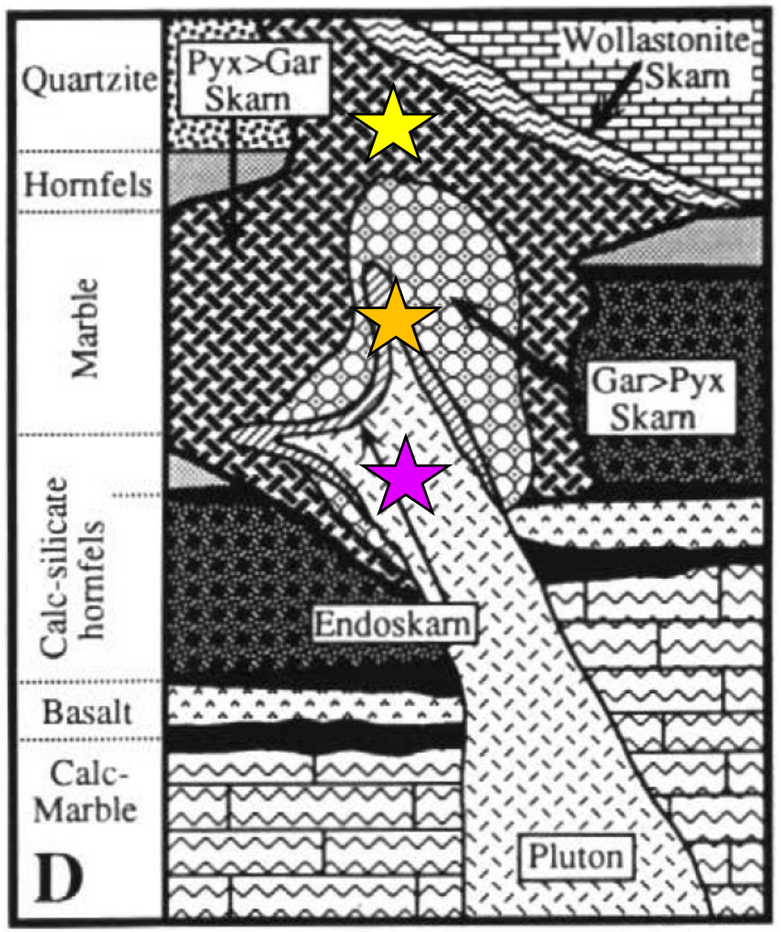


limestone ⋮ silicate melt

Reactions, fluid mobilization is much **less** obvious in the intrusion(s)

Exo, Endo, Magmatic skarn…
Cryptic contamination within magma from assimilation of carbonate wallrock



Meinert, 1992

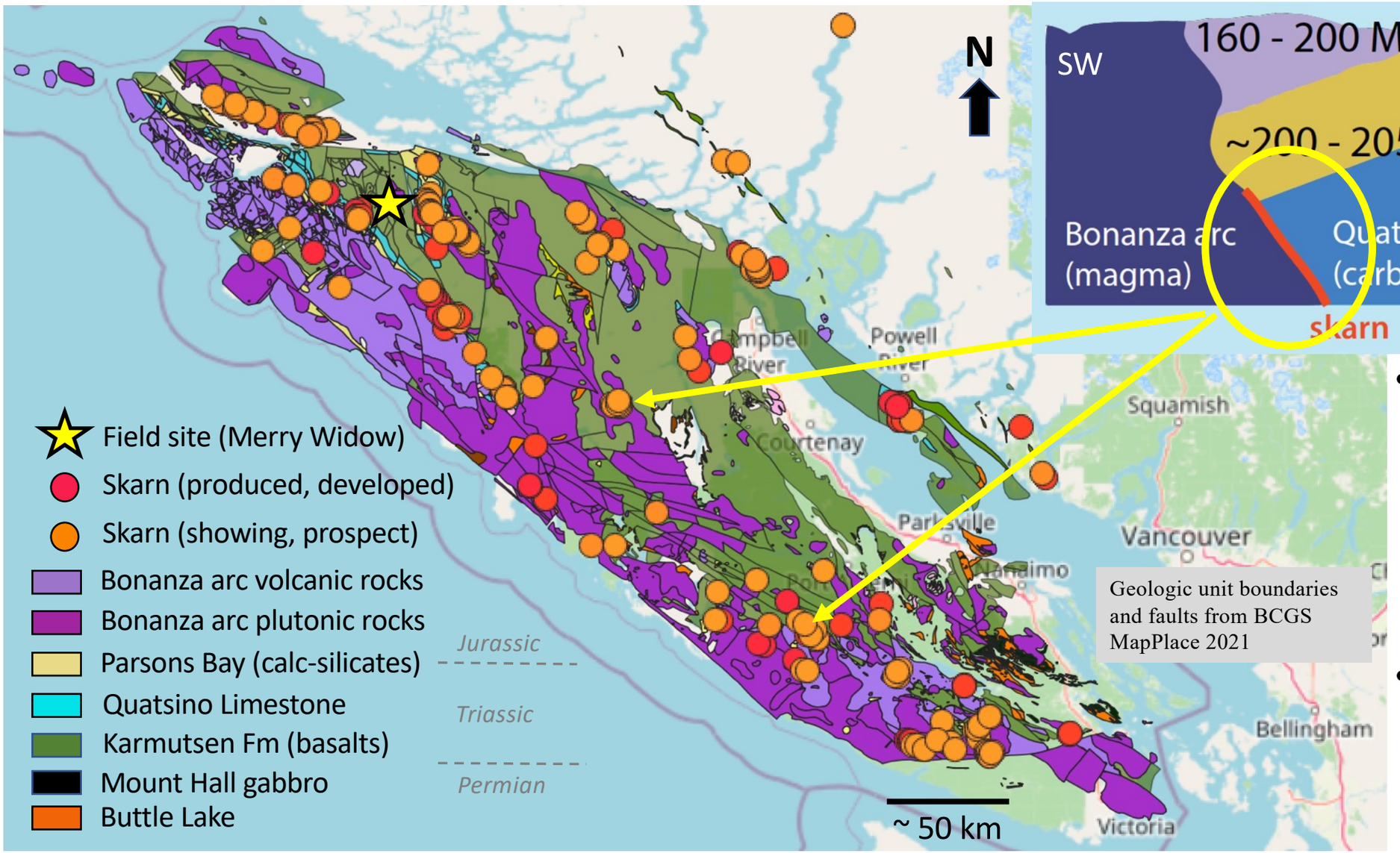
Exoskarn: decarbonized and silicified carbonate wallrock

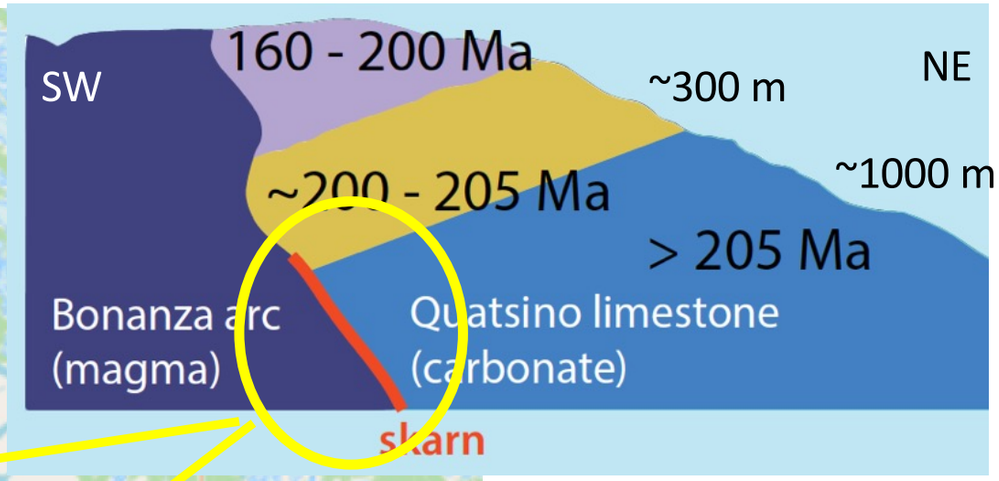
Endoskarn: calcified and desilicified igneous rocks within the intrusion

Magmatic skarn: essentially just a less obvious type of endoskarn (transfer of wallrock elements into the pluton, just not completely calcified and desilicified)

Most attention focused on exoskarn, but the endoskarn and magmatic skarn is economically interesting and important as well.

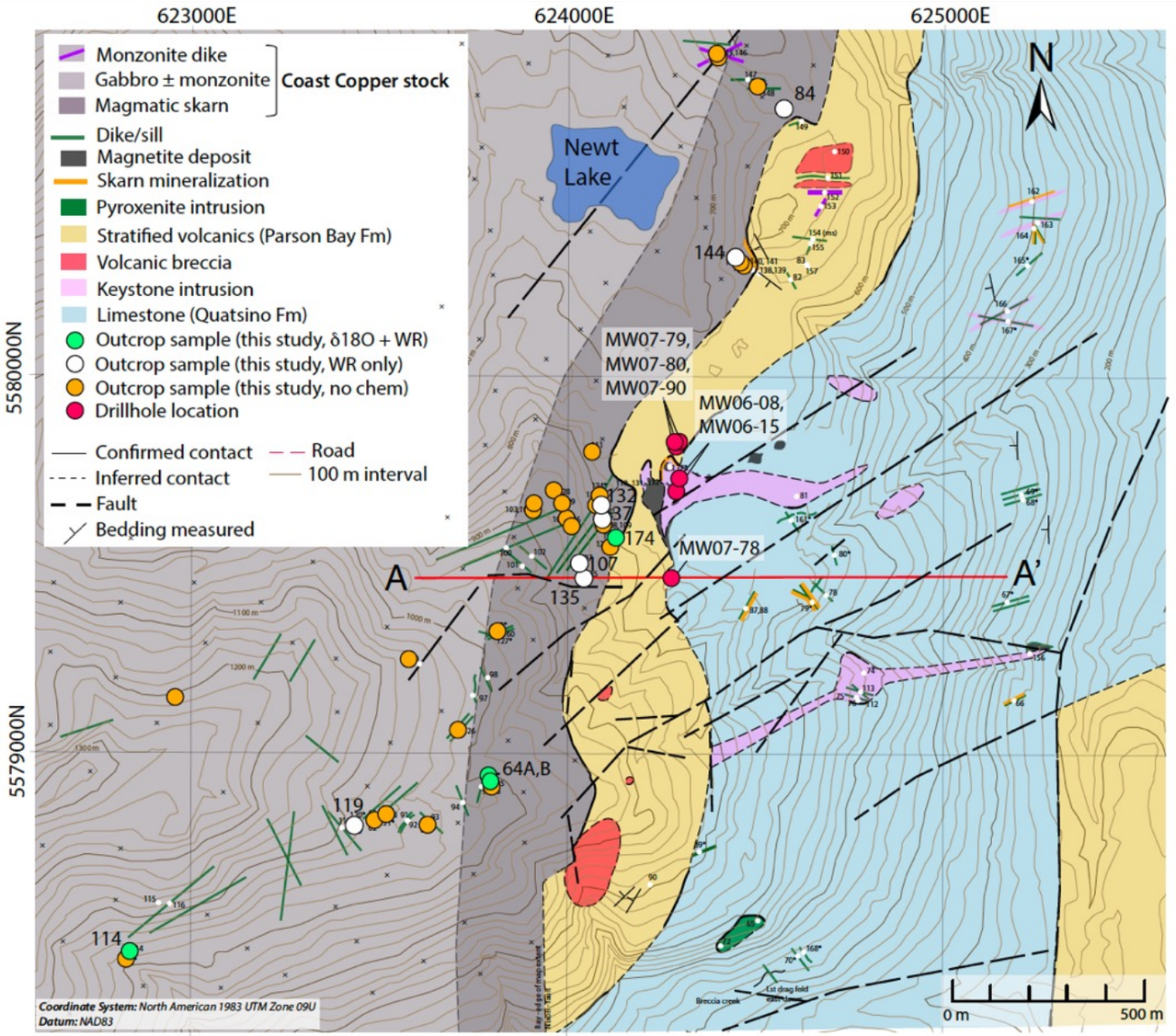
Jurassic Bonanza Arc, Vancouver Island, Canada:
Magma-carbonate interactions evident from abundant skarn occurrences





- Magmas of the Jurassic Bonanza arc intrude Triassic Quatsino limestone
- Evidence of reaction = skarn mineralization

Merry Widow Mtn, Vancouver Island, Canada:
Variety of magma-limestone interactions (m-scale dikes, km-scale pluton)

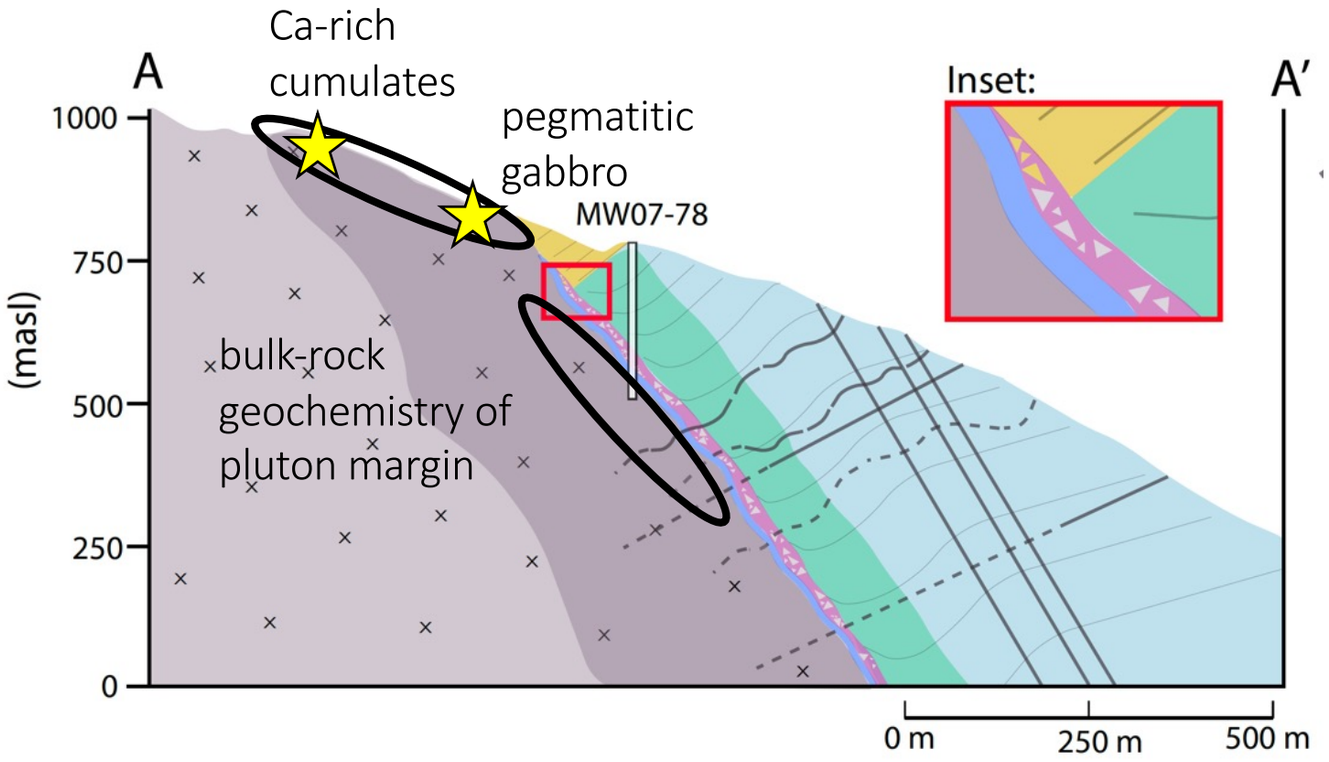


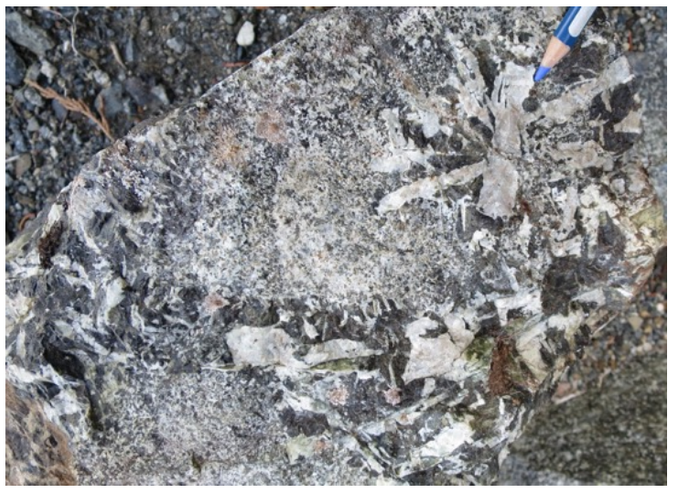
Merry Widow Pluton *(Coast Copper Stock)*

- 197.9 ± 1.3 Ma intrusion
- Gabbro ± lesser monzonite margin
- ~20 km^2
- Margin of pluton: mafic cumulates and pegmatite (coarse-grained gabbro ∴ fluids)
- Northern area is disturbed by faulting

Mapping modified after Sangster (1964), Lund (1966), Ray and Webster (1991), Nixon et al., (2011)

Merry Widow Mtn, Vancouver Island, Canada:
Interpretation of units at depth (south of main pit) from outcrop and historical drillcore logs

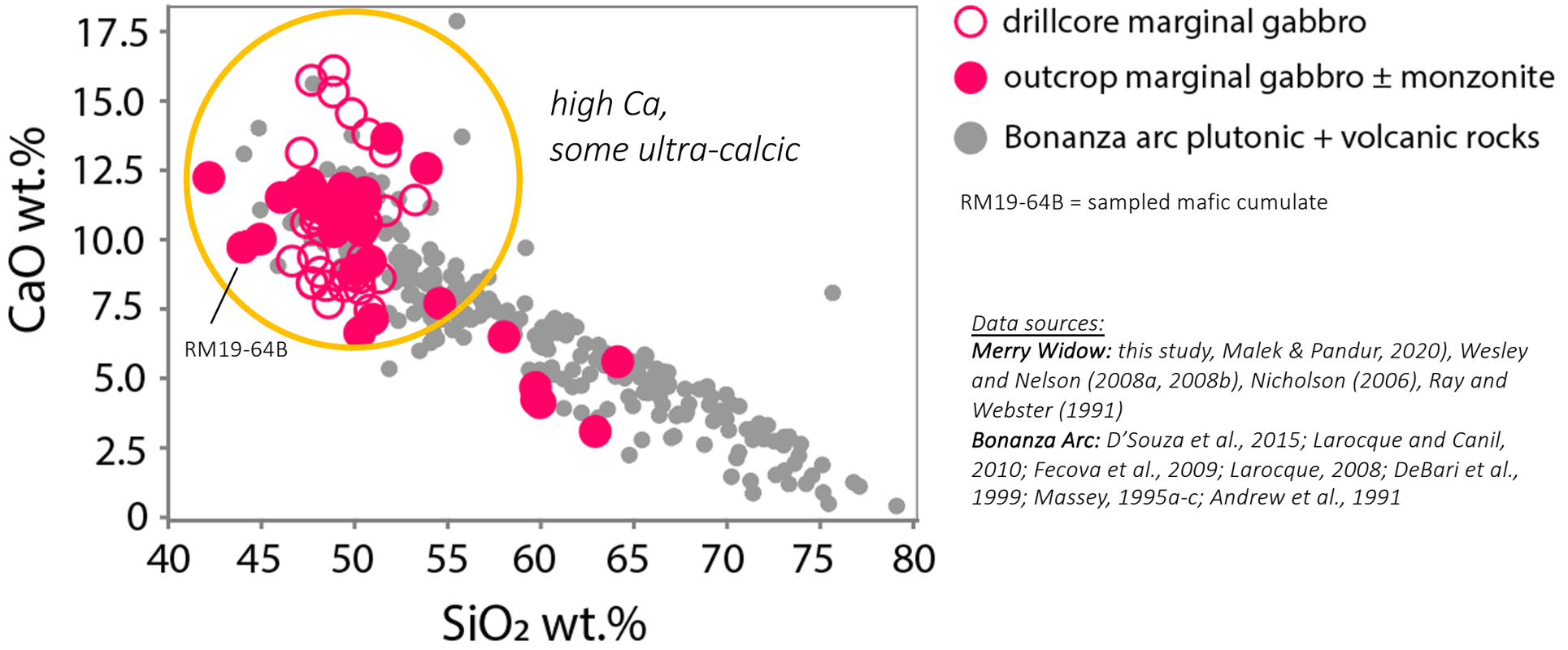




Transition from limestone to pluton characterized by:

- ~100 m of irregular exoskarn
- ~10 – 60 m of volcanic breccia
- ±3 – 10 m of recrystallized limestone
- ~20 – +200 m of magmatic skarn

Bulk-rock geochemistry:
Mafic marginal plutonic rocks are enriched in Ca, Fe, Ti, and P - depleted in Si



Data sources:

Merry Widow: *this study, Malek & Pandur, 2020), Wesley and Nelson (2008a, 2008b), Nicholson (2006), Ray and Webster (1991)*

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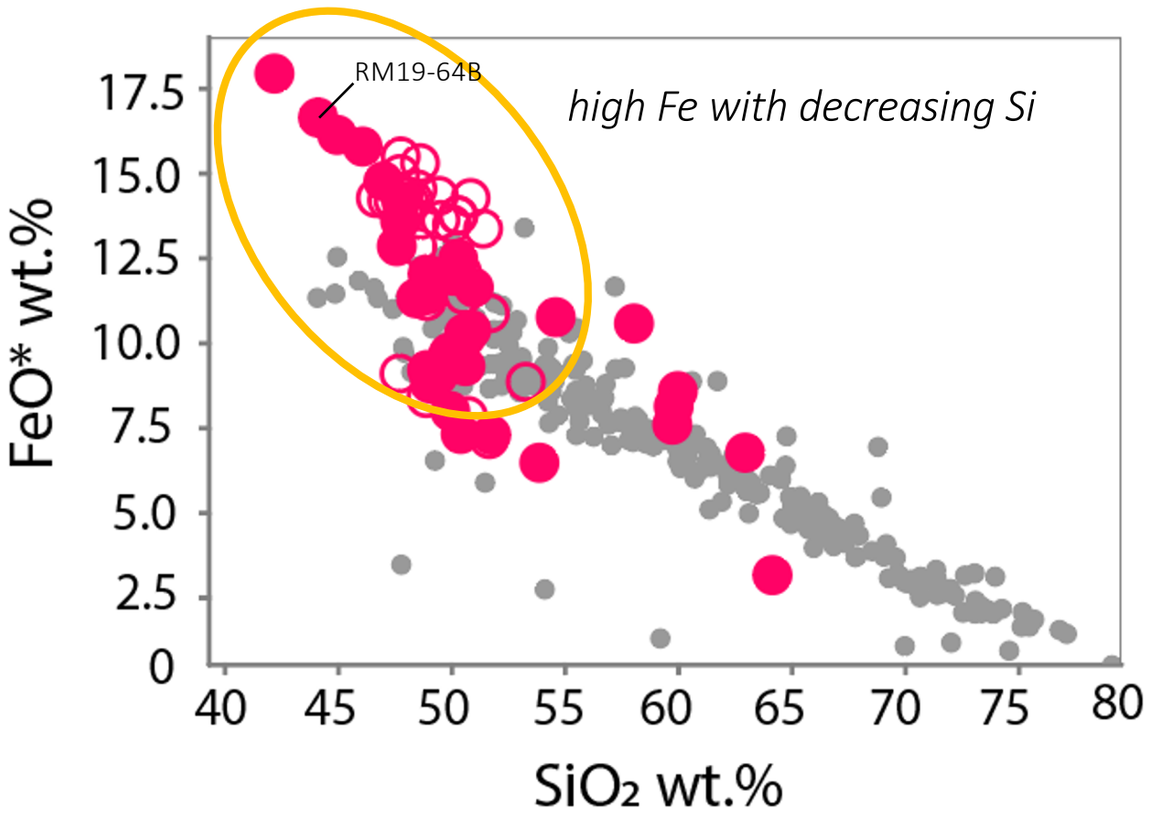

drillcore marginal gabbro

outcrop marginal gabbro ± monzonite

Bonanza arc plutonic + volcanic rocks

RM19-64B = sampled mafic cumulate

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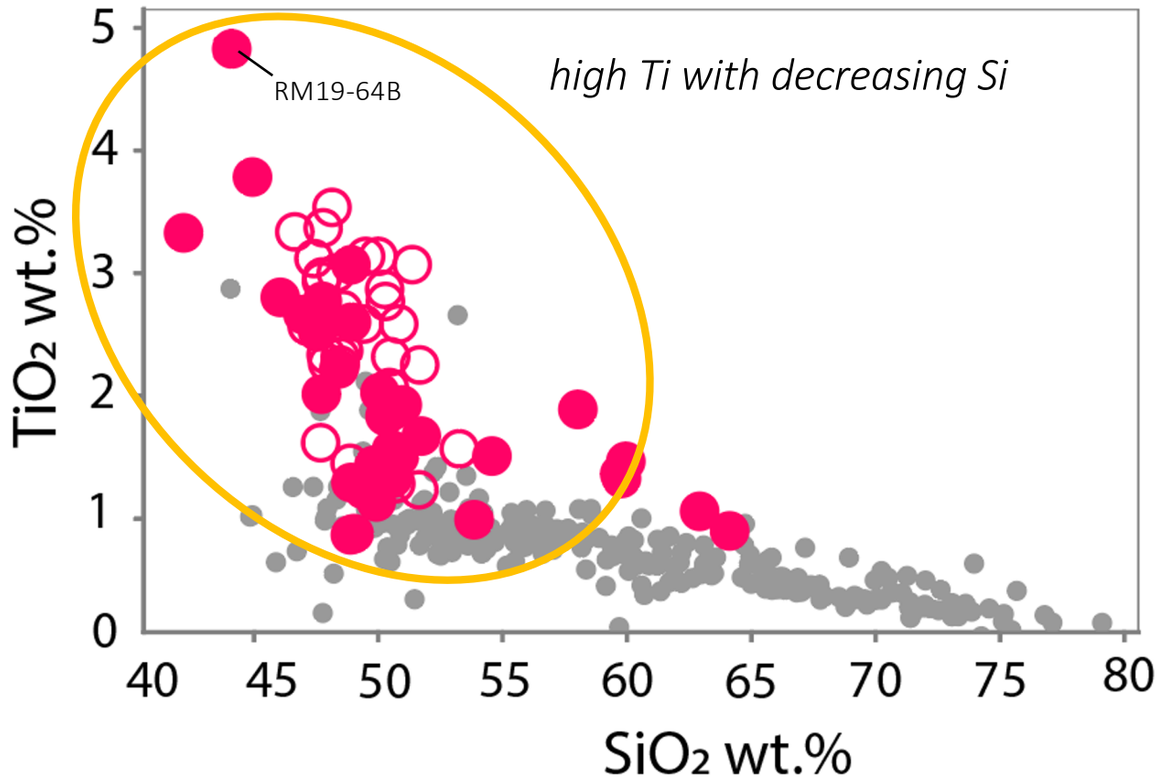

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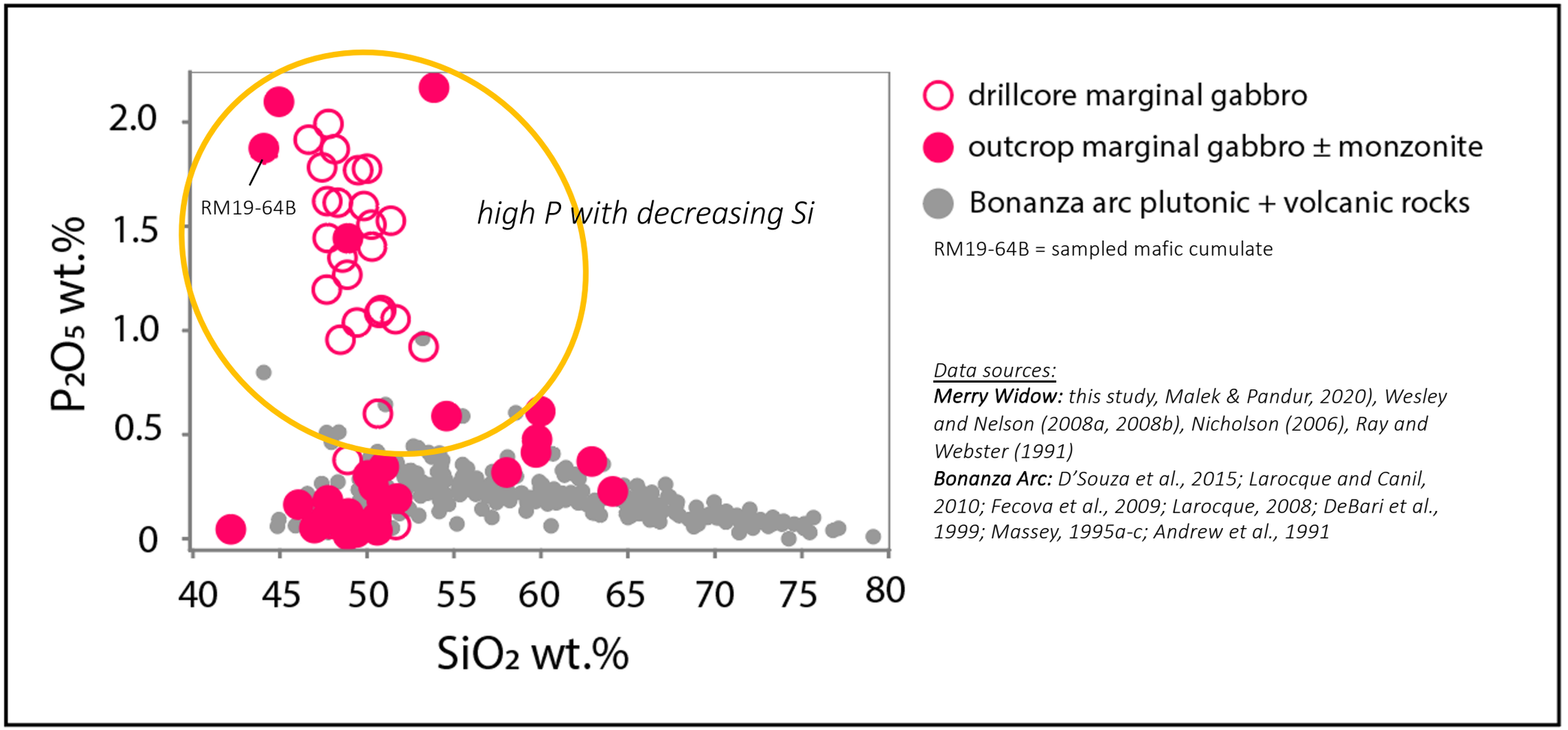
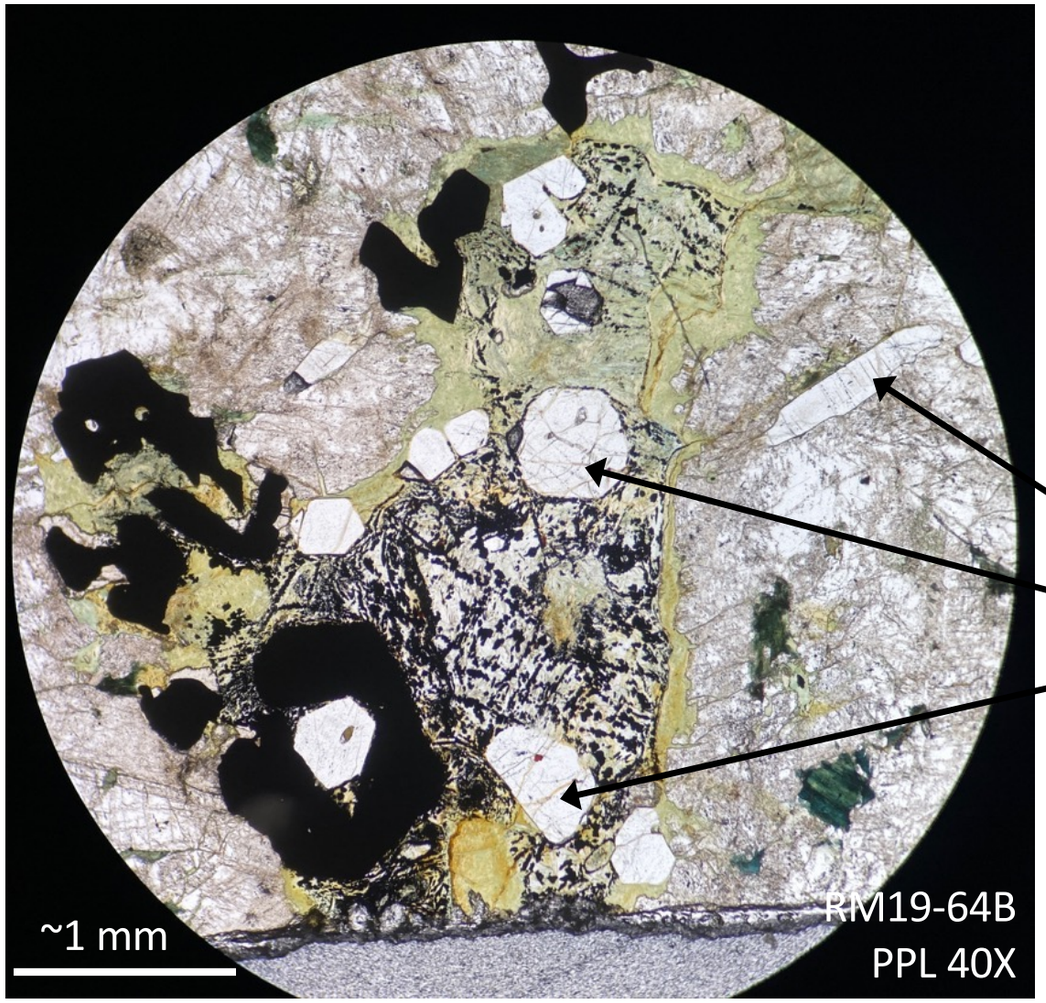
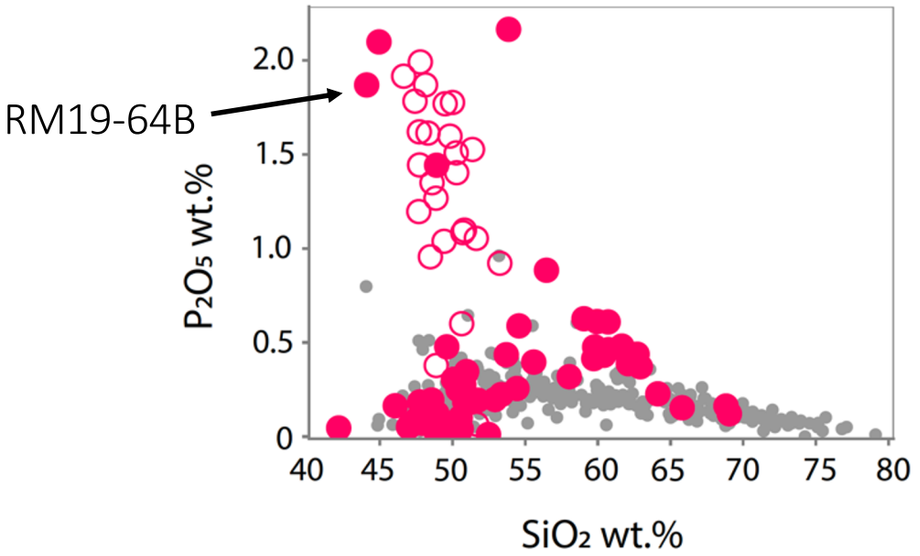


High P_2O_5 in marginal gabbro – cumulates in thin section:
Abundant apatite (>5%) in mafic cumulates supports high P_2O_5 in bulk rock chemistry



apatite
(also visible in
hand sample)



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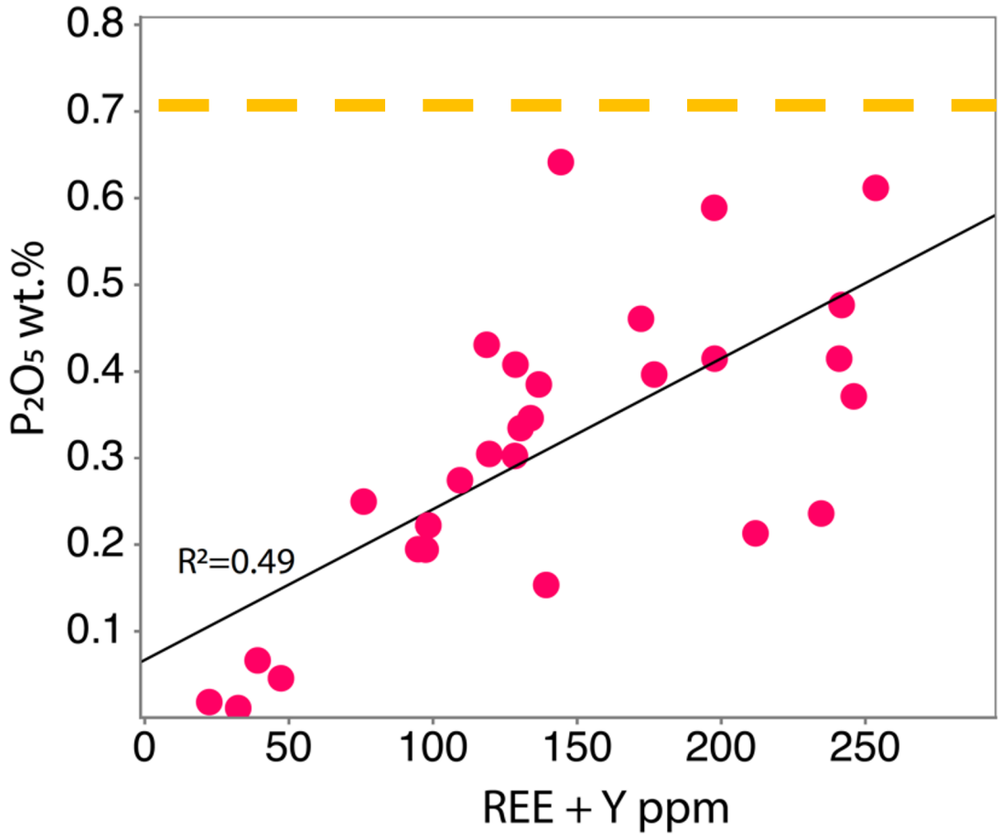
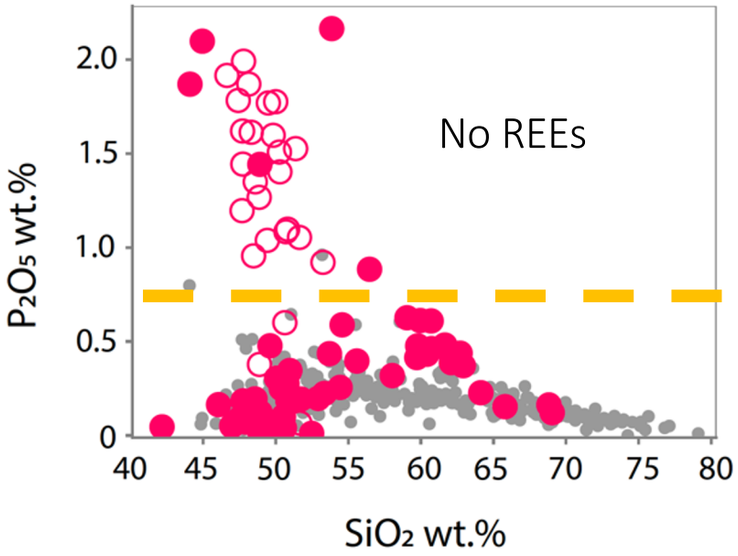
High P_2O_5 suggests an enrichment in REEs + Y:
Potential for >1000 ppm (0.1 wt%) in total REEs in marginal cumulates (2 - 2.5 wt.% P_2O_5)



MW plutonic + volcanic rocks
(non-drillcore, non-cumulate)

Data sources:
Malek & Pandur, 2020



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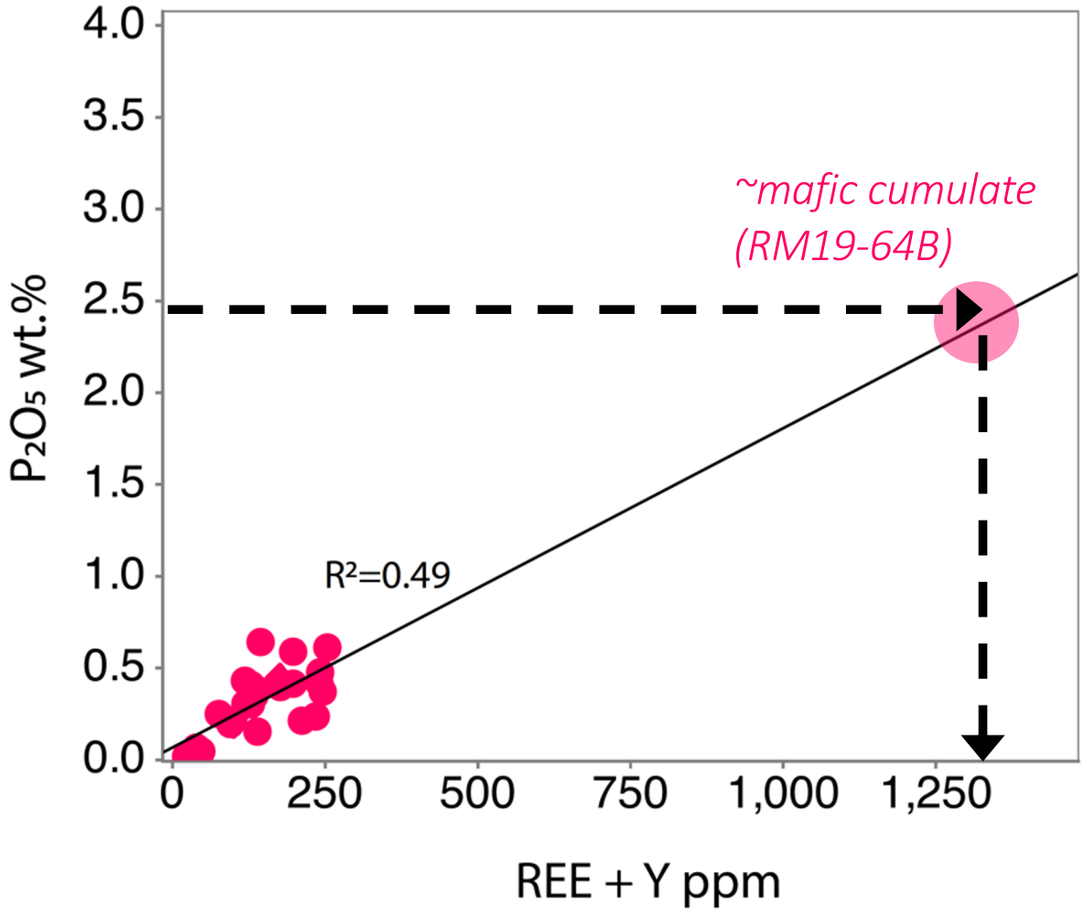
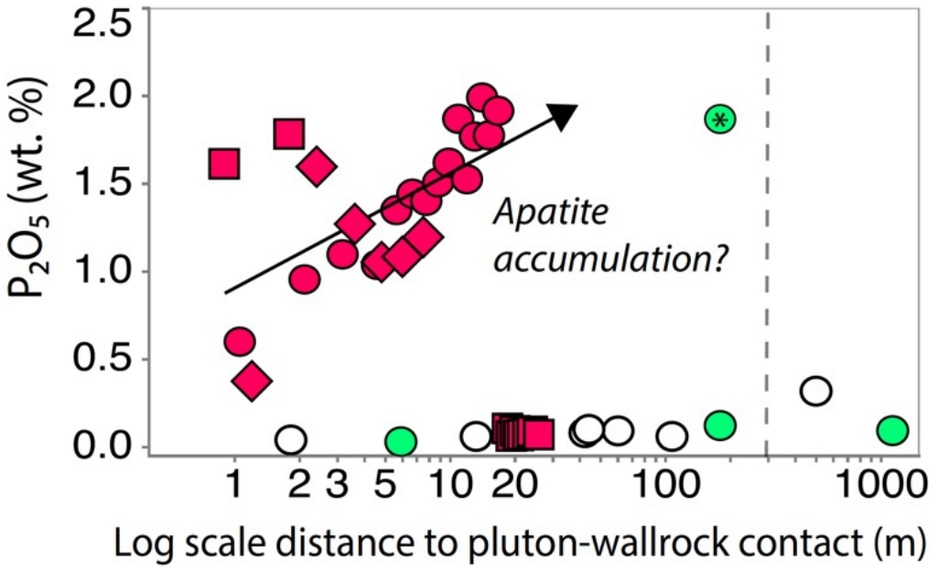


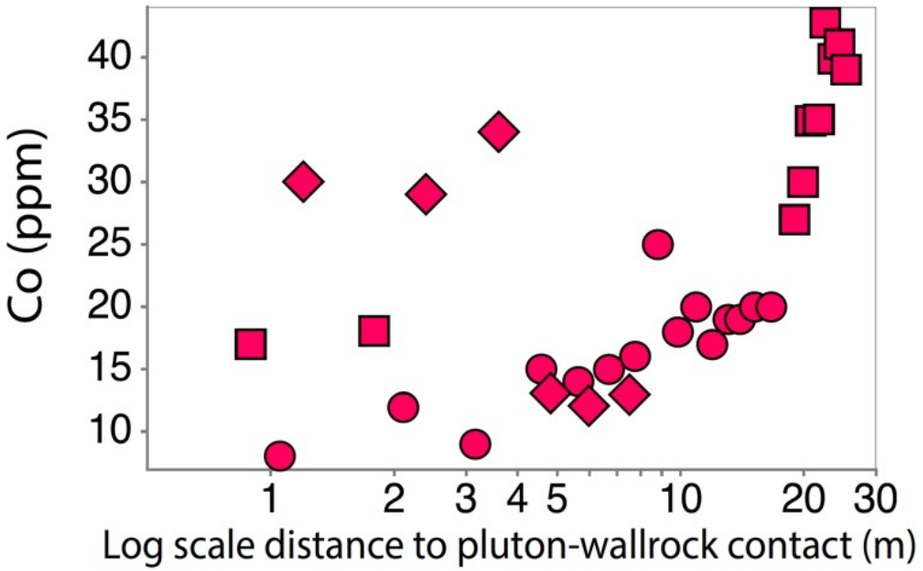
MW plutonic + volcanic rocks
(non-drillcore, non-cumulate)

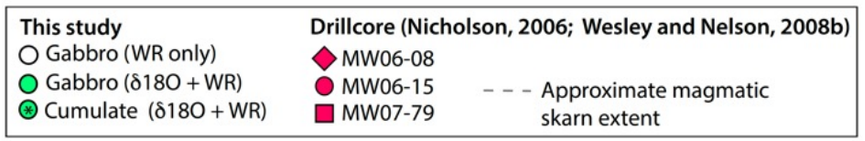
- *Marginal gabbro might be an REE target (critical metals)*
- *In progress: analyzing (and collecting more) mafic cumulates for REE analyses*

Data sources:
Merry Widow: *Malek & Pandur, 2020*

Bulk rock geochemistry – spatial comparison from pluton margin
Drillcore indicates irregular accumulation of apatite (shown) titanite, magnetite (not shown)





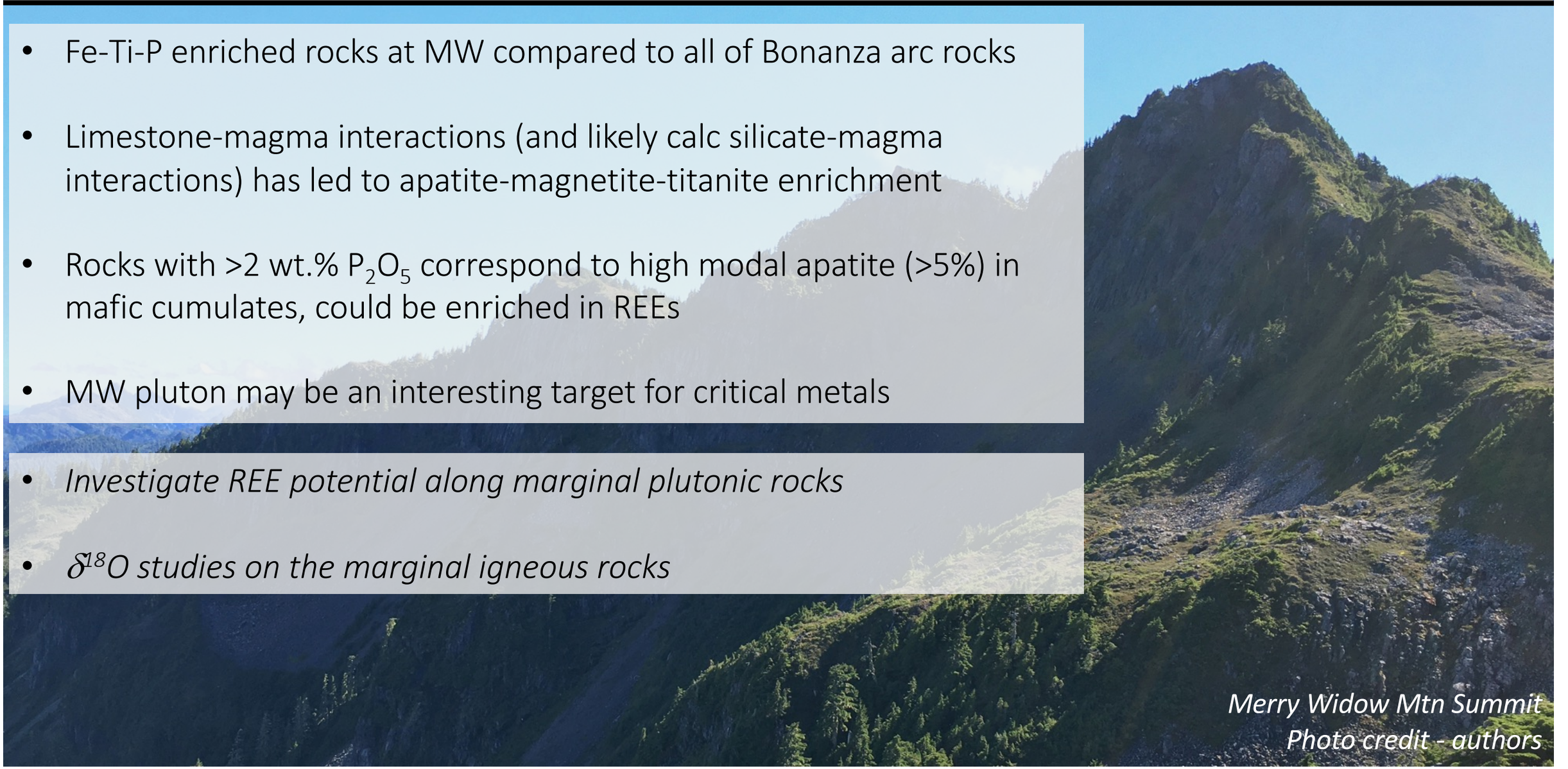


- spatially some elements (i.e., P, Co) are correlated and increase away from the contact
- encourage interest and drilling efforts into studying the endoskarn

Summary & Next Steps:

- Fe-Ti-P enriched rocks at MW compared to all of Bonanza arc rocks
- Limestone-magma interactions (and likely calc silicate-magma interactions) has led to apatite-magnetite-titanite enrichment
- Rocks with >2 wt.% P_2O_5 correspond to high modal apatite (>5%) in mafic cumulates, could be enriched in REEs
- MW pluton may be an interesting target for critical metals

- *Investigate REE potential along marginal plutonic rocks*
- *$\delta^{18}O$ studies on the marginal igneous rocks*



Merry Widow Mtn Summit
Photo credit - authors

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**note: all photos included in presentation courtesy of authors*