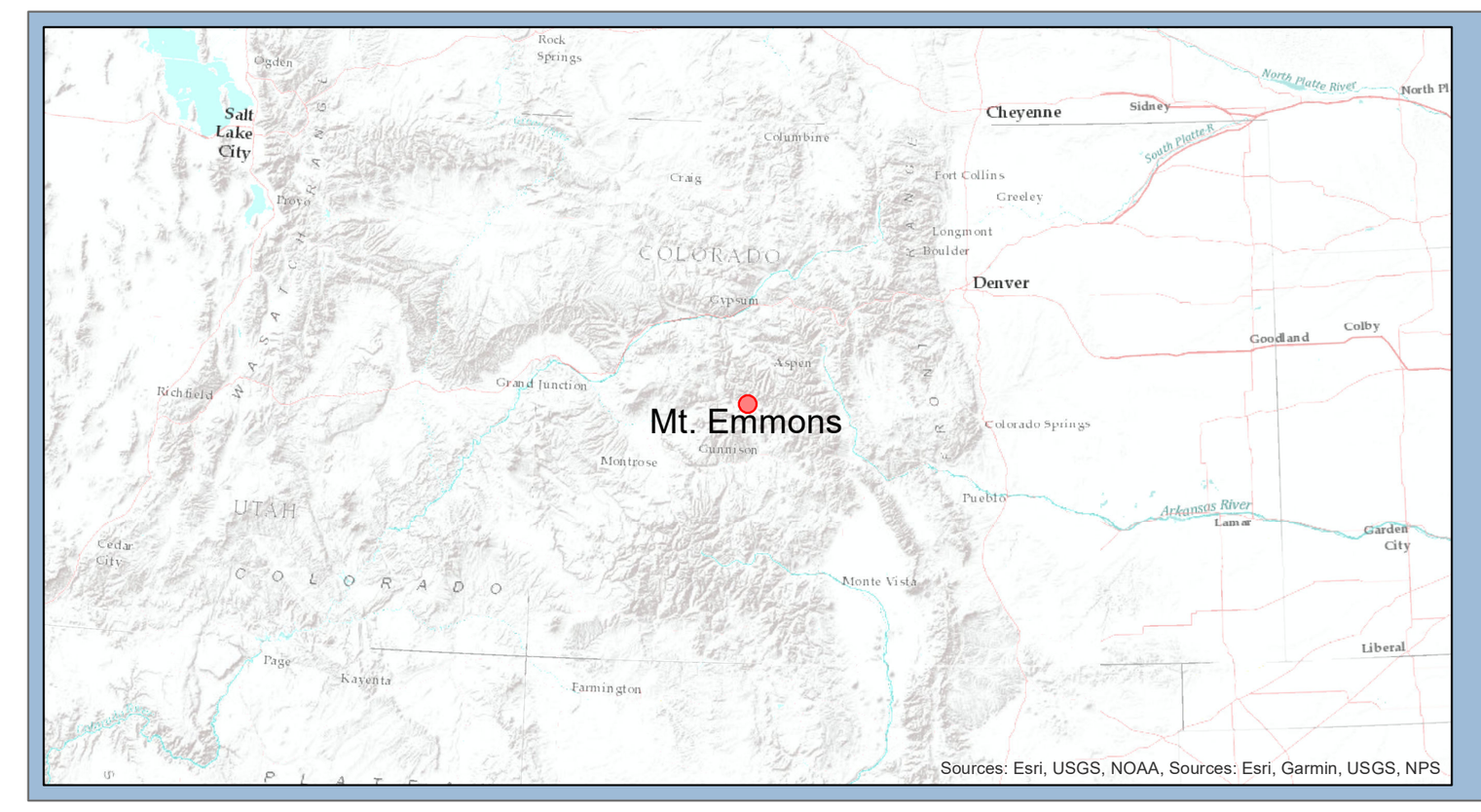

Structural and alteration framework of a base metal mineralized quartz vein system that overlies a Climax-type porphyry Mo deposit at Crested Butte, Colorado, USA

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Introduction

The porphyry Mo system at Mt. Emmons presents a unique opportunity to:

Investigate its hydrothermal footprint in unmetamorphosed sandstones, mudstones, and siltstones

Improve the porphyry Mo deposit model and its exploration criteria

Study young magmatism and tectonism in the greater west-central Colorado Mineral Belt

Understand the nature of groundwater flow and solute transport in an alpine headwater system

This poster is showing preliminary results of field mapping, with the goal to develop a structural and alteration framework in which to further investigate the hydrothermal system(s?)

Redwell Basin/Mt. Emmons- located 7 km WNW of Crested Butte, CO

1 of 5 major porphyry Mo deposits in Colorado (in top 6 in North America)

Climax- 1,790,000 t Mo (0.22%-0.54% MoS_2)
Henderson/Urad- 1,099,100 t Mo (0.35% MoS_2)
Redwell/Mt Emmons- 362,400 t Mo (0.35%-0.73% MoS_2)
Silver Creek- 124,000 t Mo (0.31% MoS_2)
Porphyry Mt prospect- 1,814 t Mo

Roof of a Climax-type porphyry deposit preserved- 1 of 3 known, only one in the Colorado Mineral Belt

Upper vein-hosted Pb-Zn-Ag-Cu-(Sn) mineralization near surface; unknow relationship between base-metal and porphyry Mo mineralization

Located in the west-central Colorado Mineral Belt, a ~500 km long and 25-60 km wide zone of Late Cretaceous (~75-43 Ma), middle Cenozoic (43-18), late Cenozoic (18-0 Ma) plutonic suites, and three related periods of mineralization

Local Geology:

Mineralized pluton composed of 18-16 Ma granitic to rhyolitic suites intruded into Cretaceous and younger metasediments

Pluton connected to a rhyolite pipe exposed at surface

Magma derived from ~1.4 Ga lower crustal felsic ± minor mafic sources with high-grade metasedimentary precursors during a transition from subduction to rifting

Two Mo-W-Sn zones at depth (Redwell stock in Redwell Basin), one over the Red Lady stock in Red Lady Basin

Base-metal (Pb, Zn, Ag, Cu, Sn) zones in pipe and near surface

Pb zone: upper to mid pipe
Zn zone: overlaps with Pb, plus lower pipe
Cu zone: overlaps with Pb-Zn, plus deep pipe
Sn zone: out-of-sync with Pb-Zn-Cu

Disseminated Alteration

Moderate disseminated chlorite in quartz-rich conglomerate; very high disseminated chlorite in organic rich layers and nodules

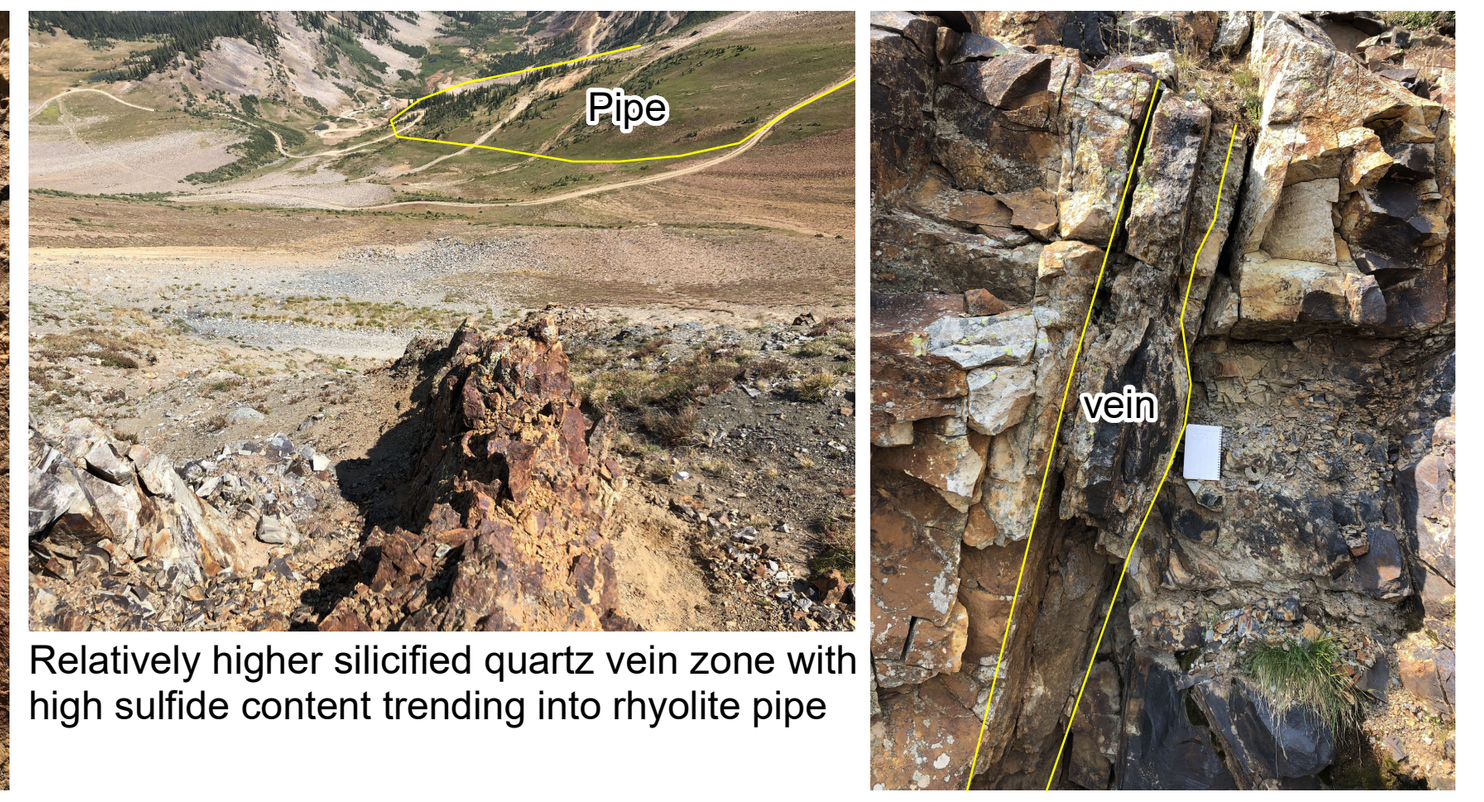
High disseminated chlorite and moderate epidote on fracture faces

High pervasive and low intensity disseminated pyrite casts; rhyolite wall rock is extremely bleached

Low pervasive and high intensity disseminated pyrite casts parallel to flow foliation in rhyolite

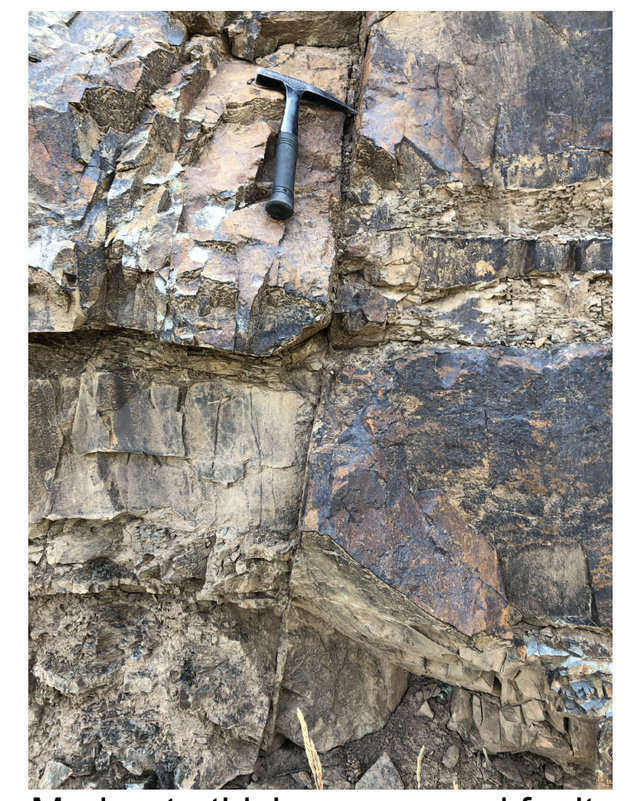
High pervasive and high intensity disseminated pyrite casts in highly silicified rhyolite zone

Vein Zones and Faults



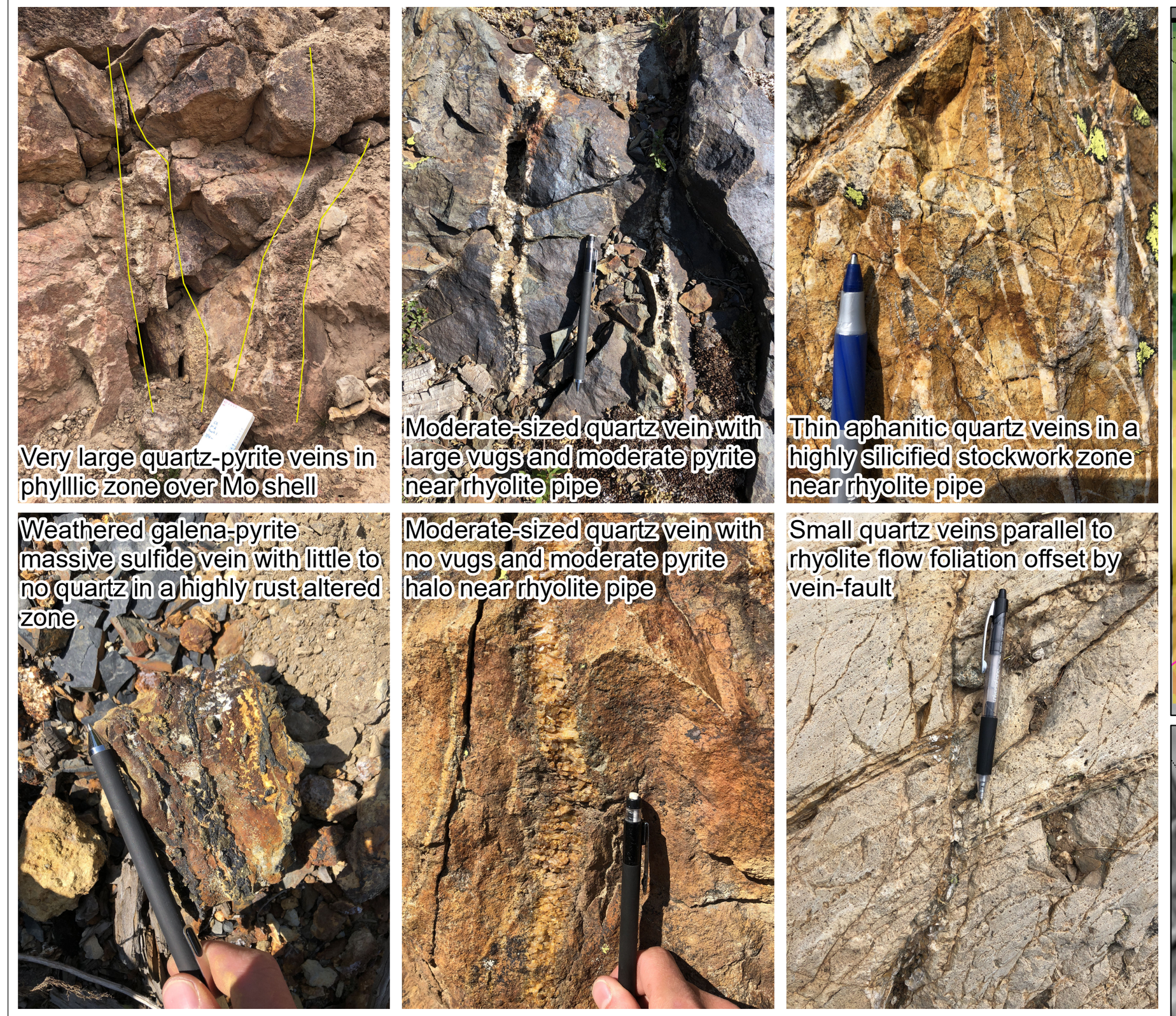
Relatively higher silicified quartz vein zone with high sulfide content trending into rhyolite pipe

Thick vein-cored fault zone proximal to pipe; more than 3m offset



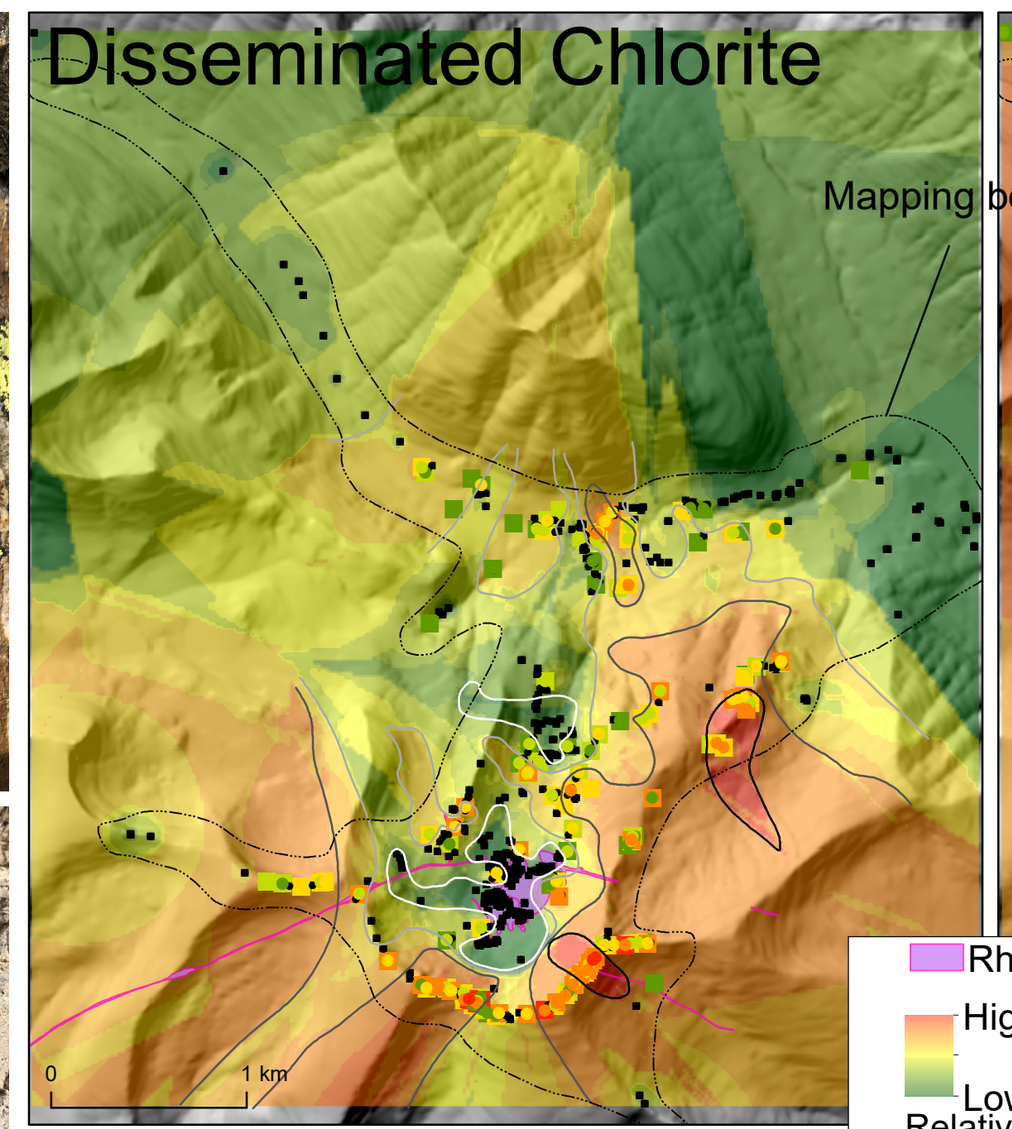
Moderate thickness normal fault with vein gouge moderate distance from rhyolite pipe

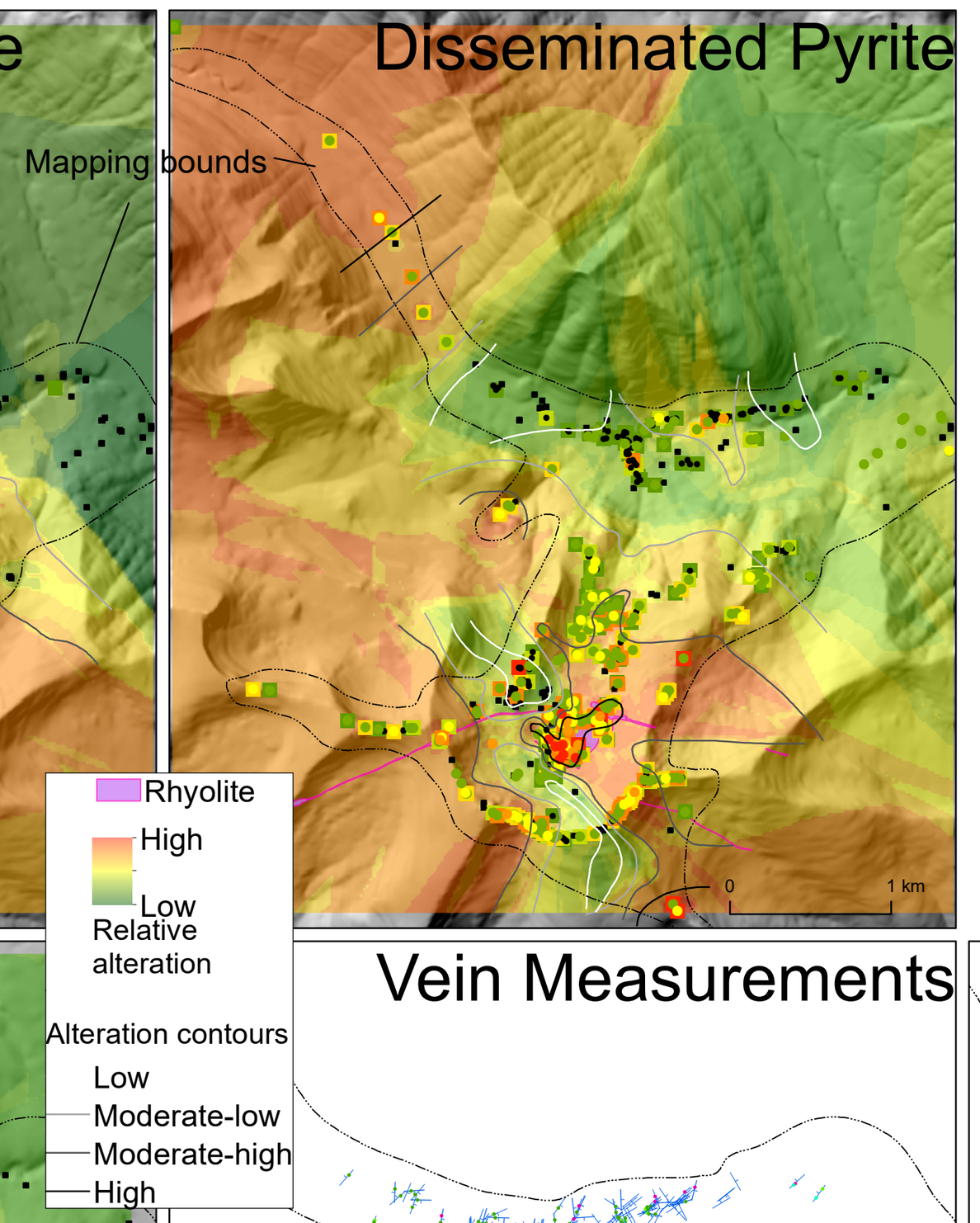
Proximal Veins

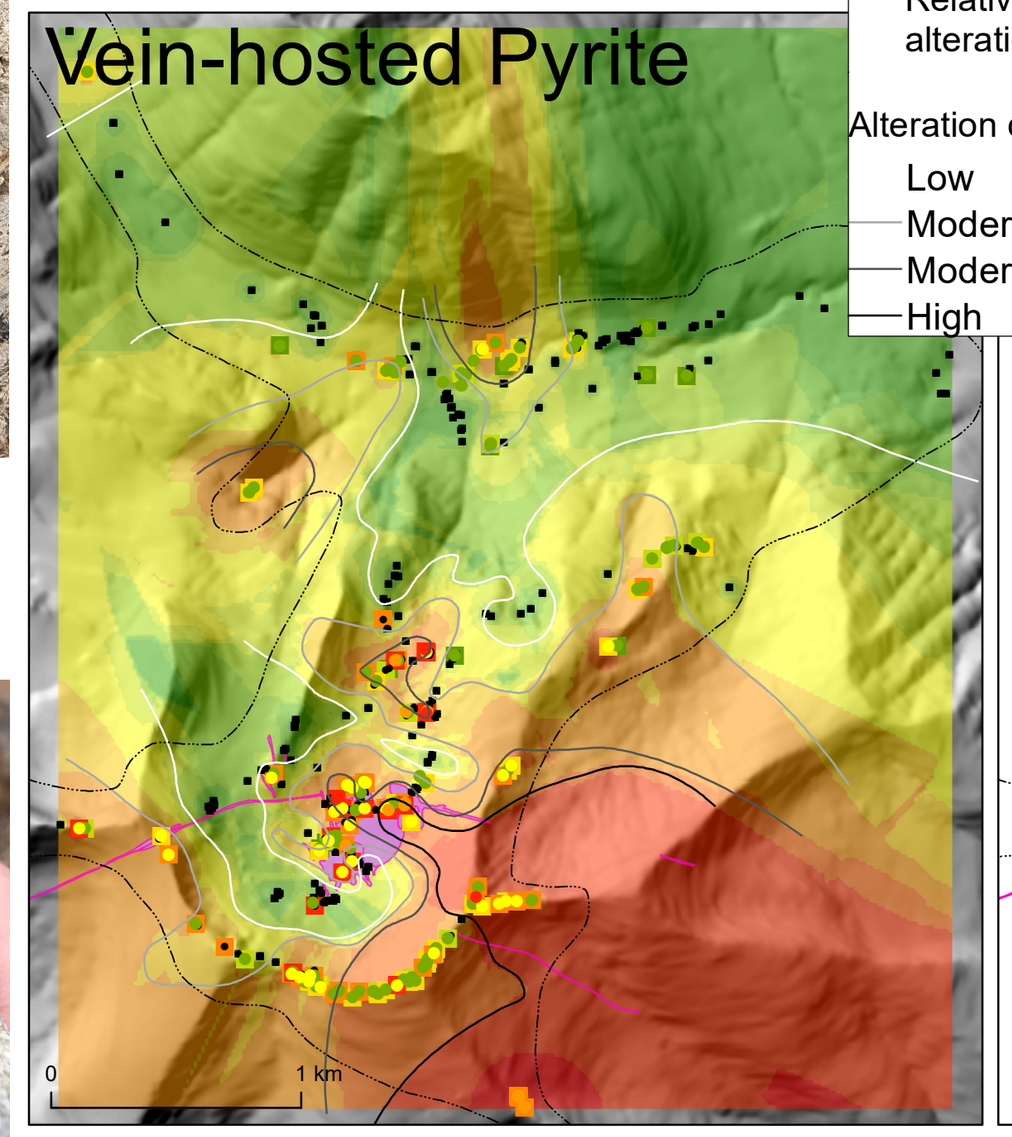


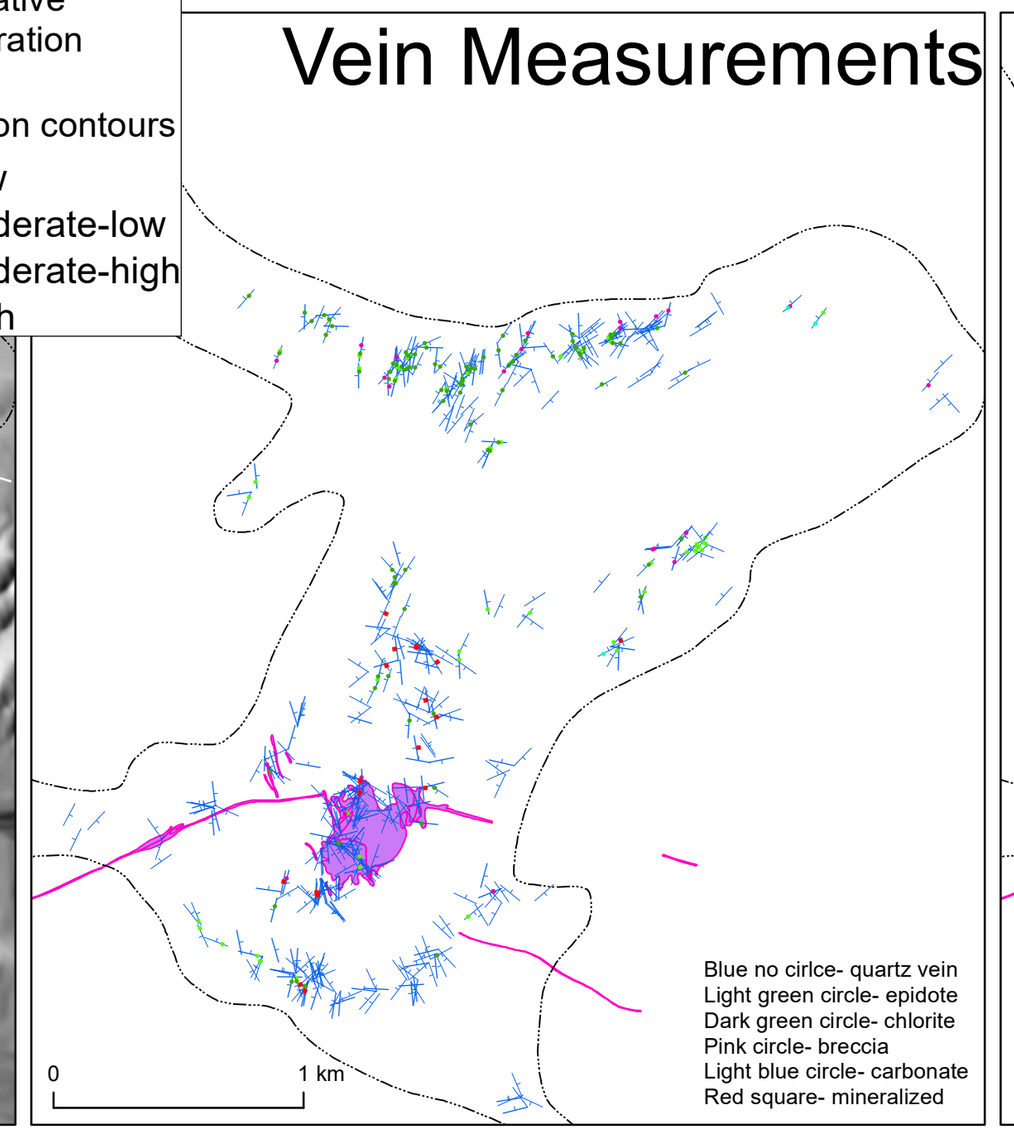
Semi-proximal and Distal Veins

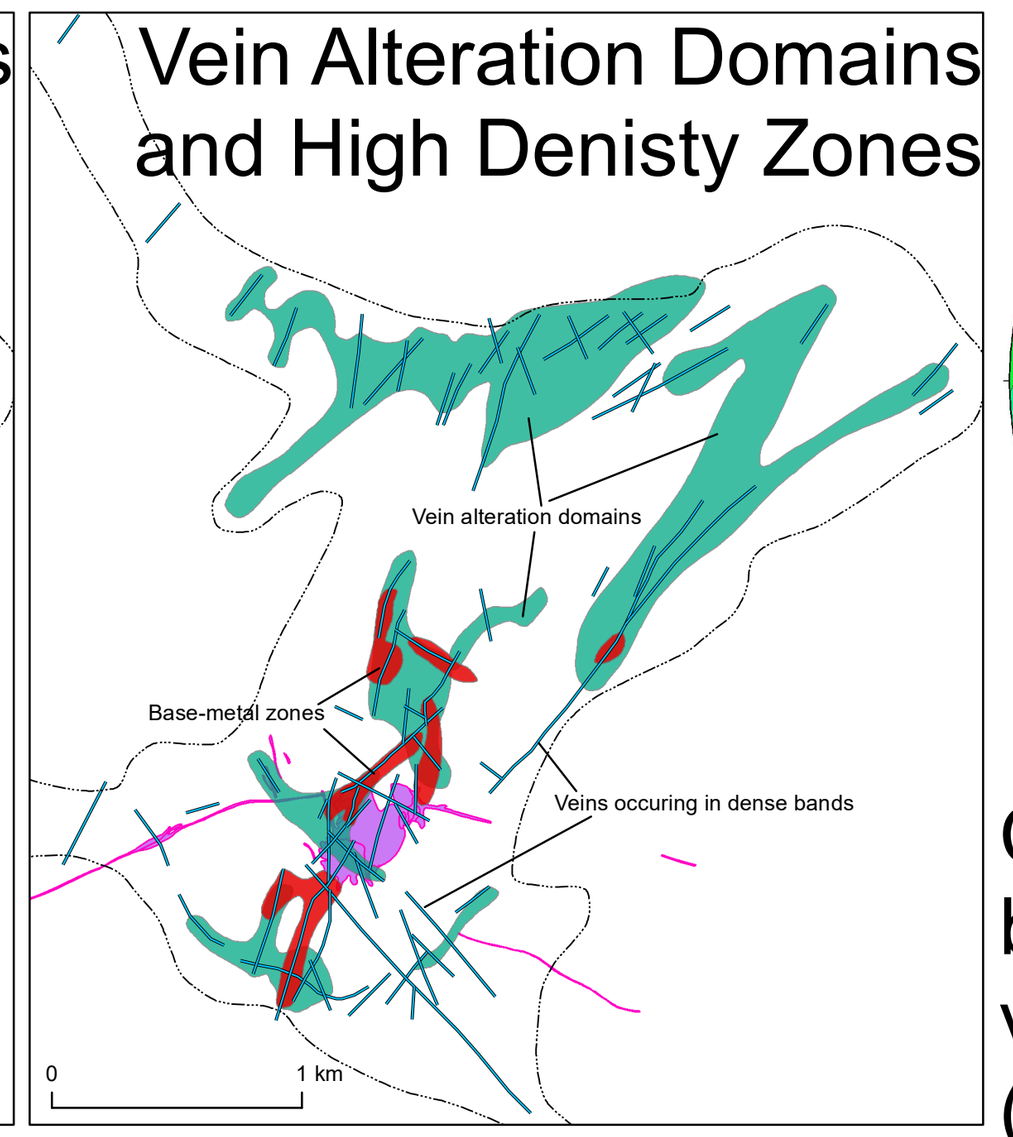
Common distal vein-occurance in brown hornfels zone; veins commonly occur in distinct bands; veins commonly with bleached/ silicified halos that increase in intensity and pervasiveness at band intersections

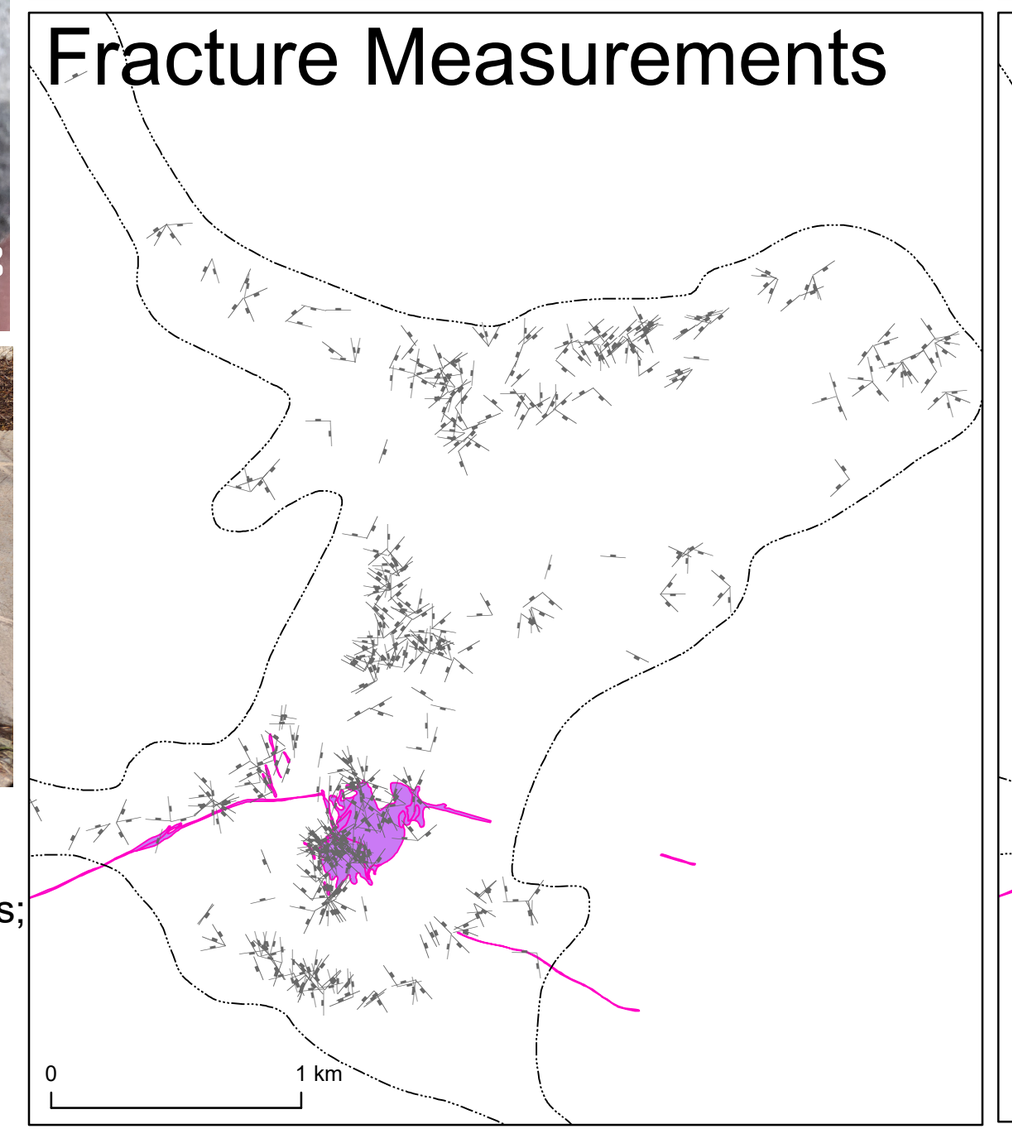


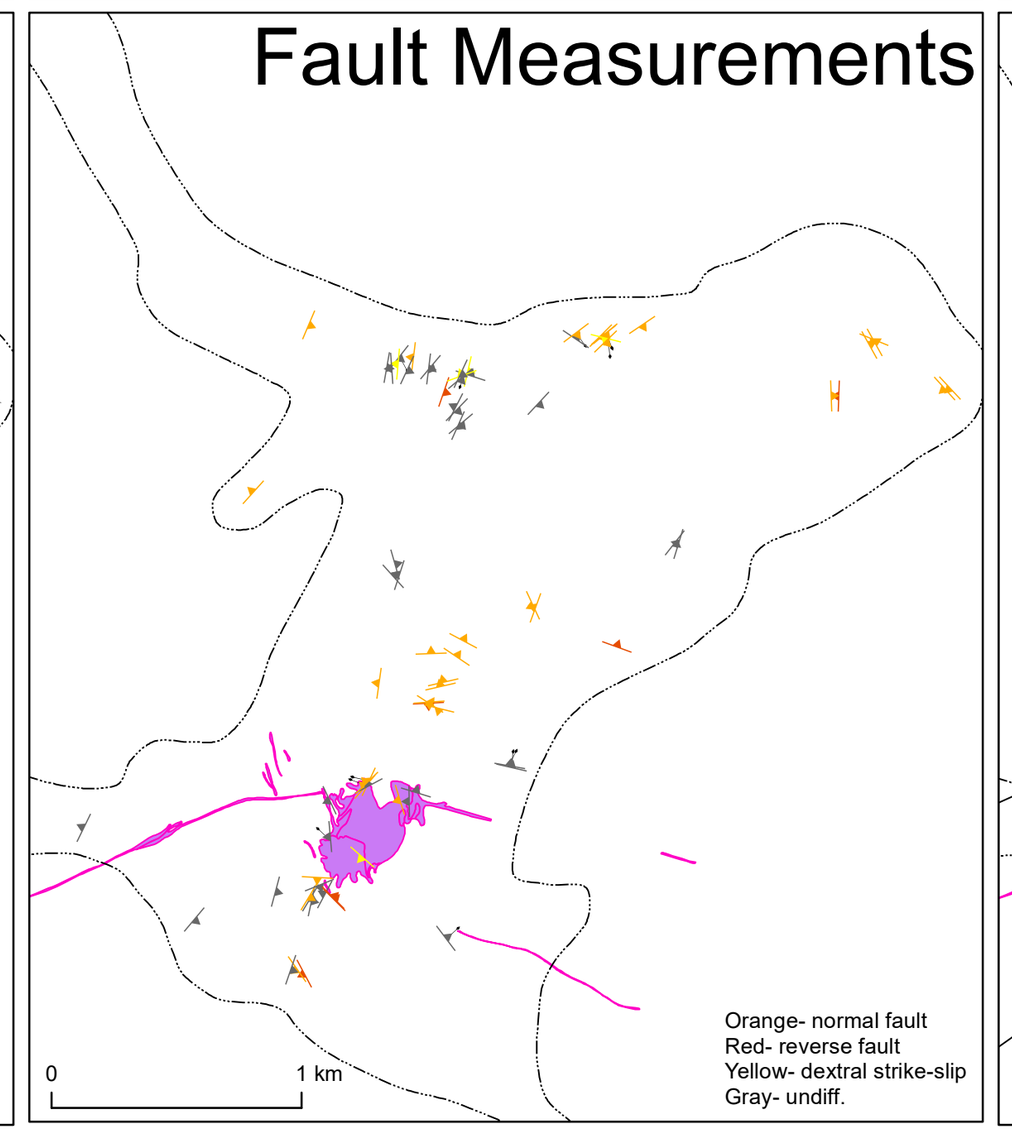


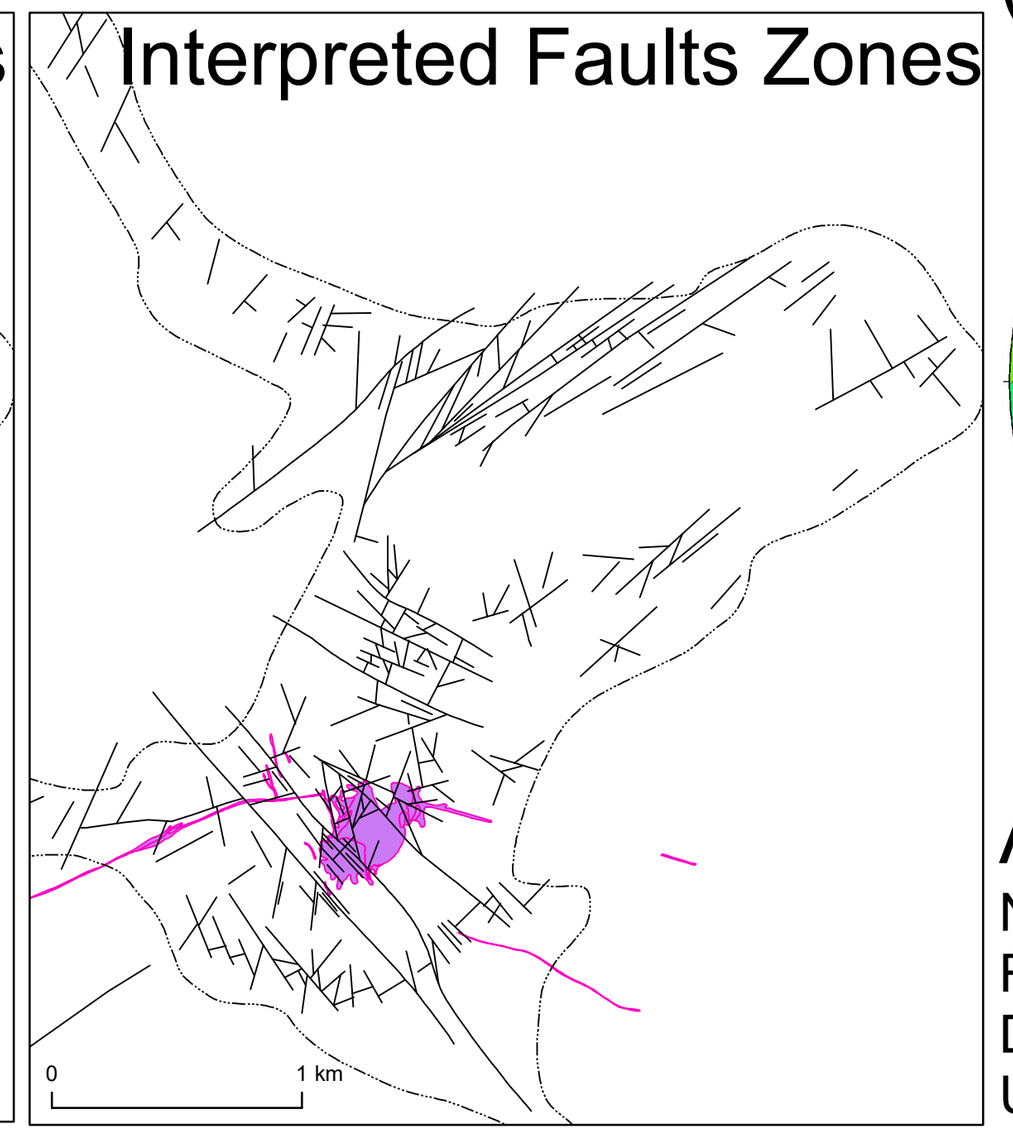




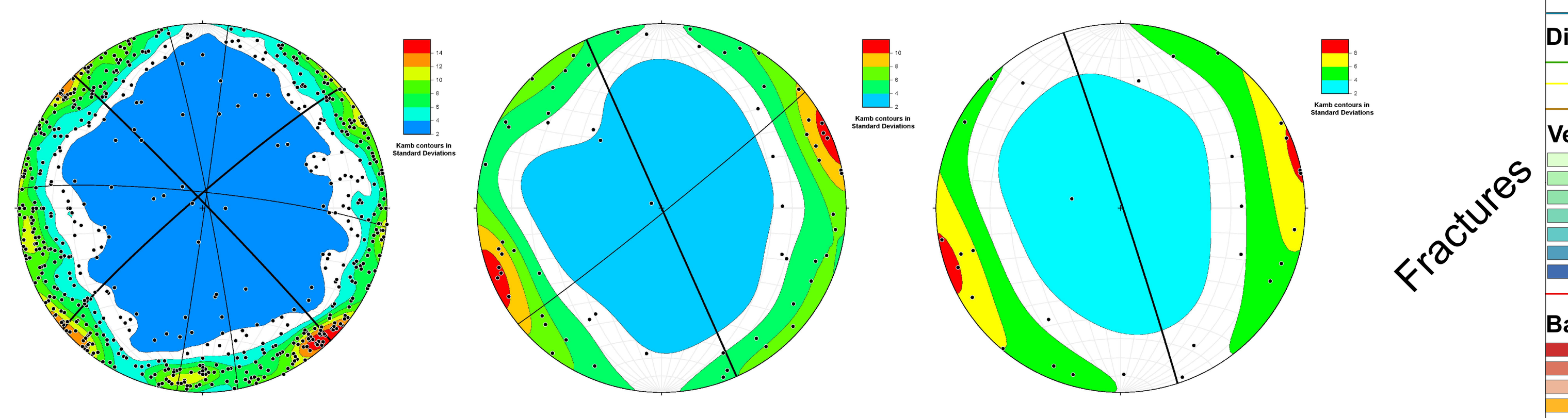








Data

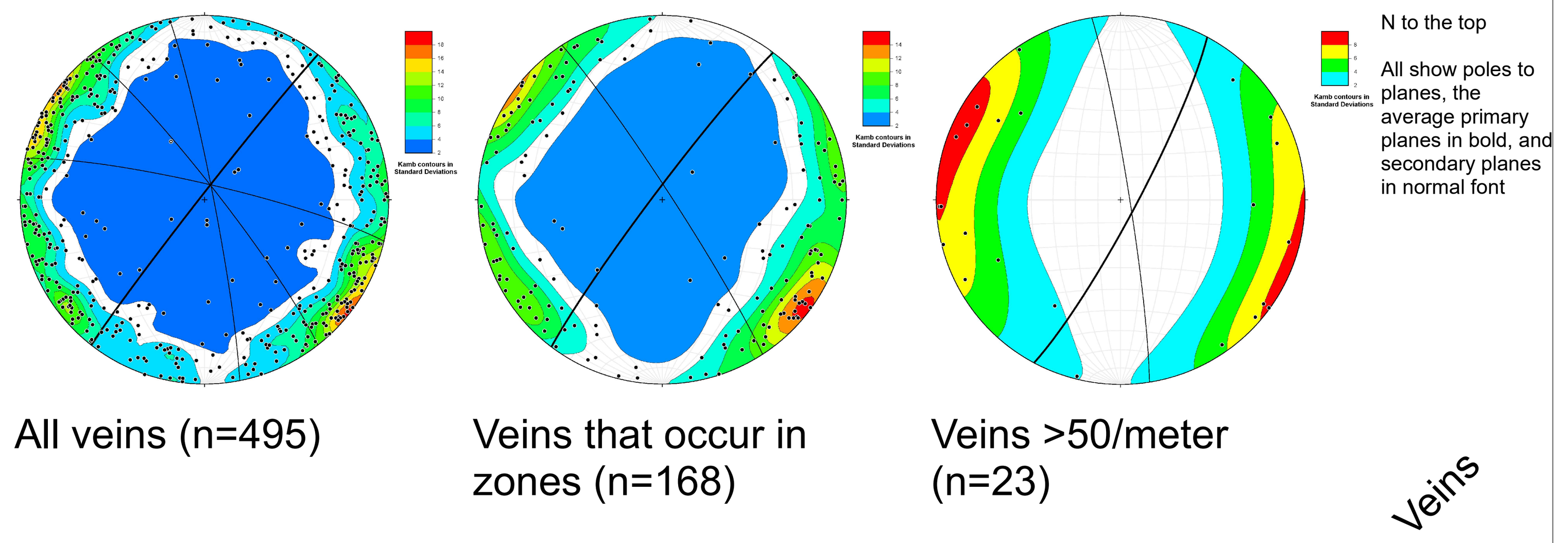


All fractures (n=623) | Fractures that occur in zones (n=65) | Fractures >50/meter (n=29)

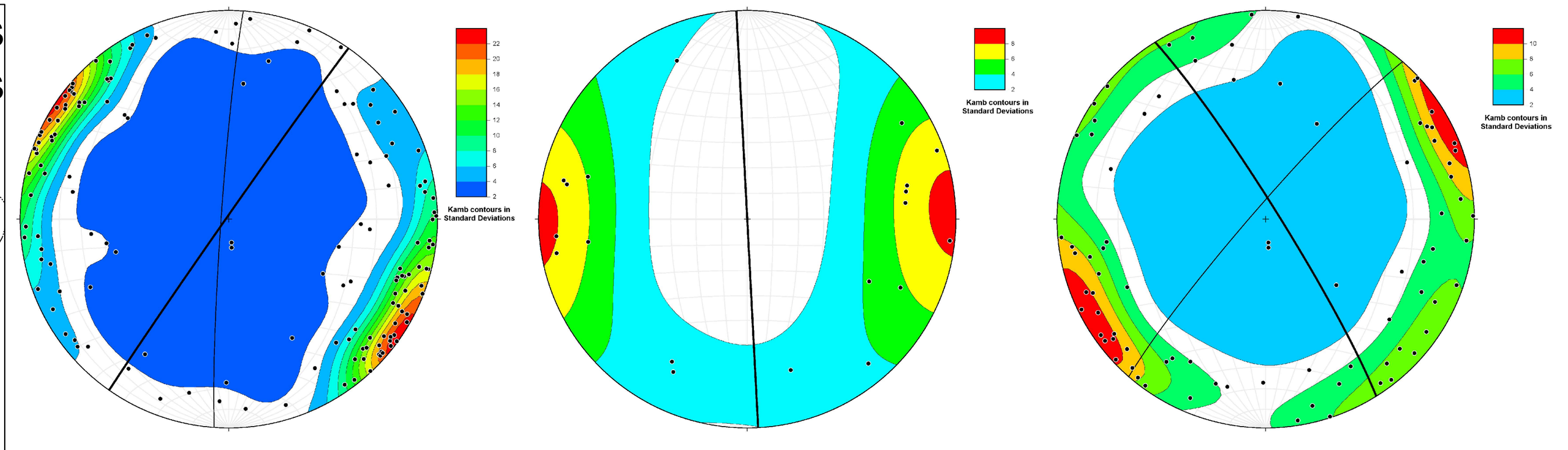
All stereonets are equal-area

N to the top

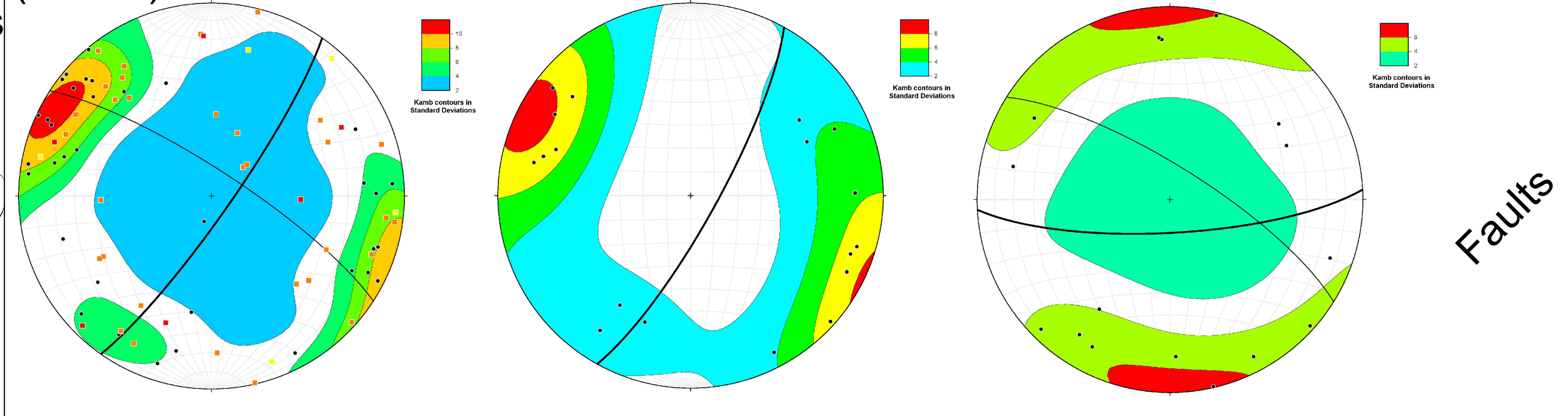
All show poles to planes, the average primary planes in bold, and secondary planes in normal font



All veins (n=495) | Veins that occur in zones (n=168) | Veins >50/meter (n=23)



Chlorite, epidote, breccia and carbonate veins (n=151) | Massive to semi-massive galena, sphalerite and cassiterite veins (n=19) | Veins with average pyrite size >0.1cm (n=84)

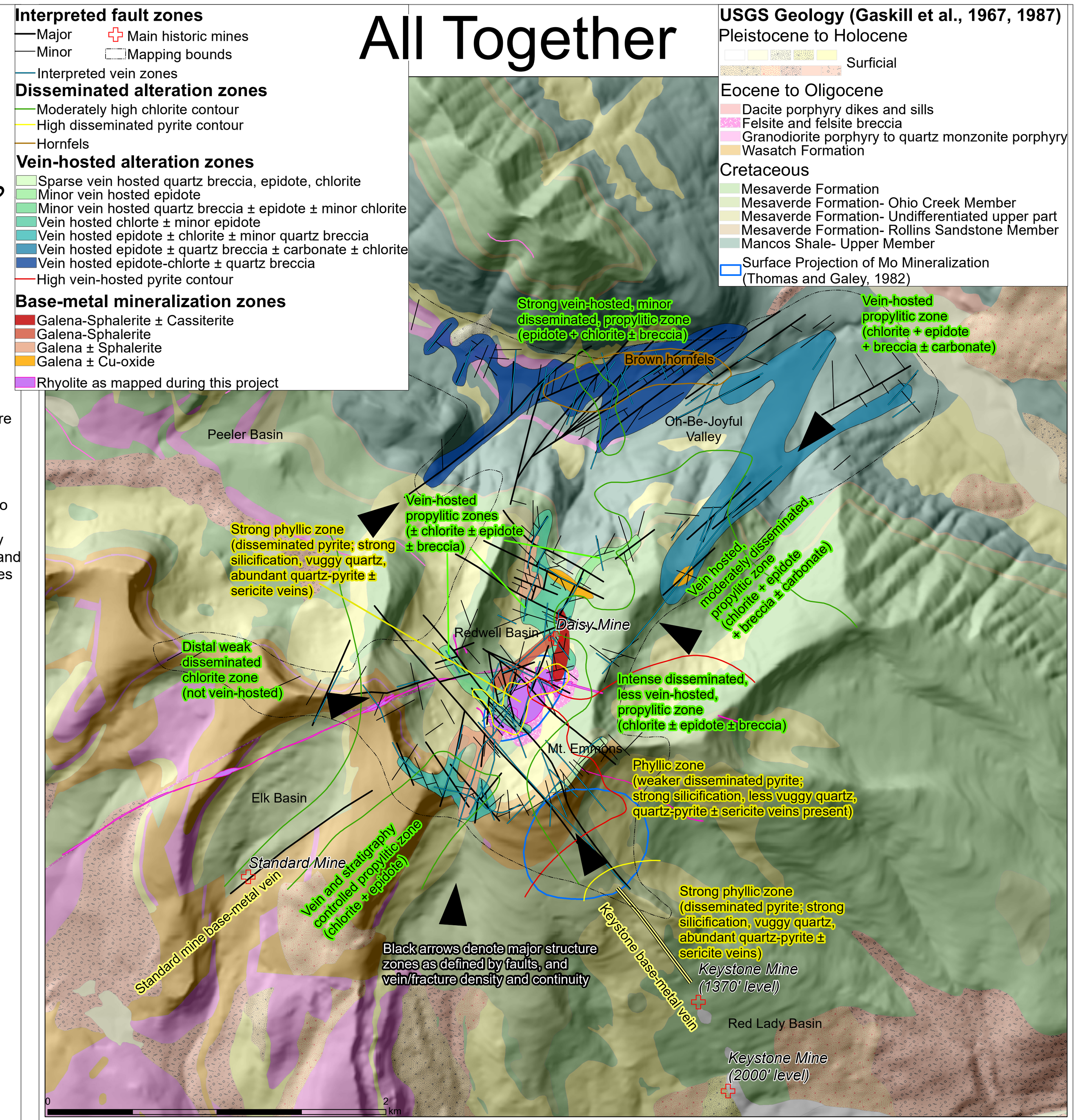


All faults (n=81)
Normal (n=33)- Orange
Reverse (n=7)- Red
Dextral (n=5)- Yellow
Undiff. (n=36)- Black

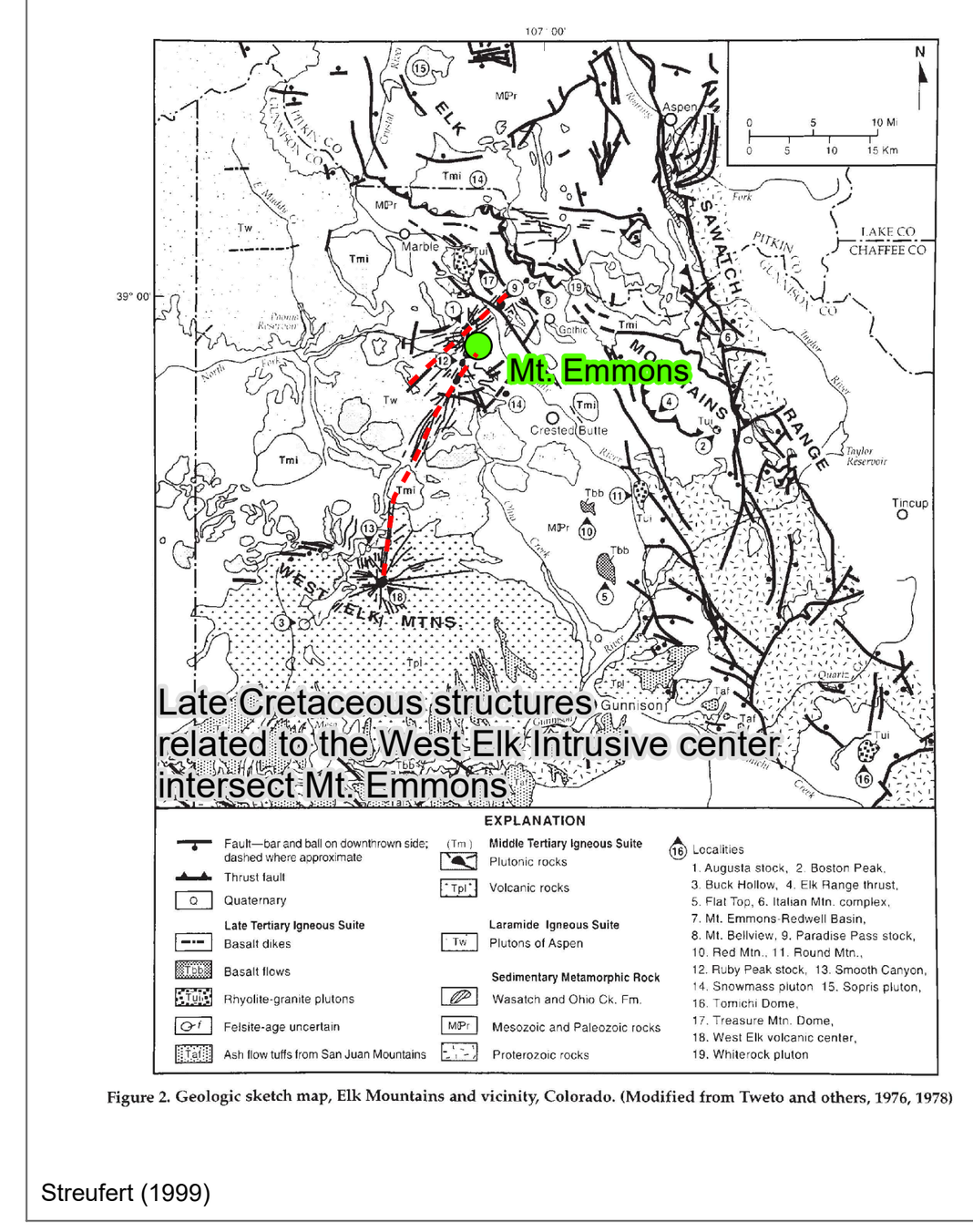
Faults >10cm thick (n=19)

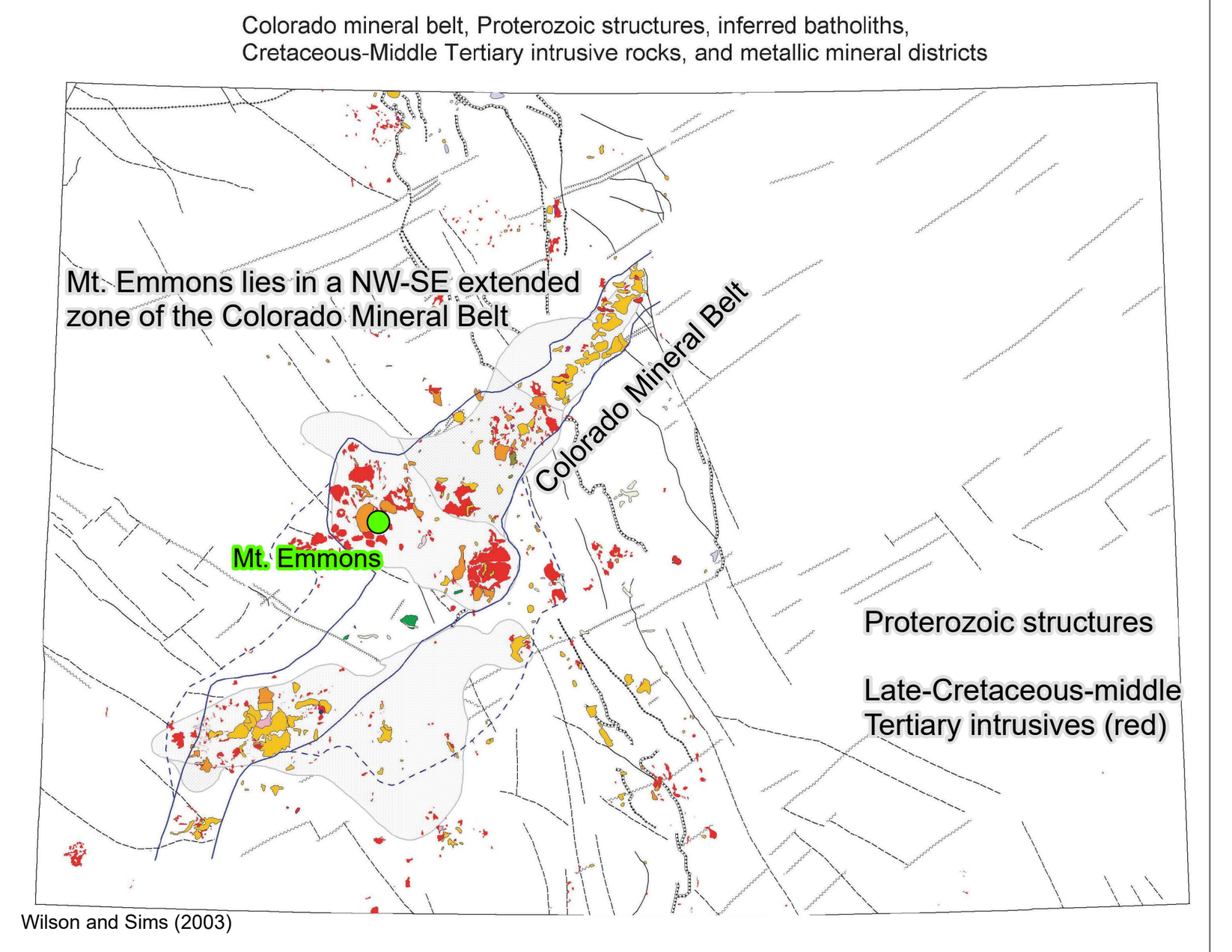
Faults >10cmoffset (n=18)

All Together



Regional Considerations





Conclusions

Major structure zones, defined by dense and continuous veins, fractures, and faults, are NE- and NW-trending near the porphyry and rhyolite, and chiefly NE-trending distal to the pipe and porphyry

All are steeply dipping

Hydrothermal alteration grades from phyllic near the Mt. Emmons porphyry Mo system, to strongly disseminated with vein-hosted propylitic veins away from the porphyry, to overwhelmingly vein-hosted propylitic distal to the porphyry

The one exception is in the rhyolite pipe in Redwell Basin, where phyllic alteration is strong and disseminated, possibly as a result of vertical flow foliation within the pipe creating conduits for vertical fluid flow over a deep porphyry, and/or because the pipe lies at the intersection of two major structural zones, also conducive to increased fluid flow

Base-metal mineralization wraps around the SW-W-NW side of the pipe, adjacent to the projected-to-surface porphyry Mo shell

Individual base-metal veins are mainly N-S-trending, bisecting the main NE/NW fracture and vein trends

Mineralization grades from galena ± sphalerite far from the rhyolite pipe, to galena + sphalerite proximal to the pipe, and contains discrete zones of cassiterite and copper mineralization

Vein-hosted alteration zones and vein zones are parallel to sub-parallel to base-metal vein zones, and both trend mainly NE rather than NW

Vertical tension openings forming in a normal stress regime would be conducive to increased fluid flow, vein formation, and mineralization in a hydrothermal system

NE-trending structures may be related to Late Cretaceous-Tertiary structures formed during widespread plutonism and volcanism in the area

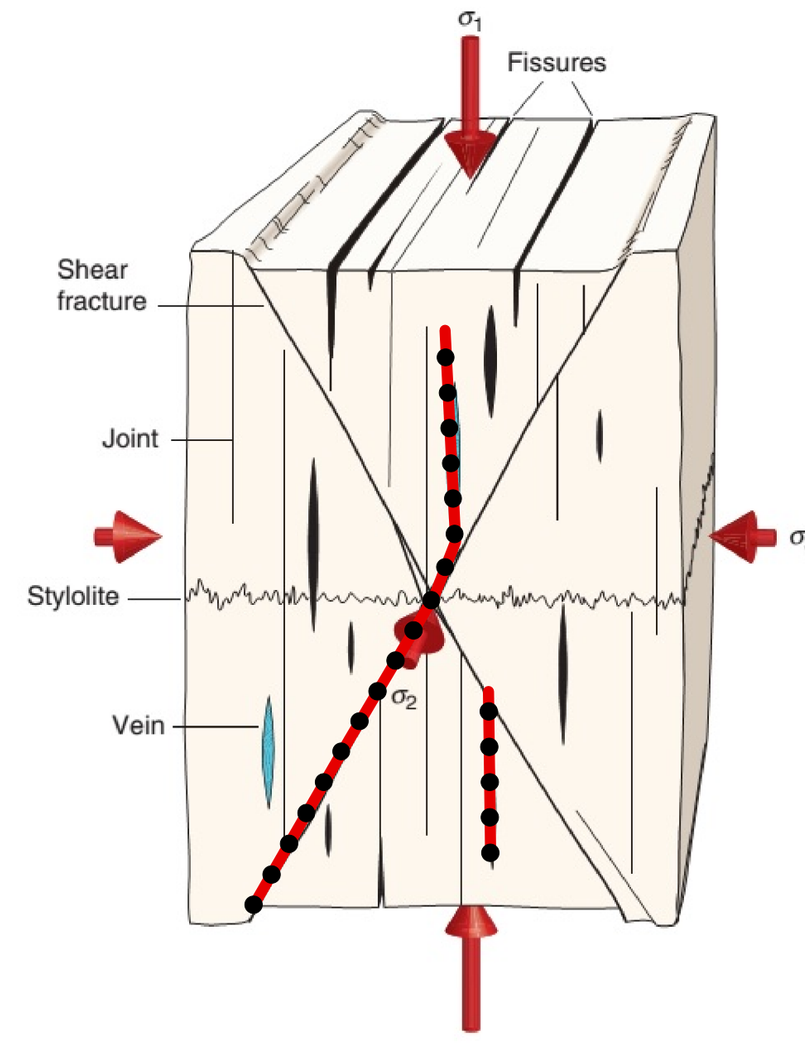
NW-trending structures may be Laramide in age, or locally related the younger brittle stress regime

Both trends are present in this part of the Colorado Mineral Belt

No Proterozoic structures were observed

Next steps: further differentiate vein types, orientations, and relationship to mineralization, alteration, and regional tectonics

Determine how base-metal and porphyry Mo mineralization are related



Schematic of massive sulfide veins taking advantage of fissure openings in a normal stress regime

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If you read this far, thank you!