Revising the Basement Map of the Lower Peninsula; New Constraints from Cores and Cuttings

Peter J. Voice, William B. Harrison III, and Joyashish Thakurta

Department of Geosciences, Western Michigan University and the Michigan Geological Survey

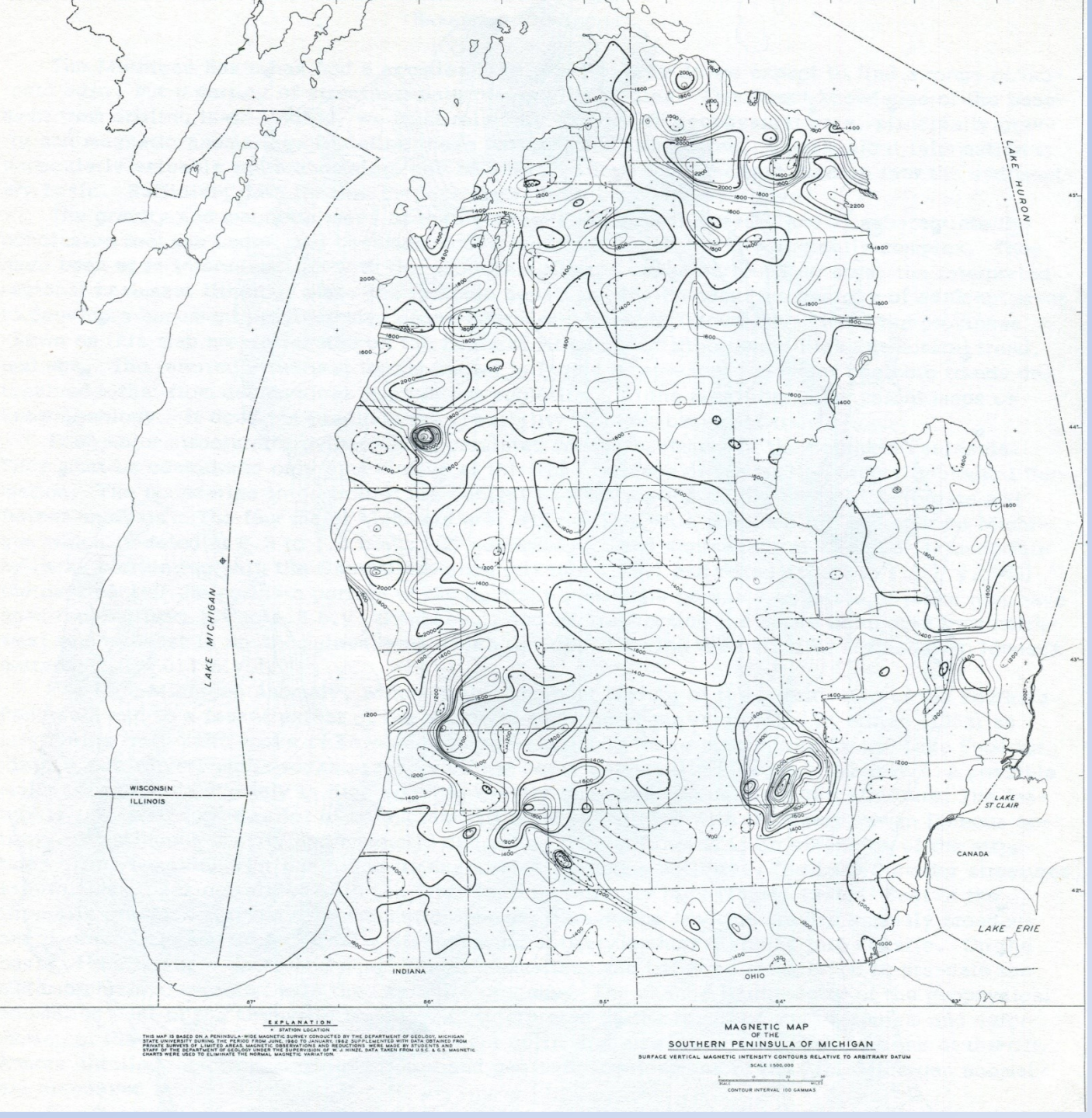
Geologic Background

- Prior datasets
  - Geophysical data (Gravity and Magnetic anomaly maps)
  - Basement maps based on well samples
  - Geochronological datasets

Bouguer Gravity Anomaly Map

C.I. = 1 milligal

Hinze and Merritt, 1969

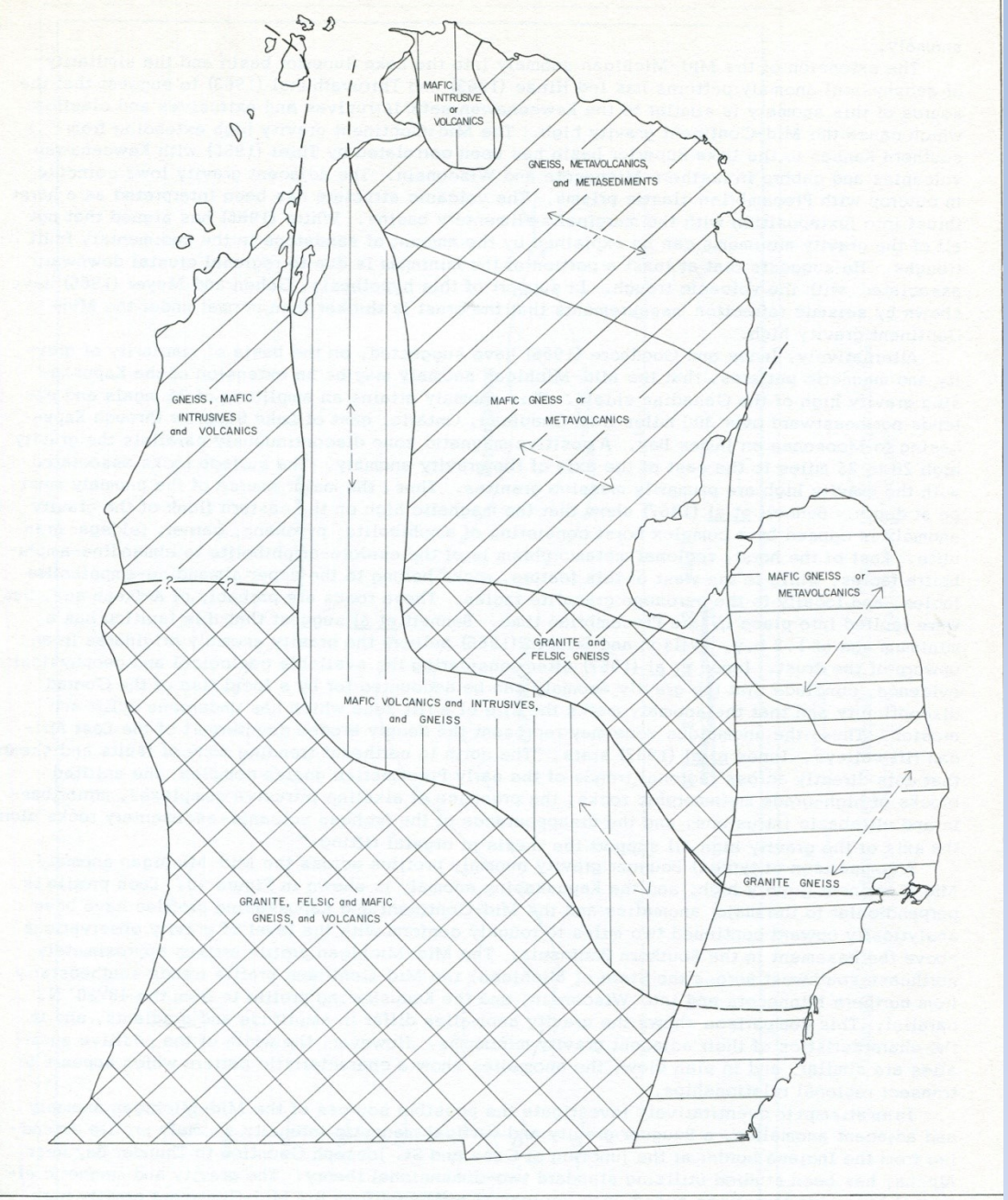


Magnetic Anomaly Map

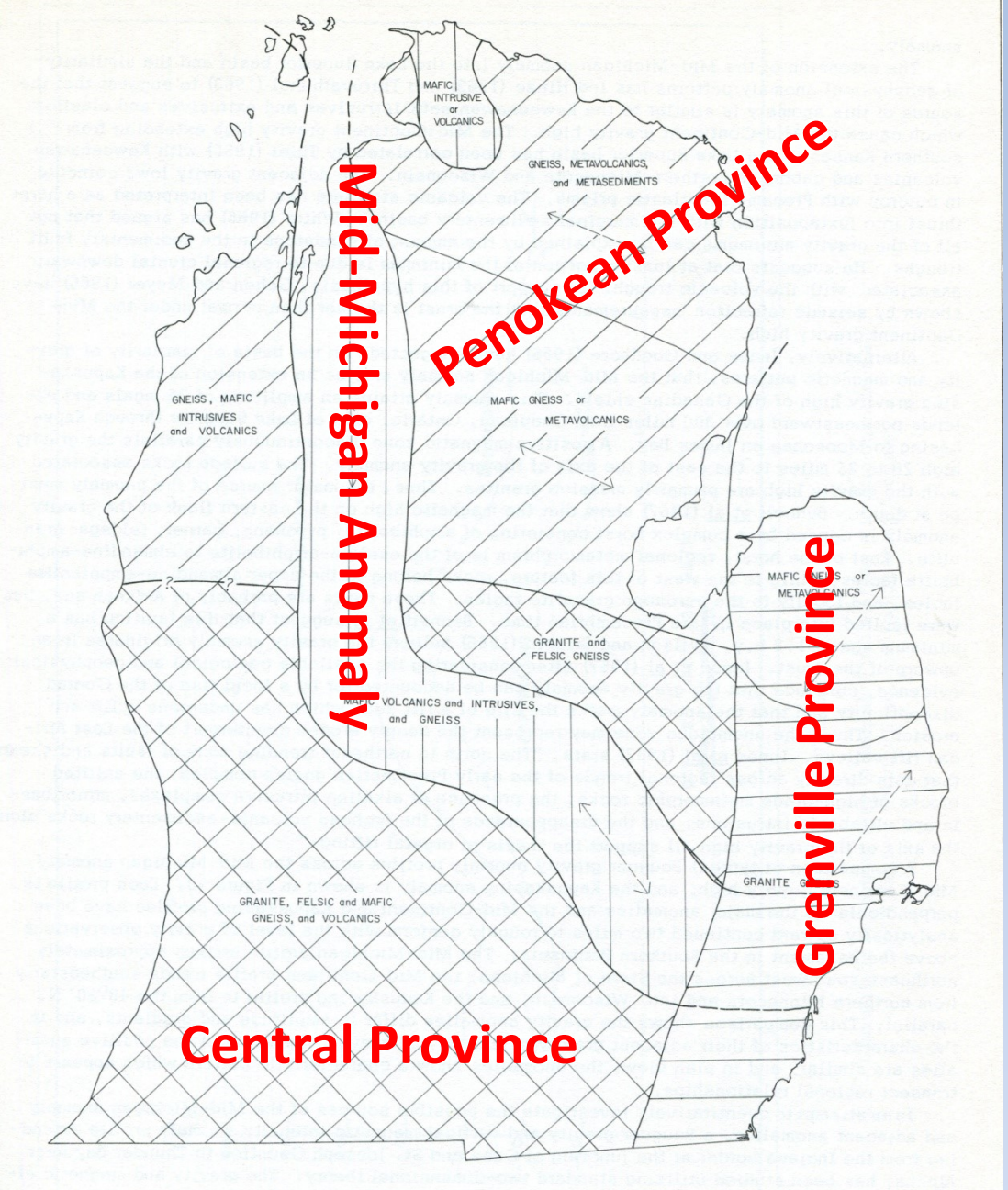
Hinze and Merritt, 1969

The Hinze Basement Map Dataset
14 wells – lithologic samples from cuttings

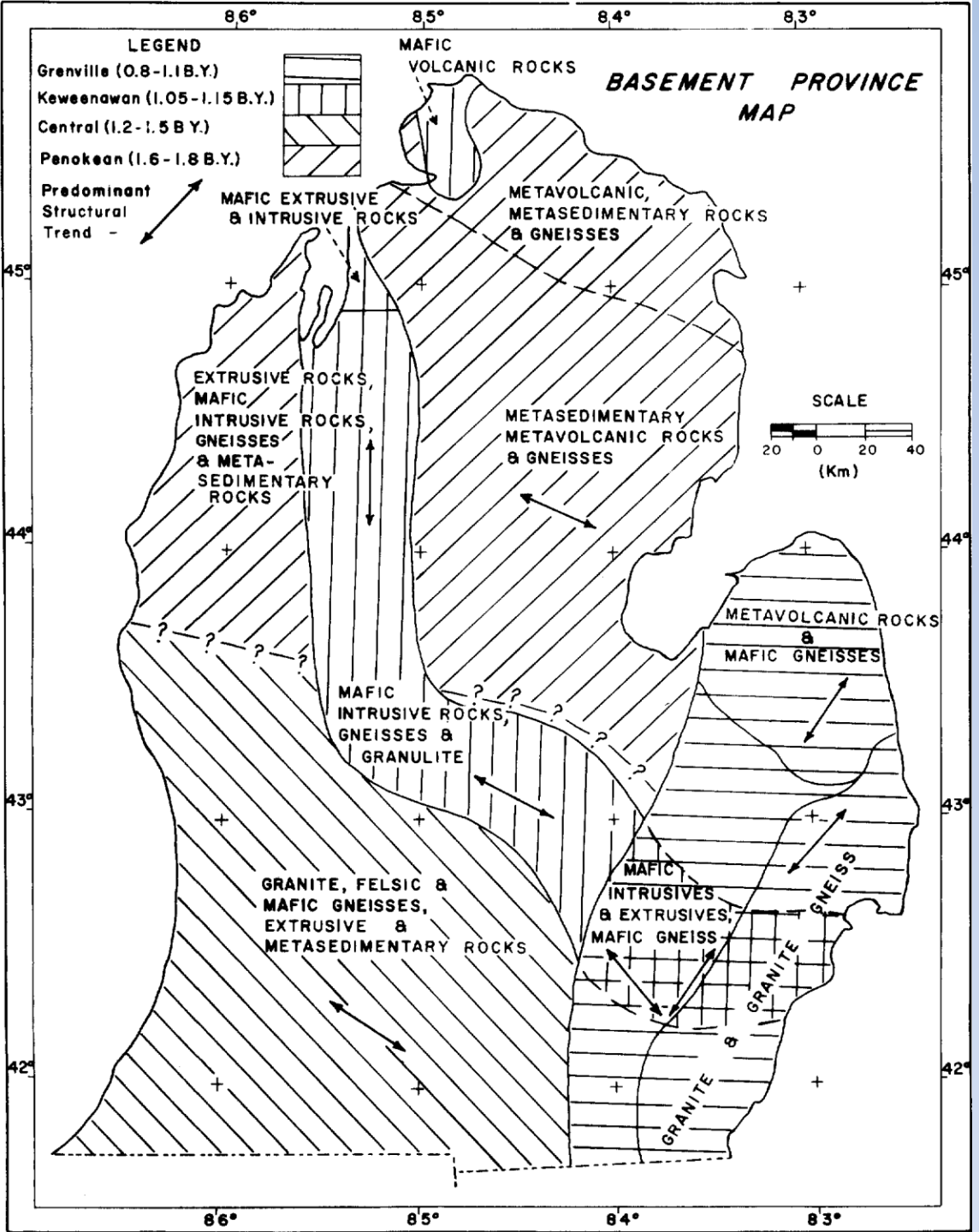
Hinze and Merritt, 1969



Hinze and Merritt, 1969



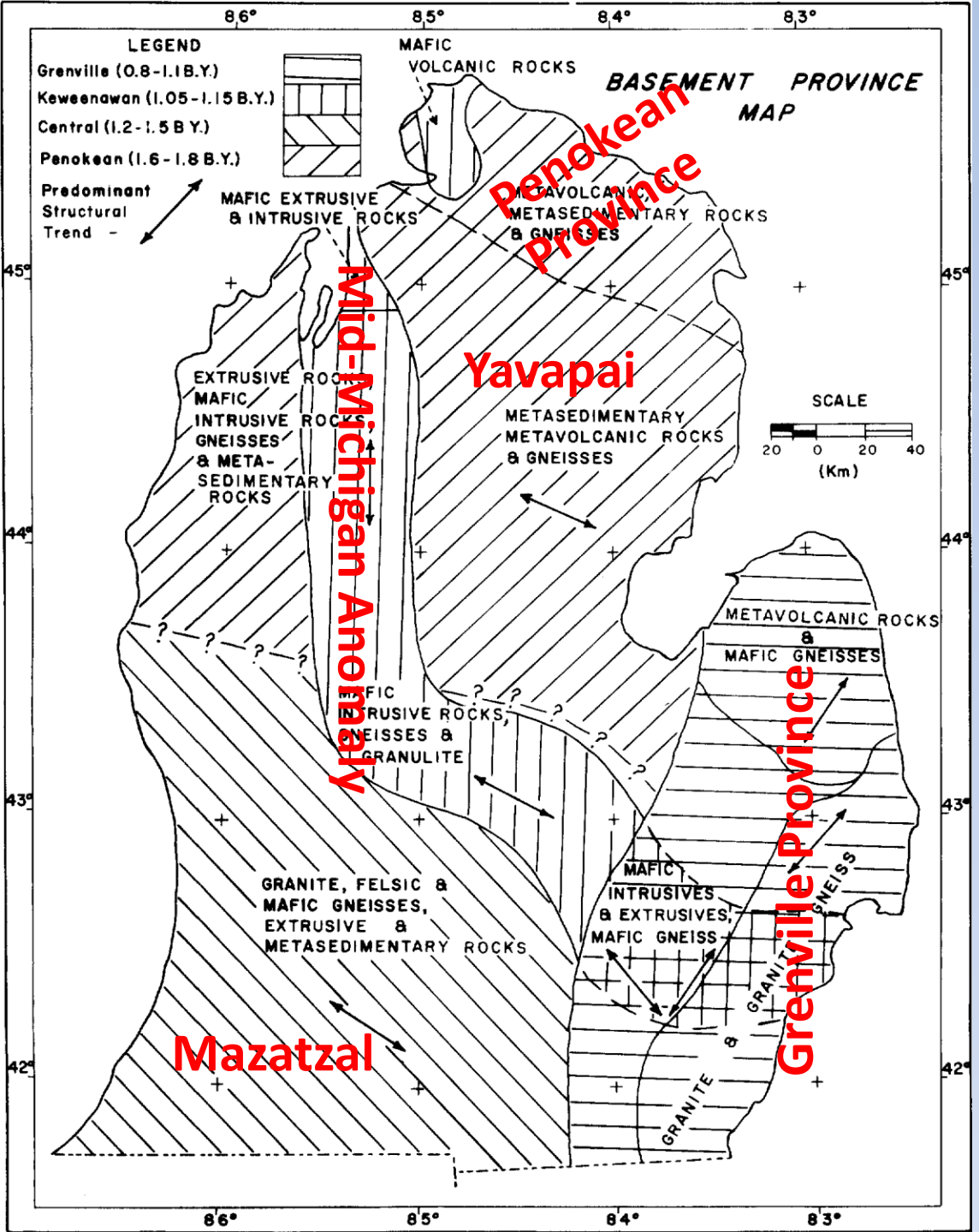
Hinze and Merritt, 1969



Revision of Basement Map

3 additional wells + refinements to geophysical datasets

Hinze et al. 1975



Revision of Basement Map

3 additional wells + refinements to geophysical datasets

Hinze et al. 1975

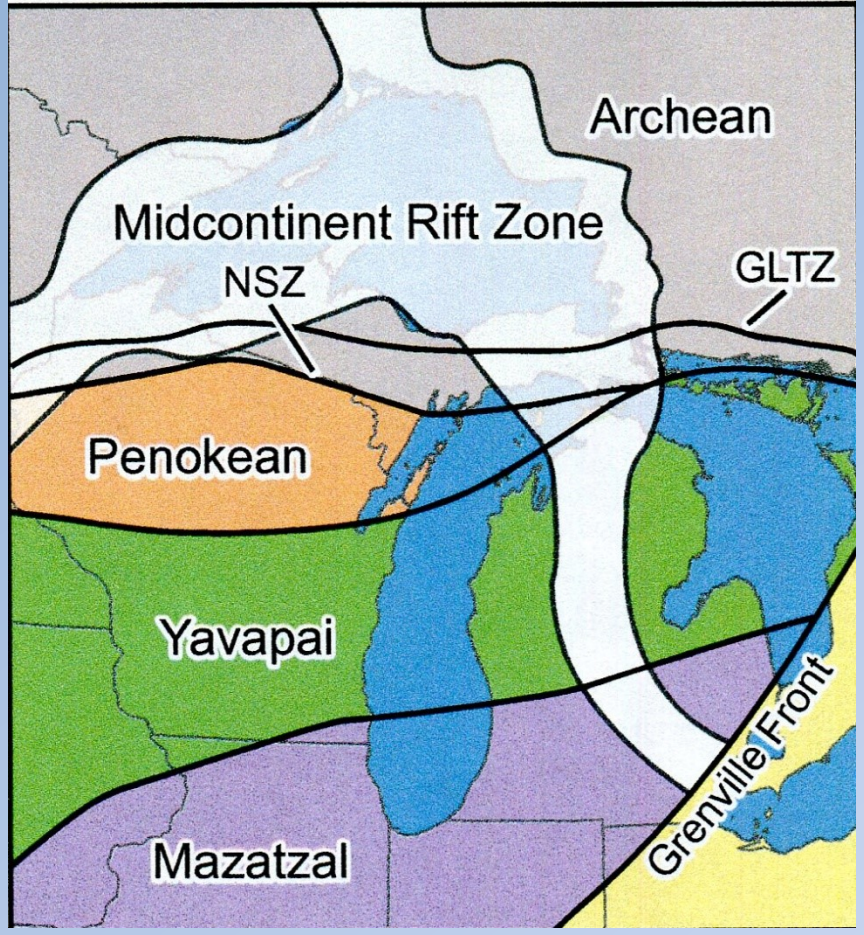
Well	Location	Method and material	Age (Ma)	Ref
McClure #2 State-Beaver Island	Charlevoix Co.	Rb-Sr and K-Ar Biotite from cuttings	1040; 1090	Lidiak et al. 1966
St. Blair 2-24	Grand Traverse Co.	U-Pb Zircon from granite	1472 ± 2	Hoppe et al. 1983
Taylor	Lenawee Co.	Rb-Sr Biotite from granite and granite-gneiss	890-970	Summerson, 1962
St. Clair #1 Hurst	St. Clair Co.	Rb-Sr and K-Ar Biotite from biotite-gneiss cuttings	900, 970	Lidiak et al. 1966
Colvin and Associates, Voss	Washtenaw Co.	Rb-Sr Gneiss (?) cuttings	840	Lidiak et al. 1966
Colvin and Associates, Meinzinger	Washtenaw Co.	Rb-Sr Gneiss cuttings	920	Lidiak et al. 1966

Most samples taken from cuttings

1. Mixed samples from multiple footages
2. Likely time-averaging multiple geologic ages (with a dominant mode slightly younger than Grenville age)
3. Many of the ages are “Model Ages”

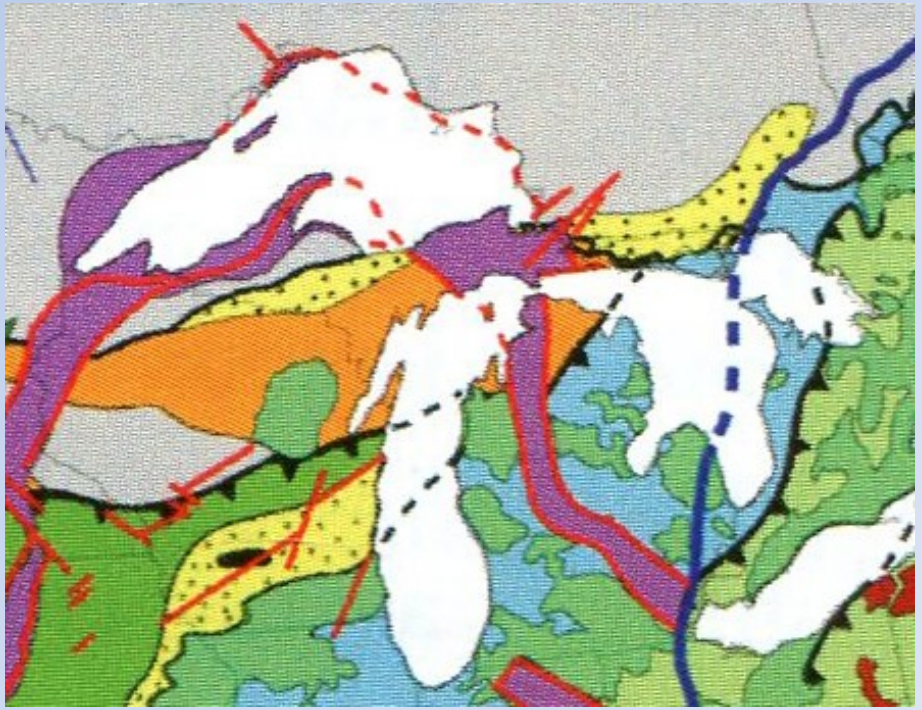
Well	Location	Method and material	Age (Ma)	Ref
McClure #2 State-Beaver Island	Charlevoix Co.	Rb-Sr and K-Ar Biotite from cuttings	1040; 1090	Lidiak et al. 1966
St. Blair 2-24	Grand Traverse Co.	U-Pb Zircon from granite	1472 ± 2	Hoppe et al. 1983
Taylor	Lenawee Co.	Rb-Sr Biotite from granite and granite-gneiss	890-970	Summerson, 1962
St. Clair #1 Hurst	St. Clair Co.	Rb-Sr and K-Ar Biotite from biotite-gneiss cuttings	900, 970	Lidiak et al. 1966
Colvin and Associates, Voss	Washtenaw Co.	Rb-Sr Gneiss (?) cuttings	840	Lidiak et al. 1966
Colvin and Associates, Meinzinger	Washtenaw Co.	Rb-Sr Gneiss cuttings	920	Lidiak et al. 1966

Only Well where the geochronological sample is not a composite sample



Bornhorst and Brandt, 2009

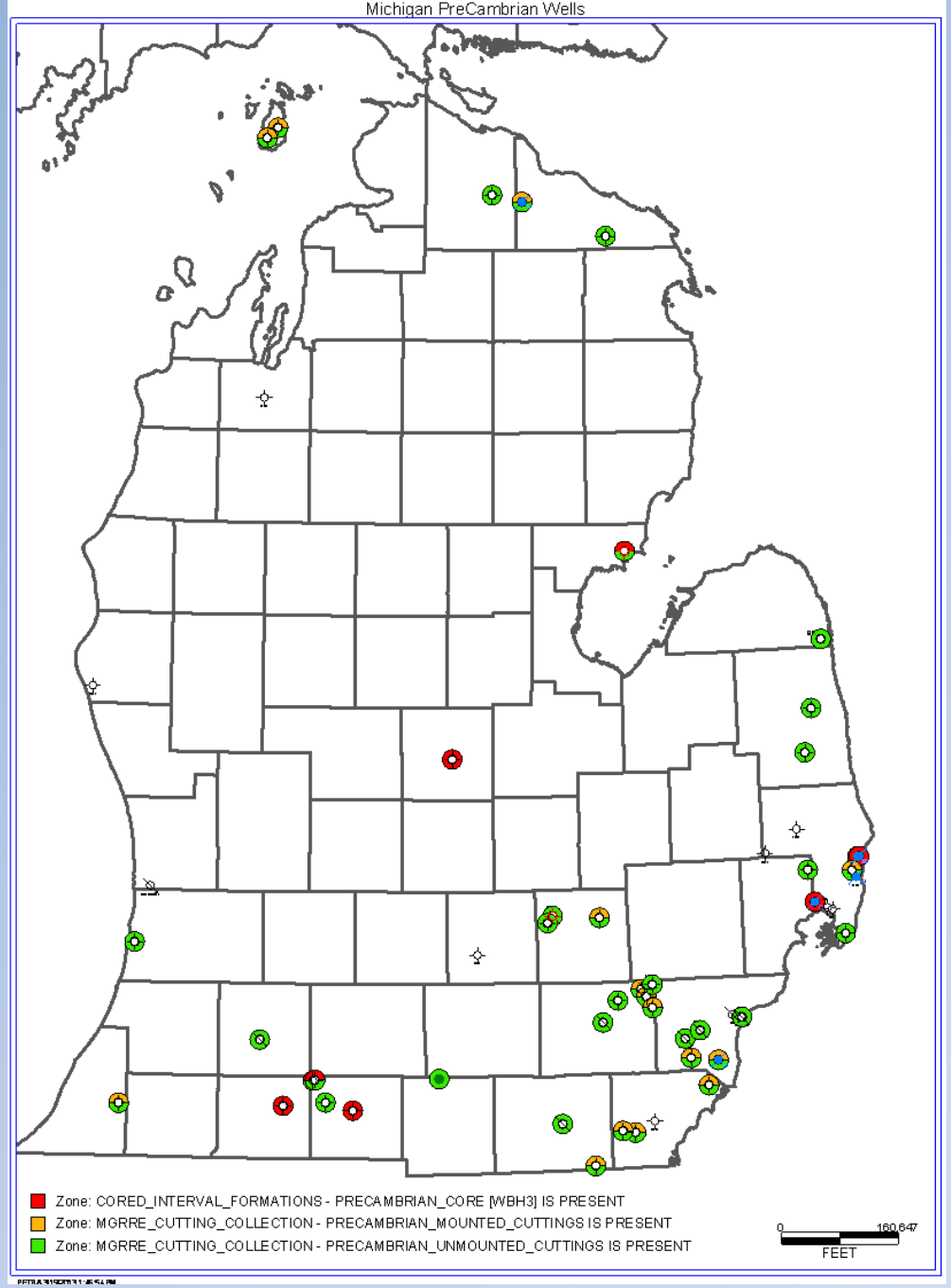
More Recent Interpretations of the basement of the Lower Peninsula



Whitmeyer and Karlstrom, 2007

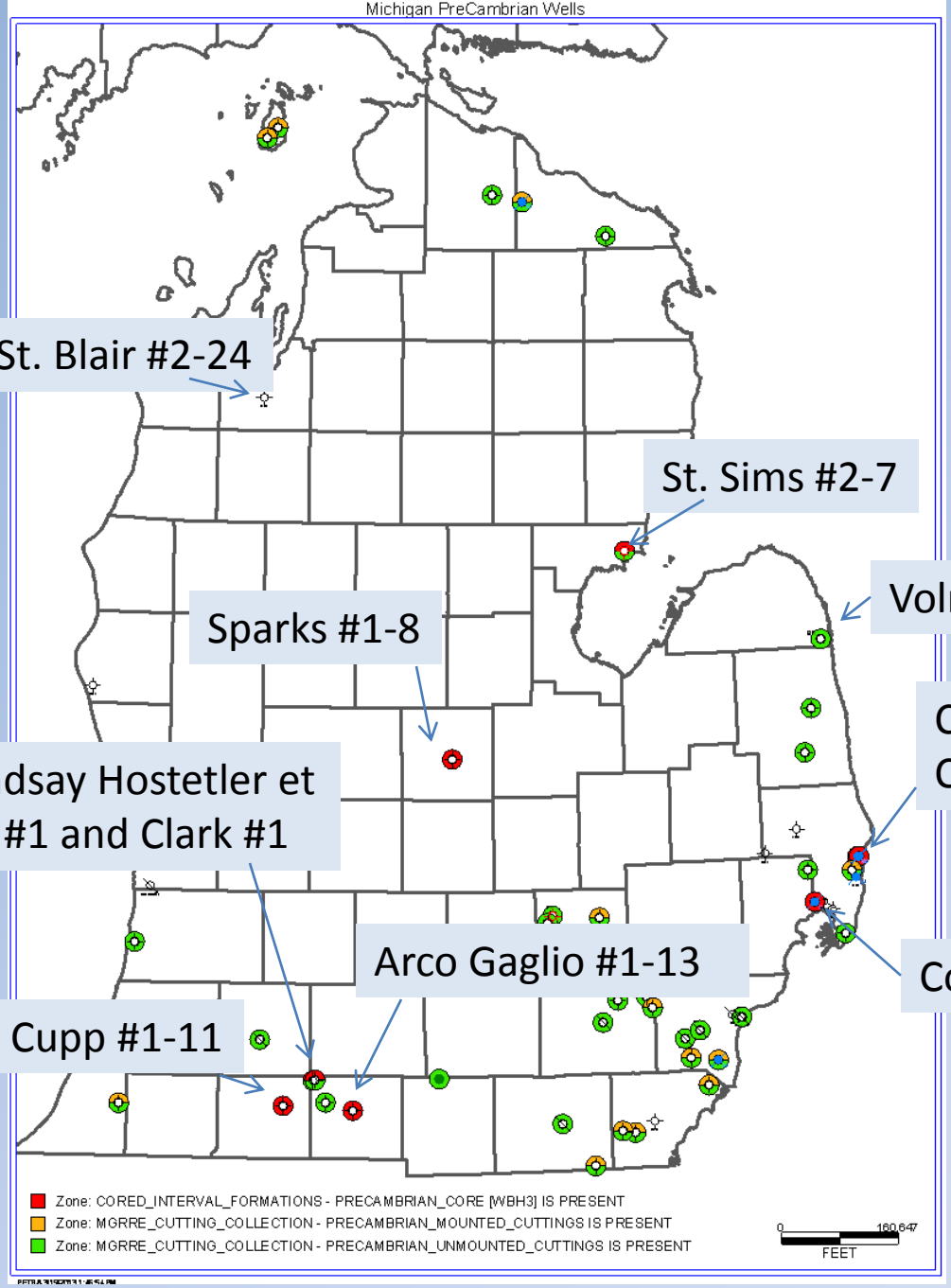
New Data

- Basement Well Collection at MGRRE
  - 9 wells with core
  - 35 wells with cuttings (10 mounted sets, 25 sets in vials)
- Two additional Basement wells with core
  - 1 currently in the BEG collection; the other is missing
  - Published reports on geology from the St. Blair #2-24



Available wells

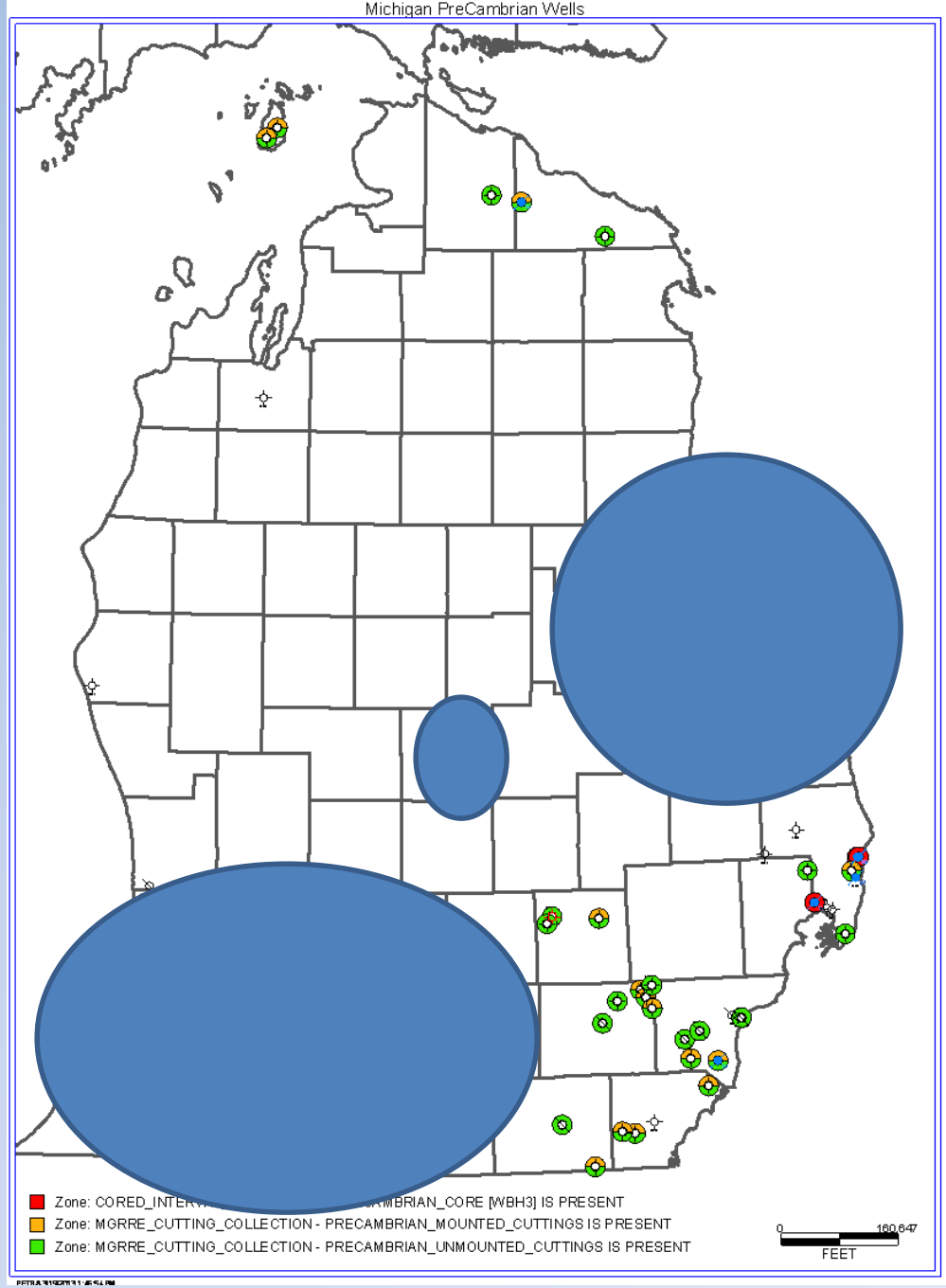
Red – core available
Green – Unmounted Cuttings
Orange – Mounted Cuttings



Available wells – Cores

St. Blair #2-24 – at BEG
Volmerling #1 – lost
Other wells – at MGRRE

Hinze and Merritt, 1969



Southwestern Michigan

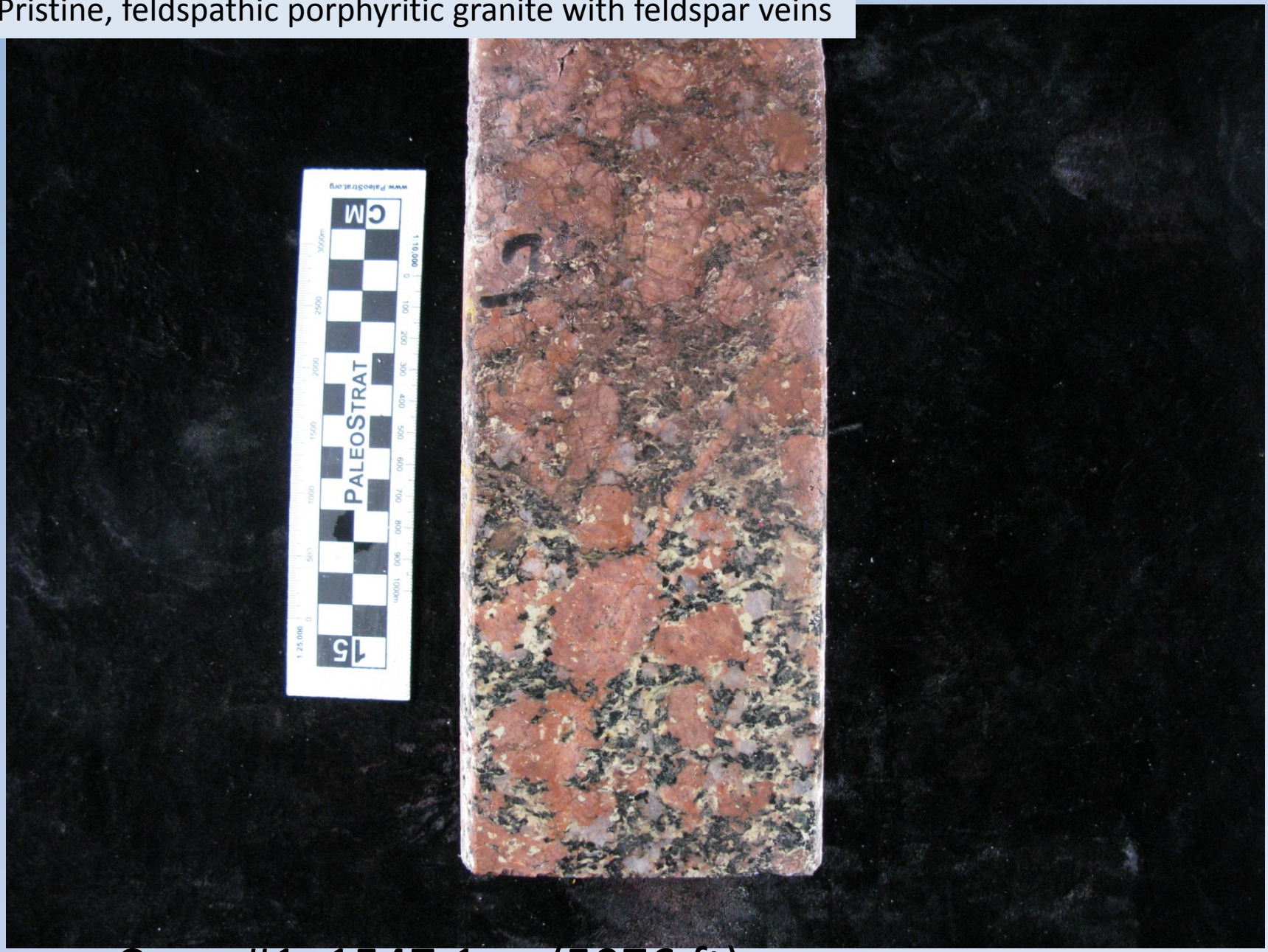
- Cupp #1-11 (St. Joseph Co.), the Lindsay Hostetler et al. #1, Clark #1, and Arco Gaglio #1-13 (Branch Co.)
- Mix of heavily fractured metasediments/meta-igneous rocks as well as unmetamorphosed granites
- Paleosols at basement-basin contact developed from granites

Arco Gaglio #1-13, 1637 m (5371 ft.)

Pristine, feldspathic porphyritic granite

Cupp #1, 1547.8 m (5078 ft)

Pristine, feldspathic porphyritic granite with feldspar veins



Cupp #1, 1547.1 m (5076 ft)

Partial alteration of feldspars and groundmass to clays

Cupp #1, 1546.9 m (5075 ft)

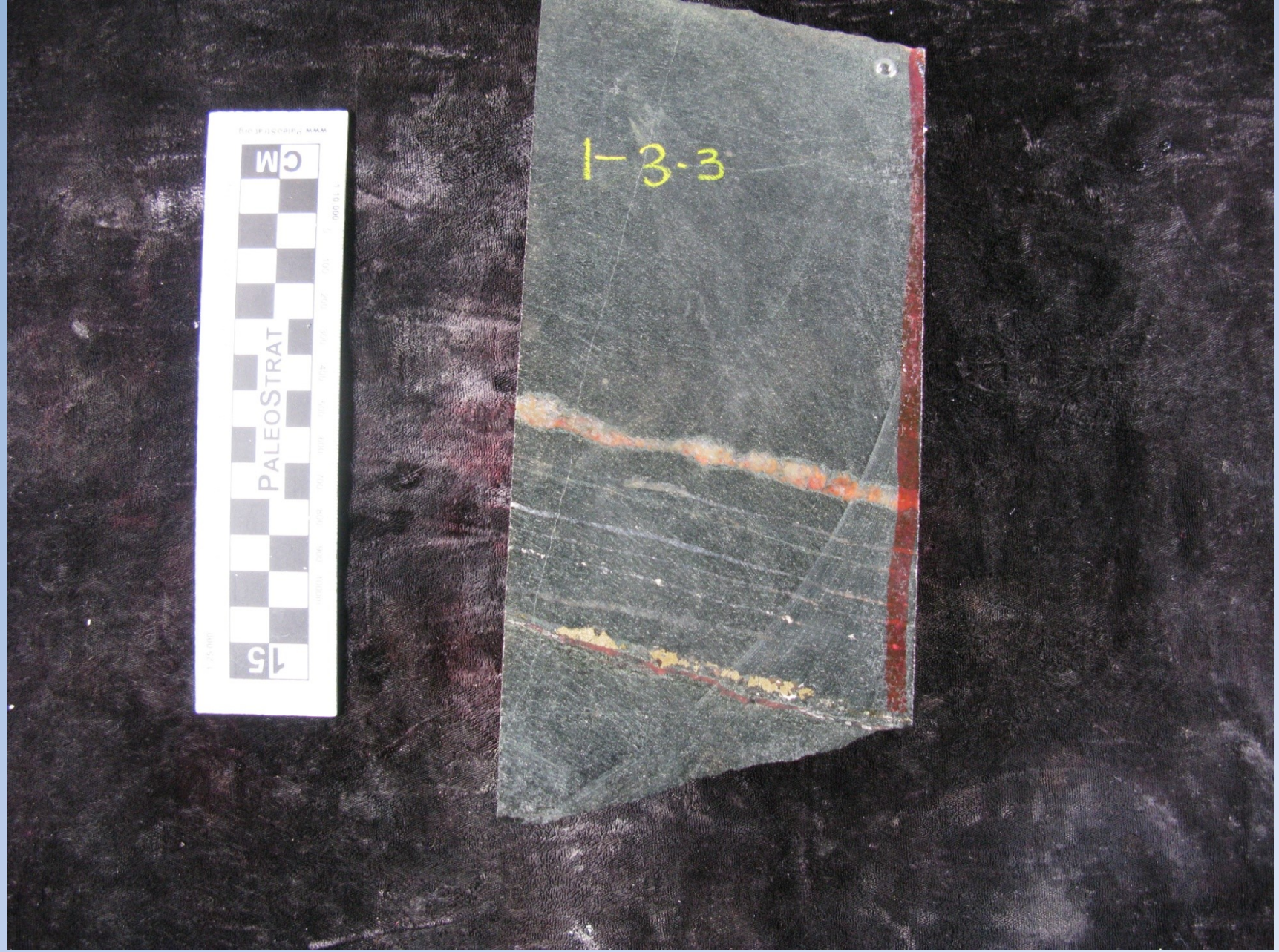
Partial alteration of feldspars and groundmass to clays

Cupp #1, 1546.5 m (5074 ft)

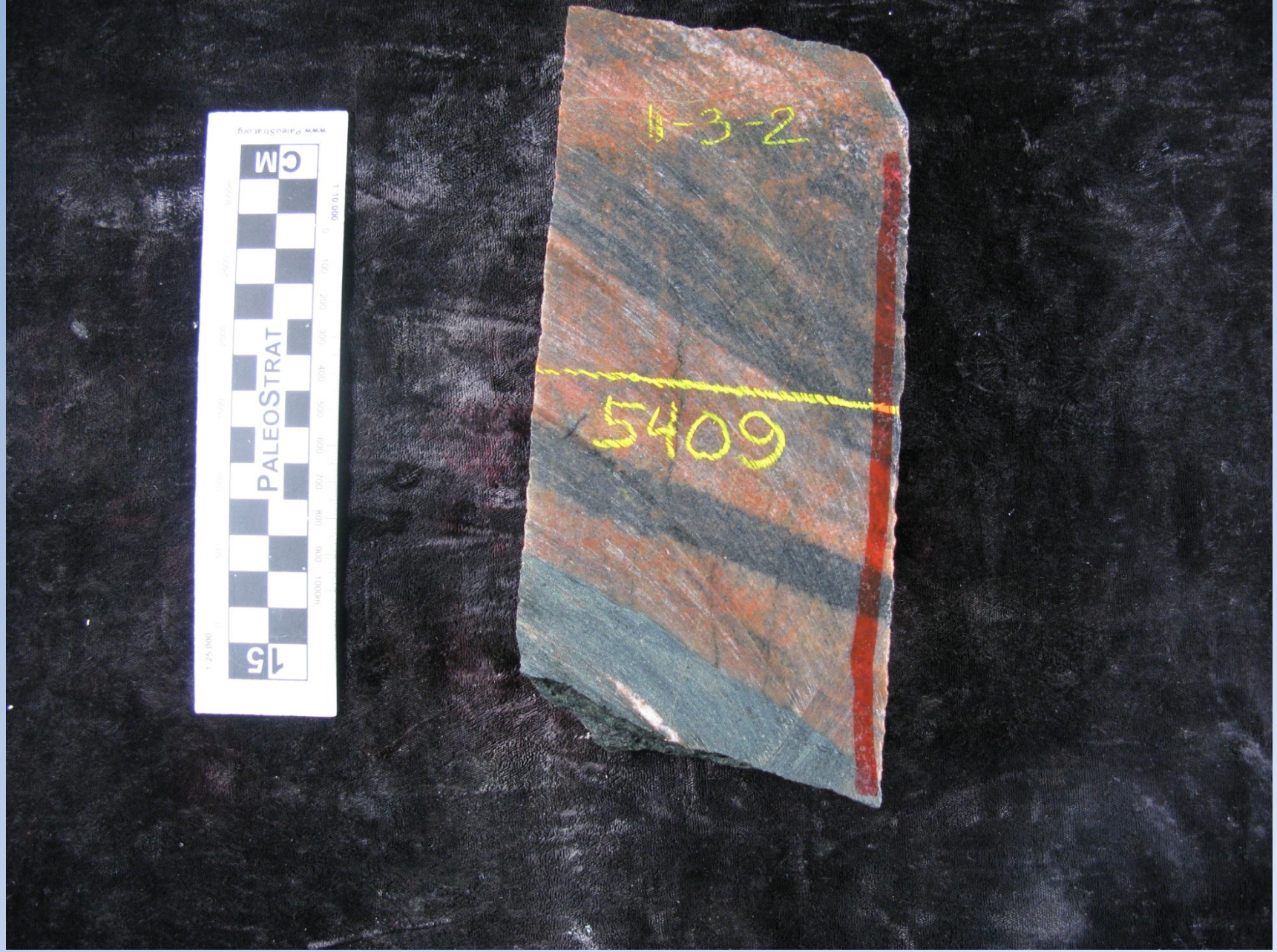
Mt. Simon Sandstone – block right above previous picture

Cupp #1, 1546.5 m (5074 ft)

Banded Gneiss, 1652.6 m (5422 ft), Lindsay Hostetler et al. #1



Banded Gneiss with pyrite seam, 1649 m (5410 ft), Lindsay Hostetler et al. #1

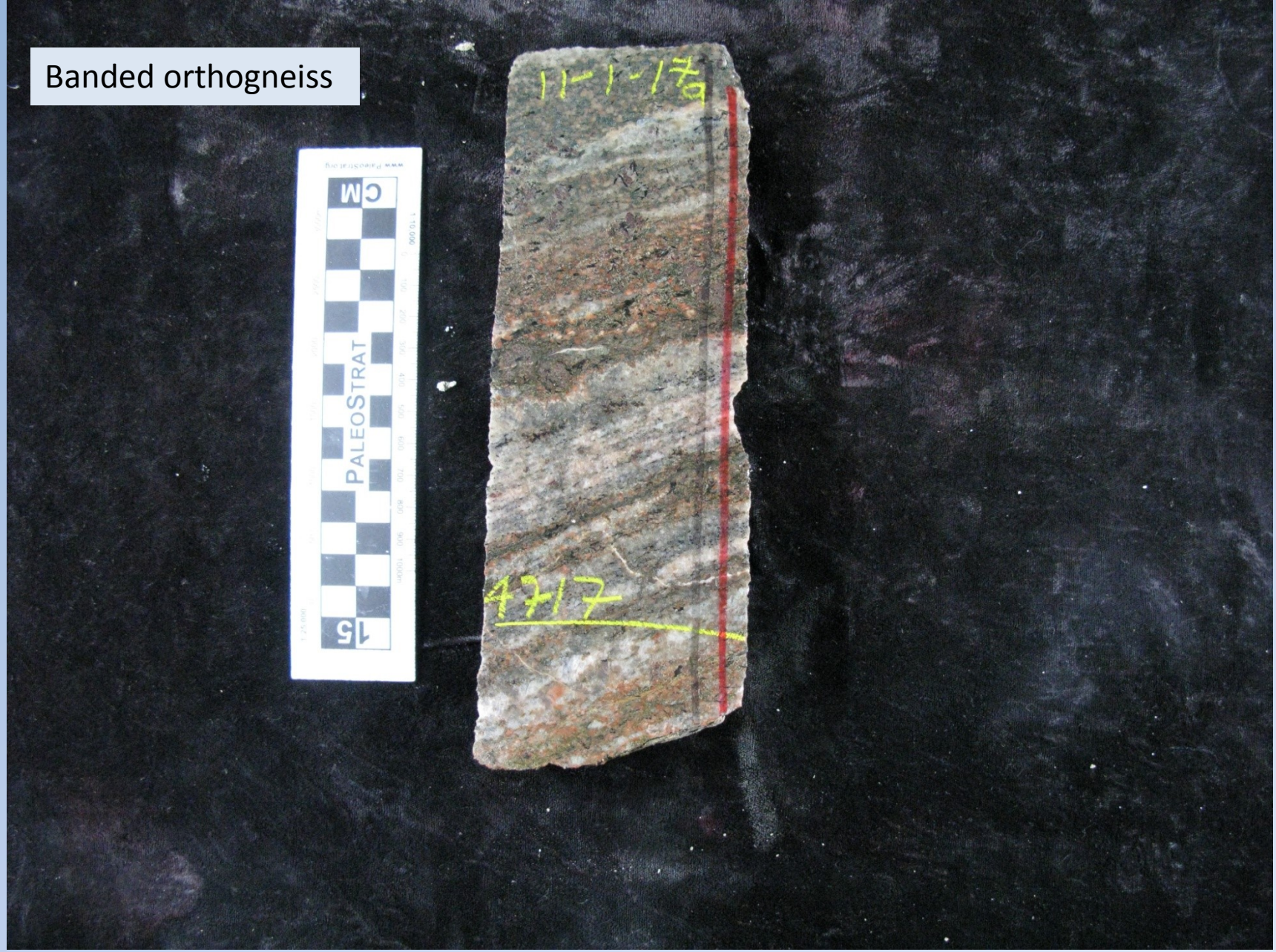


Banded Gneiss, 1648.7 m (5409 ft), Lindsay Hostetler et al. #1

Amphibolite with veins lined with K-spar, 1648 m (5407 ft), Lindsay Hostetler et al. #1

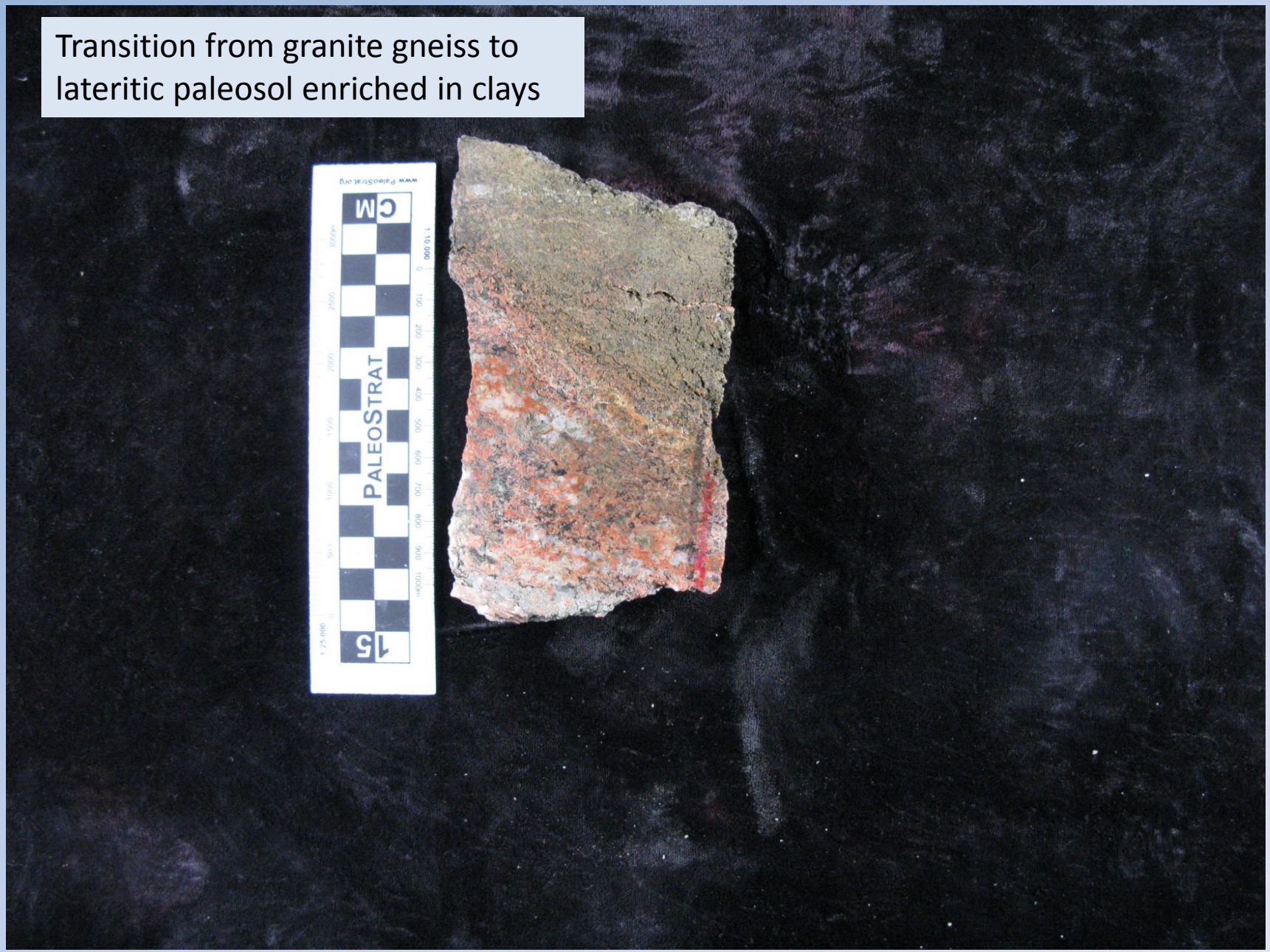
Southeastern Michigan

- Consumer Power (BD 151) #1-7, (BD 152) #2-7 and BD #139 (St. Clair Co.)
  - Metamorphosed igneous rocks
  - Granite-gneisses, granitic orthogneisses
  - The #1-7 exhibits a paleosol at the basin basement contact



Consumer Power BD #1-7, 1437.7 m (4717 ft)

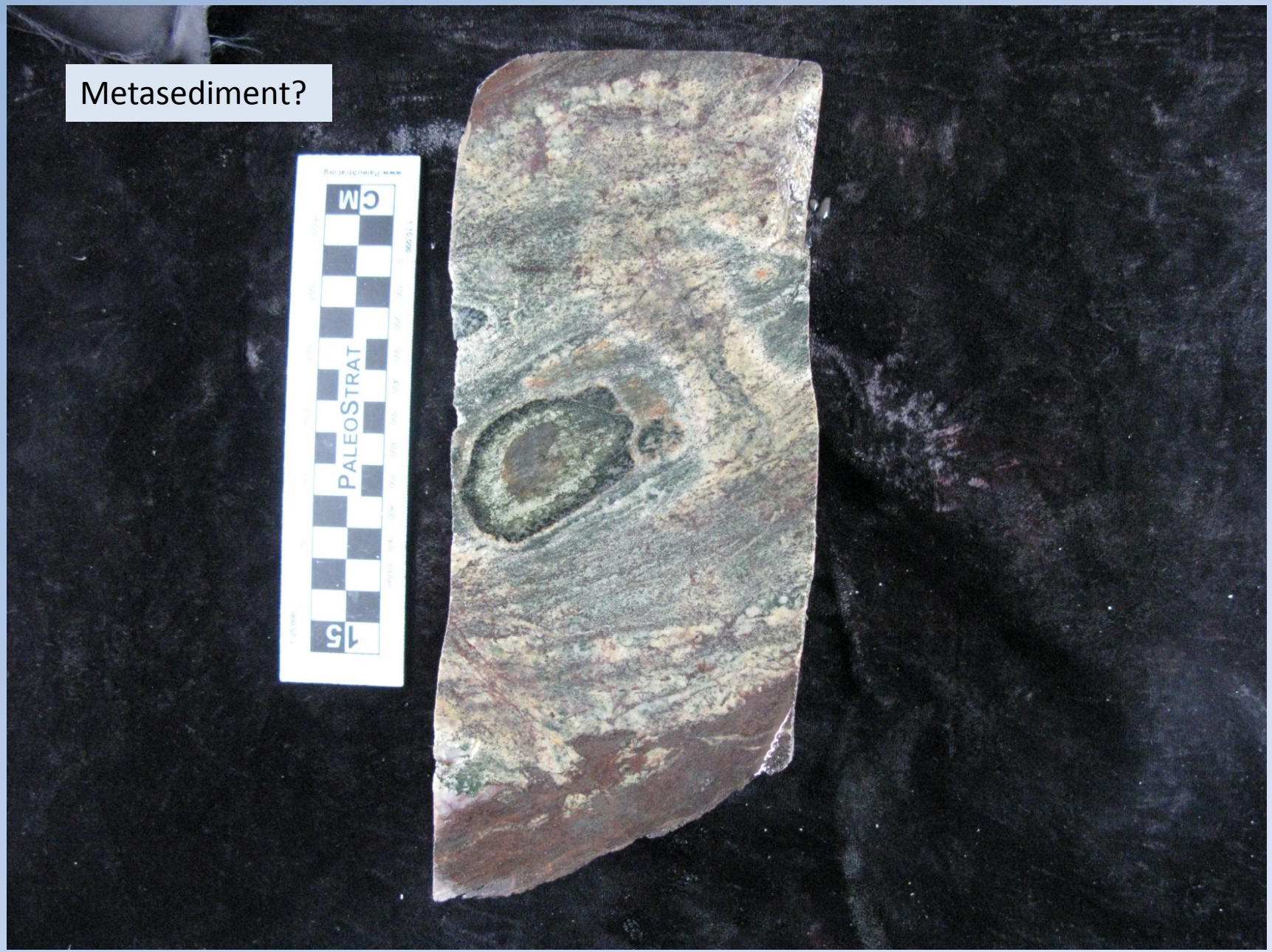
Consumer Power BD #1-7, 1437 m



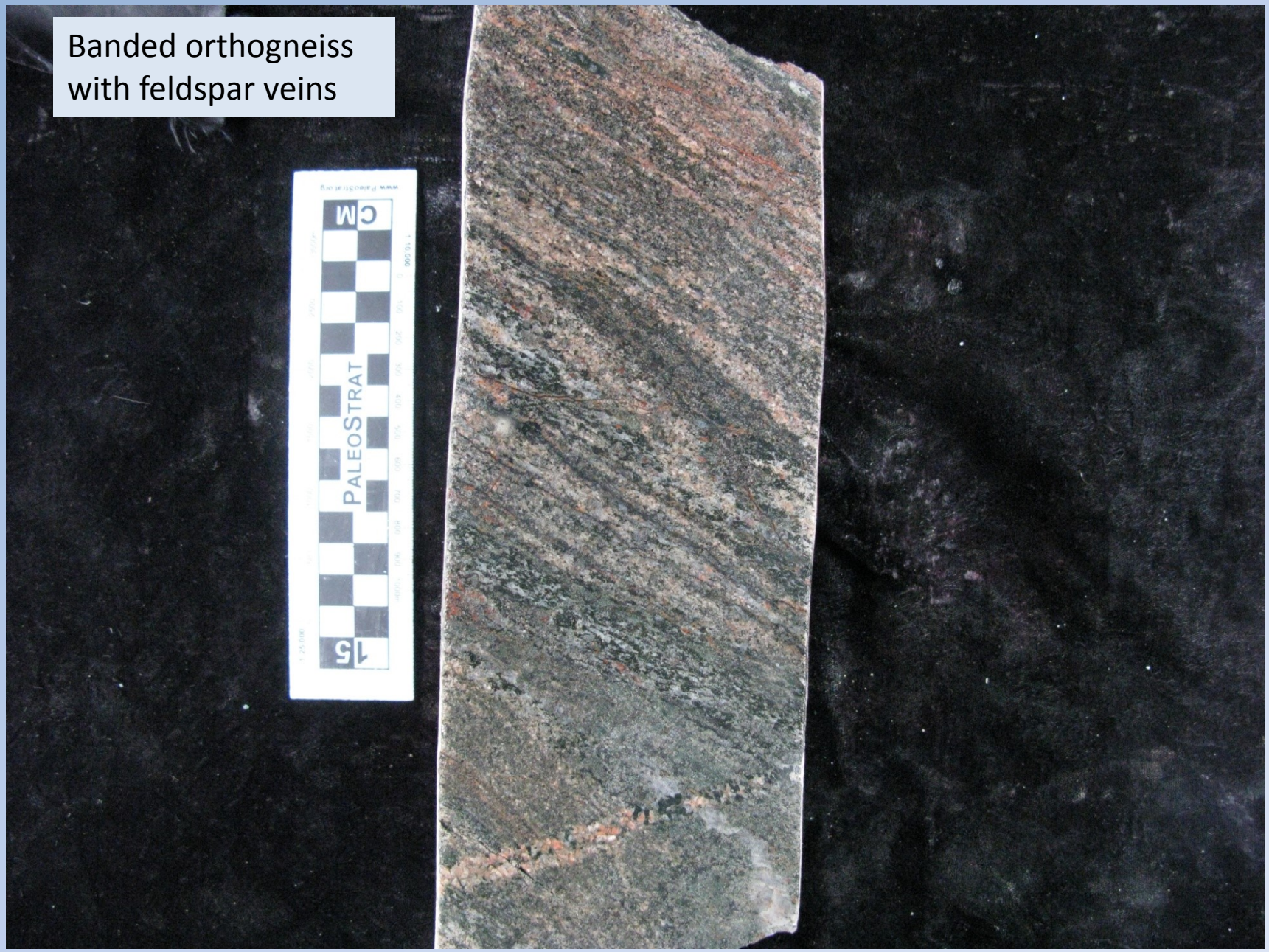
Consumer Power BD #1-7, 1436 m

Transition from granite gneiss to lateritic paleosol enriched in clays with contact with the Mt. Simon Sandstone

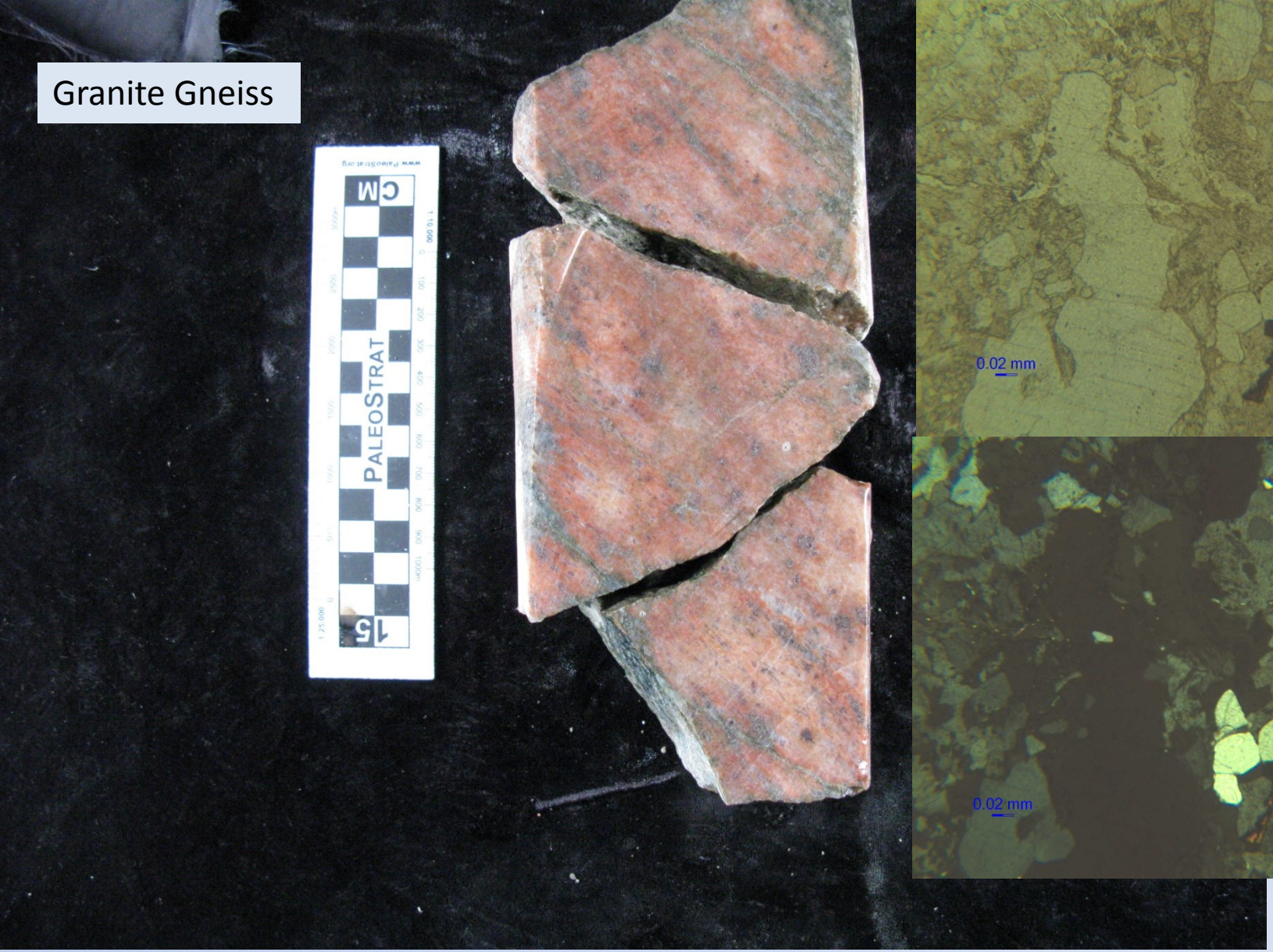
Consumer Power BD #1-7, 1436 m



Consumer Power BD #139, ~1405 m



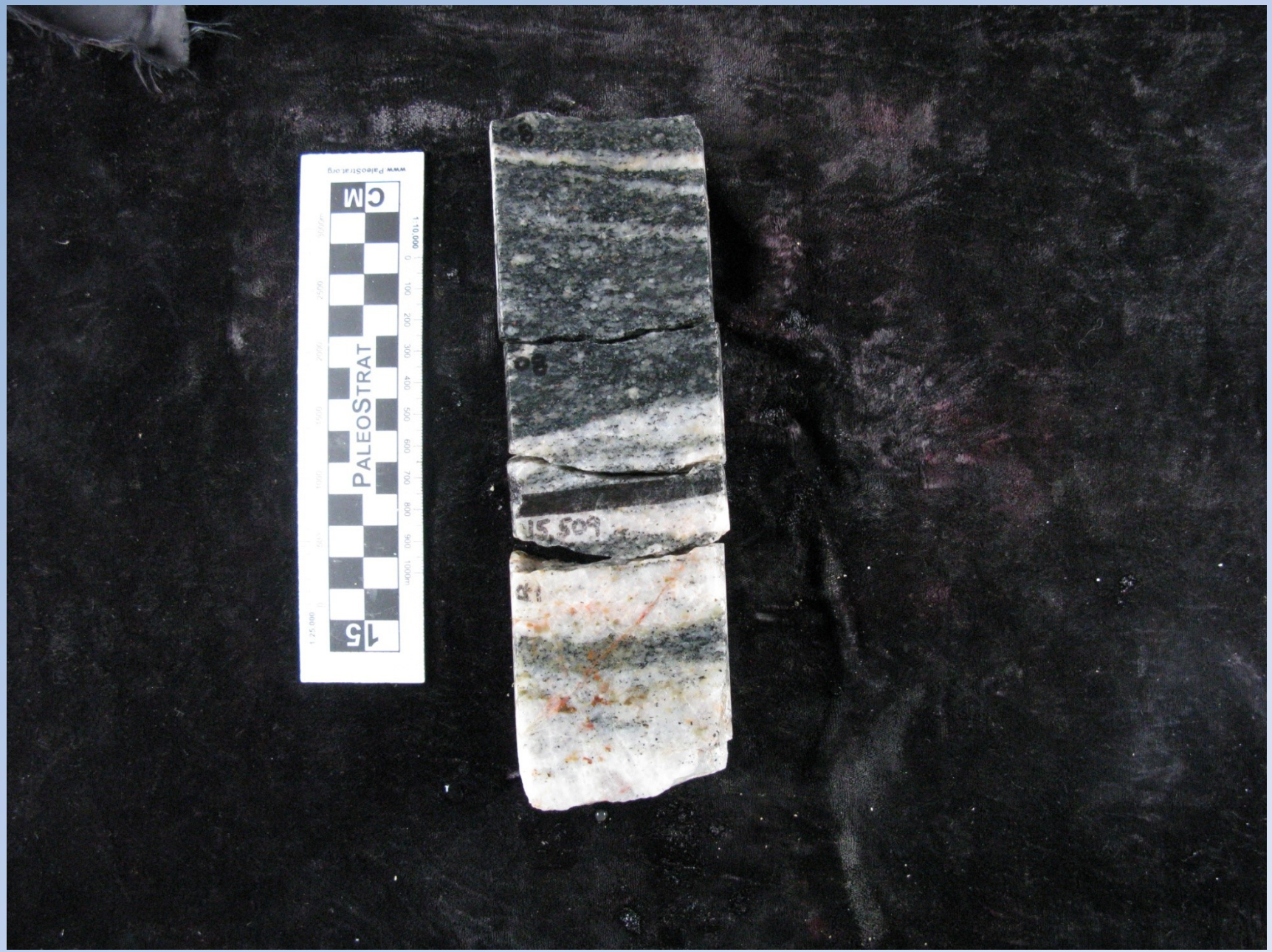
Consumer Power BD #139, 1410 m



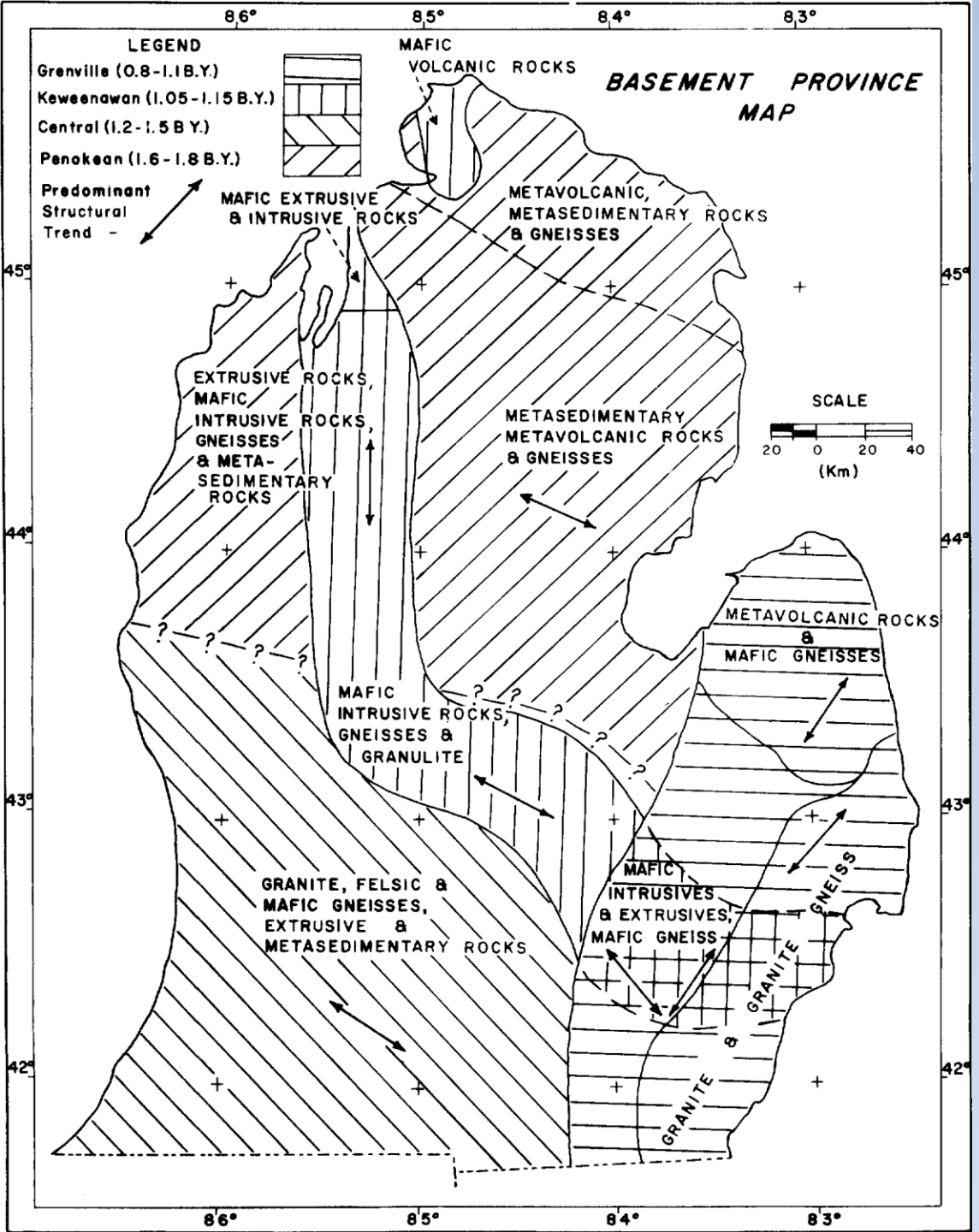
Consumer Power BD #139, 1407 m

Northeastern Michigan

- State Sims #2-7 Arenac County
- 2nd deepest well in the state
- Banded gneisses – presumably orthogneisses



St. Sims #2-7, 4727.1 m (15,509 ft)



Conclusions

New data points – show that Hinze's basement provinces exist

- More lateral variability within each province – basement heterogeneity

Hinze et al. 1975

Further Work

- Integrate Cuttings data especially in thumb region and southwestern MI
- Age dates from granites in St. Joseph-Branch Counties and from granite-gneisses in St. Clair Co.
  - See if match with current basement province models
- Further study of Paleosols – timing, paleoenvironmental conditions

Acknowledgements

- William Hinze
- Rob Van Der Voo
- Paul Potter
- Paul Daniels and Diana Morton-Thompson
- Mark Baranoski
- John Esch