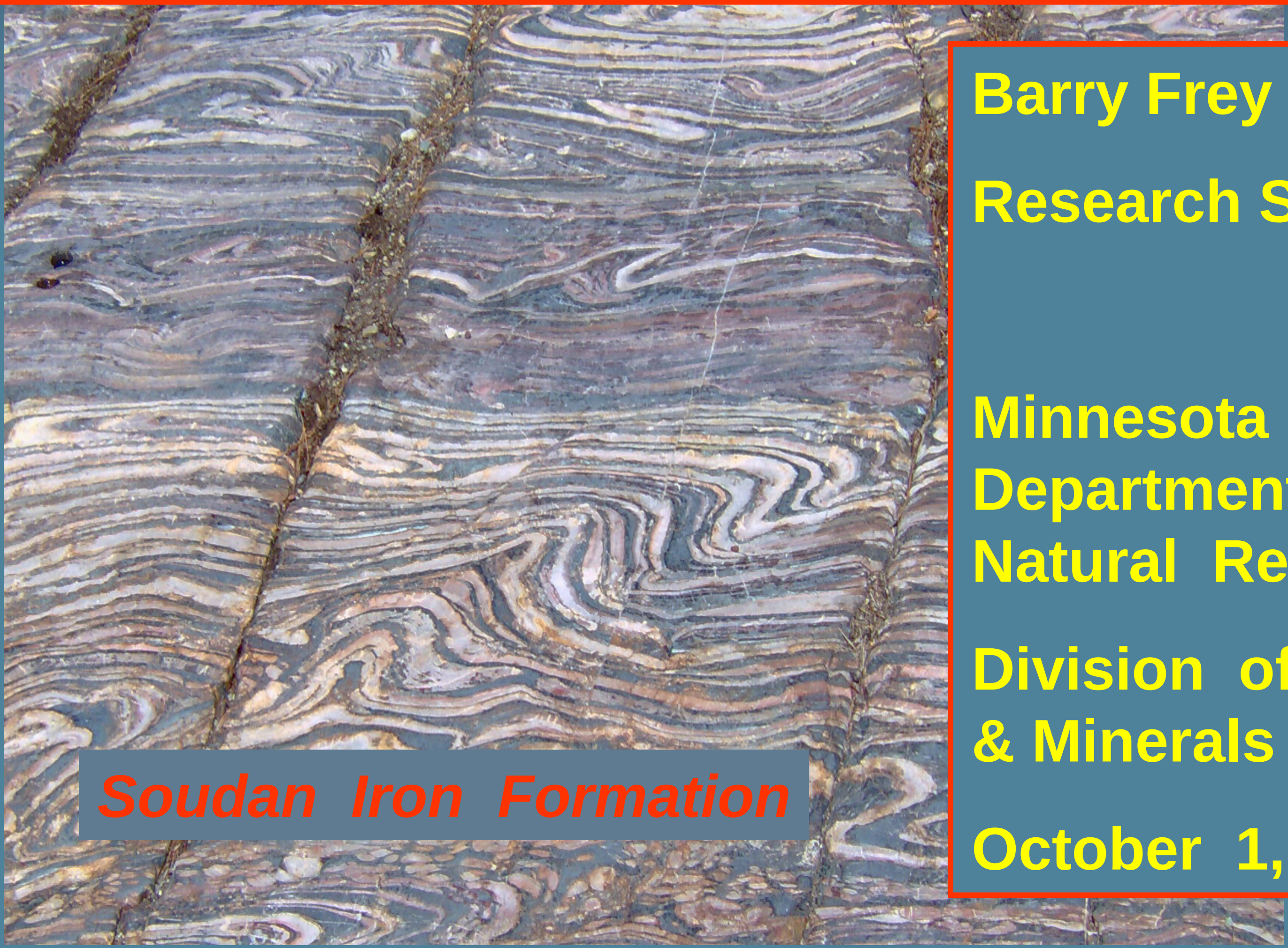
Project 373

Vermilion Greenstone Gold

New Results from Drill Holes



Barry Frey

Research Scientist 2

Minnesota Department of Natural Resources

Division of Lands & Minerals

October 1, 2008

DNR Mission

- Work with citizens to conserve/manage State's natural resources
- Provide outdoor recreation opportunities
- Provide for commercial uses of natural resources to create sustainable quality of life

Previously Unrecognized Gold-Bearing Intervals in Archived Vermilion Drill Core

Prospect	Au Mineralization Type	Semi-quantitative XRF Au Interval	Au Association
Raspberry	Intrusion Hosted	To 230 ppm Au	Pb (galena), Quartz veins, Rutile; Fe, As, Mn, Cr, Se, Sn
Raspberry	Shear zone related (remobilization?)	To 67 ppm Au	Pb (galena), Quartz veins, Rutile?; Pb, Ag, Se
Foss Lake	Algoma BIF related Au	To 28 ppm Au	Fe Oxide to Sulfide-graphite transition; As, Ba, Pb
Foss Lake	Shear zone related	To 16 ppm Au	Pyrite; Hg, As, Cu, Cr, Mo
Eagles Nest Shear	Shear zone related	To 9 ppm Au	Pyrite; Mn, Sr, Ba, Mo?, Cu?
Murray Shear	Volcanic Hosted Massive Sulfide	To 148 ppm Au	Sphalerite, pyrrhotite?; Cr, Zn, Sb, Cd, Hg

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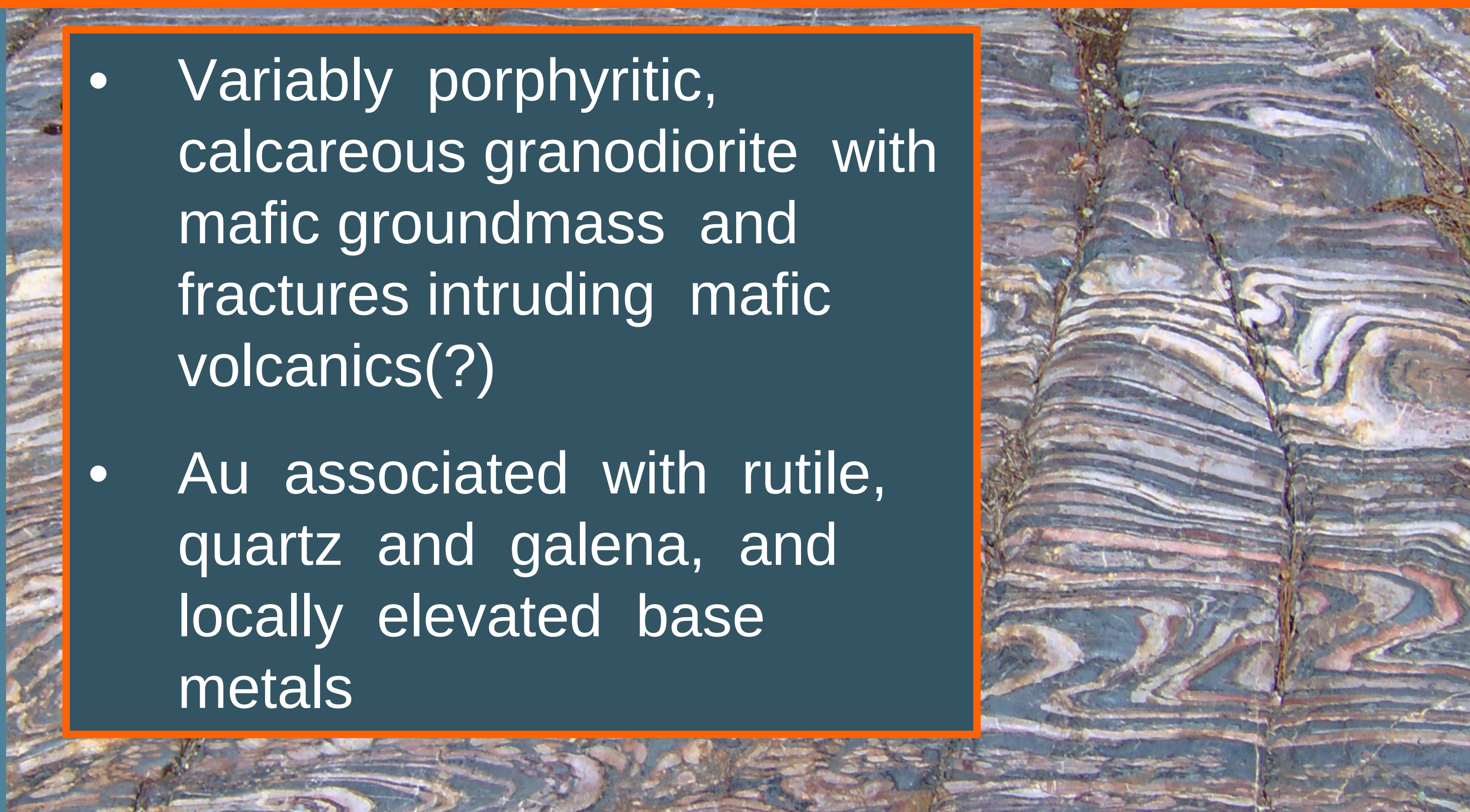
Vermilion Greenstone

Specific Results

Raspberry Prospect

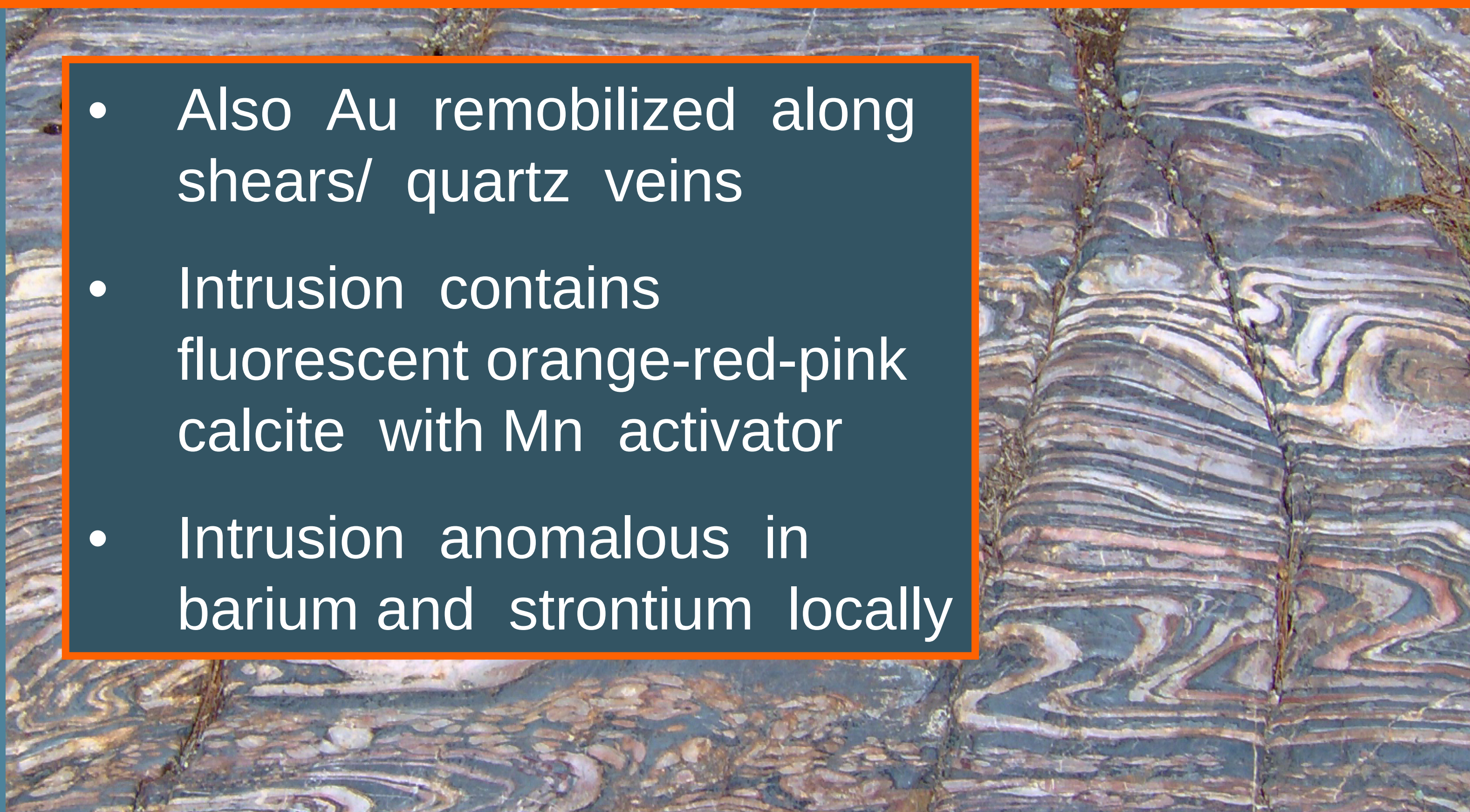


- Variably porphyritic, calcareous granodiorite with mafic groundmass and fractures intruding mafic volcanics(?)
- Au associated with rutile, quartz and galena, and locally elevated base metals

Vermilion Greenstone

Specific Results

Raspberry Prospect



- Also Au remobilized along shears/ quartz veins
- Intrusion contains fluorescent orange-red-pink calcite with Mn activator
- Intrusion anomalous in barium and strontium locally

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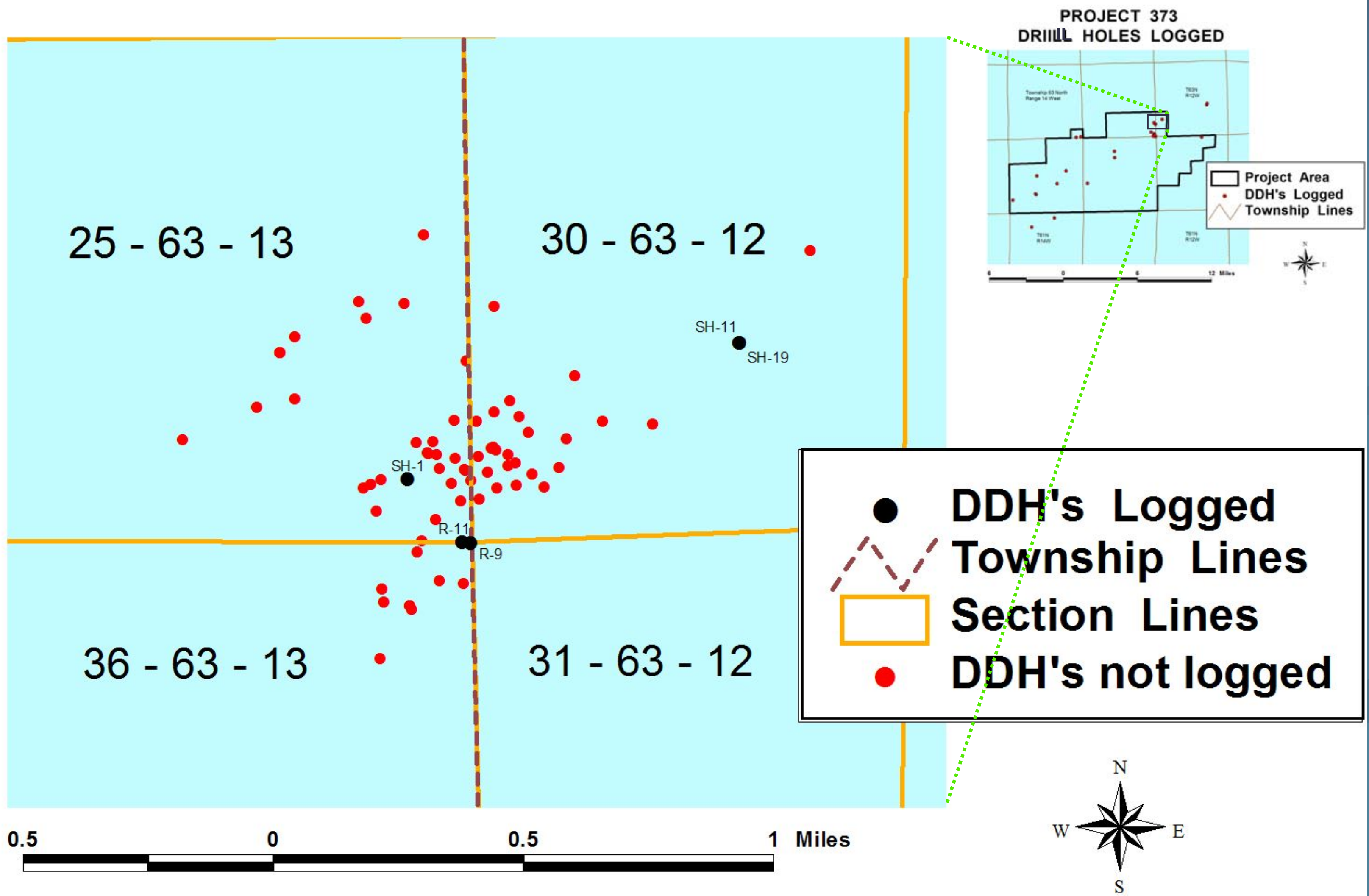
Raspberry Prospect Drill Holes



Example Semi-quantitative XRF Chemistry for DDH R-9 and R-11 All values in parts per million (ppm)

DDH	Footage	ROCK	As	Se	Mo	Ag	Au	Pb
R-9	141.7	QZ vn	18693	984	<LOD	<LOD	230	269529
R-9	141.7	QZ vn	7368	441	<LOD	<LOD	104	113093
R-9	141.7	QZ vn	<LOD	82	<LOD	213	101	39463
R-9	141.7	Granodiorite	<LOD	<LOD	35	99	48	14632
R-9	141.9	QZ vn	6746	454	<LOD	<LOD	143	143579
R-11	80.4	Granodiorite/Qtz vein	<LOD	400	17568	537	126	224991
R-11	80.4	Granodiorite/Qtz vein	<LOD	374	16568	433	119	210053
R-11	80.4	Granodiorite/Qtz vein	<LOD	<LOD	621	166	116	69287
R-11	80.4	Granodiorite/Qtz vein	<LOD	113	51	172	52	89476
R-11	80.5	Granodiorite/Qtz vein	1686	261	442	368	42	157421
R-11	81.0	Sheared Qtz vein	<LOD	<LOD	545	<LOD	37	11297
R-11	576.3	Early, complex QZ vn	139	<LOD	<LOD	<LOD	62	<LOD
R-11	576.5	Early, complex QZ vn - Altered Granodiorite	<LOD	<LOD	<LOD	<LOD	54	7147
R-11	613.5	Qz vn in metabasalt (deformed, sheared)	<LOD	30	<LOD	133	67	14619

Raspberry Prospect

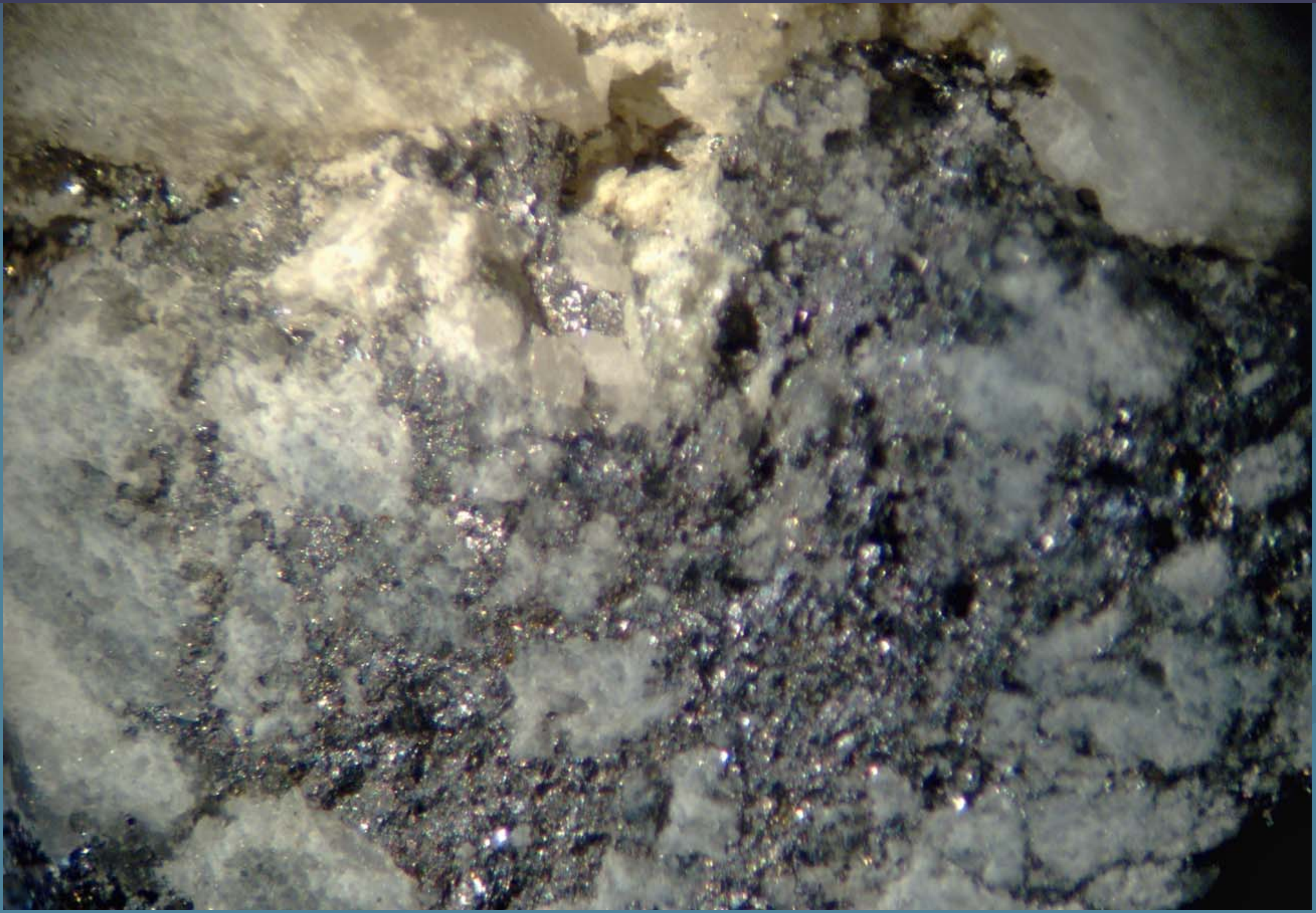
Raspberry Prospect

DDH R-9 anomalous semi-quantitative Au XRF values are from previously unassayed portions of core

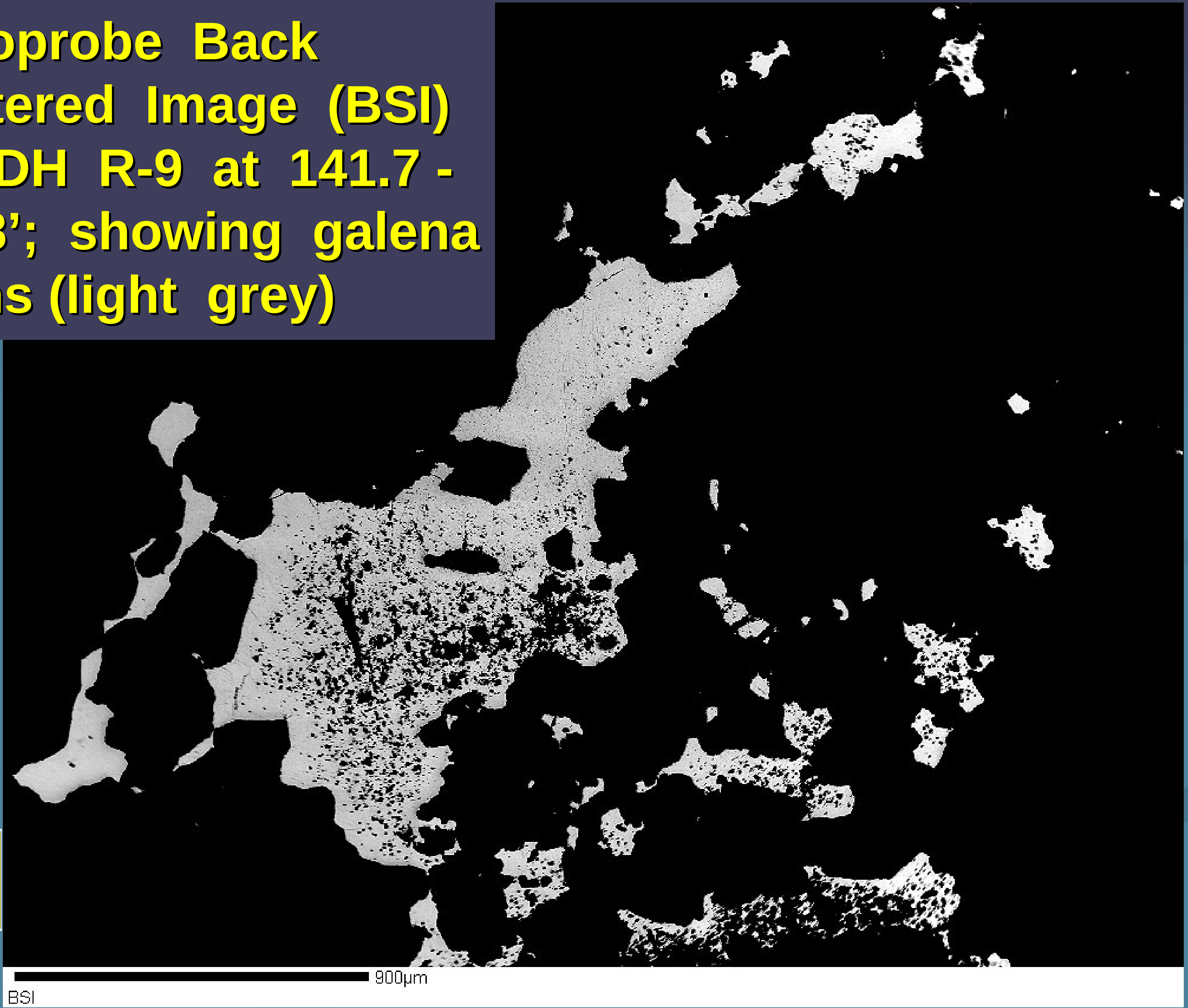
Highest previous laboratory assay was 6800 ppb for the two foot interval of 55 - 57’

DDH R-11 at 80.9’ shows typical rutile needles in vein quartz. Horizontal field of view is about 3 mm. XRF verified associated high Ti contents.

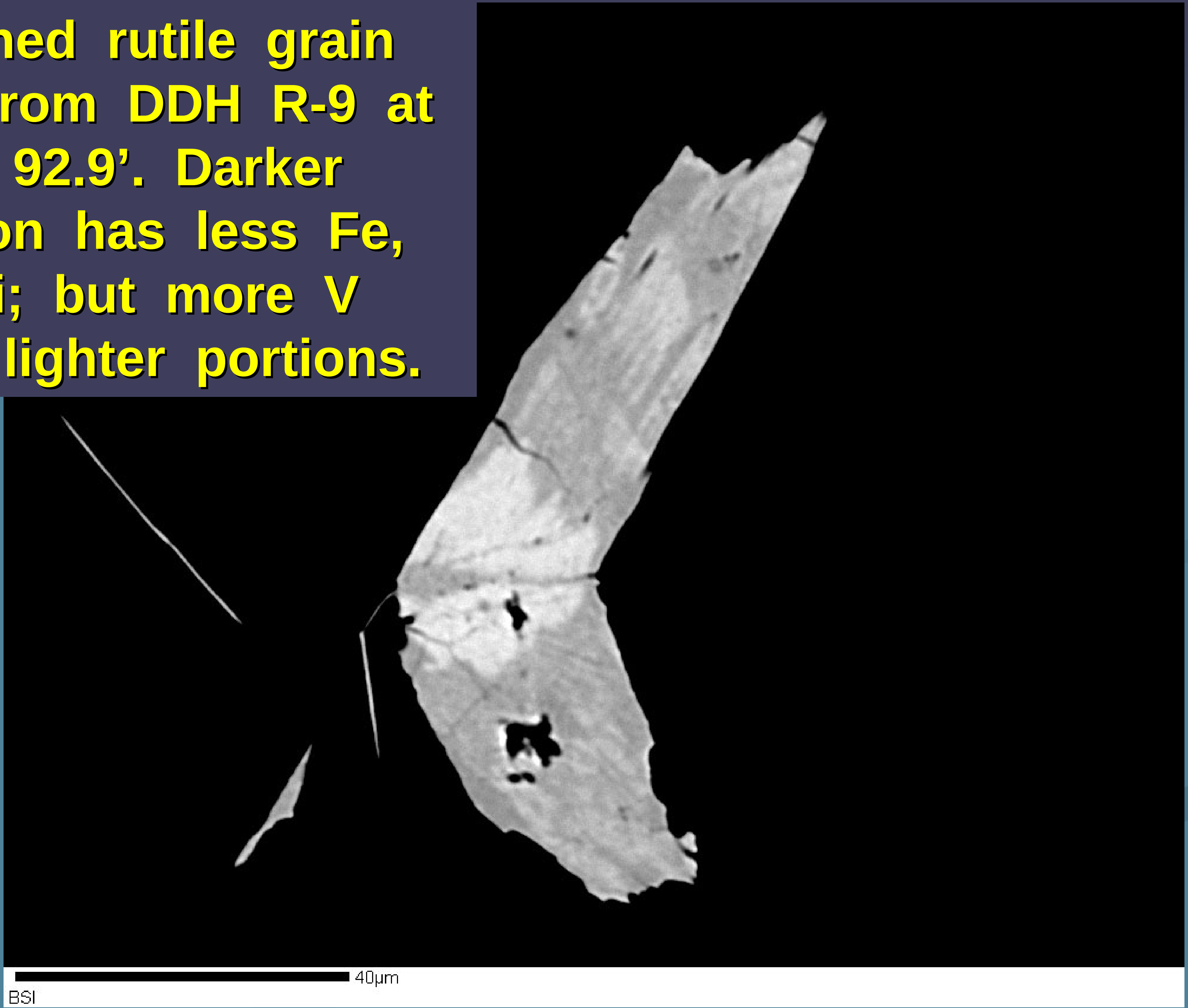
Galena in DDH R-11 at 80.4’ with 12.6mm horizontal field of view. Note interstitial Pb mineralization and vein vugs (boiling?).



Microprobe Back Scattered Image (BSI) of DDH R-9 at 141.7 - 141.8'; showing galena grains (light grey)



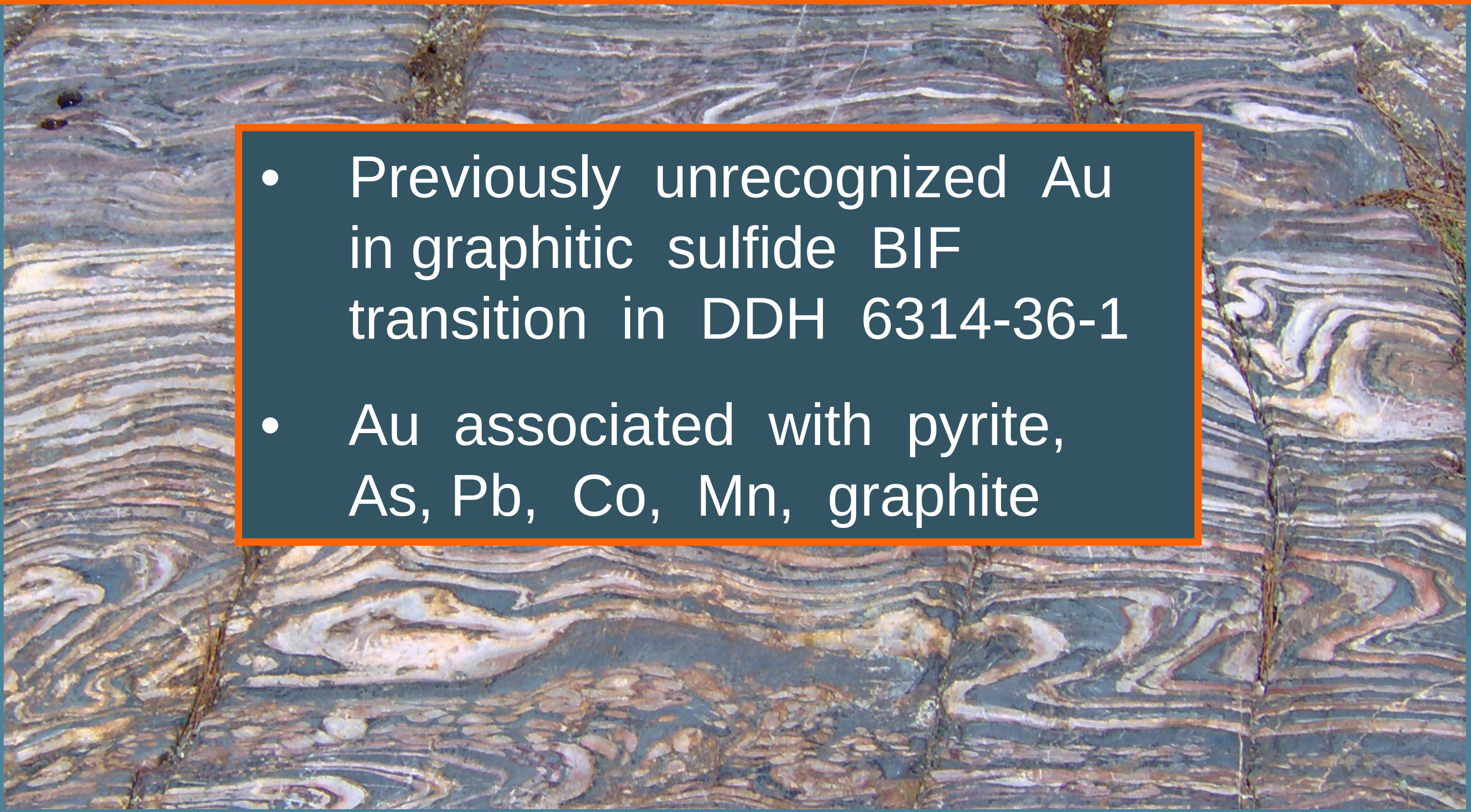
Twinned rutile grain BSI from DDH R-9 at 92.8 - 92.9’. Darker portion has less Fe, W, Si; but more V than lighter portions.



Vermilion Greenstone

Specific Results

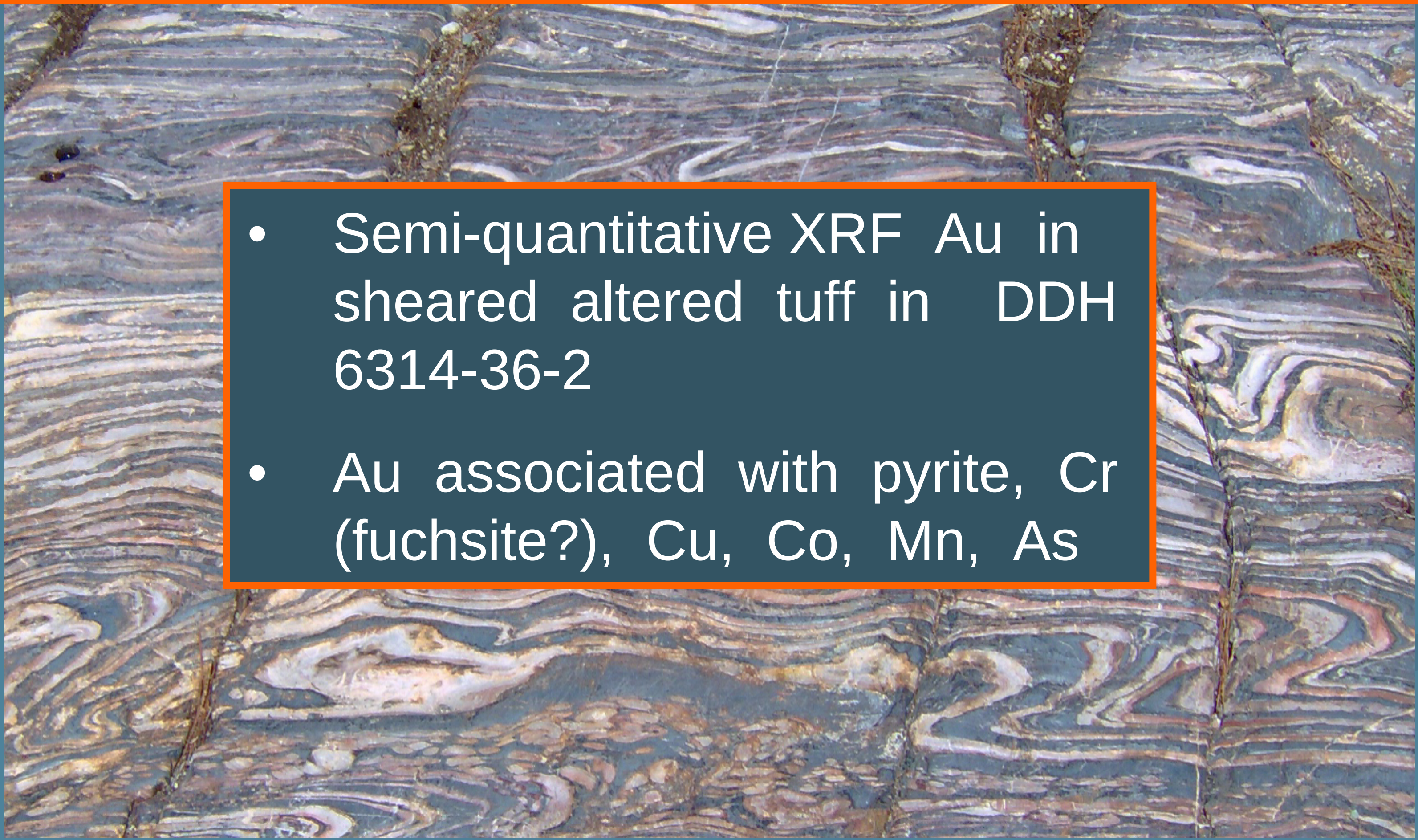
Foss Lake Prospect



- Previously unrecognized Au in graphitic sulfide BIF transition in DDH 6314-36-1
- Au associated with pyrite, As, Pb, Co, Mn, graphite

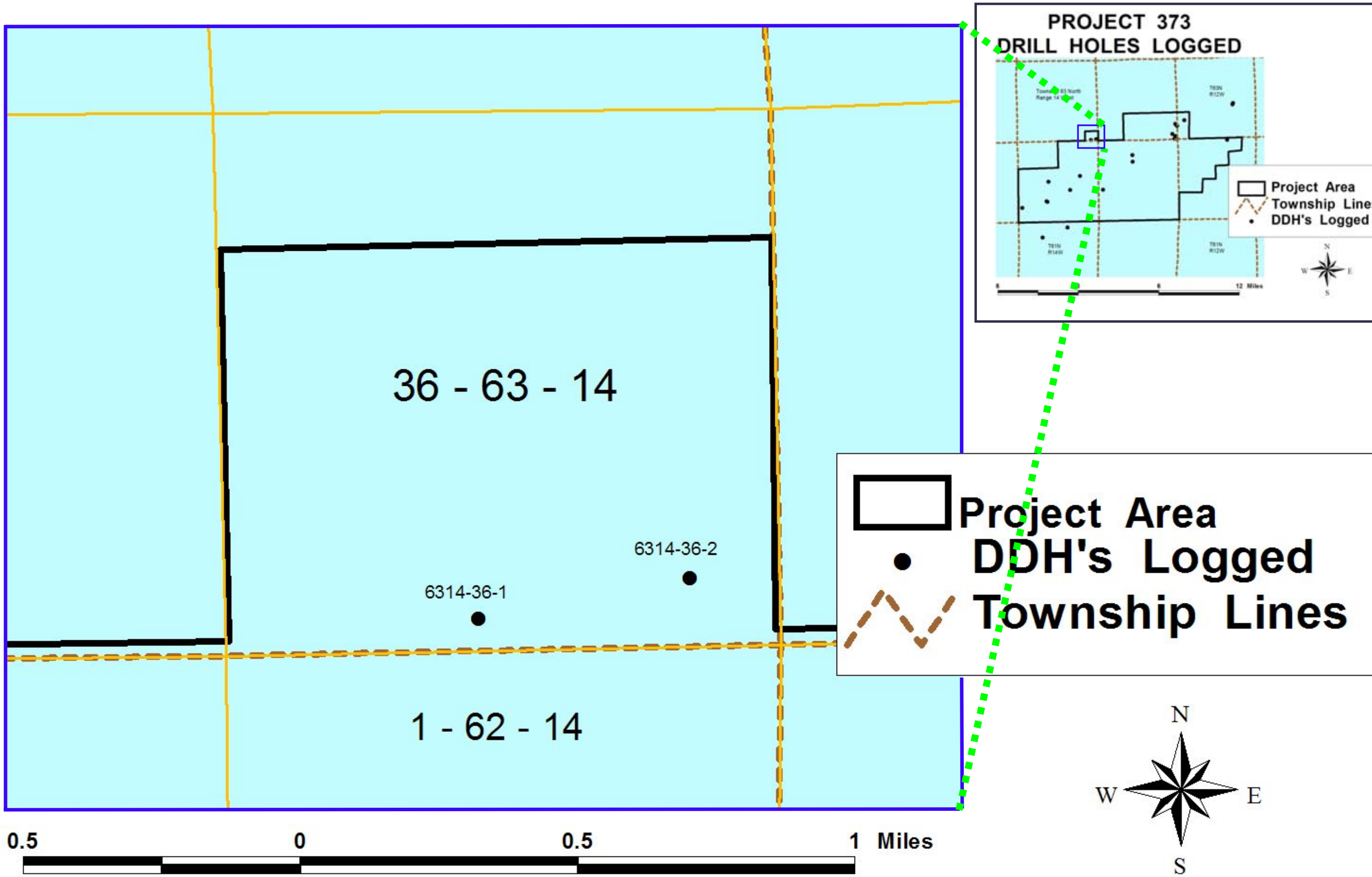
Vermilion Greenstone

Specific Results – Foss Lake Prospect



- Semi-quantitative XRF Au in sheared altered tuff in DDH 6314-36-2
- Au associated with pyrite, Cr (fuchsite?), Cu, Co, Mn, As

Foss Lake Prospect



Example semi-quantitative XRF Chemistry for DDH 6314-36-1 and 6314-36-2 All values in parts per million (ppm)

DDH	Footage	ROCK	Cr	Cu	As	Ag	Au	Hg	Pb
6314-36-2	95.4	Sheared altered felsic tuff	335	374	39	106	16	11	12
6314-36-2	95.4	Sheared altered felsic tuff	<LOD	1706	46	86	11	10	15
6314-36-2	95.4	Sheared altered felsic tuff	363	375	28	93	10	15	11
6314-36-2	95.4	Sheared altered felsic tuff	322	262	23	50	9	11	8
6314-36-2	95.4	Sheared altered felsic tuff	<LOD	2885	33	108	9	10	16
6314-36-1	312.0	Chert-Silicate?-Sulfide? BIF	<LOD	467	778	<LOD	16	<LOD	81
6314-36-1	312.2	Chert-Silicate?-Sulfide? BIF	<LOD	117	552	<LOD	10	<LOD	37
6314-36-1	312.4	Interlaminated Chert-Graphite	<LOD	188	1237	<LOD	28	<LOD	92
6314-36-1	314.0	Chert-Silicate-Graphite BIF	<LOD	339	2119	<LOD	25	<LOD	219
6314-36-1	314.0	Interlaminated Chert-Graphite	<LOD	217	1083	<LOD	18	<LOD	178
6314-36-1	314.0	Interlaminated Chert-Graphite	<LOD	549	1317	<LOD	15	<LOD	235
6314-36-1	314.0	Chert-Silicate-Graphite BIF	<LOD	557	1568	<LOD	14	<LOD	180

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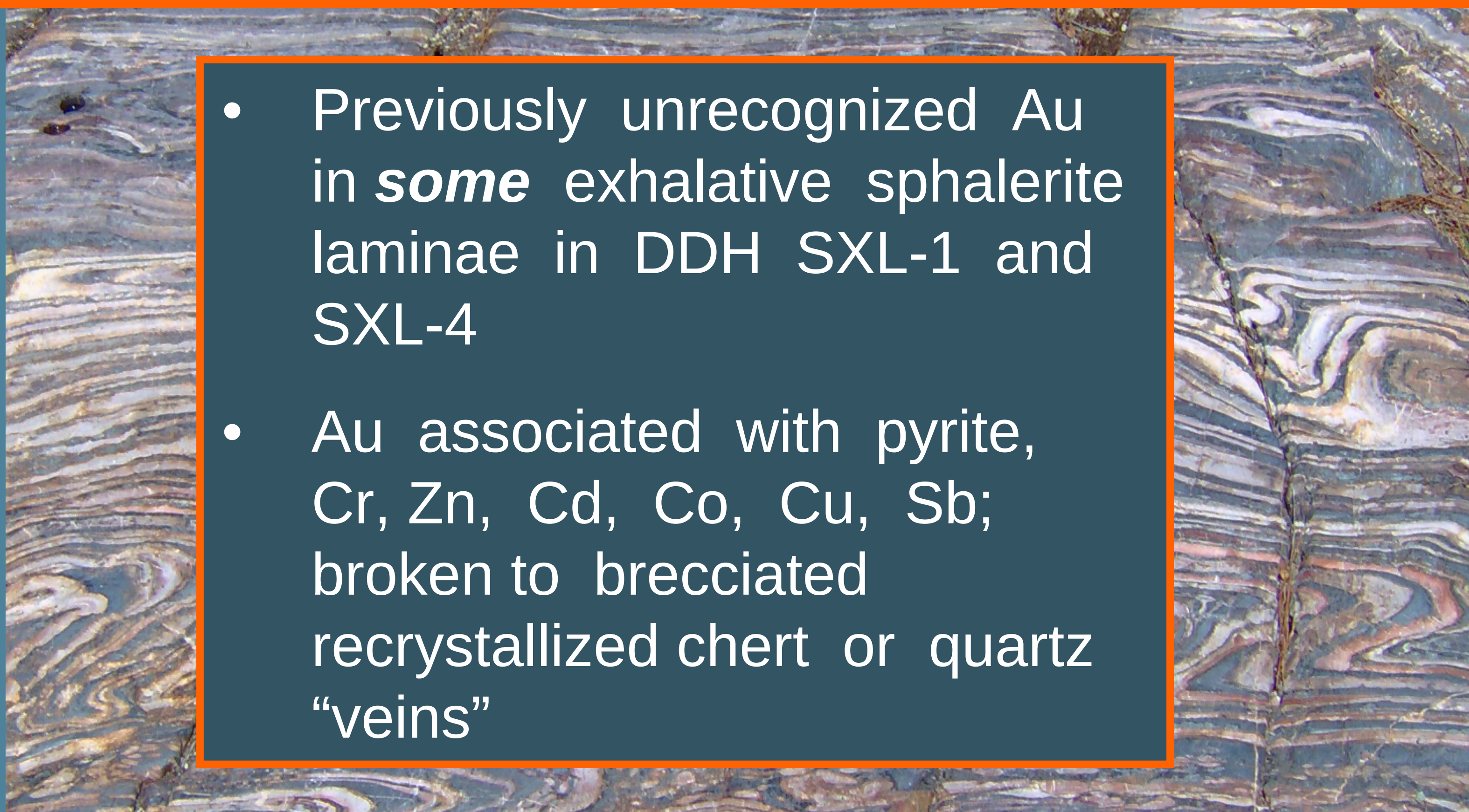
Foss Lake Prospect

Vermilion Greenstone

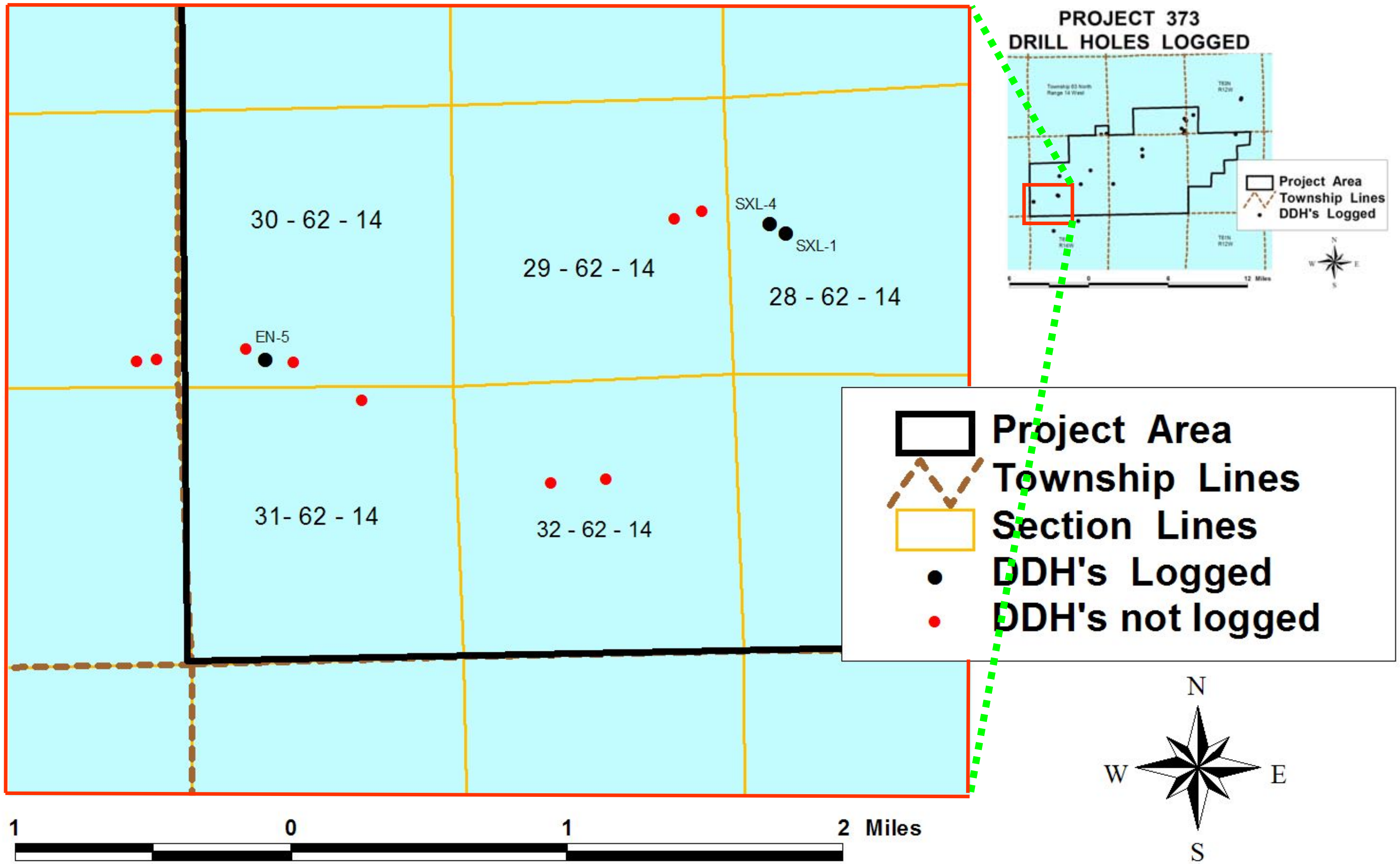
Specific Results

“Murray Shear” Prospect



- Previously unrecognized Au in ***some*** exhalative sphalerite laminae in DDH SXL-1 and SXL-4
- Au associated with pyrite, Cr, Zn, Cd, Co, Cu, Sb; broken to brecciated recrystallized chert or quartz “veins”

Murray Shear

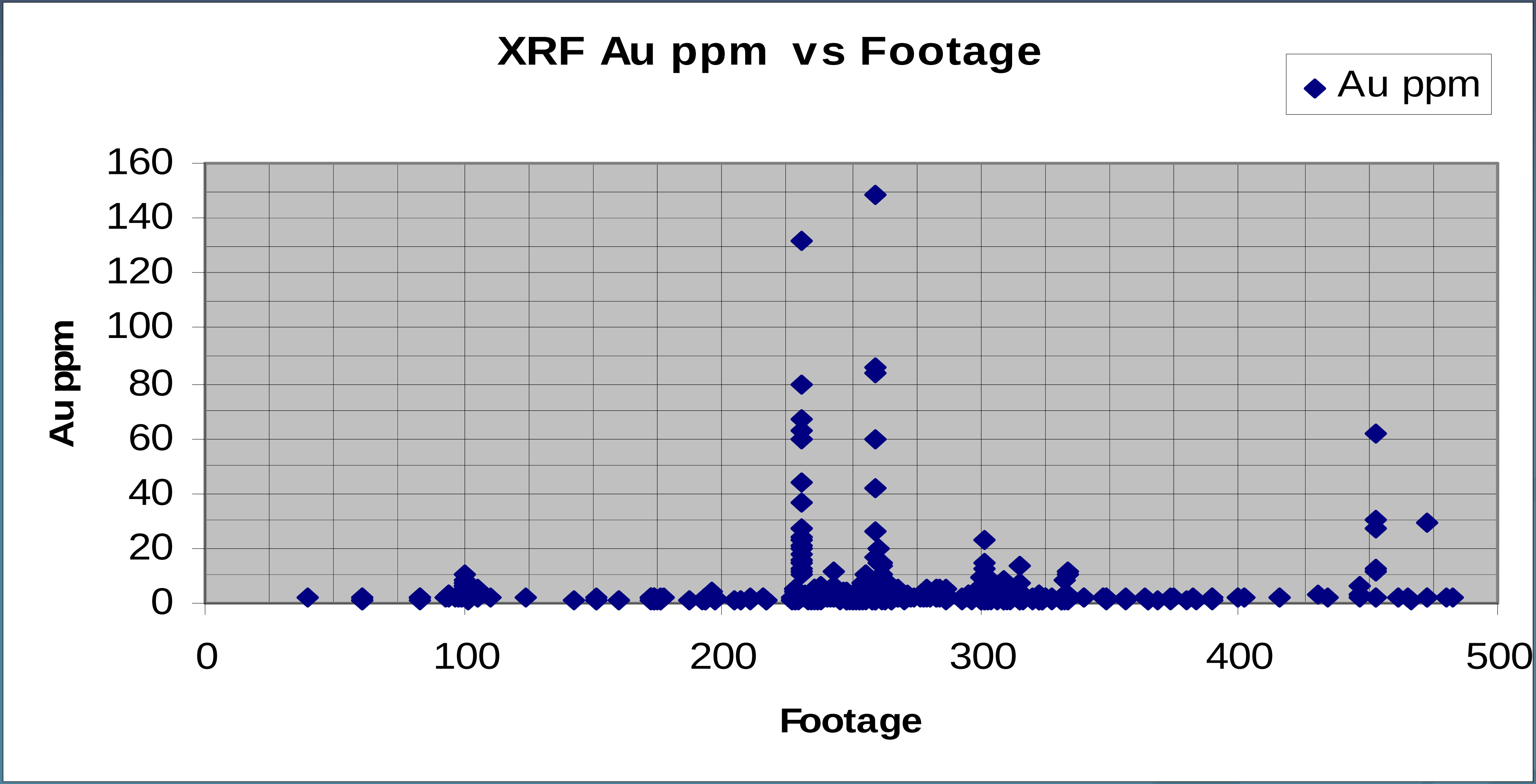


Example semi-quantitative XRF Chemistry for DDH SXL-1 and SXL-4
All values in parts per million (ppm)

DDH	Footage	ROCK	Cr	Cu	Zn	As	Cd	Sb	Au	Pb
SXL-4	143.10	Sph lam??	7782	<LOD	833821	<LOD	1400	374	76	<LOD
SXL-4	144.20	Rexlized chert-qz vn w/ sph blebs	10324	<LOD	1140016	<LOD	2017	475	103	<LOD
SXL-4	248.05	Alt felsic-int? tuff	7920	46869	851540	259	1673	315	111	34
SXL-4	248.05	Alt felsic-int? tuff	7086	53094	890629	209	1855	431	84	<LOD
SXL-4	248.05	Alt felsic-int? tuff	7717	42868	819657	327	1610	322	82	36
SXL-4	297.00	Alt fels-int tuff	5534	1242	638306	<LOD	1155	211	73	83
SXL-4	297.03	Alt fels-int tuff	8191	<LOD	880042	<LOD	1495	211	109	63
SXL-4	412.10	Chlor alt fels-int tuff	9147	4723	969477	<LOD	1764	371	119	418
SXL-4	412.20	Chlor alt fels-int tuff	6868	5609	765007	<LOD	1346	238	85	276
SXL-4	432.63	Alt int-fels? tuff; stringer 2	9990	11315	1084534	<LOD	2041	537	113	382
SXL-4	432.65	Alt int-fels? tuff; stringer 2	7146	41349	827282	61	1628	433	74	439
SXL-4	432.87	Alt int-fels? tuff; stringer 2	8383	227	935882	<LOD	1716	318	114	306
SXL-1	231.00	Tuffaceous sphal-py layer	9705	974	1017226	<LOD	2983	607	132	<LOD
SXL-1	231.00	Tuffaceous sphal-py layer	5821	1405	634850	<LOD	1957	336	67	<LOD
SXL-1	231.03	Tuffaceous sphal-py layer	6594	1142	729365	<LOD	2259	477	79	<LOD
SXL-1	258.70	Sphalerite Lamina	10618	<LOD	1182505	<LOD	1649	365	148	<LOD
SXL-1	258.90	Sph lam/stringer w/ disrupted qz/chert	6202	<LOD	675831	<LOD	1069	232	86	<LOD

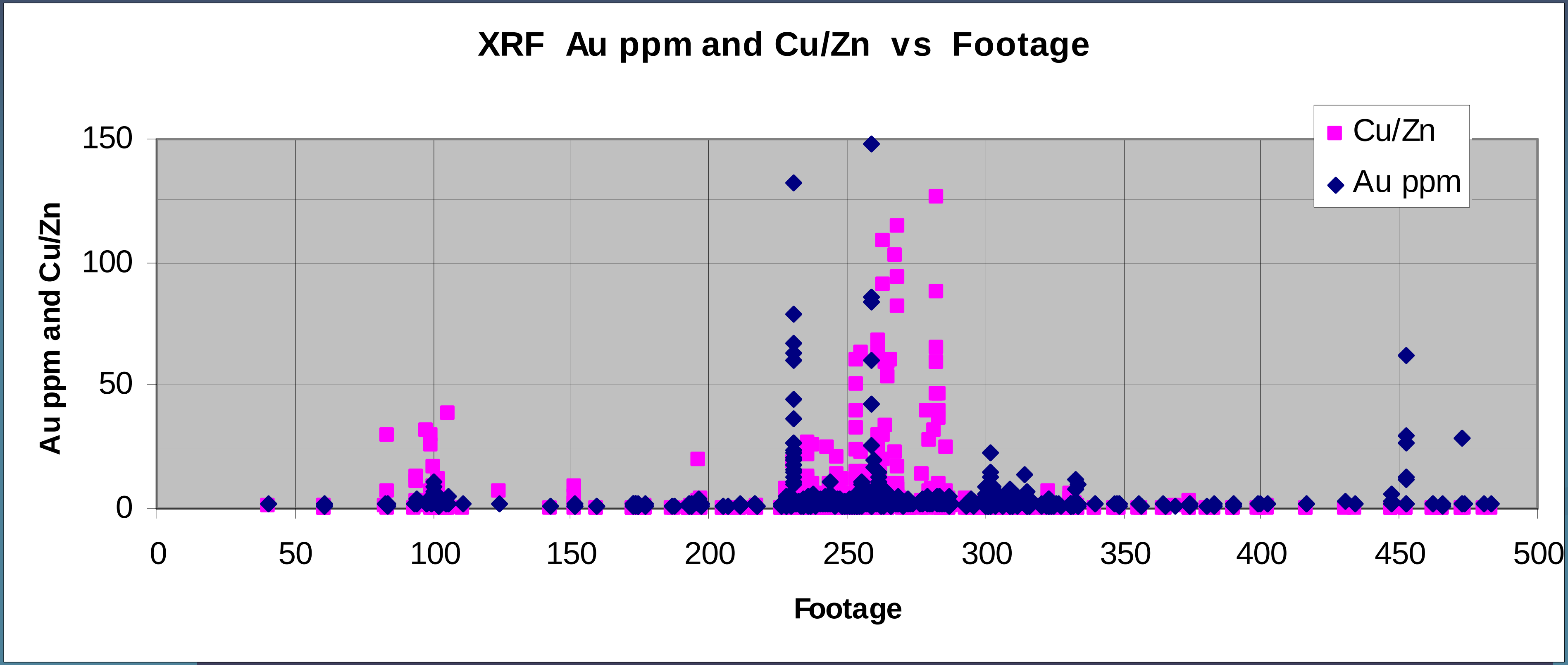
Murray Shear

DDH SXL-1



Plot of semi-quantitative XRF Au ppm versus footage for DDH SXL-1. The number of analyses at a given footage is an approximate measure of the observed sulfide amount

DDH SXL-1



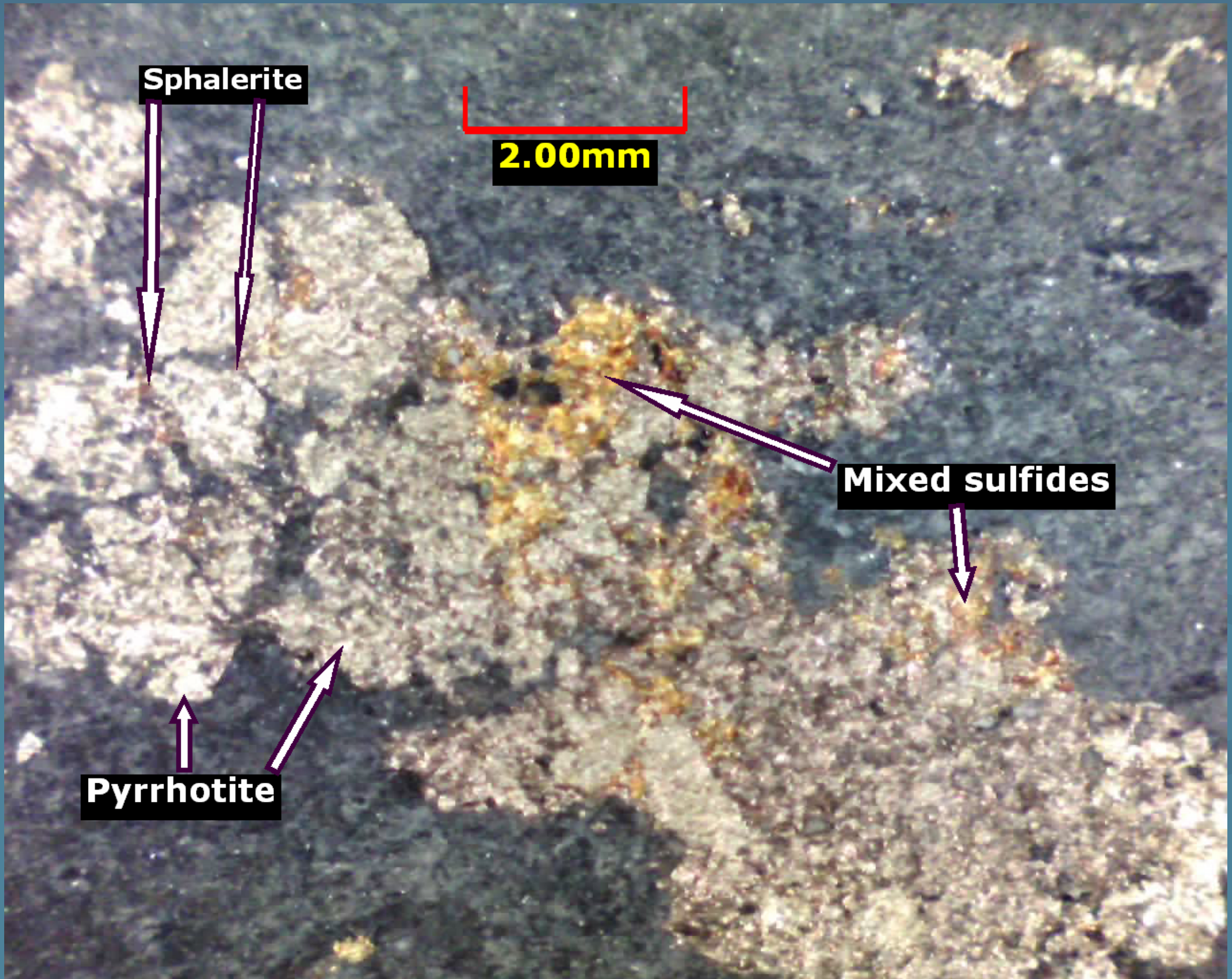
Plot of semi-quantitative XRF Au ppm versus footage for DDH SXL-1.

Copper values are highest in cross-cutting stringers, typically found below the exhalative sphalerite and Au laminae

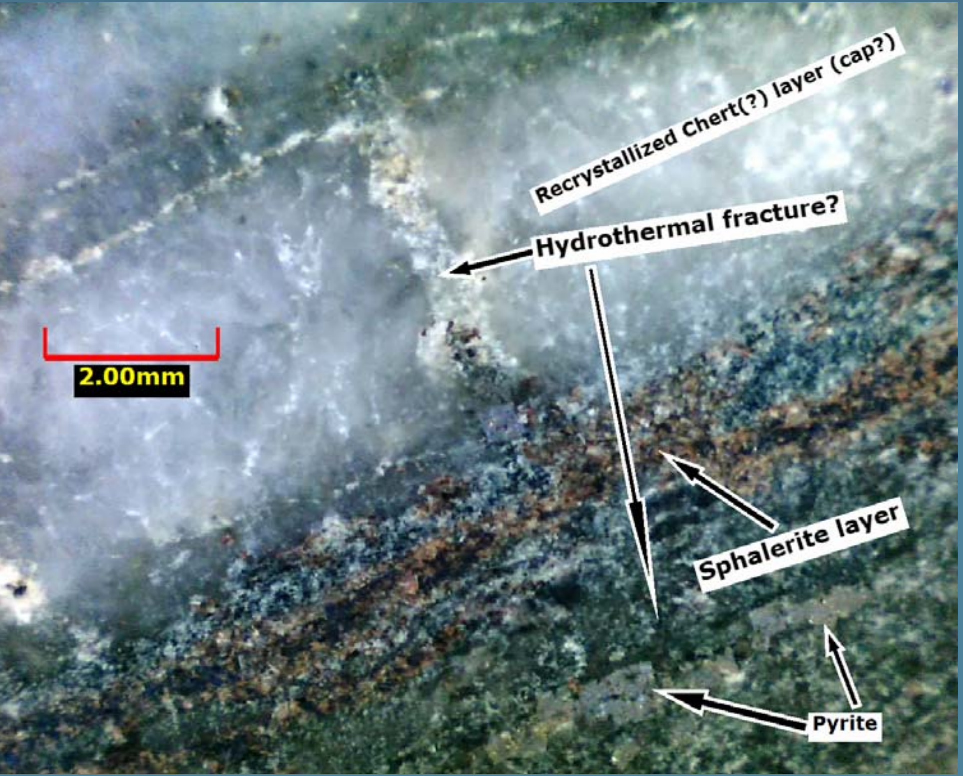
Thicker Au bearing sphalerite - pyrrhotite lamina and thinner lamina without Au from DDH SXL-1 @ 231-231.08’. Note centimeter scale and brecciated quartz within laminae.

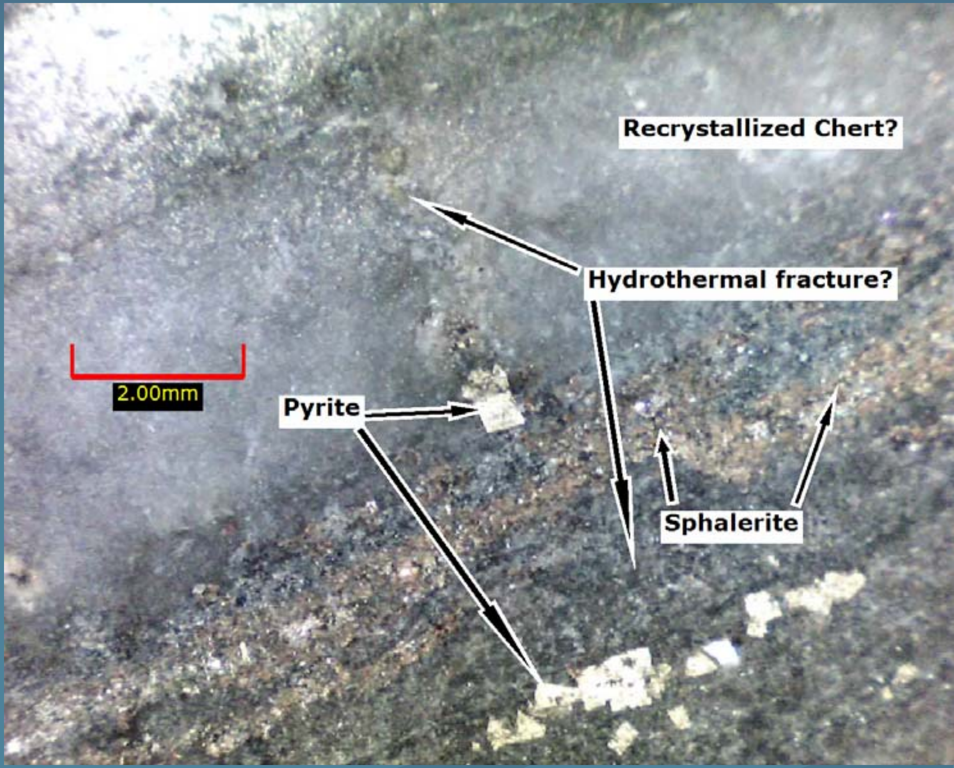
Au bearing sphalerite - pyrrhotite lamina - stringer with variable pyrite (recrystallized?) and chalcopyrite from DDH SXL-4 @ 432.4-433'. Note centimeter scale.

Picture from DDH SXL-1 @ 256.3' showing mixed sphalerite, pyrrhotite, and mixed sulfide stringer(?).



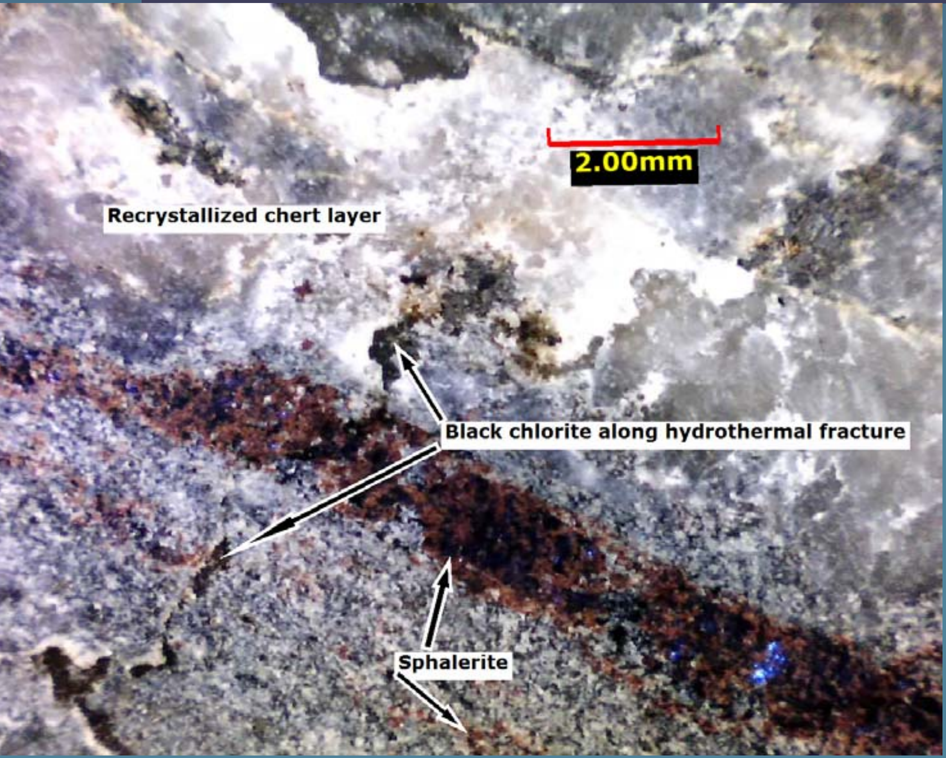
Picture from DDH SXL-1 @ 174' showing sphalerite lamina and other features with 2 different illuminations





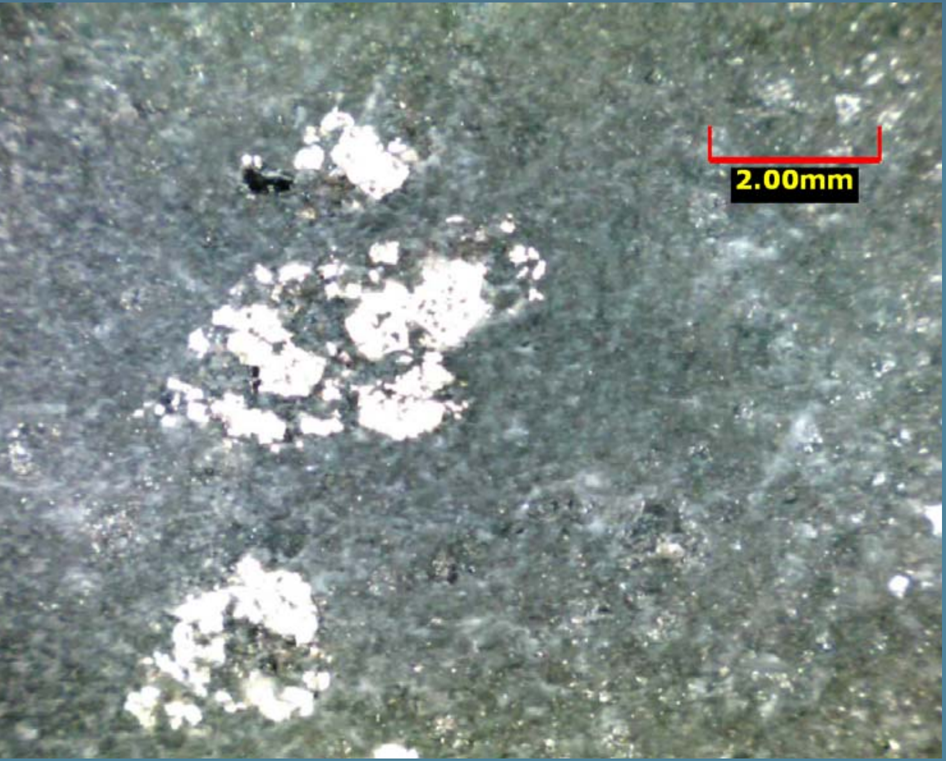
Murray Shear Prospect

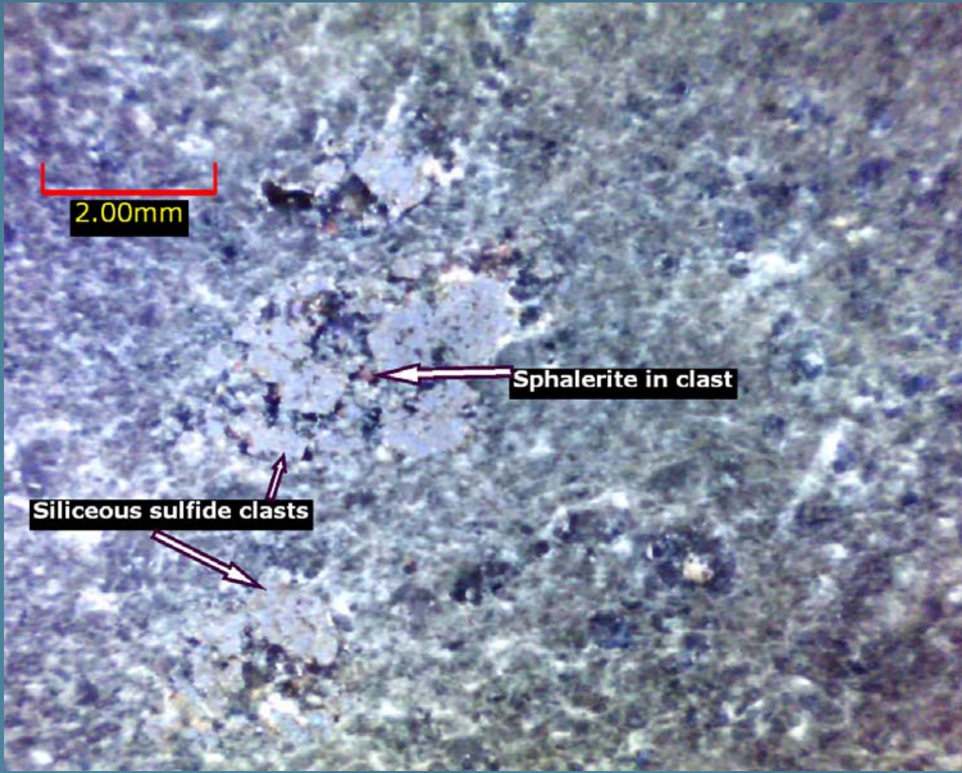
Picture from DDH SXL-1 @ 172.6' showing sphalerite lamina and other features with 2 different illuminations



Murray Shear Prospect

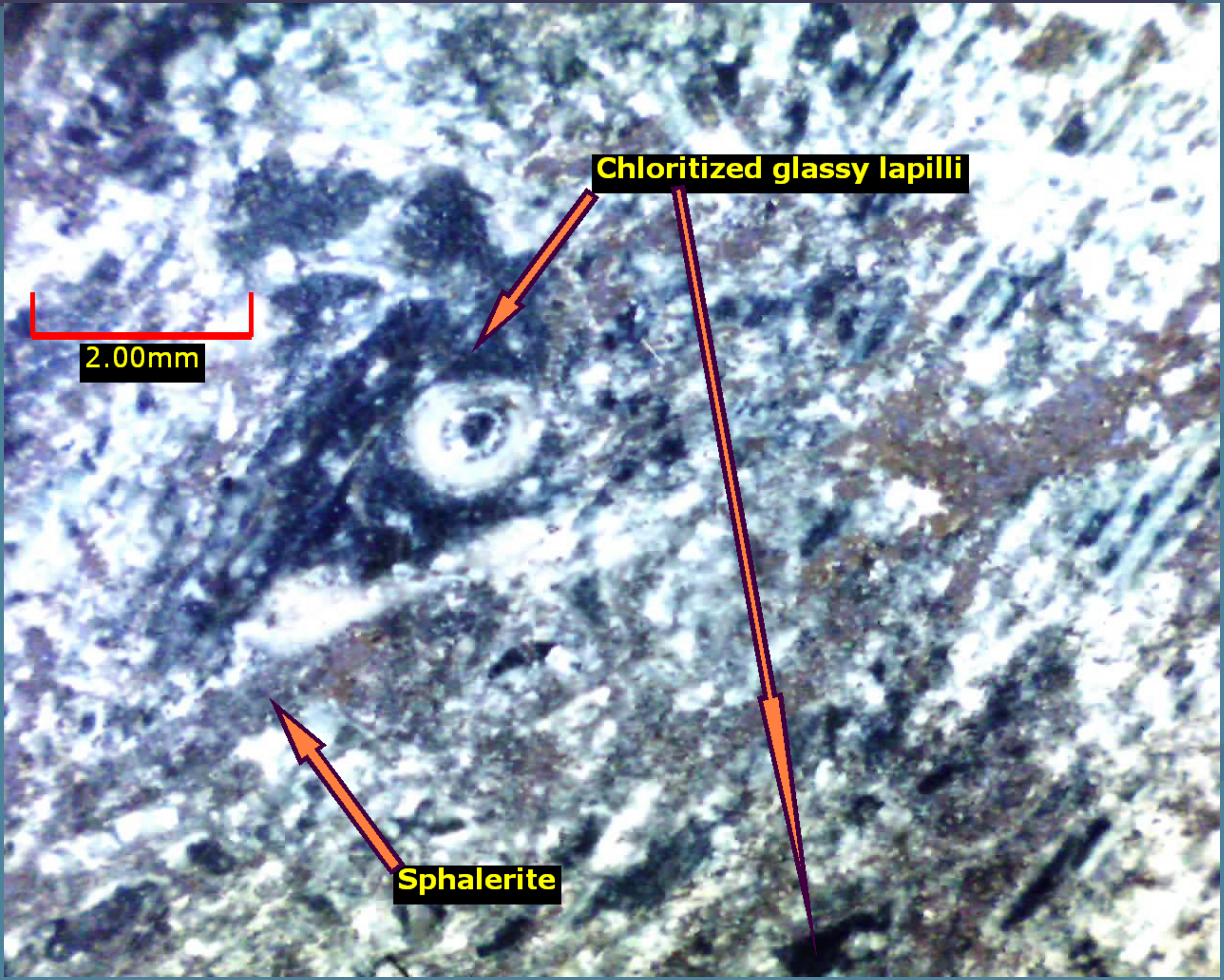
Picture from DDH SXL-1 @ 300.35' showing silicate-pyrite-sphalerite clasts or amygdales with 2 different illuminations





Murray Shear Prospect

Picture from DDH SXL-1 @ 264.8' showing black chlorite altered glass and interstitial sphalerite.

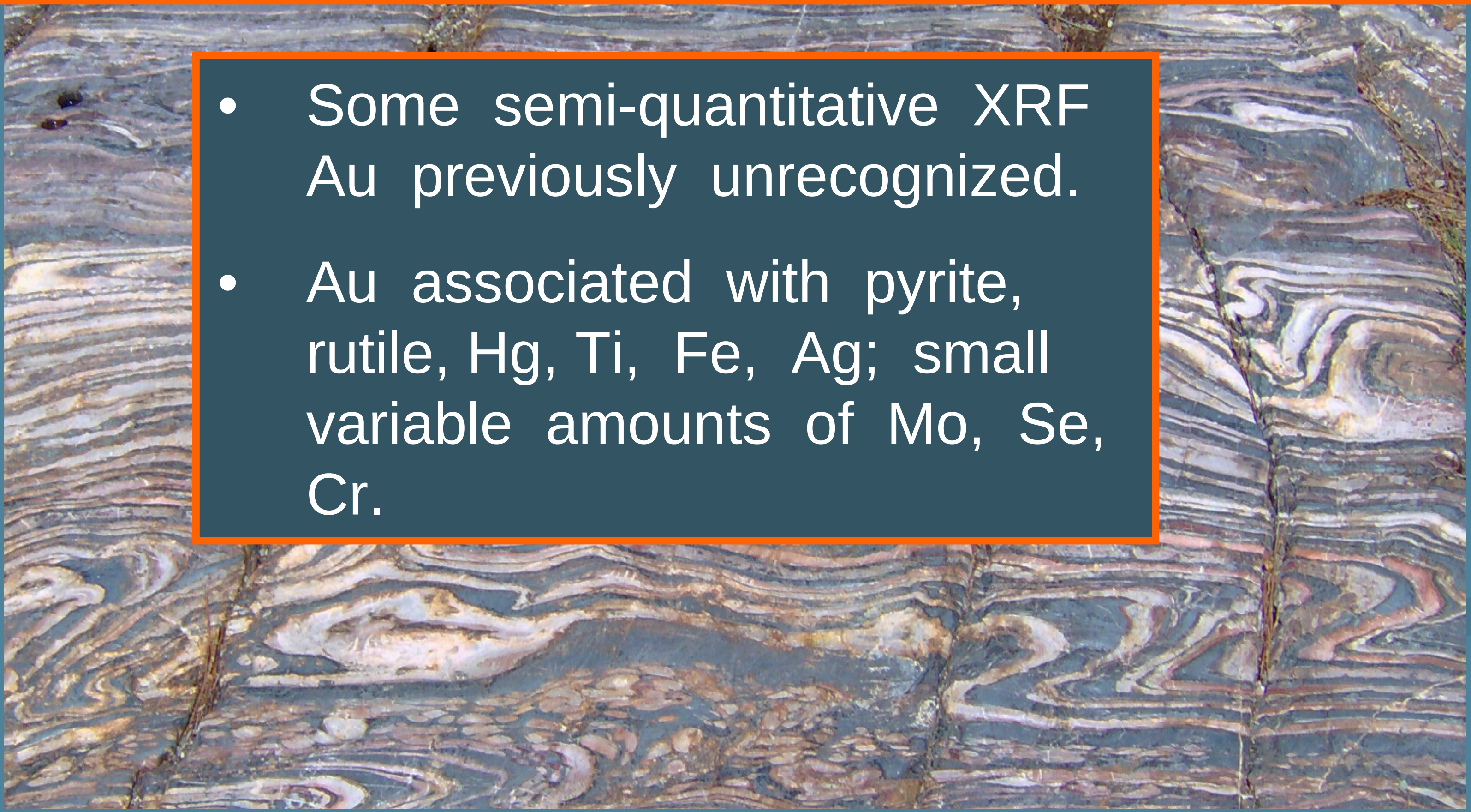


Vermilion Greenstone

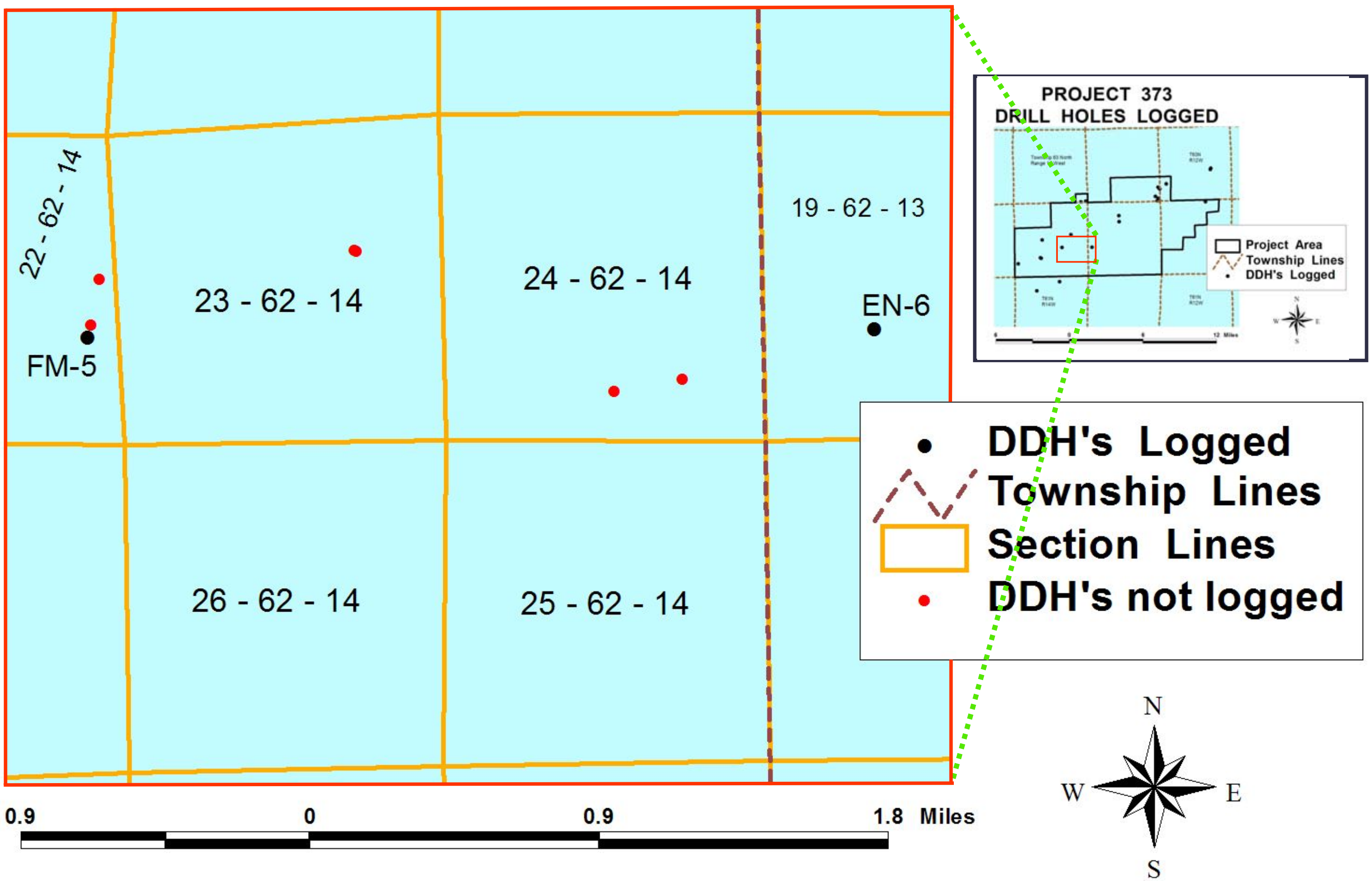
Specific Results

“Eagles Nest Shear” Prospect

- Some semi-quantitative XRF Au previously unrecognized.
- Au associated with pyrite, rutile, Hg, Ti, Fe, Ag; small variable amounts of Mo, Se, Cr.



Eagles Nest Shear



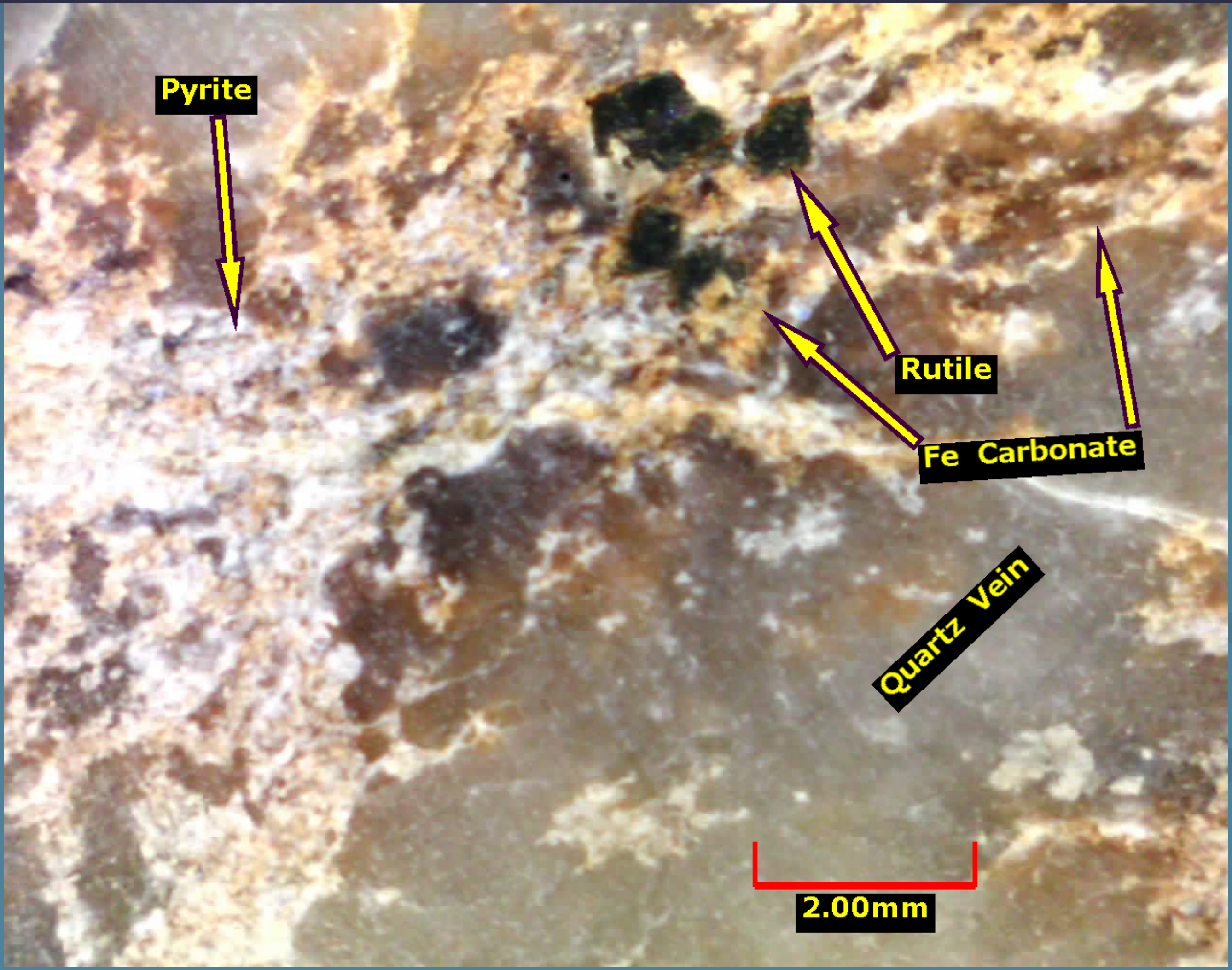
DDH FM-5 Eagles Nest Shear

DDH	Footage	ROCK	COMMENT	Ti	Cr	Fe	Co	Cu	Se	Mo	Ag	Au
FM-5	94.10	Maf flow	Interstitial calcite-flow breccia or top?; Au 3ppm XRF	<LOD	<LOD	10397	<LOD	246	<LOD	69	<LOD	3
FM-5	176.20	Large qz w/goethite-py-Fe carb vn	Py rich, ser, no goeth	7670	346	201838	1523	61	17	47	73	9
FM-5	176.20	Large qz w/goethite-py-Fe carb vn	Py rich, ser, no goeth	5460	231	92965	850	15	8	126	59	4
FM-5	177.10	Large qz w/goethite-py-Fe carb vn and sericite-py altered tuff	Py rich, ser shear/flattened volcaniclasts, no goeth; trace dark basemetal? grains	10604	458	35668	520	66	5	54	27	3
FM-5	219.70	Qz vein contact within brecciated porphyry; center on py grain	XRF 6 ppm Au	27957	431	88325	340	37	11	14	<LOD	6
FM-5	219.70	Qz vein contact within brecciated porphyry; center on different py grain		39017	498	67620	285	79	11	<LOD	<LOD	6
FM-5	219.70	Qz vein contact within brecciated porphyry; no large py grains, but same slip surface		3876	244	158567	679	1426	8	34	148	7

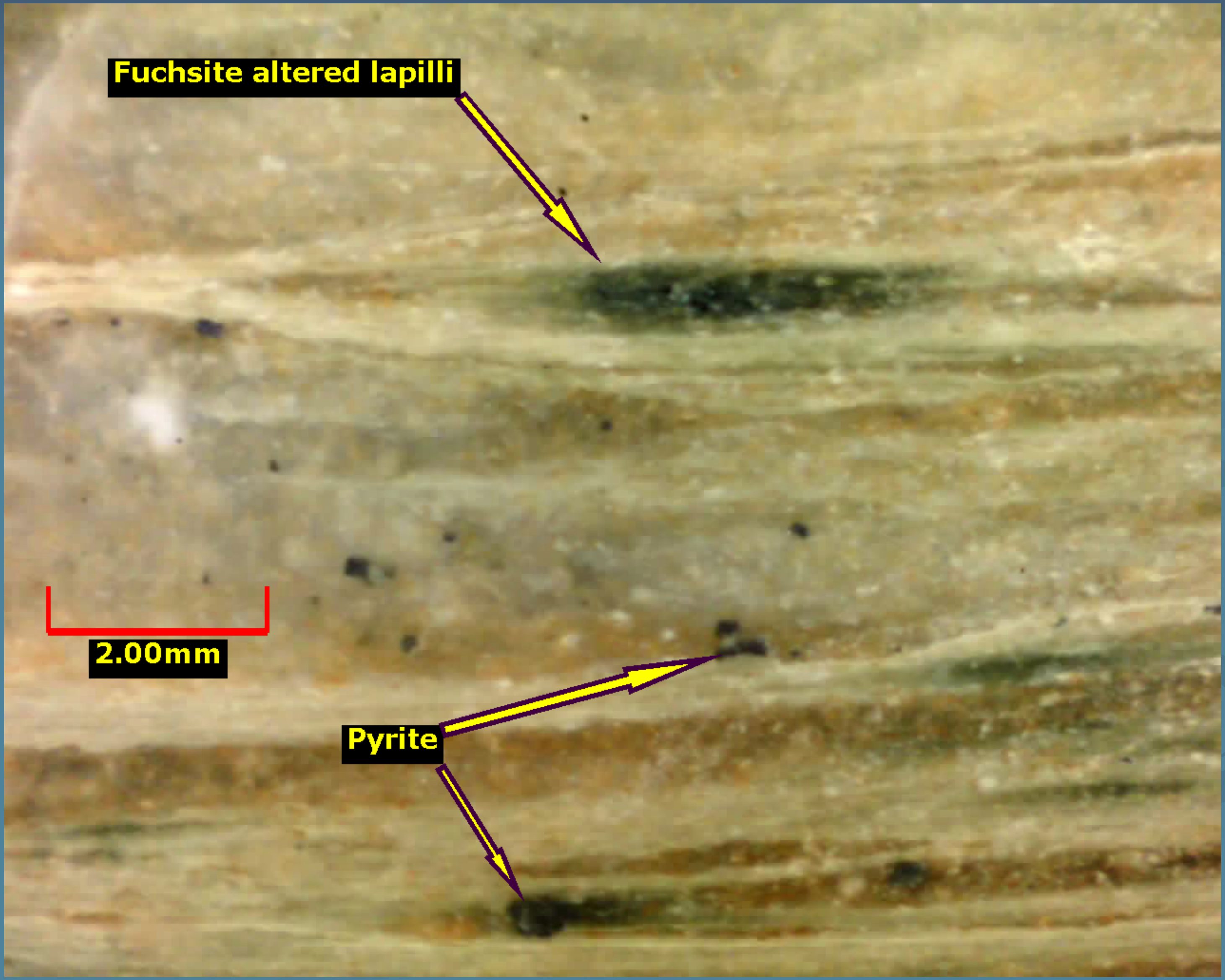
Example semi-quantitative XRF chemistry from DDH FM-5. Au in uppermost footage was previously unrecognized. All analytical values in parts per million (ppm).

Pervasively altered sericite-quartz-pyrite mylonitic felsic tuff from DDH FM-5 @ 181.4' associated with Au mineralized fault

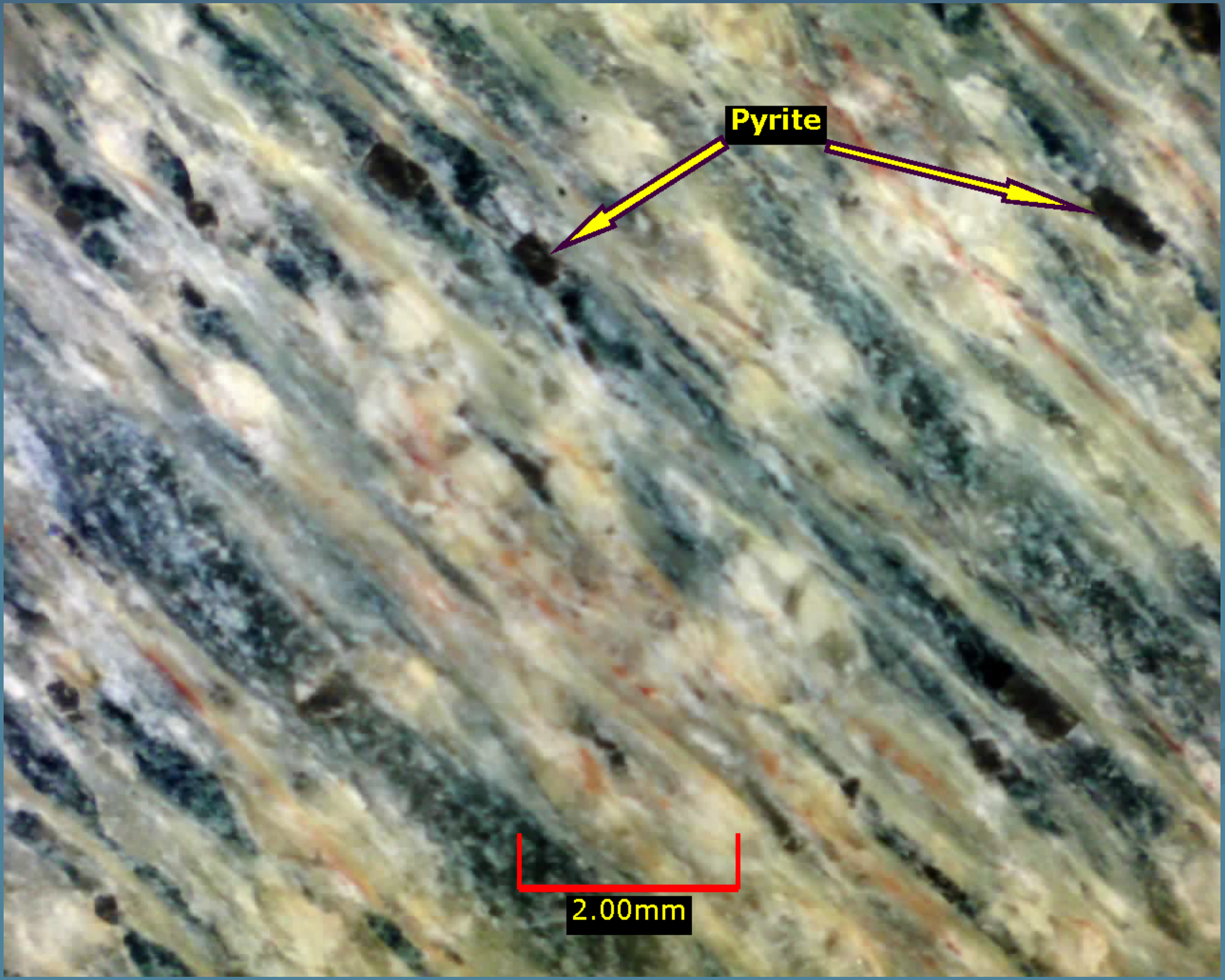
Quartz vein with Fe carbonate and rutile and minor pyrite from DDH FM-5 @ 172.8' associated with Au mineralized fault



Mylonitic felsic tuff with local fuchsite altered lapilli from DDH FM-5 @ 247.1’



Sheared, altered porphyry intrusive or crystal tuff(?) from DDH FM-5 @ 187.1' associated with Au mineralized fault

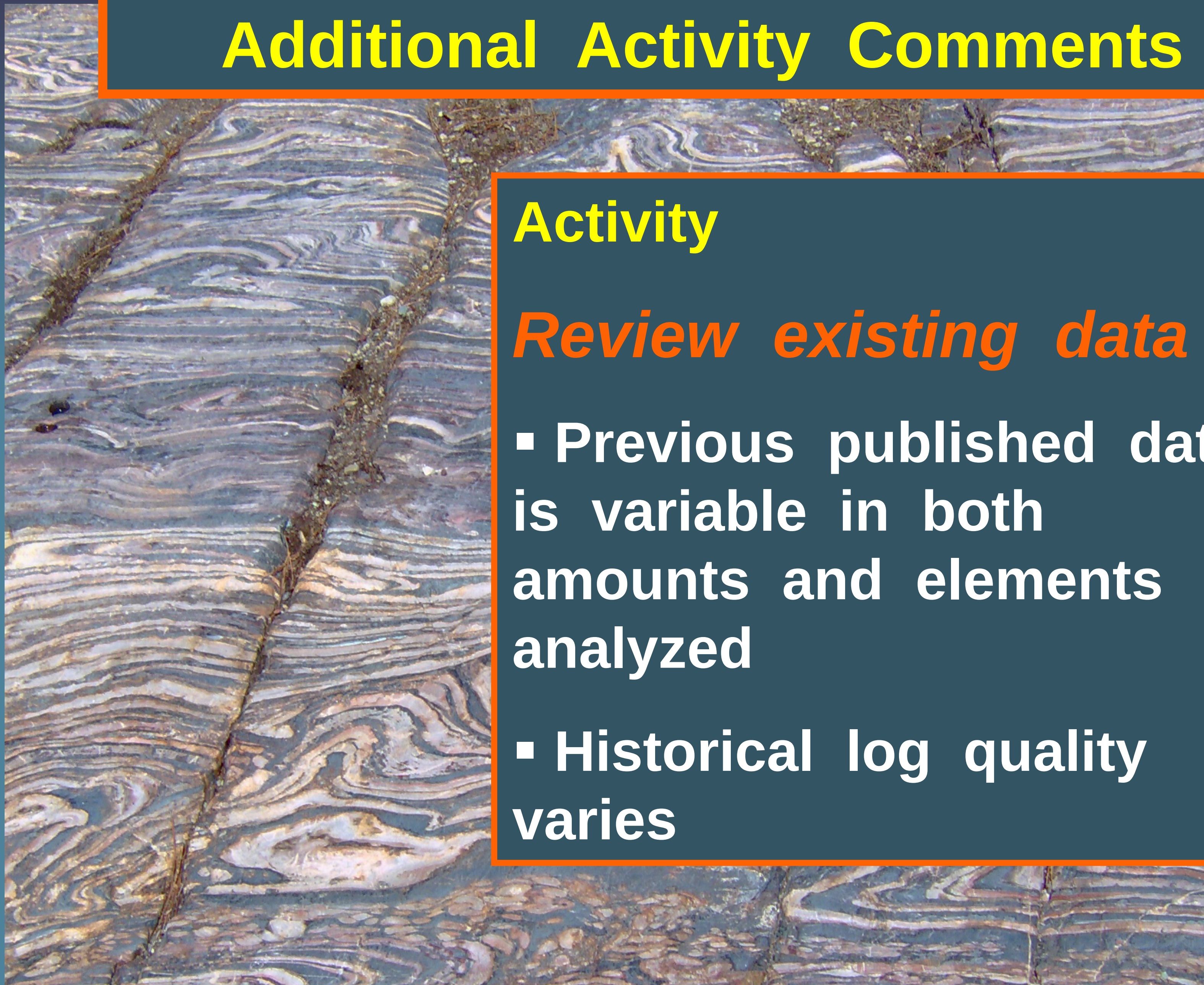


Project 373 *Vermilion Greenstone*

Activities

- Reviewed existing data
- Logged selected drill cores from identified prospects
- Used semi-quantitative hand-held XRF to screen previously unassayed drill core intervals for mineralization
- Used digital microscope to evaluate mineral associations in selected drill core intervals
- Selected 270 sample intervals for third-party quantitative geochemical analysis
- Presented data in usable formats

Additional Activity Comments

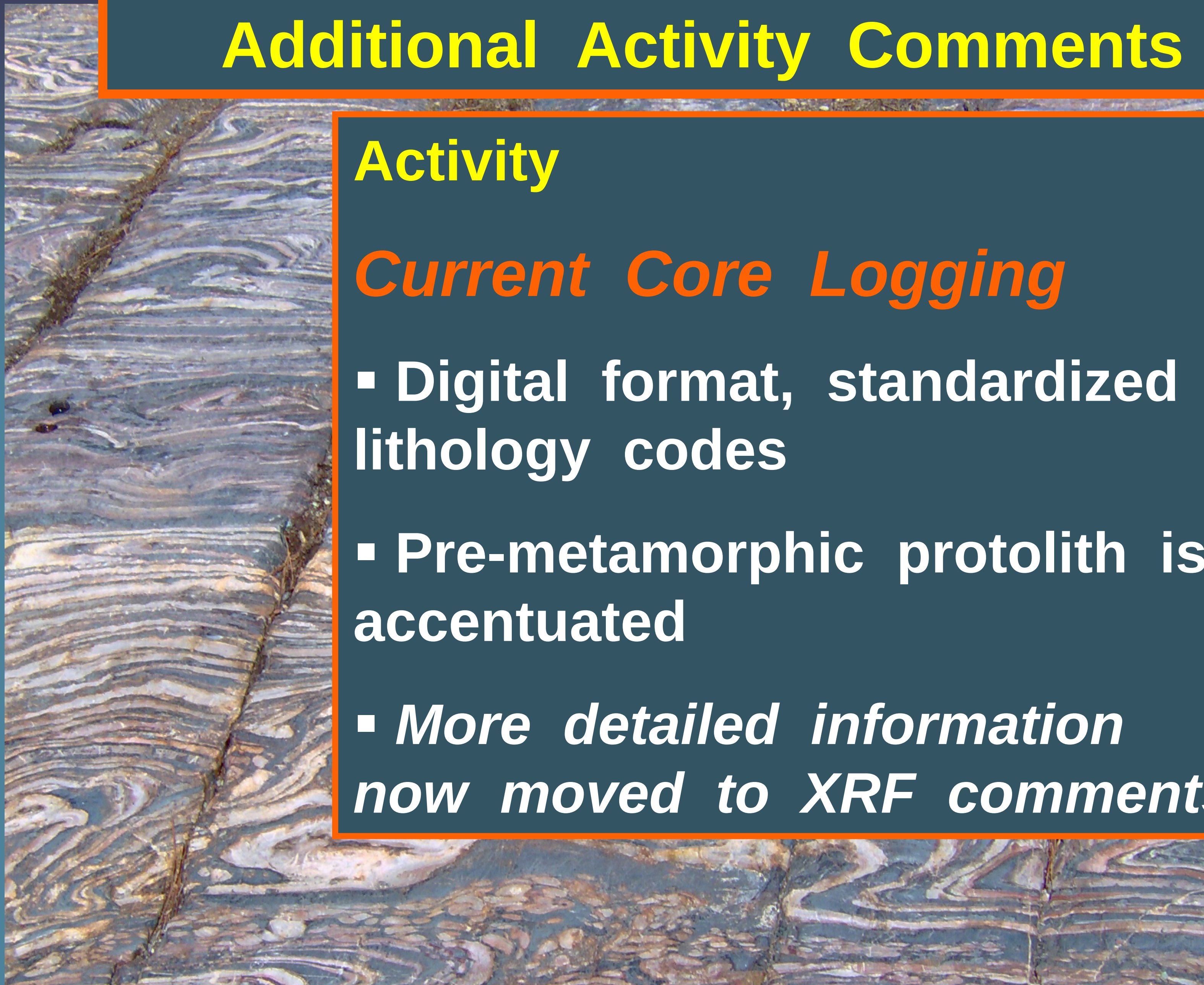


Activity

Review existing data

- **Previous published data is variable in both amounts and elements analyzed**
- **Historical log quality varies**

Additional Activity Comments



Activity

Current Core Logging

- Digital format, standardized lithology codes
- Pre-metamorphic protolith is accentuated
- *More detailed information now moved to XRF comments*

Additional Activity Comments

Activity

Used semi-quantitative, hand-held XRF

- **Semi-quantitative “Point” analyses**
- **Analysis Window is round shaped .76 cm^2**
- **Scale is useful for traversing alteration fronts or veins**

Remember when analyzing and comparing results

Additional Activity Comments

Activity

Used semi-quantitative XRF

Gold emphasis

- **Sulfides targeted**
- **Other gold related features targeted**
- **Target lithologic differences, including veining and alteration**

Additional Activity Comments

Activity

Use of hand-held XRF

XRF Data usage

- **Parts per Million (PPM) *results are semi-quantitative***

- **Our instrument gives data for Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Zr, Mo, Ag, Cd, Sn, Sb, Ba, Au, Hg, Pb**

Additional Activity Comments

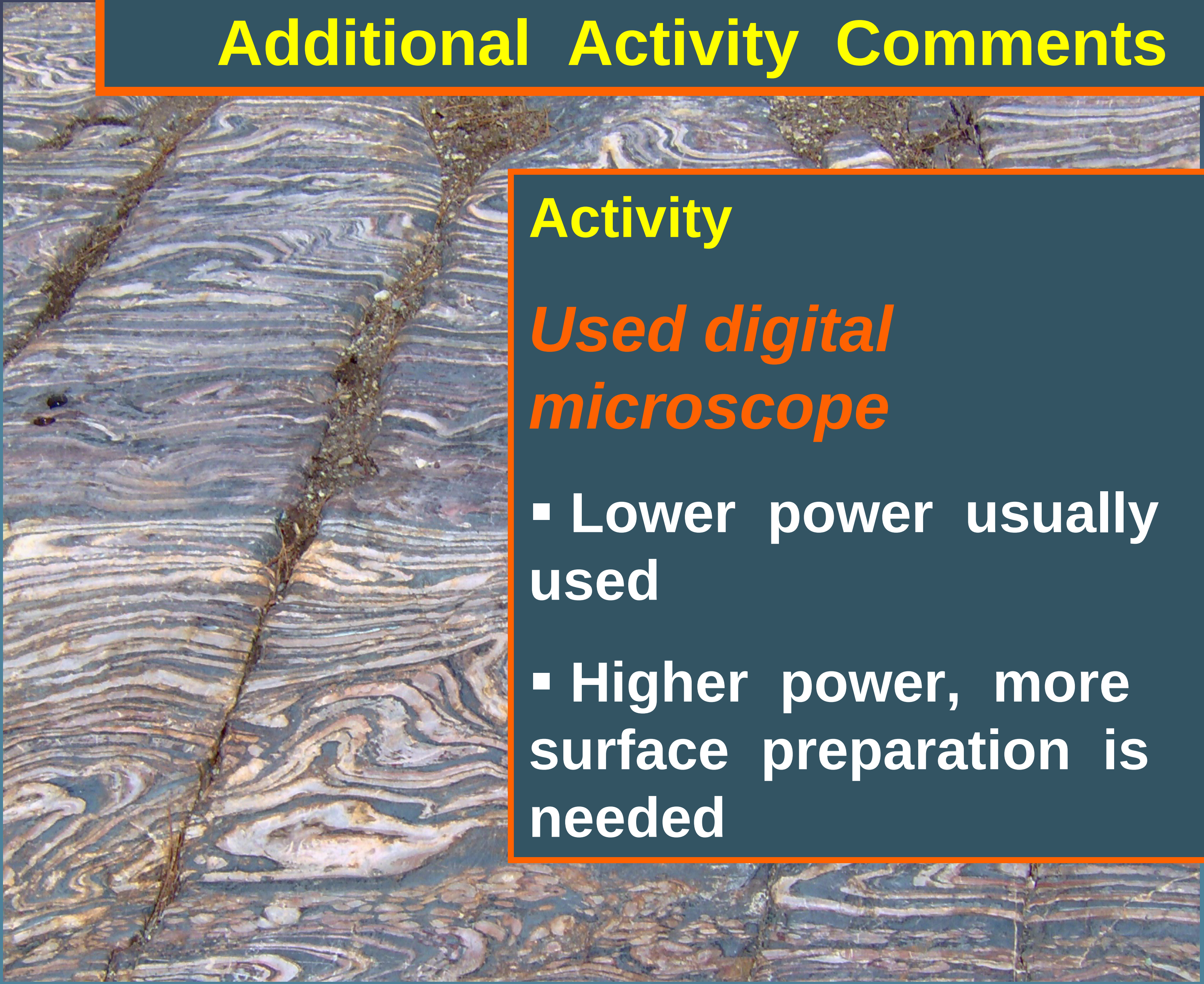
Activity

Use of hand-held XRF

XRF Data usage

- **XRF semi-quantitative data is best used comparatively as internal data sets**
- **Comparison with other, non-point chemistry data must be done *cautiously***

Additional Activity Comments



Activity

Used digital microscope

- **Lower power usually used**
- **Higher power, more surface preparation is needed**

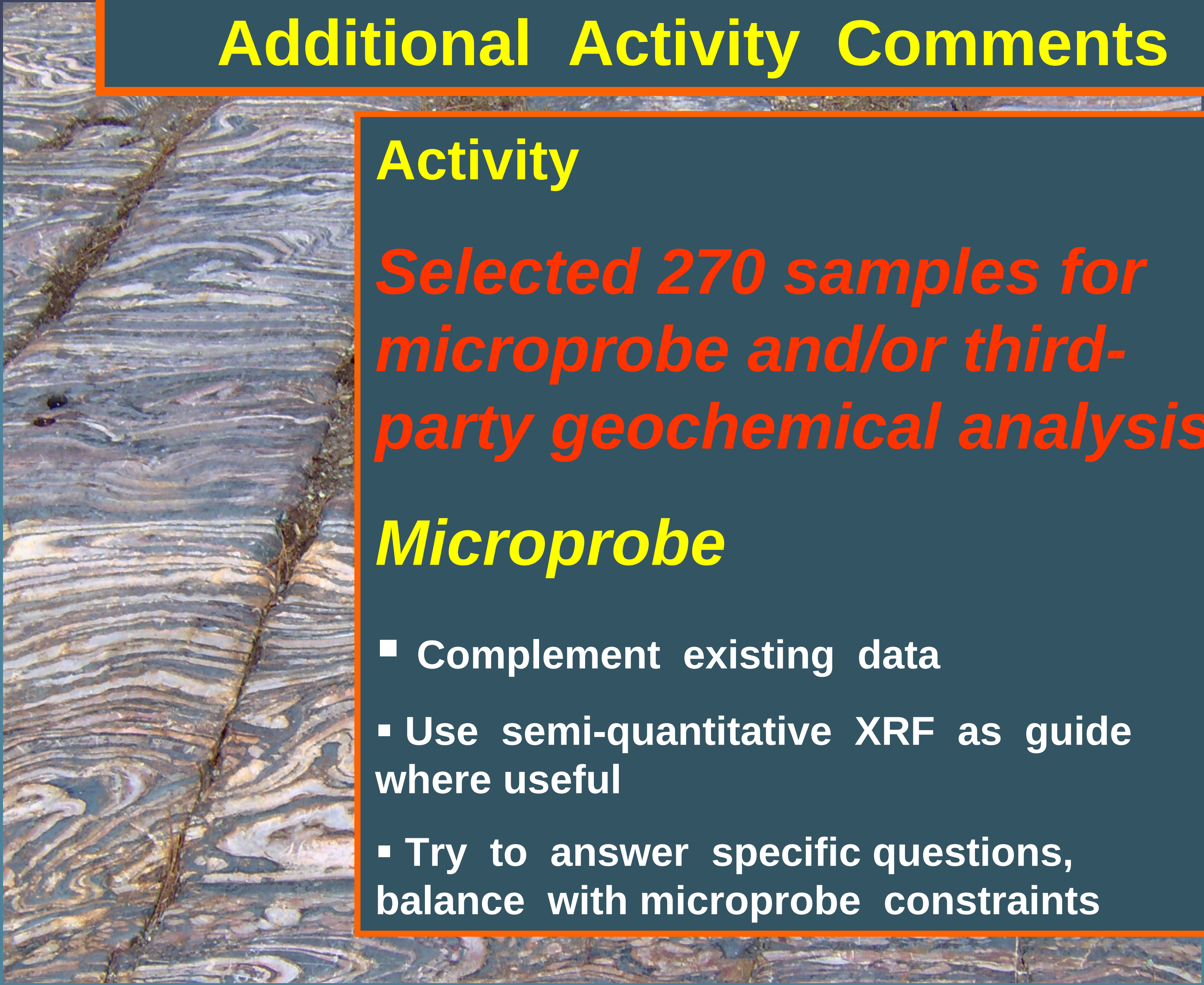
Additional Activity Comments

Activity

Choose assay, microprobe, and/or other samples

Assay

- **Complement existing data**
- **Analyze for extended suite of elements**
- **Analyze single lithologies if possible**



Additional Activity Comments

Activity

Selected 270 samples for microprobe and/or third-party geochemical analysis

Microprobe

- **Complement existing data**
- **Use semi-quantitative XRF as guide where useful**
- **Try to answer specific questions, balance with microprobe constraints**

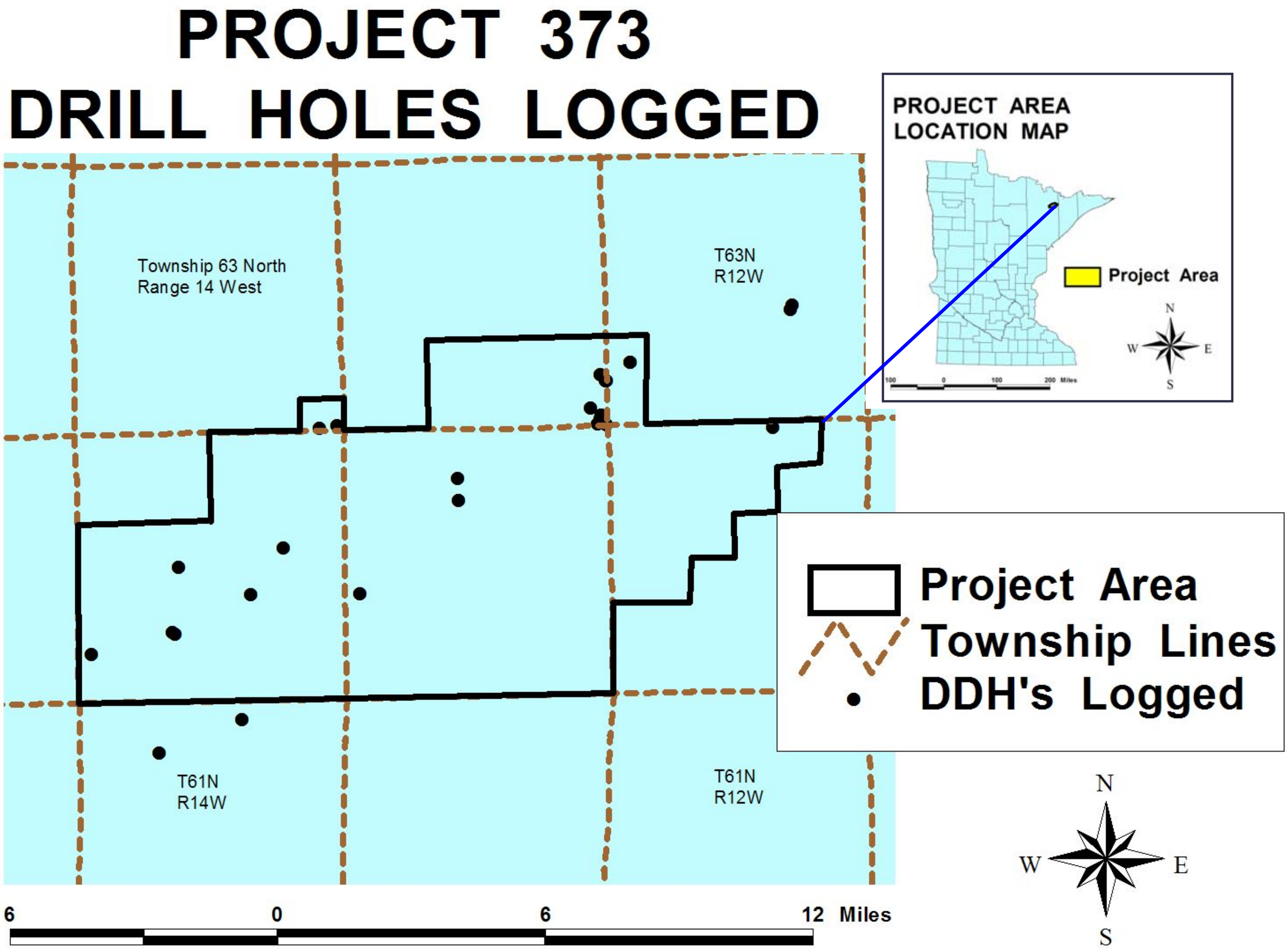
Additional Activity Comments

Activity

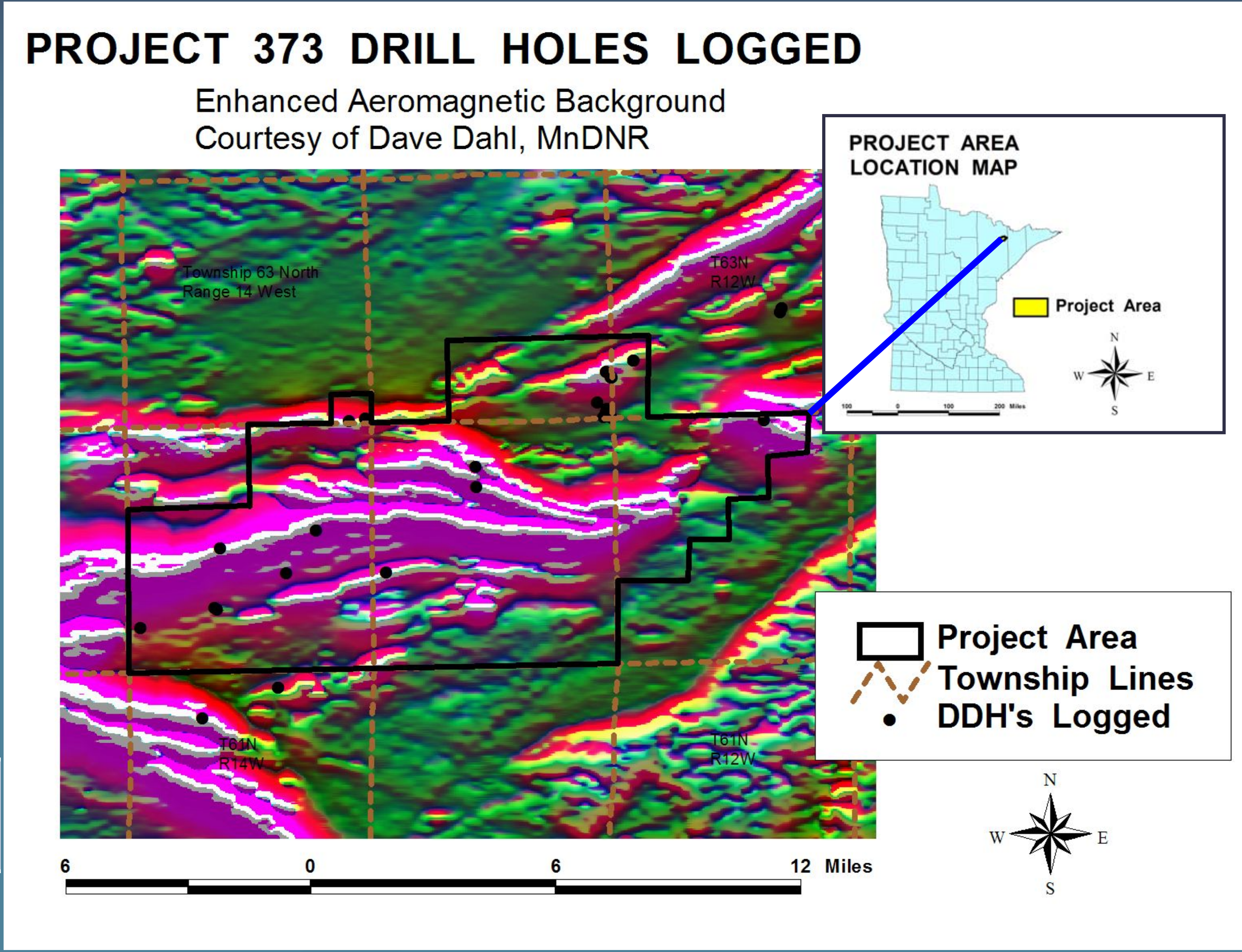
Presented data in usable formats

- PowerPoint® summaries
- Excel® spreadsheet files
- Word® text documents
- Images are JPEG format
- Limited Geographic Information System (GIS) “Shape” files are available

Vermilion Greenstone – Where was the work done?

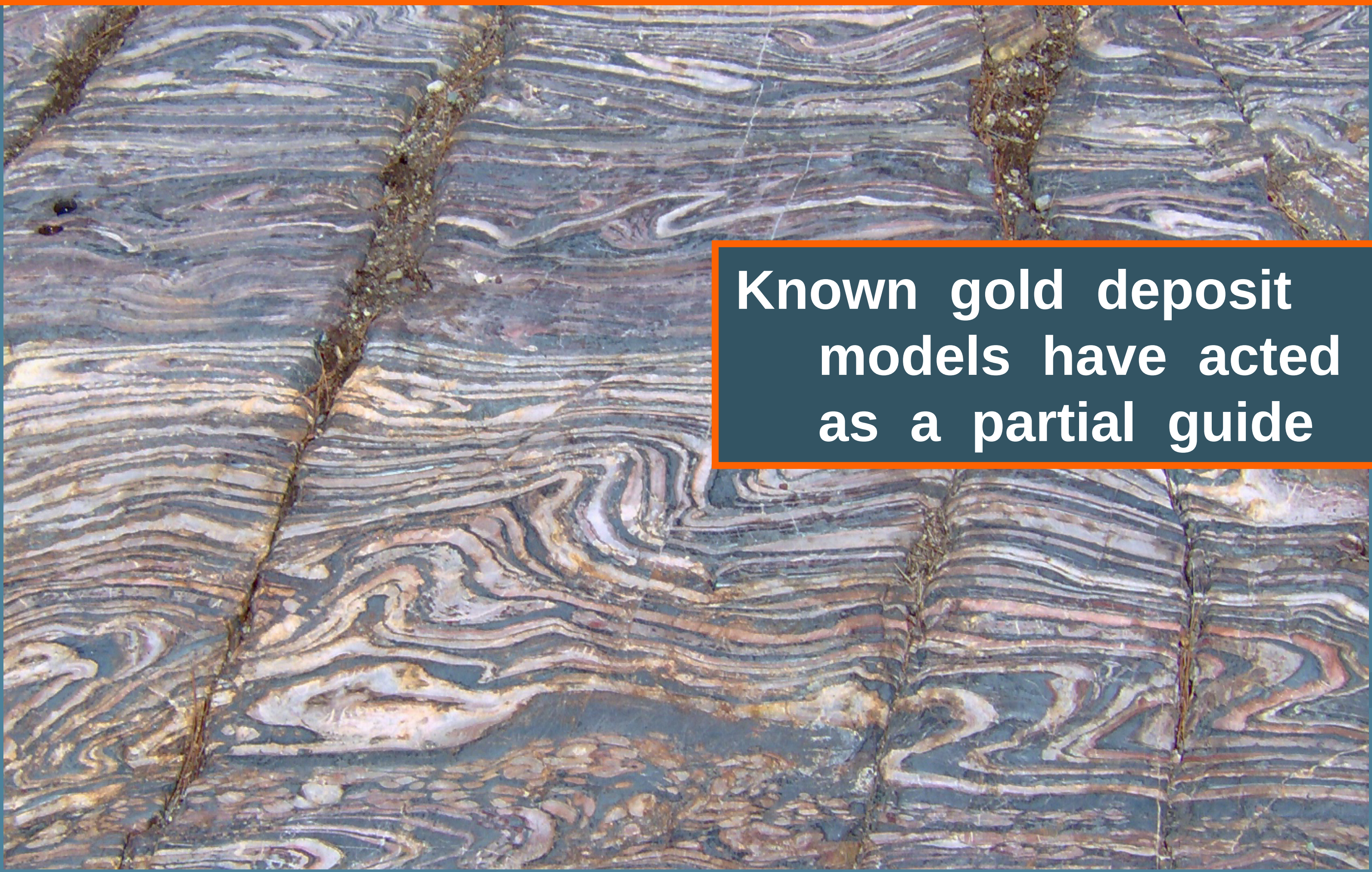


Vermilion Greenstone – Where was the work done?



Vermilion Greenstone

Framework of Gold Models

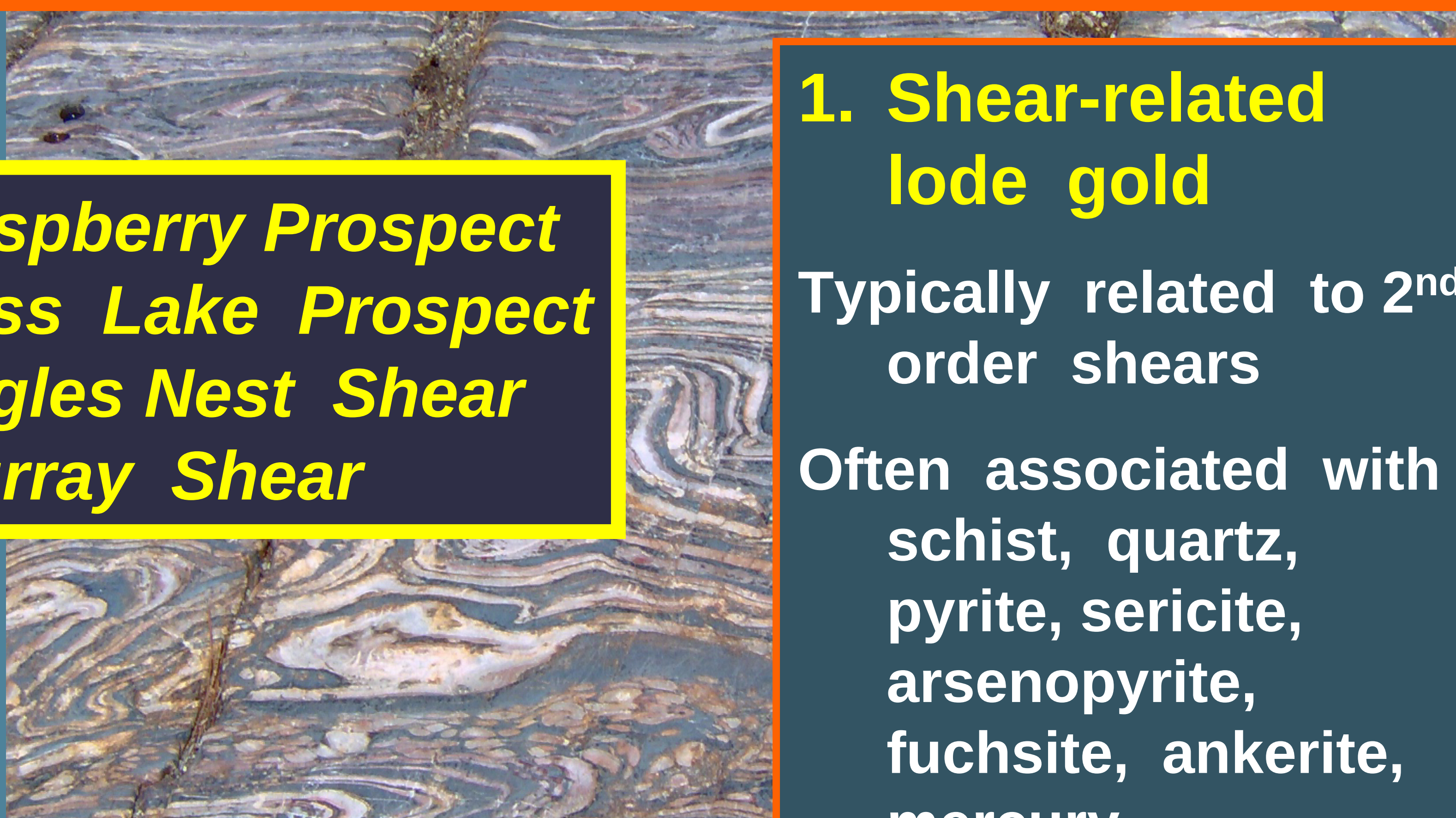


Known gold deposit models have acted as a partial guide

Conclusions –

Vermilion Greenstone

Framework of Gold Models



Raspberry Prospect
Foss Lake Prospect
Eagles Nest Shear
Murray Shear

1. **Shear-related lode gold**

Typically related to 2nd order shears

Often associated with schist, quartz, pyrite, sericite, arsenopyrite, fuchsite, ankerite, mercury

Conclusions –

Vermilion Greenstone

Framework of Gold Models

Raspberry Prospect

Foss Lake Prospect

Eagles Nest Shear

Murray Shear

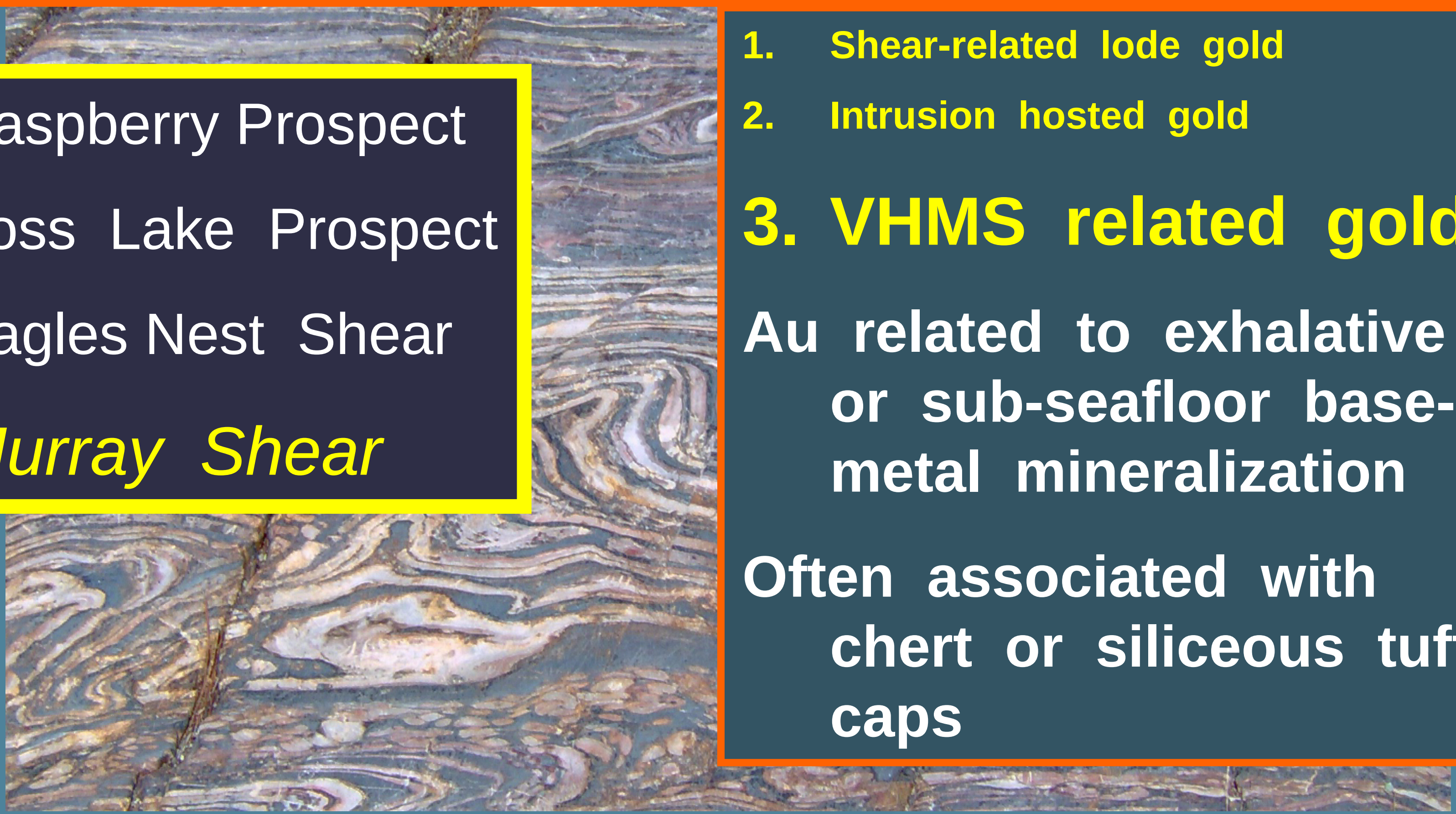
2. Intrusion hosted gold

Associated with magmatic fluids/ alteration, porphyries, fractures, minor base-metals

Conclusions –

Vermilion Greenstone

Framework of Gold Models



Raspberry Prospect

Foss Lake Prospect

Eagles Nest Shear

Murray Shear

1. Shear-related lode gold
2. Intrusion hosted gold

3. VHMS related gold

Au related to exhalative or sub-seafloor base-metal mineralization

Often associated with chert or siliceous tuff caps

Conclusions –

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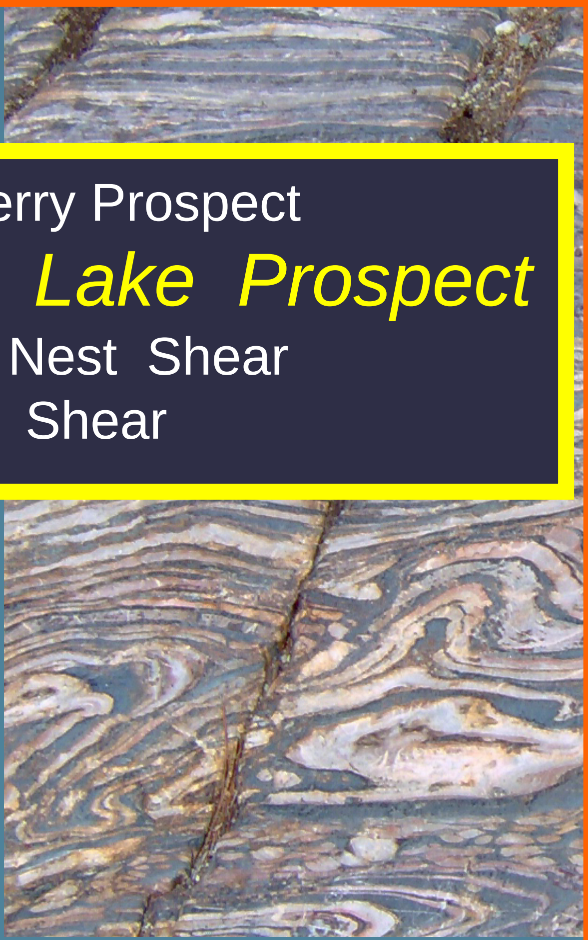
Framework of Gold Models



Raspberry Prospect

Foss Lake Prospect

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Murray Shear

1. Shear-related lode gold
2. Intrusion hosted gold
3. VHMS gold

4. Banded Iron Formation (BIF) related gold

Typically sulfidation of iron exhalative chemical sediment

Often at transitions from one BIF type to another BIF type

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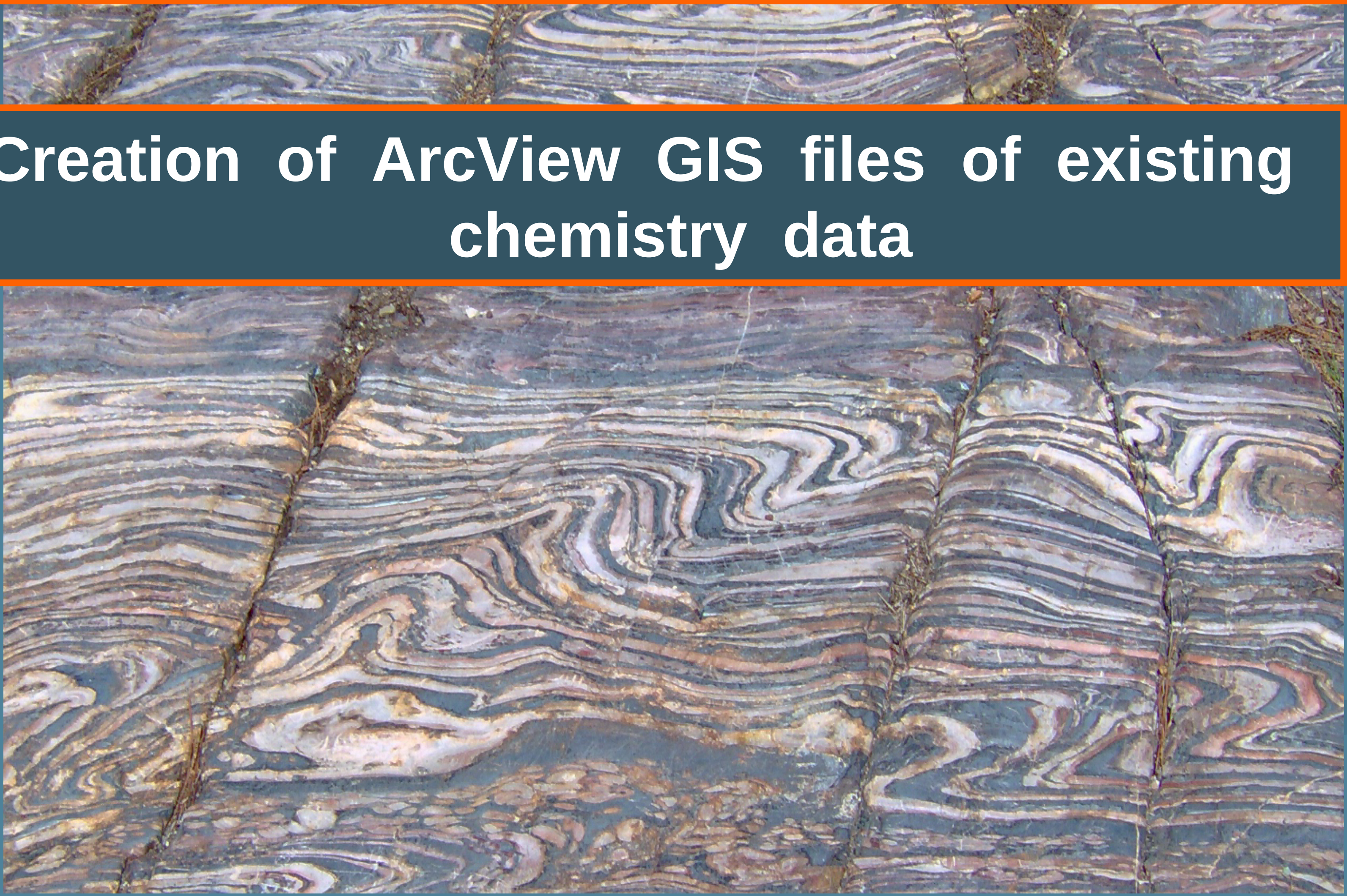
Project 373 Products



Creation of ArcView GIS files of existing chemistry data

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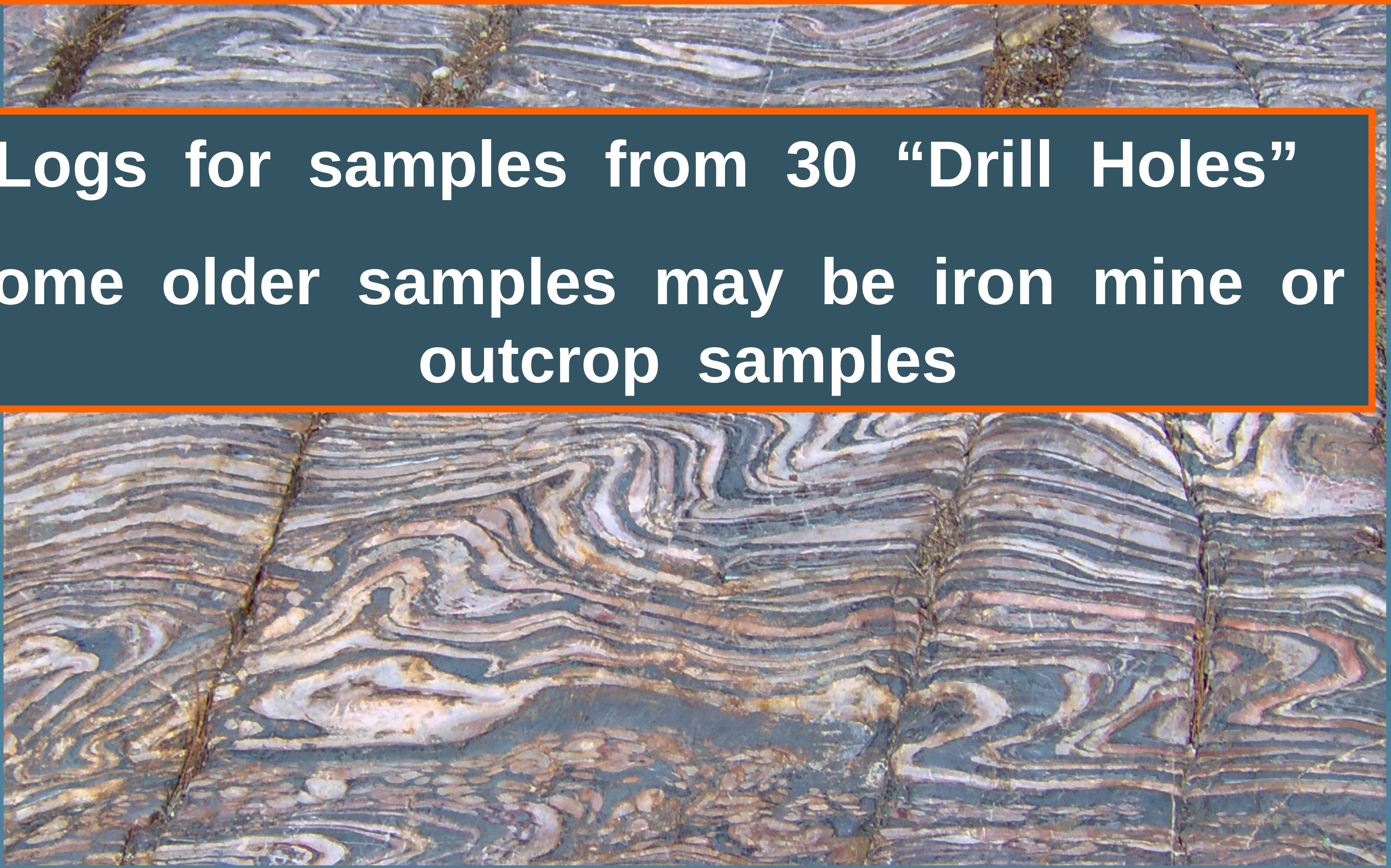
Project 373 Products



Logs for samples from 30 “Drill Holes”

Some older samples may be iron mine or outcrop samples

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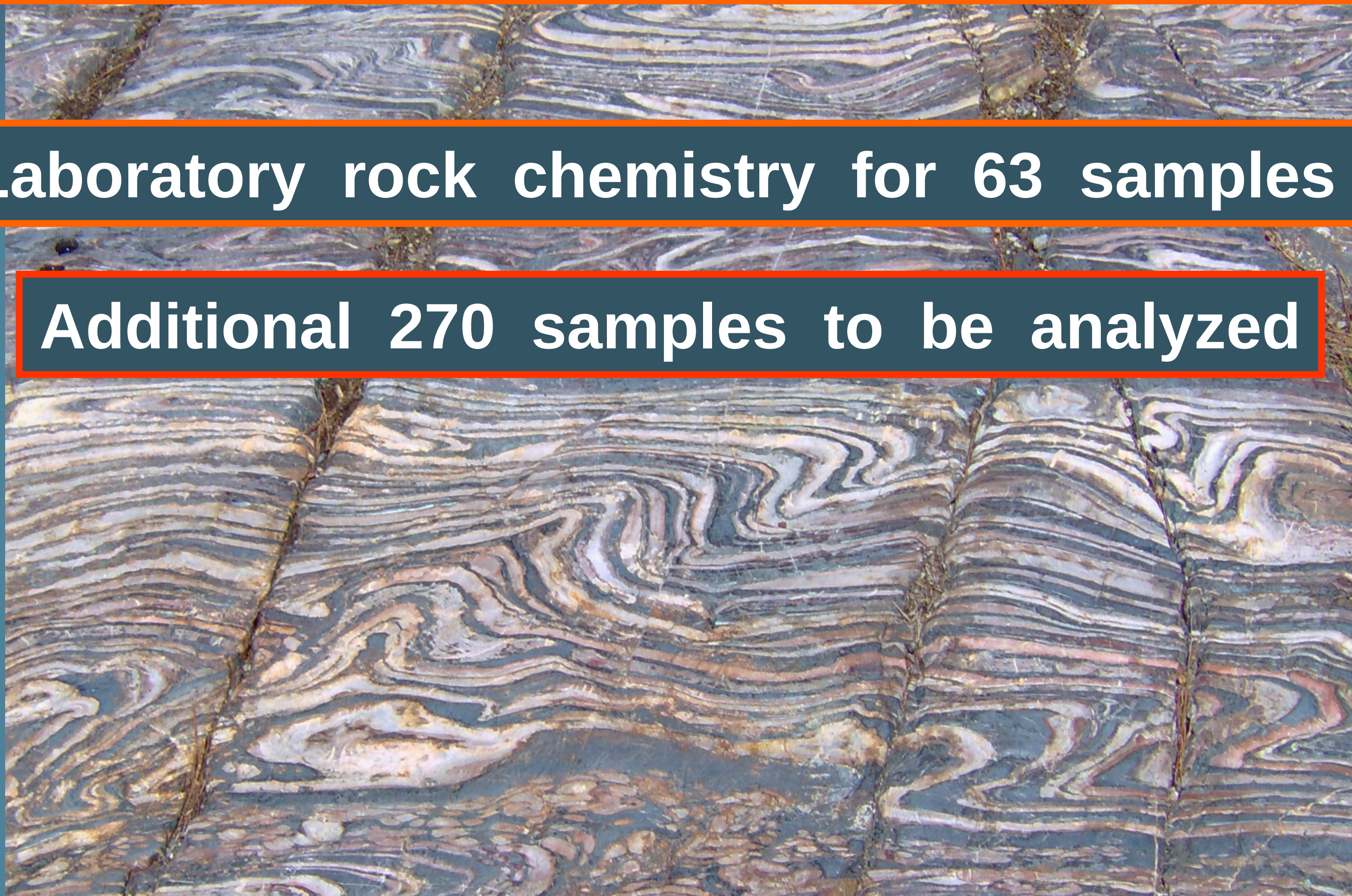
Project 373 Products



Laboratory rock chemistry for 63 samples

Additional 270 samples to be analyzed

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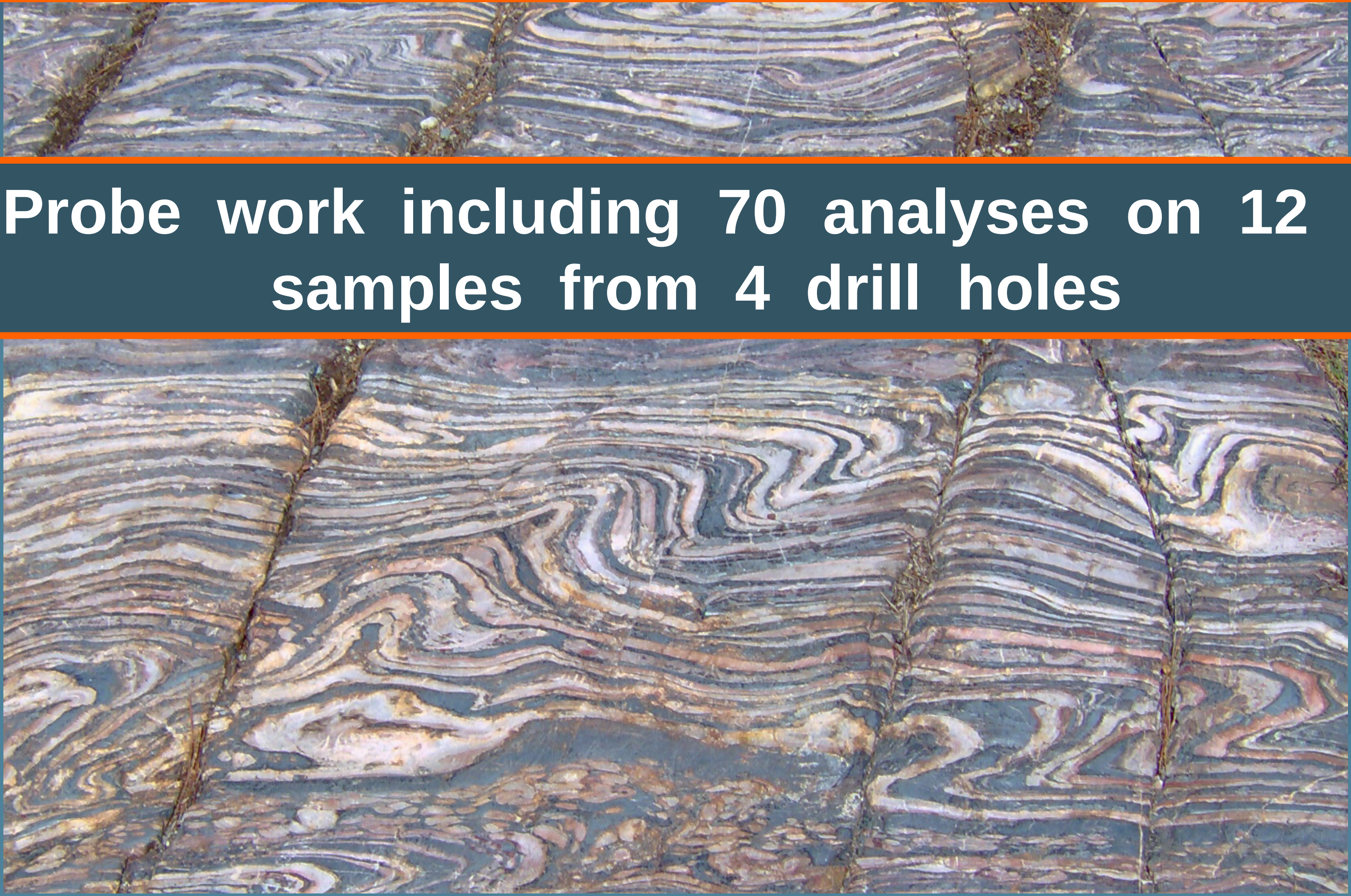
Project 373 Products



Probe work including 70 analyses on 12 samples from 4 drill holes

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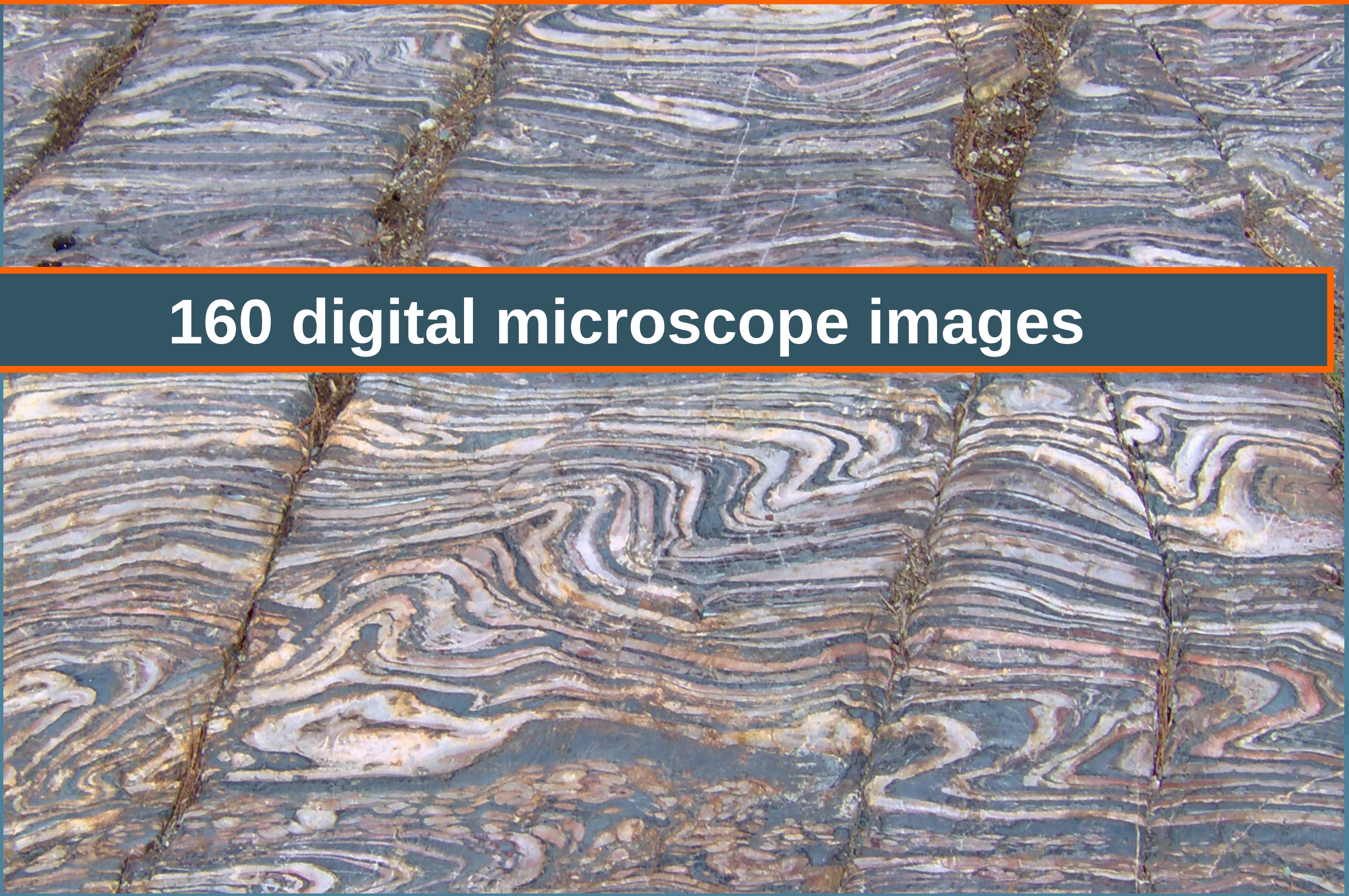
Project 373 Products



160 digital microscope images

The "Gold Rush" of 1865 eventually led to the mining of about 100 million tons of iron ore from Soudan and Ely, Minnesota. Since that time, gold exploration has occasionally emerged, but to no avail. Hopefully this work will add a few more puzzle pieces to bring the dream of 1865 to fruition.

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