Rutile Compositions at the Big Bell Au Deposit as a Guide for Exploration

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- *CSIRO colleagues, especially Ken Kinealy, Jeff Davis and David French for assistance with analysis of the rutiles*

Hydrothermal Rutile Formation

$K(Fe, Mg, Ti)_3(Si_3 Al)O_{10}(OH)_2 + S_2 \rightarrow$

Biotite

$K(Mg, Fe)_3(Si_3Al)O_{10}(OH)_2 + FeS_2 + TiO_2$

Phlogopitic biotite

$2(Fe, Ti)_3O_4 + S_2 \rightarrow Fe_3O_4 + FeS_2 + TiO_2$

Ti Mte Mte

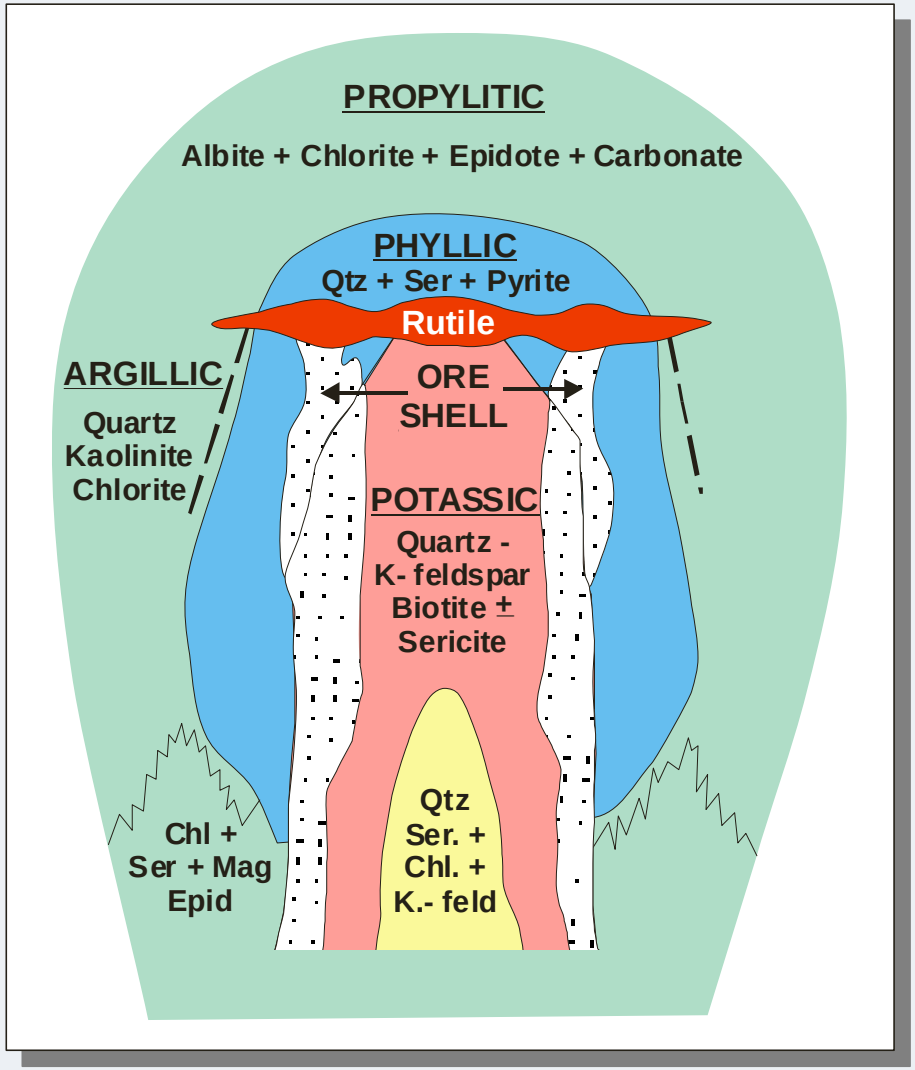
$FeTiO_3 + S_2 \rightarrow FeS_2 + TiO_2$

Ilmenite

$CaTiSiO_5 + CO_2 \rightarrow TiO_2 + CaCO_3 + SiO_2$

Sphene

Rutile Distribution in Porphyry Systems



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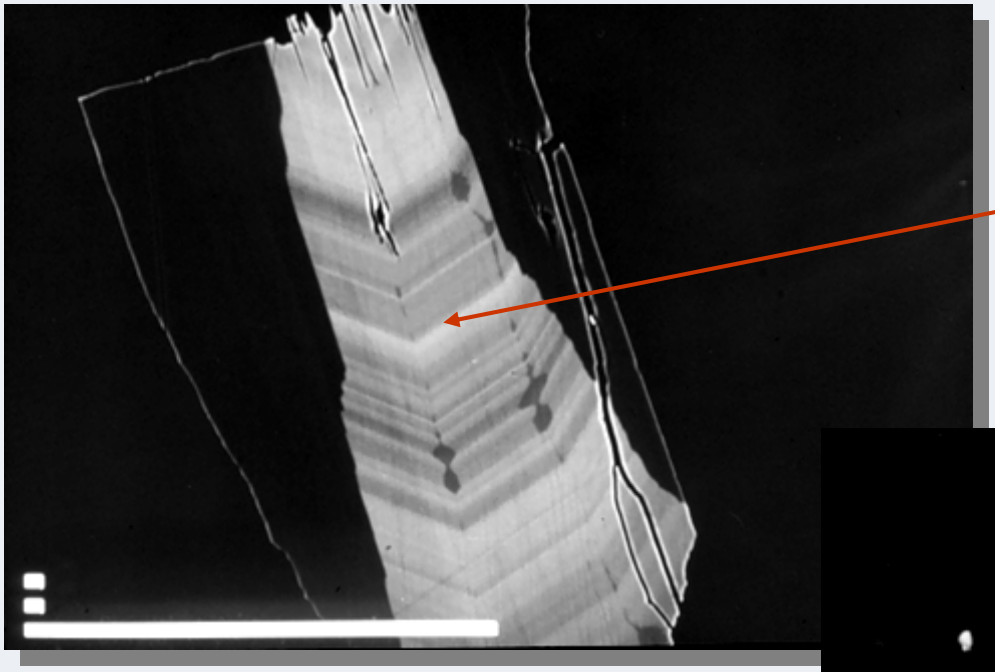
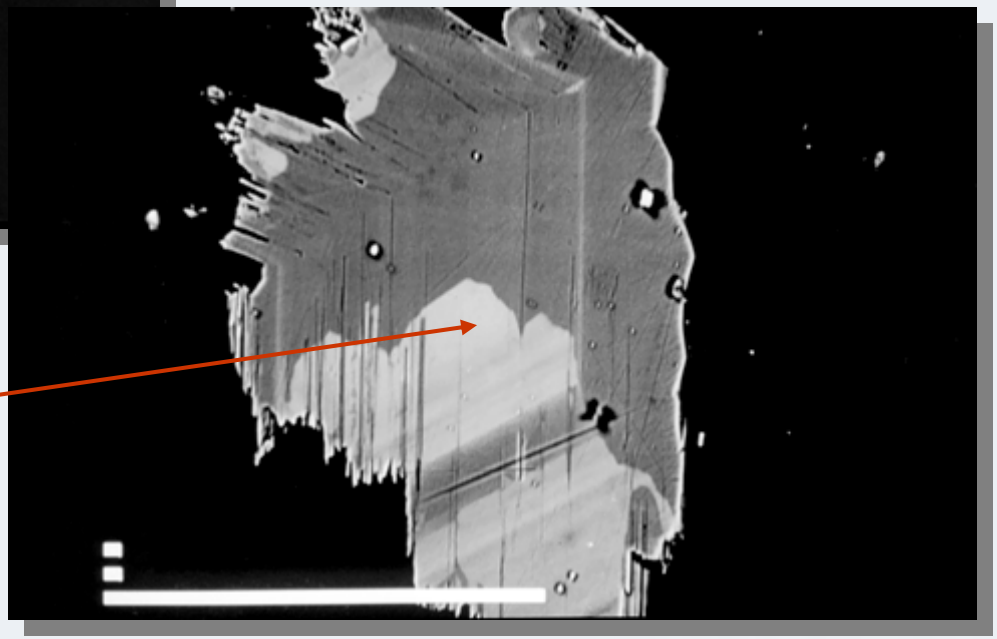
Ionic Radii (Å) of Likely Components of Rutile

W^{6+}	0.62
Sb^{5+}	0.62
Cr^{3+}	0.63
Fe^{3+}	0.64
Ta^{5+}	0.68
Ti^{4+}	0.68
Nb^{5+}	0.69
Sn^{4+}	0.71
V^{3+}	0.74
Fe^{2+}	0.74

Backscattered Electron Images of Rutile



Cr	2.7%
W	8.7%
V	2.5%



Fe	1.7%
W	2.9%
Nb	0.6%

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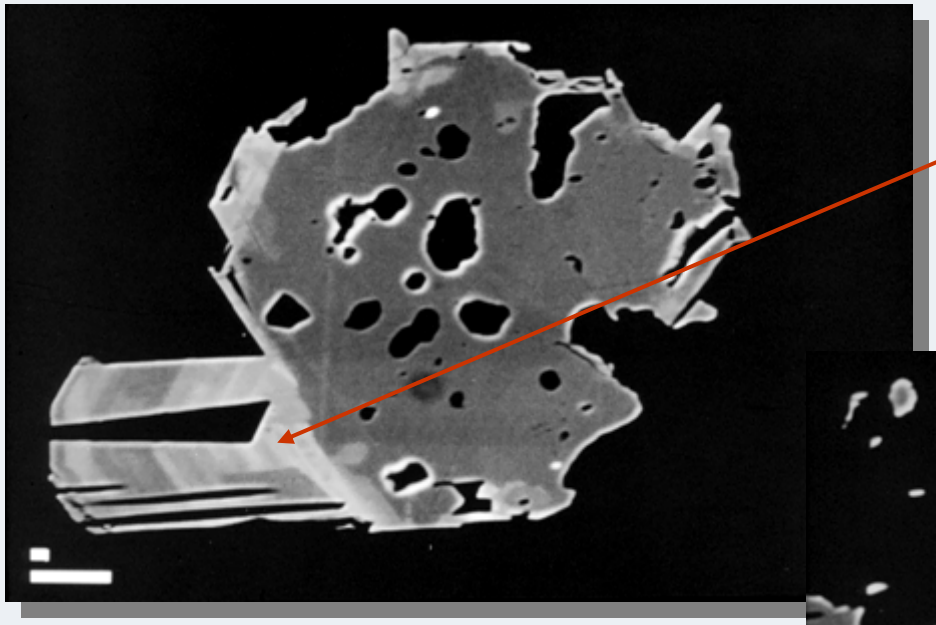
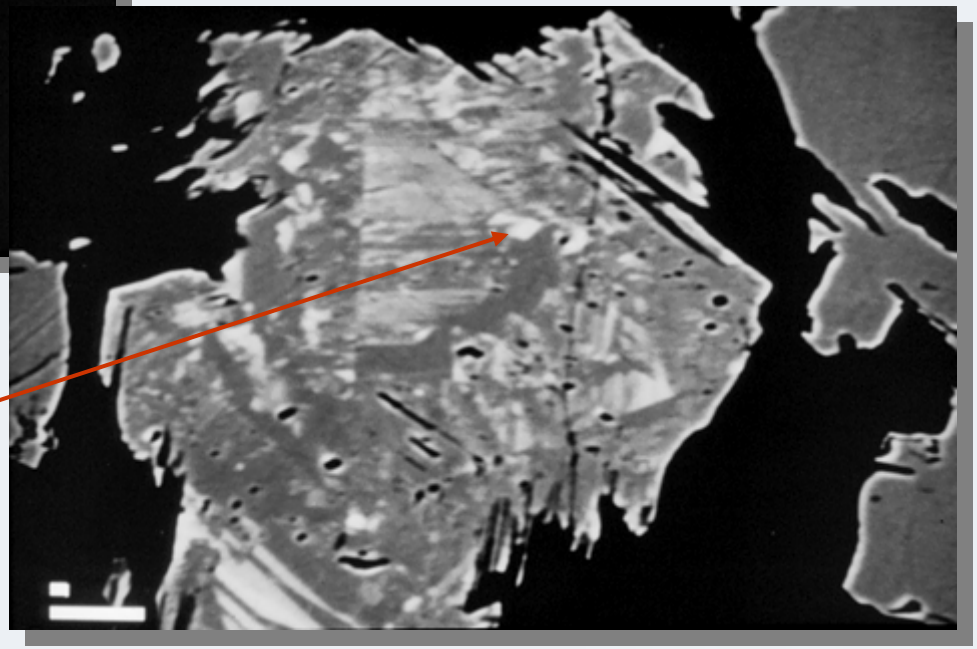
Backscattered Electron Images of Rutile



Cr 3.0%
W 3.7%



Nb 1.1%
W 5.2%
Fe 2.6%

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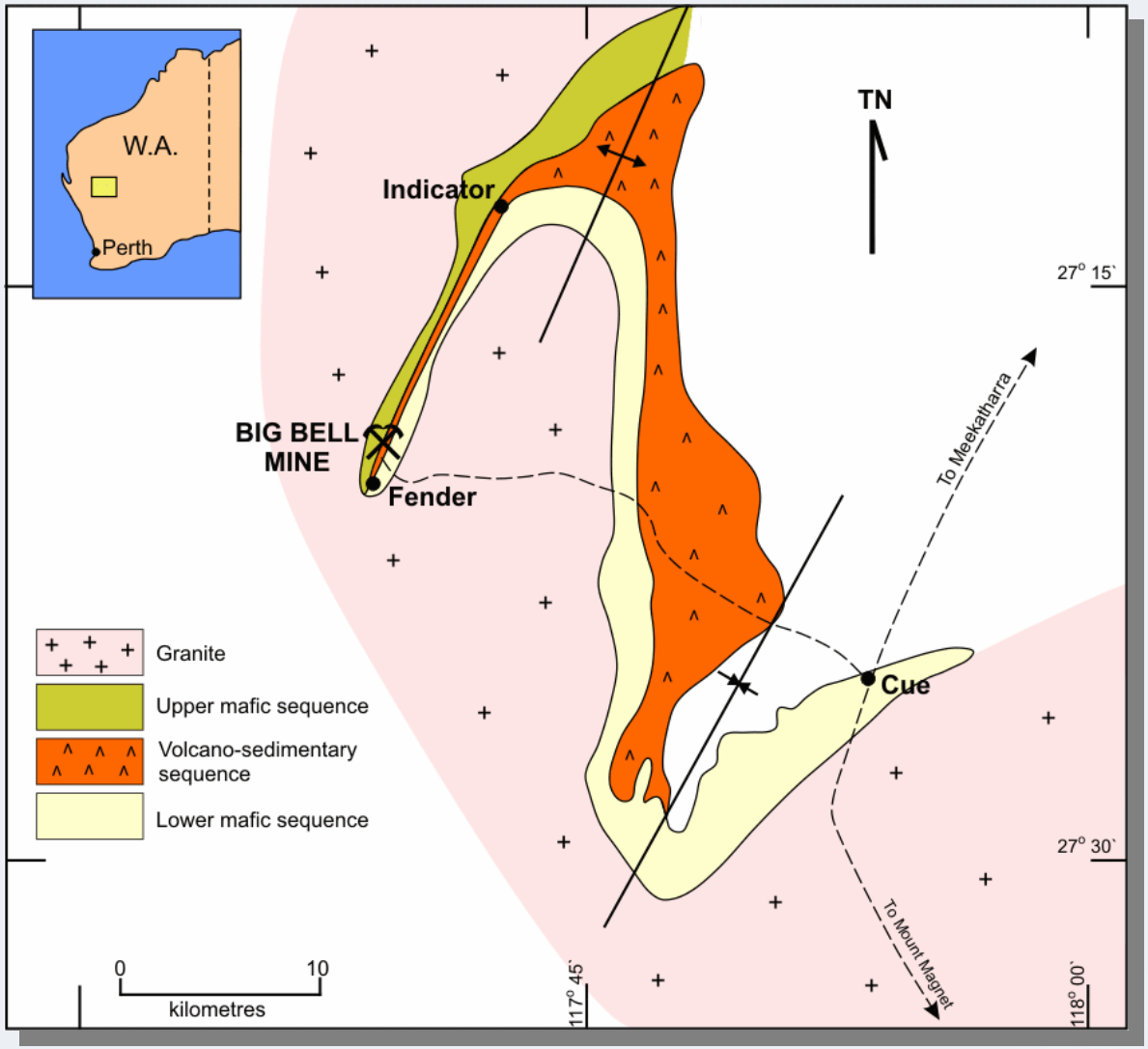
Preparation and Analysis of Rutile Grains

- **Sample (100 – 150g)**
- **Crush and size to - 250 + 45μm (if required)**
- **Separation of heavy mineral fraction (SG>2.9 - Superpanner)**
- **Clean with HF/aqua regia**
- **Mount and polish in epoxy resin block**
- **Analysis of rutile by electron microprobe (major and minor elements)**

Location of Big Bell and the Regional Geological Setting



After Chown *et al.*, 1984

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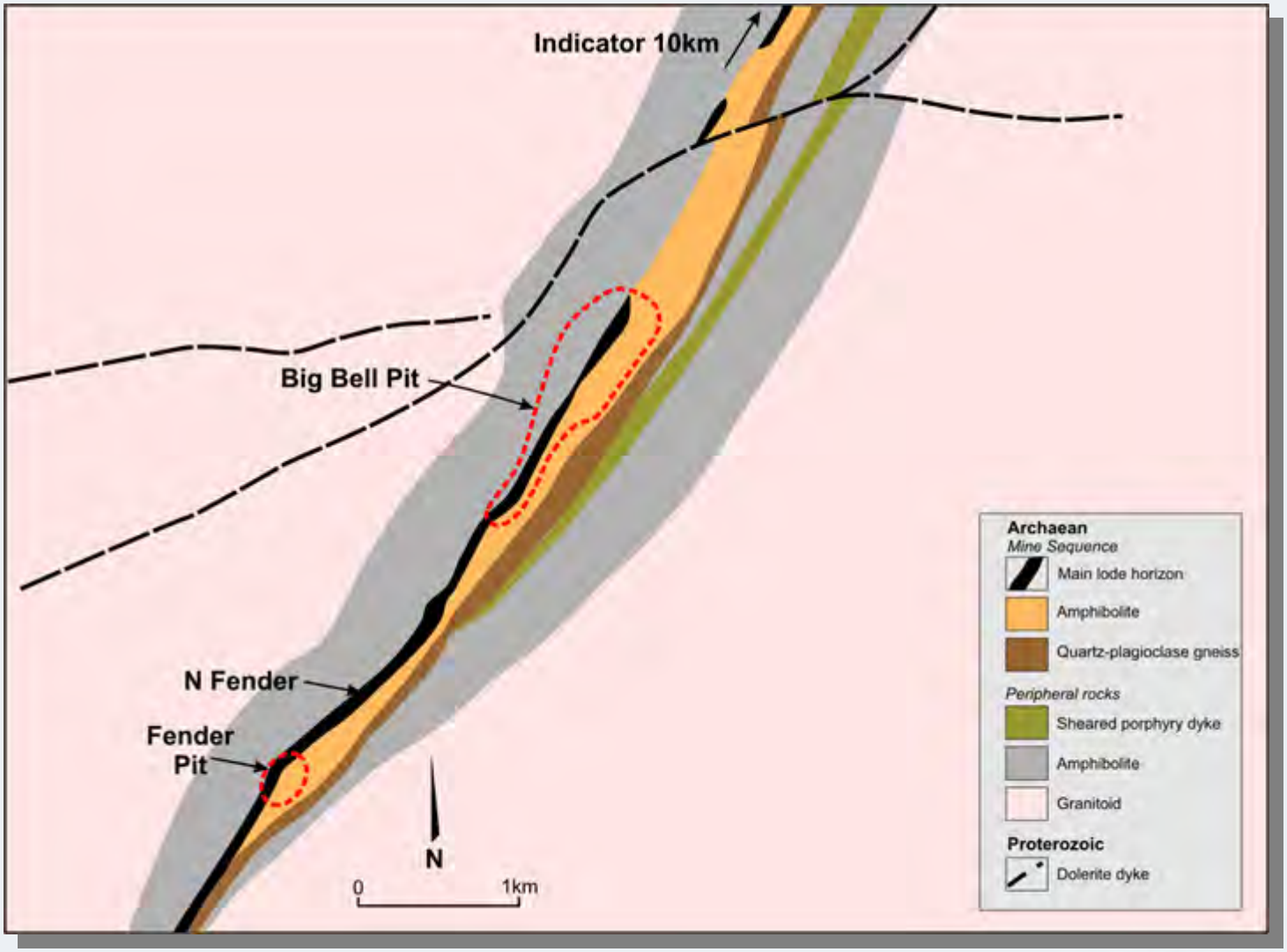
Regional Geological Setting, Big Bell



After Barnes, 1996

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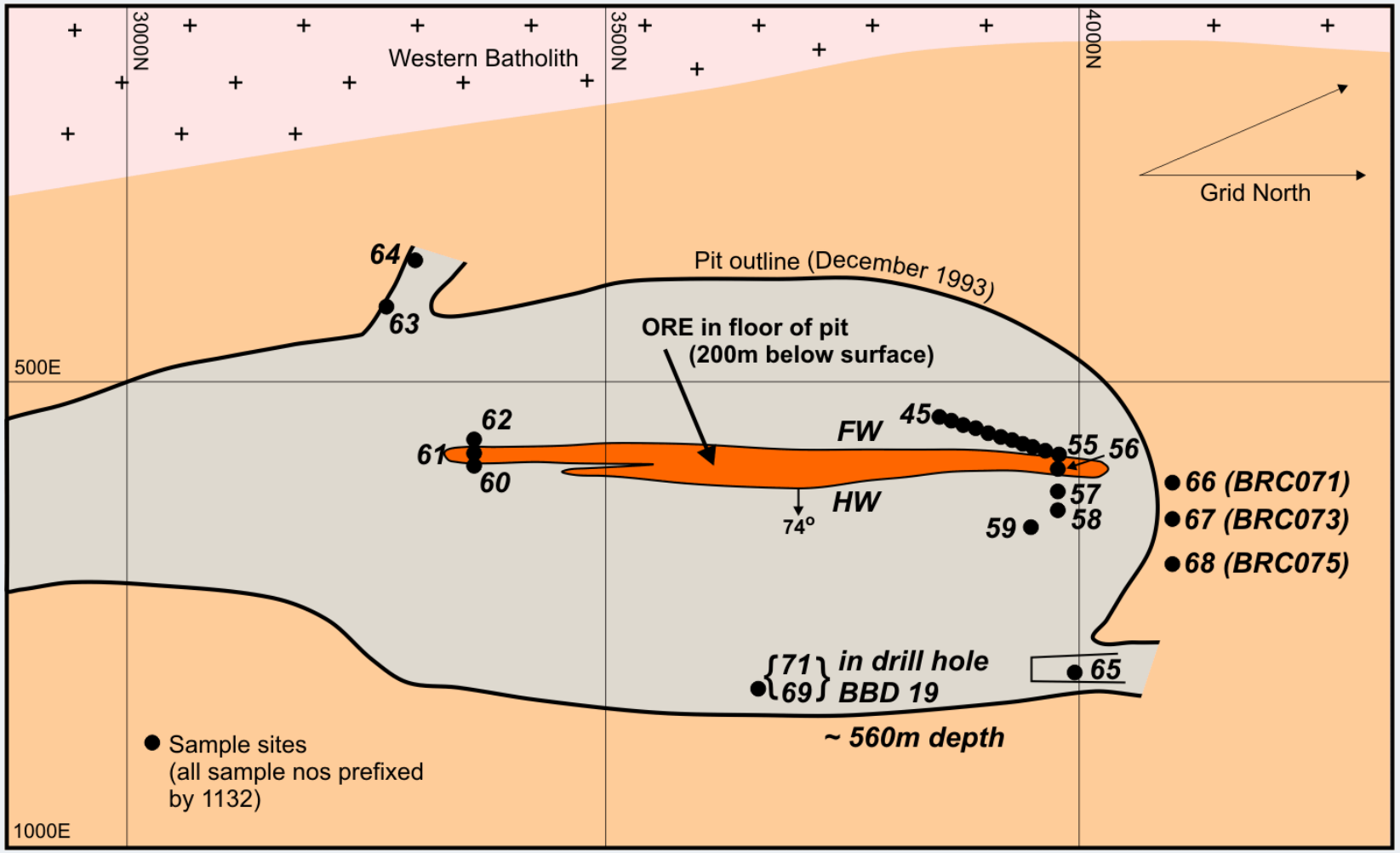
Big Bell Samples



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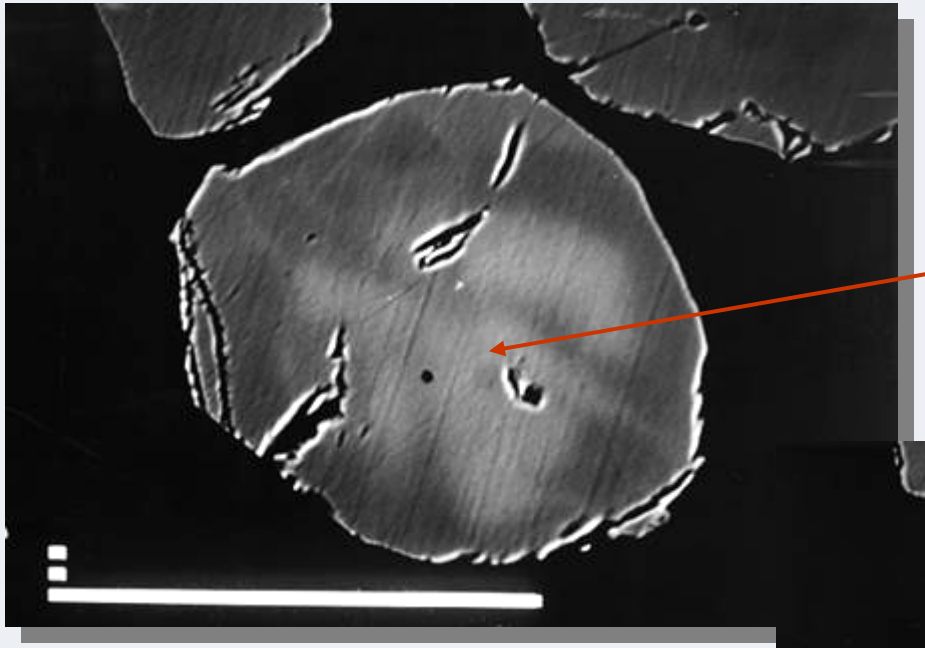
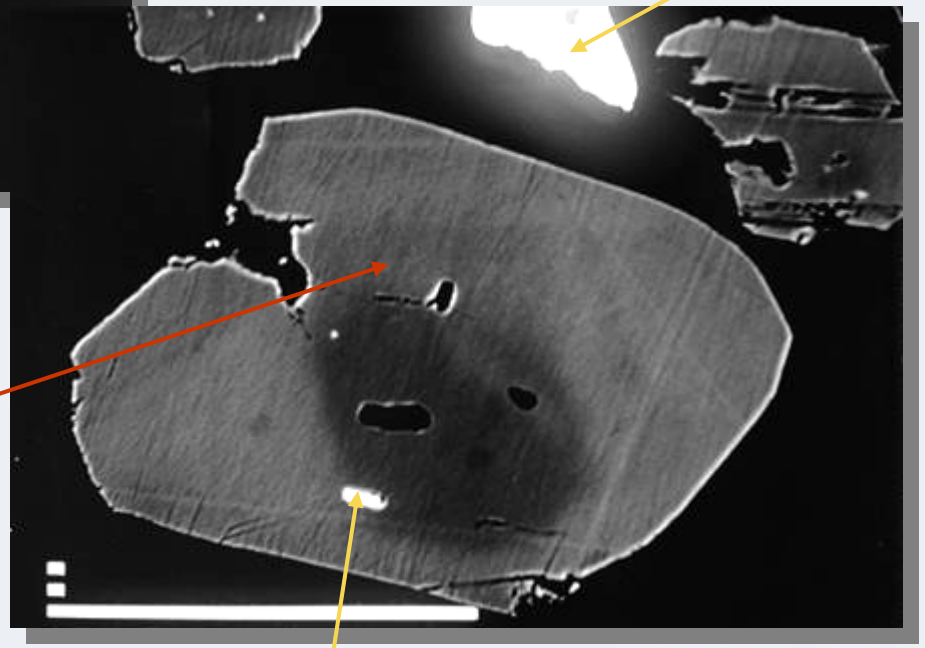
Rutiles – Ore Zone – Big Bell (Sth)



V	1.0%
W	2.6%
Sb	1.3%



V	0.5%
W	1.7%
Sb	0.8%

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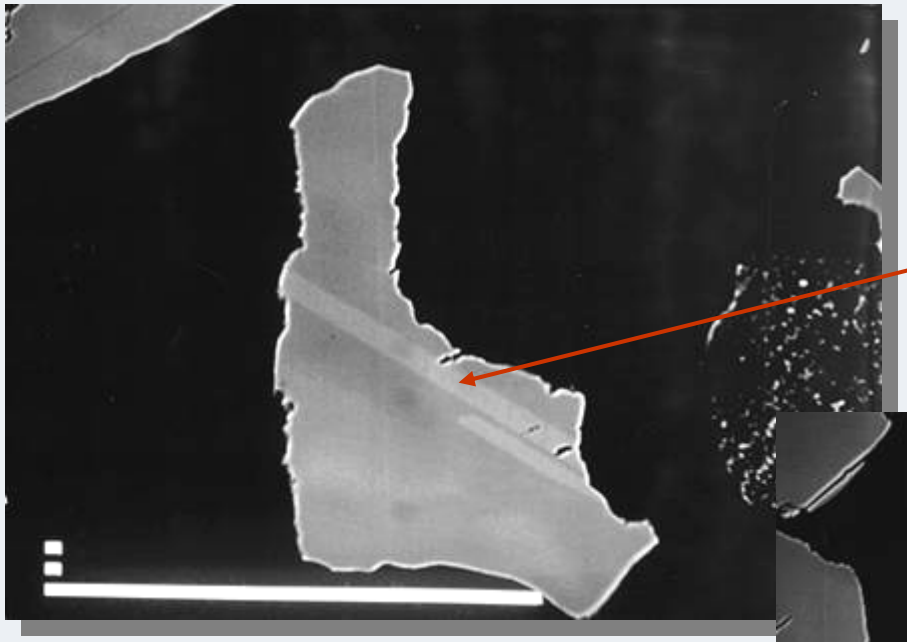
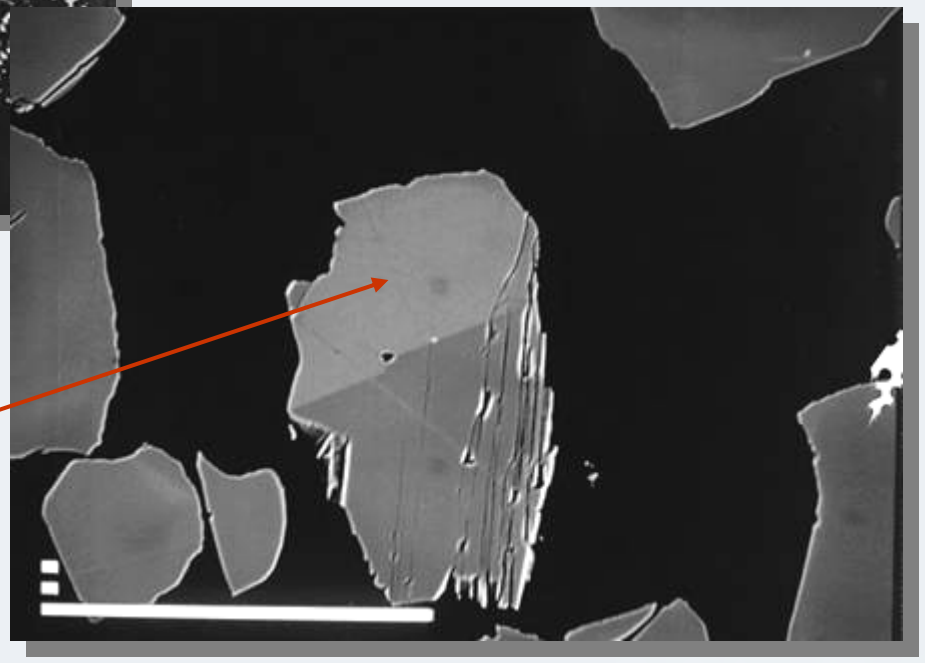
Rutiles – Ore Zone – Big Bell (Nth)



V	**0.3%**
W	**0.9%**
Sb	**0.9%**



V	**0.4%**
W	**1.3%**
Sb	**0.9%**

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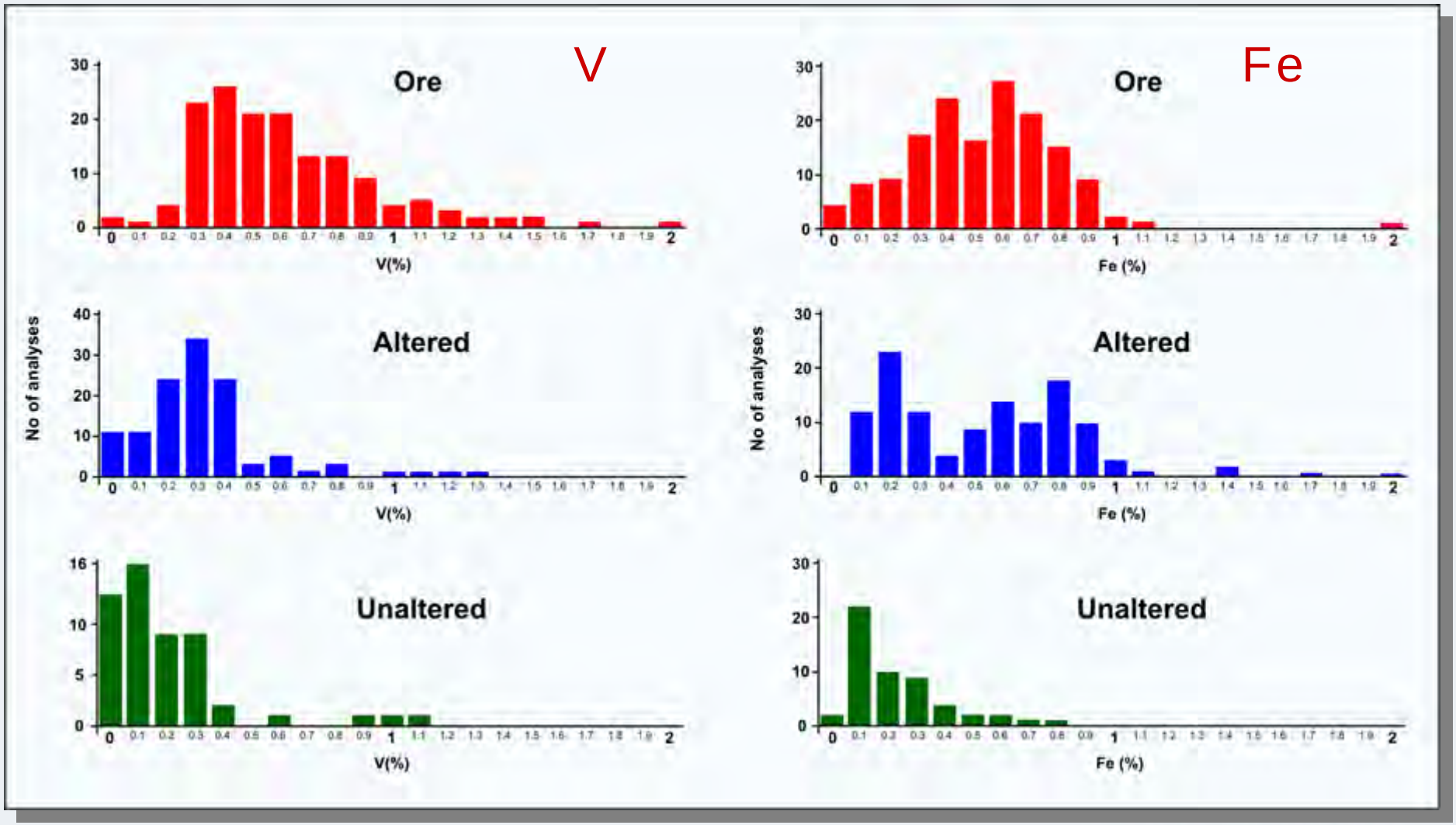
Rutile Compositions - Big Bell



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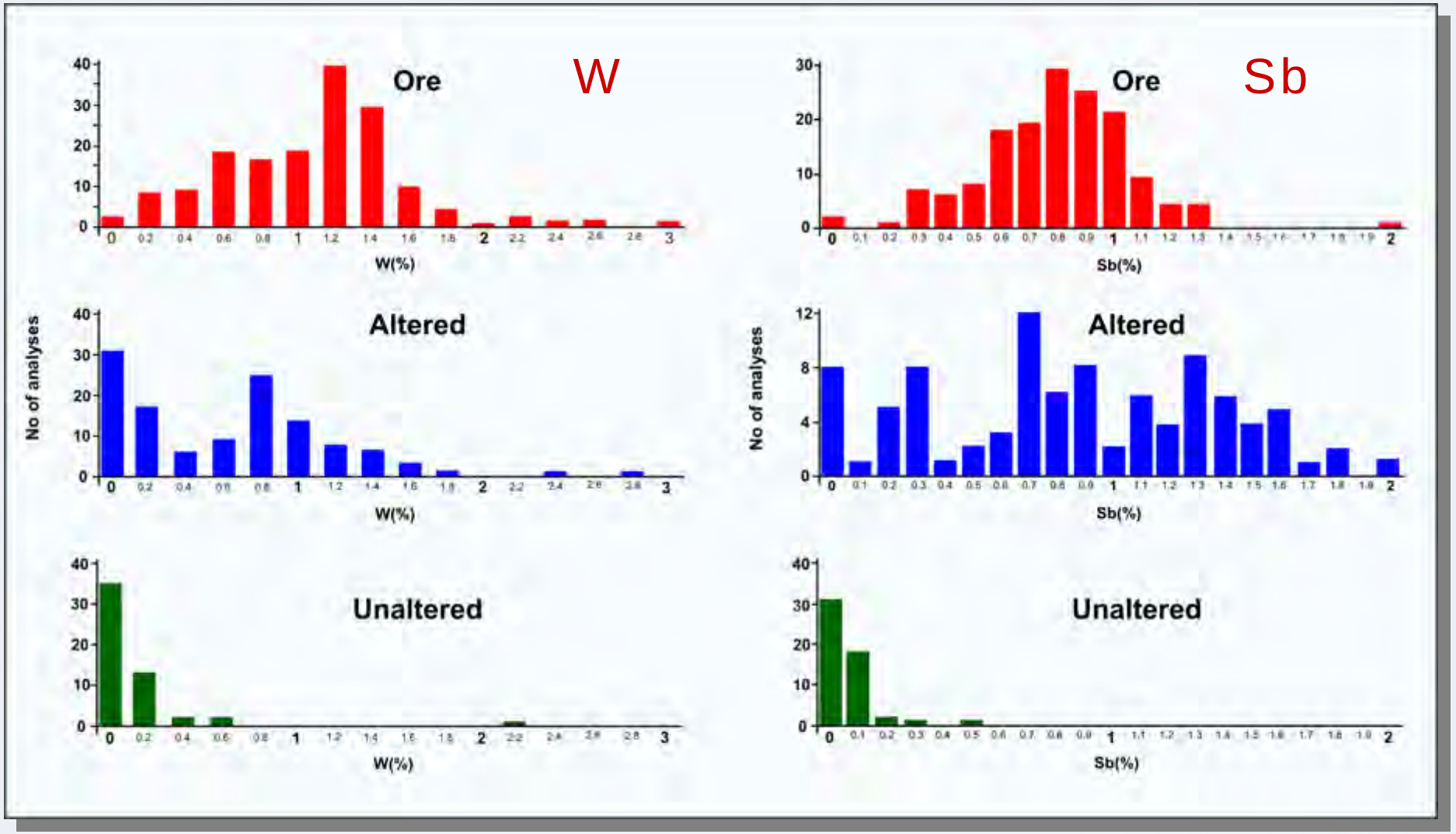

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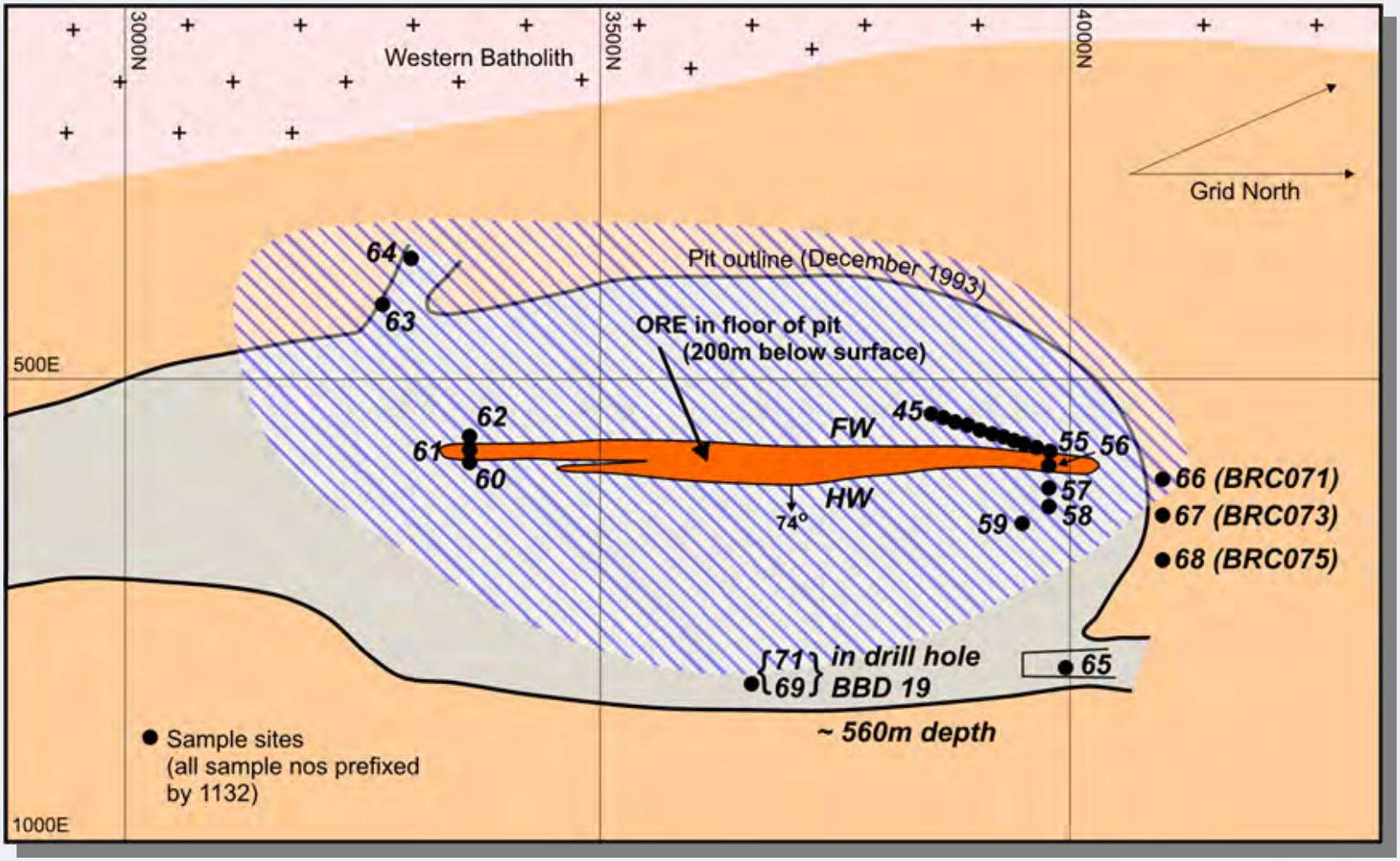
V-Sb-W Rich Rutiles – Big Bell



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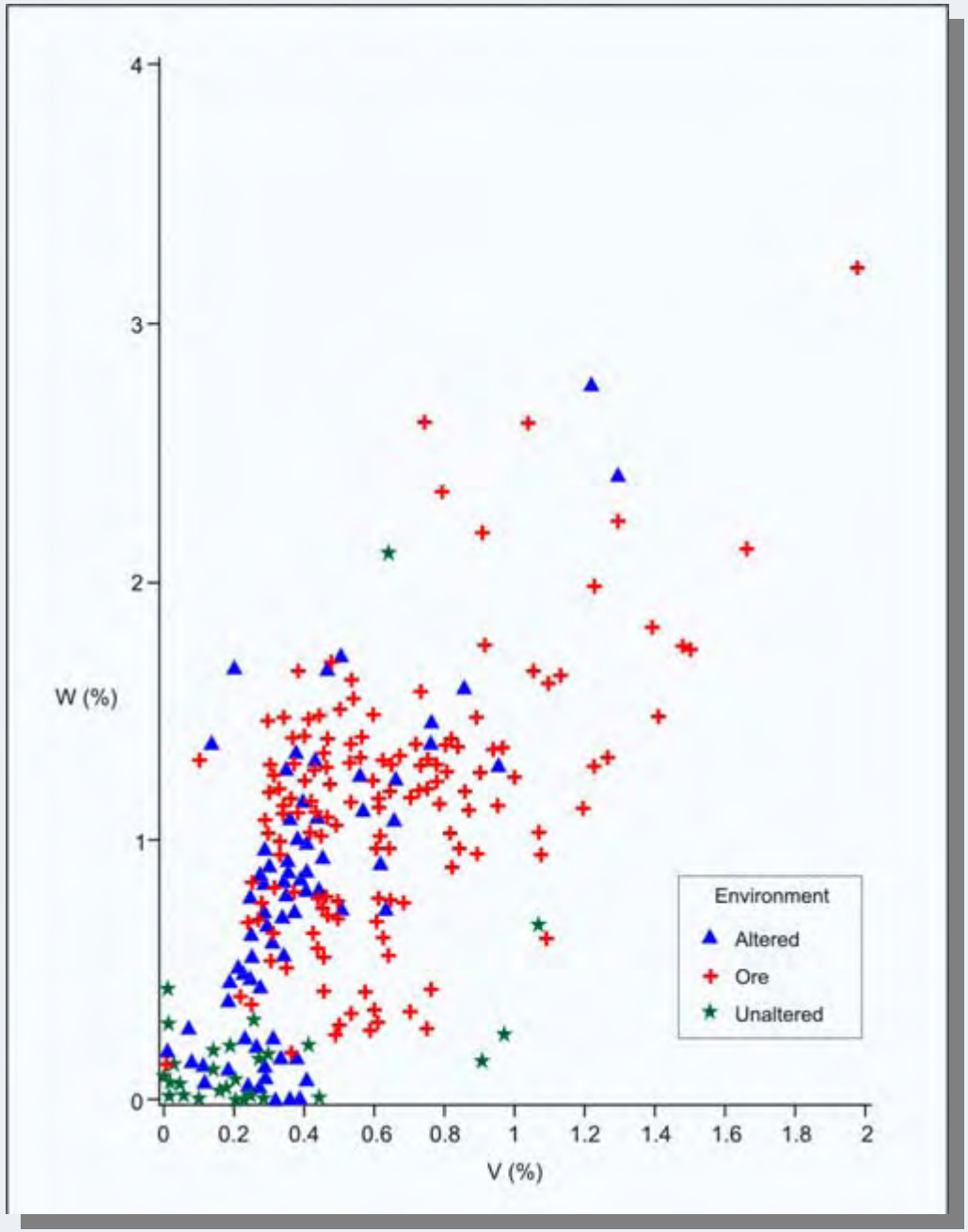

W and V in Rutiles, Big Bell

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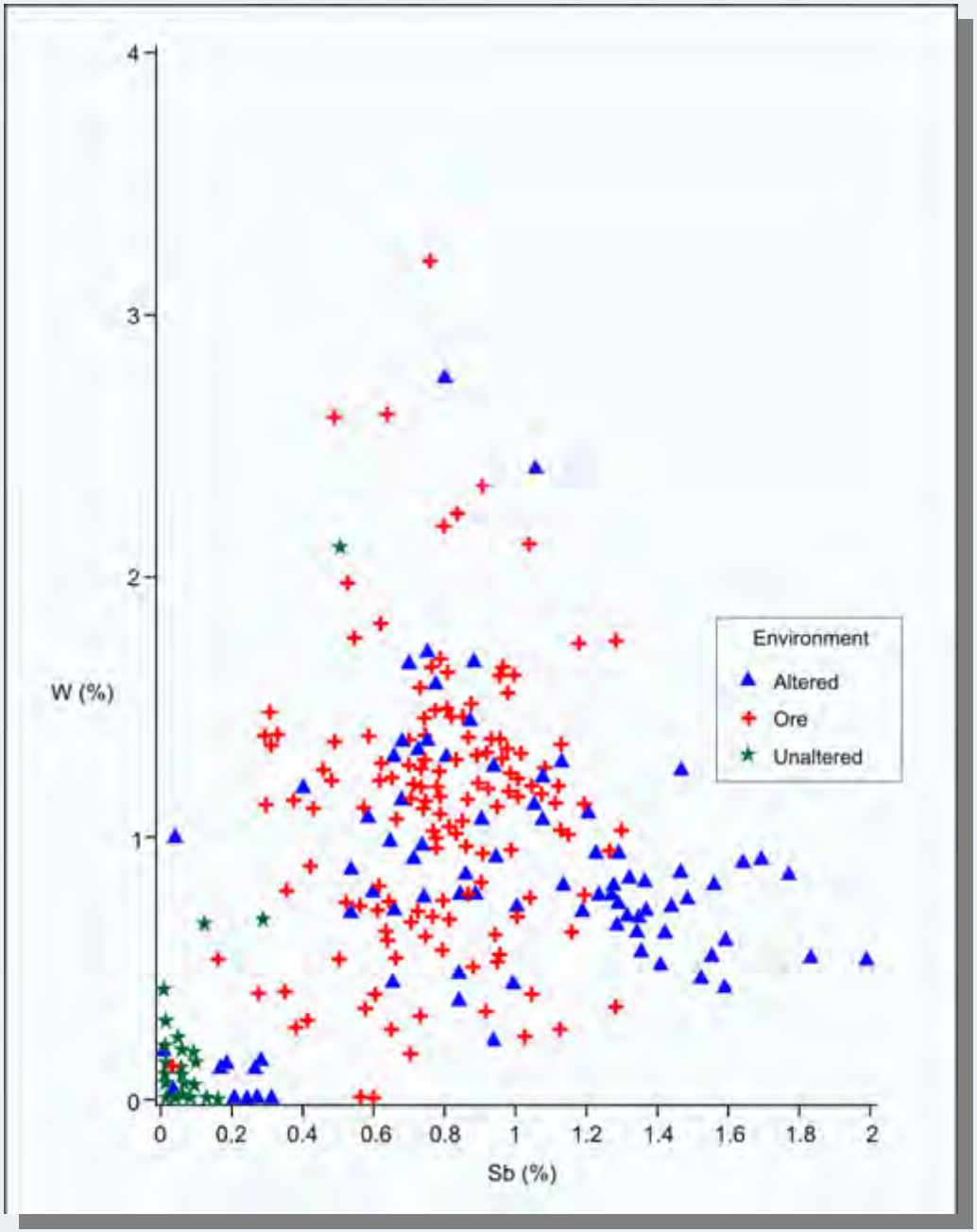

W and Sb in Rutiles, Big Bell

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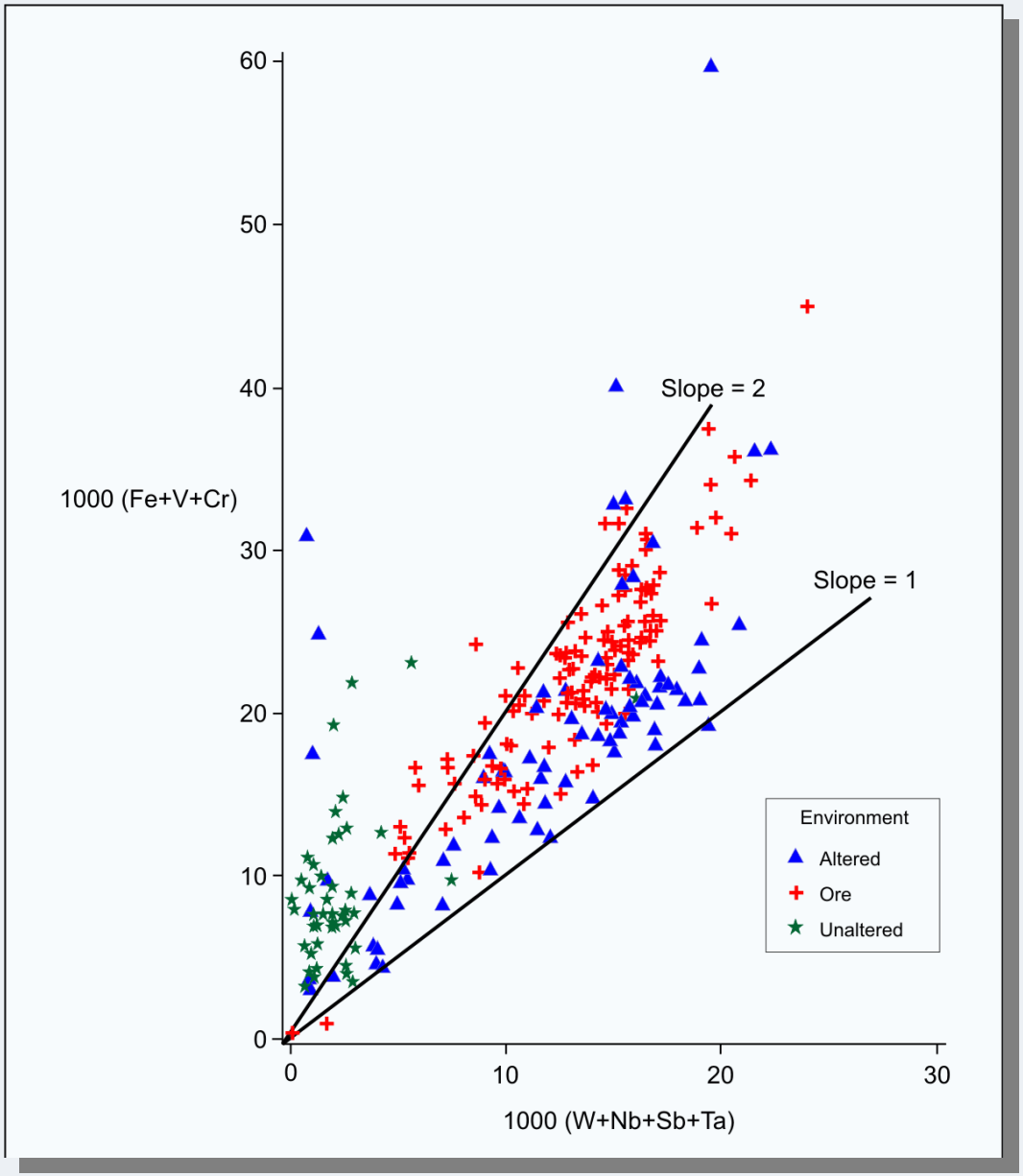

Trivalent vs Hexavalent and Pentavalent Ions in Rutiles, Big Bell

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Coupled Substitutions in Rutile at Big Bell

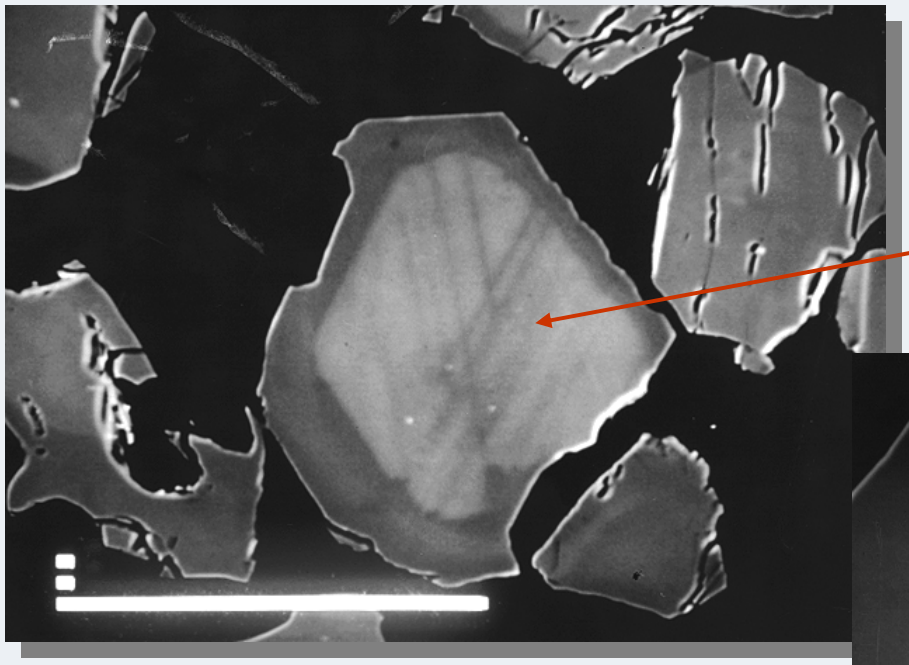
$$M^{3+} + (Nb, Sb, Ta)^{5+} = 2Ti^{4+}$$

$$2M^{3+} + W^{6+} = 3Ti^{4+}$$

Rutile at Big Bell

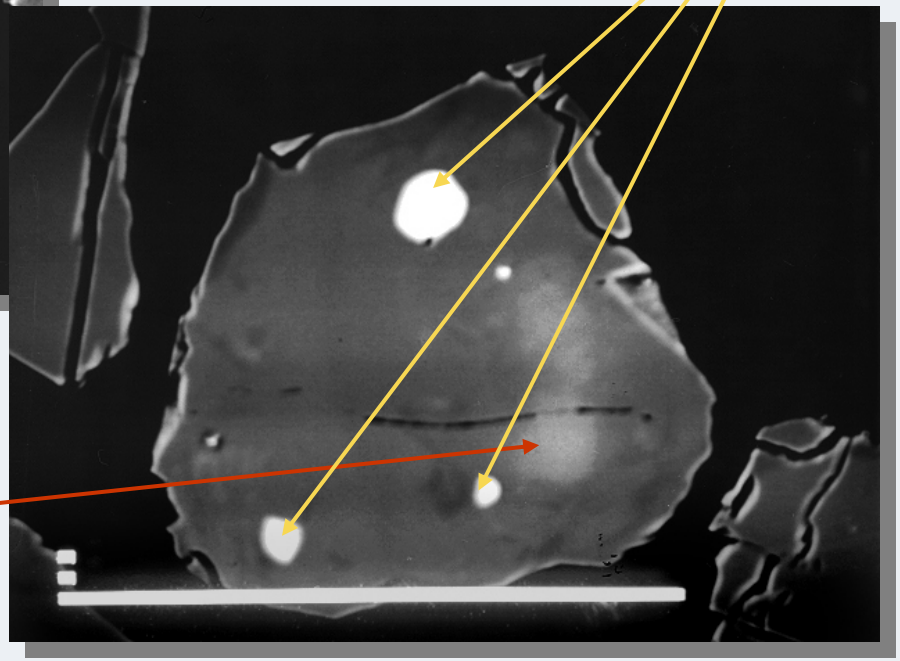
- **W+V+Sb+Fe in rutile associated with ore**
- **Coupled substitution – W and Sb balanced by trivalent ions**
- **Similar rutile geochemistry to Hemlo Au deposit**
- **W+V+Sb+Fe association in rutile extends for up to 200m footwall**

Rutiles – Indicator



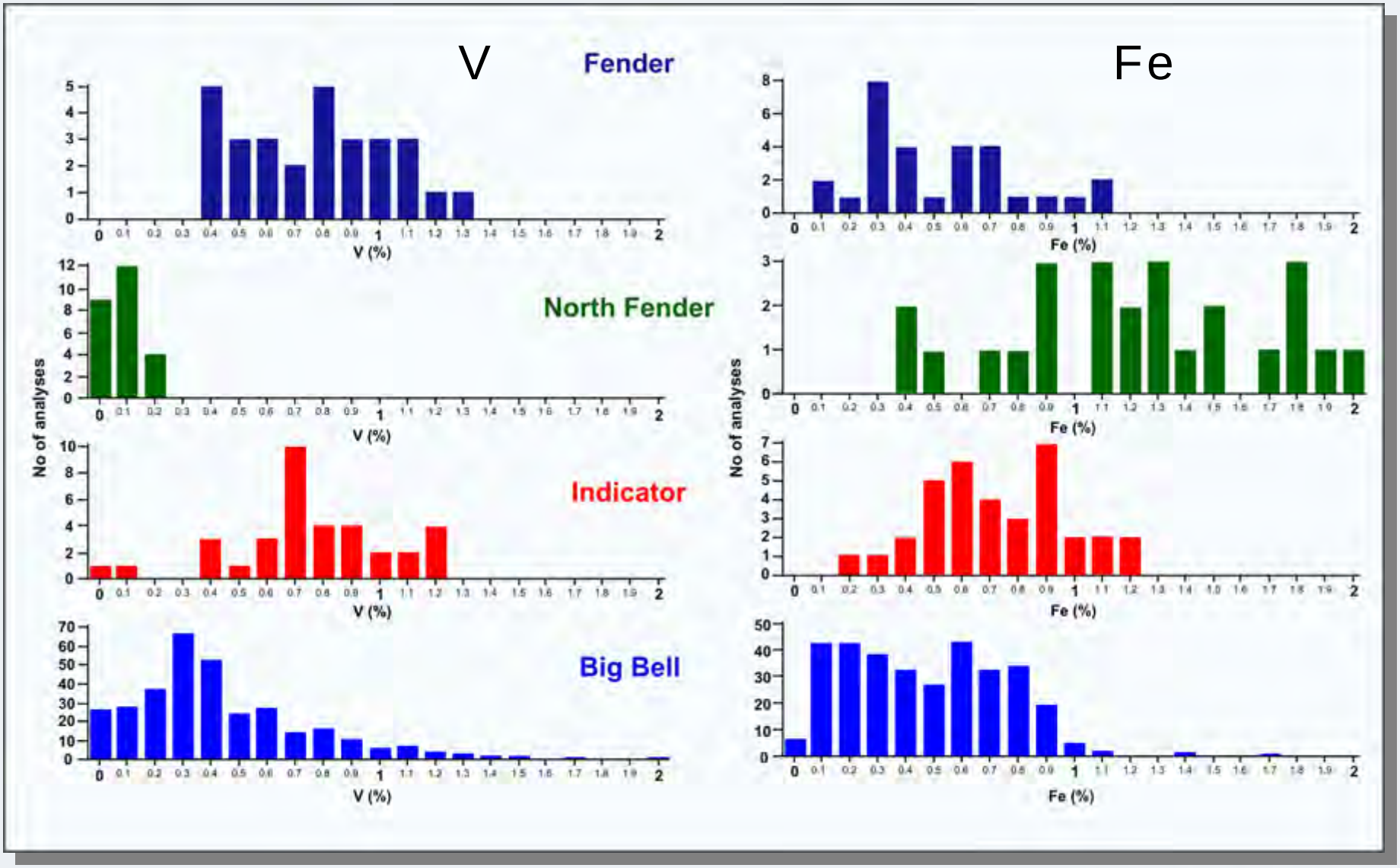
V	0.7%
Sb	1.0%
W	1.7%

Pyrite inclusions



V	1.2%
Sb	1.8%
W	0.7%

Rutile Compositions – Regional Deposits



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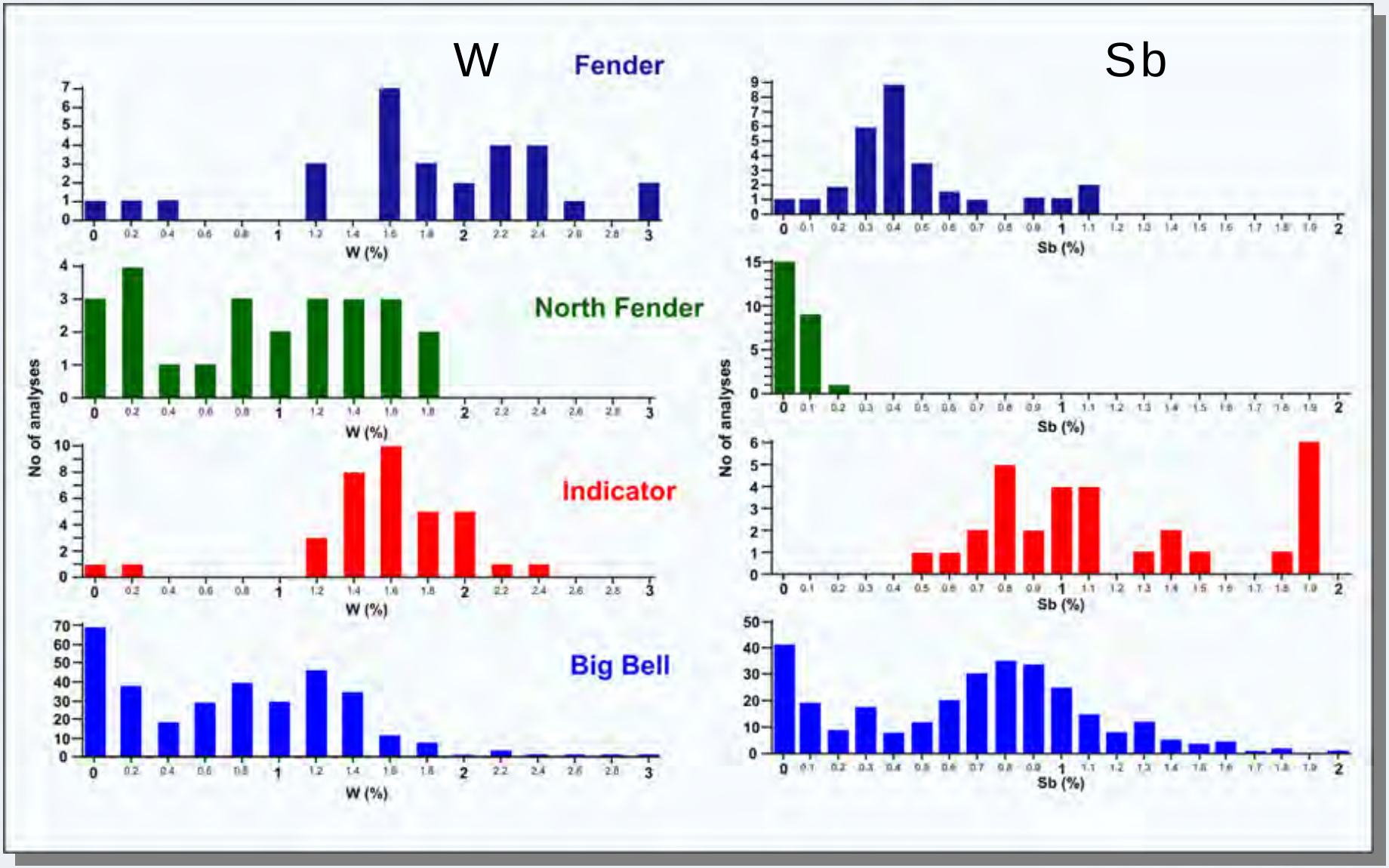

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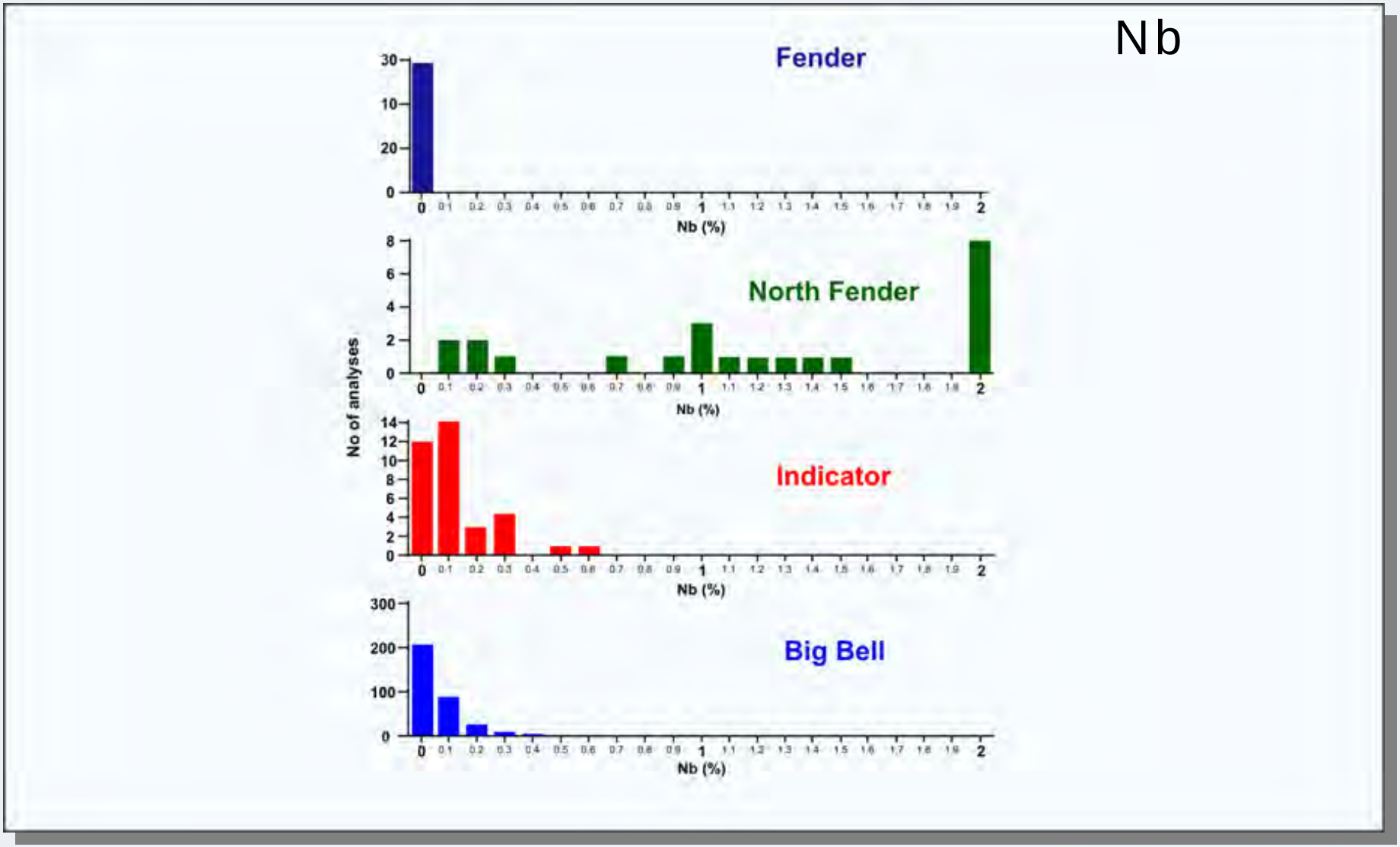

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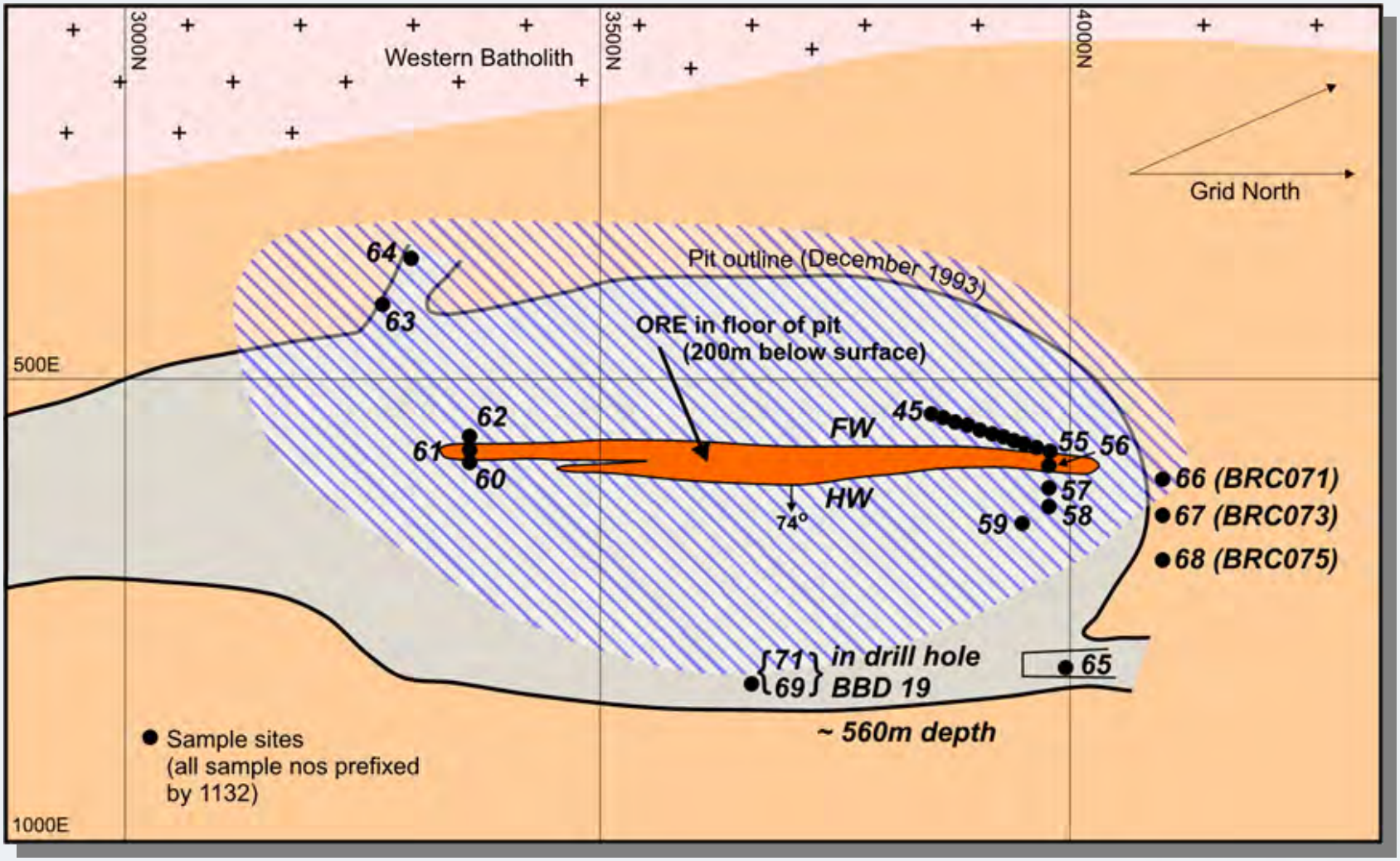
Features of Mineralization
Big Bell area

Deposit	V	W	Sb	Fe	Nb
Big Bell	√	√	√	√	x
Fender	√	√	√	√	x
Nth Fender	x	√	x	√	√
Indicator	√	√	√	√	x

Conclusions

- **Rutiles at Big Bell are enriched in V, W, Sb, Fe (*cf.* Hemlo Au deposit)**
- **These features commonly present in footwall (up to 200m) and perhaps 30m in hanging wall**
- **Rutile associated with mineralization at Indicator and Fender also has enriched V, W, Sb and Fe**
- **Rutile at Nth Fender has elevated W, Fe and Nb, *i.e.* affected by different fluids than at Big Bell**
- **Features seen in highly weathered samples**
  ⇒ Big Bell type alteration can be identified in regolith samples
- **Rutile geochemistry allows targets to be ranked**

V-Sb-W Rich Rutiles – Big Bell



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