Unravelling the origins of gold: two geological methods face to face

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valcambi suisse geoforensic

Geochemical Traceability

Socio-econo-cultural contexts

Due diligence

Blockchain

Combating the illegal market

Accountability

Risk Management

Reputation

Chemical Analysis

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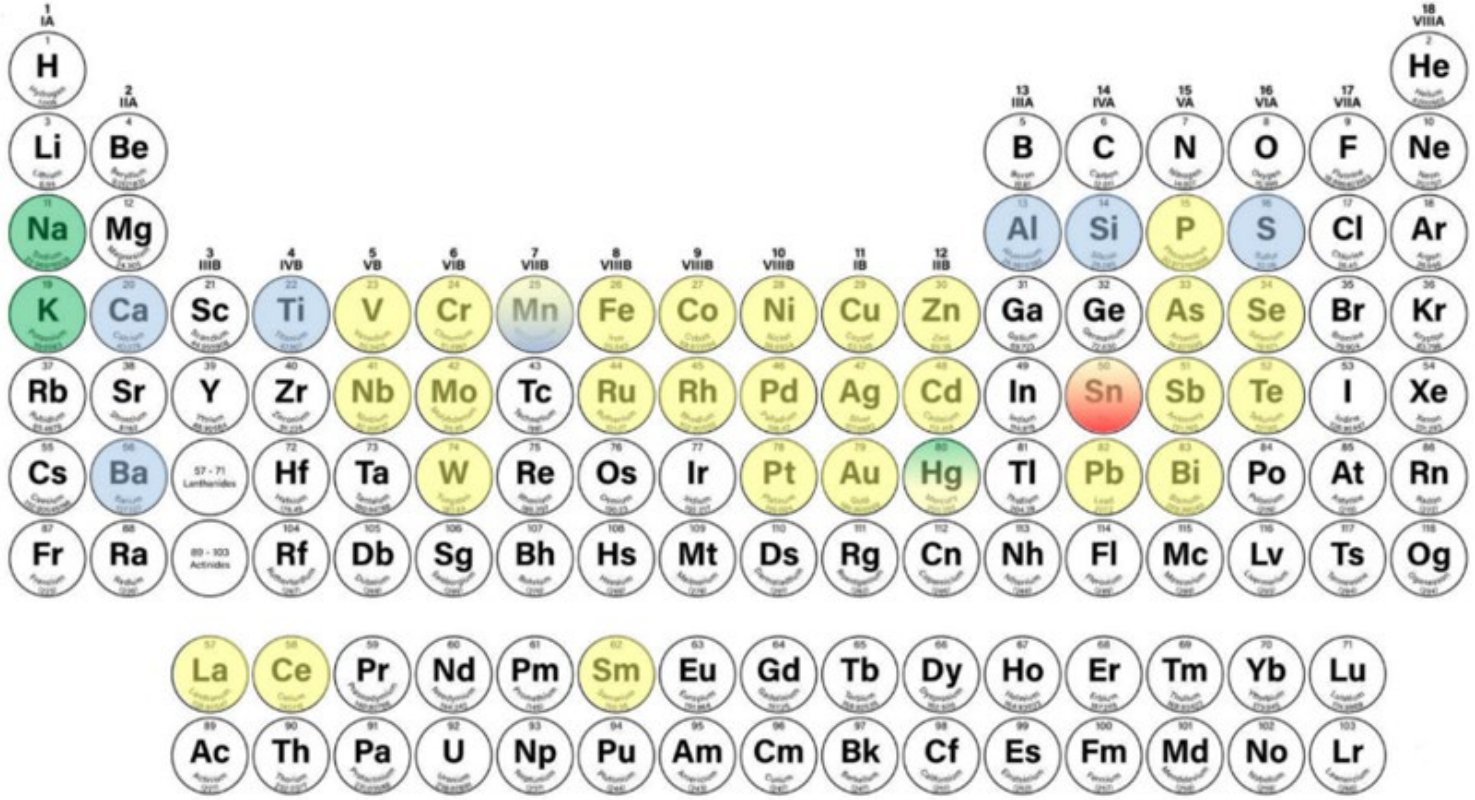

- Associated with gold
- Associated with slags
- Enrichment process
- Orebody type

→ Analysis of 20 to 50 elements

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Methodology

STEP I: REFINERY RECEIVES DORE BARS

spectrocube

Determination of the chemical composition of the doré bars

Methodology

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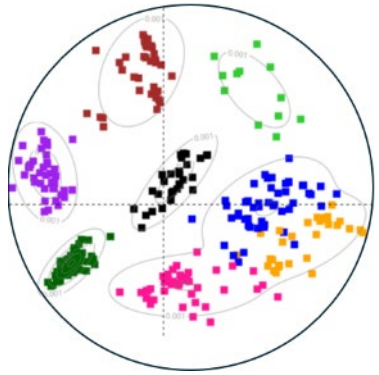
Determination of the chemical composition of the doré bars

STEP II: MODEL

Dorés:
10 - 200 samples from each supplier



AI based model

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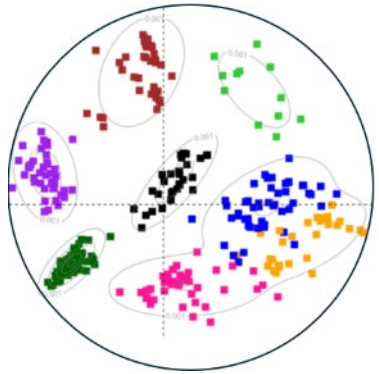
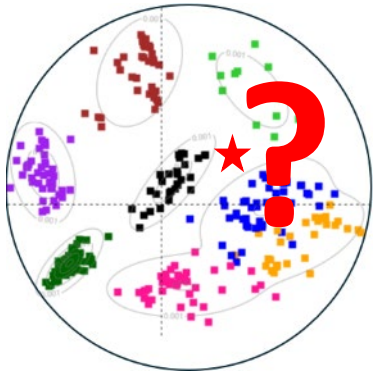


AI based model

STEP III: TESTING

Test sample: New doré



Conformity of test sample

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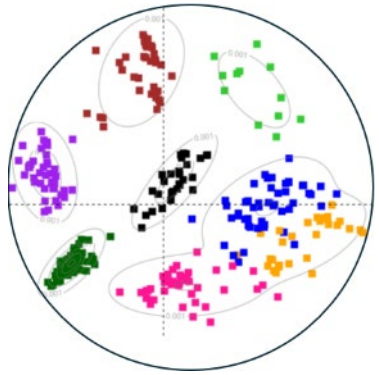

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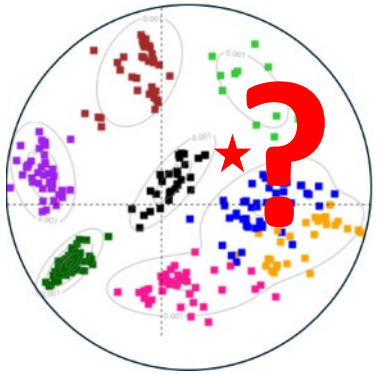

Conformity of test sample

STEP IV: CERTIFICATE

Geoforensic GOLD-ID® certificate

- Fully automated
- Accessible via a secured internet platform
- Can be integrated into a blockchain

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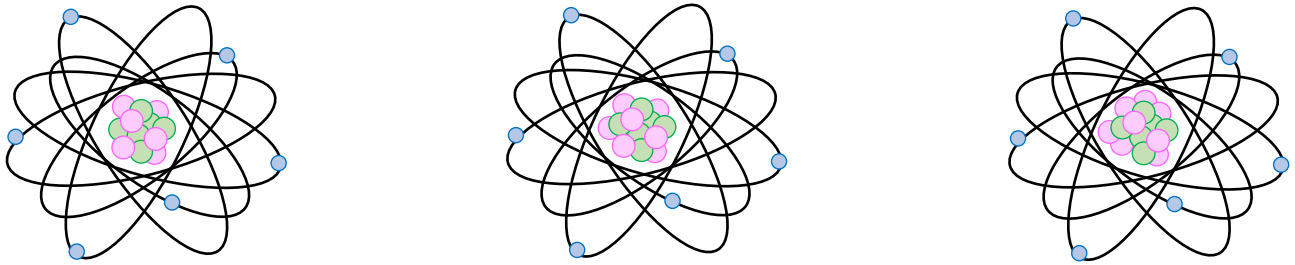
Isotope approach



1%	24%	26%	52%
^{204}Pb	^{206}Pb	^{207}Pb	^{208}Pb
STABLE	RADIOGENIC	RADIOGENIC	RADIOGENIC

Isotope approach

Determination of an analytical fingerprint of the metal based on isotopic ratio analysis

Prerequisites:

- The analytical signature does not change during metallurgical processes:

  fingerprint mine = fingerprint doré

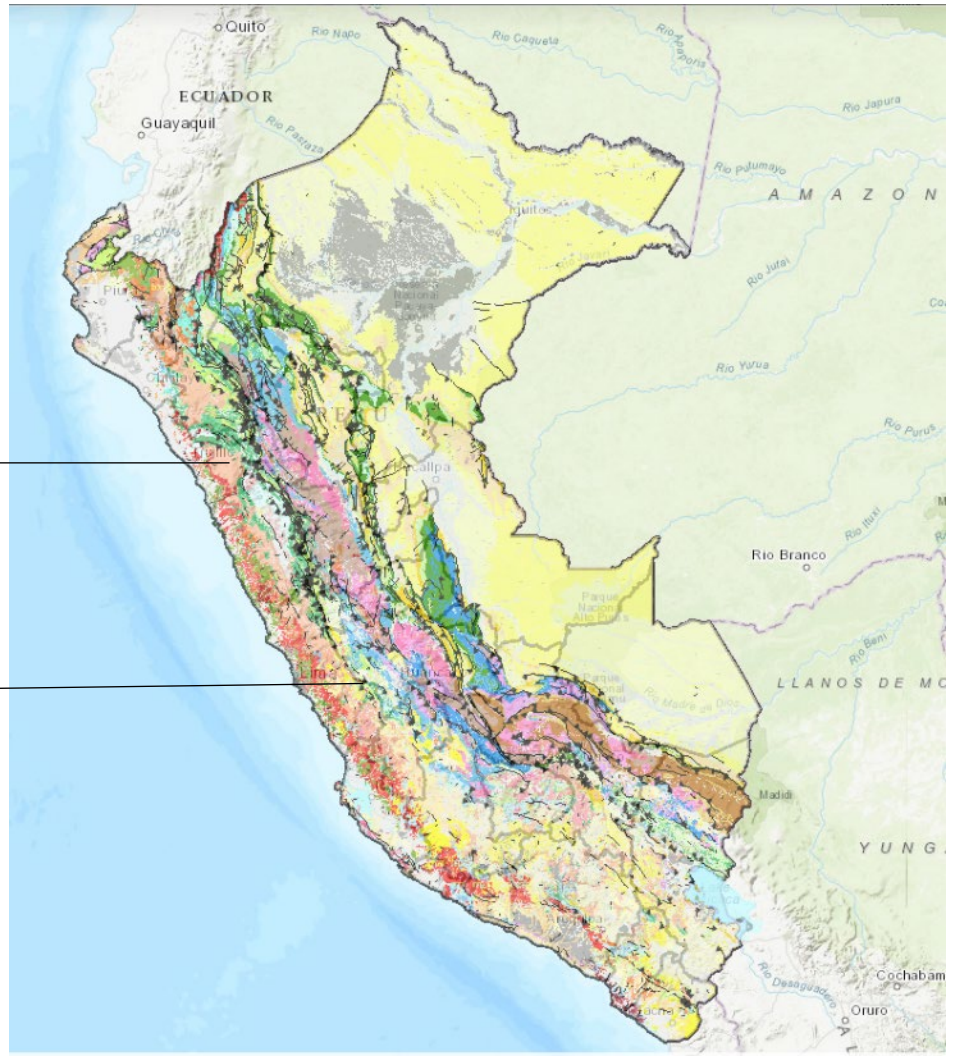
Visual evaluation based on
$^{208}Pb/^{206}Pb$
$^{207}Pb/^{206}Pb$

- More accurate measurement for Pb isotopes 206, 207 and 208 than for Pb isotope 204
- No interferences (isotope ^{204}Hg)

Features of mines A and B

B

A



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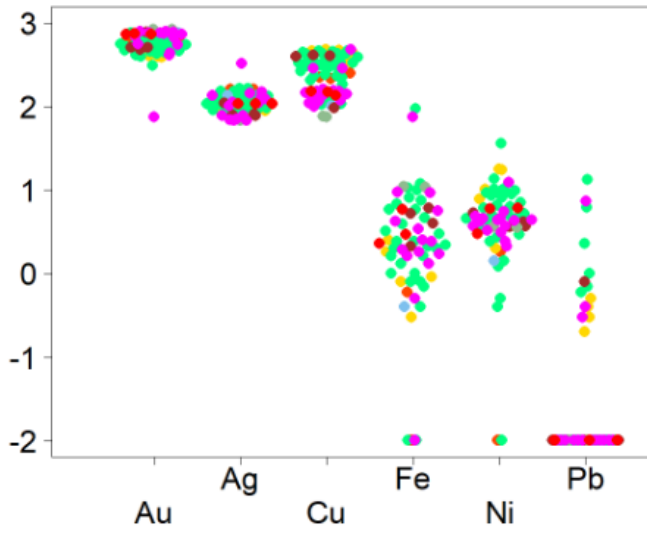
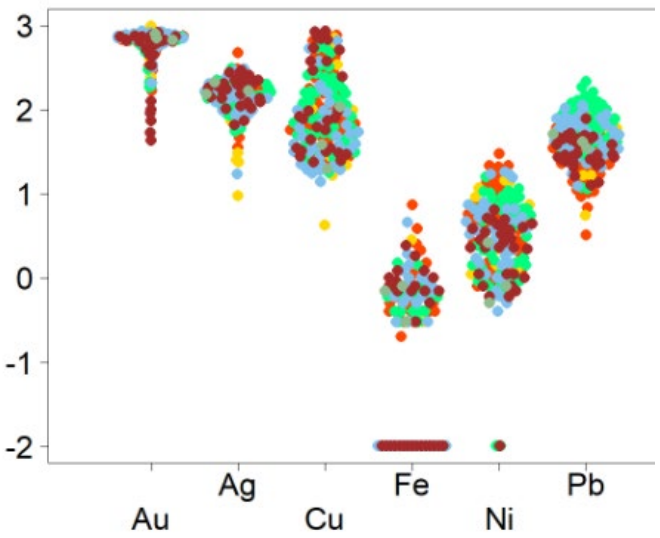
Features of mines A and B

Chemical composition of dorés: bee swarms and graphical reports

A





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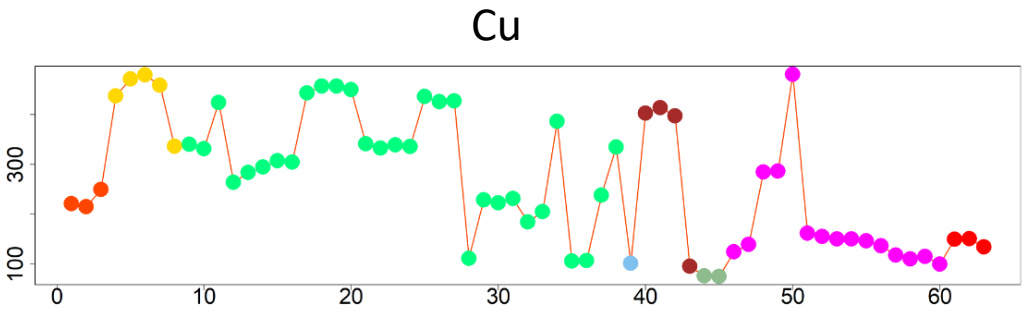

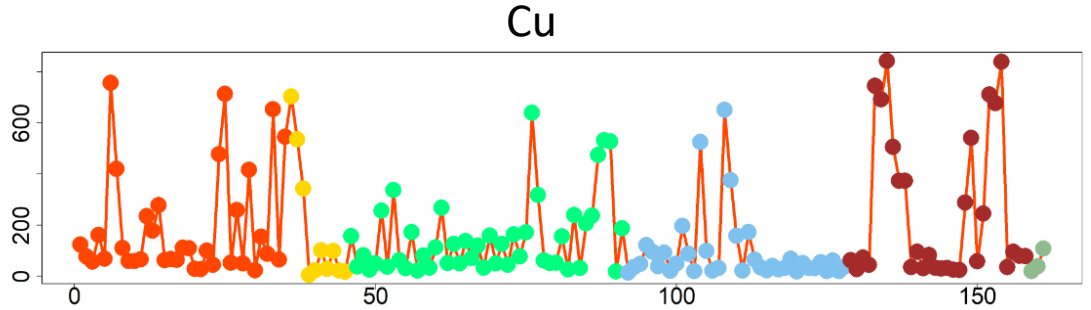

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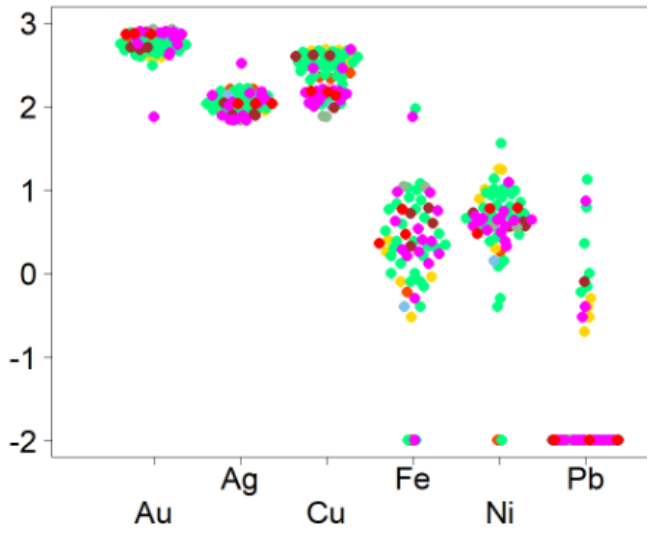

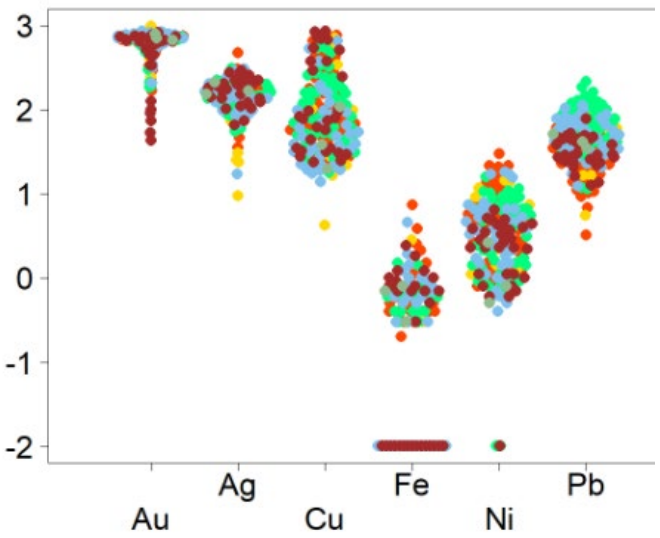

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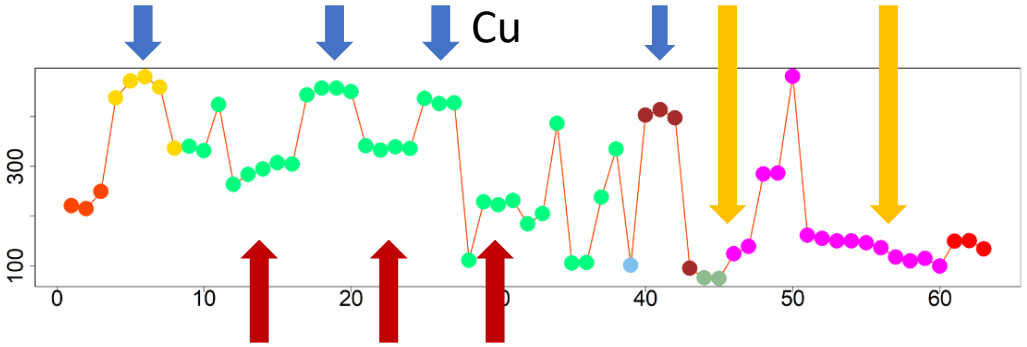

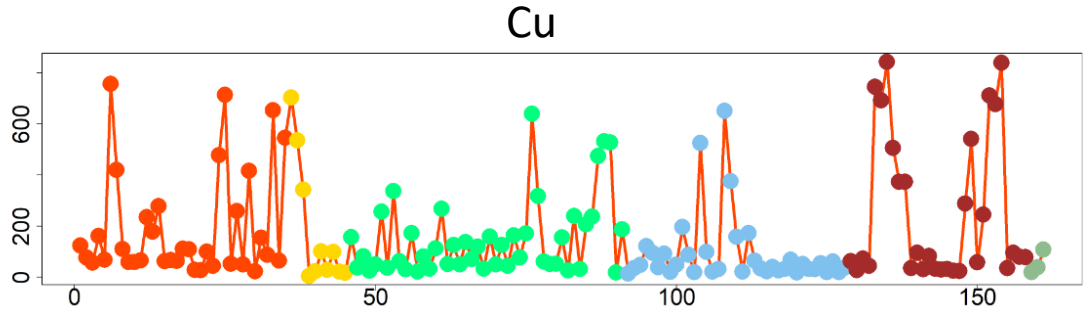

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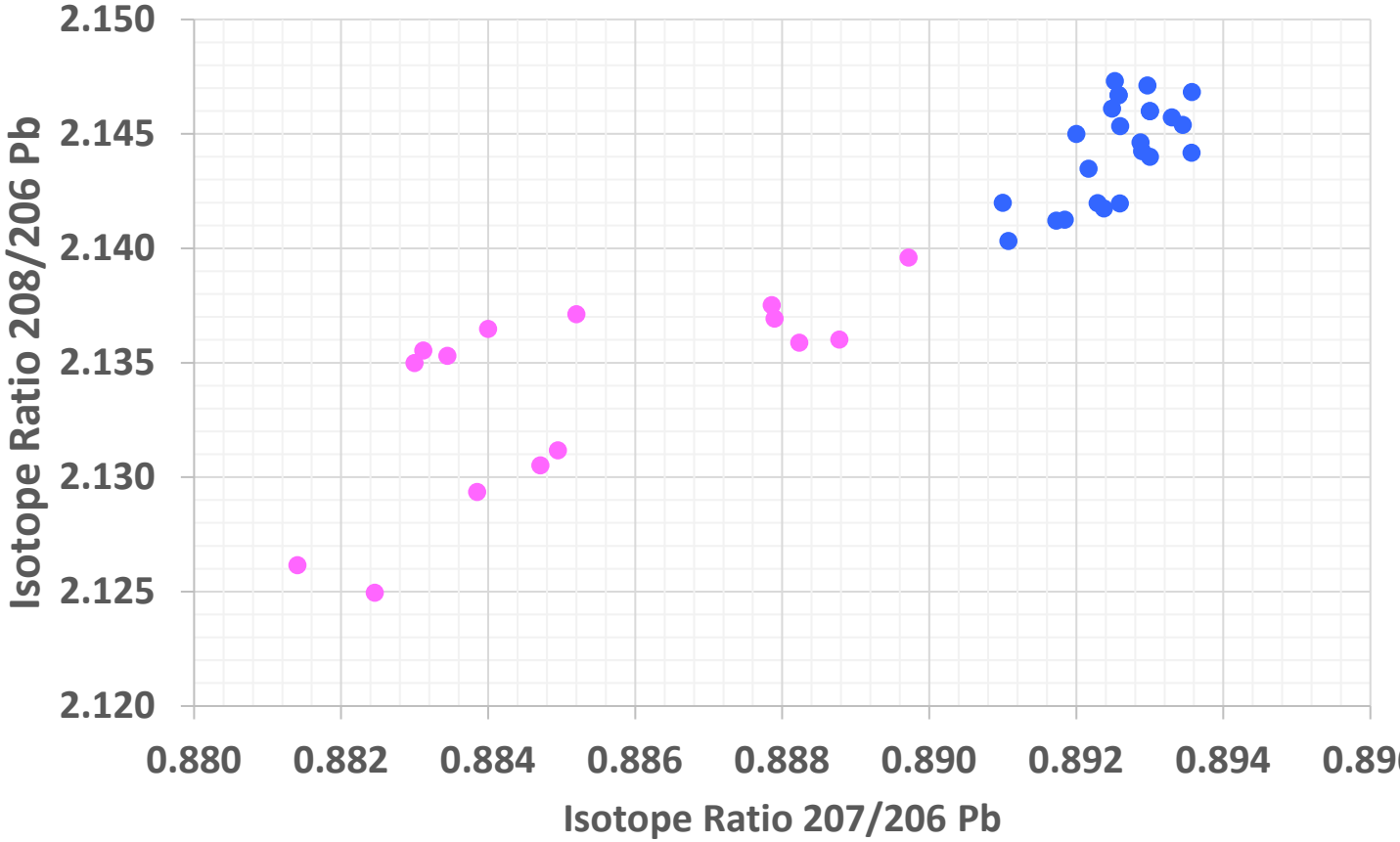
Features of mines A and B

Isotopic composition of dorés: $^{208}Pb/^{206}Pb$ vs $^{207}Pb/^{206}Pb$

A



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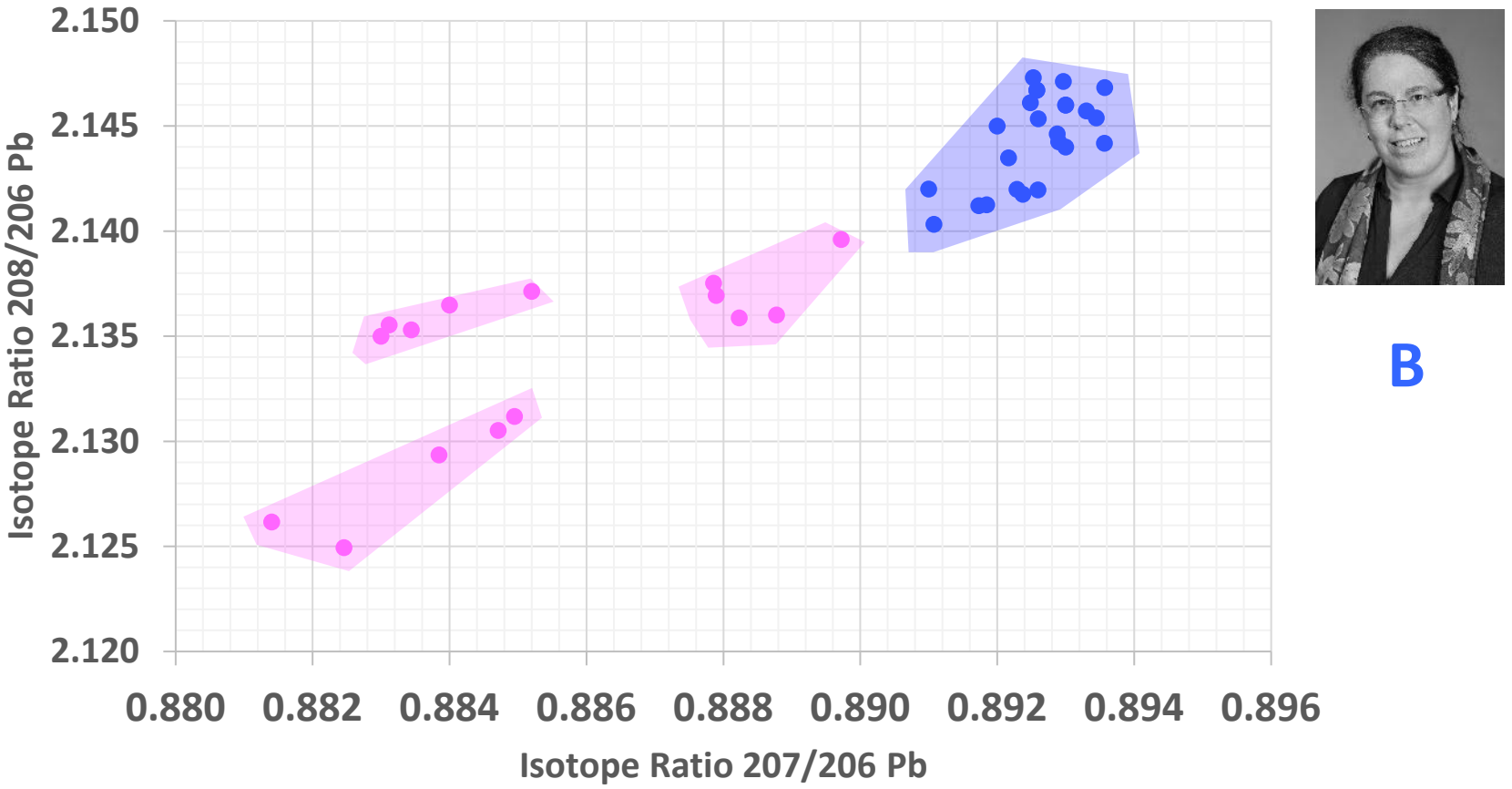

B

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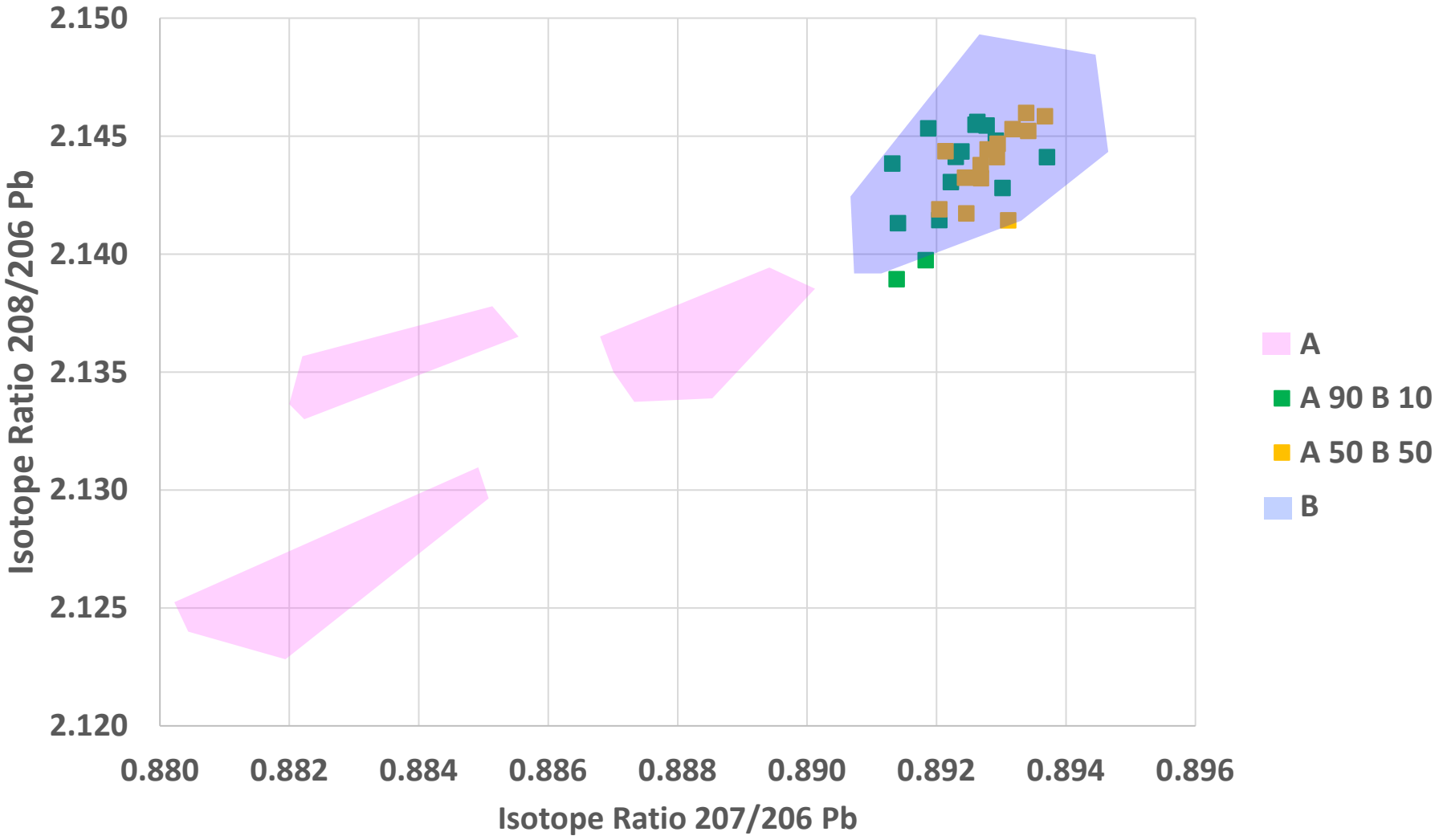
Mix of mines A and B

A 95/5 90/10 75/25 50/50 25/75 10/90 5/95 B

Mix of mines A and B



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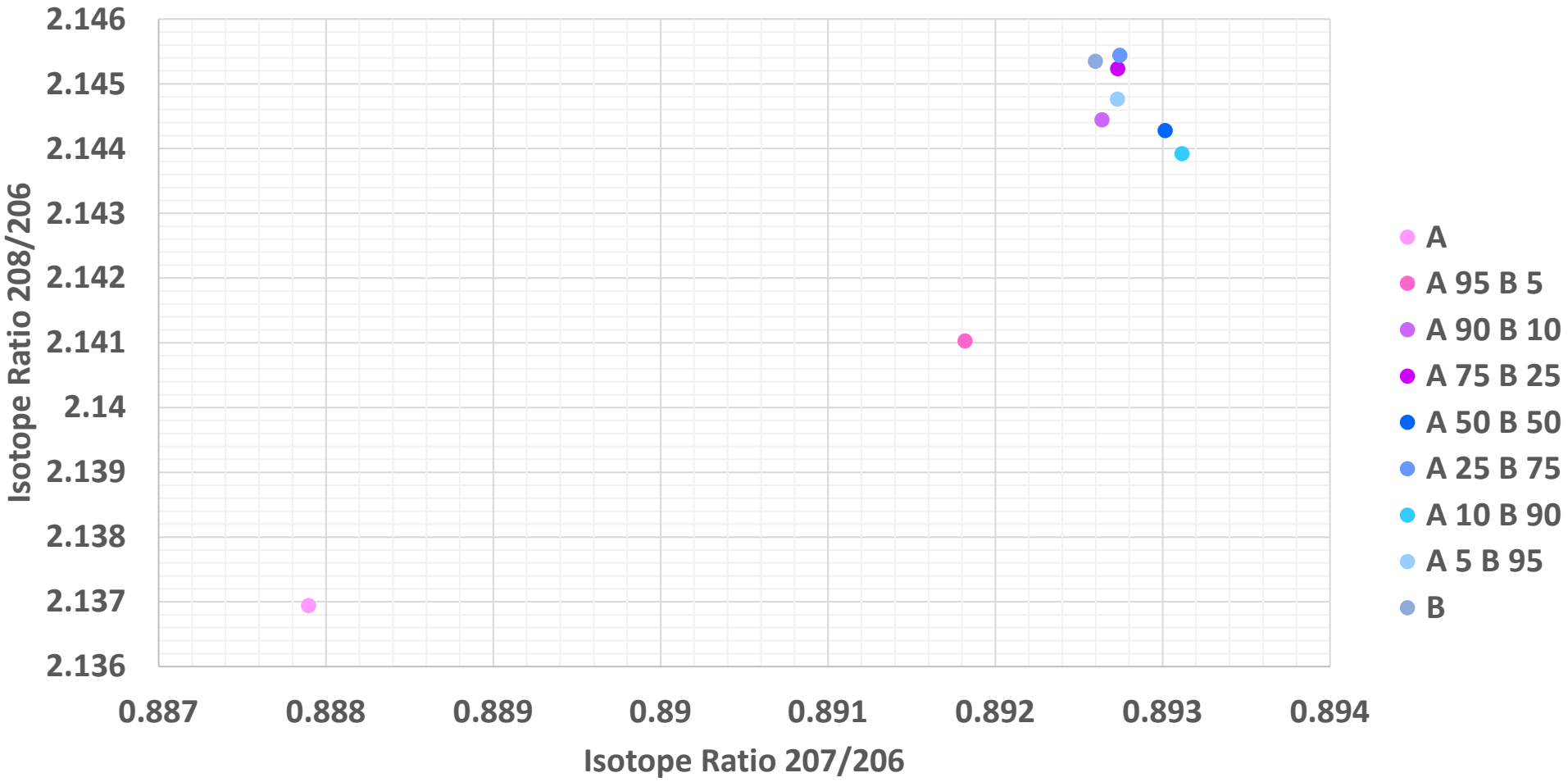

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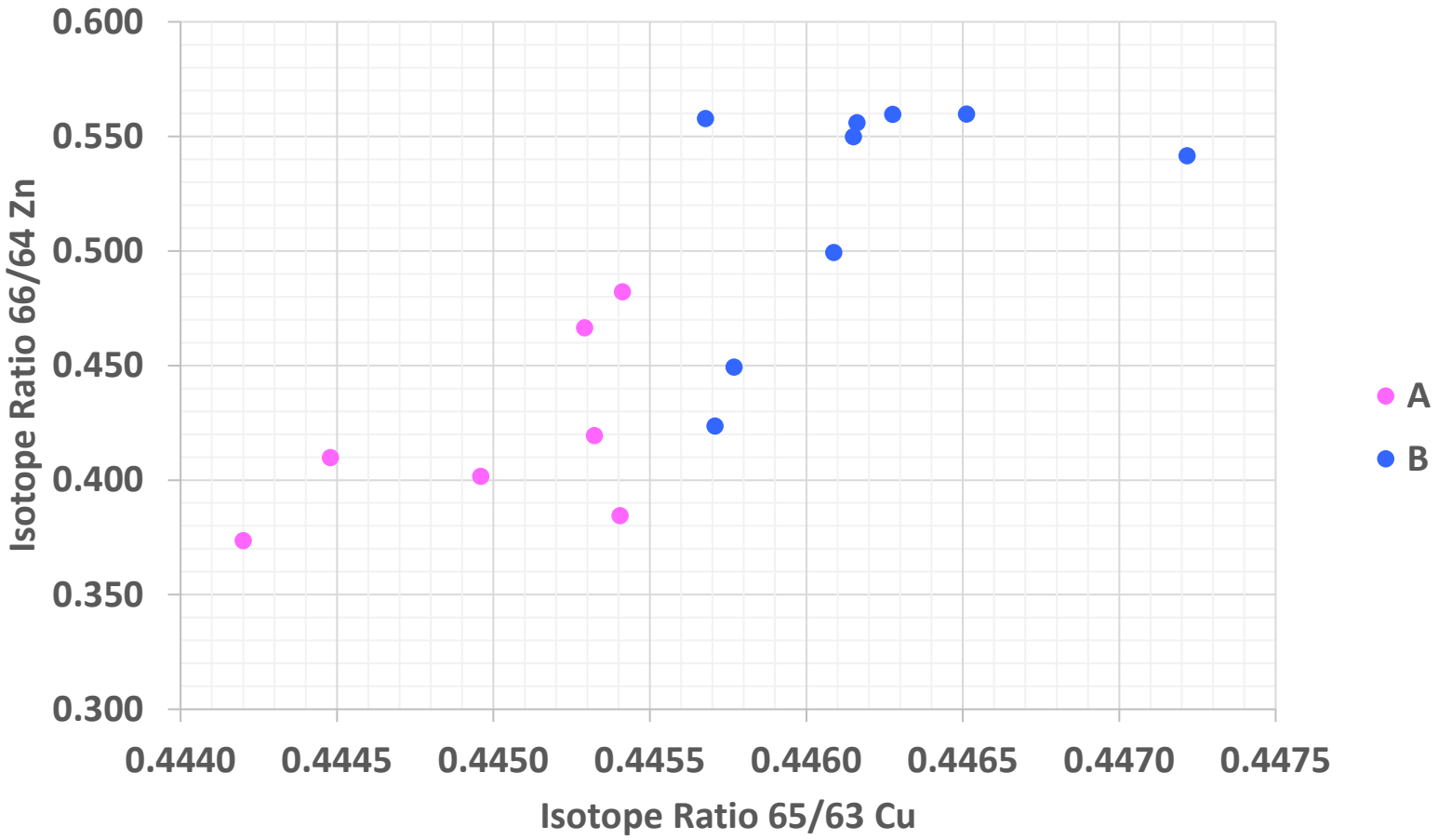
Features of mines A and B

Isotopic composition of dorés: $^{65}Cu/^{63}Cu$ vs $^{66}Zn/^{64}Zn$



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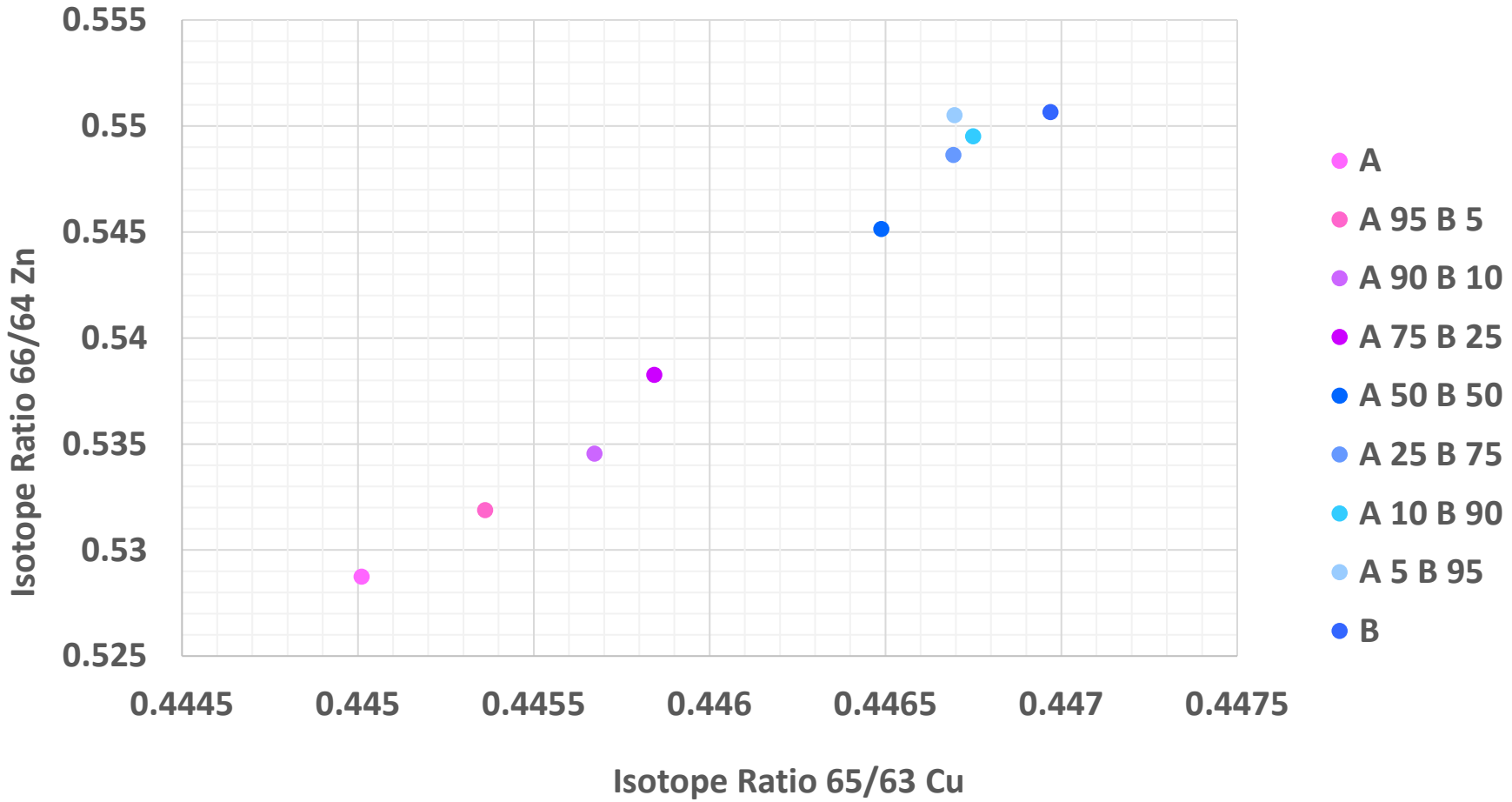

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Mix of mines A and B

Test results by geoforensic GOLD-ID®

		Conformity			
		vs A		vs B	
	Total samples	YES	NO	YES	NO
A	60	**58**	**2**	**0**	**60**
B	156	**0**	**156**	**151**	**5**

Conformity of dorés from Mine A tested against dorés from mine B and vice versa

Addition of X% to B	Outlier	Tested samples	Hit rate in %
Pure B			
5%	9	40	**23**
10%	17	40	**43**
15%	32	40	**80**
20%	36	40	**90**
30%	39	40	**98**
40%	40	40	**100**
60%	40	40	**100**
70%	39	40	**98**
80%	37	40	**93**
85%	31	40	**78**
90%	23	40	**58**
95%	11	24	**43**
Pure A			

Variable pourcentage addition of dorés from mine A to dorés from mine B

Conclusions

	geoforensic GOLD-ID®	Isotope Ratio Approach
Type of Analysis	Chemical composition	Isotopic composition
Equipment	WD-XRF	ICP-MS
Sample state	Solid	Liquid
Number of analysed elements	20 ÷ 50	3 (8 isotopes)
Data interpretation	Fully automatic	Visual
Number of reference samples	10 ÷ 15	5 ÷ 10

- Allow to confirm the origin of the material
- Mines can be distinguished even with very close geological context
- Mixes can be reliably detected from 10% with geoforensic GOLD-ID®
- Mixes can be detected by the isotopic approach but requires know-how

These two approaches are totally different but... they are complementary

Questions?

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Chat GPT

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