

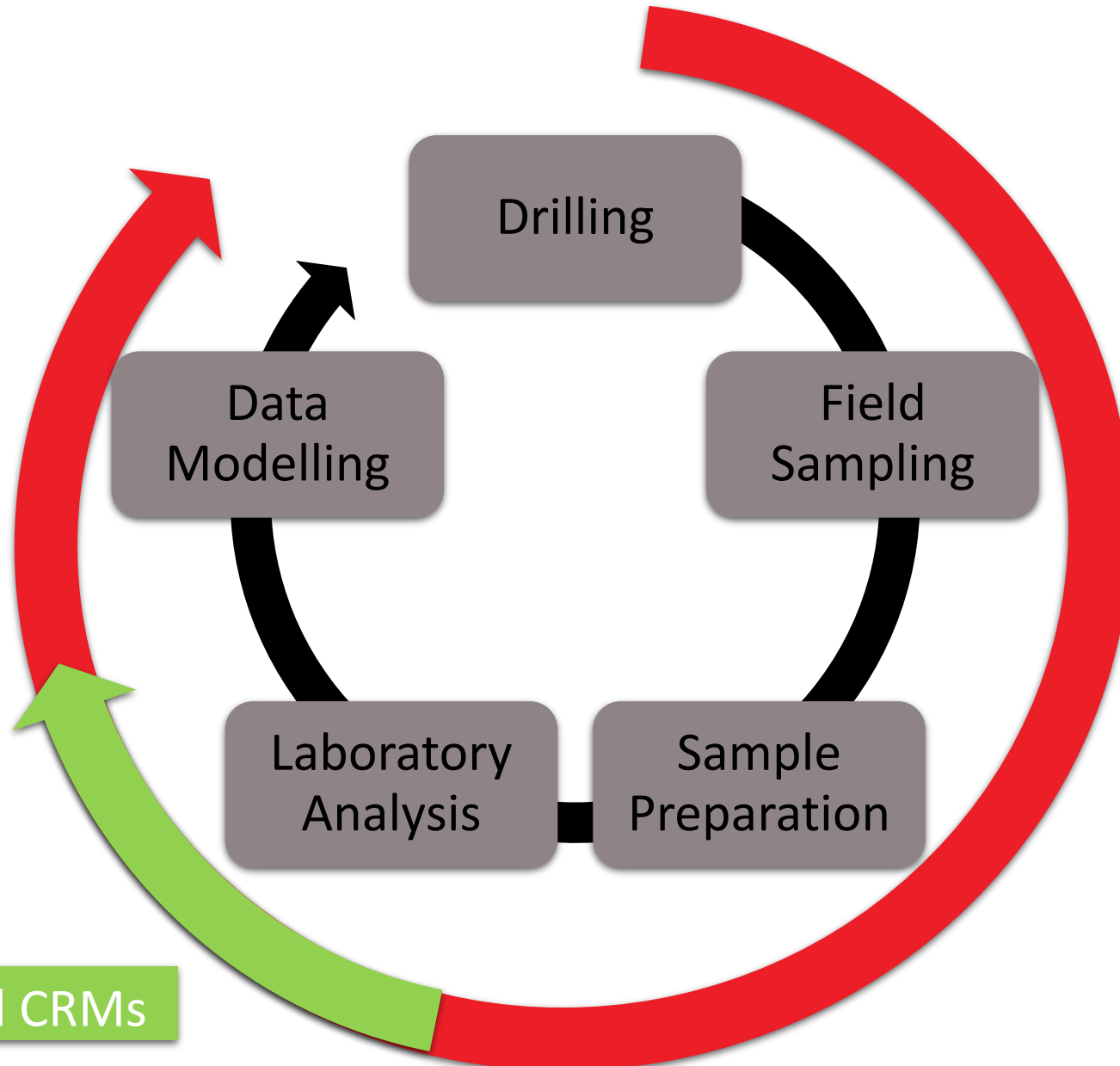


Homogeneity and Heterogeneity of Crushed Gold Certified Reference Materials

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General Manager



INTERNATIONAL
**MINING
GEOLOGY**
CONFERENCE 2024



QAQC Program

- Field Blank
- Field duplicate
- Sample prep split
- Analytical duplicate
- Submitted CRM
- Laboratory QC

Sampling Errors

Accuracy

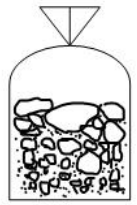
Precision

Pulverised CRMs

Sample Preparation

Analysis

Sample



Sample



Sort



Dry



Crush



Split



Pulverise



Subsample



Pulverised Aliquot



Test

Pulverised CRM



100g CRM



Aliquot



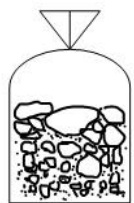
Test

Sample Preparation

Analysis

Sample

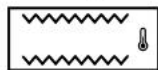
Pulverised CRM



Sample



Sort



Dry



Crush



Subsample



Crushed Aliquot



Test



“Full compacted jar”
Pulverised CRM

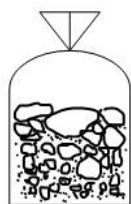


Test

Sample Preparation

Analysis

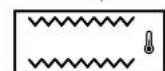
Sample



Sample



Sort



Dry



Crush



Split



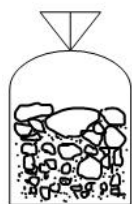
Pulverise



Subsample



Crushed CRM



2kg CRM



Sort



Dry



Crush



Split



Pulverise



Subsample



Pulverised Aliquot



Test



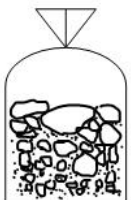
Aliquot



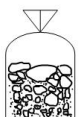
Test

	Pulverised	Crushed
Sample Submission unit	100g sachet	500g single shot Or 2kg sample to prepare
Particle size	-75 μ m or -54 μ m	-3mm or -5mm
Blind submission possible?	No	Yes
Within unit Homogeneity	Yes	No
Between Unit Homogeneity	Yes	Yes

- Independent Mineral Standards has developed a **suite** of Crushed Gold Certified Reference Materials for Fire Assay and **large mass analytical methods** (PAL and PhotonAssay™).
- This paper focuses on the Pre-Mixed variant.
- Unique patented process – embedded gold rock chips (-3mm)
- Designed to behave like chip samples from the field, or samples created in a routine sample preparation process for gold ores – **therefore needs to contain some internal heterogeneity!**



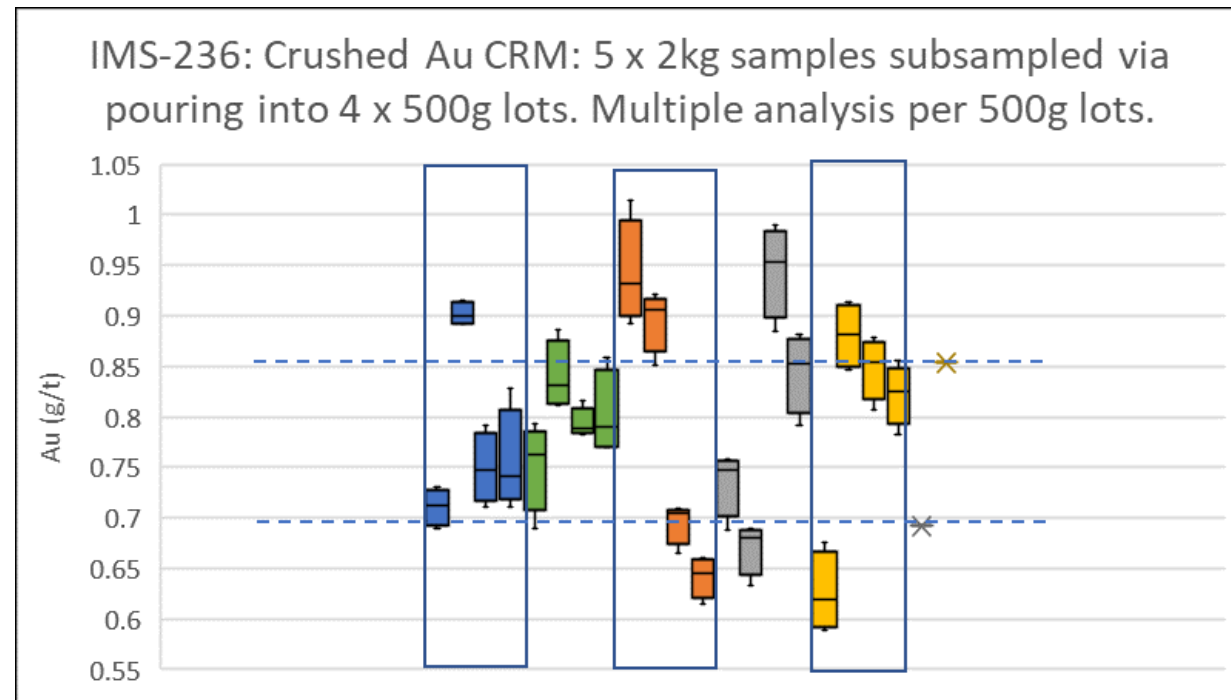
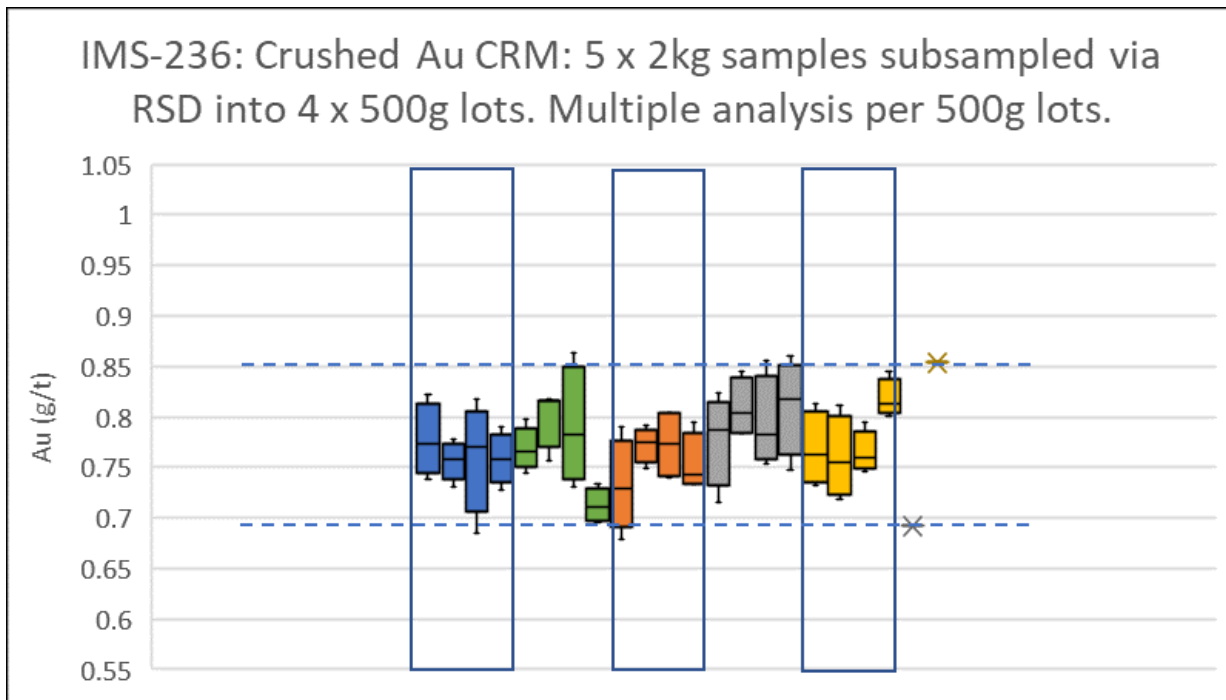
2kg units – Sample Preparation and Fire Assay



500g units – PhotonAssay™ and PAL

Au	Sample Preparation and Pb Fire Assay (2kg unit)			Photon Assay (500g unit)		
CRM	Mean (g/t)	SD (g/t)	Relative SD (%)	Mean (g/t)	SD (g/t)	Relative SD (%)
IMS-235	0.24	0.004	1.72	0.23	0.019	8.12
IMS-236	0.74	0.012	1.57	0.74	0.022	3.05
IMS-237	2.14	0.035	1.65	2.10	0.050	2.37

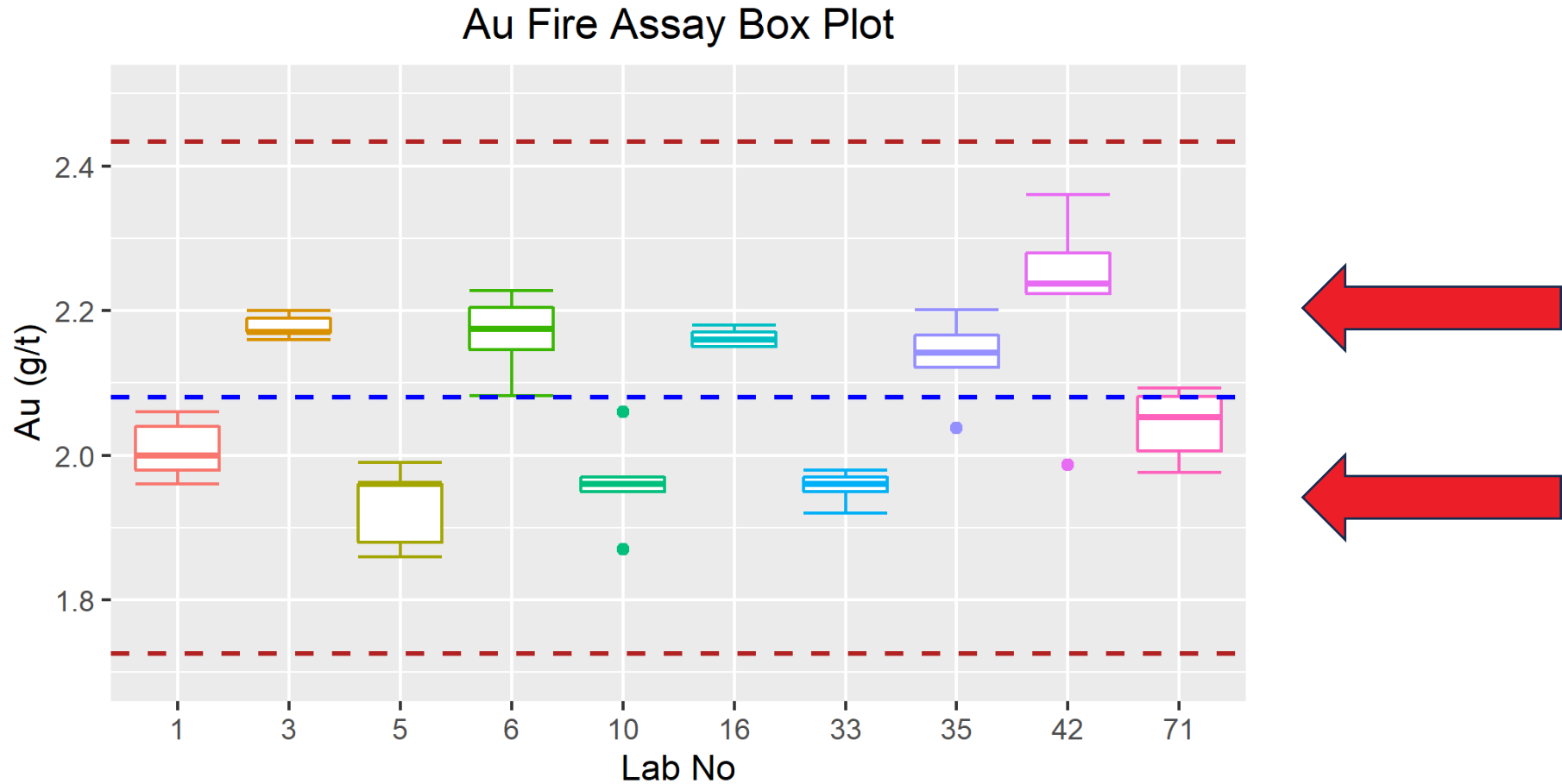
Single laboratory, multiple assays across multiple samples throughout batch



CrushedCRM™ - Pre-Mixed exhibits a degree of within-unit heterogeneity

Heterogeneity is evident when incorrect sample preparation processes are used

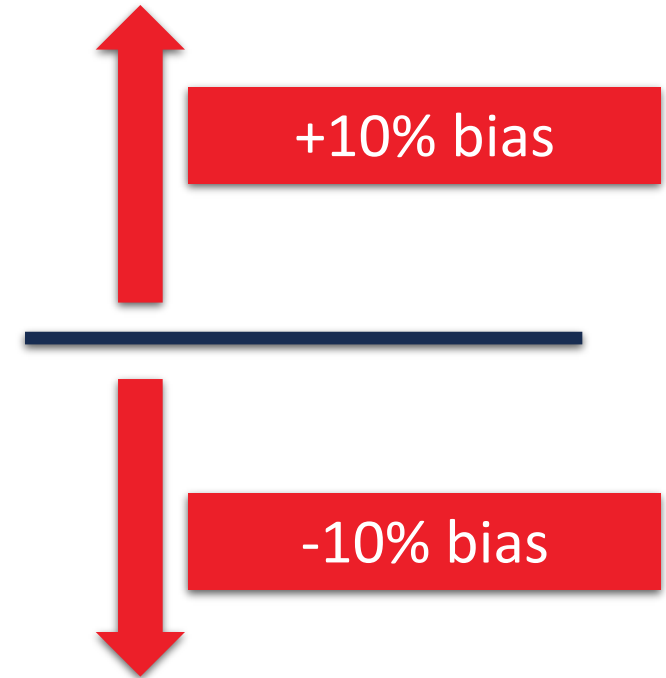
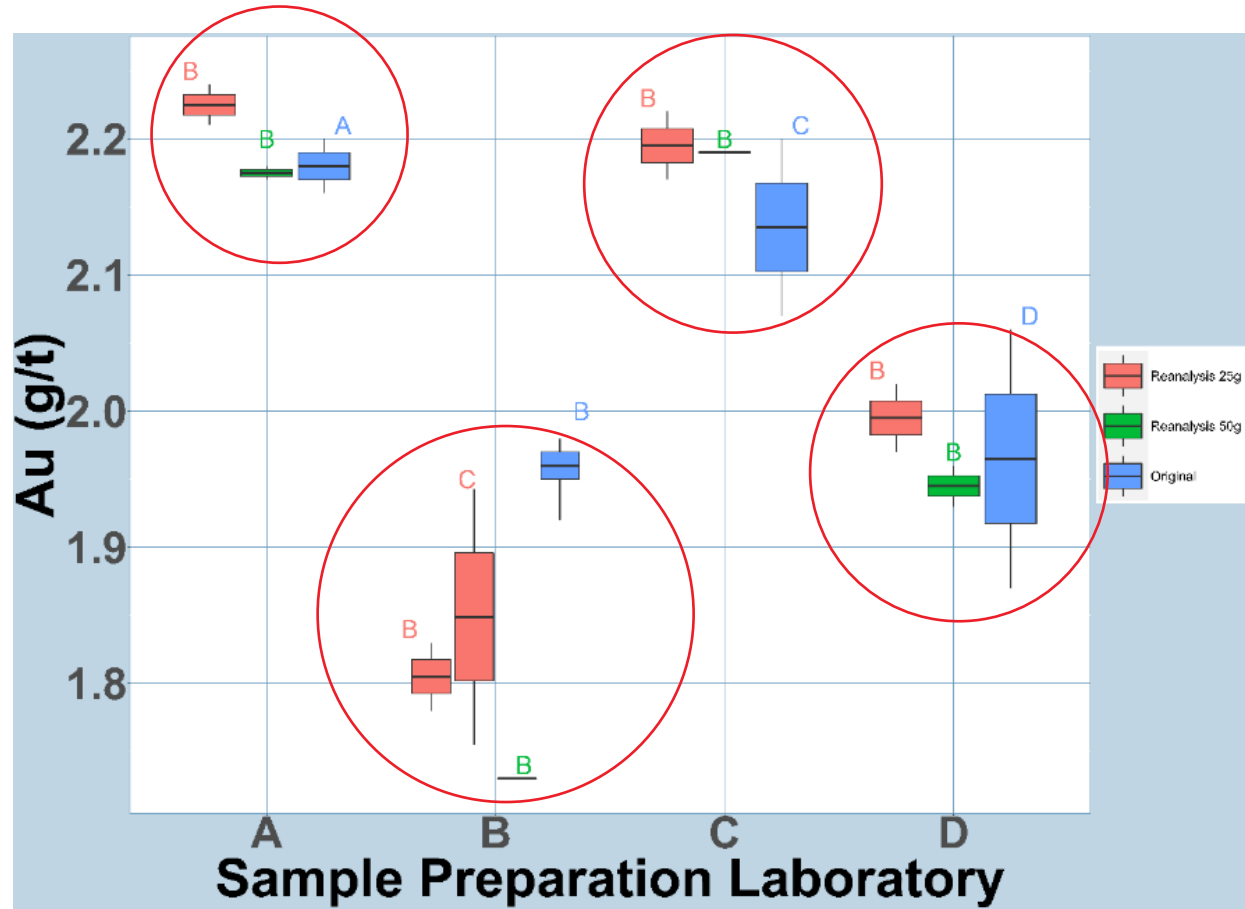
- **Fire Assay**
 - 10 laboratory study
 - 5 samples per lab
 - 2kg unit **requiring sample preparation**
 - Single analysis
- **PhotonAssay™**
 - 7 machine study
 - 5 samples per machine
 - 500g unit, no addition sample preparation
 - Single analysis



Sample Preparation AND Fire Assay

Good within-laboratory precision.

Two populations? - not evident in PhotonAssay™



- Umpire analysis aligns with the original analysis from where the samples were prepared
- Results validate the hypothesis a systematic bias in sample preparation occurred

- This study describes the homogeneity and heterogeneity characteristics of a CrushedCRM™ for GOLD methods
- CrushedCRMs™ submitted to the laboratory provide a more complete QC assessment of accuracy and precision through all laboratory processes, including sample prep
- The potential for a systematic biases to occur in sample preparation (up to 10%) has been highlighted through the use of a CRM with an appropriate level of within-unit heterogeneity
- Further work is being performed to identify the source of the bias
- Large mass analytical methods make use of crushed samples for which pulverised CRMs are problematic
- The development of CrushedCRMs™ for methods that analyse crushed samples is ongoing

Crushed CRM™

PRE-MIXED

PRIMARY

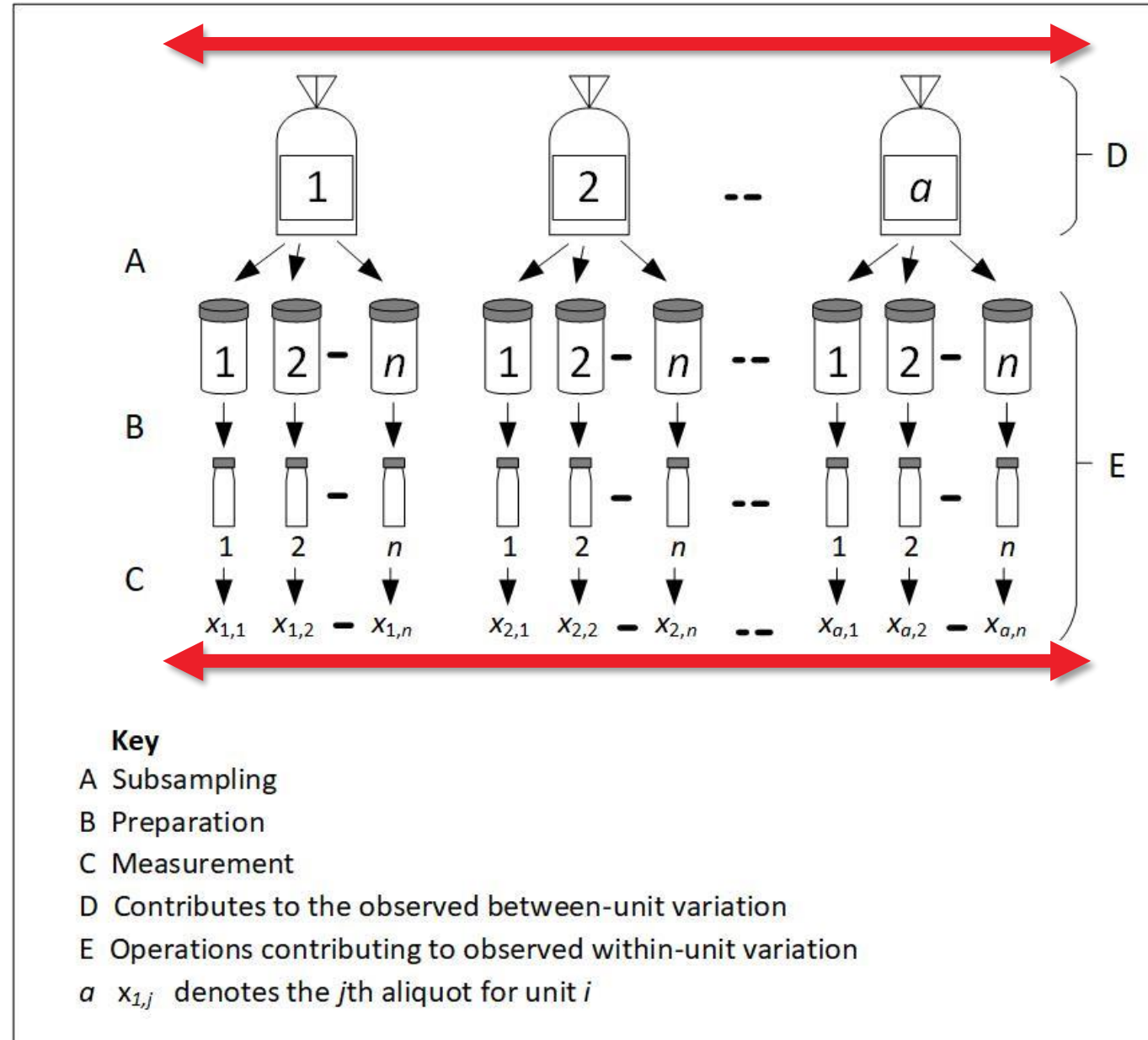
CONCENTRATE

CUSTOM



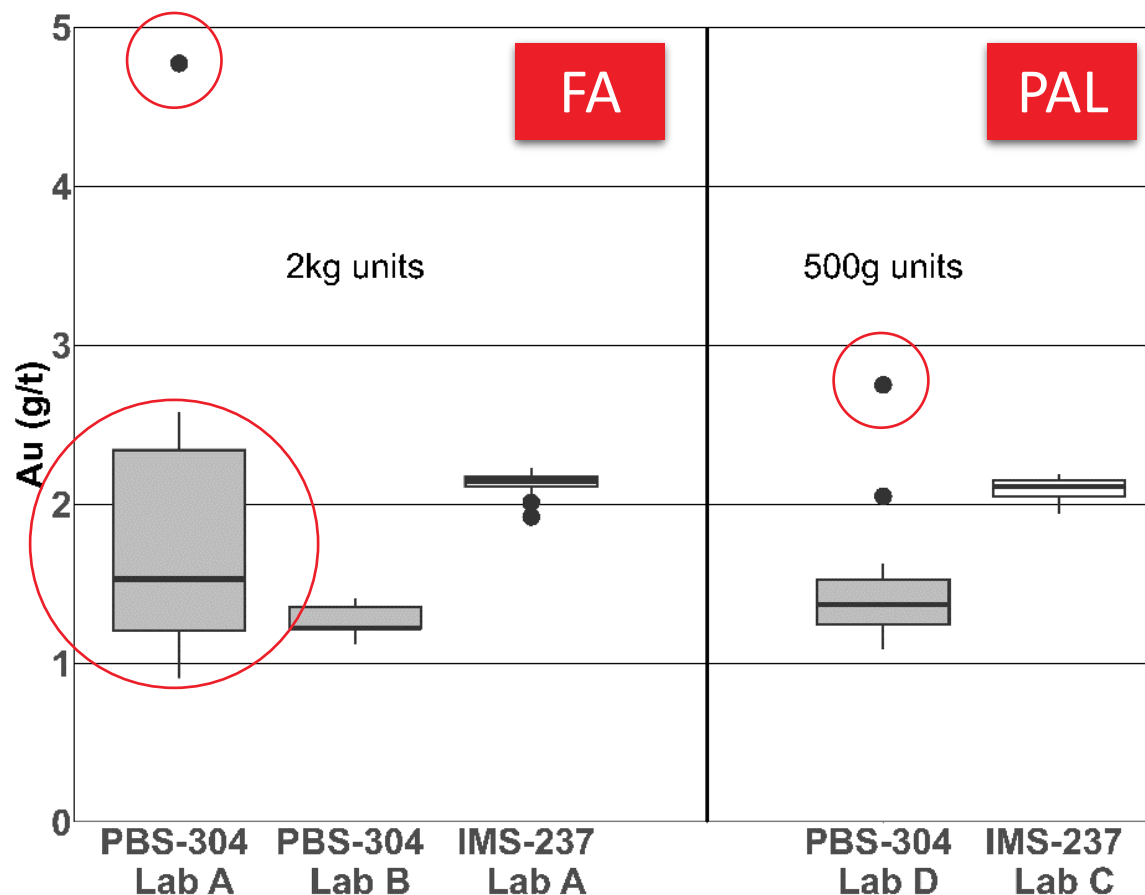
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Within batch
OR
Between Unit

Within Unit



- PBS-304 – natural ore gold CRM – same crush and homogenisation process
- IMS-237 – IMStandards' CrushedCRM™ GOLD