

Evolution
MINING

A Fine Looking Sample

**the Importance of Fines in Grade
Control Sampling to Mine to Mill
Reconciliation**

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Accurate GC is critical to the success of CGO

Persistent under-call at CGO

Introduction of Progradex and issues encountered in commissioning

Determining the importance of Fines- Granulometric test work

Cowal Gold Operations

- Mid sized open cut pit located in Central NSW
- Majority of the Mineralisation is hosted in the main dilational vein set dipping 35° to 210
- Reverse Circulation Grade Control is drilled on a 10 x 10m staggered pattern drilled at -65° towards 030

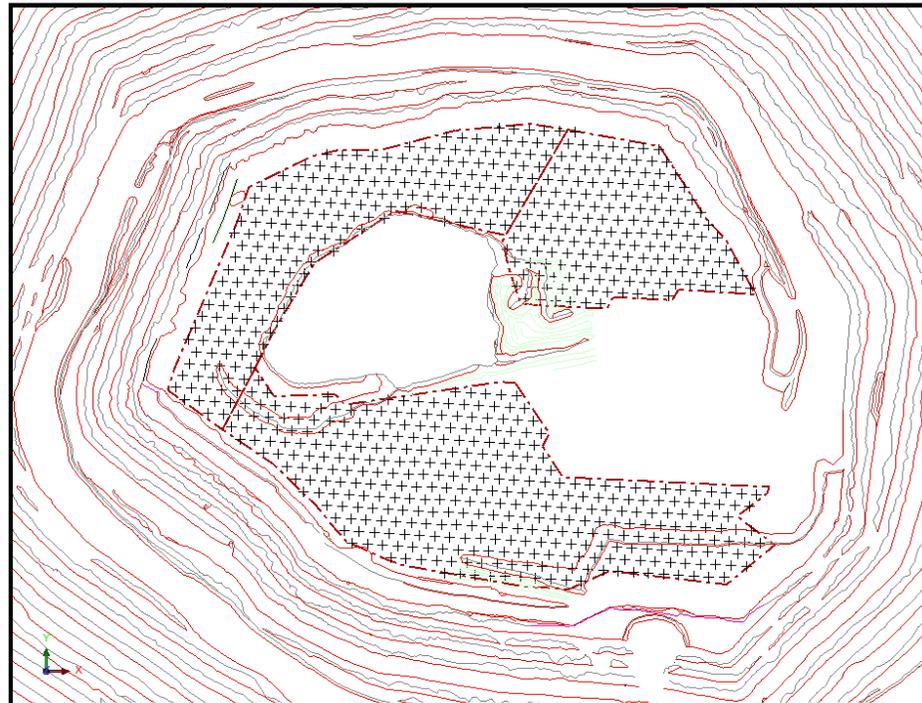


Location	Approximately 40km north-east of West Wyalong in New South Wales, Australia
Mining method	Conventional Open Cut
Minerals	Gold
Mineralisation type	Structurally hosted (epithermal to mesothermal) sheeted veins and shear hosted lodes
Process method	Grinding, gravity, flotation and cyanide leaching circuits
Process capacity	7.5Mtpa
Recovery	~83%
Ore Reserves¹	99.4Mt @ 0.89g/t Au for 2.85Moz Au
Mineral Resources¹	164.1Mt @ 0.96g/t Au for 5.0Moz Au
FY17 production guidance	245-260kozpa Au
FY17 AISC guidance	A\$885 – A\$945/oz

1. See Evolution website for Resources and Ore Reserves estimates

Why pay \$\$ for Grade Control?

- GC makes money- period.
- Low Grade, High Nugget, low spatial continuity, near isotropic on mining scale, High Coefficient of Variation
- Accurate definition of ore and waste at CGO is critical to the success of the Mine
- Resources are finite- you have one opportunity to exploit maximum value
- Reconciliation provides a check up of both our Sampling and our Ore Definition method



CGO- Baseline

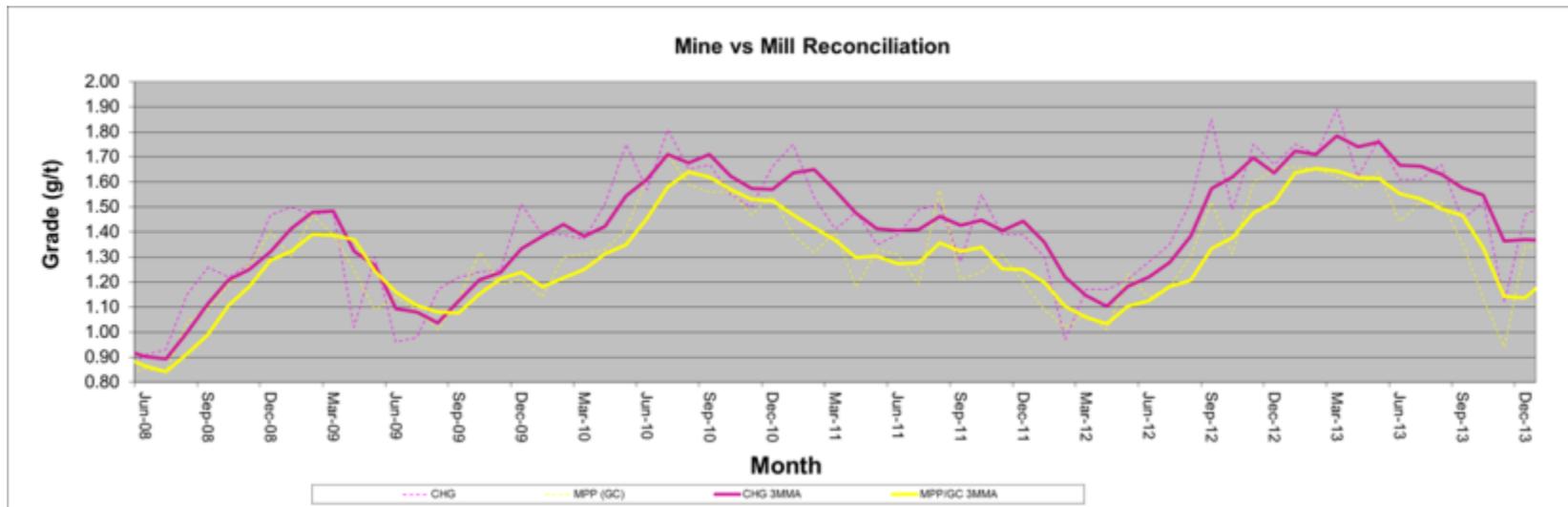
- RC sampling has been the standard GC method since operations commenced in 2005
- Multi-bench Drilling- aides forecast
- Increased data density c.f. Ore Reserve model
- Optimised azimuth and dip to intersect main dilation vein set ~80% mineralisation
- 2m sample intervals provides scope to accurately flitch mine the 9m benches
- Drilling conducted with Atlas Copco ROC L8 modified for RC drilling
- UDR Rotary Cone Splitter used to collect sample off drill rig
- Excellent repeatability 66% samples within $\pm 20\%$ RPD



The job can't be finished, only improved...

CGO- The forgiving deposit

- Between Jun 2008 and Dec 2013, consistent under-call between Mine Predicted Grade (MPP) and Calculated Head Grade (CHG)
- Good problem to have?
- NPV issues
- Delayed revenue sitting on ~8Mt stockpile
- Potential Lost Opportunities sent to Waste- Irrecoverable



There is no such thing as an unsolvable problem

CGO- the forgiving deposit

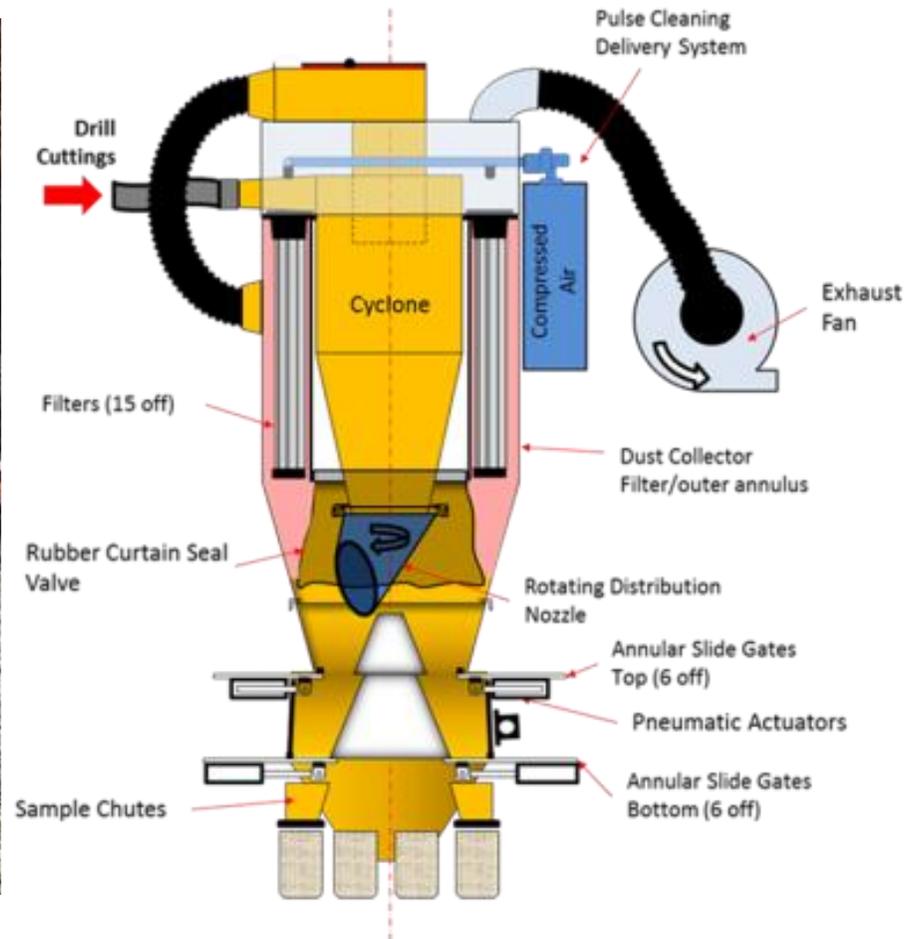
- Mine Predicted Grade consistently under-calling Calculated Head Grade
- Possible causes-
 - Au not being sampled – High grade, discontinuous Quartz Sulphide Breccia with VG
 - Sample Bias
 - Au being lost from sample – Au lost in the “fines”



A problem well put is half solved...

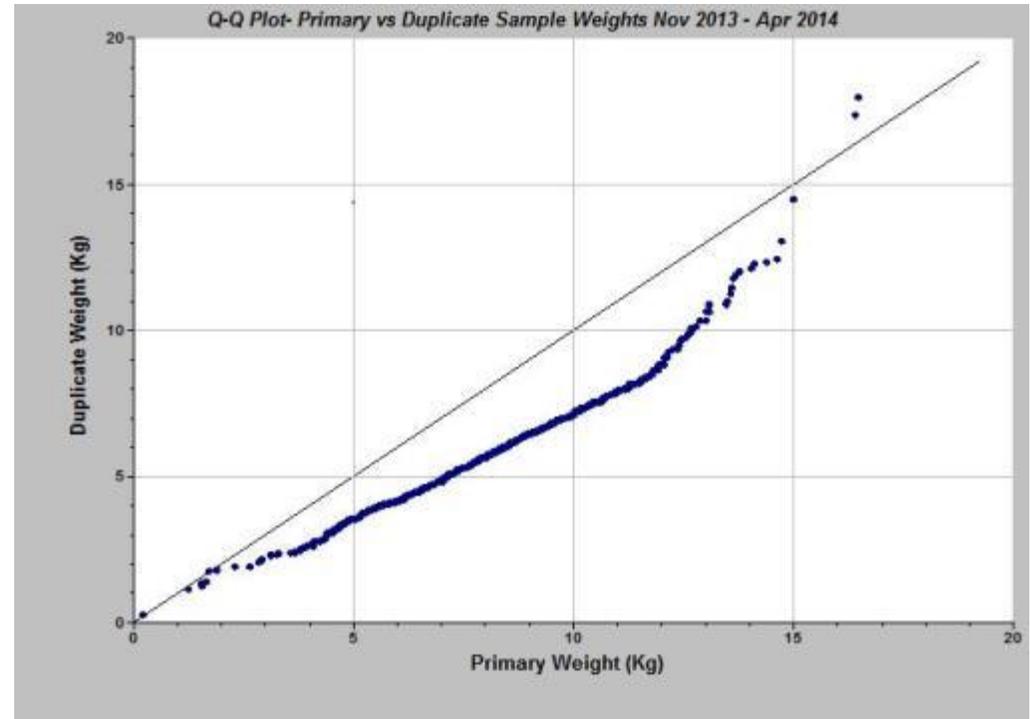
Enter the Progradex

- Re-Tendering of the Drilling services contract resulted in a purpose built DRA GC600 RC Rig equipped with the Progradex PGX1350R sampling system
- Selected due to advertised ability to capture 100% of RC Drill cuttings inclusive of fines.
- PGX originally trialled as trailer mounted, not practical for GC operation
- New rig large enough to append system to rig
- Commissioned in November 2013



Teething problems

- Problems during commissioning included
 - Bias in weight between primary and duplicate samples
 - Bias in grade between primary and duplicate samples
 - Issues with sample gates jamming
 - Issues with modifications made to system to mount of Rig
 - Excessive wear at sample inlet
 - Problems with pneumatic seals on actuators
 - Sample hang up



Life wasn't meant to be easy, but take courage: it can be delightful

- Gate replaced to seal unit
- Easily installed bisplate inlet designed for sample inlet
- Support brackets engineered for gates
- 8" hose between Sampler and Dust collector to provide adequate air draw
- Valve place on Dust collector to disengage suction during purge
- Split suction from Dust collector to 2 draw points
- Better alignment between Primary and Duplicate- although bias persists
- Drift in repeatability 51% samples within $\pm 20\%$ RPD



After rain comes sunshine

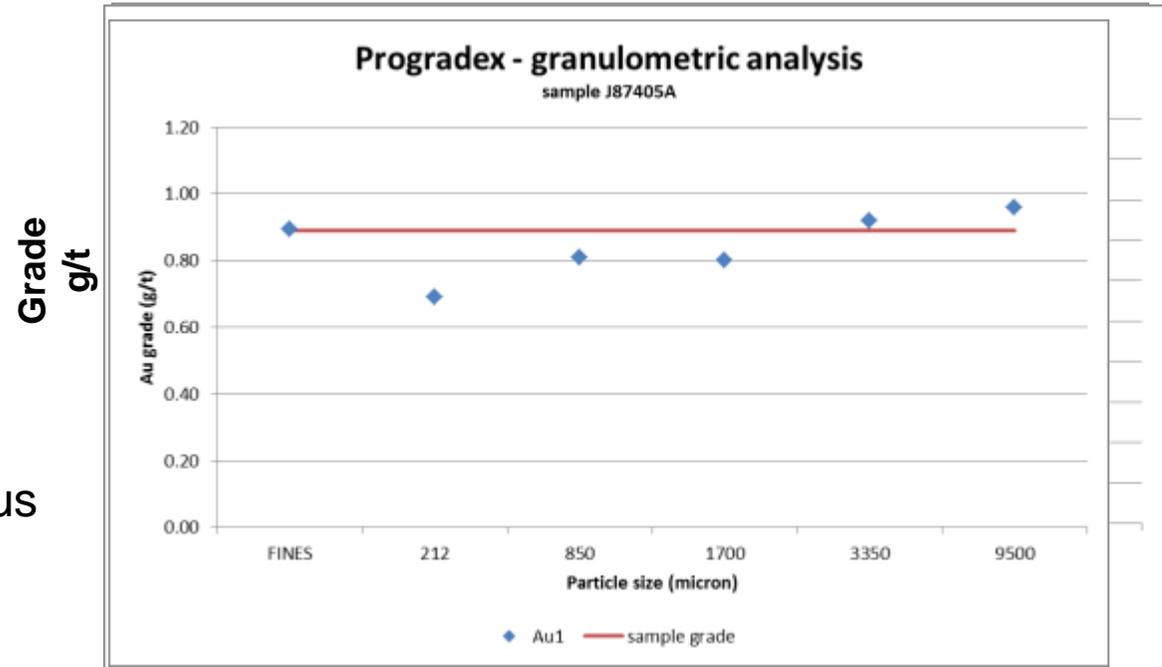
Is it worth the effort...

- How important are these “fines”?
- Granulometric work conducted to assess the importance of the fines
- Select holes in mineralised areas of the pit
- Duplicate collected, sized, weighed then assayed and compared to Primary Sample to assess importance of fines
- Specific holes drilled with Primary and Duplicate ports sampled, sized, weighed and assayed to compare bias between Primary and Duplicate ports
- Samples taken directly from the outer annulus to determine what constitutes “fines”



Results- Duplicate samples

- Fines averaged 21% of overall Sample Mass
- Fines comprised 33% of the of the sample Au content
- Typical J-shape, right skew distribution
- Suggests Au liberated in the in the fines to provide a more homogenous sample
- Not sampling fines = Au lost from sample



FINES
<212µm

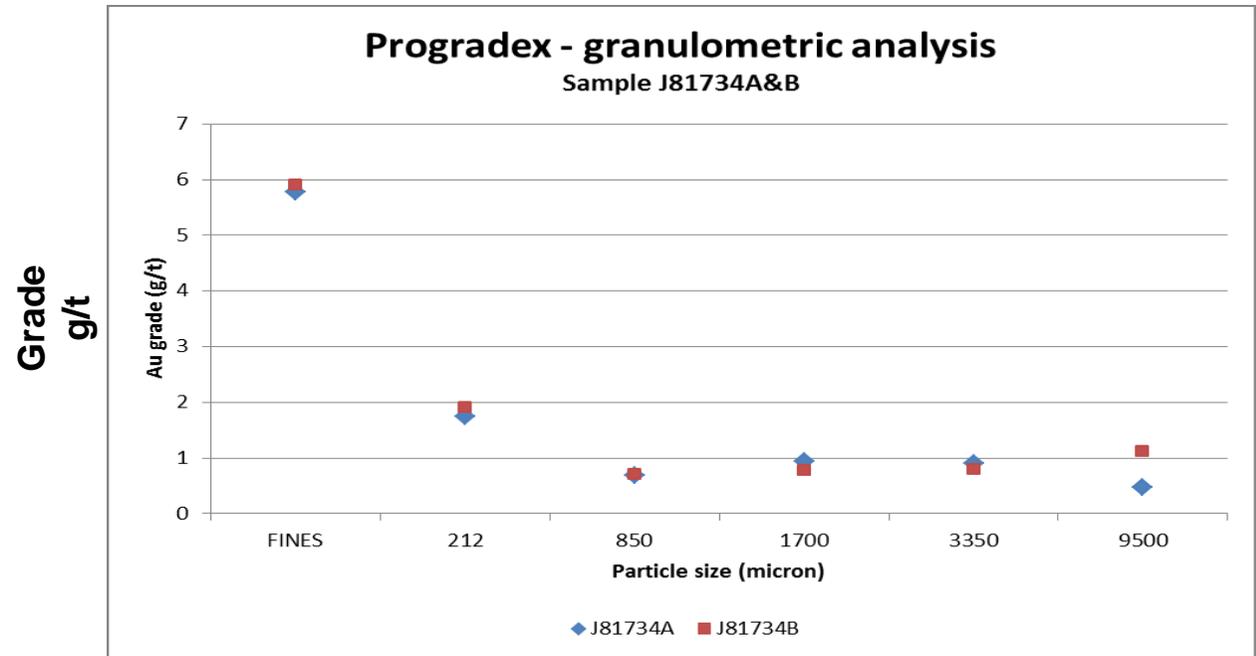


COARSE
(cm)

Primary sample grade represented by Red Line

Results- Duplicate pairs

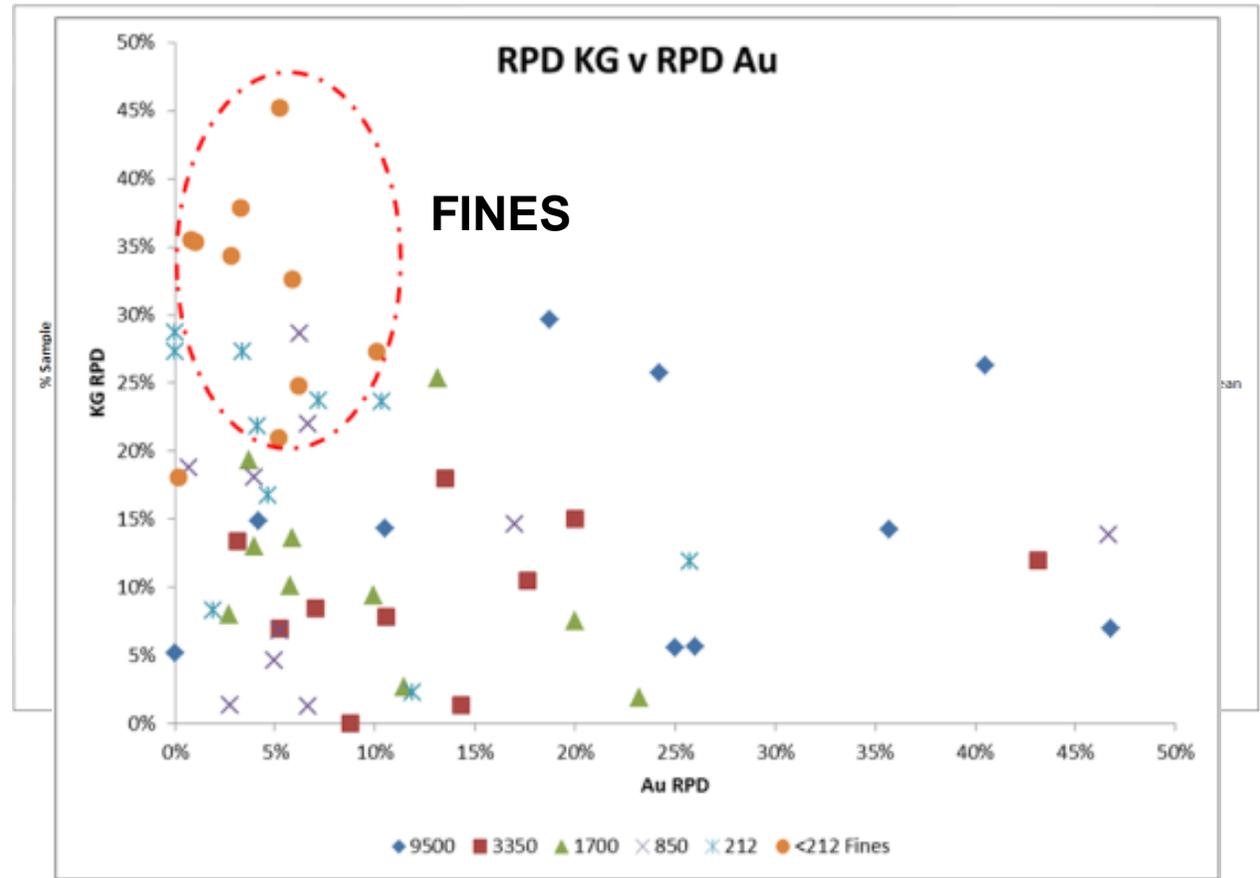
- Similar weight bias- Primary port heavier than duplicate
- Similar negative skew J distribution
- Good precision in Au grade for particle bins
- Importance of fines to overall sample grade
- Nugget effect with Coarse Bins
- Absolute Relative Percent Difference between Primary and Duplicate fines ~6%



FINES $<212\mu\text{m}$ \longrightarrow **COARSE** (cm)
Primary sample Blue Duplicate sample Red

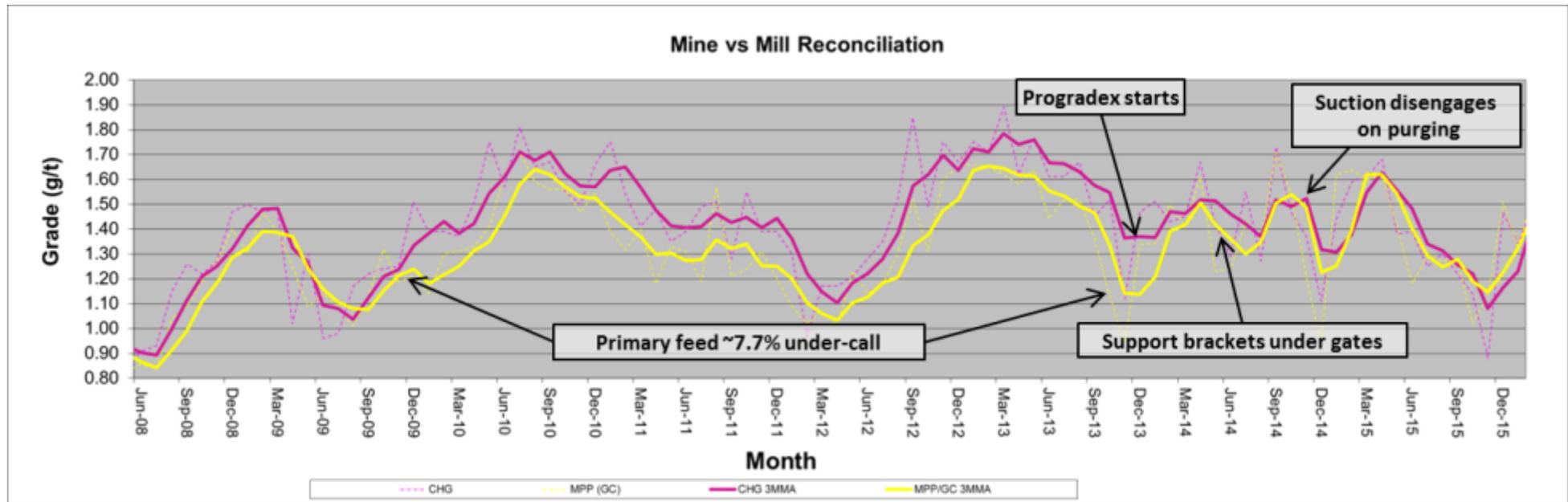
Results- Weight Variance Duplicate pairs

- If the grade is precise, why the deterioration in Field Duplicate data?
- Weight bias in fines between primary and duplicate driving the grade bias
- RPD Au for fines shows tight distribution compared to RPD Weight
- Distribution of fines between sample leading to Field Duplicate bias



Forest....Trees

- GC role is to make money- Improved Reconciliation- better delineation of ore and waste
- Weight and Grade bias reduced but still present
- Dramatic improvement in Mine Predicted Grade vs Calculated Head Grade reconciliation commencing in December 2013 with introduction of PGX and engineering solutions



Research is what I'm doing when I don't know what I'm doing...

Conclusion

- 33% of gold content in the GC samples at CGO located in the fines
- Due to elevated grade in fines, it is crucial the fines are accurately represented in an RC sample
- Field Duplicate sample bias at CGO is due to increased proportions of fines in the primary sample
- Fines are susceptible to internal airflows and pressures inside the PGX

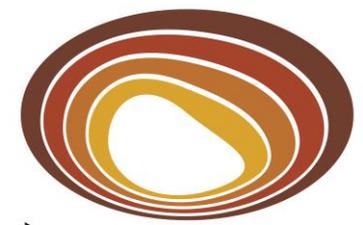


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Thank you

- Thanks to CGO and Evolution for permission to present this work
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