Development of the Falea Polymetallic Uranium Project, Mali

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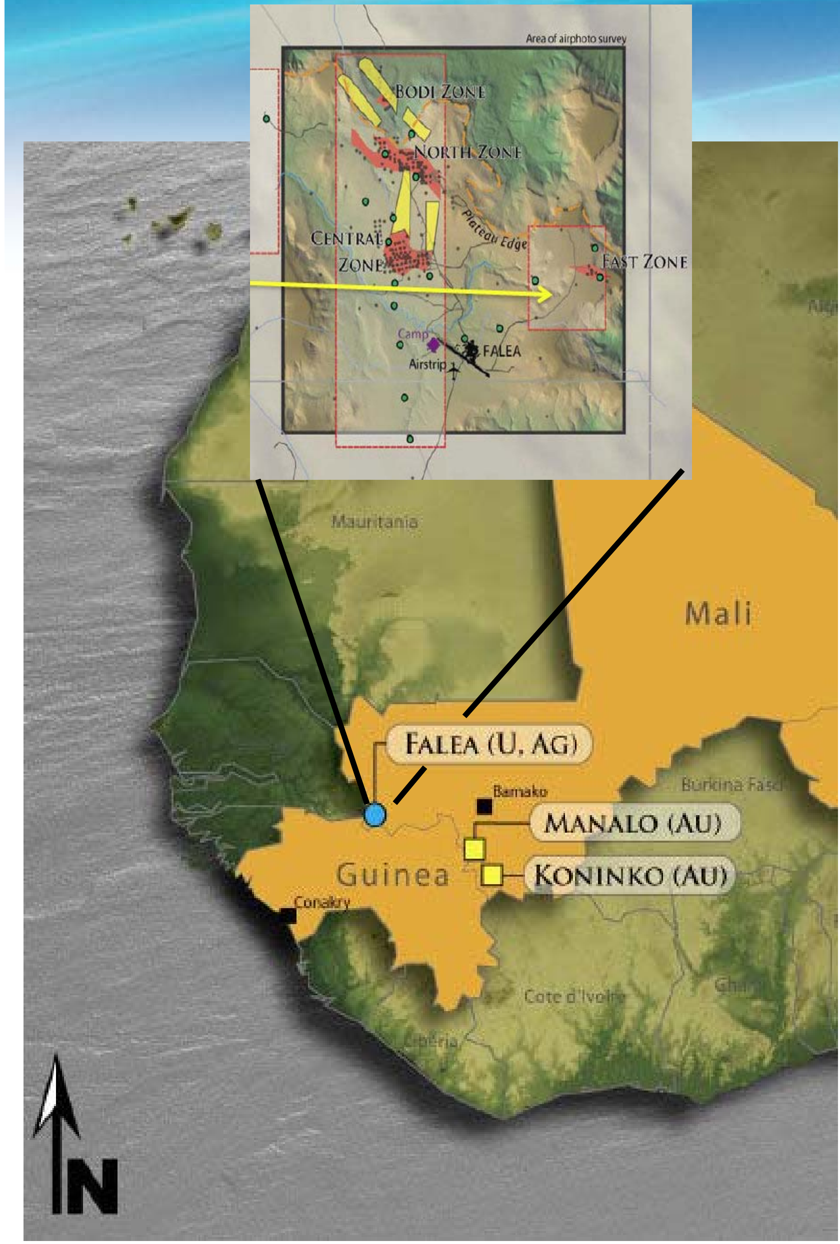
Overview

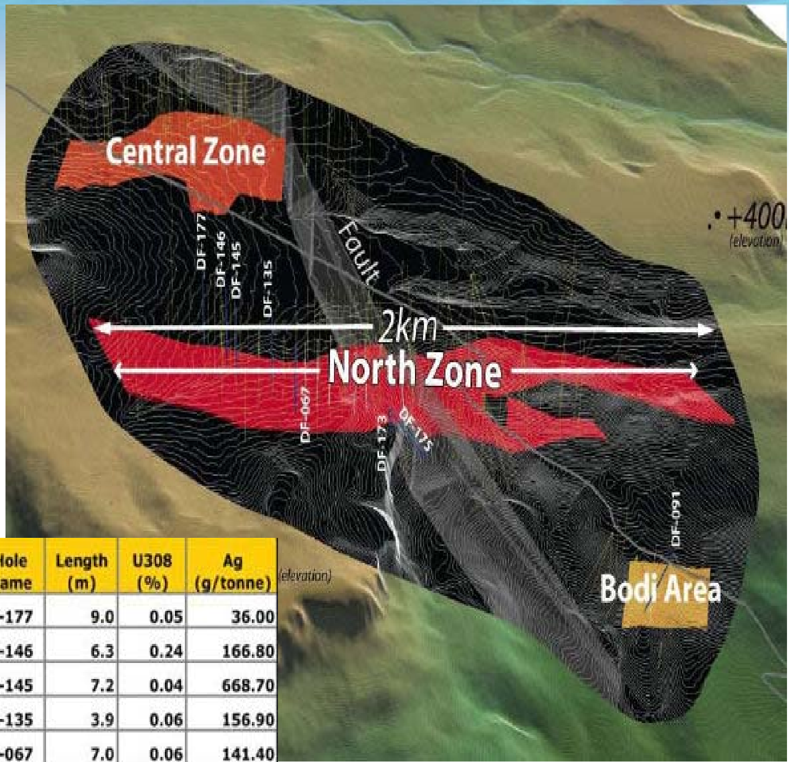
- Deposit Size & Mineral Resources
- Recent Process Development Activities
- Mineralogy of Deposit
- Flowsheet Options
- Flowsheet Performance Comparison
- Preferred Flowsheet Refinement
- On-going Work



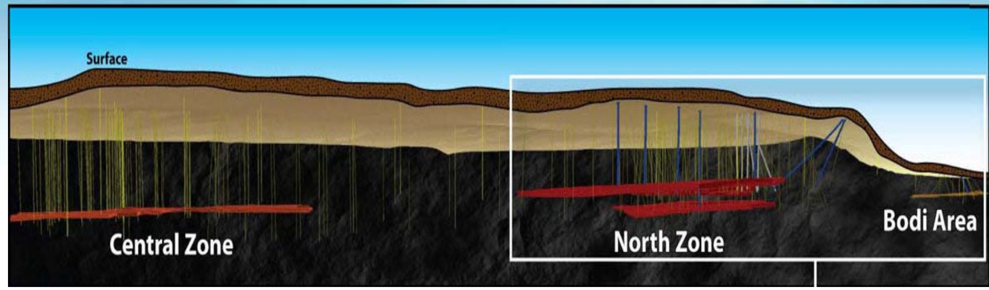
Falea Project Basics

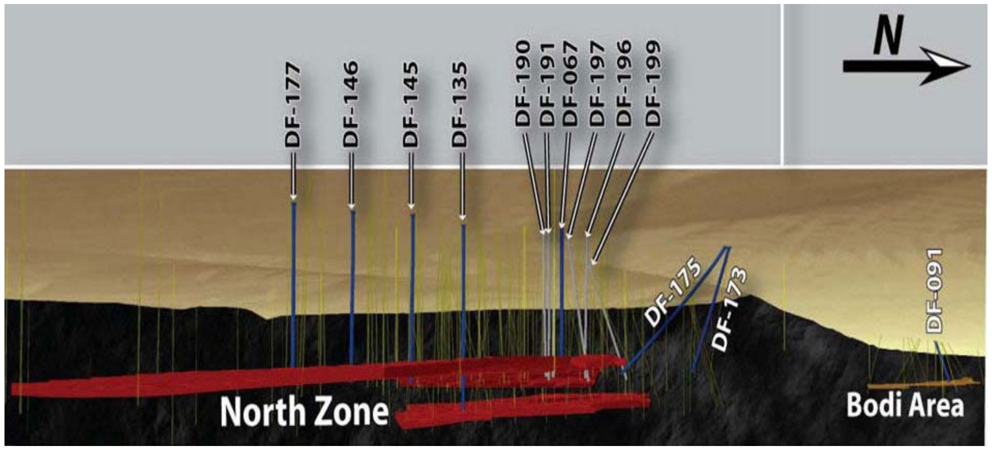
- Project now owned by Denison Mines
- ANSTO Minerals working with owner and their consultant, DRA
- Located in south western Mali, West Africa, near the intersection of the Senegal and Guinea borders
- Established mining region (mainly gold)
- Location on plateau favourable for underground operation
- Significant uranium, silver and copper mineralisation – different to other U deposits
- Excellent metallurgical outcomes to date

Deposit Dimensions & Mineral Resources



Hole Name	Length (m)	U308 (%)	Ag (g/tonne)
DF-177	9.0	0.05	36.00
DF-146	6.3	0.24	166.80
DF-145	7.2	0.04	668.70
DF-135	3.9	0.06	156.90
DF-067	7.0	0.06	141.40
DF-175	1.0	2.37	67.00
DF-173	1.0	0.14	8.30
DF-091	0.5	2.03	33.30
DF-190	4.0	0.73	183.00
including	1.0	2.52	110.00
DF-191	6.0	0.22	20.20
including	2.0	0.51	35.60
DF-192	3.0	0.45	105.30
including	2.0	0.62	155.00
DF-196	4.0	0.70	68.10
including	2.0	1.22	127.00
DF-197	2.0	1.80	141.50
including	1.0	3.05	201.00
DF-199	4.0	0.39	16.70
including	1.0	0.12	6.07
including	1.0	1.40	37.90





** Diagrams from Denison Mines website, Mineral Resources from Minxcon, Nov 2012*

	Cut-off	Tonnes	U_3O_8 (%)	U_3O_8 (lbs)	Silver (Oz)	Copper (lbs)
M & I	0.03%	15,670,000	0.09	29,581,000	27,940,000	74,220,000
Inferred	0.03%	15,350,000	0.05	15,688,000	8,910,000	81,190,000
Total				**45,269,000**	**36,850,000**	**155,410,000**

- Only 5% explored, all zones remain open

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Recent Process Development Activities 1

- 2010 – Preliminary metallurgical testwork at SGS Lakefield in Johannesburg
  - Very good uranium recoveries possible
  - Flotation is feasible to separate out copper/silver as sulphides
- March 2011 – ANSTO Minerals (Phase 1)
  - Acid and carbonate leaching
  - Solid/liquid separation
  - Flotation of ore and acid leach residue
  - Potential process flowsheets identified
- November 2011 – (Phase 2)
  - Comprehensive program to generate data for economic assessment of alternative flowsheets
  - DRA - selection of preferred process route

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Recent Process Development Activities 2

- March 2013 – Phase 2 Extension (refine preferred option)
  - Milling and flotation piloting program
  - Concentrate leach optimisation
  - Options for silver recovery
  - Radionuclide deportment through the process flowsheet
- February 2014 – Phase 3 (further refinement)
  - IX recovery of uranium
  - Production of uranium oxide concentrate
  - Copper recovery
  - Radiometric sorting
  - Environmental testwork on tailings

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Mineralogy

- Dominant uranium-bearing mineral is uraninite
  - Typically observed in association with quartz, chlorite or muscovite
- Coffinite also present, often in association with uraninite, quartz and muscovite, chlorite, and sulphides
- Brannerite present and typically associated with muscovite
- Copper is present as sulphide minerals, mainly chalcopyrite
- Silver present mainly as argentite (Ag_2S), but also as tennantite $(Cu,Ag,Zn,Fe)_{12}As_4S_{13}$ and in native form
- Gangue consists mainly of quartz, muscovite, chlorites, carbonates, and feldspars

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Mineralogy - Distribution

- Mineralogy (XRD) on "Typical" Ore and Acid Leach Residue

Mineral	Chemical formula	Ore	Leach Residue	Level of Attack
Quartz	SiO_2	70	76	Very Low
Muscovite	$KAl_2Si_3AlO_{10}(OH)_2$	11.9	13.6	Low
Clinochlore	$(Mg,Fe)_6(Si,Al)_4O_{10}(OH)_8$	6.6	5.7	Medium
Dolomite	**$CaMg(CO_3)_2$**	**3.3**	**nd**	Complete
Calcite	**$CaCO_3$**	**1.8**	**nd**	Complete
Albite	$NaAlSi_3O_8$	2.2	0.6	High
Riebeckite	$(Na,Ca)_2(Fe,Mg,Al)_5(Si,Al)_8O_{22}(OH)_2$	0.8	0.4	
$CaSO_4.xH_2O$	$CaSO_4$	0.8	2.1	Formed from calcite and dolomite
Apatite	$Ca_5(PO_4)_3(F,OH,Cl)$	0.7	0.3	
Hematite	Fe_2O_3	0.6	0.4	
Pyrite	**FeS_2**	**0.6**	**0.4**	
Chalcopyrite	**$CuFeS_2$**	**0.6**	**0.3**	
Rutile	TiO_2	0.5	0.2	
Microcline	$KAlSi_3O_8$	0.3	0	

- Confirms that main acid consuming minerals are carbonates (calcite and dolomite), chlorite, feldspars (albite, microline), also apatite and chalcopyrite
- Carbonate leach data confirms that sulphides are the main consumers of carbonate

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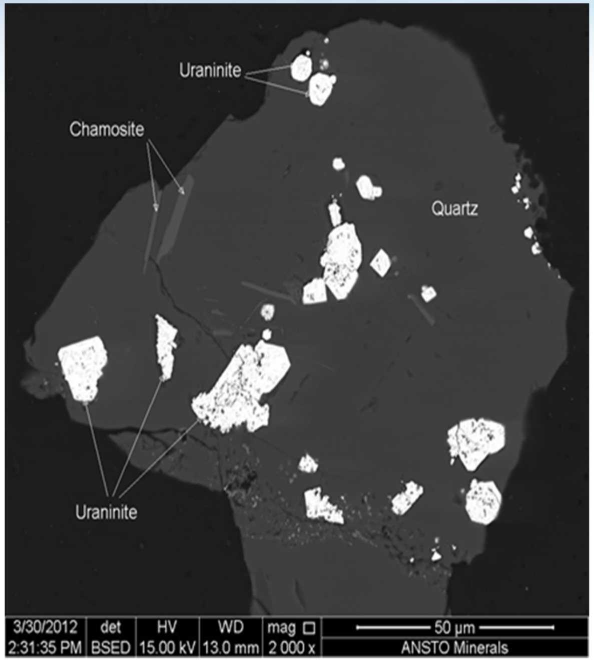
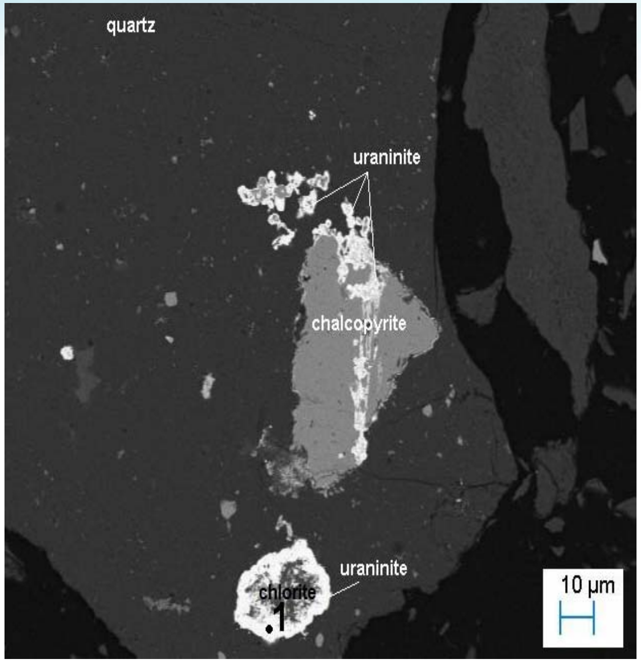
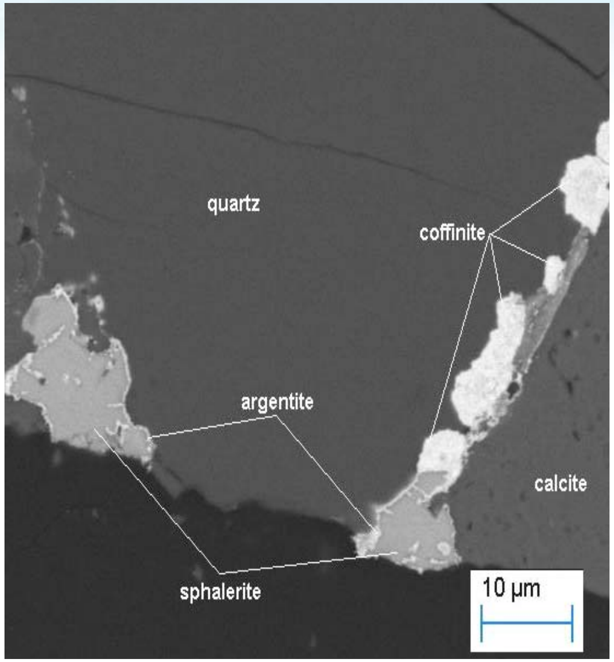
Uranium/Ag Minerals in the Ore



Uraninite and chamosite inclusions within a quartz particle.



Uraninite/pitchblende inclusions within a chalcopyrite particle enclosed by quartz.



Coffinite (bright white) aggregates interstitial to calcite and quartz. Argentite partially rims two of the coffinite aggregates.

- Uranium is mostly present as easily leachable uraninite
- Argentite is found associated with uraninite and coffinite
- Adequate uranium liberation is achieved by grinding to a P_{80} of 75 µm

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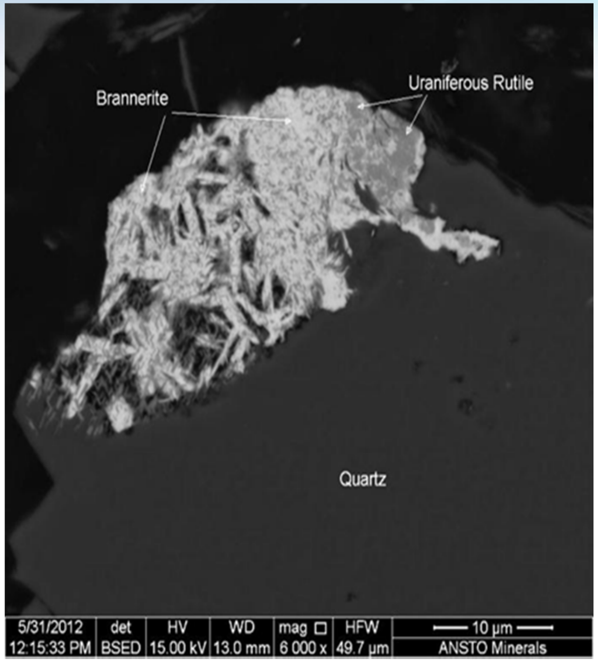
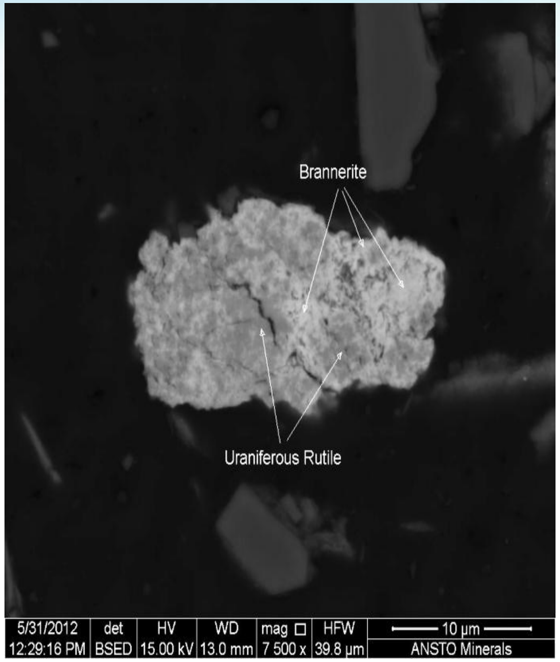
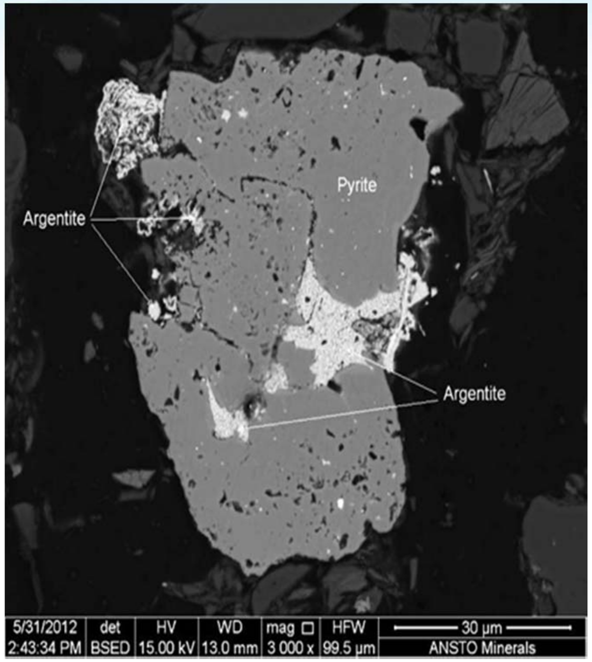
Mineralogy of Acid Leach Residue



Intergrown brannerite and uraniferous rutile at the edge of a particle of quartz.



A small liberated particle composed of brannerite and uraniferous rutile.



Argentite in association with pyrite.

- Brannerite and uraniferous rutile were the major uranium-bearing phases observed in leach residue
- The silver-rich phase, argentite (Ag_2S) was present

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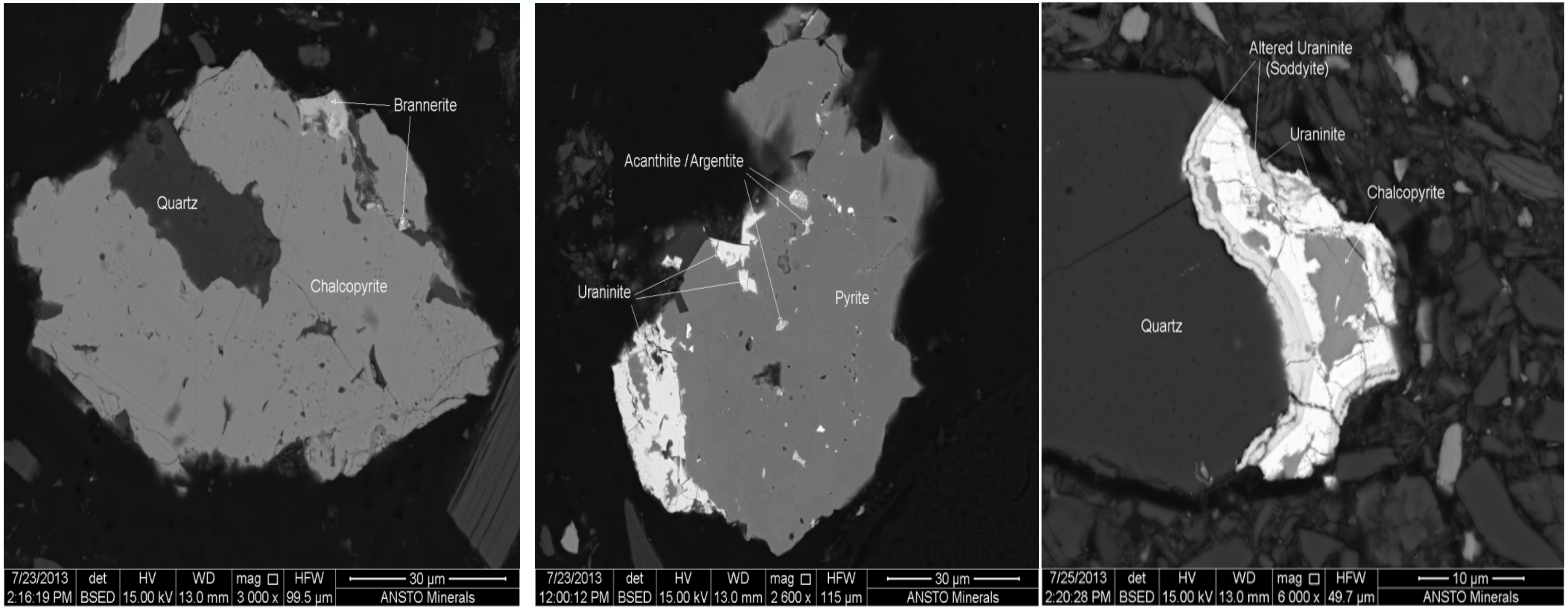
Flotation Concentrate



- Practically all unlocked sulphides report to concentrate

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Flowsheet Options

- Polymetallic nature of the Falea deposit - a range of flowsheet options
- Considerations – carbonates in acid leaching; sulphides in alkaline leaching; need to recover Ag and Cu
- Two primary flowsheet options assessed:
  1) Acid uranium leach of ore / flotation of leach residue to recover sulphide concentrate, treat for Cu and Ag
  2) Flotation of ore / alkaline uranium leaching of float tails / float concentrate treated for Cu and Ag recovery
- Various sub-options considered for each flowsheet

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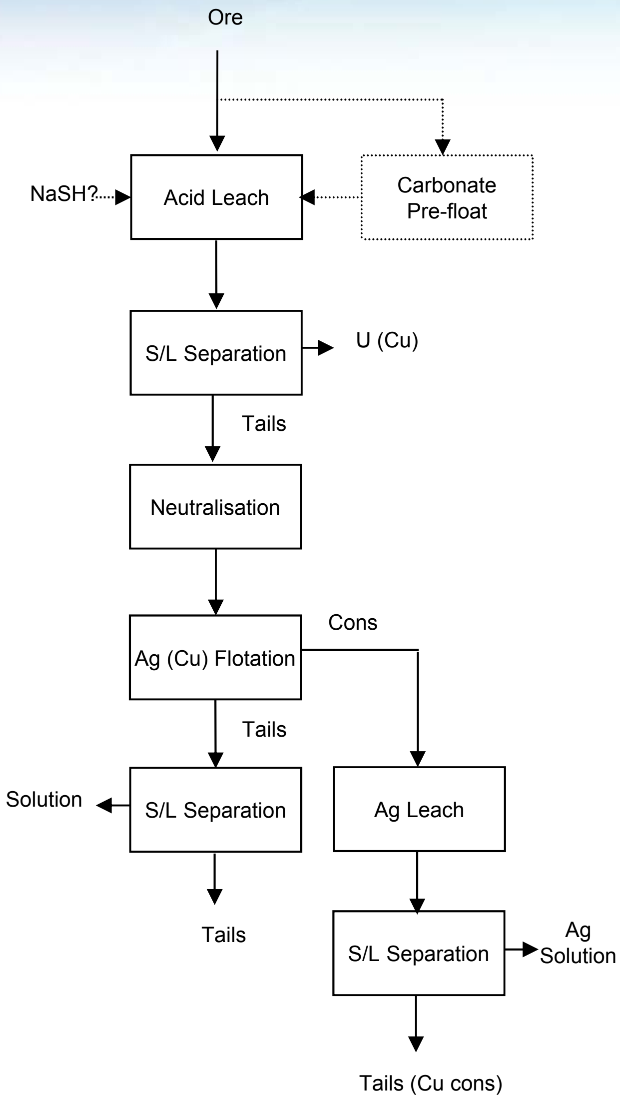
Flowsheet Option A – Leach / Flotation



- Uranium extracted by acid leach on ore, recovered from solution by conventional processing (high Cu extraction)
- Potential carbonate pre-float to reduce acid consumption (U loss too high)
- Cu leached may be recovered by SX. Alternatively, sulphide addition to leach may suppress copper leaching
- Flotation of neutralised acid leach slurry, float concentrate is leached to recover silver

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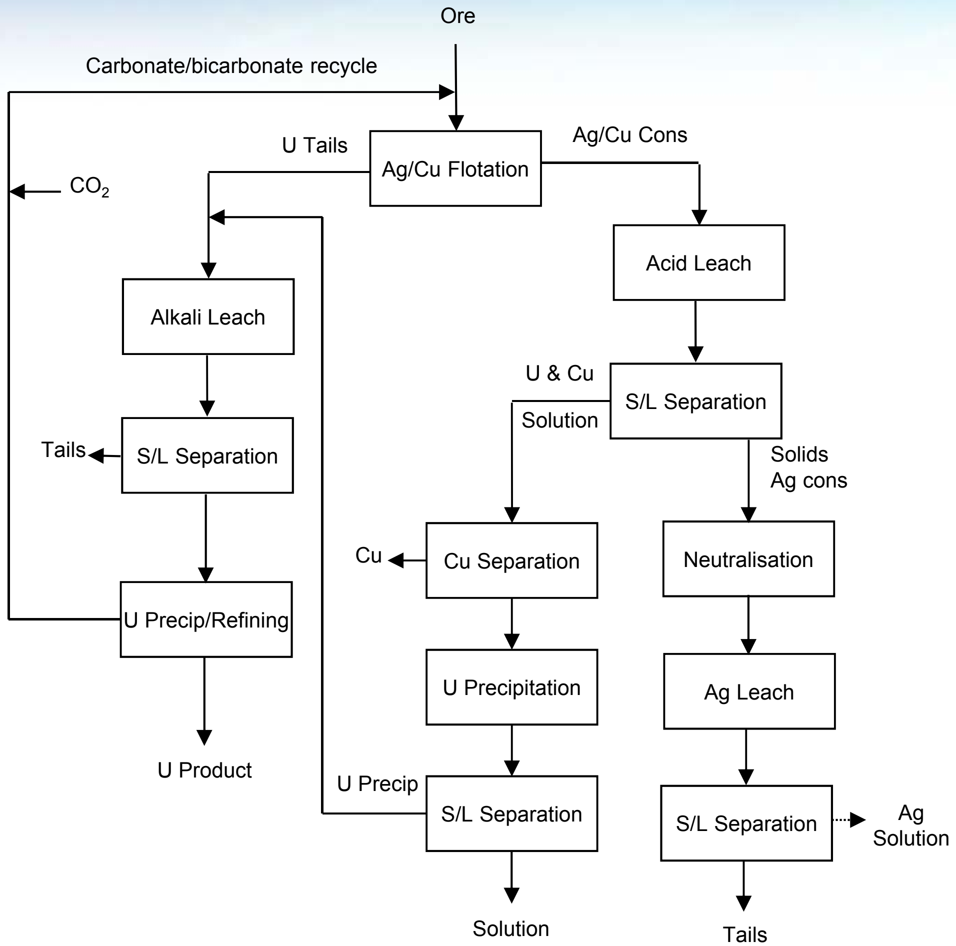
Flowsheet Option B – Flotation Up Front

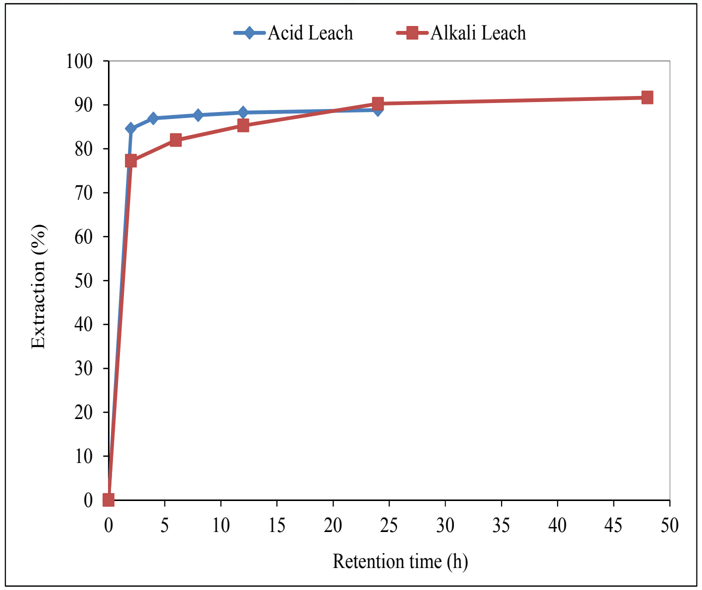


- Flowsheet designed to give higher product yield and reduced reagent demand
  - Sulphides report to concentrate, reducing carbonate consumption in alkaline uranium leach on tails
  - Carbonates report to float tails reducing acid consumption in Cu/U leaching
- Uranium extracted by conventional carbonate leaching
- Cu / Ag separation achieved by oxidative acid leaching

- Uranium associated with sulphide minerals recovered and recycled to the carbonate leach circuit

Flowsheet Performance Comparison

- High recoveries of copper and silver to concentrate for both flotation of ore and leach residue
- Uranium extraction is >90% in both flowsheets
- Copper extraction is less for the Ore Leach/ float flowsheet
- For both flowsheets silver recoveries similar – scope for improvement
- Flotation and alkaline/acid leach of tails/concentrate (B) (aka Beaverlodge) selected as preferred process after trade-off studies by DRA



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Preferred Flowsheet (B) Refinement

- Engineering studies by DRA identified options and areas for investigation, refinement :
  - Production of saleable Ag/Cu float concentrate
  - Processes for improved Ag (and Cu) recovery from float concentrate
  - Assess options for Cu recovery
  - Use IX for U recovery, rather than direct precipitation
  - Options for silver metal production
  - Tracking of radionuclide deportment – by-product processes
  - Application of radiometric sorting
- Piloting of Milling and Flotation completed

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Concentrate Treatment

- Ag – significant value as by-product – options for recovery:
- Option A
  - After U leaching - sell Ag/Cu concentrate – Radionuclides too high
  - Leach RNs from concentrate – moderate success, low residual RNs
  - RNs possible marketing impact
- Option B
  - Oxidative acid leach – dissolve U and Cu – oxidise AgS - leach in CN
  - Ag jarosite formation/not soluble in CN
  - Alternative POX leach, roast leach, lime boil (ineffective /costly)
  - Optimised atmos. oxidative leach selected - > 85% Ag recovery

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U/Ag/Cu Recovery

- Cu successfully recovered by Fe cementation - SX an option
- U precip with MgO, successfully recovered in primary alkaline leach
- Ag recovery by Zn cementation or C adsorption demonstrated
- U recovered by IX/bicarbonate elution – SDU precip/redissolve/UO_4 precip
  - On-spec $UO_4.2H_2O$ produced

On-going work

- Production of final Ag product
- Variability study – test selected process on range of ore types

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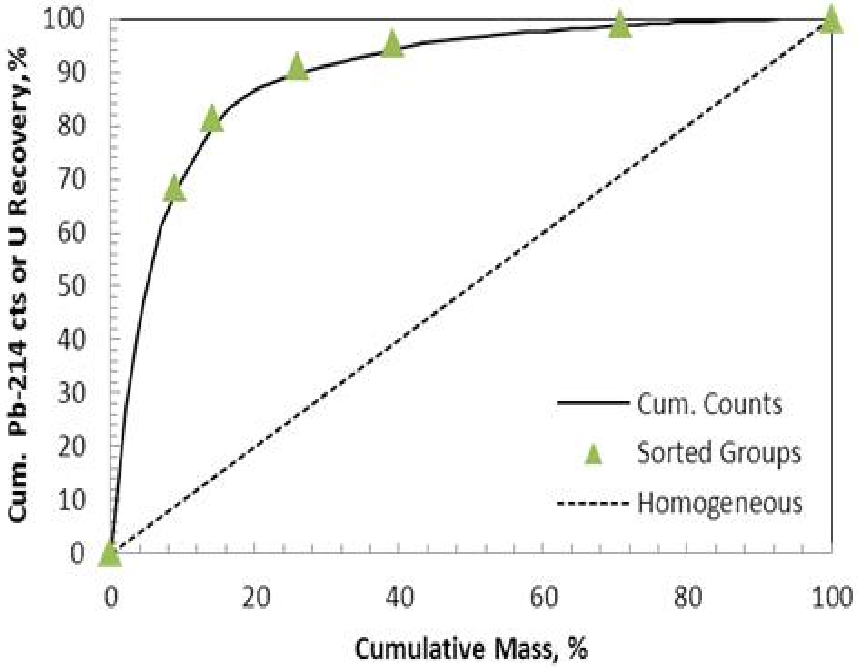
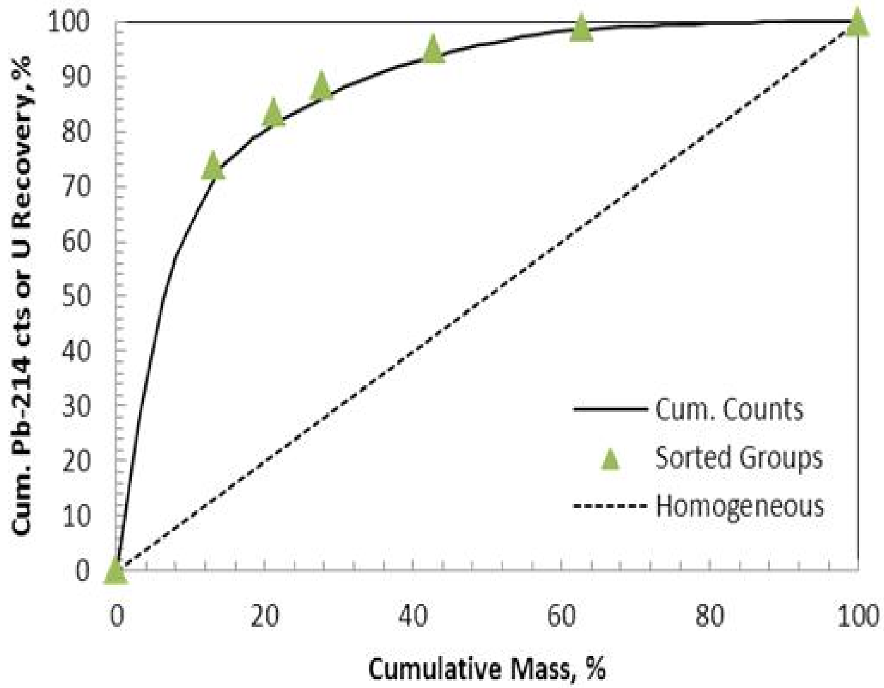
Other Enhancements

- Upgrade by radiometric sorting – lab results encouraging

-65 +38 mm



-38 +19 mm



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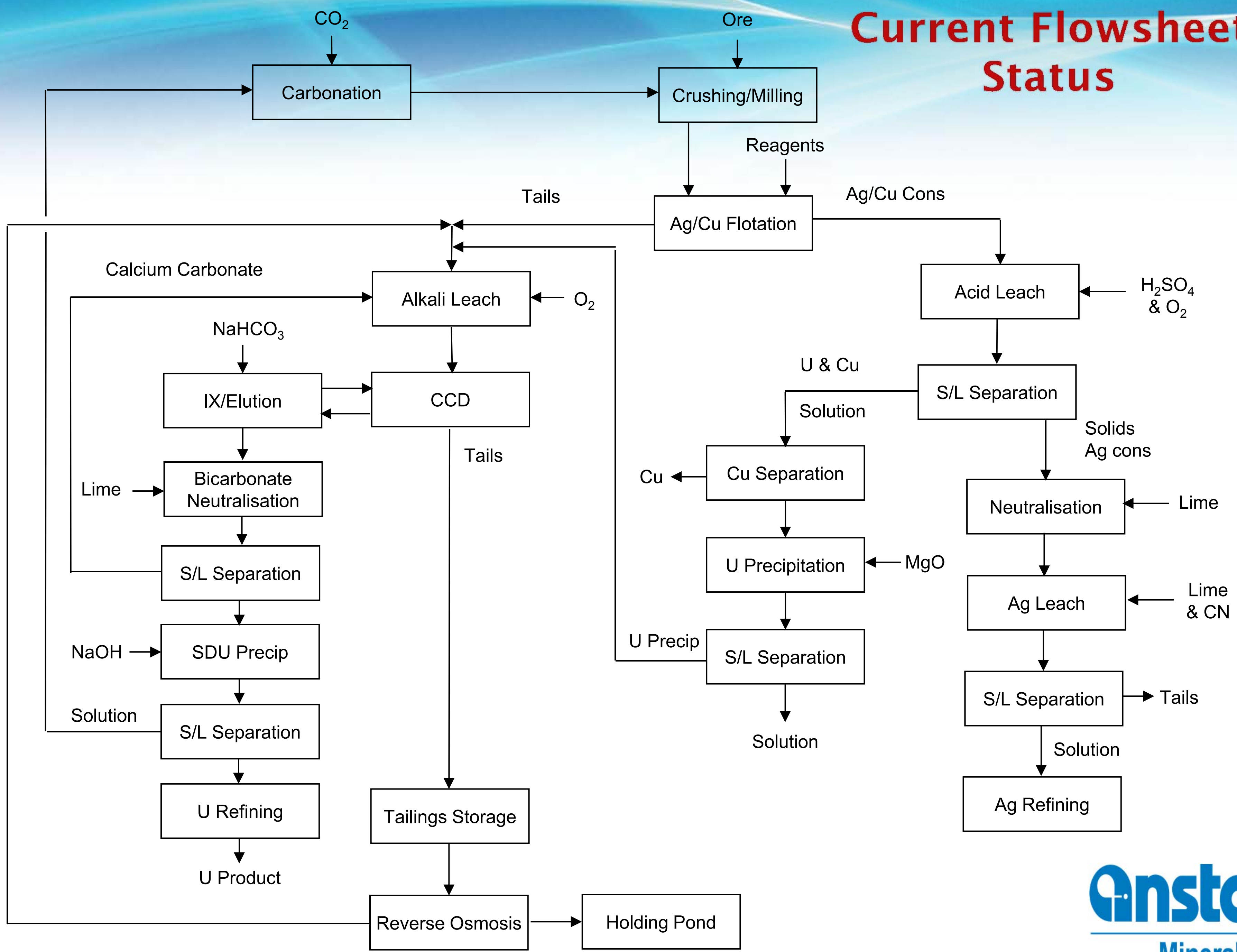
Current Flowsheet Status



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