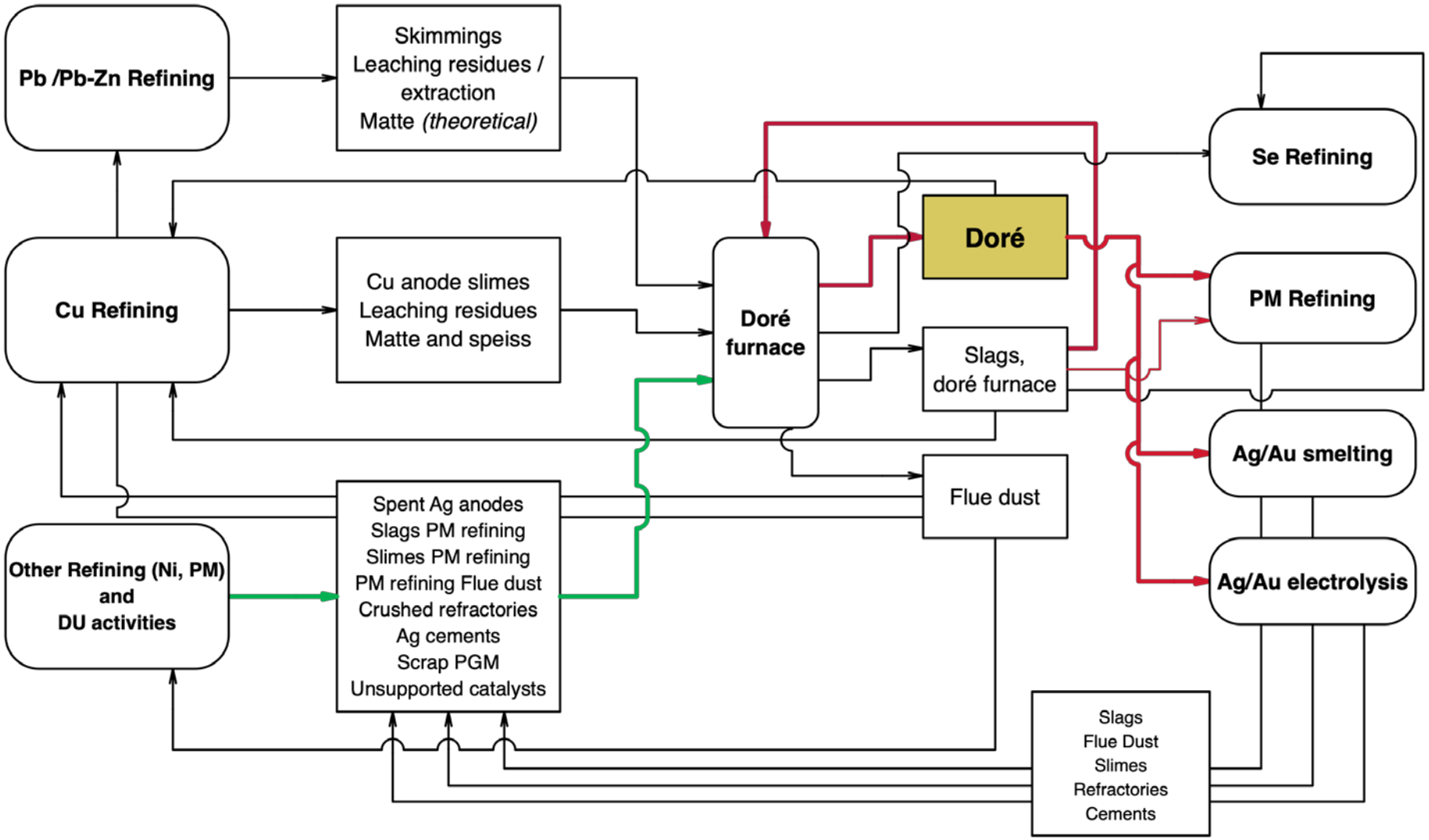
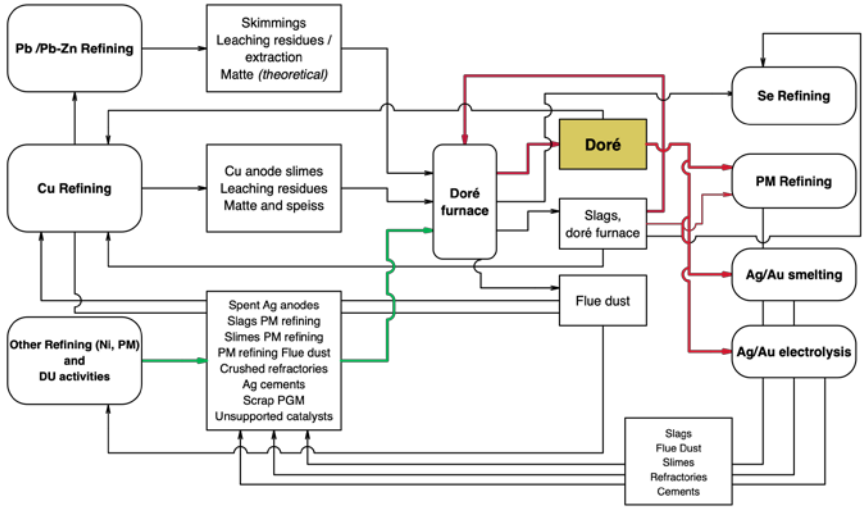
1. Production of Doré



Green/red arrows are used for influx from/outflux to precious metal sector, related to the substance discussed.

1. Production of Doré



Usual composition of Doré:

Type	Name of the element	Symbol	Species present	Typical concentration (%)	Concentration range (%)
Precious metals	Silver	Ag	Metallic	71,6	15-99
	Gold	Au	Metallic	8,5	0-83
	Iridium	Ir		0,8	0-12
	Palladium	Pd		0,90	0-5,1
	Platinum	Pt		0,63	0-2,6
	Rhodium	Rh		0,63	0-7,1
	Ruthenium	Ru		1,3	0-20
Other metals	Aluminium	Al	Al2O3	0,03	0-0,4
	Antimony	Sb	Metallic	0,07	0-1,1
	Arsenic	As	Metallic	0,07	0-0,5
	Barium	Ba	Metallic?	0,02	0-0,4
	Bismuth	Bi		0,33	0-3,1
	Cadmium	Cd	Metallic?	0,003	0-0,05
	Copper	Cu	Metallic	6,4	0-50
	Chromium	Cr		0,09	0-1,5
	Lead	Pb	Metallic	0,72	0-5,0
	Iron	Fe	Metallic	1,5	0-25
	Magnesium	Mg	MgO	0,16	0-2,5
	Nickel	Ni	Metallic?	0,47	0-7,8
	Selenium	Se	Metallic?	0,36	0-2,5
	Tellurium	Te	Metallic	2,3	0-22
	Tin	Sn	Metallic	0,07	0-1,1
	Zinc	Zn	Metallic	0,37	0-5,0
Total				97,3	

Production of Doré process:

The process known as 'production of doré' concentrates Ag, Au and PGMs from a diversity of materials in a crude PM alloy.

Also known in the trade as Gold or silver doré, Doré consists in bars/ingots or anodes and their residues (spent anodes) resulting from pyro-metallurgical processes applied on feeds with high precious metals content (primary feeds such as PM ores, Ag-rich Zn-Pb ores, etc. an/or secondary feeds such as process residues, PM/PGM-containing scrap etc.).

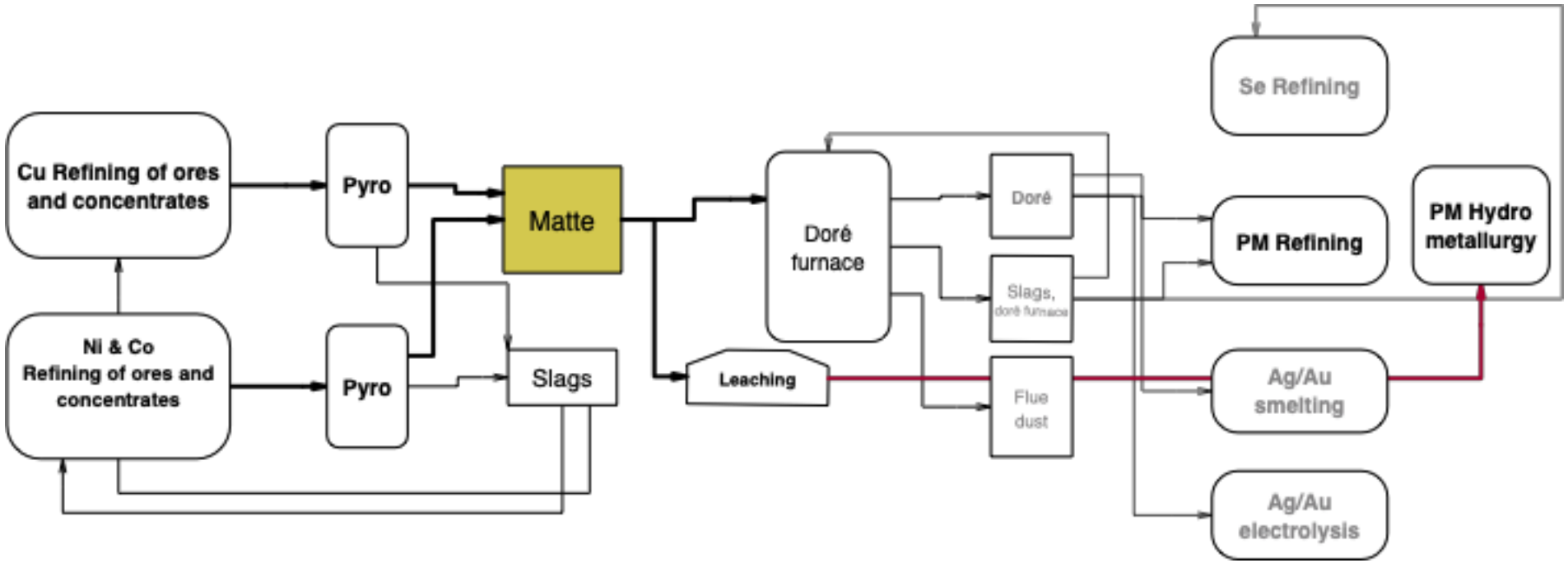
Typically, the production happens in batch-wise processes in function of the composition of the input materials which may result from prior metallurgical processes such as Matte PM or which may need to be treated before such as the drying of decoppered slime e.g.

Note on the role of lead in the production of Doré:

PM sector-specific influx materials: Pb is an impurity and has no role (not a collector). The doré will be processed in a converter where the Pb will go into the slag phase. Depending on the concentration of base metals, the slag may be sent to a base metal refiner.

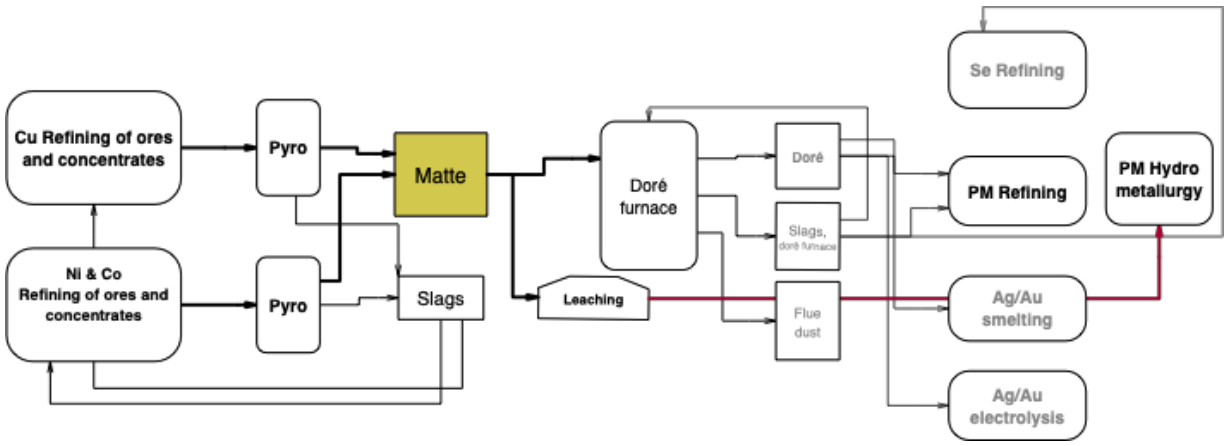
Base metal sector-specific materials:
Pb acts as collector material in the materials used for the production of Doré, but it is ***not*** a collector in the production of Doré.
Pb (as Pb drosses) can be added as **fluxing agent**.

2. Matte PM



Green/red arrows are used for influx from/outflux to precious metal sector, related to the substance discussed.

2. Matte PM



Usual composition:

Type	Name of the element	Symbol	Species present	Typical concentration (%)	Concentration range (%)
Precious metals	Silver	Ag	Sulphides	10,8	0,034 - 25
	Gold	Au	Metallic? Sulphides?	1,7	0 - 5
	Iridium	Ir	Sulphides	1,6	0 - 5
	Palladium	Pd	Sulphides	2,1	0 - 5
	Platinum	Pt	Sulphides	1,7	0 - 5
	Rhodium	Rh	Sulphides	1,6	0 - 5
	Ruthenium	Ru	Sulphides	1,6	0 - 5
Other metals	Aluminium	Al	Al2O3	0,68	0 - 2,4
	Antimony	Sb	Sulphide?	1,1	0 - 2,5
	Arsenic	As	As2O3, As2O5?	3	1,1 - 6,2
	Bismuth	Bi	Sulphide?	0,5	0 - 2,5
	Carbon	C		0,12	0 - 0,62
	Calcium	Ca	CaO	1,2	0 - 4,4
	Cadmium	Cd	CdS	0,019	0 - 0,09
	Cobalt	Co	CoS	1,3	0 - 6,5
	Chromium	Cr	Cr2O3	1	0 - 2,5
	Copper	Cu	CuS	16	6,4 - 32
	Iron	Fe	Sulphides and bound to spinels	13	0 - 32
	Lead	Pb	Sulphide	6,3	0,5 - 10
	Magnesium	Mg	MgO	0,28	0 - 1
	Manganese	Mn		0,055	0 - 0,27
	Nickel	Ni	Metallic?	15	0,31 - 32
	Sulphur	S	Metal sulphides	14	0 - 30
	Selenium	Se		0,074	0 - 0,37
	Sodium	Na		0,18	0 - 0,91
	Silicon	Si		3,9	0 - 15
	Tellurium	Te	Metallic?	1,7	0 - 5,7
	Titanium	Ti		0,04	0 - 0,19
	Tin	Sn	Sulphide?	0,91	0 - 2,1
	Zinc	Zn	ZnS	0,55	0 - 2,7
Total				102	

Matte is a substance resulting from the smelting of precious metals and its alloys obtained from primary and secondary sources and including recycled plant intermediates.
Matte, precious metal is composed primarily of base metal sulphides containing precious metals and may contain other residual non-ferrous metals and their compounds in varying concentrations.
Furhter treatment consists in either either leaching, followed by hydrometallurgical refinig or pyrometallurgical processing via the 'Doré- route'.

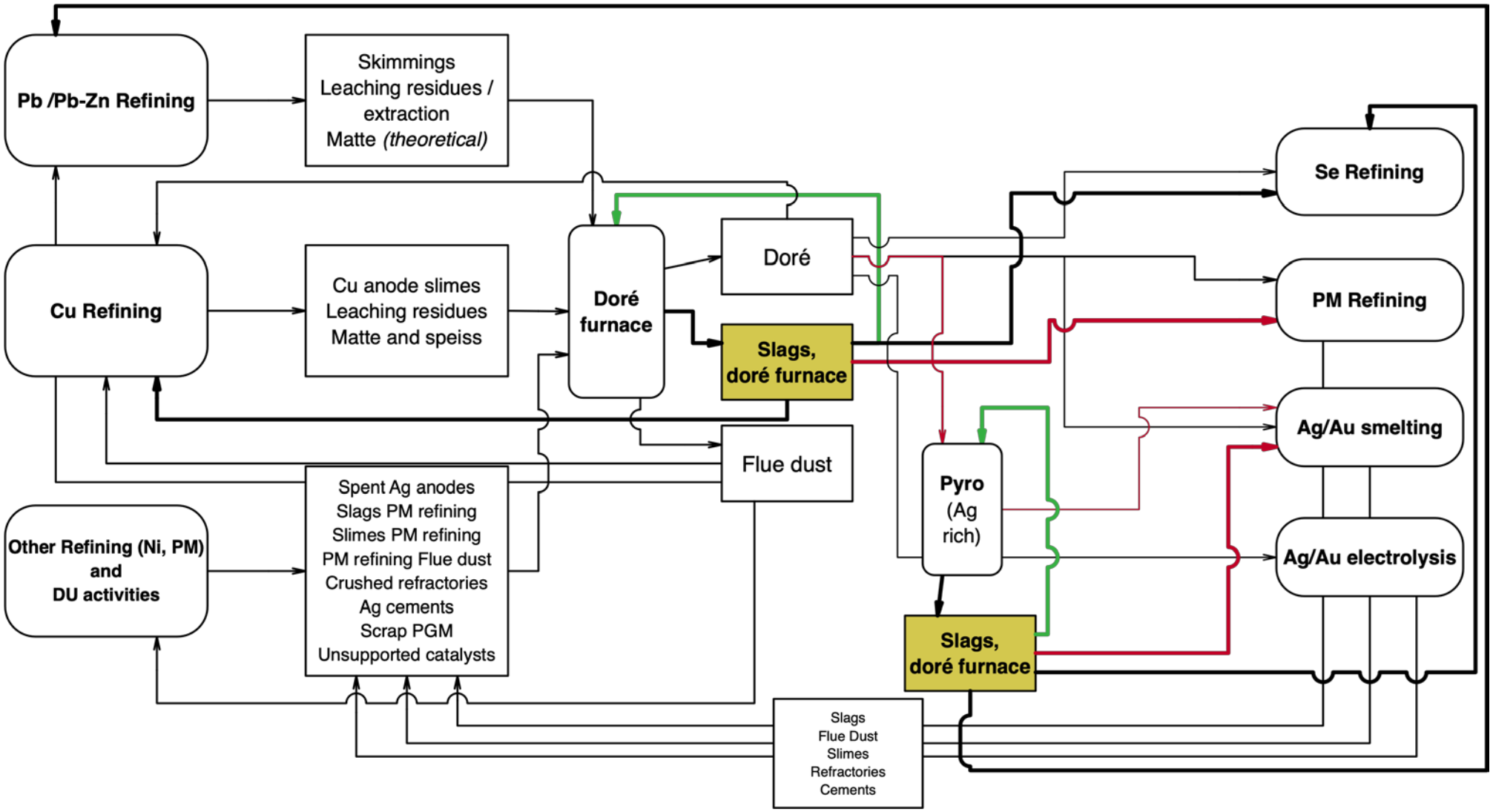
The other output from the pyrometallurgical process described above is a molten slag formed by the silica, alumina, iron oxides, calcium oxides, and other minor oxides. The slag is lighter than the matte, floating on the surface and is tapped off and sent back to the base metal refiners in order to recover the valuable base metal from it.

Note on the role of lead in the production of Matte PM:

Pb is an impurity in Cu or Ni flows where Cu or Ni are the carriers (Ni: Pb at trace level only, so mainly Cu)

Not relevant for PM sector-specific flows

3.1 Slags, doré furnace



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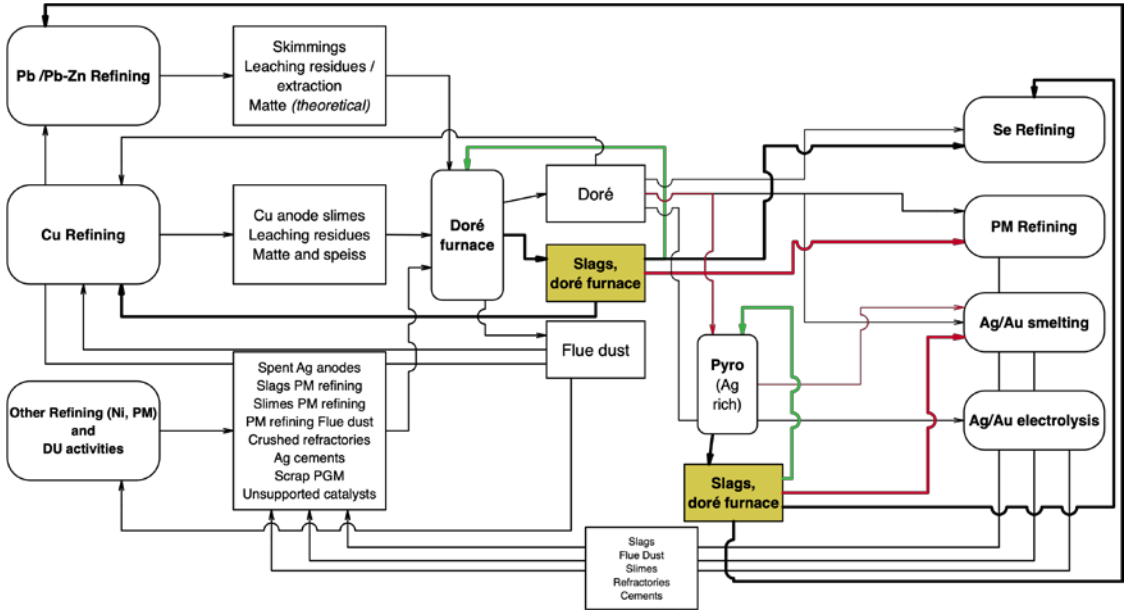
3.1 Slags, doré furnace



These slags result from precious metals refining, whether to produce doré or to further process doré. They may contain a variety of constituents, comprising metal oxides, together with added fluxing agents (borates, silicates, aluminates and carbonates).
They will either be re-smelted in a precious metal refining loop (if the precious metal content in the slag is valuable) or sent back to a base metal refinery to recover the base metal of value.
The Pb content (oxides, silicates) will depend on the input material.

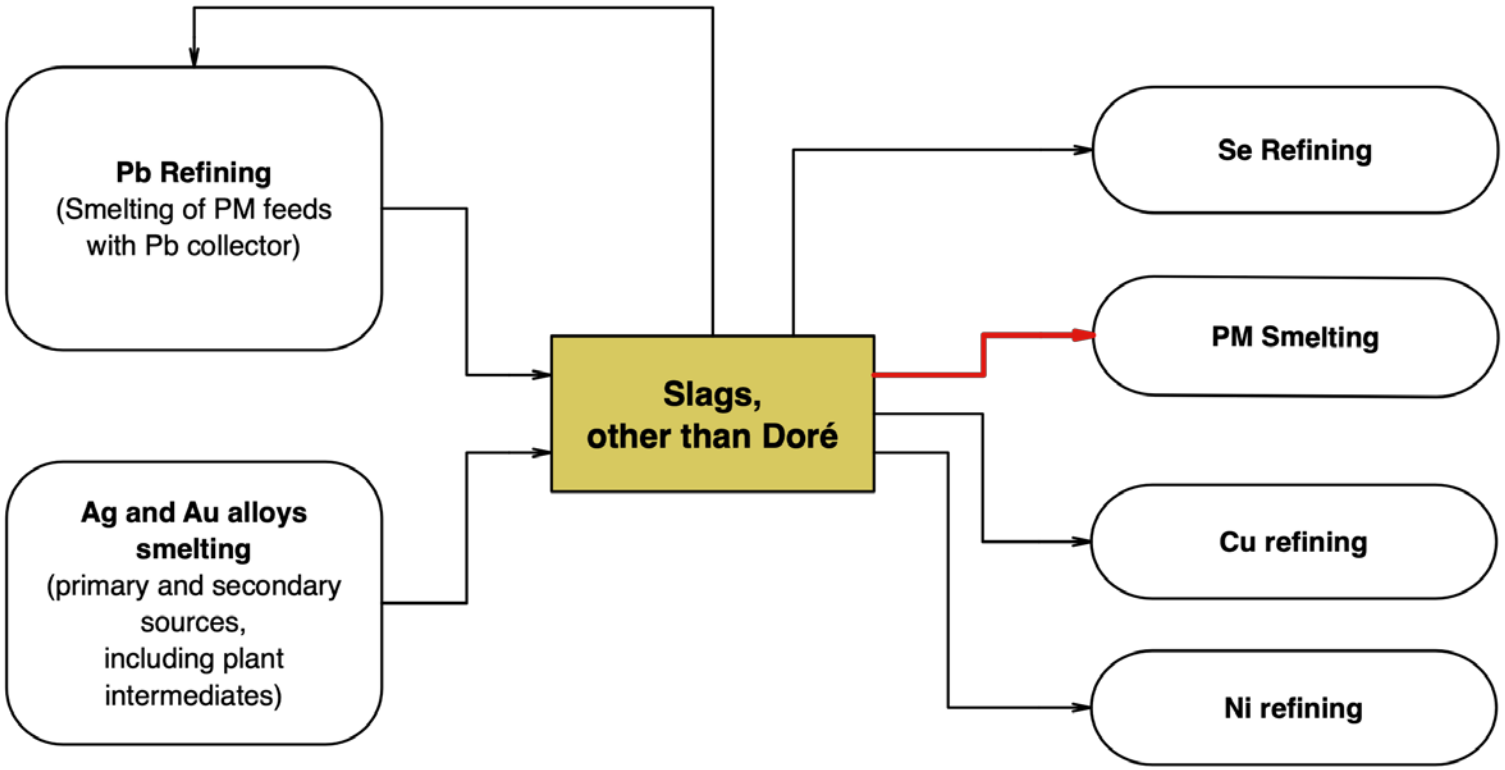
Usual composition:

Type	Name of the element	Symbol	Species present	Typical concentration (%)	Concentration range (%)
Precious metals	Silver	Ag	Metallic, oxides	2,9	0 – 7,1
	Gold	Au	Metallic?	0,4	0 - 3
	Platinum Group Metals	Ir, Pd, Pt, Rh, Ru		0,01	0 – 0,05
Other metals/ constituents	Aluminium	Al	Oxides?	0,3	0 - 2,9
	Arsenic	As	Oxides	1,1	0 - 3,9
	Boron	B	Borate, oxides	0,4	0 - 2,7
	Barium	Ba	Oxides, sulphate	3,6	0 - 16,4
	Bismuth	Bi	Oxides	0,9	0 - 2,7
	Calcium	Ca	Oxides	0,3	0 - 2,1
	Chromium	Cr	Oxides?	0,06	0 - 0,35
	Copper	Cu	Oxides, metallic	10	0,9 - 38
	Iron	Fe	Oxides	2,7	0 - 19
	Potassium	K		0,11	0 - 1
	Magnesium	Mg		0,01	0 - 0,1
	Manganese	Mn		0,002	0 - 0,02
	Sodium	Na	Oxides, carbonate, salts	3,7	0 - 14
	Nickel	Ni	Oxides	0,76	0 - 2,7
	Lead	Pb	Silicate, oxides	23	0 - 44
	Sulphur	S	Metal sulfides/sulphates	0,44	0 - 4
	Antimony	Sb	Oxides	2,6	0 - 10
	Selenium	Se		0,57	0 - 3,8
	Silicon	Si	Silicates	5,3	0 - 12
	Tin	Sn		1,9	0 - 8,7
	Strontium	Sr		0,04	0 - 0,4
	Tellurium	Te	Oxides, metallic, salts	2	0 - 10
	Zinc	Zn	Oxide, silicate?	1,5	0 – 5,1
Total				64,9	

Note on the role of lead in the production of Slags Doré furnace:

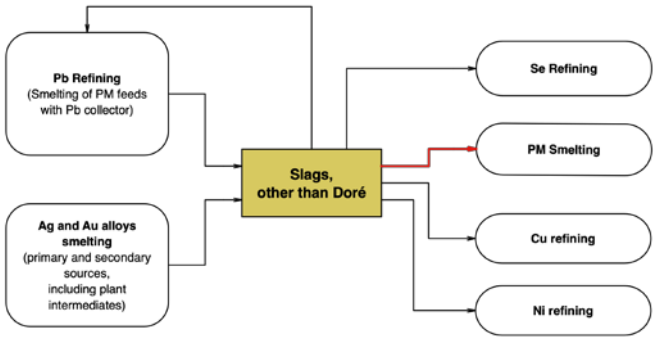
Pb can be used as a fluxing agent in the doré furnace. Other fluxes are borax or soda.

3.2 Slags, other than Doré



Green/red arrows are used for influx from/outflux to precious metal sector, related to the substance discussed.

3.2 Slags, other than Doré



These slags result from two processes whose aim is to produce a concentrated form of precious metals:

- treatment of calcined scrap metals and oxides with borax, litharge (PbO) and sodium carbonate followed by fusion
- Smelting of silver and its alloys from primary and secondary sources, including plant intermediates and and are typically rich in Si02and other gangue constituants and may contain other residual non-ferrous metals and their compounds.

They can either be re-smelted in a precious metal refining loop (if the precious metal content in the slag is valuable) or sent back to a base metal refinery to recover the base metal(s) of value.

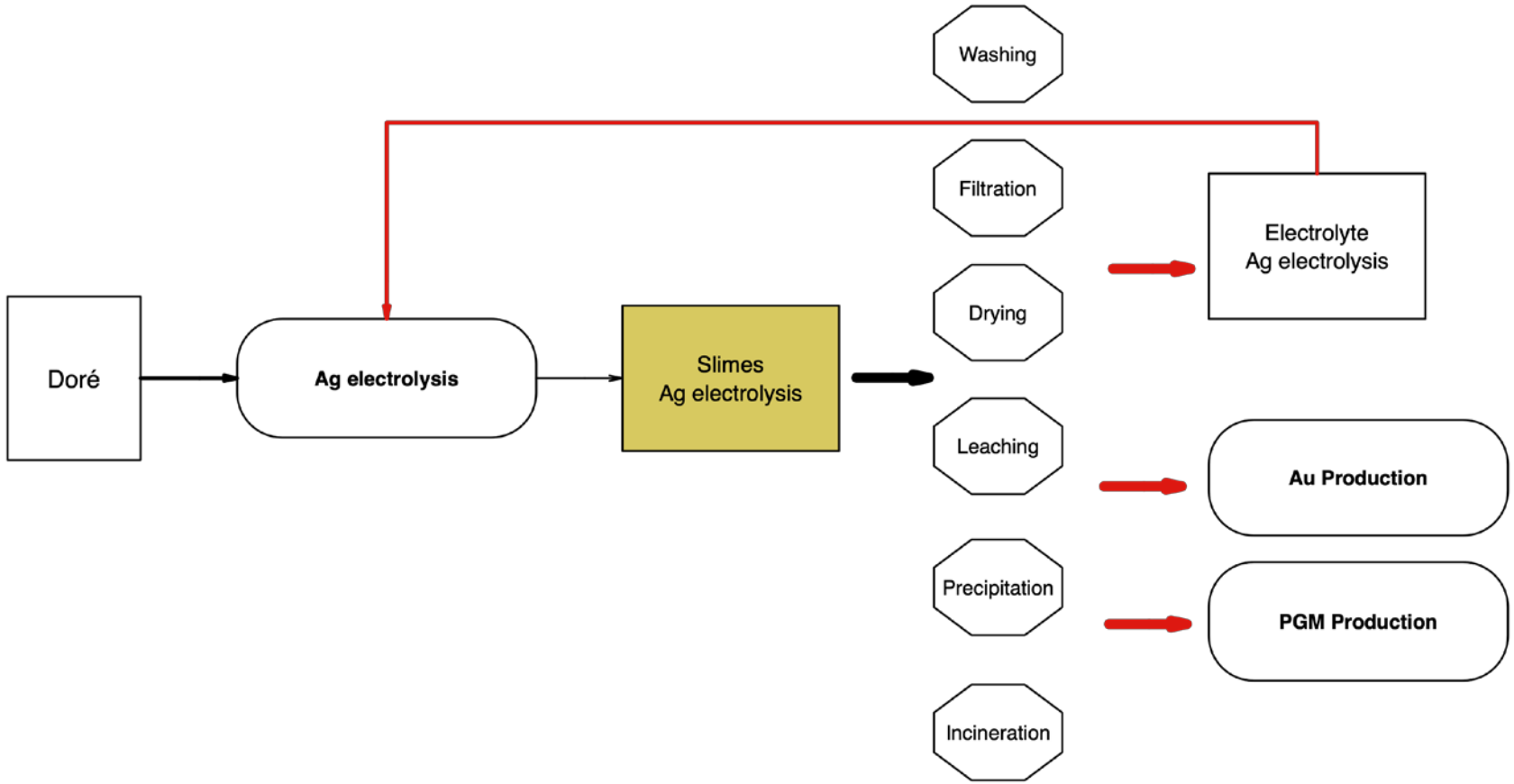
Note on the role of lead in the production of Slags, other than Doré:

No role, Pb (in metallic, oxidic or silicate form) is an impurity at very low concentration

Usual composition:

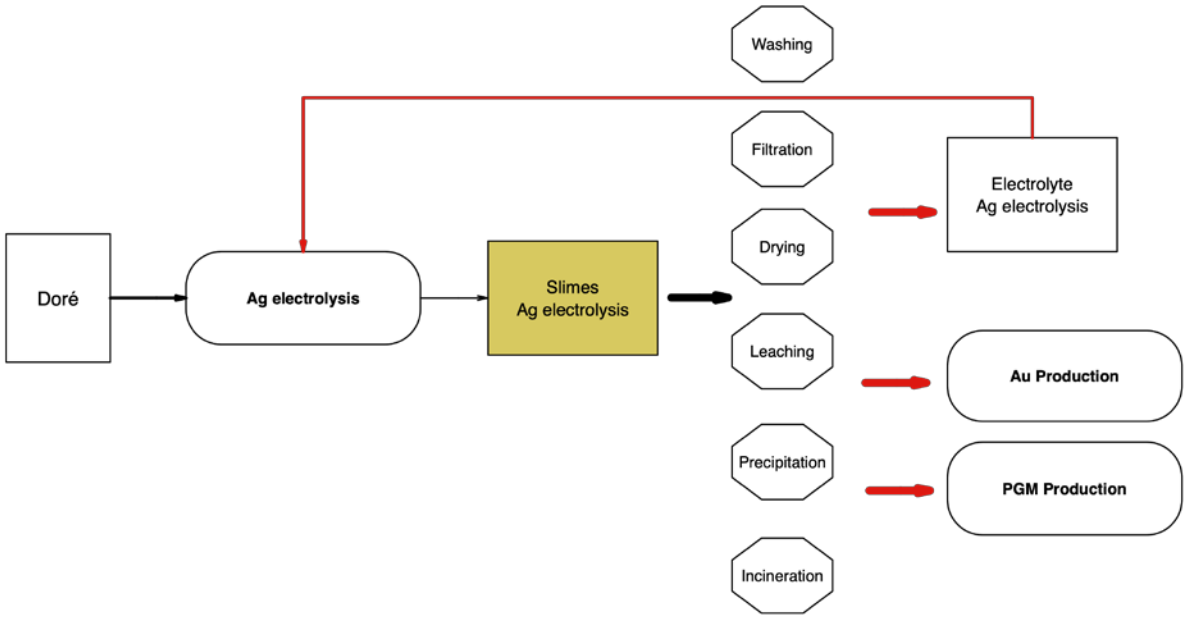
Type	Name of the element	Symbol	Species present	Typical concentration (%)	Concentration range (%)
Precious metals	Silver	Ag	Metallic, oxides	0,25	0 - 0,9
	Gold	Au	Metallic?	0,2	0 - 0,7
	Iridium	Ir	Metallic?	0,06	0 - 0,3
	Palladium	Pd	Metallic?	0,07	0 - 0,3
	Platinum	Pt	Metallic?	0,07	0 - 0,3
	Rhodium	Rh	Metallic?	0,06	0 - 0,3
	Ruthenium	Ru	Metallic?	0,06	0 - 0,3
Other metals/ constituents	Aluminium	Al	Oxides, silicates	6,4	3 - 11,5
	Arsenic	As	Oxides, silicates	0,01	0 - 0,04
	Boron	B	Borate, oxides, silicates	1,2	0 - 5,6
	Barium	Ba	Oxides, silicates	1,8	0,04 - 8
	Bismuth	Bi	Oxides	0,02	0 - 0,1
	Carbon	C		1,7	0 - 4,7
	Calcium	Ca	Oxides, silicates	7,7	1,5 - 20
	Cadmium	Cd	Oxides	0,002	0 - 0,01
	Cesium	Ce	Oxides	0,4	0 - 2
	Chlorine	Cl		0,4	0 - 1
	Cobalt	Co	Oxides, silicates sulfide	0,07	0,01 - 0,25
	Chromium	Cr	Oxides, silicates	0,7	0,3 - 1,5
	Copper	Cu	Oxides, silicates sulfide	0,4	0,1 - 1
	Iron	Fe	Oxides, silicates	6,4	3 - 10
	Potassium	K	Oxides	0,45	0 - 1,2
	Magnesium	Mg	Oxides, silicates	1,8	0,2 - 6,5
	Manganese	Mn	Oxides, silicates	0,2	0,05 - 0,4
	Sodium	Na	Oxides, silicates, chloride	17	0,1 - 45
	Nickel	Ni	Oxides, silicates, sulphide, metallic	0,16	0,05 - 0,3
	Phosphor	P	Phosphates	0,15	0 - 0,5
	Lead	Pb	Oxides, silicates, metallic	0,36	0,02 - 0,9
	Sulphur	S	Metal sulfides/sulphates	0,19	0 - 0,4
	Antimony	Sb	Oxides, silicates	0,03	0 - 0,1
	Selenium	Se	Oxides, silicates	0,08	0 - 0,2
	Silicon	Si	Silicates	17	13 - 20
	Tin	Sn	Oxides, silicates	0,11	0 - 0,2
	Strontium	Sr		0,07	0 - 0,3
	Tellurium	Te	Oxides, silicates	0,01	0 - 0,05
	Titanium	Ti	Oxides, silicates	0,65	0,2 - 2
	Zinc	Zn	Oxides, silicates	0,81	0 - 1,8
	Zirconium	Zr	Oxides, silicates	1,2	0,2 - 2,7
Total				68,2	

4.1 Slimes, Ag electrolysis



Green/red arrows are used for influx from/outflux to precious metal sector, related to the substance discussed.

4.1 Slimes, Ag electrolysis



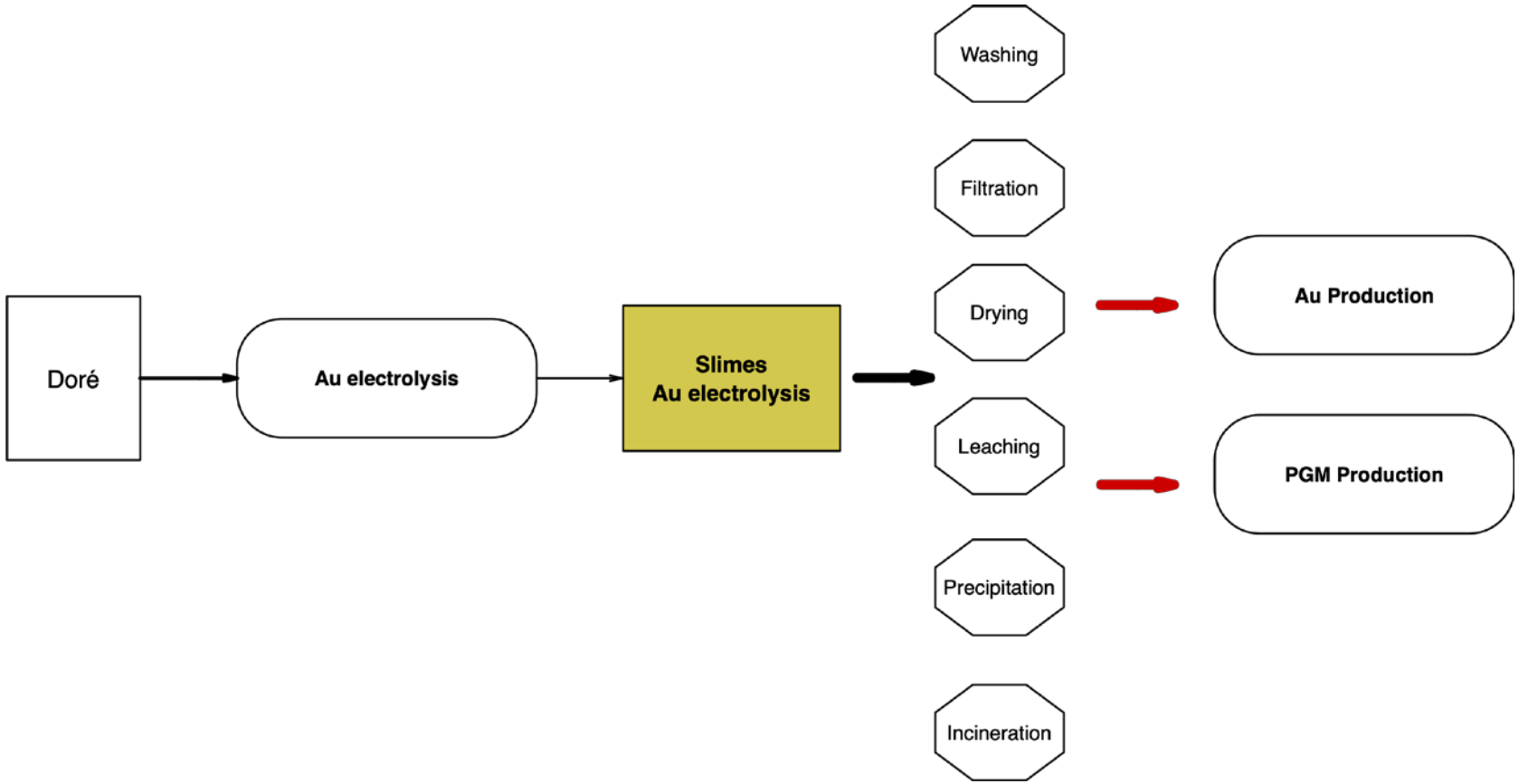
Bullion containing silver (from Doré production) is treated in cells charged with a nitric electrolyte. These cells produce fine silver and leave a residue that may be rich in gold.
Process: The residue (slime) from the silver-cells will go through a process that will i.a. provide an electrolyte for the silver cells (Ag electrolysis).

Note on the role of lead in the production of Slags, Ag electrolysis:

This PM concentration **does not intentionally contain lead** (only impurity) as lead would interfere with the further PM extraction and purification.

In flows from Ag electrolysis, Pb as nitrate remains in the electrolyte and needs to be removed.

4.2 Slimes, Au electrolysis



Note on the role of lead in the production of Slimes, Au electrolysis

This PM concentration **does not intentionally contain lead** (only impurity) as lead would interfere with the further PM extraction and purification.

Insufficient info

Green/red **arrows** are used for influx from/outflux to **precious metal sector, related to the substance discussed.**

4.3 Residues from PM leaching and dissolution

Note on the role of lead in the production of Slimes, Au electrolysis

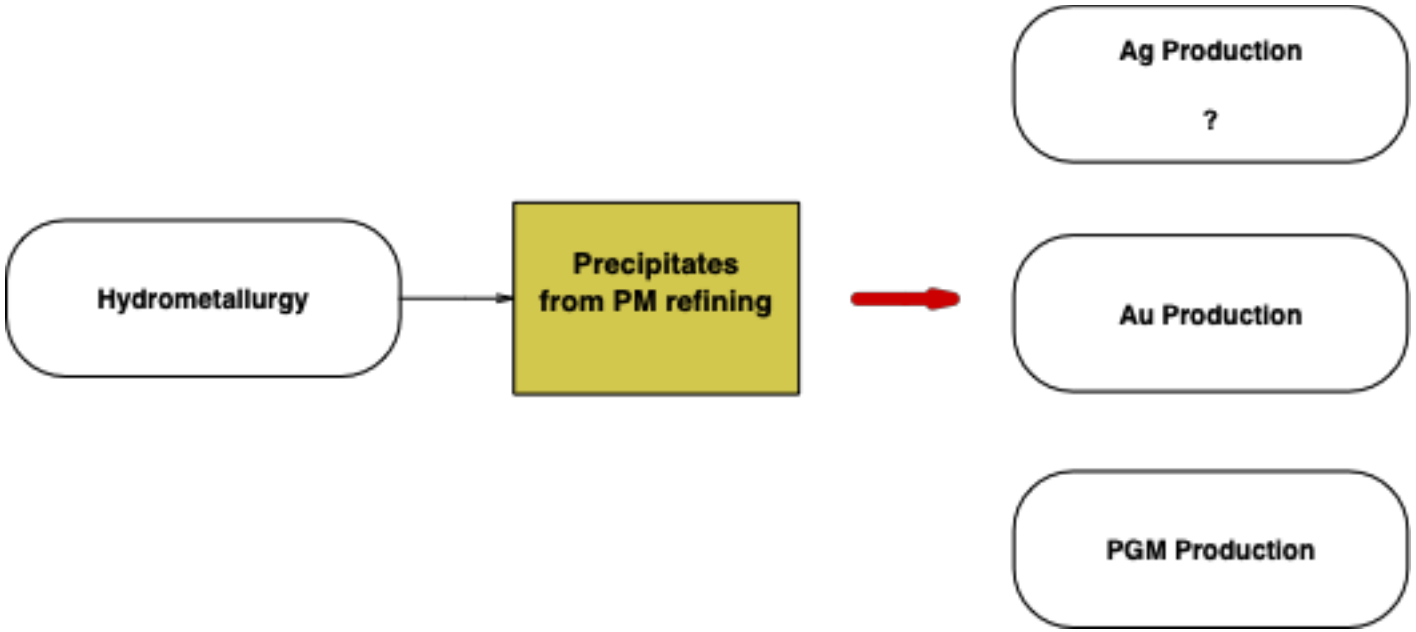
This PM concentration **does not intentionally contain lead** (only impurity) as lead would interfere with the further PM extraction and purification.

This substance – in a solid phase - results from a leaching and dissoulution step in a hydrometallurgical process.

Insufficient info

Green/red **arrows** are used for influx from/outflux to **precious metal sector, related to the substance discussed.**

4.4 Precipitates from PM refining



Note on the role of lead in the production of Precipitates from PM refining

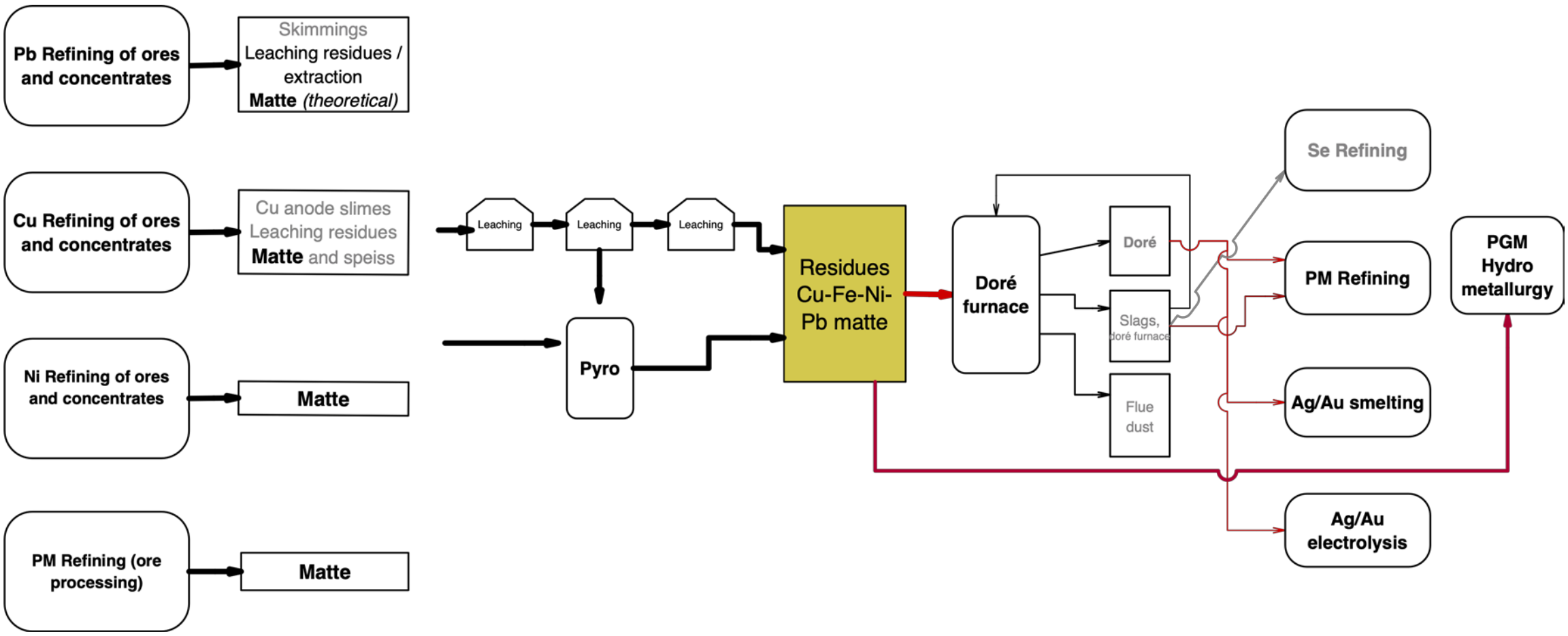
This PM concentration **does not intentionally contain lead** (only impurity) as lead would interfere with the further PM extraction and purification.

This substance – in a solid phase- results from precipitation and crystallisation step in a hydrometallurgical process.

Insufficient info

Green/red **arrows** are used for influx from/outflux to **precious metal sector, related to the substance discussed.**

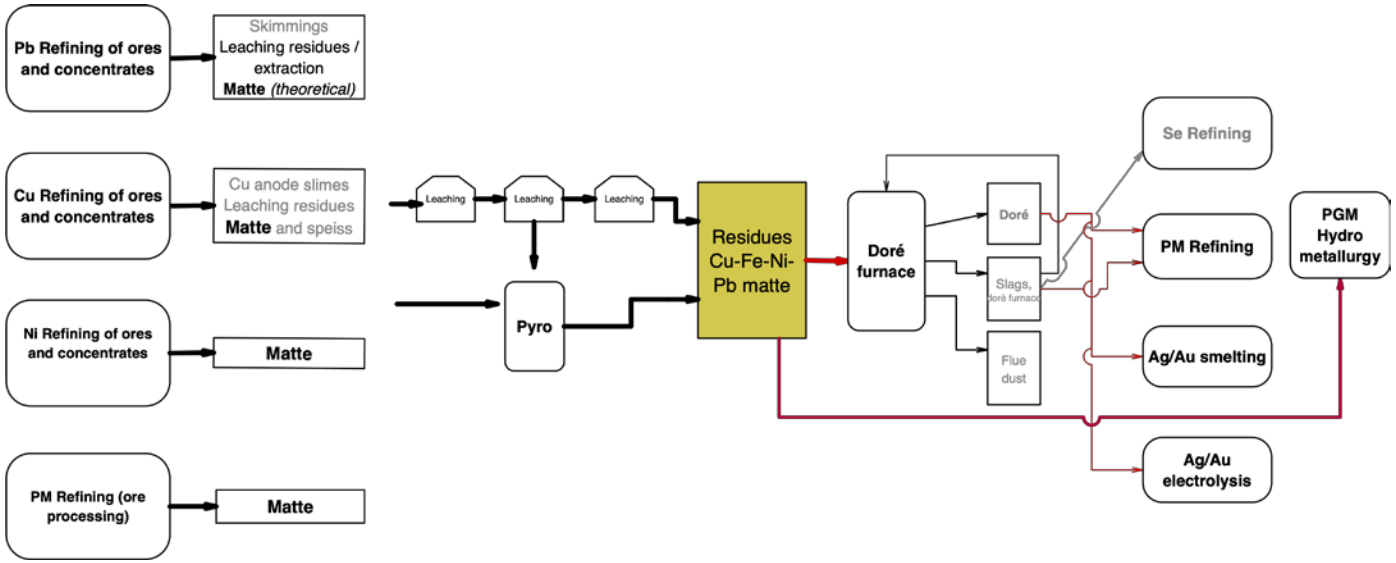
5.1 Residues, copper-iron-lead-nickel matte, sulfuric acid-insol



Green/red arrows are used for influx from/outflux to precious metal sector, related to the substance discussed.

5.1 Residues, copper-iron-lead-nickel matte, sulfuric acid-insol.

Usual composition:



Type	Name of the element	Symbol	Species present	Typical concentration (%)	Concentration range (%)
Precious metals	Silver	Ag	Metallic	6,7	0 - 20
	Gold	Au	Metallic	0,83	0 - 2,5
	Iridium	Ir	Metallic	4,2	0 - 10
	Palladium	Pd	Metallic	12	0 - 25
	Platinum	Pt	Metallic	12	0 - 25
	Rhodium	Rh	Metallic	4,7	0 - 10
	Ruthenium	Ru	Metallic	5	0 - 10
Other metals/ constituents	Aluminium	Al	Al2O3, biotite	0,73	0 - 1,2
	Arsenic	As	As2O3	2,3	2 - 2,6
	Barium	Ba	BaO	0,33	0 - 1
	Bismuth	Bi		0,33	0 - 1
	Calcium	Ca	CaO	2,5	0 - 7,5
	Cobalt	Co	Metallic	0,15	0 - 0,5
	Chromium	Cr	Cr2O3, FeCr2O4	0,39	0 - 1,1
	Copper	Cu	Cu2O, CuSO4, CuS-Cu9S5, CuFeS2	17	6 - 28
	Iron	Fe	Fe3O4, NiFe2O4, Fe3S5O21, FeCr2O4, FeS-FeS2, FeO(OH), (FeNi)9S8	16	7,8 - 22
	Potassium	K	K2O	0,12	0 - 0,4
	Magnesium	Mg	MgO	0,4	0 - 1
	Manganese	Mn	MnO	0,34	0 - 1
	Sodium	Na		0,31	0 - 0,93
	Nickel	Ni	NiSO4, NiFe2O4, (FeNi)9S8	3,3	2,6 - 4,5
	Lead	Pb	PbS	1,6	0,4 - 3,5
	Sulphur	S	Metal sulfides/sulphates	9,3	3 - 14
	Antimony	Sb	Metallic	0,92	0,2 - 1,6
	Selenium	Se	CuSe	3,8	0 - 6
	Silicon	Si	SiO2	3,6	1,2 - 7,5
	Tin	Sn	Metallic	0,36	0 - 1
	Tellurium	Te	Metal telluride	4,2	0 - 10
	Zinc	Zn		2,5	0 - 7,5
Total				116	

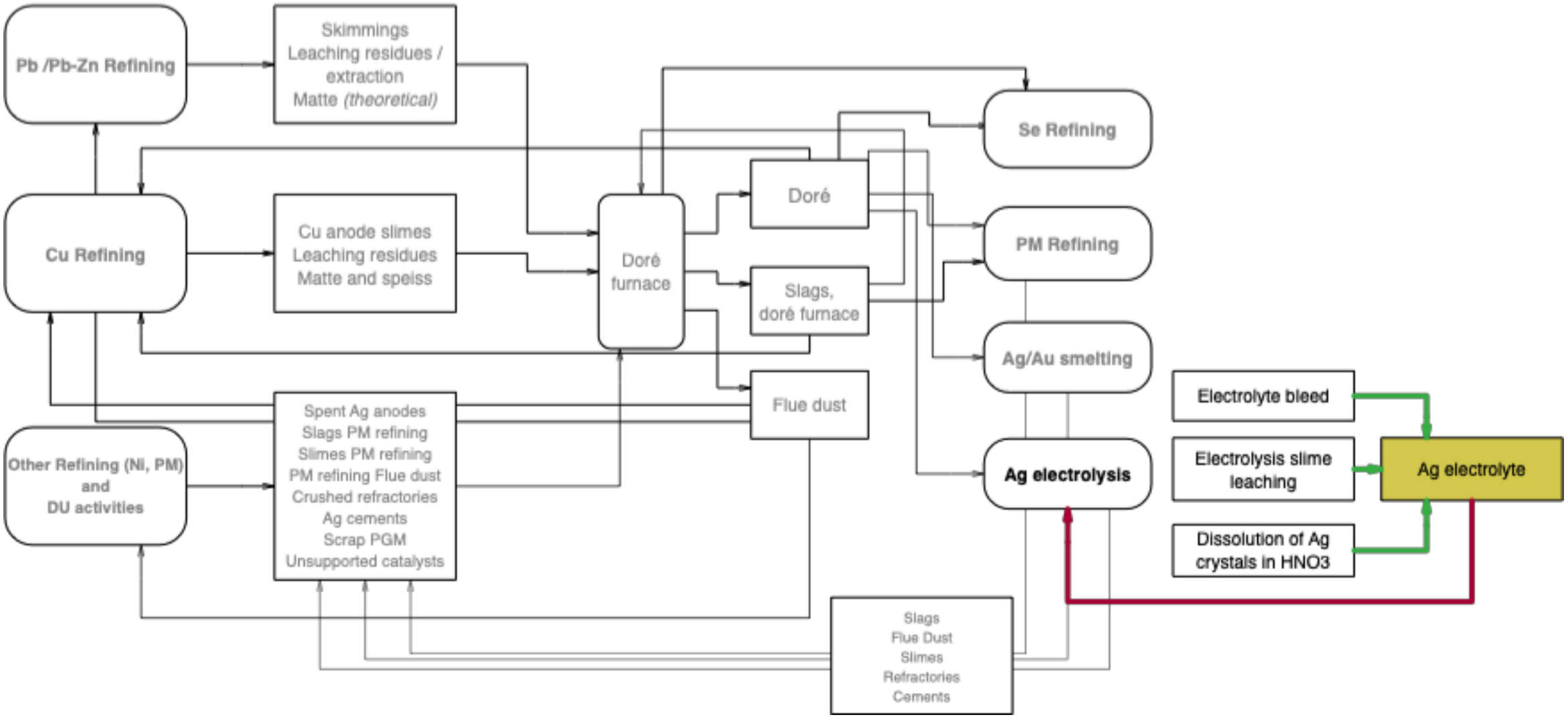
The substance consists in dry or wet insoluble residues resulting from successive sulfuric acid-based leaching and/or pyro-metallurgical processes applied on primary and secondary streams originating from the refining of copper, nickel and other base metals- containing ores and concentrates.

Residues from copper-iron-lead-nickel matte leaching mainly contain precious and base metals such as copper, nickel and iron in metallic, sulphate, hydroxide and other mineral forms in varying concentrations.

Note on the role of lead in the production of Residues, Cu-Fe-Pb-Ni matte, sulfuric acid insol.

Pb: is an impurity with no function

6.1 Ag electrolyte



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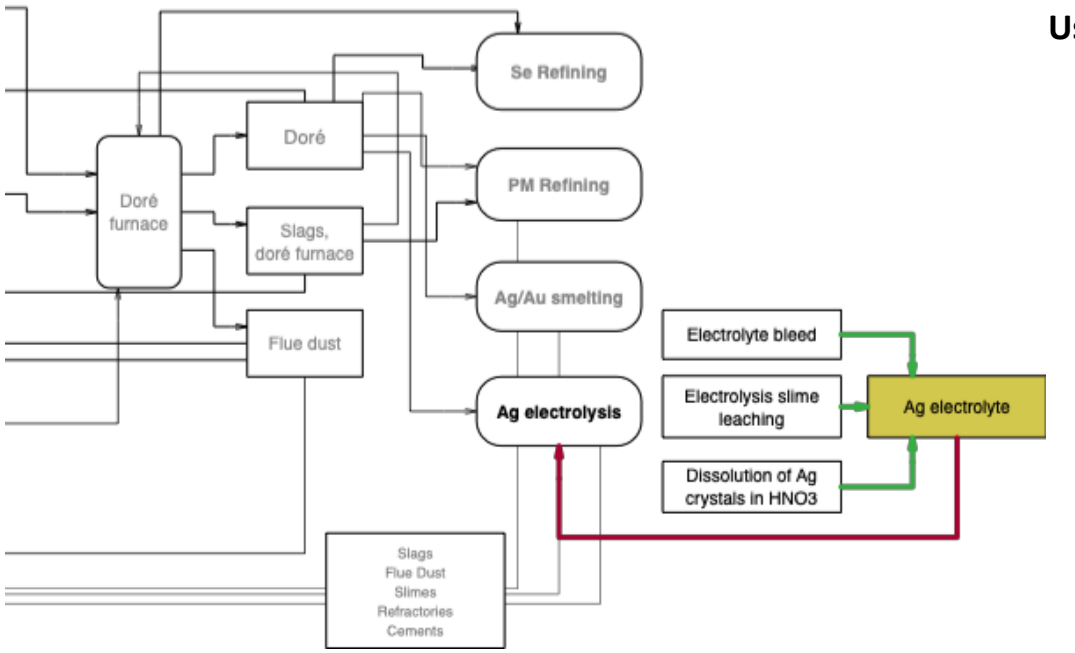
6.1 Ag Electrolyte



Usual composition:

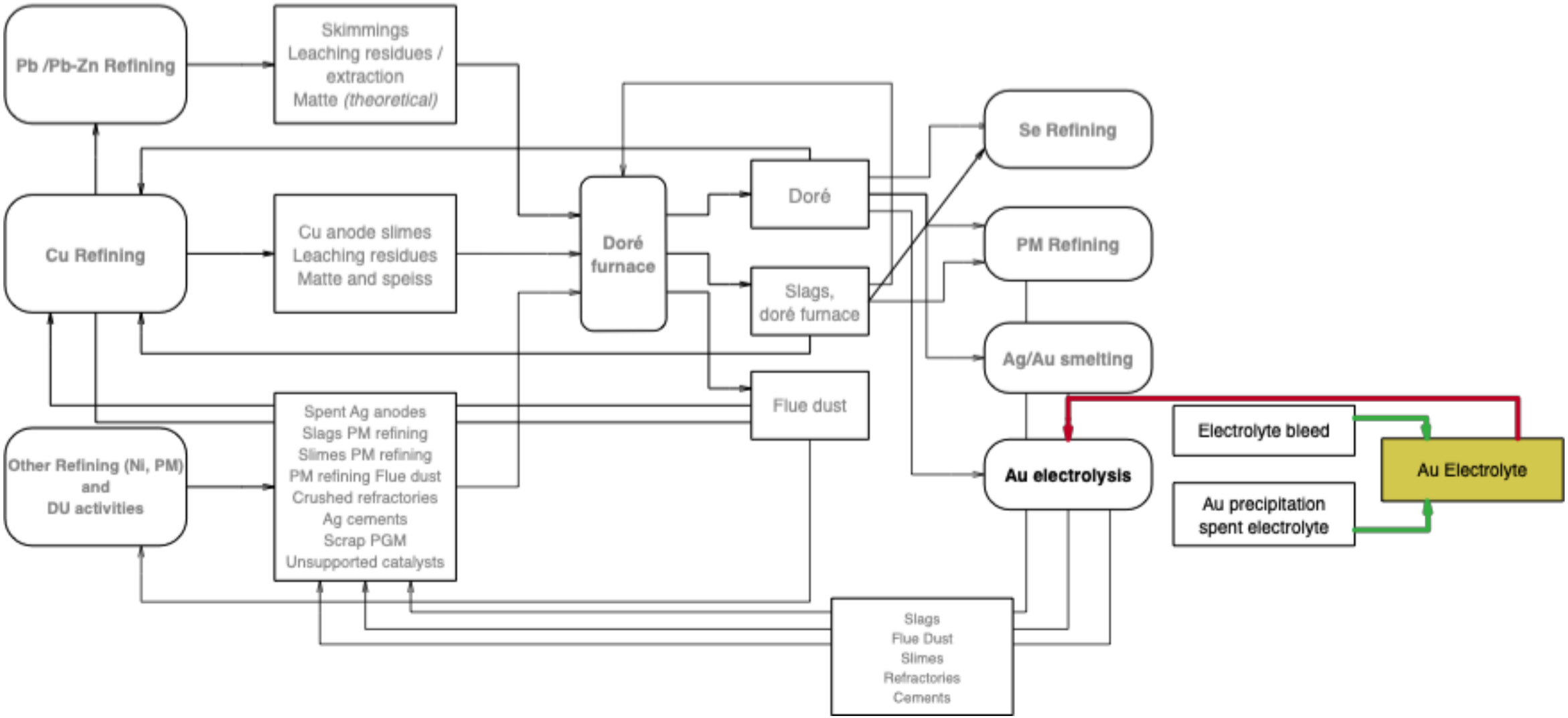
Type	Name of the element	Symbol	Species present *(one line per species)*	Usual concentration ranges (%)
Precious metals	Silver	Ag	AgNO3	7,5-21
	Palladium	Pd		0-3
	Platinum	Pt		0-0,2
Other metals	Cadmium	Cd		0-0,5
	Copper	Cu	Cu(NO3)2	0-30
	Lead	Pb	Pb(NO3)2	0-2
	Tin	Sn		0-1
	Zinc	Zn		0-5
Other constituents	Nitrogen	N	HNO3	0,02-0,7
	Water	H20	Water	0-76

Fresh or spent aqueous silver nitrate solution used in and resulting from the electrolytic refining of silver.
This electrolyte is constituted of silver nitrate, copper dinitrate, nitric acid, and it may contain some other metallic and non-metallic ions in varying concentrations, which will vary depending on the nature and composition of the primary or secondary raw material from which silver is recovered.

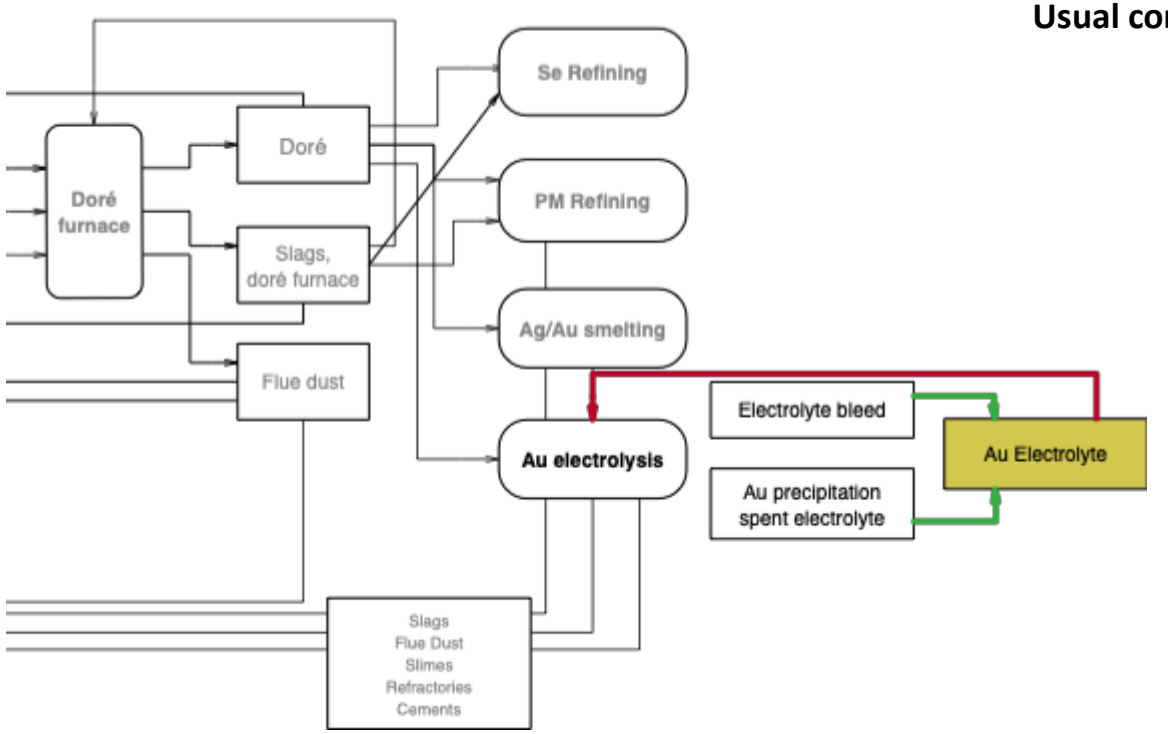
Note on the role of lead in the production of Ag electrolyte

Pb is present at very low concentration (trace)

6.2 Au electrolyte



6.2 Au electrolyte



Usual composition:

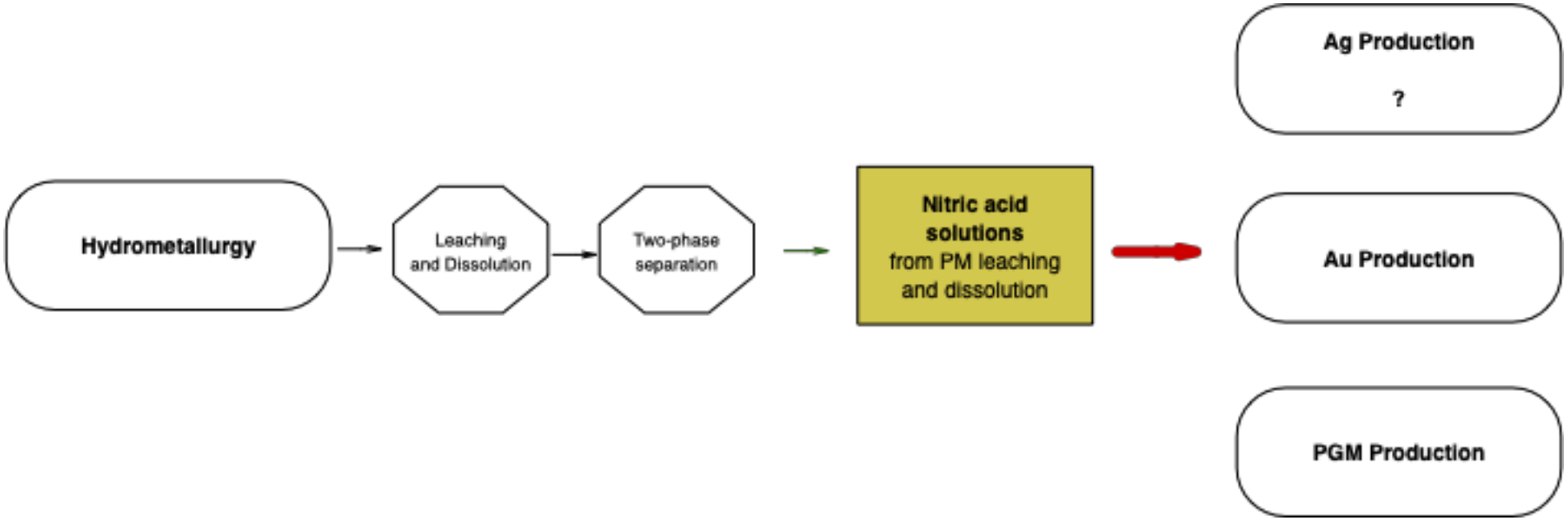
Type	Name of the element	Symbol	Species present *(one line per species)*	Typical concentration range
Precious metals	Gold	Au	AuCl4	0-33
	Iridium	Ir		0-2,5
	Palladium	Pd		0-2,5
	Platinum	Pt		1-29
	Rhodium	Rh		0-2,5
	Ruthenium	Ru		0-2,5
Other Metals	Copper	Cu		0-2
Other constituents	Chlorine	Cl	HCl	0-17,5
	Water	H20	Water	0-43

Fresh or spent aqueous gold trichloride solution used in and resulting from the electrolytic refining of gold.
This electrolyte is constituted of gold trichloride, clorhidric acid, and it may contain some other metallic and non-metallic ions in varying concentrations, which will vary depending on the nature and composition of the primary or secondary raw material from which gold is recovered.

Note on (the role of) lead in the production of Au electrolyte

Pb is not present

6.3 Nitric acid solutions from PM leaching and dissolution



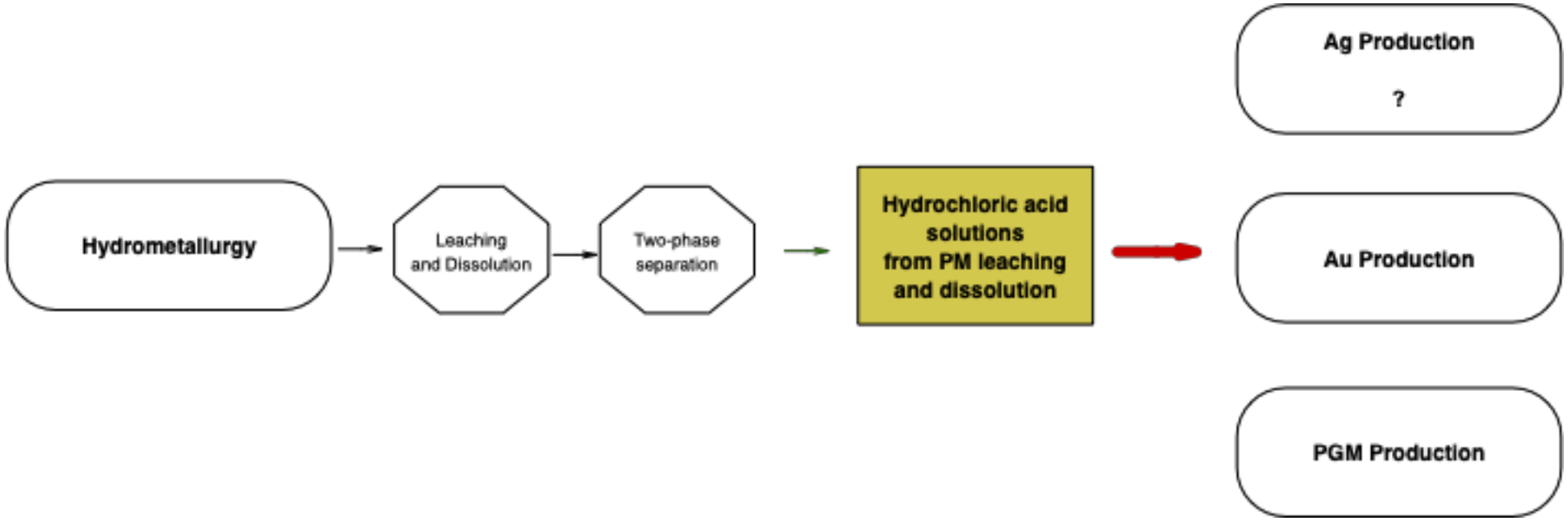
This substance – in a liquid phase- results from precipitation and crystallisation step in a hydrometallurgical process.

Note on (the role of) lead in the production of Nitric acid solutions from PM leaching and dissolution

Pb is not present

Insufficient info

6.4 Hydrochloric acid solutions from M leaching and dissolution



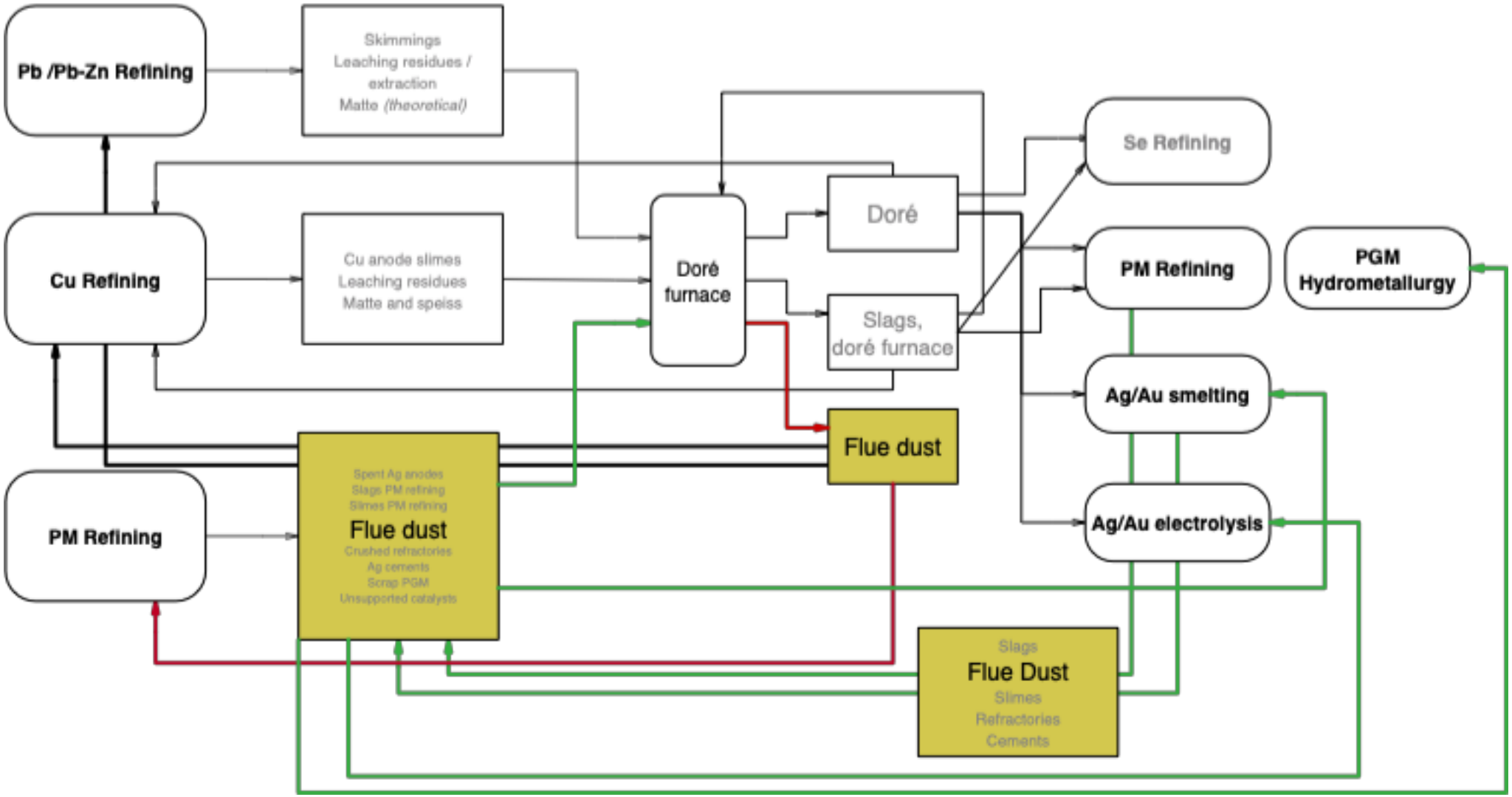
This substance – in a liquid phase- results from precipitation and crystallisation step in a hydrometallurgical process.

Note on (the role of) lead in the production of Hydrochloric acid solutions from PM leaching and dissolution

Pb is not present

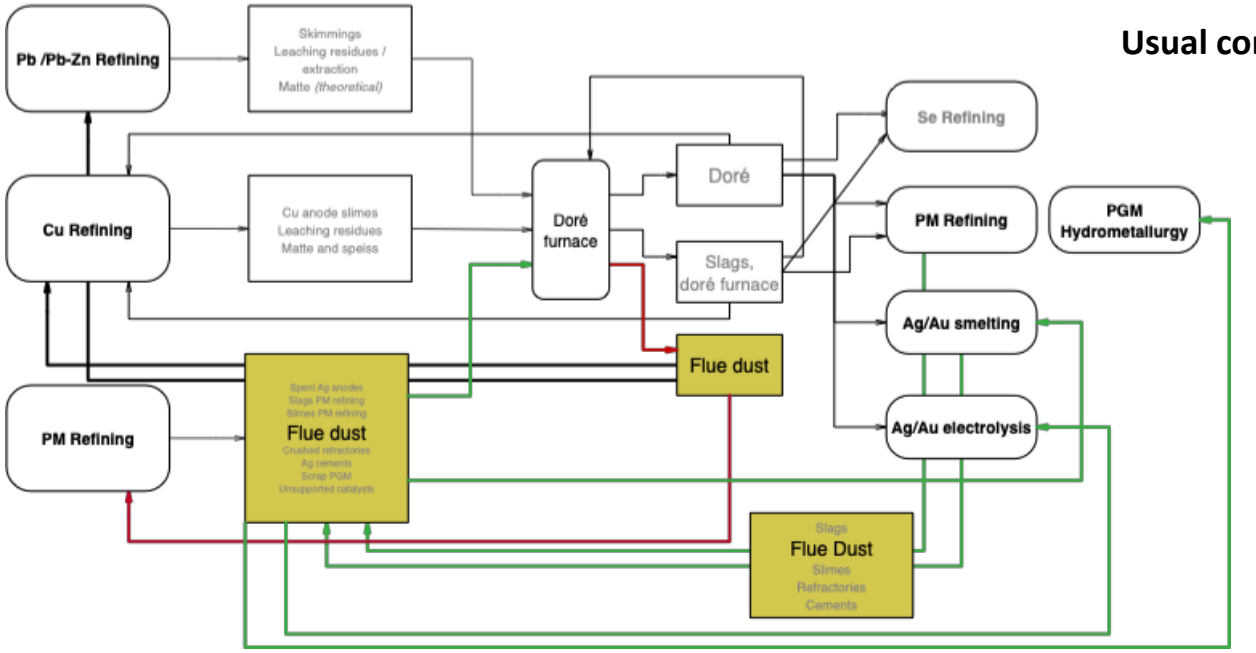
Insufficient info

7. Flue dust, precious metal refining



Green/red arrows are used for **influx from/outflux to precious metal sector, related to the substance discussed.**

7. Flue dust, precious metal refining



Usual composition:

Type	Name of the element	Symbol	Species present	Typical concentration (%)	Concentration range (%)
Precious metals	Silver	Ag	Ag2O, sulphide, etc.	8,5	0,3 - 18
	Gold	Au		0,08	0 - 0,25
	Iridium	Ir		1,4	0 - 7,5
	Osmium	Os		0,17	0 - 1
	Palladium	Pd		1,4	0 - 7,5
	Platinum	Pt		1,4	0 - 7,5
	Rhodium	Rh		1,4	0 - 7,5
	Ruthenium	Ru		1,4	0 - 7,5
Other metals/ constituents	Aluminium	Al	Al2O3	1,1	0 - 5,5
	Arsenic	As	Pb3(AsO4)2	0,64	0 - 1,2
	Boron	B		0,27	0 - 1,5
	Bismuth	Bi	Bi(OH)3	2,3	0,1 - 7,5
	Bromine	Br		0,08	0 - 0,5
	Calcium	Ca	CaO	3,2	0 - 11
	Cadmium	Cd		0,32	0 - 1,3
	Cerium	Ce		0,25	0 - 1,5
	Chlorine	Cl		9,8	0 - 23
	Chromium	Cr	Cr203	0,11	0 - 0,6
	Copper	Cu	Cu(OH)2	4,3	0,55 - 9,7
	Fluorine	F		0,02	0 - 0,09
	Iron	Fe		1,7	0 - 9,7
	Potassium	K		1,2	0 - 4,6
	Sodium	Na		1,9	0 - 7,5
	Nickel	Ni		0,35	0 - 1,1
	Lead	Pb	PbO, Pb(OH)2, Pb3(AsO4)2	18	2,8 - 50
	Sulphur	S		1,5	0 - 4,5
	Antimony	Sb	Sb(OH)3	0,69	0 - 2,2
	Selenium	Se		5,6	0 - 25
	Silicon	Si	SiO2	1,15	0 - 6,5
	Tin	Sn		1,2	0 - 3
	Tellurium	Te		1,8	0 - 6,8
	Zinc	Zn	ZnO	8,4	0 - 15,5
Total				81,6	

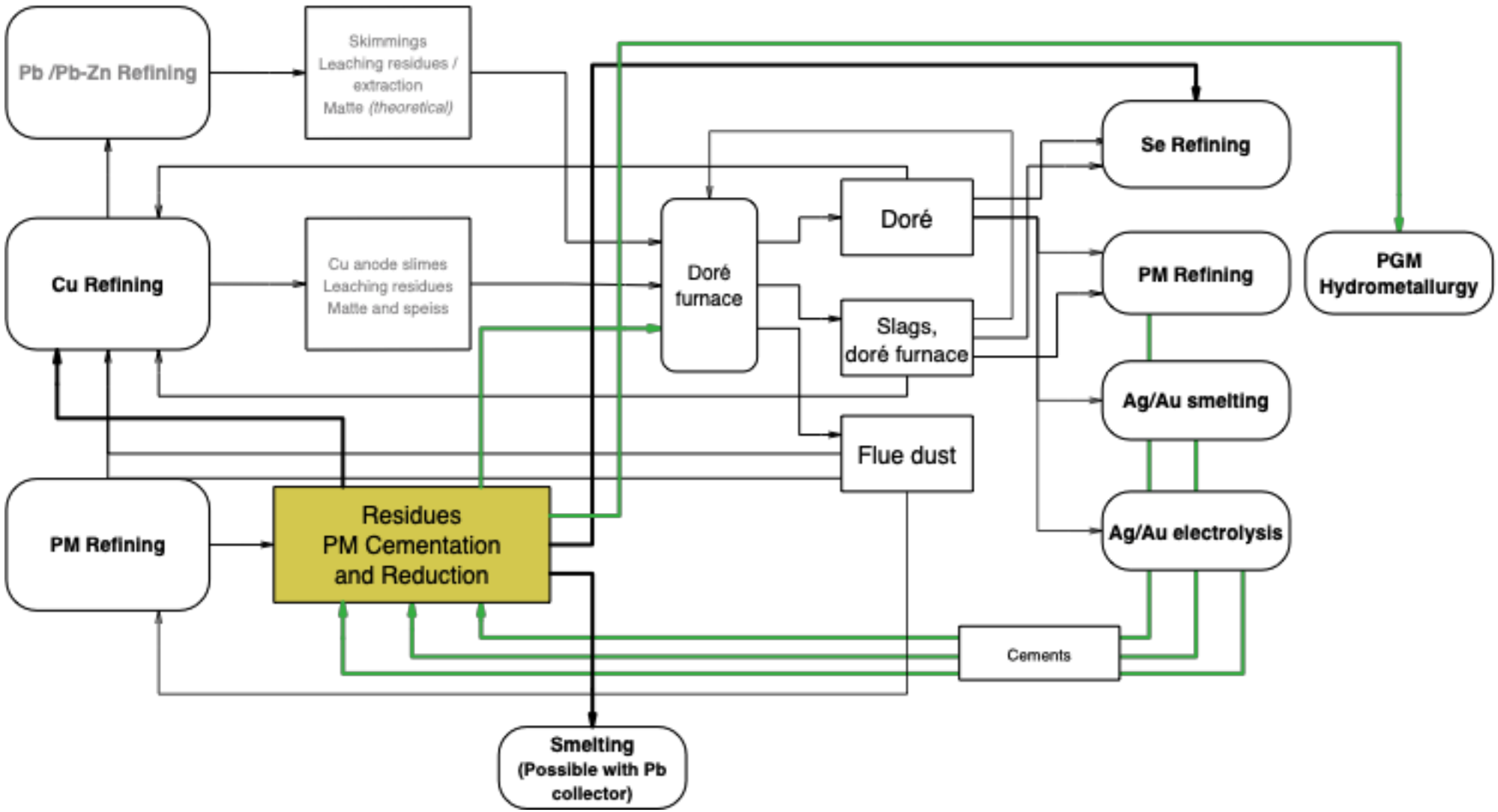
The flue dust is generated as a by-product during the pre-treatment, smelting, refining and/or use of precious metals and their alloys obtained from primary and secondary sources, including recycled plant intermediates.

If the main operation of a given site that day was to smelt input material to produce doré or matte, the flue dust will be very rich in base metals and possibly also silver, and comparatively poor in gold and PGM. To the contrary, if the main operation of a given site that day was to pre-treat spent catalysts before hydro-metallurgical recovery of PGM, the flue dust will be very rich in nickel and PGM, when compared to other constituents.

Note on (the role of) lead in the production of Flue dust, precious metal refining

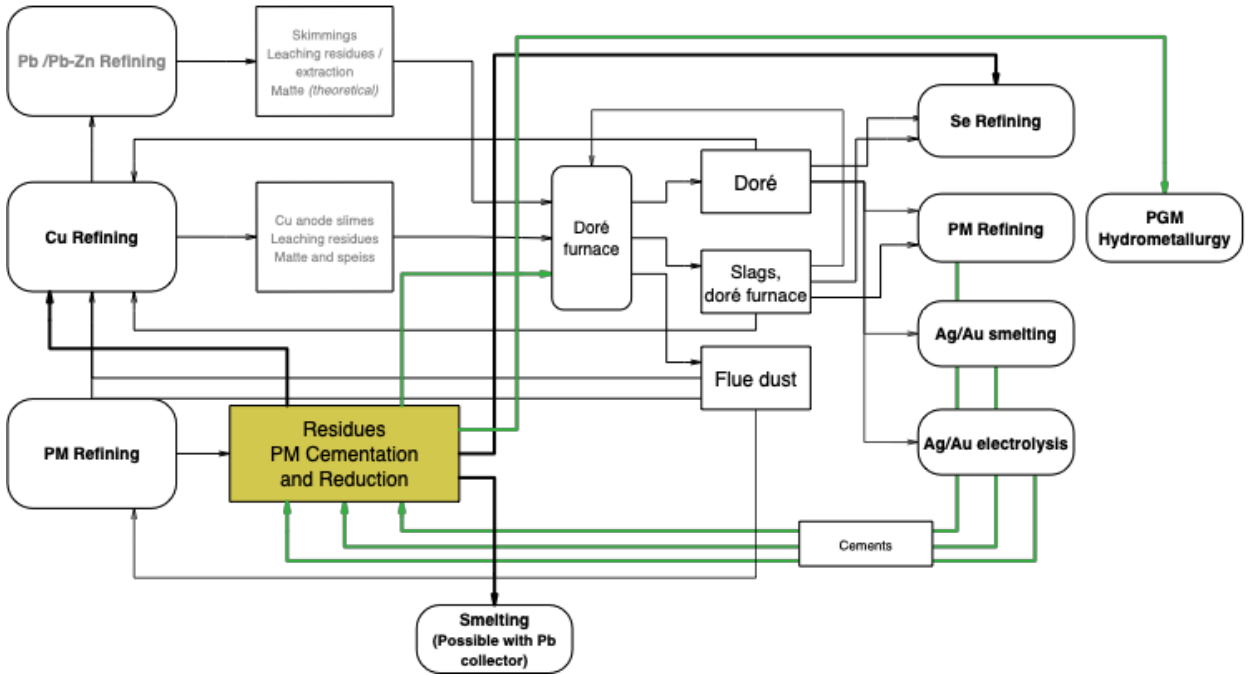
The substance contains relatively high concentrations of lead as a result of its carrier function in many pyro-metallurgical refining steps, especially when the lead refining is physically not fully segmented from the PM refining.

8. Residues, precious metal refining cementation and reduction



Green/red arrows are used for influx from/outflux to precious metal sector, related to the substance discussed.

8. Residues, precious metal refining cementation and reduction



Usual composition:

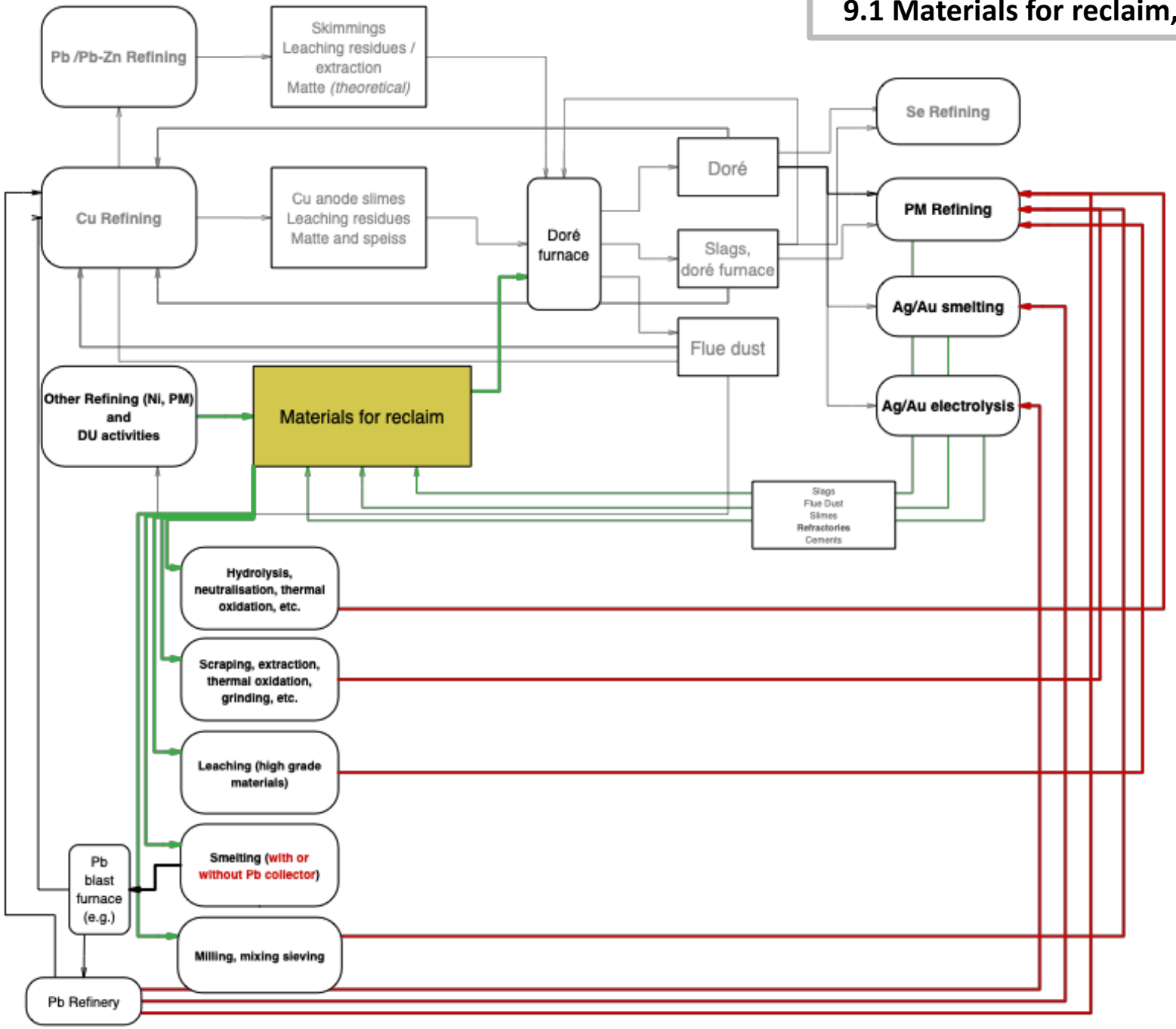
Type	Name of the element	Symbol	Species present	Typical concentration (%)	Concentration range (%)
Precious metals	Silver	Ag	Metallic and other	29	0 - 91
	Gold	Au	Metallic and other	6,5	0 - 40
	Iridium	Ir		6,5	0 - 40
	Palladium	Pd		1,8	0 - 12,5
	Platinum	Pt		6,3	0 - 40
	Rhodium	Rh		5,9	0 - 40
	Ruthenium	Ru		9,7	0 - 40
Other metals/ constituents	Aluminium	Al	Al2O3	2	0 - 10
	Arsenic	As		0,46	0 - 3
	Bismuth	Bi		0,05	0 - 15
	Carbon	C		0,56	0 - 5
	Calcium	Ca		3,4	0 - 13,5
	Chlorine	Cl		1,4	0 - 6
	Cobalt	Co		0,11	0 - 1
	Chromium	Cr	Cr2O3	0,22	0 - 1,5
	Copper	Cu	Metallic, carbonate, hydroxide, oxide, nitrate	23	0,04 - 68
	Iron	Fe	Metallic and other	3,8	0 - 12,5
	Potassium	K		0,11	0 - 1
	Magnesium	Mg		0,1	0 - 0,9
	Sodium	Na		0,05	0 - 0,5
	Nickel	Ni		0,3	0 - 1
	Lead	Pb	Chloride/Oxide (1:10)	4,5	0 - 15
	Sulphur	S	Sulfides, sulphates	1,5	0 - 7
	Antimony	Sb		0,56	0 - 10
	Selenium	Se		13	0 - 94
	Silicon	Si	SiO2	2,9	0 - 15
	Tin	Sn		0,11	0 - 1
	Tellurium	Te		2,8	0 - 10
	Titanium	Ti		0,03	0 - 0,3
	Zinc	Zn		2,4	0 - 17,5
Total				129	

The materials covered here are dry and wet residues recovered through cementation and/or reduction with a reducing agent (such as Al, Cu, Fe, Zn or organic agents) of PM refining streams before release to wastewater treatment operations.
The residues include cements (precipitates) and polishing sludges which generally contain precious metals, metal oxides and metal chlorides in varying concentrations.
Depending on composition, they can be further processed in pyrometallurgical or hydrometallurgical processes.

Note on (the role of) lead in the production of Residues, precious metals refining cementation and reduction

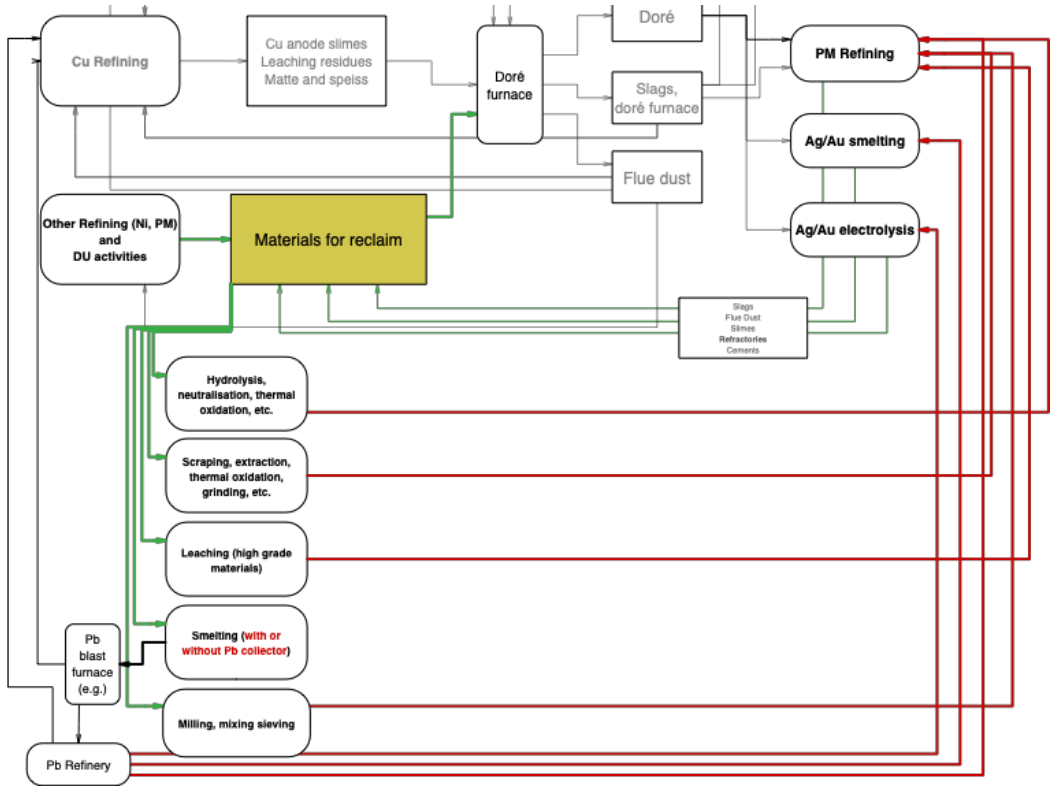
Pb is not likely to be present or only as impurity and the metal plays no metallurgical role.

9.1 Materials for reclaim, precious metals with or without support



Green/red arrows are used for **influx from/outflux to precious metal sector, related to the substance discussed.**

9.1 Materials for reclaim, precious metals with or without support



Usual composition:

Type	Name of the element	Symbol	Species present	Typical concentration (%)	Concentration range (%)
Precious metals	Silver	Ag	Metallic or oxidic	5,1	0 - 50
	Gold	Au	Metallic or oxidic	5,1	0 - 50
	Iridium	Ir		12	0 - 45
	Palladium	Pd		16	0 - 50
	Platinum	Pt		16	0 - 50
	Rhodium	Rh		18	0 - 45
	Ruthenium	Ru		9,4	0 - 43
Other metals/ constituents	Aluminium	Al	Al2O3	11	0 - 41
	Arsenic	As		0,9	0 - 5
	Barium	Ba		0,4	0 - 5
	Bismuth	Bi		0,5	0 - 5
	Carbon	C		9,7	0 - 50
	Calcium	Ca		3,4	0 - 36
	Cadmium	Cd		0,4	0 - 5
	Cobalt	Co		3,8	0 - 15
	Chromium	Cr		2,5	0 - 15
	Copper	Cu		6,1	0 - 20
	Iron	Fe	Fe2O3	7,3	0 - 25
	Potassium	K		1,3	0 - 10
	Magnesium	Mg	MgCl	1	0 - 7,5
	Manganese	Mn		1,7	0 - 10
	Nickel	Ni		6,7	0 - 33
	Lead	Pb		4,6	0 - 20
	Antimony	Sb		0,4	0 - 5
	Selenium	Se		2,6	0 - 15
	Silicon	Si	SiO2	7,6	0 - 25
	Tellurium	Te		3	0 - 15
	Titanium	Ti	TiO2	1,2	0 - 5
	Zinc	Zn		3,3	0 - 15
	Zirconium	Zr	ZrO2	1,5	0 - 19
Total				162	

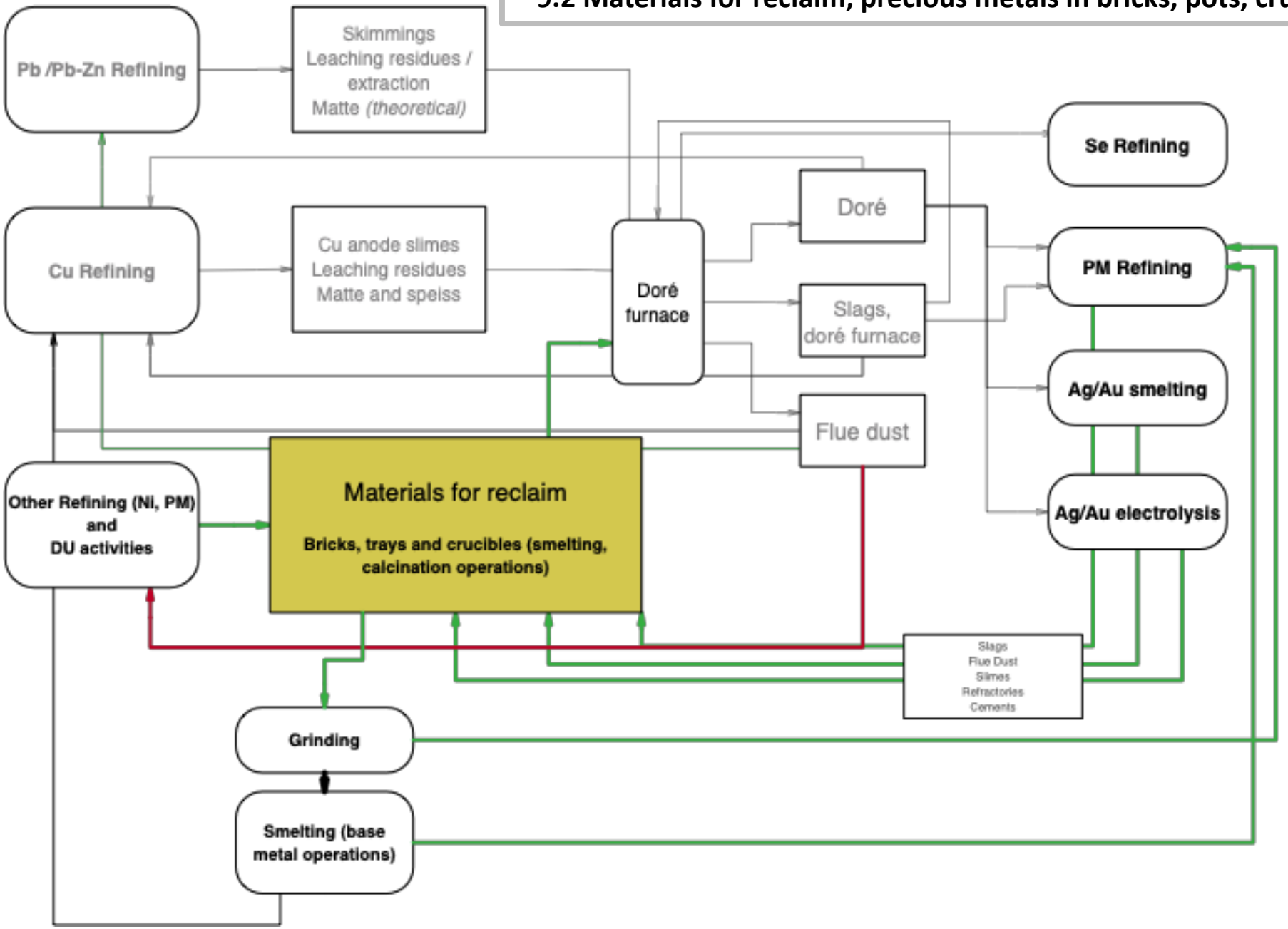
Description of the materials: Primary and secondary sources of precious metals in metallic, oxide, chloride and other forms in varying concentrations, resulting from the application of thermal or thermo-chemical processes or end-of-life criteria whose supports may, where present, include varying amounts of:
□ Ceramics (such as silica, alumina and zeolites),
□ Carbon or organics (such as carbon, paper, or plastics), and/or
□ Metallics (such as stainless steel or other transition metal alloys).
Examples: Spent (auto-)catalysts; materials arising from industrial, electronic, dentistry, jewelry, and other applications; photographic film; spent fuel cells, etc.
Processing: Depending on the type of materials and their grade and the processes available, the materials will follow the 'Doré route' or be prepared for direct uptake in PM refining.

Note on (the role of) lead in the production of Materials for reclaim, precious metals with or without support

No role (except if the low grade material has to go through a smelting process where a Pb collector may be used)

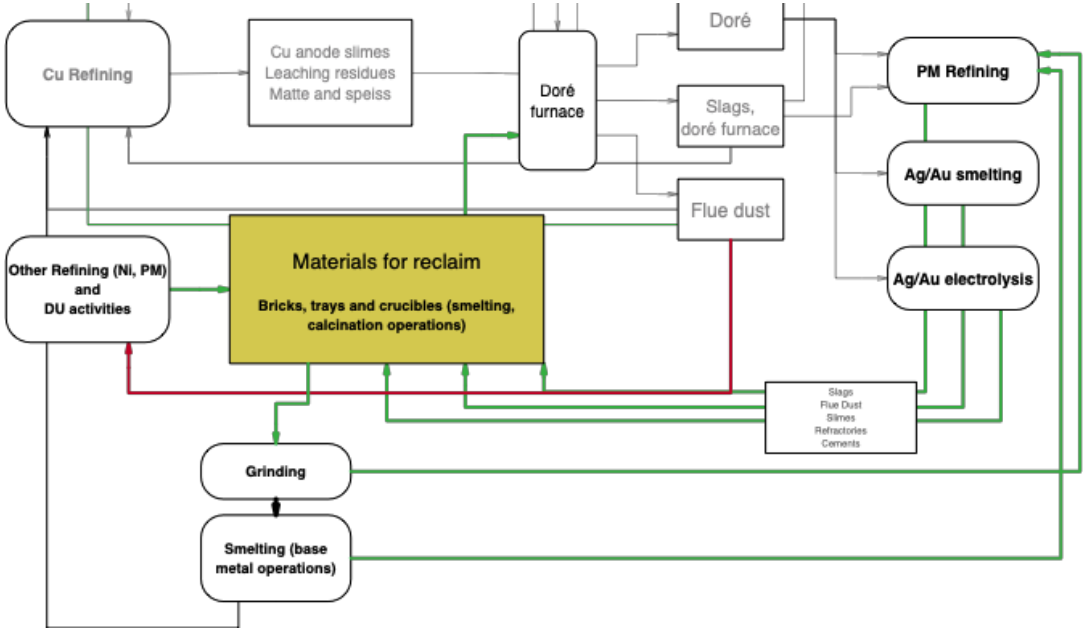
Concentrations will depend on the feed which also explains the further use of the materials for reclaim.
PM-sector specific feeds will contain very low levels of lead (impurity). An example of exception is the Lindlar's catalyst which contains palladium on calcium carbonate that has been doped with sulfur or lead...

9.2 Materials for reclaim, precious metals in bricks, pots, crucibles and trays, etc.



Green/red arrows are used for influx from/outflux to precious metal sector, related to the substance discussed.

9.2 Materials for reclaim, precious metals in bricks, pots, crucibles and trays, etc.



Usual composition:

Type	Name of the element	Symbol	Species present	Typical concentration (%)	Concentration range (%)
Precious metals	Silver	Ag		0,5	0 - 2,5
	Gold	Au		0,09	0 - 0,5
	Iridium	Ir		0,23	0 - 1
	Palladium	Pd		0,25	0 - 1
	Platinum	Pt		0,17	0 - 1
	Rhodium	Rh		0,17	0 - 1
	Ruthenium	Ru		0,24	0 - 1
Other metals/ constituents	Aluminium	Al	Al2O3	8,5	0 - 20
	Arsenic	As		0,01	0 - 0,1
	Barium	Ba		0,5	0 - 2,5
	Bismuth	Bi		0,04	0 - 0,3
	Carbon	C		7,7	0 - 38
	Calcium	Ca		1,3	0 - 3
	Cobalt	Co		0,07	0 - 0,5
	Chromium	Cr	Cr2O3	5,3	0 - 13
	Copper	Cu	CuO	1,5	0 - 5
	Iron	Fe	Fe2O3	5,4	0 - 22
	Potassium	K	K2O	0,52	0 - 2,5
	Magnesium	Mg	Mg0	9	0 - 32
	Sodium	Na		0,09	0 - 0,61
	Niobium	Nb		0,36	0 - 2,5
	Nickel	Ni	NiO	0,32	0,02 - 1
	Lead	Pb	PbO	13	0,15 - 85
	Sulphur	S		0,08	0 - 0,5
	Antimony	Sb		0,07	0 - 0,5
	Selenium	Se	SeO2	0,02	0 - 0,1
	Silicon	Si	SiO2	12	0 - 26
	Tin	Sn		0,38	0 - 2,2
	Tellurium	Te		0,07	0 - 0,5
	Titanium	Ti		0,58	0 - 2,5
	Zinc	Zn	ZnO	0,26	0 - 1
	Zirconium	Zr	ZrO2	5,5	0 - 25
Total				74,2	

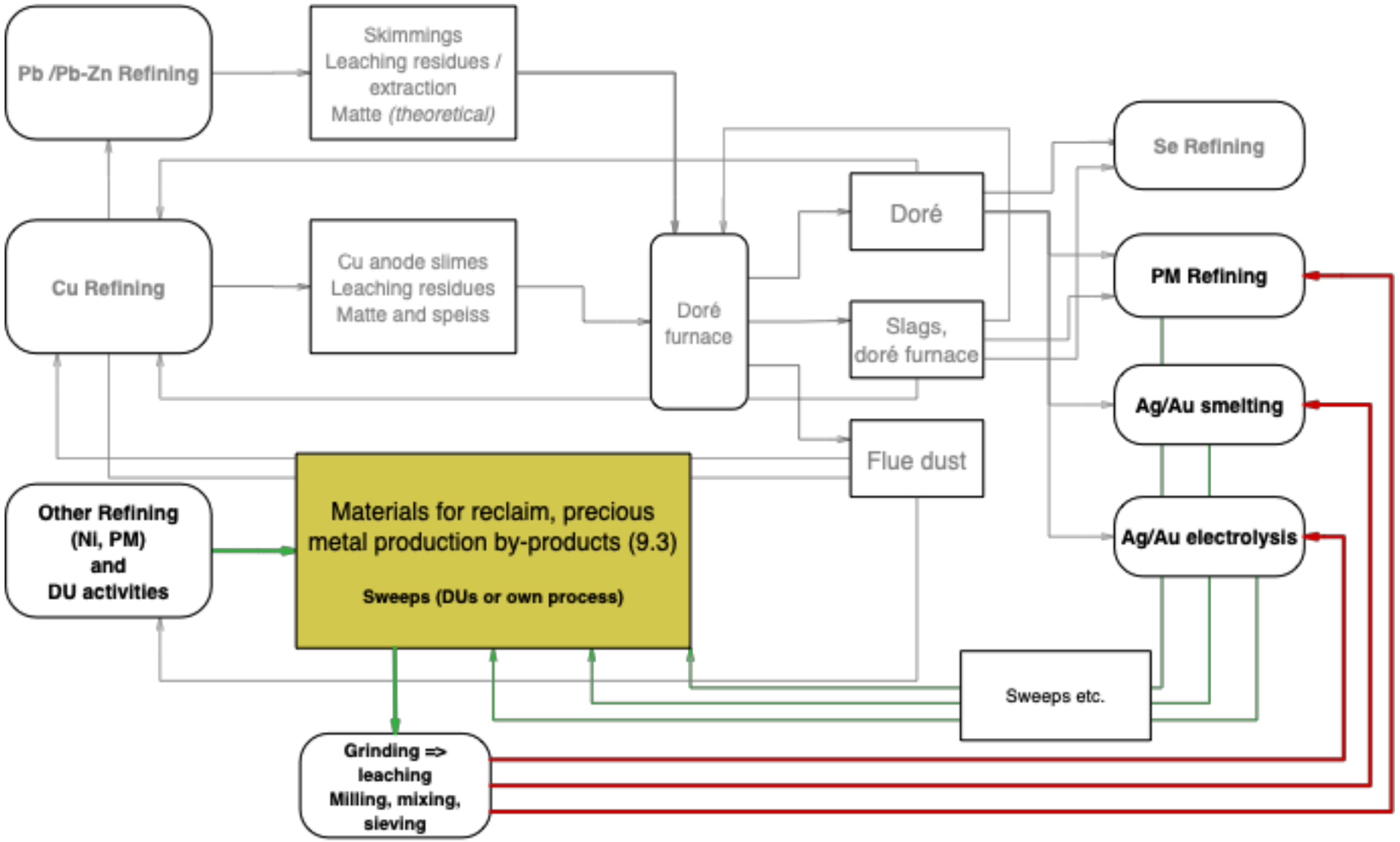
Description of the materials: Spent artifacts (such as bricks, pots, crucibles and trays) used in the processing of precious metal streams that have retained fractions of precious metals from/during processing and that are reclaimed as secondary sources of precious metals.
These materials may be silicate or refractory-based and contain low and varying concentrations of precious metals in metallic, oxide, and other forms.
Processing: These materials are crushed to varying degrees and added to smelting furnaces where they act as both flux and precious metal source.

Note on (the role of) lead in the production of Materials for reclaim, precious metals in bricks, pots, crucibles and trays, etc.

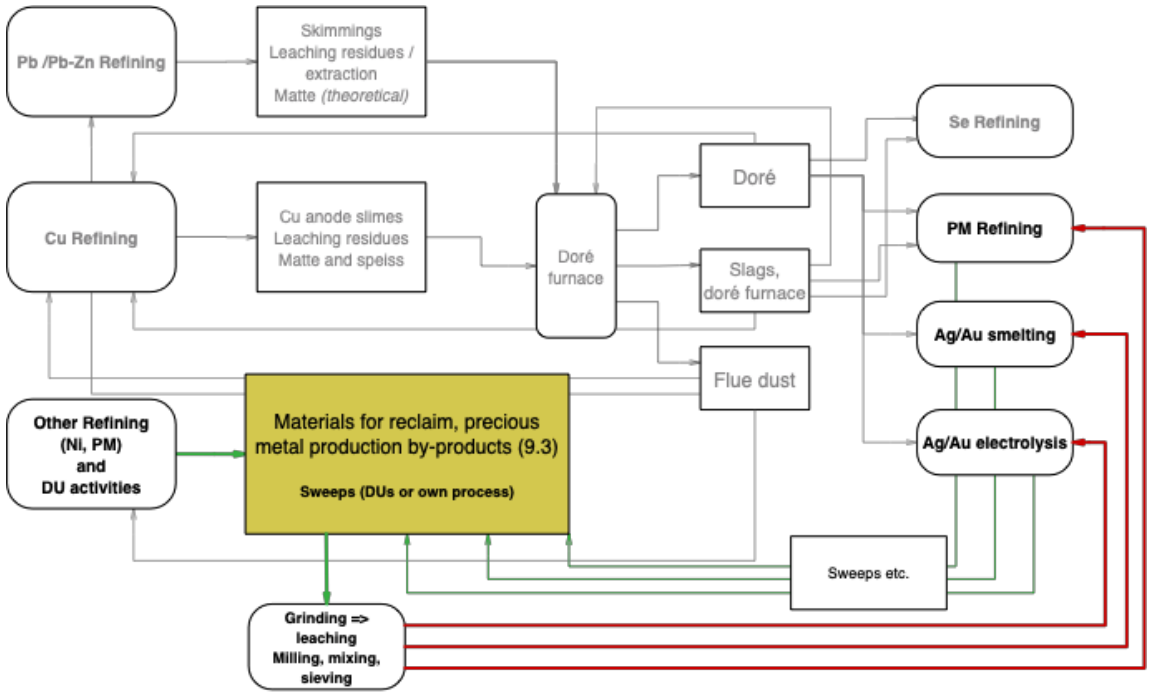
Concentrations will depend on the feed materials in the furnaces.
PM-sector specific feeds will contain low levels of lead which will be colected in a subsequent slag phase (transformed into aggregate or to be disposed of).

Non-PM specific feeds may contain significant amounts of lead. Pb will be further used as lead collector (Base metal operations) or flux material (Doré) in further smelting processes.

9.3 Materials for reclaim, precious metal production by-products



9.3 Materials for reclaim, precious metal production by-products

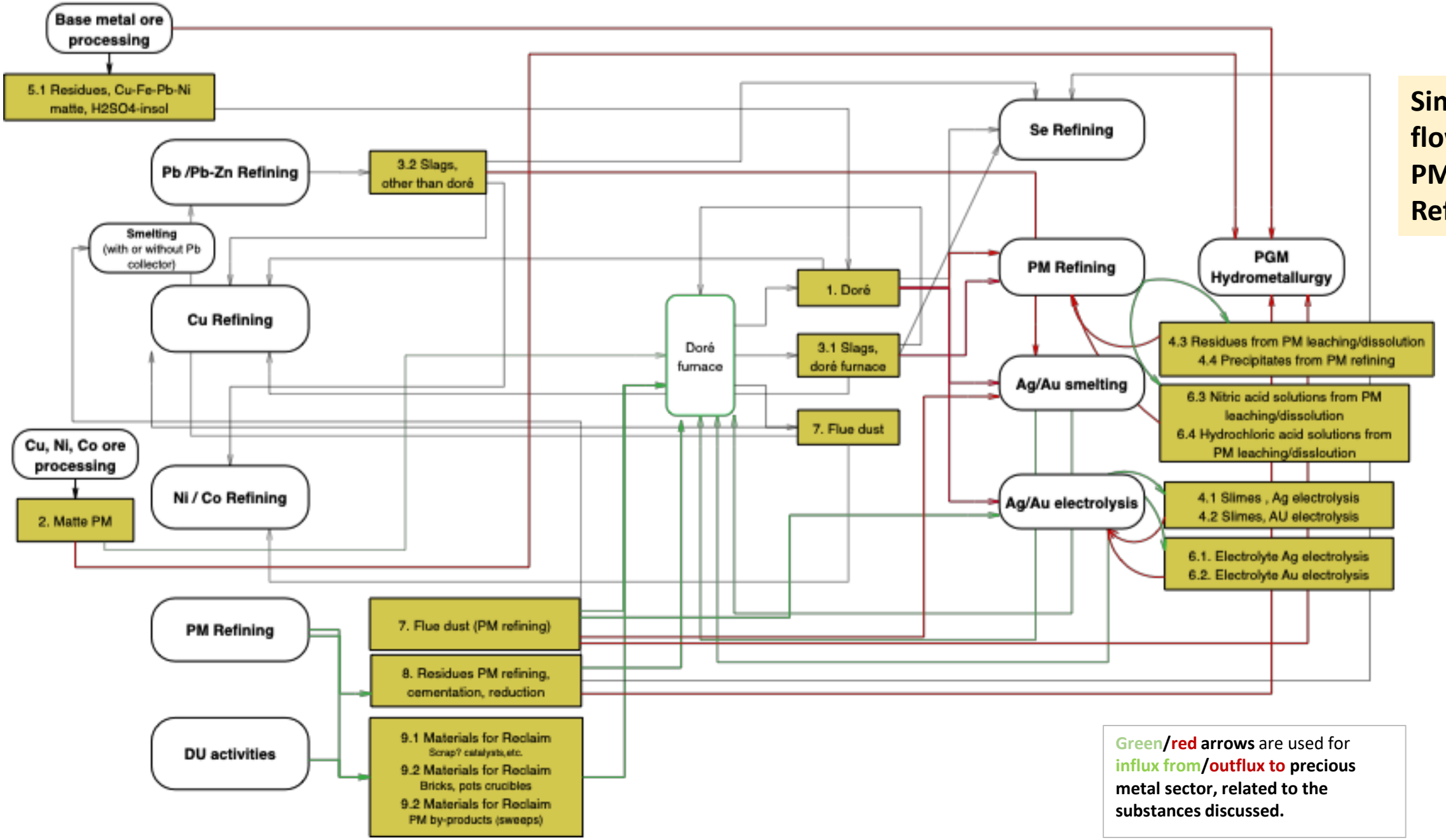


Usual composition:

Type	Name of the element	Symbol	Species present	Typical concentration (%)	Concentration range (%)
Precious metals	Silver	Ag		3,5	1 - 6
	Gold	Au		1,5	0 - 5
	Iridium	Ir		3,8	0,6 - 8,5
	Palladium	Pd		3,9	1 - 8,5
	Platinum	Pt		4,3	1 - 8,5
	Rhodium	Rh		3,8	0 - 8,5
	Ruthenium	Ru		4	1 - 8,5
Other metals/ constituents	Aluminium	Al	Al2O3	6,2	0 - 15
	Arsenic	As	As2O3?	1	0 - 3,6
	Barium	Ba		1,9	0 - 7,5
	Bismuth	Bi	Bi2O3	0,03	0 - 0,1
	Bromine	Br		3,4	0 - 14
	Calcium	Ca		2,6	0 - 11
	Cadmium	Cd		0,5	0 - 2
	Chlorine	Cl		8,7	0 - 21
	Cobalt	Co		0,63	0 - 2,5
	Chromium	Cr		3	0,2 - 9
	Copper	Cu		6	0,5 - 15
	Iron	Fe		13	0 - 40
	Potassium	K		2,8	0 - 11
	Sodium	Na	Na2O	4,7	0 - 18
	Nickel	Ni		2,8	0,2 - 5,5
	Lead	Pb		7,6	0 - 27
	Sulphur	S		0,88	0 - 2,5
	Antimony	Sb		1,7	0 - 5,4
	Selenium	Se		0,13	0 - 0,3
	Silicon	Si	SiO2	5,9	0 - 15
	Tin	Sn		2,1	0 - 5,5
	Tellurium	Te		1,7	0 - 6,2
	Titanium	Ti	TiO2	2,4	0 - 8
	Zinc	Zn		2,3	0,25 - 5
	Zirconium	Zr		0,13	0 - 0,5
Total				107	

Description of the materials: Materials that are non-intentional products of the production and refining of precious metals, which contain precious metals as well as other metals and their compounds (oxides and others) in varying concentrations.
Example: so-called production “sweeps” and dusts.
Processes: These materials will either undergo hydrometallurgical processes to leach the precious metal content or be smelted to recover the precious metals.

Note on (the role of) lead in the production of Materials for reclaim, precious metals production by-products
No role and often not even present (trace/impurity).



Simplified flows of PM Refinables

Green/red arrows are used for influx from/outflux to precious metal sector, related to the substances discussed.