

Human Health and Environmental classification of PM Refinables
as reviewed in light of the 4th ATP to CLP with MeClas by using the composition and T/D data available in the ID Cards, the reference samples, the individual company streams, and any new information becoming available

Version: 24 March 2014

General comments

- a. LR IUCLID 5 files will cover all classifications relevant for each Refinable
- b. Co-registrants are invited to include exactly the same information in section 1.2 of IUCLID 5 as the one included in the LR file to cover all streams registered by the LR (in addition to their Legal Entity (LE)-specific composition). Section 2 of IUCLID 5 on classification should only be completed in the LR's file in order to prevent other registrants to be regarded as opting-out from the proposed classifications (which may trigger higher registration fees and requests for harmonisation by ECHA or Member States)
- c. Company-specific classifications and refinements:
- Should be done by using MeClas, which is freely available (www.meclas.eu)
 - By applying in-house data on species, T/D, and particle size and/or surface area
- d. For the purpose of classification, the compositions of the PM Refinables are defined by means of formulas rather than elemental concentration ranges because in some cases, it was not possible to derive "generic" compositions covering all companies without excessively exceeding total composition of 100%. However, the CLP mixture ruling is quite complex with various metal compounds having a combination of generic and specific concentration limits. Also, calculations with T/D results require smart simplification of the solubility corrections and ERV with various metals being removed from the water column and others that are not readily removable. Despite careful quality control, the derivation of the formulas is vulnerable to errors. Companies are therefore strongly recommended to use MeCLAS, which is freely available, considerably less vulnerable to errors and up-to-date with the latest harmonised and self-classifications as well as ERV values to derive the classification.
- e. If a company stream is not properly addressed from a composition and/or classification viewpoint in the LR IUCLID 5 file (classifications in the LR's file can be more conservative and severe), the company can adopt less stringent classification in its SDS (cf. ECHA Helpdesk's answer to KGHM's question dated November 2010)
- f. Classifications in the LR file may be proposed as:
- Grouped classifications based on composition profile → this is proposed for smaller and more uniform (yet still sufficiently variable to be considered as UVCB) groups, where a number of given composition profiles is expected to be manufactured and/or imported
 - o Doré
 - o Matte, PM refining
 - o Slags, PM refining, doré production
 - o Slags, PM refining, production of PM containing materials other than doré
 - o Residues matte leaching
 - o Ag electrolyte
 - o Au electrolyte
 - o Materials for reclaim, PM production by-products
 - o Pb bullion, PGM rich
 - Grouped classifications based on cluster analysis and expert judgement → this is proposed for very large and variable groups, where many combinations are possible and hence there was a need to apply cluster analysis to identify conservative classification profiles to arrive at a reasonable number of possible classifications for the individual streams belonging to each UVCB substance
 - o Slimes and sludges, PM refining
 - o Flue dust
 - o Residues cementation and reduction
 - o Materials for reclaim, PM with or without support
 - o Materials for reclaim, PM in bricks, pots, crucibles and trays, etc.
- g. Compositions or triggers associated to each classification provide a non-exhaustive list of those constituents which can be present in each Refinable (compromise between referring only to major driver versus listing all classified elements)
- h. Reference to classification cut-offs will be done by using the elemental composition (species added in Remarks field) associated to CLP cut-offs. Please note that the DSD classification cannot always be unambiguously linked to CLP classification.
- i. Target organs

Metal species	Target organ
Cd, CdO	Kidneys, lungs and bones
Pb compounds	Central nervous system and systems for reproduction
Ni, NiSO4	Respiratory tract

1. Doré:

Notes:

- All constituents assumed to be in metallic form
- Human health classification driven by several constituents including Ni and Pb
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition

	Classification CLP	Composition / classification drivers
1	No classification	Ni < 1%; Pb ~~comp~~ < 0,053%; Co < 1%; Cd < 0,1%; ~~Cu2O < 10%~~ $100 / ((As\% + Se\% + Te\%)/100 + (Cu2O\% + Pb\text{-}comp\% + Sb\%)/500) > 2000 \text{ mg/kg}$ <u>In case 28d TDP data or equivalent are available demonstrating no env classification (otherwise, Chronic 4 safety net classification applies) (%Ag x 0,000045 + %Cu x 0,00276) x 100 < 1 and chronic 28d TDP is available + MECLAS calculation</u>
2	Repro. 1A, ~~STOT Rep 2~~ , ENV Ch 3	Ni < 1%; Pb ~~comp~~ : 0,3 - 0,05% - 0,51%; Co < 1%; Cd < 0,1%; ~~Cu2O < 10%~~ $100 / ((As\% + Se\% + Te\%)/100 + (Cu2O\% + Pb\text{-}comp\% + Sb\%)/500) > 2000 \text{ mg/kg}$ $(\%Ag \times 0,000045 + \%Cu \times 0,00276) \times 100 > 1$
3	~~Carc. 2~~ , Repro. 1A, STOT Rep ~~2~~ 4, ENV Ch 3	Ni < 1%; Pb ~~comp~~ 0,51-15% - 10%; Co < 1%; Cd < 0,1%; ~~Cu2O < 10%~~ $100 / ((As\% + Se\% + Te\%)/100 + (Cu2O\% + Pb\text{-}comp\% + Sb\%)/500) > 2000 \text{ mg/kg}$ $(\%Ag \times 0,000045 + \%Cu \times 0,00276) \times 100 > 1$
4	Carc. 2, Repro. 1A, STOT Rep ~~2~~ 4, Skin sens. 1, ENV Ch 3	Ni >= 1%; ~~Pb < 10%; Pb-comp 0,5-15%;~~ Co < 1%; Cd < 0,1%; ~~Cu2O < 10%~~ $100 / ((As\% + Se\% + Te\%)/100 + (Cu2O\% + Pb\text{-}comp\% + Sb\%)/500) > 2000 \text{ mg/kg}$ $(\%Ag \times 0,000045 + \%Cu \times 0,00276) \times 100 > 1$
5	Carc. 2, Repro. 1A, STOT Rep ~~2~~ 4, Skin sens. 1, Acute tox oral ~~inh~~ 4, ENV Ch 2	Ni >= 1%; Pb ~~comp~~ 0,5-15% < 10%; Co < 1%; Cd < 0,1%; ~~Cu2O < 10%~~ $100 / ((As\% + Se\% + Te\%)/100 + (Cu2O\% + Pb\text{-}comp\% + Sb\%)/500) \text{ between } 300 - 2000 \text{ mg/kg}$ $(\%Ag \times 0,000045 + \%Cu \times 0,00276) \times 10 \text{ between } 1 \text{ and } 10$

STOT drivers: Pb compounds, Ni

2. Matte, precious metals refining:

Notes:

- All constituents assumed to be in metallic or sulphide form
- Grouped classifications proposed
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition

	Classification CLP	Composition / classification drivers
1	Carc. 1B, Repro. 1A, STOT Rep 2 (driver: CdS), ENV Ch 2	Ni powder < 1%; CoS < 1% Cd: 0,1% - 1%; Pb comp: 0,05% - 0,5% $100 / ((\%As + \%Se \text{ comp} + \%Te/Te \text{ comp})/100 + (\%Cd + \%Pb \text{ comp} + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se \text{ comp})/700 + (\%Pb \text{ comp} + Pb \text{ powder} + \%Sb/Sb \text{ comp})/4500) > 5 \text{ mg/l}$ $(\%Cu \times 0,024 + \%Pb \times 0,044 + \%Co \times 0,11) < 1$ $(\%Cu \times 0,00062 + \%Pb \times 0,048 + \%Co \times 0,69) * 10 > 1$
2	Carc. 2, Repro. 1A, STOT Rep 1 (driver: Ni), ENV Ch 2, Skin sens. 1	Ni powder $\geq$ 10% Pb comp $\geq$ 0,5%; Cd < 0,1% $100 / ((\%As + \%Se \text{ comp} + \%Te/Te \text{ comp})/100 + (\%Cd + \%Pb \text{ comp} + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) > 2000$ $100 / ((\%As + \%Se \text{ comp})/700 + (\%Pb \text{ comp} + Pb \text{ powder} + \%Sb/Sb \text{ comp})/4500) > 5 \text{ mg/L}$ $(\%Cu \times 0,024 + \%Pb \times 0,044 + \%Co \times 0,11) < 1$ $(\%Cu \times 0,00062 + \%Pb \times 0,048 + \%Co \times 0,69) * 10 > 1$
3	Carc. 2, Repro. 1A, STOT Rep 1 (driver: Ni), ENV Ac 1, ENV Ch 1, Skin sens. 1, Acute tox oral+inh 4	Ni powder $\geq$ 10% Pb comp $\geq$ 0,3%; Cd < 0,1% $100 / ((\%As + \%Se \text{ comp} + \%Te/Te \text{ comp})/100 + (\%Cd + \%Pb \text{ comp} + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) \text{ between } 300 - 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se \text{ comp})/700 + (\%Pb \text{ comp} + Pb \text{ powder} + \%Sb/Sb \text{ comp})/4500) \text{ between } 1 \text{ and } 5 \text{ mg/L}$ $(\%Cu \times 0,024 + \%Pb \times 0,044 + \%Co \times 0,11) > 1$ $(\%Cu \times 0,00062 + \%Pb \times 0,048 + \%Co \times 0,69) > 1$

3. Slags, precious metals refining:

3.1. Slags, doré furnace:

Notes:

- Slags produced as by-products in the production (smelting, reduction, converting, and refining processes) of doré
- Slags using caustic soda, sand, sodium carbonate, borax, silica, coke as fluxing agent
- Fluxes used influence composition and hence, resulting classification
- In most slags, presence of free silica cannot be ruled out (and would have no improvement on the classification in any case)
- Refinement for silica where relevant can be done with XRD and dustiness data that would show amorphous silica instead of crystalline one, and no potential for inhalation
- B presence as sodium borate/borax in Borate/borax slag only; present as boron oxide in remaining slags
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition

	Classification CLP	Composition / classification drivers
1	ENV Ac 1, ENV Ch 1, STOT Rep 1, Repro. 1A, Carc. 1A, Skin sens 1, Eye dam. 1, Skin 1B, Acute tox oral 3, Acute tox inh 4	$\%As_2O_3 \geq 5\%$ $\%CaO + \%Ag_2O \geq 3\%$ $\%CdO < 1\%$ $\%NiO \geq 0,1\%$ or $\%As_2O_3 \geq 0,1\%$ $\%Pb \text{ comp} \geq 0,3\%$ $\%SiO_2 \geq 10\%$ $100 / ((\%Se)/100 + (\%Cu_2O + \%Pb \text{ comp} + \%Pb \text{ powder} + \%BaO_2 + \%CoO + \%MnO_2)/500)$ between 50 and 300 mg/kg $100 / ((\%Se)/700 + (\%Cu_2O + \%Pb \text{ comp} + \%Pb \text{ powder} + \%BaO_2 + \%MnO_2)/4500)$ between 1 and 5 mg/L $(\%As_2O_3 + \%CdO \times 10 + \%CoO \times 10 + \%Cu_2O + \%Pb \text{ comp} \times 10 + \%Se \text{ comp} \times 10 + \%ZnO + \%Ag \text{ comp} \times 1000 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Pt \text{ comp} \times 10 + \%Ti \text{ comp} + \%Rh \text{ comp} + \%Ru \text{ comp}) > 25\%$ $(\%As_2O_3 + \%CdO \times 100 + \%CoO \times 10 + \%Cu_2O + \%Pb \text{ comp} + \%Se \text{ comp} + \%ZnO + \%Ag \text{ comp} \times 100 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Pt \text{ comp} + \%Ti \text{ comp} + \%Rh \text{ comp} + \%Ru \text{ comp}) > 25\%$

STOT drivers: Pb comp, NiO

3.2. Slags, production of PM containing materials other than doré:

Notes:

- Slags produced as a by-product in the smelting of PM bearing feeds to produce a PM containing material other than doré subject to further refining
- Slags using sodium carbonate, borax, silica, lime, alumina, phosphate, calcium hydroxide as fluxing agent
- Fluxes used influence composition and hence, resulting classification
- In most slags, presence of free silica cannot be ruled out (and would have no improvement on the classification in any case)
- Refinement for silica where relevant can be done with XRD and dustiness data that would show amorphous silica instead of crystalline one, and no potential for inhalation
- B presence as sodium borate/borax in Borate/borax slag only; present as boron oxide in remaining slags
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition

	Classification CLP	Composition / classification drivers
1	ENV Ac 1, ENV Ch 1, STOT Rep 1, STOT Se 3, Repro. 1A, Carc. 1A, Eye dam. 1, Skin 2	$\%As_2O_3 < 5\%$ $\%CaO \geq 20\%$ $\%CdO < 1\%$ $\%NiO < 0,1\%$ $\%Pb \text{ comp} \geq 0,5\%$ $\%SiO_2 \geq 10\%$ $100 / ((\%Se)/100 + (\%Cu_2O + \%Pb \text{ comp} + \%Pb \text{ powder} + \%BaO_2 + \%CoO + \%MnO_2)/500)$ > 2000 mg/kg $100 / ((\%Se)/700 + (\%Cu_2O + \%Pb \text{ comp} + \%Pb \text{ powder} + \%BaO_2 + \%MnO_2)/4500)$ > 5 mg/L

		$\begin{aligned} & (\%As_2O_3 + \%CdO \times 10 + \%CoO \times 10 + \%Cu_2O + \%Pb \text{ comp} \times 10 + \%Se \text{ comp} \times 10 + \\ & \%ZnO + \%Ag \text{ comp} \times 1000 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Pt \text{ comp} \times 10 + \%Ti \\ & \text{comp} + \%Rh \text{ comp} + \%Ru \text{ comp}) > 25\% \\ & (\%As_2O_3 + \%CdO \times 100 + \%CoO \times 10 + \%Cu_2O + \%Pb \text{ comp} + \%Se \text{ comp} + \%ZnO + \\ & \%Ag \text{ comp} \times 100 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Pt \text{ comp} + \%Ti \text{ comp} + \%Rh \text{ comp} \\ & + \%Ru \text{ comp}) > 25\% \end{aligned}$
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STOT drivers: Pb comp, SiO₂

4. Slimes and sludges, precious metals refining:

Notes:

- Streams from precious metals hydro-metallurgical refining processes are grouped in light of their likely hazardous composition and associated classification
- Species selected for the purpose of deriving classifications are as per ID Card. When several species are provided, the worst one was selected
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition

	Classification CLP	Composition / classification drivers
1	ENV Ac 1, ENV Ch 1	%NiCl₂ < 0,01%; %Sb₂O₃ < 1%; %Pb < 0,05%; %Co < 0,1%; %CdCl₂ < 0,1%; %As₂O₃ < 0,1% %Na₂B₄O₇ < 5,5%; %Se comp < 10%; %MnO₂ < 10% $\frac{\%H_2SO_4}{5} + \frac{\%As_2O_3}{1} + \frac{\%NiCl_2}{10} + \frac{\%CaO}{10} < 1$ $\frac{\%H_2SO_4}{5} + \frac{\%As_2O_3}{1} + \frac{\%CaO}{1} + \frac{\%Pd \text{ comp}}{10} + \frac{\%Na_2B_4O_7}{10} < 1$ $100 / ((\%As_2O_3)/5 + (\%Se \text{ comp} + \%Te/Te \text{ comp} + \%CdCl_2)/100 + (\%BaO_2 + \%Co + \%CuSO_4 + \%Pb \text{ comp} + \%NiSO_4 + \%NiCl_2 + \%ZnSO_4 + \%Cu_2O + \%MnO_2 + \%Pd \text{ comp})/500) > 2000 \text{ mg/kg}$ $100 / ((\%CdO + \%CdCl_2)/100 + (\%Se \text{ comp})/700 + (\%BaO_2 + \%Pb \text{ comp} + \%NiSO_4 + \%NiCl_2 + \%MnO_2 + \%BaO_2)/4500) > 5 \text{ mg/L}$ $(\%As_2O_3 + \%CdO \times 10 + \%CoO \times 10 + \%Cu_2O + \%Pb \text{ comp} \times 10 + \%Se \text{ comp} \times 10 + \%ZnO + \%Ag \text{ comp} \times 1000 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Pt \text{ comp} \times 10 + \%Ti \text{ comp} + \%Rh \text{ comp} + \%Ru \text{ comp} + \%CuSO_4 \times 10 + \%NiSO_4 + \%ZnSO_4) > 25\% *$ $(\%As_2O_3 + \%CdO \times 100 + \%CoO \times 10 + \%Cu_2O + \%Pb \text{ comp} + \%Se \text{ comp} + \%ZnO + \%Ag \text{ comp} \times 100 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Pt \text{ comp} + \%Ti \text{ comp} + \%Rh \text{ comp} + \%Ru \text{ comp} + \%CuSO_4 + \%NiSO_4 + \%ZnSO_4) > 25\% *$
2 (Low Ni, As, Pb)	ENV Ac 1, ENV Ch 1, Acute tox oral 4, Skin sens 1	%NiCl₂: 0,01% - 0,1%; %Sb₂O₃ < 1%; %Pb < 0,05%; %Co < 0,1%; %CdCl₂ < 0,1%; %As₂O₃ < 0,1% %Na₂B₄O₇ < 5,5%; %Se comp < 10%; %MnO₂ < 10% $\frac{\%H_2SO_4}{5} + \frac{\%As_2O_3}{1} + \frac{\%NiCl_2}{10} + \frac{\%CaO}{10} < 1$ $\frac{\%H_2SO_4}{5} + \frac{\%As_2O_3}{1} + \frac{\%CaO}{1} + \frac{\%Pd \text{ comp}}{10} + \frac{\%Na_2B_4O_7}{10} < 1$ $100 / ((\%As_2O_3)/5 + (\%Se \text{ comp} + \%Te/Te \text{ comp} + \%CdCl_2)/100 + (\%BaO_2 + \%Co + \%CuSO_4 + \%Pb \text{ comp} + \%NiSO_4 + \%NiCl_2 + \%ZnSO_4 + \%Cu_2O + \%MnO_2 + \%Pd \text{ comp})/500) \text{ between } 300 - 2000 \text{ mg/kg}$ $100 / ((\%CdO + \%CdCl_2)/100 + (\%Se \text{ comp})/700 + (\%BaO_2 + \%Pb \text{ comp} + \%NiSO_4 + \%NiCl_2 + \%MnO_2 + \%BaO_2)/4500) > 5 \text{ mg/L}$ $(\%As_2O_3 + \%CdO \times 10 + \%CoO \times 10 + \%Cu_2O + \%Pb \text{ comp} \times 10 + \%Se \text{ comp} \times 10 + \%ZnO + \%Ag \text{ comp} \times 1000 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Pt \text{ comp} \times 10 + \%Ti \text{ comp} + \%Rh \text{ comp} + \%Ru \text{ comp} + \%CuSO_4 \times 10 + \%NiSO_4 + \%ZnSO_4) > 25\% *$ $(\%As_2O_3 + \%CdO \times 100 + \%CoO \times 10 + \%Cu_2O + \%Pb \text{ comp} + \%Se \text{ comp} + \%ZnO + \%Ag \text{ comp} \times 100 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Pt \text{ comp} + \%Ti \text{ comp} + \%Rh \text{ comp} + \%Ru \text{ comp} + \%CuSO_4 + \%NiSO_4 + \%ZnSO_4) > 25\% *$
3 (Med Ni, As, Pb)	ENV Ac 1, ENV Ch 1, Acute tox oral 4, Acute tox inh 4, Skin 2, Eye dam. 2, Resp/skin sens 1, Muta 2, Carc. 1A, STOT Rep 1 (driver: NiCl ₂ or Pb comp)	%Co >= 1% or %NiCl₂: 1%-10% %CdCl₂ < 0,1%; %Pb < 0,3%; $\frac{\%H_2SO_4}{15} + \frac{\%As_2O_3}{5} < 1$ $\frac{\%H_2SO_4}{5} + \frac{\%As_2O_3}{1} + \frac{\%NiCl_2}{10} + \frac{\%CaO}{10} >= 1$ $\frac{\%H_2SO_4}{15} + \frac{\%As_2O_3}{3} + \frac{\%CaO}{3} < 1$ $\frac{\%H_2SO_4}{5} + \frac{\%As_2O_3}{1} + \frac{\%CaO}{1} + \frac{\%Pd \text{ comp}}{10} + \frac{\%Na_2B_4O_7}{10} >= 1$ $100 / ((\%As_2O_3)/5 + (\%Se \text{ comp} + \%Te/Te \text{ comp} + \%CdCl_2)/100 + (\%BaO_2 + \%Co + \%CuSO_4 + \%Pb \text{ comp} + \%NiSO_4 + \%NiCl_2 + \%ZnSO_4 + \%Cu_2O + \%MnO_2 + \%Pd \text{ comp})/500) \text{ between } 300 - 2000 \text{ mg/kg}$ $100 / ((\%CdO + \%CdCl_2)/100 + (\%Se \text{ comp})/700 + (\%BaO_2 + \%Pb \text{ comp} + \%NiSO_4 + \%NiCl_2 + \%MnO_2 + \%BaO_2)/4500) \text{ between } 1 \text{ and } 5 \text{ mg/L}$
4 (High Ni, As, Pb)	Acute tox oral 3, Acute tox inh 4, Skin corr 1A, Eye dam. 1, Resp/skin	%NiCl₂ >= 1%; %CdCl₂ > 0,1%; %Pb >= 0,3%; $\frac{\%H_2SO_4}{15} + \frac{\%As_2O_3}{5} >= 1$

1, Muta 1B, Carc. 1A, Repro. 1A, STOT Rep 1 (driver: Pb comp), ENV Ac 1, ENV Ch 1	$100 / ((\%As_2O_3)/5 + (\%Se \text{ comp} + \%Te/Te \text{ comp} + \%CdCl_2)/100 + (\%BaO_2 + \%Co + \%CuSO_4 + \%Pb \text{ comp} + \%NiSO_4 + \%NiCl_2 + \%ZnSO_4 + \%Cu_2O + \%MnO_2 + \%Pd \text{ comp})/500)$ between 50 - 300 mg/kg $100 / ((\%CdO + \%CdCl_2)/100 + (\%Se \text{ comp})/700 + (\%BaO_2 + \%Pb \text{ comp} + \%NiSO_4 + \%NiCl_2 + \%MnO_2 + \%BaO_2)/4500)$ between 1 and 5 mg/L
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* Note that Diammonium hexachloroplatinate, platinum dioxide, dihydrogen hexahydroxyplatinate platinum dinitrate, dipotassium tetrachloroplatinate, tetraammineplatinum dichloride, palladium (black), palladium dichloride, palladium dioxide, Rhodium (black), dicarbonyl(pentane-2,4-dionato-O,O')rhodium, diammonium sodium(nitritoN)rhodate, Ruthenium (black), Tris(nitrato-O)nitrosylruthenium, Ruthenium (IV) oxide are not classified for environment.

5. Residues, leaching processes:

5.1. Residues, matte leaching:

Notes:

- One of PMC's simplest groups covering streams from a very specific precious metals refining process (hence, a lot of uniformity across compositions and resulting classifications)
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition

	Classification CLP	Composition / classification drivers
1	Carc. 1A, Repro. 1A, Muta 2, STOT Rep 1, ENV Ac 1, ENV Ch 1, Resp/Skin sens. 1, Skin corr. 2, Acute tox oral 3, Eye dam. 1	NiSO₄ >= 1%; Pb >= 0,3%; Ag >= 0,15%; As₂O₃ 3% - 5% $100 / ((As_2O_3\%)/5 + (Se\% + Te\%)/100 + (Cu_2O\% + CuSO_4\% + Pb\% + Sb\% + NiSO_4\%)/500)$ between 50 - 300 mg/kg $100 / ((Se\% + Te\%)/700 + (Pb\% + Sb\% + NiS\% + NiSO_4\%)/4500) > 5$ mg/L
2	Carc. 1A, Repro. 1A, Muta 2, STOT Rep 1, ENV Ac 1, ENV Ch 1, Resp/Skin sens. 1, Skin corr. 2, Acute tox oral 3, Eye irrit. 2	NiSO₄ >= 1%; Pb >= 0,3%; Ag >= 0,15%; As₂O₃ 1% - 3% $100 / ((As_2O_3\%)/5 + (Se\% + Te\%)/100 + (Cu_2O\% + CuSO_4\% + Pb\% + Sb\% + NiSO_4\%)/500)$ between 50 - 300 mg/kg $100 / ((Se\% + Te\%)/700 + (Pb\% + Sb\% + NiS\% + NiSO_4\%)/4500) > 5$ mg/L
3	Carc. 1A, Repro. 1A, Muta 2, STOT Rep 1, ENV Ac 1, ENV Ch 1, Resp/Skin sens. 1, Skin corr. 2, Eye dam. 1, Acute tox oral 3, Acute tox inh 4	NiSO₄ >= 1%; Pb >= 0,3%; Ag >= 0,15%; As₂O₃ 3% - 5%; $100 / ((As_2O_3\%)/5 + (Se\% + Te\%)/100 + (Cu_2O\% + CuSO_4\% + Pb\% + Sb\% + NiSO_4\%)/500)$ between 300 - 2000 mg/kg $100 / ((Se\% + Te\%)/700 + (Pb\% + Sb\% + NiS\% + NiSO_4\%)/4500)$ between 1 and 5 mg/L

STOT driver: NiSO₄

6. Electrolytes:

6.1. Ag electrolyte:

Notes:

- One of PMC's simplest groups covering streams from a very specific precious metals refining process (hence, a lot of uniformity across compositions and resulting classifications)
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition

	Classification CLP	Composition / classification drivers
1	Repro. 1A, STOT Rep 1, ENV Ac 1, ENV Ch 1, Skin corr. 1B, Eye dam. 1, Skin sens 1	Pb 0,3 - 1%; HNO₃/0,2 + H₂SO₄/0,15 + AgNO₃/0,05 < 1 Pd comp > 1% $100 / ((ZnSO_4\% + Pb\% + CuSO_4\%)/500) > 2000 \text{ mg/kg}$ $(\%AgNO_3 \times 1000 + \%Pd \text{ compounds} \times 10 + \%CuSO_4 \times 10 + \%Pt \text{ compounds} \times 10 + \%Pb \text{ compounds} \times 10 + \%ZnSO_4) \geq 25\%$
2	Acute tox oral 4, ENV Ac 1, ENV Ch 1, Skin corr. 1B, Eye dam. 1, Skin sens 1, STOT Rep 2	Pb < 0,3 %; HNO₃/0,2 + H₂SO₄/0,15 + AgNO₃/0,05 < 1 Pd comp < 1% $100 / ((ZnSO_4\% + Pb\% + CuSO_4\%)/500) \text{ between } 300 \text{ and } 2000 \text{ mg/kg}$ $(\%AgNO_3 \times 1000 + \%Pd \text{ compounds} \times 10 + \%CuSO_4 \times 10 + \%Pt \text{ compounds} \times 10 + \%Pb \text{ compounds} \times 10 + \%ZnSO_4) \geq 25\% *$

* Note that Diammonium hexachloroplatinate, platinum dioxide, dihydrogen hexahydroxyplatinate platinum dinitrate, dipotassium tetrachloroplatinate, tetraammineplatinum dichloride, palladium (black), palladium dichloride, palladium dioxide, Rhodium (black), dicarbonyl(pentane-2,4-dionato-O,O')rhodium, diammonium sodium(nitritoN)rhodate, Ruthenium (black), Tris(nitrato-O)nitrosylruthenium, Ruthenium (IV) oxide are not classified for environment.
STOT driver: Pb comp

6.2. Au electrolyte:

Notes:

- One of PMC's simplest groups covering streams from a very specific precious metals refining process (hence, a lot of uniformity across compositions and resulting classifications)

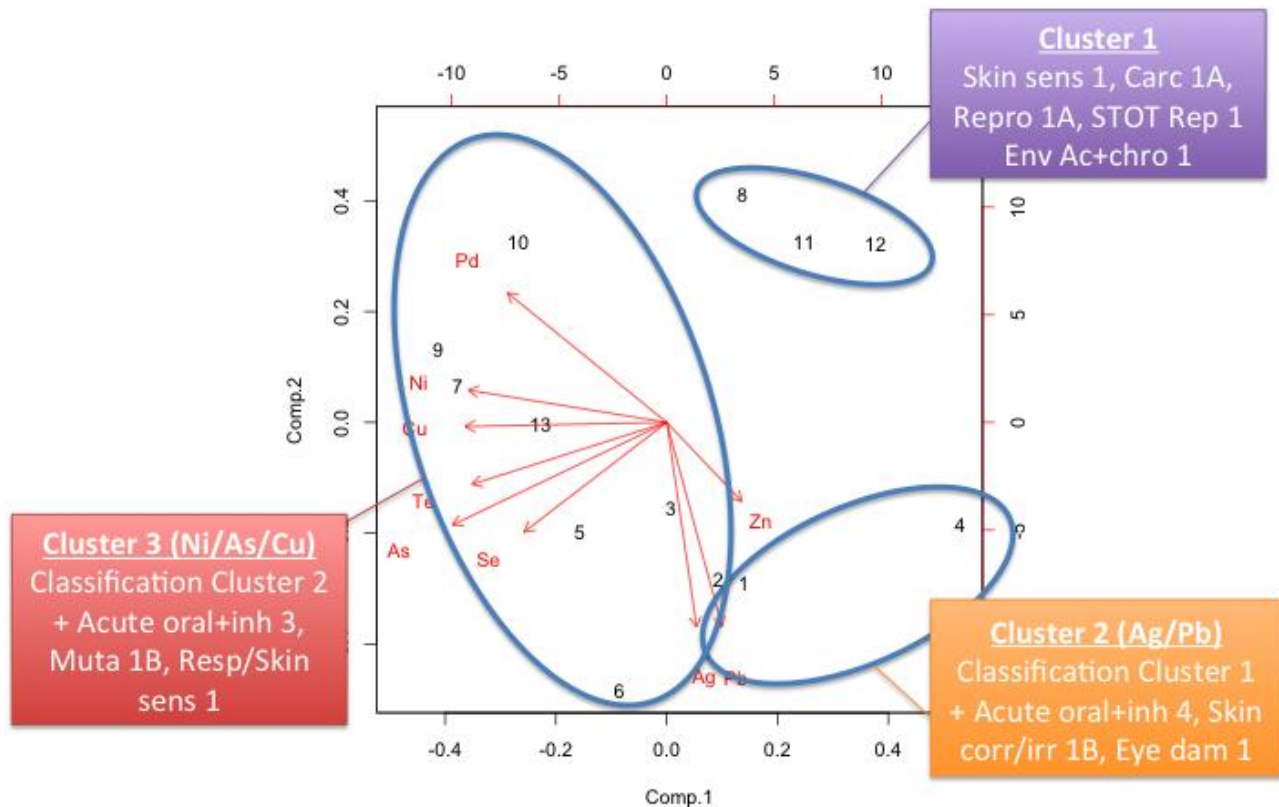
	Classification CLP	Composition / classification drivers
1	ENV Ac 1, ENV Ch 1, Skin corr 1A, Resp/Skin sens. 1, Eye dam. 1, Acute tox oral+inh 4	Pb < 0,05%; HCl > 5%; PtCl₄ > 1% $100 / ((PtCl_4\%)/100 + (CuSO_4\%)/500) \text{ between } 300 - 2000 \text{ mg/kg}$ $100 / HCl\% / 700 \text{ between } 1 \text{ and } 5 \text{ mg/L}$ $(\%Pd \text{ compounds} \times 10 + \%CuSO_4 \times 10 + \%Au \text{ compounds} + \%PtCl_4 + Ru\% + Rh\%) \geq 25\% *$

* Note that Diammonium hexachloroplatinate, platinum dioxide, dihydrogen hexahydroxyplatinate platinum dinitrate, dipotassium tetrachloroplatinate, tetraammineplatinum dichloride, palladium (black), palladium dichloride, palladium dioxide, Rhodium (black), dicarbonyl(pentane-2,4-dionato-O,O')rhodium, diammonium sodium(nitritoN)rhodate, Ruthenium (black), Tris(nitrato-O)nitrosylruthenium, Ruthenium (IV) oxide are not classified for environment.

7. Flue dust, precious metals refining:

Notes:

- One of PMC's largest group
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition
- Two main principal components for flue dust samples are Pb/Ag and Ni/As/Cu. The first cluster is characterised by relatively low metal concentrations (except for Pb). The second cluster has relatively high Ag/Pb concentrations, mostly from PM smelting process/pyrometallurgical refinement. The third cluster has relatively high Cu/As/Ni concentrations, mostly from metal dore smelting, refining in TBRC Converter and decopperised slime from copper electrolysis.



	Classification CLP	Composition / classification drivers
1	Skin sens 1, Carc. 1A, Repro. 1A, STOT Rep 1, ENV Ac 1, ENV Ch 1	$(\%As_2O_3 + \%SnCl_4 + \%AgNO_3) < 1\%$ $10 \times (\%As_2O_3 + \%SnCl_4 + \%AgNO_3 + \%CuSO_4) + \%NiSO_4 < 10\%$ $CuSO_4 < 10\%$; $NiO: 0,1\% - 10\%$; $NiSO_4: 0,01\% - 1\%$; $Pb \text{ comp} \geq 0,3\%$ $Se \text{ comp} < 10\%$; $Pt \text{ hexachloroplatinates} < 1\%$ $100 / ((\%As_2O_3)/5 + (\%Se \text{ comp} + \%Te/Te \text{ comp})/100 + (\%Cu_2O + \%Pb \text{ comp} + \%CuSO_4 + \%NiSO_4)/500) > 2000 \text{ mg/kg}$ $100 / ((\%Se \text{ comp})/700 + (\%Pb \text{ comp} + \%NiSO_4)/4500) \text{ between } > 5 \text{ mg/L}$ $(\%As_2O_3 + \%Pb \text{ comp} + \%Se \text{ comp} \times 10 + \%ZnO + \%NiSO_4 + \%AgNO_3 \times 1000 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Rh/Rh \text{ comp} + \%Ru/Ru \text{ comp} + \%Pt/Pt \text{ comp} \times 10 + \%Cu_2O \times 10 + \%Ag \text{ comp} \times 1000 + \%CuSO_4 \times 10) > 25\% *$ $(\%As_2O_3 + \%Pb \text{ comp} \times 10 + \%Se \text{ comp} + \%ZnO + \%NiSO_4 + \%AgNO_3 \times 100 + \%Au \text{ comp} + \%Pd \text{ comp} \times 10 + \%Rh/Rh \text{ comp} + \%Ru/Ru \text{ comp} + \%Pt/Pt \text{ comp} + \%Cu_2O + \%Ag \text{ comp} \times 100 + \%CuSO_4) > 25\% *$
2 (high Ag/Pb)	Acute tox oral 4, Acute tox inh 4, Skin corr/irr 1B, Eye dam. 1, Skin sens 1, Carc. 1A, Repro. 1A, STOT Rep 1, ENV Ac 1, ENV Ch 1	$(\%As_2O_3 + \%SnCl_4 + \%AgNO_3) \geq 3\%$ $NiO \geq 0,1\%$ or $As_2O_3 \geq 0,1\%$ $NiSO_4 < 0,01\%$; $Pb \text{ comp} \geq 0,3\%$; $Pt \text{ hexachloroplatinates} < 1\%$ $NiO: 1\% - 10\%$ or $Se \text{ comp} \geq 10\%$ $100 / ((\%As_2O_3)/5 + (\%Se \text{ comp} + \%Te/Te \text{ comp})/100 + (\%Cu_2O + \%Pb \text{ comp} + \%CuSO_4 + \%NiSO_4)/500) \text{ between } 300 \text{ and } 2000 \text{ mg/kg}$

		$100 / ((\% \text{Se comp}) / 700 + (\% \text{Pb comp} + \% \text{NiSO}_4) / 4500)$ between 1 and 5 mg/L $(\% \text{As}_2\text{O}_3 + \% \text{Pb comp} + \% \text{Se comp} \times 10 + \% \text{ZnO} + \% \text{NiSO}_4 + \% \text{AgNO}_3 \times 1000 + \% \text{Au comp} + \% \text{Pd comp} \times 10 + \% \text{Rh/Rh comp} + \% \text{Ru/Ru comp} + \% \text{Pt/Pt comp} \times 10 + \% \text{Cu}_2\text{O} \times 10 + \% \text{Ag comp} \times 1000 + \% \text{CuSO}_4 \times 10) > 25\%$ * $(\% \text{As}_2\text{O}_3 + \% \text{Pb comp} \times 10 + \% \text{Se comp} + \% \text{ZnO} + \% \text{NiSO}_4 + \% \text{AgNO}_3 \times 100 + \% \text{Au comp} + \% \text{Pd comp} \times 10 + \% \text{Rh/Rh comp} + \% \text{Ru/Ru comp} + \% \text{Pt/Pt comp} + \% \text{Cu}_2\text{O} + \% \text{Ag comp} \times 100 + \% \text{CuSO}_4) > 25\%$ *
3 (high Ni/ As/Cu)	Acute tox oral 3, Acute tox inh 3, Skin corr/irr 1B, Eye dam. 1, Resp/Skin sens 1, Carc. 1A, Muta 1B, Repro. 1A, STOT Rep 1, ENV Ac 1, ENV Ch 1	$(\% \text{As}_2\text{O}_3 + \% \text{SnCl}_4 + \% \text{AgNO}_3) \geq 3\%$ $\text{CdSO}_4 \geq 0.1\%$ $\text{NiSO}_4 \geq 0.01\%$ or $\text{As}_2\text{O}_3 \geq 0.1\%$ $\text{NiO} \geq 10\%$ or $\text{NiSO}_4 \geq 1\%$ or $\text{Pt hexachloroplatinates} \geq 1\%$ $\text{Pb comp} \geq 0.3\%$ $100 / ((\% \text{As}_2\text{O}_3) / 5 + (\% \text{Se comp} + \% \text{Te/Te comp}) / 100 + (\% \text{Cu}_2\text{O} + \% \text{Pb comp} + \% \text{CuSO}_4 + \% \text{NiSO}_4) / 500)$ between 50 and 300 mg/kg $100 / ((\% \text{Se comp}) / 700 + (\% \text{Pb comp} + \% \text{NiSO}_4) / 4500)$ between 0,5 and 1 mg/L $(\% \text{As}_2\text{O}_3 + \% \text{Pb comp} + \% \text{Se comp} \times 10 + \% \text{ZnO} + \% \text{NiSO}_4 + \% \text{AgNO}_3 \times 1000 + \% \text{Au comp} + \% \text{Pd comp} \times 10 + \% \text{Rh/Rh comp} + \% \text{Ru/Ru comp} + \% \text{Pt/Pt comp} \times 10 + \% \text{Cu}_2\text{O} \times 10 + \% \text{Ag comp} \times 1000 + \% \text{CuSO}_4 \times 10) > 25\%$ * $(\% \text{As}_2\text{O}_3 + \% \text{Pb comp} \times 10 + \% \text{Se comp} + \% \text{ZnO} + \% \text{NiSO}_4 + \% \text{AgNO}_3 \times 100 + \% \text{Au comp} + \% \text{Pd comp} \times 10 + \% \text{Rh/Rh comp} + \% \text{Ru/Ru comp} + \% \text{Pt/Pt comp} + \% \text{Cu}_2\text{O} + \% \text{Ag comp} \times 100 + \% \text{CuSO}_4) > 25\%$ *

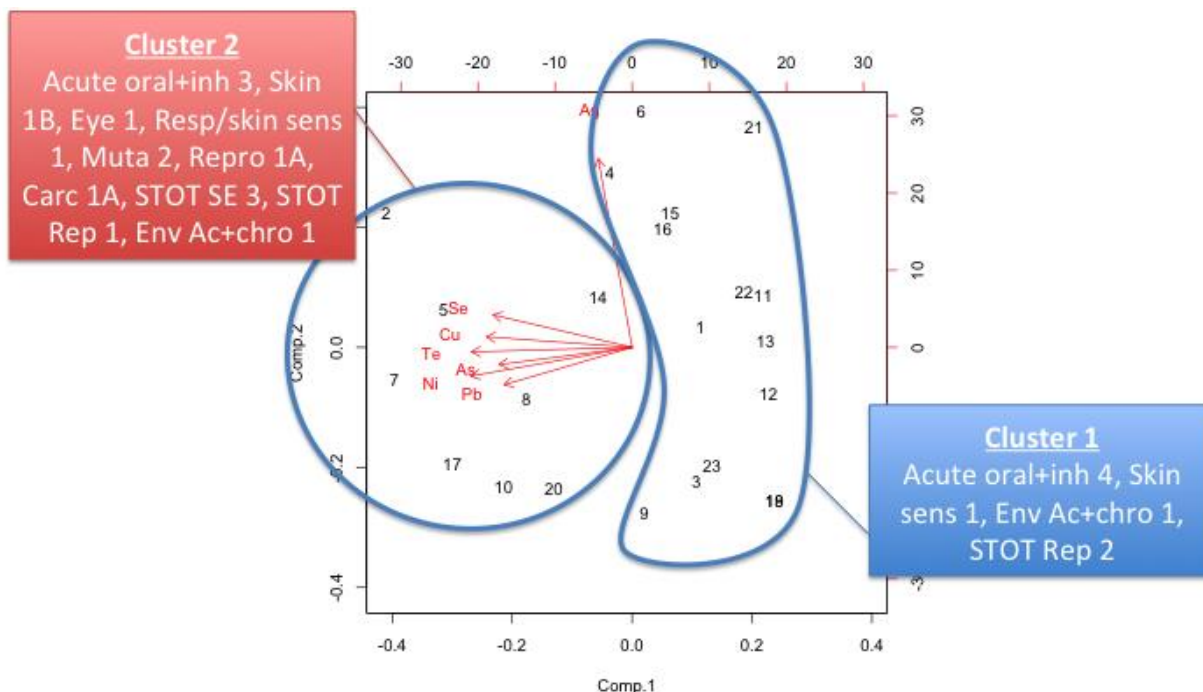
* Note that Diammonium hexachloroplatinate, platinum dioxide, dihydrogen hexahydroxyplatinate platinum dinitrate, dipotassium tetrachloroplatinate, tetraammineplatinum dichloride, palladium (black), palladium dichloride, palladium dioxide, Rhodium (black), dicarbonyl(pentane-2,4-dionato-O,O')rhodium, diammonium sodium(nitritoN)rhodate, Ruthenium (black), Tris(nitrato-O)nitrosylruthenium, Ruthenium (IV) oxide are not classified for environment.

STOT drivers: Pb comp or NiSO4

8. Residues cementation and reduction, precious metals refining

Notes:

- One of PMC's largest group
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition
- The two main principal components are a Pb/Ni/As/Cu component and an Ag component. The first cluster has relatively low metal concentrations. Cluster 2 is characterised by relatively high metal concentrations.



	Classification CLP	Composition / classification drivers
1	Acute tox oral 4, Acute tox inh 4, Skin sens 1, ENV Ac 1, ENV Ch 1, STOT Rep 2	Sb2O3 < 1%; As2O3 < 0,1%; NiSO4: 0,01% - 0,1% and NiO < 0,1% Pb comp < 0,3%; Se comp < 10%; CaO < 1% %SnCl4 + %AgNO3 + %As2O3 < 1% 10x(%SnCl4 + %AgNO3 + %As2O3 + %CaO + %CuSO4) + NiSO4 < 10% 100 / ((%As2O3)/5 + (%Se comp + %Te/Te comp)/100 + (%CuSO4 + %Pb com + %NiSO4)/500) between 300 - 2000 mg/kg 100 / ((%Se comp)/700 + (%Pb comp + %NiSO4)/4500) between 1 and 5 mg/L (%As2O3 + %Pb comp x 10 + %Se comp x10 + %ZnO + %NiSO4 + %AgNO3 x 1000 + %Au comp + %Pd comp x 10 + %Rh/Rh comp + %Ru/Ru comp + %Pt/Pt comp x 10 + %Ti/Ti comp) > 25% * (%As2O3 + %Pb comp + %Se comp + %ZnO + %NiSO4 + %AgNO3 x 100 + %Au comp + %Pd comp x 10 + %Rh/Rh comp + %Ru/Ru comp + %Pt/Pt comp + %Ti/Ti comp) > 25% *
2	Acute tox oral 3, Acute tox inh 3, Skin 1B, Eye dam. 1, Resp/skin sens 1, Muta 2, Repro. 1A, Carc. 1A, STOT SE 3, STOT Rep 1, ENV Ac 1, ENV Ch 1	NiSO4 >= 1%; As2O3 >= 0,1% or NiSO4 >= 0,1% or NiO >= 0,1% Pb comp >= 0,3%; NiSO4 >=1% or NiO >= 10%; %SnCl4 + %AgNO3 + %As2O3 >= 3% 100 / ((%As2O3)/5 + (%Se comp + %Te/Te comp)/100 + (%CuSO4 + %Pb com + %NiSO4)/500) between 50 - 300 mg/kg 100 / ((%Se comp)/700 + (%Pb comp + %NiSO4)/4500) between 0,5 and 1 mg/L (%As2O3 + %Pb comp x 10 + %Se comp x10 + %ZnO + %NiSO4 + %AgNO3 x 1000 + %Au comp + %Pd comp x 10 + %Rh/Rh comp + %Ru/Ru comp + %Pt/Pt comp x 10 + %Ti/Ti comp) > 25% * (%As2O3 + %Pb comp + %Se comp + %ZnO + %NiSO4 + %AgNO3 x 100 + %Au comp + %Pd comp x 10 + %Rh/Rh comp + %Ru/Ru comp + %Pt/Pt comp + %Ti/Ti comp) > 25% *

* Note that Diammonium hexachloroplatinate, platinum dioxide, dihydrogen hexahydroxyplatinate platinum dinitrate, dipotassium tetrachloroplatinate, tetraammineplatinum dichloride, palladium (black), palladium dichloride, palladium

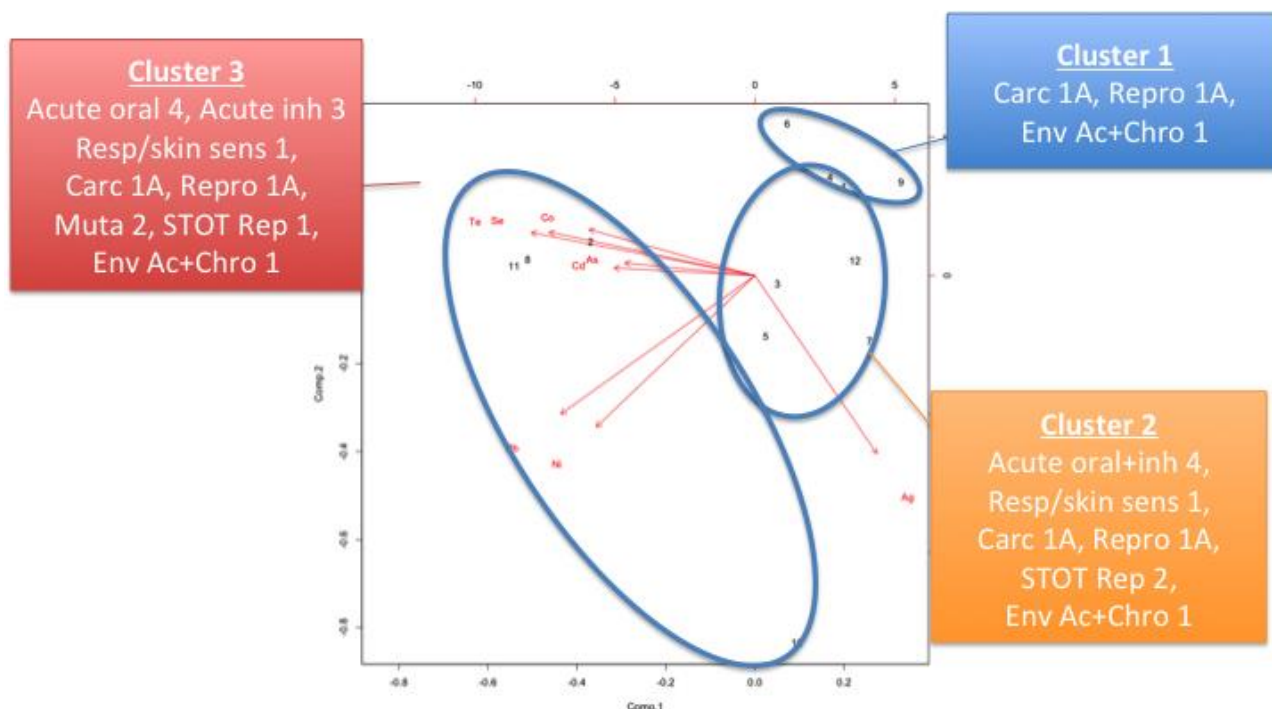
dioxide, Rhodium (black), dicarbonyl(pentane-2,4-dionato-O,O')rhodium, diammonium sodium(nitritoN)rhodate, Ruthenium (black), Tris(nitrato-O)nitrosylruthenium, Ruthenium (IV) oxide are not classified for environment.
STOT driver: NiSO4 or Pb comp

9. Materials for reclaim:

9.1. Materials for reclaim, PM with or without support:

Notes:

- One of PMC's largest group
- All constituents assumed in metallic and oxide form
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition
- The main principal component driving classification is the Pb/Ni component. The first, second and third cluster have respectively relatively low, medium and high Pb/Ni concentrations



	Classification CLP	Composition / classification drivers
1 (low Pb/Ni)	Carc. 1A, Repro. 1A, ENV Ac 1, ENV Ch 1	NiO 0,1% - 1%; Cd < 1%; Pb powder 0,3% - 10%; Se < 10%; Co < 1% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%BaO_2 + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) > 2000 \text{ mg/kg}$ $100 / ((\%Cd)/100 + (\%As + \%Se)/700 + (\%BaO_2 + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) > 5 \text{ mg/L}$ $(\%Co \times 0,11 + \%Ag \times 45 + \%Ni \times 0,007) > 1$ $(\%Co \times 0,69 + \%Ag \times 11 + \%Ni \times 0,007) > 1$
2 (med Pb/Ni)	Acute tox oral 4, Acute tox inh 4, Resp/skin sens 1, Carc. 1A, Repro. 1A, STOT Rep 2, ENV Ac 1, ENV Ch 1	NiO $\geq$ 0,1%; Cd < 1%; Pb powder $\geq$ 0,3%; Co $\geq$ 1% Se $\geq$ 10% or NiO: 1% - 10% or Pb powder $\geq$ 10%; $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%BaO_2 + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500)$ between 300 and 2000 mg/kg $100 / ((\%Cd)/100 + (\%As + \%Se)/700 + (\%BaO_2 + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500)$ between 1 - 5 mg/L $(\%Co \times 0,11 + \%Ag \times 45 + \%Ni \times 0,007) > 1$ $(\%Co \times 0,69 + \%Ag \times 11 + \%Ni \times 0,007) > 1$
3 (high Pb/Ni)	Acute tox oral 4, Acute tox inh 3, Resp/skin sens 1, Carc. 1A, Repro. 1A, Muta 2, STOT Rep 1, ENV Ac 1, ENV Ch 1	NiO $\geq$ 0,1%; Cd $\geq$ 1%; Pb powder $\geq$ 0,3%; Co $\geq$ 1% Cd $\geq$ 10% or NiO $\geq$ 10% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%BaO_2 + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500)$ between 300 and 2000 mg/kg $100 / ((\%Cd)/100 + (\%As + \%Se)/700 + (\%BaO_2 + \%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500)$ between 0,5 and 1 mg/L

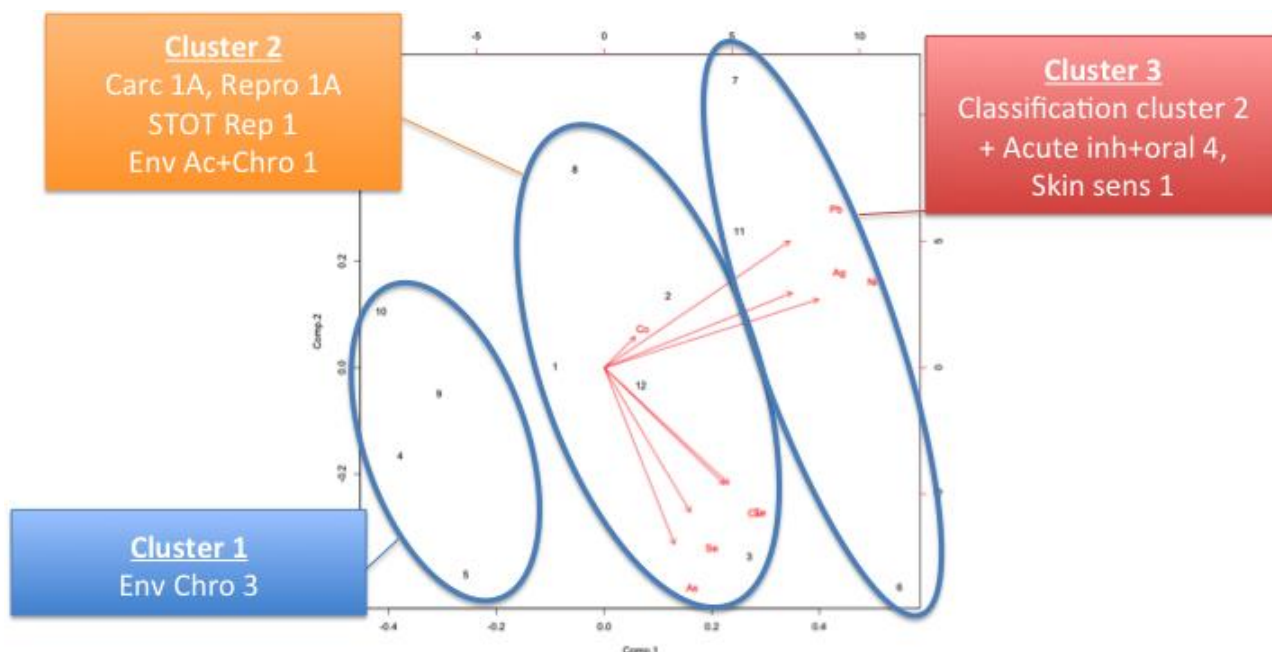
		$(\%Co \times 0,11 + \%Ag \times 45 + \%Ni \times 0,007) > 1$ $(\%Co \times 0,69 + \%Ag \times 11 + \%Ni \times 0,007) > 1$
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STOT drivers: Pb powder or NiSO₄

9.2. Materials for reclaim, PM in bricks, pots, crucibles and trays:

Notes:

- One of PMC's largest group
- All constituents in oxide, silicate and metallic form
- Grouped classification proposed, the main principal component driving classification is the Pb/Ni component. The first, second and third cluster have respectively relatively low, medium and high Pb/Ni concentrations



	Classification CLP	Composition / classification drivers
1 (low Ni/Pb)	ENV Ch 3	NiO < 0,1%; Pb comp < 0,05%; Se < 10%; Co < 1% $100 / ((\%As + \%Se + \%Te \text{ comp})/100 + (\%Pb \text{ comp} + \%Sb/Sb \text{ comp})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Pb \text{ comp} + \%Sb/Sb \text{ comp})/4500) > 5 \text{ mg/L}$ $(\%Ag \times 5,15 + \%Cu \times 0,08) < 1$ $(\%Ag \times 1,05 + \%Cu \times 0,031) * 10 < 1$
2 (med Ni/high Pb)	Carc. 1A, Repro. 1A, STOT Rep 1 (driver: Pb comp), ENV Ac 1, ENV Ch 1	NiO 0,1% - 1%; Pb comp >= 0,3%; Pb comp >= 0,5% or Se >= 10%; Co < 1% $100 / ((\%As + \%Se + \%Te \text{ comp})/100 + (\%Pb \text{ comp} + \%Sb/Sb \text{ comp})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Pb \text{ comp} + \%Sb/Sb \text{ comp})/4500) > 5 \text{ mg/L}$ $(\%Ag \times 5,15 + \%Cu \times 0,08) > 1$ $(\%Ag \times 1,05 + \%Cu \times 0,031) > 1$
3 (high Ni/Pb)	Acute tox inh 4, Acute tox oral 4, Skin sens 1, Carc. 1A, Repro. 1A, STOT Rep 1 (driver: NiO), ENV Ac 1, ENV Ch 1	Pb comp >= 0,3% NiO >= 1% and Co < 1% $100 / ((\%As + \%Se + \%Te \text{ comp})/100 + (\%Pb \text{ comp} + \%Sb/Sb \text{ comp})/500) \text{ between } 300 - 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Pb \text{ comp} + \%Sb/Sb \text{ comp})/4500) \text{ between } 1 - 5 \text{ mg/L}$ $(\%Ag \times 5,15 + \%Cu \times 0,08) > 1$ $(\%Ag \times 1,05 + \%Cu \times 0,031) > 1$

9.3. Materials for reclaim, PM production by-products:

Notes:

- All constituents assumed in metal or metal oxide form
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition
- Grouped classification proposed

	Classification CLP	Composition / classification drivers
1	No classification	Co <1%; Ni <1%; Pb powder <0.3%; Se < 10%; Pd comp < 1% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) > 5 \text{ mg/L}$ $(\%As + \%Cu \text{ powder} \times 10 + \%Pb \text{ powder} \times 10 + \%Ag + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) < 25\%$ $100 \times (\%As + \%Cu \text{ powder} + \%Pb \text{ powder} + \%Ag \times 10 + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) + 10 \times (\%Sb/Sb \text{ comp}) + (\%Ni \text{ powder} + \%Ba) < 25\%$
2	Carc. 2, Repro. 1A, STOT Rep 2 (driver: Ni or Pb), ENV Ac 1, ENV Ch 1, Skin sens. 1	Co < 1%; Ni: 1%-10%; Pb powder >= 0,3% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) > 5 \text{ mg/L}$ $(\%As + \%Cu \text{ powder} \times 10 + \%Pb \text{ powder} \times 10 + \%Ag + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) > 25\%$ $(\%As + \%Cu \text{ powder} + \%Pb \text{ powder} + \%Ag \times 10 + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) > 25\%$
3	Carc. 2, Repro. 1A, STOT Rep 1 (driver: Ni or Pb), ENV Ac 1, ENV Ch 1, Skin sens. 1, Acute tox oral 4, Acute tox inh 4	Co < 1%; Ni >= 10%; Pb powder >= 0,3% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) \text{ between } 300 - 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) \text{ between } 1 - 5 \text{ mg/L}$ $(\%As + \%Cu \text{ powder} \times 10 + \%Pb \text{ powder} \times 10 + \%Ag + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) > 25\%$ $(\%As + \%Cu \text{ powder} + \%Pb \text{ powder} + \%Ag \times 10 + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) < 25\%$
4	Carc. 2, STOT Rep 2 (driver: Ni), ENV Ac 1, ENV Ch 1, Resp/Skin sens. 1	Co >= 1%; Ni: 1%-10%; Pb powder < 0,3% $100 / ((\%As + \%Se + \%Te/Te \text{ comp})/100 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/500) > 2000 \text{ mg/kg}$ $100 / ((\%As + \%Se)/700 + (\%Sb/Sb \text{ comp} + \%Pb \text{ powder})/4500) > 5 \text{ mg/L}$ $(\%As + \%Cu \text{ powder} \times 10 + \%Pb \text{ powder} \times 10 + \%Ag + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) > 25\%$ $(\%As + \%Cu \text{ powder} + \%Pb \text{ powder} + \%Ag \times 10 + \%Cr \times 10 + \%Rh + \%Ru + \%Ti + \%Zn \text{ powder}) < 25\%$

10. Pb bullion, PGM rich:

Notes:

- One of PMC's simplest groups covering streams from a very specific precious metals refining process (hence, a lot of uniformity across compositions and resulting classifications)
- Mainly metallic
- Note that classification drivers are (worst-case) assumptions and do not necessarily represent real species/mineralogical composition

	Classification CLP	Composition / classification drivers
1	Carc. 2, Repro. 1A, STOT Rep 1 (driver: Ni or Pb), ENV Ac 1, ENV Ch 1, Skin sens. 1, Acute tox oral 4	Ni powder $\geq 1\%$; Pb powder $\geq 7\%$; Cd $< 0,1\%$ $100 / ((Te\% + Se\% + Sb\% + As\%)/100 + (Pb \text{ powder}\%)/500)$ between 300 - 2000 mg/kg $100 / ((Se\% + Sb\% + As\%)/700 + Pb \text{ powder}\%/4500) > 5 \text{ mg/L}$ $(\%Cu \times 0,4 + \%Pb \times 0,14) > 1$ $(\%Cu \times 0,05 + \%Pb \times 0,056) > 1$

Assume surface area of 1 mm particle size (expressed as m²/g) unless provided otherwise by registrant