

If earthworms cannot help: tiered approach in line with chemical legislation

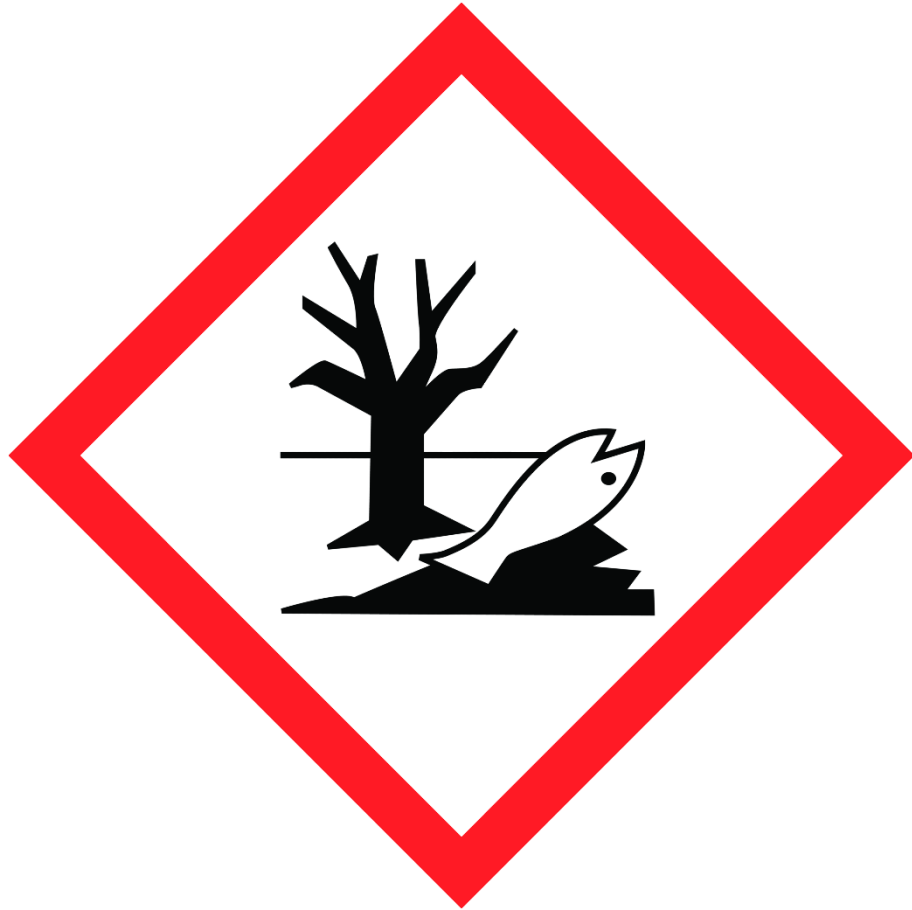
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*Interessengemeinschaft der
Thermischen Abfallbehandlungsanlagen
in Deutschland e.V.*

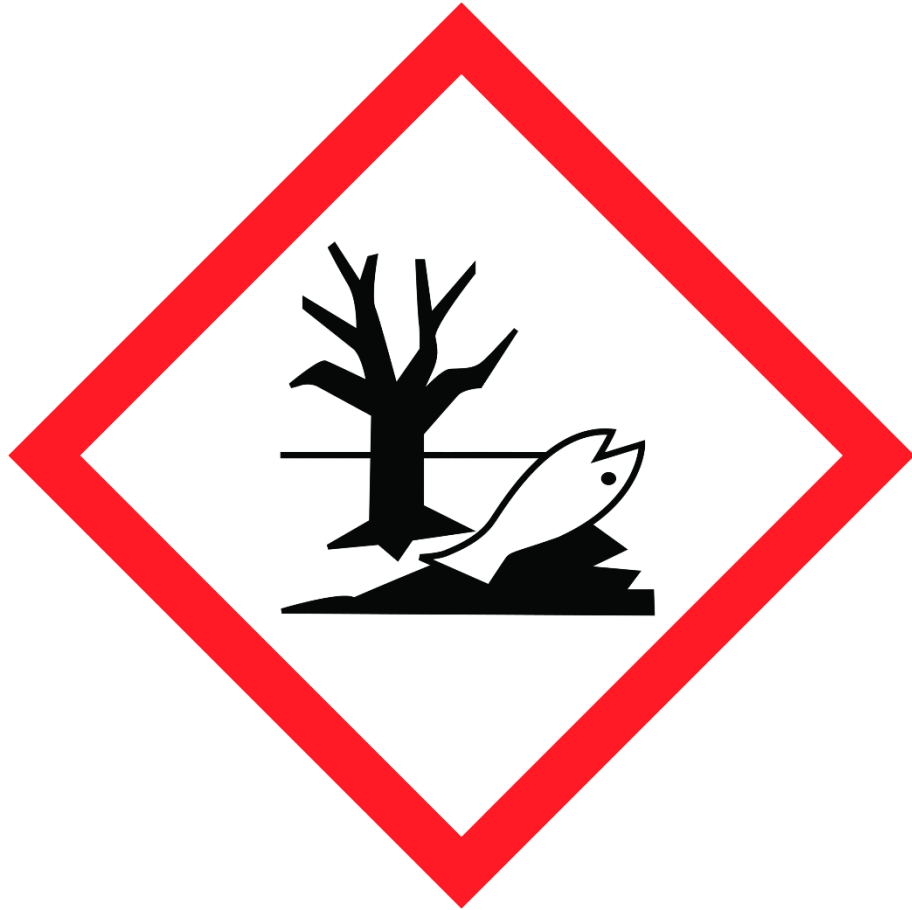
CLASSIFICATION OF BOTTOM ASH

H(P)14 - INTRINSIC PROPERTIES OR RISK ASSESSMENT



H14 Ecotoxic

**The
root
of
all
„evil“**

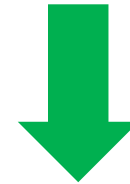


H14 Ecotoxic

**The
root
of
all
discussions...**



- **Fresh, processed and aged bottom ash**
- **Coarse and fine metals**
- **Aging process influencing pH-value, leaching behaviour etc.**



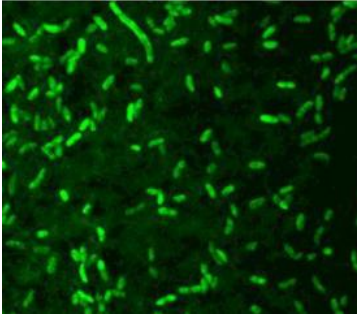
**limited application areas
for recovery (e.g. road
construction, walls etc.)**



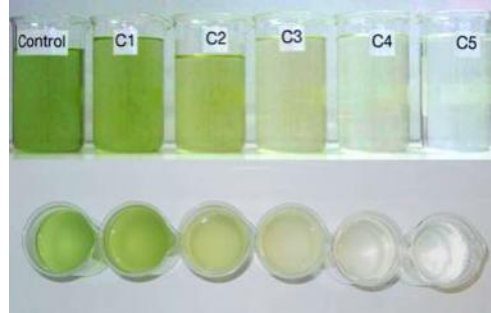
The first attempt: ecotox-testing with biotest

Biotest scheme based on soil testing -

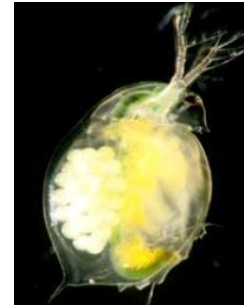
Three aquatic and three terrestrial test methods:



luminescent
bacteria test



algae growht
inhibition test



daphnia test



earthworm
test



bacteria contact
test



plant growth
test

Results biotest:

- test scheme questionable
- strongly fluctuating results
- no reliable reproducibility
- time consuming
- high cost



Official result biotest:

A comprehensive assessment of bottom ash with regard to the H-14 criterion according to the European Waste Catalogue is only possible by a combination of chemical and biological studies.



A few years later...

THE EUROPEAN WAY:

**ALIGNMENT OF WASTE AND
CHEMICAL LEGISLATION**

with a „little“ bit of risk assessment regarding HP14

Classification of waste according to the list of wastes (as hazardous or non-hazardous waste) should be based on a guidance document (not legally binding for Member States) taking into account classification approaches of chemical legislation (CLP).

But:

Under CLP, substances and mixtures with known composition are carefully classified on the basis of their intrinsic hazard potential, but the input and output of waste incineration plants is extremely heterogeneous. CLP classification methods - only based on chemical analyses, without taking waste-specific characteristics into account - can lead to significant inaccuracies in the classification results - especially with regard to HP14 "ecotoxic".



The European way

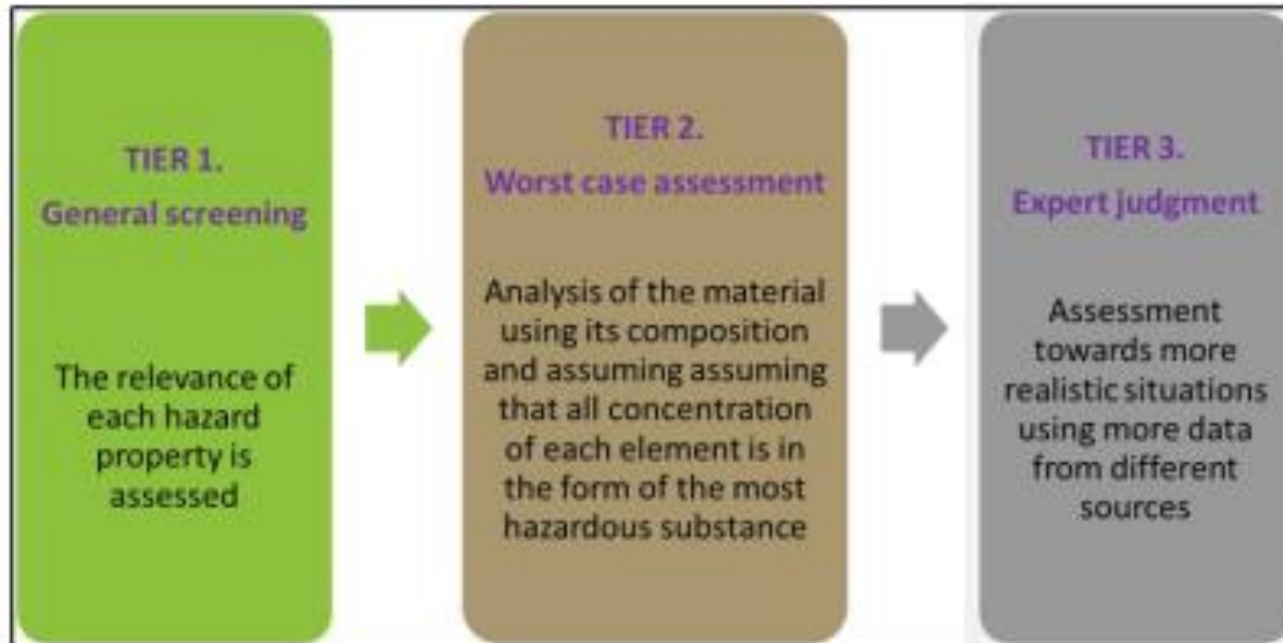
Basis: waste legislation, CEWEP bottom ash dossier and ECN



Waste classification is based on Commission Decision 2000/532/EC on the List of Waste (LoW) amended by Commission Decision 2014/995/EU and Annex III of the Waste Framework Directive 2008/98/EC (WFD), amended by Commission Regulation (EU) No 1357/2014 (1 June 2015) due the implementation of the Regulation (EC) No 1272/2008 (CLP regulation): all hazardous properties (HP1 – HP 15) have to be checked.



tiered approach based on CEWEP bottom ash dossier values (95th percentile of European bottom ash composition)



Element	Average	Median	Min	Max	95 percentile	95 percentile	N
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	
Ca	130833	125586	50825	198289	190442	19.0	322
CO3	61073	59100	26160	103800	103404	10.3	38
Fe	58714	56703	34216	118220	103299	10.3	259
Si	82713	84180	61060	96078	93898	9.4	129
Al	47232	44627	30527	75089	71620	7.2	311
Cl	9211	5943	3644	37633	37188	3.7	136
Na	21379	22270	12308	34791	32121	3.2	234
TOC	10092	9340	1350	42760	24664	2.5	1382
Mg	12429	11242	6377	34372	21025	2.1	287
K	7748	7595	4854	12722	11857	1.2	260
P	5633	5049	2531	12556	11773	1.2	220
Cu	3275	2510	738	17620	8863	0.89	1699
S	3862	3475	1310	16808	7873	0.79	455
Ti	4244	4112	2873	7479	6636	0.66	262
Zn	3241	2871	1142	9370	6250	0.63	1697
C	3171	2919	1119	5702	5383	0.54	69
Pb	1309	1058	197	6441	3969	0.40	1706
Ba	1102	958	760	2970	2207	0.22	288
Mn	1173	1104	644	2248	1965.3	0.20	313
PO4	248	10	10	1360	1311	0.13	38
F	148	71	13	1779	1219.5	0.12	78
Cr	353	315	115	852	754	0.075	1701
NO3	172	100	5	875	732	0.073	38
Ni	185	153	38	850	531	0.053	1696
Sn	181	154	52	737	519	0.052	335
B	198	183	30	532	401	0.040	191
Sr	271	270	267	369	356	0.036	136
Sb	73	63	18	250	159	0.016	612
NH4	53.3	46.5	5	131	128	0.013	43
NO2-	13	1	<1	100	100	0.010	38
Co	31.8	23	11	103	91.1	0.0091	376
Br	44.7	42	23	95	80.6	0.0081	50
Mo	30.1	28	5	84	80.6	0.0081	533
V	41.2	36	19	248	76.3	0.0076	349
As	17.3	14.7	4.4	73.2	46.5	0.0047	1615
Ag	15.2	14.3	2.3	47.1	37.5	0.0038	127
Tl	6.7	3.8	3.4	27.5	28.6	0.0029	137
Li	14	14	2	29	23	0.0023	92
Te	10	9.8	5.3	24.8	22	0.0022	49
Cd	4.8	4.3	1.1	117	13.9	0.0014	1661
Se	5.2	4.7	2.3	12.2	12.7	0.0013	145
Bi	2.1	0.05	0.05	11.3	7.4	0.00074	34
Hg	2.3	1.53	1.39	9.69	7.3	0.00073	316
Be	1.2	0.83	0.46	6.6	2.3	0.00023	162
CN	0.7	0.64	0.5	0.94	0.9	0.00009	50
Cr VI	0.5	0.5	0.3	0.8	0.8	0.00008	82
Sol frac %	2.5	2.6	1.4	4.2	4.1		31
LOI %	4.2	4.6	2.6	6	5.9		81
pH	10.86	10.78	9.28	12.13	11.74		1639

Result of the ECN-tiered approach: critical calculation of HP14

Tier 1	HP 1:	explosive	NH	general screening
	HP 2:	oxidizing	NH	
	HP 3:	flammable	NH	
	HP 9:	infectious	NH	
	HP12:	release of an acute toxic gas	NH	
	HP 15:	yielding another substance	NH	
Tier 2	HP 5:	STOT/Aspiration toxicity	NH	worst case analysis
	HP 6, Σ:	acute toxicity	NH	
	HP 11:	mutagenic	NH	
	HP 13:	sensitising	NH	
Tier 3	HP 4, Σ:	irritant	NH	expert judgement
	HP 7:	carcinogenic	NH	
	HP 8, Σ:	corrosive	NH	
	HP 10:	toxic for reproduction	NH*	
	HP 14, Σ:	eco-toxic	H/NH*	

only relevant calculation method for HP14:

$$100 * \Sigma c_H410 + 10 * \Sigma c_H411 + \Sigma c_H412 \geq 25\%$$

HP14 assessment based on total contact of elements

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bottom ash most probably hazardous

HP14 Assessment based on eluates (risk based approach)

->

Bottom ash most probably non-hazardous

THE „GERMAN“ CLASSIFICATION APPROACH

Commission Decision 2000/532/EC on the List of Waste (LoW) amended by Commission Decision 2014/995/EU:

...

2. Classification of waste as hazardous

...

- The concentration limits defined in Annex III to Directive 2008/98/EC **do not apply to pure metal alloys in their massive form** (not contaminated with hazardous substances). Those waste alloys that are considered as hazardous waste are specifically enumerated in this list and marked with an asterisk (*).

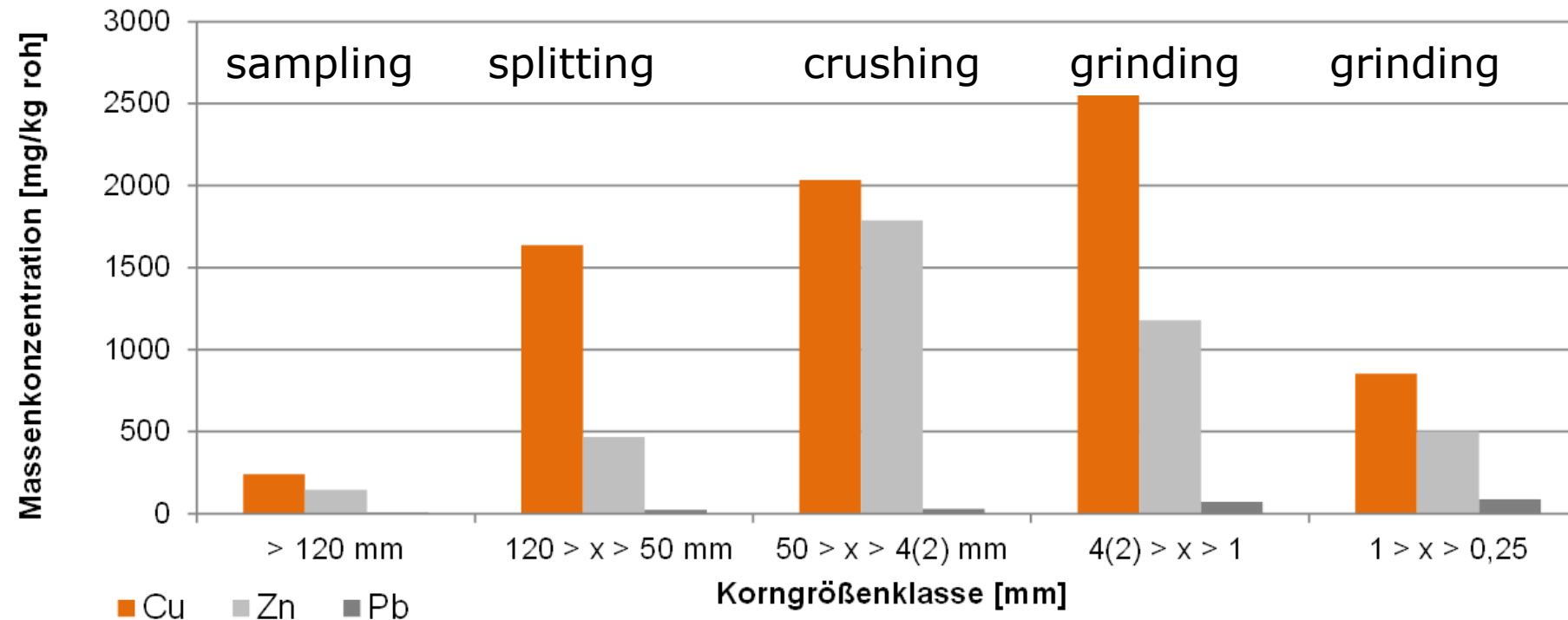
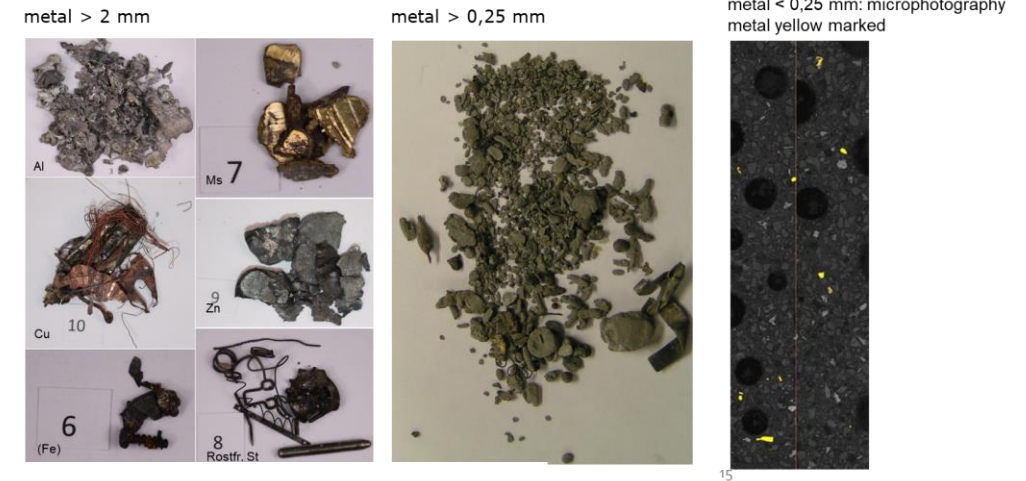
THE BIRTH OF THE “BIG”-METHOD...

Standard-classification of bottom ash

- Database: CEWEP-bottom ash dossier, historic and new bottom ash data Germany (IGAM/ITAD)
- Basis for HP1 - HP13 and HP15: **ECN** „tiered approach“ used for CEWEP assessment
- Basis for HP14
 - Total content analysis of bottom ash using real data for the distribution of pure and bound metals (lead, copper, nickel, zinc) as well as their relevant binding forms – **bIG** investigations by **bifa** Umweltinstitut GmbH, **ITM** (University of Duisburg-Essen) and **GKS** (WtE-plant in Schweinfurt)
 - Safeguarding the HP14 classification through risk-based based assessment analogous to the HP14 assessment from the ECN report (eluate check)

Assessment of four groups of „metals“:

- Group 0: solid metals or alloying metals

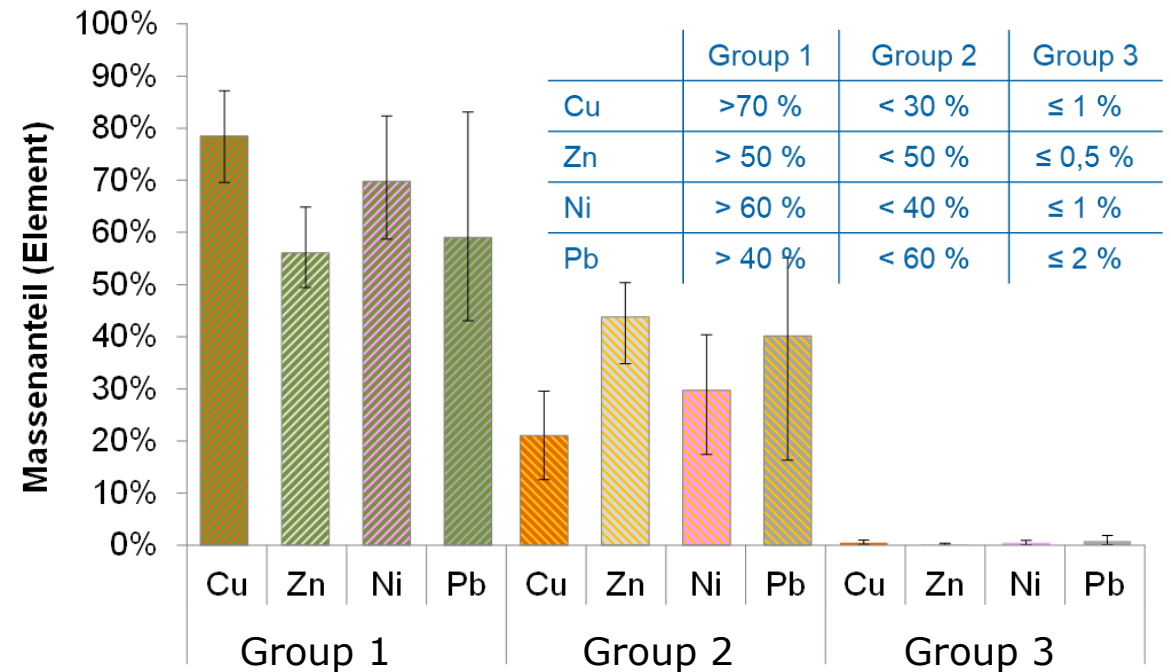
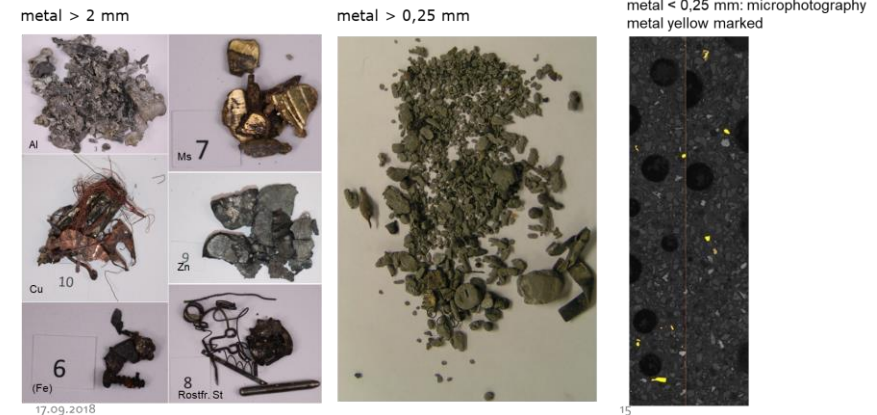


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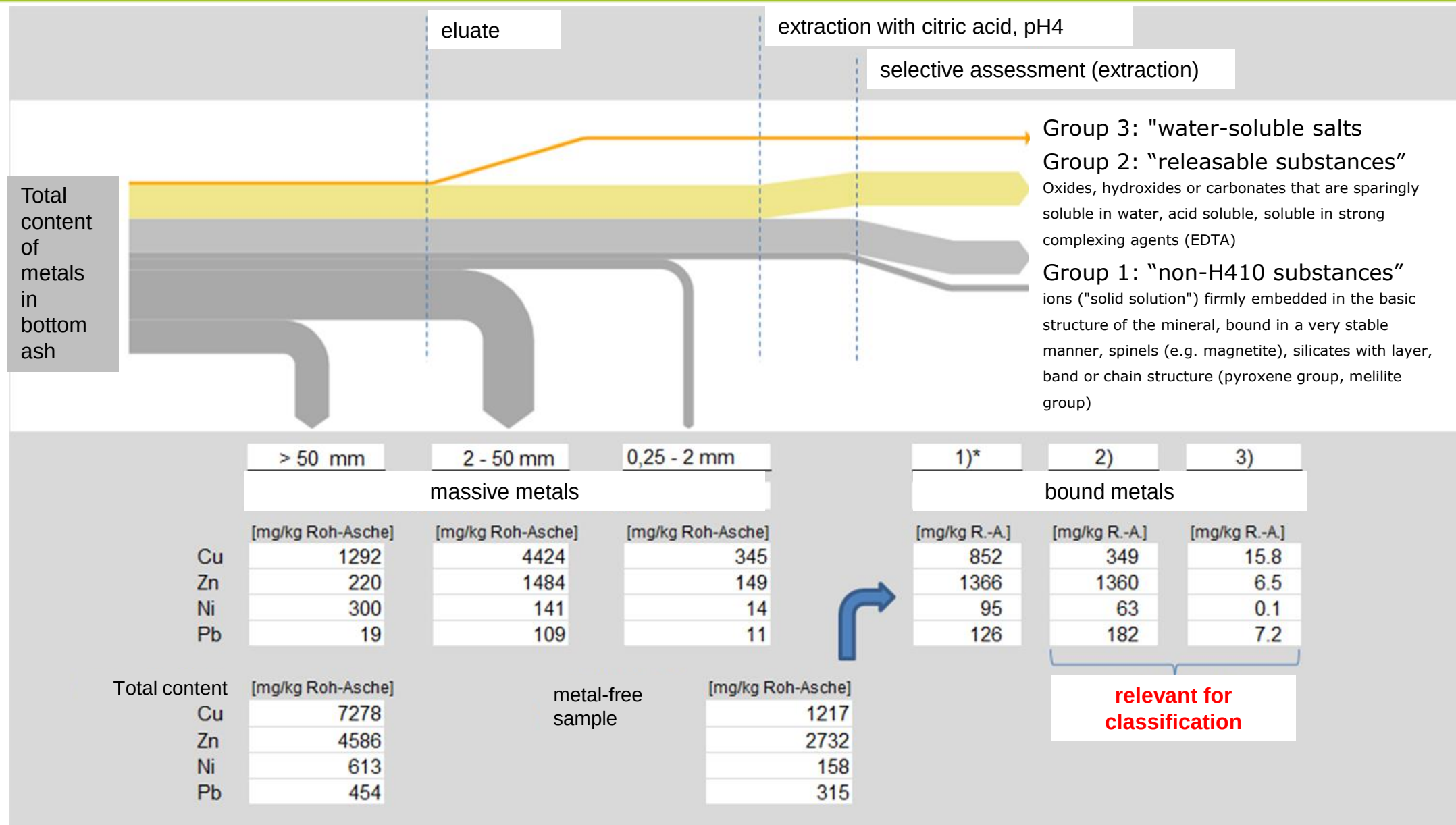
Pesticide	Massenkonzentration (gesamt) [mg/kg roh-Rostasche]
A_379_2	2000
A_380_2	2500
A_381_2	2000
A_382_2	2500
A_383_2	1800
A_384_2	2000
A_385_2	3200
A_386_2	2000
A_387_2	1500
A_388_2	2000
A_389_2	2500
A_390_2	2200
A_391_2	2200
A_392_2	2000
K_393_2	1800
K_394_2	1800
K_395_2	1200
K_396_2	800
B_397_2	1800
B_398_2	1800
P_399_2	1500
P_400_2	2000
P_401_2	1800
P_402_2	1800
P_403_2	1500
P_404_2	1500
P_405_2	1200
G_406_2	2200
G_407_2	1800
G_408_2	3500
G_409_2	2800
D_410_2	2500
D_411_2	2500
D_412_2	2200
D_413_2	1800
D_414_2	2200
D_415_2	3800
D_416_2	2000
D_417_2	2000
I_418_2	2500
I_419_2	2800
A_420_2	1800
A_421_2	1800
B_422_2	4800
B_423_2	800
B_424_2	800
B_425_2	1000
C_426_2	1500
C_427_2	2000

Four groups of „metals“:

- Group 0: solid metals or alloying metals
- Group 1: “non-H410 substances”
ions ("solid solution") firmly embedded in the
basic structure of the mineral, bound in a very
stable manner
spinels (e.g. magnetite)
silicates with layer, band or chain structure
(pyroxene group, melilite group)
- Group 2: “releasable substances”
Oxides, hydroxides or carbonates that are
sparingly soluble in water, acid soluble, soluble
in strong complexing agents (EDTA)
- Group 3: "water-soluble salts"
Subordinate salts (partly react to hydroxides)
Oxo complexes (anions with Cu, Zn, Pb)



The biG-HP14 result (example)



Tier 1	HP 1:	explosive	NH	general screening
	HP 2:	oxidizing	NH	
	HP 3:	flammable	NH	
	HP 9:	infectious	NH	
	HP12:	release of an acute toxic gas	NH	
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	HP 7:	carcinogenic	NH	
	HP 8, Σ :	corrosive	NH	
	HP 10:	toxic for reproduction	NH*	
	HP 14, Σ :	eco-toxic	NH	

It can be concluded,
that bottom ash is
generally to be classified
as **non-hazardous!**

Thanks for your patience



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