TOXIC ELEMENTS IN COAL AND THEIR ASHES

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This paper reveals the presence of potentially toxic elements in Romanian coals and in ashes from their combustion. It shows that elements such as Arsenic, Antimony, Mercury, Lead, Copper, Cadmium, Bismuth, Silver, Zinc, Chromium, Manganese, Thallium, Barium, Beryllium, exist in coal structure in concentrations below than the lethal values.Their presence in the composition of coals is related to the structure of coals and ashes and to potentially toxic soluble components.The concentrations of these elements in Romanian coals is shown in this study, the samples of coals have been determined with neutron activation analysis of the sample in a nuclear reactor. The results demonstrate that in these coals and their ashes, there is no risk of chemical hazards.

Keywords: coal, ash, toxic elements, NAA

1. Introduction

To ensure a clean environment concerning the processing and utilization of some Romanian coals and their ashes, the chemical toxicity is determined in this study. The chemical elements result from the associated minerals and from the transformation process during their burning.

In Table 1 are shown the main coal associated minerals. [1-5]

Tabel 1

Coal associated minerals

Group	Species	Formula
Shale	Muscovite; Hydromuscovite Ilite; Bravaisite; Montmorillonite	$(K,Na,H_3O,Ca)_2(Al,Mg,Fe,Ti)_4(Al,Si)_8O_{20}(OH,F)_4$
Kaolin	Kaolinite; Livesite; Metahalloysite	$Al_2(SiO_3)(OH)_4$
Sulfide	PyriteMarcasite	FeS_2
Carbonate	Ankerite; Ankerit calcte; Ankerit dolomit	(Ca, Mg, Fe, Mn) CO_3
Chloride	Sylvinite; Halite	KCl; NaCl
Minerals	Quartz Feldspar Garnet Hornblende Gypsum Apatite Zircon	SiO_2 $(K,Na)_2O{\cdot}Al_2O_3{\cdot}6SiO_2$ $3CaO{\cdot}Al_2O_3{\cdot}3SiO_2$ $CaO{\cdot}3FeO{\cdot}4SiO_2$ $CaSO_4{\cdot}2H_2O$ $9CaO{\cdot}3P_2O_3{\cdot}CaF_2$ $ZrSiO_4$

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	Epidote	$4CaO{\cdot}3Al_2O_3{\cdot}6SiO_2{\cdot}H_2$
	Biotite	$K_2O{\cdot}MgO{\cdot}Al_2O_3{\cdot}3SiO_2{\cdot}H_2O$
	Augite	$CaO{\cdot}MgO{\cdot}2SiO_2$
	Prochlorite	$2FeO{\cdot}2MgO{\cdot}Al_2O_3{\cdot}2SiO_2{\cdot}2H_2O$
	Diaspore	$Al_2O_3{\cdot}H_2O$
	Lepidocrocite	$Fe_2O_3{\cdot}H_2O$
	Magnetite	Fe_3O_4
	Cianite	$Al_2O_3{\cdot}SiO_2$
	Staurolite	$2FeO{\cdot}5Al_2O_3{\cdot}4SiO_2{\cdot}H_2O$
	Topaz	$(AlF)_2SiO_4$
	Tourmaline	$H_9Al_3(BOH)_2Si_4O_{19}$
	Hematite	Fe_2O_3
	Penninite	$5MgO{\cdot}Al_2O_3{\cdot}3SiO_2{\cdot}2H_2O$

The table show that potentially toxic elements As, Sb, Hg, Pb, Cd, Sr, Ta are usually not associated minerals. It is possible that these elements can exist in coal only by the interaction of chemical material and water percolation.

Concentrations of potentially toxic elements in Earth's crust and lethal doses are presented in Table 2. [6-8]

Tabel 2

Toxic elements in ground

Element	Letal dose (ppm)	Solid content (ppm)
As	0,12 – 0,3	60
Sb	45	1
Hg	1,500	0,02
Pb	500	100
Cu	10000 – 15000	10,900
Cd	1000	20
Bi	8000	2
Ag	10000	90
Zn	3000-5000	8500
Cr	5000	0,02
Mn	5000	800
Ta	500	1
Ba	4000	2-5%

2. Methods and apparatus

The Neutron activation analysis (NAA) apparatus the content of toxic elements was determined in Romanian coals (pit coal, brown coal and lignite) and their resulted ashes from the combustion.[9]

Interaction of distilled water and coals or hot ashes in their treatment and solid waste analysis was investigated.

It is studied the distribution of elements in the principal types of Romanian coal in various stages of carbonification and ashes. Coal structure has the ability to capture these toxic elements.

NAA is a nuclear process used for determining the concentrations of elements in a great number of materials. [10,11]

NAA method allows discrete sampling of elements as it disregards the chemical form of a large number of materials and focuses only on its nucleus. The method requires a source of neutrons. The sample is bombarded with neutrons, causing the elements to form radioactive isotopes.

The radioactive emissions and radioactive decay paths for each element are well known. Using this information, it is possible to study spectra of the emissions of the radioactive sample, and determine the concentrations of the elements within it. It have been investigated some of Romanian representative coals , for each carbonification with a specific ash content.

Neutron activation reactions are generally more numerous than those with charged particles that have to cross the potential barrier, they can penetrate the core from the small weight to the heaviest.

Measurements were performed on raw coals of various ranks from lignite to antracite.

The toxic elements in some Romanian coals are presented in Table 3 and in Table 4. We used NAA method to determine the toxic elements in some Romanian coals.

Tabel 3

Toxic elements in Romanian coals

Sample from :	Ash	Elements (ppm)													
	%	As	Sb	Hg	Pb	Cd	Cd	Bi	Ag	Zn	Cr	Mn	Ta	Ba	Be
Lignite, Schitu Golesti	36,2	10	7	-	15	10	-	5	-	24	23	5	-	42	7
Pit coal Lupeni	33,1	6	3	-	10	5	-	2	-	15	7	9	-	31	4
Pit coal Anina	38,2	4	2	-	5	3	-	1	-	11	5	7	-	22	2
Antracite Schela	41,5	1	1	-	2	2	-	2	-	10	3	6	-	6	1

Tabel 4

Toxic elements in Romanian coals ashes

Sample from:	Ash	Elements (ppm)													
	%	As	Sb	Hg	Pb	Cu	Cd	Bi	Ag	Zn	Cr	Mn	Ta	Ba	Be
Lignite ash, (Schitu Golesti)	36,2	30	20	-	50	30	-	15	-	65	63	53	-	130	23
Pit coal ash (Lupeni)	33,1	18	11	-	31	16	-	6	-	42	21	28	-	100	13
Pit coal ash (Anina)	38,2	12	7	-	14	11	-	4	-	36	16	22	-	70	5
Antracite ash (Schela)	41,5	3	2	-	11	7	-	5	-	26	12	20	-	15	3

The toxic elements in coal are focused below the toxicity degree for the earth's crust.

By burning the organic mass, higher concentrations appear in ash with a chemically inert glassy structure.[10]

In the water residue from the interaction at a high temperature with coals and ashes toxic elements doesn't appear.

Heavy metals have toxicity only in the presence of soluble salts or in other salts.

3. Conclusions

The content of elements associated with coal is based on the composition and geological membership of the rocks surrounding the ore.

1. Chemical toxicity of an item depends on the chemical composition and structure of ore that is embedded.
2. The content of toxic elements in Romanian coal is below the allowable limit.
3. Romanian coals and ashes from the combustion don't have chemical toxicity due to ordinary chemicals.
4. The interaction between coal and water does not lead to leaching the toxic elements, because they are strictly included in the vitreous structure.
5. Occurrence of toxic elements in some parts of coal may indicate attempts to disperse certain residues.
6. The impact of the ashes deposits in the environment is limited by the inert entering in air and soil with negative and polluting effects from the physical particles and not with chemical substances.

R E F E R E N C E

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