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MINERALOGICAL AND LEACHING CHARACTERISTICS OF BENEFICIATED COAL PRODUCTS FROM SANTA CATARINA, BRAZIL

CIVEIRA, M. S., RAMOS, C. G., TAFFAREL, S. R., KAUTZAMNN, R. M.

Academic Work

Introduction

- The coal washing techniques generally used in the Jorge Lacerda Power Station, in Santa Catarina state, include jigging, dense medium separation and cyclones. Although such stockpiles may be designed to prevent escape of water, leachates from the stockpile may still be released to the ground of surface water in a variety of ways.
- This study therefore aims to investigate the nature of the mineral matter in the coals produced in Santa Catarina Basin, and also the extent to which different major and trace elements might be mobilized from te coal when exposed to water under laboratory leaching test conditions.

1. Sampling program

- 20 samples of mined and (in most cases) beneficiated products from the main seams were collected from 12 localities (fig 1). Fresh samples were collected at each location immediately after the coal cleaning process, but in some cases, the samples were collected from product stockpiles that had been exposed for approximately 18 months before sampling took place.
- Then, the samples were quartered and individually homogenized in the field according to ASTM 1991, reduced in size by hand and milled to provide a representative sample of 0.5 kg. So, the samples were dried (40ºC, 16h) homogenized and sieved through a 450 µm screen.

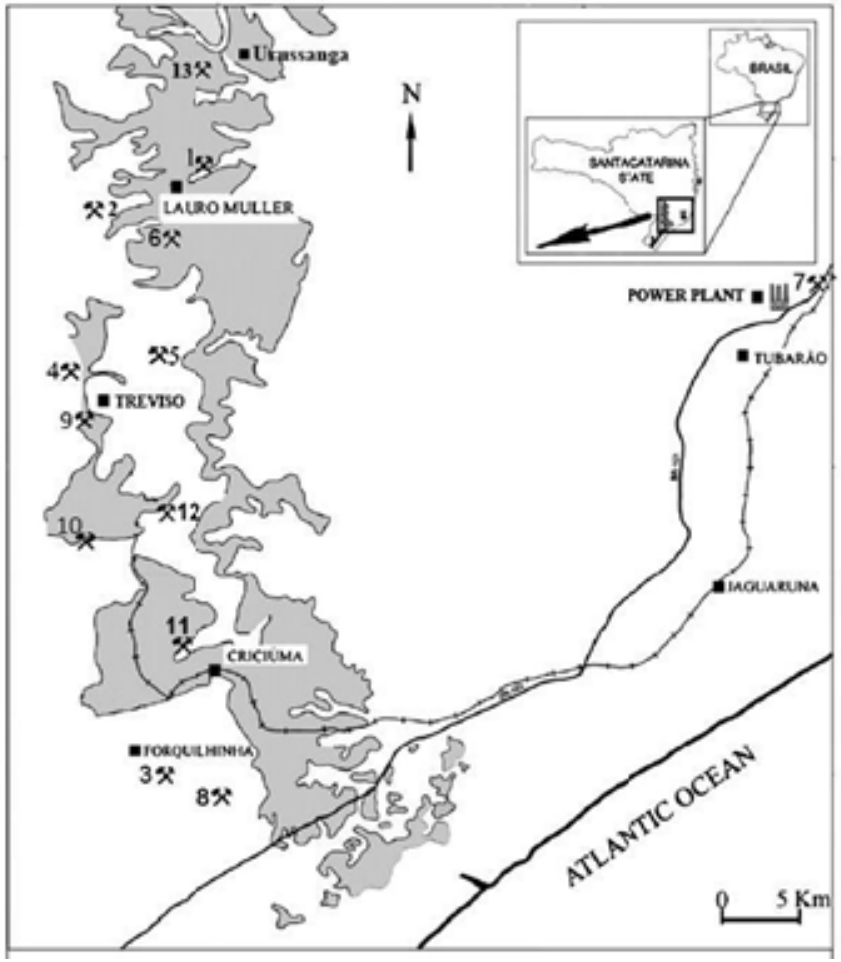

Fig 1. Location of sampling sites in Santa Catarina

2. Analytical methods

- The mineralogy of each LTA was evaluated by X-ray powder diffraction, the chemical analyses of individual particles exposed on natural and/or polished surfaces coal samples was performed with Scanning electron microscope (SEM), fitted with an energy-dispersive X-ray spectrometer (EDS).

- Coal samples were ashed at 815ºC, and the resultant ashes were then calcined at 1050ºC, mixed with lithium borate and fused into borosilicate disks. The major element oxides were determined by X-ray fluorescence (XRF) spectrometry.

- The coal samples were acid digested following a two-step digestion method devised to retain volatile elements (Querol et al., 1997). The resulting solutionm was then analyzed by inductively coupled plasma atomic-emission spectrometry (ICP-AES) and inductively coupled plasma mass spectrometry (ICP-MS) to determine the trace element concentrations.

Results and discussions

- On a minerals included basis the coals contain from 17 to 60% vitrinite, mainly in the form of collotelinite, and 17 to 60% inertinite, mainly fusinite and semifusinite. (fig 2a, c).

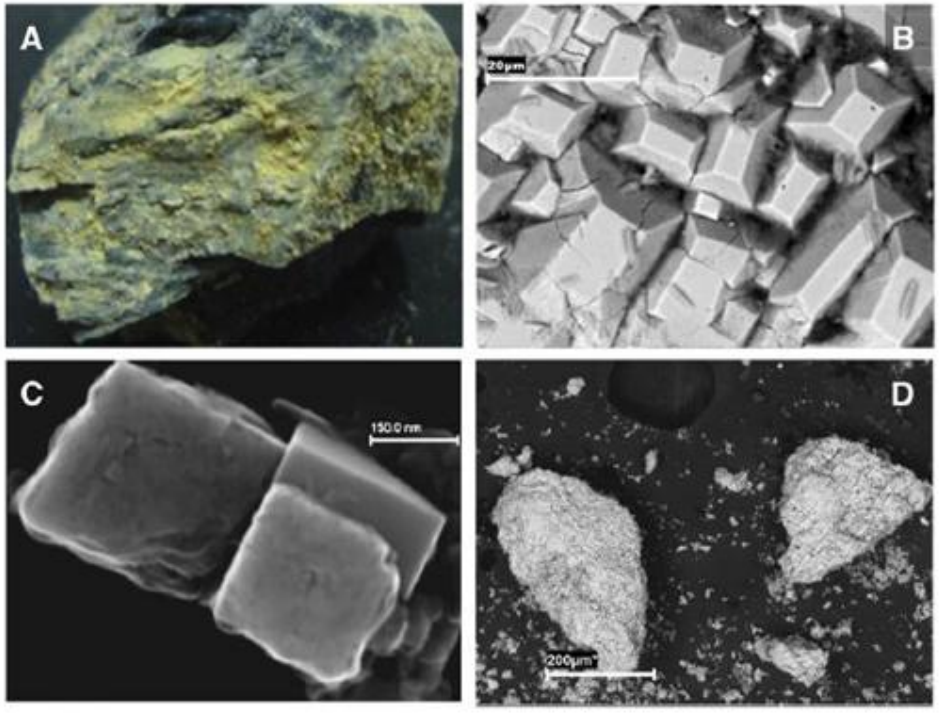

Fig. 2. (A) Pseudomorphs of jarosite (yellow to light brown) after pyrite in a coal fragment (CR-50); (B) Cubic pyrite crystals on a natural surface under the SEM; (C) Replacement of cubic pyrite crystals by jarosite; (D) Hematite typically also present in samples containing jarosite

- The mineralogy of the LTAs isolated from the coals is given in table 1. Pyrite is a minor but sifnificant constituent of the LTA isolated, making up to around 3.5% of the mineral matter.

- Calcite is present in the LTA of some of the coal samples, although again only in minor proportions (less than 5%).

- Bassanite ($CaSO_4 \cdot 1/2\ H_2O$) is present in all but one of the LTAs,m along in one case (CR-22) with gypsum.

Table 1. Mineralogy of coal LTAs from XRD and Siroquant (wt. %).

	CR-02	CR-06	CR-10	CR-16	CR-18	CR-22	CR-24	CR-29	CR-36	CR-37
LTA yield	39,9	55,4	44,4	43,1	41,9	43,9	49,9	48,0	36,4	37,9
Quartz	15,3	24,7	12,1	26,5	11,4	20,9	26,1	25,7	15,6	17,0
Kaolinite	30,3	11,2	20,7	5,9	27,5	56,1	8,1	8,4	29,1	31,1
Illite	19,3	17,6	11,4	24,4	13,1	11,9	22,3	20,4	28,6	30,3
I/S	30,5	32,5	45,8	28,4	31,6		33,0	35,0	21,5	18,4
Feldspar		10,3	2,7	6,8	0,3		4,5	5,4	0,2	
Pirite	1,9	1,5	1,1	1,7	2,4	2,4	3,4	3,2	1,2	1,2
Calcite			2,8	1,6	2,4	1,7	2,6	0,4	2,4	1,6
Dolomite					6,1					
Siderite					0,7					
Apatite						0,8				
Anatase			1,2	0,7	1,5			0,4	0,8	
Rutile			1,2	0,9	0,3				0,2	
Bassanite	2,8	2,3	1,0	3,1	2,7	1,7		1,0	0,5	0,4
Gypsum						4,6				

	CR-41	CR-43	CR-44	CR-49	CR-50	CR-58	CR-59	CR-65	CR-66.1	CR-66.2
LTA yield	37,8	49,5	37,5	37,4	66,1	51,9	52,0	54,7	46,6	21,7
Quartz	15,5	19,1	15,7	22,2	20,3	19,1	17,4	16,4	22,0	40,7
Kaolinite	17,3	20,9	16,7	43,6	28,4	29,8	30,3	26,8	37,4	35,5
Illite	20,2	15,8	25,8	13,5	20,8	14,8	16,1	14,1	14,1	7,2
I/S	43,5	41,7	34,2	9,9	25,0	31,9	22,7	33,1	28,7	10,6
Feldspar						1,0	0,9	0,7		
Pirite	0,6	0,5	1,6	0,8		0,1	0,4	2,1	1,0	2,7
Jarosite			1,1		3,3	1,6	6,3	3,9	3,5	1,7
Calcite	0,8	0,3	1,7	4,2						
Dolomite				0,9						
Anatase	1,1	0,9	1,4		1,3	1,4	1,5	1,2	1,3	
Rutile				2,1	0,1	0,1	2,3	0,7		
Bassanite	1,0	0,7	1,6	2,7	0,8	0,3	2,1	1,0	2,1	1,8

- As might be expected from the LTA percentages in table 1, almost all the coals have relatively high 815ºC ash yields. The ashes contain 4.5 to 9% Fe2O3, suggesting that, as well as occurring in pyrite and jarosite.

- Although all of the samples, with the exception of CR-66.2, have similar overall proportions of the individual major and trace elements. The concentrations of Al, Fe and S, as well as those of Cd, Co, Cu, Ni and Zn, are significantly higherin the leachates from the acid-generating coals than from the other coal samples.

Conclusions

- Higher concentrations of several elements of potential environmental significance, including Cd, Co, Cu, Ni and Zn, are found in leachates from the oxidized coal samples. This suggests that Santa Catarina coals, such as those in operating power station stockpiles, may be expected to produce leachates with neutral to slighty acid pH levels, but coals in which the pyrite has been oxidized, such as stored and reprocessed rejects or materials from longer-standing stockpiles, may produce quit acid leachates containing greater concentrations of several environmentally-significant elements.

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