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GESTIÓN DE RECURSOS MINERALES, 2009 - 2019

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ABSTRACT

In this work a proposal for the mineral resources having into consideration the economic value of the thermal coal deposits of Colombia is being presented. Also, a methodological proposal is been carried out to determine an approximate economic value of these types of deposits in the country. This methodological proposal arises from the simulation of three possible scenes (optimistic, normal, and pessimist) for the extraction of national coal deposits, given under different types of environmental conditions, technical and financial, proper of this type of research.

KEY WORDS: Economic valuation; Colombia; Management; Mineral resources.

RESUMEN

En este trabajo se propone un modelo para la gestión de los recursos minerales teniendo como base la valoración económica de los depósitos de carbón térmico de Colombia. Así mismo, se realiza una propuesta metodológica para llevar a cabo una aproximación a la valoración económica de este tipo de depósitos en el país. Esta propuesta metodológica surge de la simulación de tres escenarios posibles (optimista, normal y pesimista) para la extracción de los depósitos de carbón nacionales, dadas entre otras, unas condiciones de tipo ambiental, técnico y financiero, propias de este tipo de recursos.

PALABRAS CLAVES: Carbón; Valoración económica; Colombia; Gestión; Recursos minerales.

1. INTRODUCTION

This work sets out to propose an estimatation of the economic value of thermal coals in Colombia, trying to keep a theoretical margin of the traditional methods of the valuation of mineral and energetic resources. Also, a methodolgical proposal is carried out in a way to find an approximate economical valuation (Lane, 1991) of the carboniferous resources of Colombia, with an special emphasis in thermal coals.

This methodological proposal analyzes the definitions of values and parametrical relations for three types of carboniferous deposits during simulation of three possible scenes (optimistic, normal, and pessimist). In this way the estimation of the economic value of thermal coals in Colombia are realized, defining the values and projections of carboniferous deposits for the period bewteen the years of 2000 to 2019, with base in: historical data of coal extraction; the base prices for the liquidation exemptions and annual incomes.

The practical and technical application to estimate the economic value (Carpenter, et al, 2005) of thermal coals in Colombia that is being carry out in this work, is an estimate that could be a useful reference to the organizations in charged of the management, planning, regulations and control of the mining sectors in Colombia, for future negotiations with national and foreign investors.

2. DEFINITIONS OF VARIABLES

In a schematic way one is going away to demonstrate a methodology (Azcárate, 1982) to determine the commercial value of a mineral deposit (Vy).

The earnings of a mining company come from, in terms of productive inversions, the sum of the total inversion, I, and the Vy, in this sense, both in consequence participate of the results or annual flow, F, whose general expression is:

$$F = E - \sum Costs - T - J \tag{1}$$

Where:

E: income by annual sales

$\sum$: costs: operation costs + general costs

T: taxes

J: investment (reinvestment)

It is had for last year:

$$F_i(1+p)^{n-i} \tag{2}$$

Being p the general level cost of the money

In the same sense, global wealth contributed by the project (Gt) comes from the following equation:

$$Gt = \sum_{i=1}^{n} F_i(1+p)^{n-i} \tag{3}$$

Because such earnings come from the investment (I) and the deposit value (Vy), therefore:

$$Gt = \sum_{i=1}^{n} Fi(1+p)^{n-i} = (I + Vy) * (1 + p) \tag{4}$$

If the value of Gt is transferred instantly from the initial production, n years before, the a priori value is left, from the mining business, VM, defined by the following equation:

$$VM = Gt * (1 + p)^{-n} = \sum_{i=1}^{n} Fi(1 + p)^{-i} = I + Vy \tag{5}$$

Clearing the value deposit (Vy) from the equation (4) and expressing it with positive exponents, it has:

$$Vy = -I + \sum_{i=1}^{n} Fi(1 + p)^{-i} = -I + \sum_{i=1}^{n} \frac{Fi}{(1 + p)^{i}} \tag{6}$$

Where the value of a deposit (Vy) subject to a mining operation whose annual flow is being constant over time, it will have at the moment of realization or at the moment of extraction the following expression:

$$Vy = -I + [(1 - K)(E - C) + K(Am + Ag + Cf) - J)] * \sum_{i=1}^{n} F(1 - p)^{-i} \tag{7}$$

From the 7 equation, it has:

Vy: Value of the deposit

I: Total investment of the mining business

K: Fiscal percentage of the net profit

E: Annual income, (Hustrulid and Kuchta, 2006)

C: Annual costs (direct as well as indirectly)

Am: Annual Amortization

Ag: Bottom of exhaustion, for amortization of deposits

Cf: Annual financial loads

J: Annual reinvestments

p: Actualization rate or discount rate

n: Life of the mining operation

Next the equation 7 is utilized, where it demonstrates an approach, the efficiency of the defined model.

In Table 1 values are indicated as well as parametrical relations for the three types of deposits, which at the end are part of the same operation, but whose scene is part of the exogenous variables at mineral deposits, like could be others: legislation, discount rate, environmental variables, level of taxes, technological change.

Table 1. Values and parametrical relations for three types of deposits.

Variable	Model of mining operation		
	Optimistic Scene	Normal Scene	Pessimistic Scene
I	2E	2E	2E
C	0.5E	0.5E	0.5E
K	0.33	0.4	0.5
Am	I/20	I/15	I/10
n	20 years	15 years	10 years
p	12%	15%	20%
$\sum_{i=1}^{n}(1-p)^{-i}$	7.469	5.847	4.192
Cf	0	0	0
J	0	0	0

Source: Azcárate (1982)

In equation 7, the value of Ag can be found in function with any of the following three variables:

a. As the percentage of the income, meaning, Ag = α. E

b. As the percentage of the net benefit, meaning, Ag = ß(E - C)

c. As linear amortization of the deposit value, meaning, Ag = γ.Vy/n

Having into consideration the mention above, it could be said that, á, ß y ã, possess fixed values like they are defined next: α = 0.075; ß = 0.30 y γ = 1 (Azcárate, 1982).

After the realized substitution on the equation 7, the deposit value, Vy, founds expressed as a linear function within an inversion (I) and the annual income (E), like shown in Table 2.

Table 2. Deposit Value as a function of the investment (I) and the annual income (E)

Ag	Deposit Value		
	Optimistic Scene	Normal Scene	Pessimist Scene
α = 0.075	-0.75I + 2.68E	-0.73I + 1.93E	-0.69I + 1.21E
ß = 0.30	-0.81I + 2.78E	-0.79I + 2.02E	-0.76I + 1.29E
γ = 1	-0.80I + 2.84E	-0.86I + 2.07E	-0.88I + 1.33E

Source: Azcárate (1982) and own substitutions.

After substituting the value of I=2E for the three different scenes and for the values of Ag (?, ß and ?) are the intervals of the deposit values expressed as a function of the income of annual sales, in the following way:

a. For the optimistic scene the values of Vy are found in the interval:

$1.1E \leqslant Vy \leqslant 1.24E$

b. In the same way for the normal scene the values of Vy are found in the interval:

$0.24E \leqslant Vy \leqslant 0.47E$

c. The pessimist scene present values of Vy in the interval:

$-0.17E \leqslant Vy \leqslant -0.33E$

Until here the proposal presents an approximation of the economic valuation of the mineral resources, as a theoretical contribution - conceptual of the same.

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3. ESTIMATE OF THE ECONOMIC VALUE OF THERMAL COAL IN COLOMBIA

Considering the equation 7 and defending with bases on own characteristics of the Colombian mining sectors the different variables that interfere in such equation, shown next, for thermal coal deposits, the application, practical and technical approach at the economic value of mentioned deposits.

Like previously shown and after the realized substitution, the value of the deposit is found expressed as a linear function within the investment (I) and the annual income (E). Given among others, the conditions of national public order, since, in particular those zones where mining extractive activities are developed, conflicts of public order appear constantly, limiting the normal development of the extractive activities and of benefit (Franco, 2006), it becomes necessary in equation 7 in the annual benefits, add an associated cost to physical security (Ms), that could be of order of 0.01E ? Ms ? 0.03E. The deposit value (Vy) stays expressed in the equation 8, as:

$$Vy = -I + [(1-K)(E-C-Ms) + K(Am + Ag + Cf) - J] * \sum_{i=1}^{n} F(1-p)^{-i} \quad (8)$$

Equation 8 gives count of the deposit value (Vy) in general terms for the mineral resources of Colombia. Next the equation 8 will be used to find in added form the value of the coal deposits.

Having as reference frame equation 8 defines in the Table 3 the values and parametrical relations associated with the deposits of stem coals under the scenes optimistic, normal and pessimist.

Table 3. Values and parametrical relations for coal deposits

Variable	Optimistic Scene	Normal Scene	Pessimist Scene
I	2E	2E	2E
C	0.4E	0.4E	0.4E
K	0.3	0.4	0.5
Am	I/20	I/15	I/10
n	20 years	15 years	10 years
p	12%	15%	20%
$\sum_{i=1}^{n}(1-p)^{-i}$	7.469	5.847	4.192
Cf	0	0	0
J	0	0	0
Ag ($\alpha = 0.075$)	0.075E	0.075E	0.075E
Ms	0.02E	0.02E	0.02E

Substituting in the equation 8 the values and parametrical relations for coal deposits presented in Table 3 and conducting the indicated operations, it is had for an optimistic scene the value of the deposit, Vy = 1.42E; for a normal scene the value of the deposit, Vy = 0.52E; and the value for the deposit of a pessimist scene, Vy = - 0.20E.

Considering the previous results of the deposit values for the different sceneries raised, the corresponding simulations (Winker, 2001) are carried out to find the different values of the carboniferous deposits in Colombia between the periods 2000 - 2019. Table 4 and Figure 1, contains the values and the different realized projections.

Table 4. Values and projections of the coals deposits in Colombia for the periods 2000 - 2019

Year	Coal Extraction * [Thousands of Tons]	Price Bases** [US$/Ton]	Annual Income [Millions of Dollars]	Scene and deposit values [Millions of Dollars]		
				Optimist	Normal	Pessimist
2000	38242	14	535.388	760.251	278.402	(107.078)
2001	43911	17,4	764.051	1.084.953	397.307	(152.810)
2002	39485	15,8	623.863	885.885	324.409	(124.773)
2003	50028	16,5	825.462	1.172.156	429.240	(165.092)
2004	53888	16,2	872.986	1.239.640	453.953	(174.597)
2005	59675	23	1.372.525	1.948.986	713.713	(274.505)
2006	65507	33,3	2.181.383	3.097.564	1.134.319	(436.277)
2007	69902	31,1	2.173.952	3.087.012	1.130.455	(434.790)
2008	73502	25,2	1.852.250	2.630.196	963.170	(370.450)
2009	*78292*	*27,7*	*2.170.390*	*3.081.954*	*1.128.603*	*(434.078)*
2010	*82970*	*28,7*	*2.377.640*	*3.376.249*	*1.236.373*	*(475.528)*
2011	*87648*	*29,5*	*2.588.913*	*3.676.257*	*1.346.235*	*(517.783)*
2012	*92326*	*30,4*	*2.804.121*	*3.981.851*	*1.458.143*	*(560.824)*
2013	*97004*	*31,2*	*3.023.170*	*4.292.902*	*1.572.048*	*(604.634)*
2014	*101682*	*31,9*	*3.245.968*	*4.609.274*	*1.687.903*	*(649.194)*
2015	*106360*	*32,6*	*3.472.422*	*4.930.839*	*1.805.659*	*(694.484)*
2016	*111038*	*33,3*	*3.702.442*	*5.257.467*	*1.925.270*	*(740.488)*
2017	*115716*	*34,0*	*3.935.941*	*5.589.037*	*2.046.690*	*(787.188)*
2018	*120394*	*34,7*	*4.172.838*	*5.925.429*	*2.169.876*	*(834.568)*
2019	*125072*	*35,3*	*4.413.051*	*6.266.532*	*2.294.786*	*(882.610)*

(*): The projections of extraction where made with bases on the historical (UPME, 2006) extraction data (between the years 2000 and 2008) and having into consideration linear models. For carboniferous deposits the following model was used: $Ex = 4678*t + 31512$, with a $R^2 = 0.960$. Where: Ex: Annual extraction of coal in thousands of tons; t: time in years and R2: Coefficient of correlation.

(**): The projections of the base prices were realized with base on the historical (INGEOMINAS, 2009) data (between the years 2000 to 2008) of the different ministerial resolutions and considering potential models. For carboniferous deposits the following model was used: $Pb = 12,44* t^{(0,348)}$, with a $R^2 = 0,620$. Where: Pb: Price base with liquidation of royalties, in weights by ton per thermal coal; t: time in years and R^2: Coefficient of correlation.

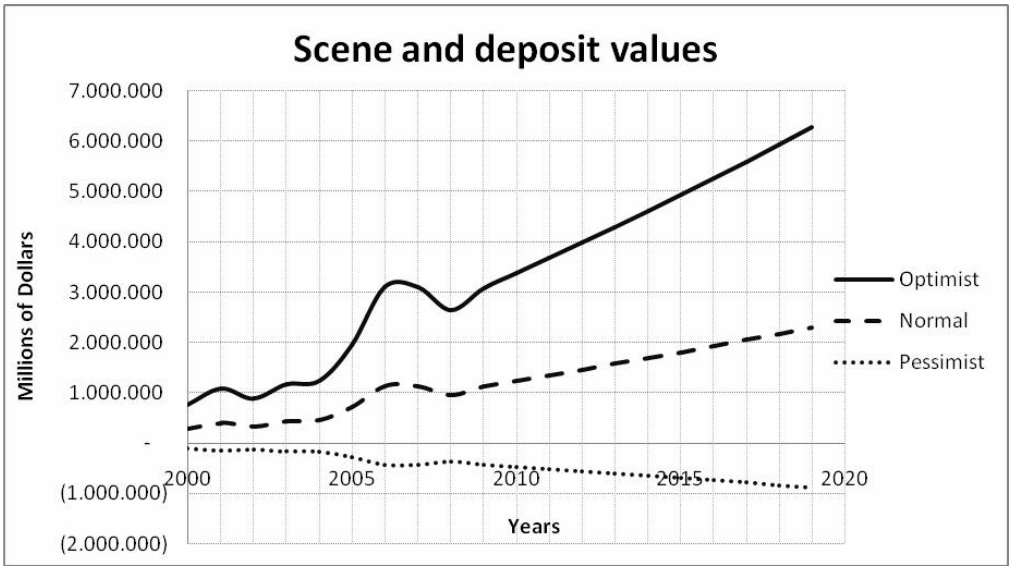

Figure 1. Scene (Optimist, Normal and Pessimist) and deposit values

The results found in Table 4 and Figure 1 can serve of reference to state organizations for future negotiations of the mineral resources of the country.

4. CONCLUSIONS

a. This work gives a step to the construction process of a structure that allows monetary counts of mineral resources. The obtained quantitative results are improvable in the measurement that allows better information for the application of the theoretical frame, nevertheless the methodological proposal that is applicable to local level as much as a regional level and improve in agreement with the advances in the efficiencies (technical and technological) of operation and transformation of carboniferous resources.

b. The practical and technical application that finds the value of the coal deposits in Colombia being carried in this work is an approach that can serve to the organizations in charged of the management, planning, regulation and control the Colombian mining sector, for future negotiations with national or foreign investors.

c. With the found results of the values and projections of the carboniferous deposits in Colombia for the periods 2000-2019, in the three scenes, is evident that by improving the conditions of the fiscal platform and financial for the pessimist scene, the approach to the economic valuation of these carboniferous deposits will improve substantially for the state organizations in charged of realizing future negotiations with investors of private character (national or foreign), will have in consideration the values found here and therefore, the negotiations will be more equitable for the proprietor of the resources of the subsoil.

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