

**SUSTAINABLE DEVELOPMENT:
MATERIALS TECHNOLOGY AND
INDUSTRIAL DEVELOPMENT IN BRAZIL**

Roberto C. Villas Bôas

SED25

CE

CNPq

CETEM

PRESIDENTE DA REPÚBLICA: Fernando Henrique Cardoso
MINISTRO DA CIÊNCIA E TECNOLOGIA: José Israel Vargas

PRESIDENTE DO CNPq: José Galizia Tundisi
DIRETOR DE DESENV. CIENT. E TECNOLÓGICO: Marisa Cassin
DIRETOR DE PROGRAMAS: Eduardo Moreira da Costa
DIRETOR DE UNIDADES DE PESQUISA: José Ubirajara Alves

CETEM - CENTRO DE TECNOLOGIA MINERAL

CONSELHO TÉCNICO-CIENTÍFICO (CTC)

Presidente: Roberto C. Villas Bôas

Vice-presidente: Juliano Peres Barbosa

Membros Internos: Juliano Peres Barbosa; Luiz Gonzaga Sobral; Ronaldo Luiz Correa dos Santos e Fernando Freitas Lins (suplente)

Membros Externos: Antonio Dias Leite Junior; Arthur Pinto Chaves; Octávio Elísio Alves de Brito; Saul Barisnik Suslick e Luiz Alberto C. Teixeira (suplente)

DIRETOR: Roberto C. Villas Bôas

DIRETOR ADJUNTO: Juliano Peres Barbosa

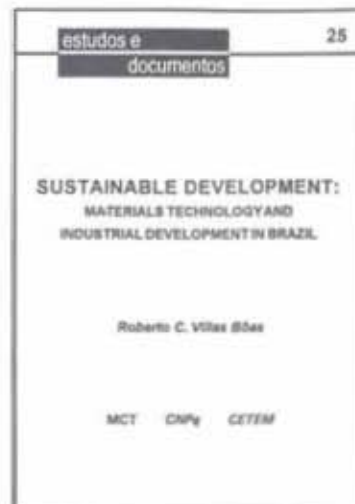
DEPTº DE TRATAMENTO DE MINÉRIOS (DTM): Adão Benvindo da Luz

DEPTº DE METALURGIA EXTRATIVA (DME): Luiz Gonzaga S. Sobral

DEPTº DE QUÍMICA INSTRUMENTAL (DQI): Roberto Rodrigues Coelho

DEPTº DE ESTUDOS E DESENVOLVIMENTO (DES): Carlos Cesar Peiter

DEPTº DE ADMINISTRAÇÃO (DAD): Antônio Gonçalves Dias



ISSN - 0103-6319

Roberto C. Villas Bôas
CETEM's Researcher and Director

CT-00006261-2

MCT - Ministério da Ciência e Tecnologia



CETEM - Centro de Tecnologia Mineral

1995

SED 25
03
Tombos: 006225

CETEM
SÉRIE ESTUDOS E DOCUMENTOS
BIBLIOTECA CONSELHO EDITORIAL

Editor
Ronaldo Luiz dos Santos
Conselheiros Internos
Reg. N.º 190 Data 20/08/95
Maria Laura T. M.G. C. Barreto, Irene C. de M. H. de Medeiros Portela, Francisco E. de Vries Lápido Loureiro, Francisco R. C. Fernandes.

Conselheiros Externos
Luís Henrique Sanchez (USP), José Raimundo A. Ramos (UFRJ), Eduardo C. Damasceno (USP), Saul Barisnik Suslick (UNICAMP), Abraham Benzaquem Sicsu (Fundação Joaquim Nabuco), Helena Maria Lastres (IBICT), Hildebrando Hermann (UNICAMP), Rupen Adamian (COPPE/UFRJ)

A **Série Estudos e Documentos** publica trabalhos que busquem divulgar estudos econômicos, sociais, jurídicos e de gestão e planejamento em C&T, envolvendo aspectos tecnológicos e/ou científicos relacionados à área minero-metalúrgica.

CETEM

F. F. MONTEIRO		
17-B - 6369		
COL. DE	VOL	VOL N.º
LATA	COORDENAÇÃO EDITORIAL E REVISÃO	
REG. N.º	EDITORAÇÃO ELETRÔNICA	
BMB	ILUSTRAÇÃO	

Villas Bôas, Roberto C.

Sustainable development: materials technology and industrial development in Brazil/Roberto C. Villas Bôas. - Rio de Janeiro: CNPq/CETEM, 1995.

21p.: il. - (Série Estudos e Documentos, 25)

1. Desenvolvimento sustentável. 2. Tecnologia de materiais - Brasil. 3. Desenvolvimento industrial - Brasil. I. Título. II. Série. III. Centro de Tecnologia Mineral.

ISBN 85-7227-059-0

ISSN 0103-6319

CDD 338.9

PRESENTATION

This paper addresses to the questions posed by developing sustainable policies regarding materials technology and industrial growth in Brazil.

Thus the questions of minimizing energy usage, minimizing environmental impacts and maximizing social satisfaction in pursuing the SD goals in a National Materials policy are discussed.

Rio de Janeiro, May, 1995.

Roberto C. Villas Bôas
CETEM's Researcher and Director

CONTENTS

ABSTRACT.....	1
1. INTRODUCTION.....	3
2. NATIONAL MATERIALS POLICY FRAMEWORK.....	4
3. MATERIALS RESOURCES ANALYSIS	6
4. INFRASTRUCTURE MATERIALS TECHNOLOGY DEVELOPMENT.....	8
5. MATERIALS TECHNOLOGY AND QUALITY MANAGEMENT	9
6. ENVIRONMENTAL IMPACTS	12
7. FINANCING AND INVESTMENT OPTIONS.....	13
8. ENVIRONMENTAL SOCIOECONOMIC POLICY AND STRATEGIC PLANNING FOR MATERIALS.....	15
9. PLANNING IN A SUSTAINABLE DEVELOPMENT ENVIRONMENT	17
9.1 Minimization of energy usage	17
9.2 Minimization of materials use.....	18
9.3 Minimization of the environmental impact.....	18
9.4 An adequate social satisfaction	19
REFERENCES	20

ABSTRACT

Materials play a fundamental role in developing a nation. How deep such a role will depend upon the overall economy, as expressed through its own domestic industrial production and innovation capacity, its consumer demands, and, last but not least, its worldwide exchanging power.

The National Materials Policy (NMP) has to direct itself towards the aspirations of the society in building up the development of the country facing all of the pros and cons of such a path. In this paper, the Brazilian NMP, an analysis of its material resources, an overview of the materials technology infrastructure, the role of Quality in the country's materials management, the environmental impacts of materials production, the financing and investment options, the socioeconomic policy framework and its consequent Strategic Planning for minerals are presented.

A final speculative consideration on planning in a Sustainable Development (SD) environment is also presented.

Key words: *materials, new materials, sustainable development, National policies*

1. INTRODUCTION

The social-economical development of a given country needs, to be effective, to be based upon an infrastructure framework that is capable of giving rise, as well as to maintain and modify, the social wishfulness of that society. Such wishes are manifested in the political will of the society, that directs the routes to be followed, the social-economical targets and priorities to be reached in short and medium terms.

Traditionally, the economical development is measured by its Gross National Product (GNP), or the equivalent Per Capita Income (PCI), indicator that is well known and acceptable by the whole of the nations. These indicators, quite satisfactory to measure the development of the economical production of a given country, are however, inadequate to measure the "social satisfactions" of a given society and have been subjected to several criticisms.^[1]

What is then, this "social satisfaction" and how it relates to the materials technology and the industrial development ?

It is the purpose of this paper to review some of the issues that are considered important nationwide to Brazil in order to assess its path toward development, focusing its materials foundations.

2. NATIONAL MATERIALS POLICY FRAMEWORK

Brazil's national materials policy allows the country to supply internally the vast majority of substances utilized in its industrial production^[2].

In fact, few items related to the materials needs of the country are imported.

Brazil's mineral production accounts today around 2% of the GNP, as well as the crude oil production of the country is today in the order of 700,000 barrels per day (bpd), although the estimated demand reached 1,300,000 bpd.

The mineral production is responsible for the basic materials foundation of the national industry, allowing the income of hard currency through exports. For instance, of the 60 major exporting industrial enterprises of the country 34 are materials based, i.e., iron ore - 5 enterprises; steel 6; non-ferrous metals 6 enterprises; transport material 9; chemical wood pulp 3; etc. The main purchasing economic blocs of Brazilian products are, in decreasing order: the European Economic Community (9.9 USD billion); the U.S.A. (7.7 USD billion); Asia, excluded Middle East, (5.3 USD billion, Japan accounting for 45% of it); the Latin American Association for Integration (3.2 USD billion); and other blocs (5.4 USD billion).^[3]

These facts reflect the main body of the Brazilian Materials Framework as shown in Table 1.

Table 1 - Brazilian Materials Framework

Material	Overall Situation	Observations
Iron & Steel	Self-sufficient and exports	Exports manufactured products
Non-Ferrous Metals	Deficient, with exceptions	Exception: aluminum
Ferrous Metals	Self-sufficient and exports	Exception: molybdenum
Noble Metals	Self-sufficient	Exceptions: platinum group; silver coming from recycled materials and imports
Energy Resources	Deficient, with exception	Exception: uranium
Industrial Minerals	Sufficient, with exceptions	Exceptions: sulphur, potassium, bentonite
Rare Earths	Potential geological reserves and deficient production	New projects in expansion
Building Materials	Sufficient and exports	Red ceramics and dimension stones exportation
New Materials	Deficient production	Industry utilizes imported precursors
Plastics	Sufficient	Exception: special engineering plastics

Governmental organizations and enterprises in Brazil have been producing studies and documents analyzing the materials situation of the country, its vulnerability and self-sufficiency.^[2,3,4,5,6,7] Today's policy is to enlarge the Brazilian capability to produce raw as well as special steels, to enlarge the domestic competitiveness in the petrochemical sector, to maintain in a competitive way its capability in the aluminum sector, to promote, in an environmentally acceptable way, its gold and cassiterite production, to favor the dimension stones production, to faster its competitiveness in the red ceramics sector, and last but not least, its R & D and production of selected New Materials products.

3. MATERIALS RESOURCES ANALYSIS

Figure 1 presents the relative importance of the several mineral based materials in the Brazilian economy, and Table 2 shows the dependence of the Brazilian economy related to some strategic metals.^[7] Extraction industry includes activities at mines and quarries, while engineering industry means activities related to foundry, refining and so on.

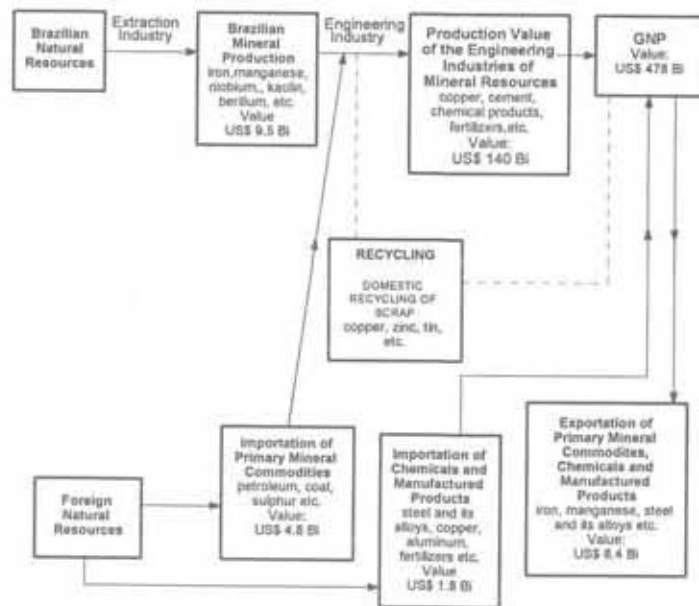


Figure 1 - Relative Importance of Minerals Based Materials in Brazilian Economy^[2]

Table 2 - Brazilian Dependence on some Strategic Metals

Metal	Dependence %		Supplier
	ore	manufactured	
Ti	22	15	South Africa and Australia
Mn	0	3	N.I.
Ta	0	100	U.S.A., Australia, Swiss
Cr	5	1	Philippines and South Africa
Pt Group	N.I.	100	Germany, USA and Belgium
W	50	17,5	Bolivia, USA, Germany, Singapore and Mexico
Va	100	0	Germany, South Africa, The Netherlands
Mo	99	100	Chile, USA and England

Obs: N.I. stands for not identified

From both Figure 1 and Table 2 an overall view of the Brazilian materials situation is readily seen.

4. INFRAESTRUCTURE MATERIALS TECHNOLOGY DEVELOPMENT

The national framework to promote engineering education and training in materials reveals the existence of several Universities, throughout the 26 States of Brazil, that offer courses and degrees in all branches of engineering sciences. About 30% of them offers courses and training directly linked to materials.

As well as, of the 100 research institutions located throughout the country, either governmental and private, around 45 do carry on research in the materials field.^[8,9]

The Brazilian industry, being very active in developing materials products does have a significant participation in promoting social development through the application and uses of materials.^[10]

However, the Brazilian enterprises that are internationally competitive are expressing their concerns towards a new management approach regarding R & D efforts and customers satisfaction.

Such new management style has been prompt forwarded by the Japanese steel industries specially, promoting an "on line" research reply to the customers.

5. MATERIALS TECHNOLOGY AND QUALITY MANAGEMENT

The Brazilian Government launched in 1990 the Brazilian Program for Quality and Productivity (PBQP). After two years of implantation the proposals and impacts of such a Program on industry have being reviewed by the Secretariat of Strategic Affairs (SAE) and a group of involved entities of which SEBRAE, the Supporting Service to Micro and Small Enterprises, DNEQ/USP, Center for Quality Studies of the São Paulo University, ABIPTI, the Brazilian Association of Industrial Technological Research Institutions, the Ministry of Industry and Commerce, the American Chamber of Commerce of São Paulo and the Exame Magazine, among the most prominent.

The results of the conducted survey are shown below^[11]:

- a) Training: 60% of the sampling universe spends less than 100 USD a year, per employee. Those enterprises that produces "tailor made" services to the clients are the ones that most invest in training. The exporting companies are claiming to train more than 50% of their working force; the non-exporting are in the range of 0 to 25%. As well as, in the most advanced industrial enterprises there is a trend of coupling such training in **quality** with the overall **planning** of the firm, derived from its Strategic Planning.
- b) Efforts to Q. & P.: observing the relationship enterprises/suppliers, the evaluations regarding better quality are (half divided; half feels that there was a quality improvement and half doesn't; at the same time, there is a general agreement that no significative reduction in prices occurred (probably due to the economic uncertainties of the period).

A Price Waterhouse study^[12], sampling 1000 large enterprises throughout Brazil, shows the following declared obstacles to the PBQP implantation, as presented in Table 3.

Table 3. Declared Obstacles to the PBQP Goals

MOTIVE	PERCENTAGE (%)
Market instability hindering planning	52.3
Lack of training	46.9
Suppliers qualifications	27.7
Unfavorable environment	23.8
Barriers from the medium level supervision	20.8
Lack of financial resources	20.0
Motivation/Support from higher administration	20.0
Ignoring the methodology of implementing	19.2
Equipment obsolescence	19.2
Time required to develop new technologies	14.6
Cost/Benefit Analysis for implementing	10.8
Turnover of employees	10.0
Barriers in acquiring new technologies	6.9

Observation: the percentage points reflects more than one answer per firm.

An average cost of implanting the Quality Program, for an industry employing 1200 people is of the order of USD 50 to 70 thousand and consumes 6 months^[13]; it may reach USD 100 to 130 thousand for larger organization, with several regional branches.^[14]

The exporting materials based industries had conducted their training programs, implemented their Q & P effective projects and obtained, or are in the process of, the ISO-9000 certification.

A very interesting campaign was launched by MBR - Minerações Brasileiras Reunidas (the largest iron ore exporter, second to CVRD, with revenues of USD 317 million in 1990), through its Olympics 5"S" Program.^[15]

Each operational sector of MBR had to search for and implement solutions regarding the working environment, aiming to promote an economy in job time, reducing the energy expenditure of the employees, to prevent work accidents, to avoid pollution, to achieve better productivity and cost reductions. It is claimed that USD 100 thousand per year has been achieved, only through cleaning of the minerals processing plant; from the 530 Men Hour per Week (MHPW) that were spent to clean that industrial area, just 170 MHPW are now utilized. The 5"S" stands for the Japanese words SEIRI (arrangement), SEITON (ordering), SEISOH (cleanness), SEIKETSU (health) and SHITSUKE (auto discipline).

6. ENVIRONMENTAL IMPACTS

Heavy metals continues to be the greatest source of pollution regarding the materials based industries, together with CO_x/NO_x/SO_x emissions.

In relative terms, a lot has been accomplished specially if one looks at the situation of the Cubatão Industrial Complex in São Paulo, today and four years ago.

The same might be true, here and there, due to the severe environmental law passed by the National Congress.

Nevertheless, to enforce the law in an economical unstable environment is not a trivial task !

Social pressures in the vicinity of the urban areas do cause the law to be obeyed in the nearby located industries. In remote areas of the country, mainly in the Amazon, where mercury and silting are a problem, there is almost no way to enforce the law !

As for the big materials enterprises, i.e., steel industries, petrochemicals, non-ferrous and ferrous foundries, automobile and naval manufactures, package, etc., negotiating approaches towards the environmental law obligations are being taken between the State agencies and the industries.

7. FINANCING AND INVESTMENT OPTIONS

The astonishing world situation that started with the demolishing of Berlin Walls, followed by the falling of the Communist Party from power in the eastern countries, culminating with the disruption of the Soviet Union and the sole rising of U.S.A. as the military power, brought the world to an unique and very delicate point of equilibrium.

What is the fate of Africa, South America and vast portions of poor Asia ? What is the real participation of such economies in the free world market ?

In the EEC block money is flowing within Europe, west/west, west/east.

Japanese money is heavily flowing towards U.S.A. and, in smaller amounts, nearby Asian countries.

American money is being flown to Europe, some eastern Asian countries and Japan.

Petrodollars are flowing to the Big Seven.

What about financing money for economical development ?

Regarding the Brazilian situation, besides the fact that within the American Continent the USA is, by far, the major mineral and materials producer, there are some niches available for expansions of the materials based industry.

These niches are related to the energy input needed in such industries (Brazilian electrical power production is in the order of 236,000 GWh), to the overall infrastructure of the economy (around USD500 Billion/GNP) and a general satisfactory education level of the professionals.

Therefore, industrial branches in the sector of paper and pulp mill, iron and steel, petrochemicals, cement, fertilizers and general metallurgy show a trend for expansions, representing today around 30% of the GNP.

It is envisaged that soon after the political institutional environment in Brazil calms down, new foreign as well as internal investors will play their role.

8. ENVIRONMENTAL SOCIOECONOMIC POLICY AND STRATEGIC PLANNING FOR MATERIALS

Now comes the point to discuss the concept of "social satisfaction" as referred to in the introduction of this paper. Such might be explained by the stage reached for a given society, in harmony with its environment, and in which the social targets and objectives of the community have credibility and feasibility to be achieved.

From this it might be inferred that "social satisfaction" is peculiar to a given society; and might be differentiated for diverse societies; has to be in harmony with the neighboring societies; does not assume the same economical development in distinct societies.

Thus, any Strategic Planning for materials has to bear in its foundations the definition of the "social satisfaction" that the country is aiming at.

If such "social satisfaction" is expressed in terms of GNP, or PCI, then solely overall economical development is being aimed for, in the implicit assumption that the growing of the economy is sufficient to promote the social development of the people.

However, if such "social satisfaction" has not to be measured by the aforementioned indexes, the materials balance, translated into the strategic planning for materials of that particular society, has to include the basic assumptions of minimizing energy consumption, minimizing materials consumption and minimizing the environmental impact caused by materials production.

These are in fact, the proposals underlying the Sustainable Development concept.

It is worthwhile to observe that the aforementioned propositions are not independent from the world's power struggles; rather, they require a very serious, and synergetic, compromise of the nations of the world, in special the G-7.

It follows that such an adoption of the SD concepts, regarding the more issues strictly related to the materials scene, will bring:

- a) a global political convenance over the control of the materials exchange and production between the several geopolitical regions;
- b) a global political convenance involving the allocations, and reallocations, of different "technological levels" worldwide, to the several geopolitical regions.

9. PLANNING IN A SUSTAINABLE DEVELOPMENT ENVIRONMENT

This is an speculative chapter, where the author tries to foresee some of the criteria that have to be bored forward if the SD concepts are to be utilized for planning the materials policy of a given country.

9.1 Minimization of energy usage

In order to reach the global compromise, a necessary review of the world's energy consumption is a must, regarding:

- a) the energy sources: what are those that mostly impact the environment ?; What are those that utilize huge masses of materials ?; What are those that most attend the community needs (jobs, relocation of cities, etc.);
- b) the energy dissipation: i.e., the energetic efficiencies of the demanding sectors, in a worldwide scale, and their redistribution and dimensions of the problem;
- c) the energy use profile: disposable products, with quite ephemeral life-cycle, consumption energy. This is very stringent in central economies;
- d) the energy criteria: leading to the conception, definition and implementing of energetic management models that minimizes energy misuse in a worldwide trend.

9.2 Minimization of materials use

In the sequence of a managerial program to minimize energy consumption, that of materials utilization minimization follows:

- a) the planning of developing, and uprising, of extraction, processing and manufacturing industries realigned worldwide, and re-oriented that searches the targets of the minimization of energy consumption, minimization of environmental impact and that promote the "social satisfaction";
- b) industries that are technological capable of recovering by-and-co-products and promote the production of recyclable items;
- c) the design criteria: has to conceive materials that are, or might be, substitutes between themselves;
- d) that minimizes the design and production of superfluous materials;
- e) that are corrosion resistant.^[16]

9.3 Minimization of the environmental impact

The environmental impact promoted by the human being is quite inherent to the productive activity. Thus, when utilizing energy to extract, process and manufacture a material, the environment is being altered.

To reach a global compromise regarding minimization of the environmental impact, planners, economists, engineers, scientists and politicians, in special, have to pay attention:

- a) to the processes that are born within the synergism between energy, materials and environment;

- b) to favor, through legislation and scientific development, clean technologies having low energy and materials inputs;
- c) to the implicit need to alter the environment aiming "social satisfaction" !

9.4 An adequate social satisfaction

This is the central issue of the SD concept: how to conceive, define and implement an "adequate" social-satisfaction ? How "adequate" is adequate ?

Is the adequation different to different societies ? If so, which one is the privileged and which is not ? How to agree in a global fashion ?

From this author's point of view, it is quite obvious that such is the central issue of the SD proposals.

Will it be necessary to lower down the living standards of the central economies and increase those of the periphery ? How should this be done and which organization body is going to be responsible for its control ?

Those issues are left open, since even no speculative answer might be attempted in the world's scenario of today !

REFERENCES

1. BRUNDTLAND, Gro Harlem, "Our common future", Oxford/New York, Oxford University Press, 1987.
2. DNPM, "Anuário Mineral Brasileiro", Ministério das Minas e Energia, 1992.
3. GABEIRA, G.L., Synthesis of the Brazilian Economy, CNI, 1991, pp. 1-77.
4. CAMPOS SOARES, Rinaldo, "Technological Prospects for the Brazilian iron and steel industry" *Materials and Society*, (15), no. 4, 1991, pp. 395-421.
5. "Diagnóstico do Complexo de Metais Não-Ferrosos" Ministério da Indústria e do Comércio, 1990, pp. 1-112.
6. INT, "Novos Materiais - Desafios e Oportunidade", (1),(2),(3),(4),(5), Secretaria da Ciência e Tecnologia, 1992, pp. (1-117),(1-108),(1-48),(1-72),(1-64).
7. VILLAS BÔAS, R. C., "Minérios Estratégicos: Perspectivas", *Série Tecnologia Mineral*, 56, CETEM/CNPq, 1992, pp. 1-27.
8. LASTRES, H. M. M. et al, "Novos Materiais: capacitação e potencialidades nacionais" *N. Mat.*, Ministério da Ciência e Tecnologia, 1988, pp. 1-360.
9. VILLAS BÔAS, R. C., "Brazil's National Policy on New Materials" UNIDO Expert Papers, 1987.
10. VILLAS BÔAS, R. C., "Standardization for Advanced Materials: Experiences and Strategies for Future in Brazil", ABIPTI, 1991, pp. 1-43.

11. PBQP "Pesquisa: Qualidade e Produtividade no Meio Empresarial", SAE/DME/COTEC, 1992, pp. 1-23.
12. Price Waterhouse "An analysis of PBQP", as reported in *Folha de São Paulo*, 25.03.93, Dinheiro, 1993.
13. LOBOS, J., "Economia Instável atrasa Programas de Qualidade", *Folha de São Paulo*, 25.03.93, Dinheiro, 1993.
14. CAMPOS, C., IBQN, personal communication, 1993.
15. AFONSO, B., "MBR faz Olimpíadas pela Qualidade e dá de Prêmio uma visita a CBMM", *Jornal CBMM*, Ano IV, no. 49, 1993, pp. 21-28.
16. VILLAS BÔAS, R. C., "Os Novos Materiais e a Corrosão", *Série Tecnologia Mineral*, CETEM/CNPq, 1991, pp. 1-18.

**NÚMEROS PUBLICADOS NA SÉRIE
TECNOLOGIA MINERAL**

1. Flotação de Carvão: Estudos em Escala de Bancada - Antonio R. de Campos, Salvador L. M. de Almeida e Amílcar T. dos Santos, 1979. (esgotado)
2. Beneficiamento de Talco: Estudos em Escala de Bancada - Nelson T. Shimabukuro, Carlos Adolpho M. Baltar e Francisco W. Hollanda Vidal, 1979. (esgotado)
3. Beneficiamento de Talco: Estudos em Usina Piloto - Nelson T. Shimabukuro, Carlos Adolpho M. Baltar e Francisco W. Hollanda Vidal, 1979. (esgotado)
4. Flotação de Cianita da Localidade de Boa Esperança (MG) - Ivan O. de Carvalho Masson e Tulio Herman A. Luco, 1979. (esgotado)
5. Beneficiamento de Diatomita do Ceará - José A. C. Sobrinho e Adão B. da Luz, 1979. (esgotado)
6. Eletrorecuperação de Zinco: uma Revisão das Variáveis Influentes - Roberto C. Villas Bôas, 1979. (esgotado)
7. Redução da Gipsita com Carvão Vegetal - Ivan O. de Carvalho Masson, 1980. (esgotado)
8. Beneficiamento do Diatomito de Canaveira do Estado do Ceará - Franz Xavier H. Filho e Marcello M. da Veiga, 1980. (esgotado)
9. Moagem Autógena de Itabirito em Escala Piloto - Hedda Vargas Figueira e João Alves Sampaio, 1980. (esgotado)
10. Flotação de Minério Oxidado de Zinco de Baixo Teor - Carlos Adolpho M. Baltar e Roberto C. Villas Bôas, 1980. (esgotado)
11. Estudo dos Efeitos de Corrente de Pulso Sobre o Eletrorefino de Prata - Luiz Gonzaga dos S. Sobral, Ronaldo Luiz C. dos Santos e Delfin da Costa Laureano, 1980. (esgotado)
12. Lixiviação Bacteriana do Sulfeto de Cobre de Baixo Teor Caraíba - Vicente Paulo de Souza, 1980. (esgotado)
13. Flotação de Minérios Oxidados de Zinco: uma Revisão de Literatura - Carlos Adolpho M. Baltar, 1980. (esgotado)
14. Efeito de Alguns Parâmetros Operacionais no Eletrorefino do Ouro - Marcus Granato e Roberto C. Villas Bôas, 1980. (esgotado)
15. Flotação de Carvão de Santa Catarina em Escala de Bancada e Piloto - Antonio R. de Campos e Salvador L. M. de Almeida, 1981. (esgotado)
16. Aglomeração Seletiva de Finos de Carvão de Santa Catarina: Estudos Preliminares - Lauro Santos N. da Costa, 1981.
17. Briquetagem e a sua Importância para a Indústria - Walter Schinzel e Regina Célia M. da Silva, 1981. (esgotado)
18. Aplicação de Petrografia no Beneficiamento de Carvão por Flotação - Ney Hamilton Porphírio, 1981.
19. Recuperação do Cobre do Minério Oxidado de Caraíba por Extração por Solventes em Escala Semipiloto - Ivan O. C. Masson e Paulo Sérgio M. Soares, 1981. (esgotado)

20. Dynawhirlpool (DWP) e sua Aplicação na Indústria Mineral - Hedda Vargas Figueira e José Aury de Aquino, 1981. (esgotado)
21. Flotação de Rejeitos Finos de Scheelita em Planta Piloto - José Farias de Oliveira, Ronaldo Moreira Horta e João Alves Sampaio, 1981. (esgotado)
22. Coque de Turfa e suas Aplicações - Regina Célia M. da Silva e Walter Schinzel, 1982.
23. Refino Eletrolítico de Ouro, Processo Wohlwill - Juliano Peres Barbosa e Roberto C. Villas Bôas, 1982. (esgotado)
24. Flotação de Oxidados de Zinco: Estudos em Escala Piloto - Adão Benvindo da Luz e Carlos Adolpho M. Baltar, 1982.
25. Dosagem de Ouro - Luiz Gonzaga S. Sobral e Marcus Granato, 1983.
26. Beneficiamento e Extração de Ouro e Prata de Minério Sulfetado - Márcio Torres M. Penna e Marcus Granato, 1983.
27. Extrações por Solventes de Cobre do Minério Oxidado de Caraíba - Paulo Sérgio M. Soares e Ivan O. de Carvalho Masson, 1983.
28. Preparo Eletrolítico de Solução de Ouro - Marcus Granato, Luiz Gonzaga S. Sobral, Ronaldo Luiz C. Santos e Delfin da Costa Laureano, 1983. (esgotado)
29. Recuperação de Prata de Fixadores Fotográficos - Luiz Gonzaga dos Santos Sobral e Marcus Granato, 1984. (esgotado)
30. Amostragem para Processamento Mineral - Mário V. Possa e Adão B. da Luz, 1984. (esgotado)
31. Indicador de Bibliotecas e Centros de Documentação em Tecnologia Mineral e Geociências do Rio de Janeiro - Subcomissão Brasileira de Documentação em Geociências - SBDG, 1984.
32. Alternativa para o Beneficiamento do Minério de Manganês de Urucum, Corumbá-MS - Lúcia Maria Cabral de Góes e Silva e Lélío Fellows Filho, 1984.
33. Lixiviação Bacteriana de Cobre de Baixo Teor em Escala de Bancada - Teresinha R. de Andrade e Francisca Pessoa de França, 1984.
34. Beneficiamento do Calcário da Região de Cantagalo-RJ - Vanilda Rocha Barros, Hedda Vargas Figueira e Rupen Adamian, 1984.
35. Aplicação da Simulação de Hidrociclones em Circuitos de Moagem - José Ignácio de Andrade Gomes e Regina C. C. Carriso, 1985.
36. Estudo de um Método Simplificado para Determinação do "Índice de Trabalho" e sua Aplicação à Remoagem - Hedda Vargas Figueira, Luiz Antonio Pretti e Luiz Roberto Moura Valle, 1985.
37. Metalurgia Extrativa do Ouro - Marcus Granato, 1986. (esgotado)
38. Estudos de Flotação do Minério Oxidado de Zinco de Minas Gerais - Francisco W. Hollanda Vidal, Carlos Adolpho M. Baltar, José Ignácio de A. Gomes, Leonardo A. da Silva, Hedda Vargas Figueira, Adão B. da Luz e Roberto C. Villas Bôas, 1987.
39. Lista de Termos para Indexação em Tecnologia Mineral - Vera Lúcia Vianna de Carvalho, 1987.
40. Distribuição de Germânio em Frações Densimétricas de Carvões - Luiz Fernando de Carvalho e Valéria Conde Alves Moraes, 1986.
41. Aspectos do Beneficiamento de Ouro Aluvionar - Fernando A. Freitas Lins e Leonardo A. da Silva, 1987.
42. Estudos Tecnológicos para Aproveitamento da Atapulgita de Guadalupe-PI - Adão B. da Luz, Salvador L. M. de Almeida e Luciano Tadeu Silva Ramos, 1988.

43. Tratamento de Efluentes de Carvão Através de Espessador de Lamelas - Francisco W. Hollanda Vidal e Franz Xaver Horn Filho, 1988.
44. Recuperação do Ouro por Amalgamação e Cianetação: Problemas Ambientais e Possíveis Alternativas - Vicente Paulo de Souza e Fernando A. Freitas Lins, 1989. (esgotado)
45. Geopolítica dos Novos Materiais - Roberto C. Villas Bôas, 1989. (esgotado)
46. Beneficiamento de Calcário para as Indústrias de Tintas e Plásticos - Vanilda da Rocha Barros e Antonio R. de Campos, 1990.
47. Influência de Algumas Variáveis Físicas na Flotação de Partículas de Ouro - Fernando A. Freitas Lins e Rupen Adamian, 1991.
48. Caracterização Tecnológica de Caulim para a Indústria de Papel - Rosa Malena Fernandes Lima e Adão B. da Luz, 1991.
49. Amostragem de Minérios - Maria Alice C. de Goes, Mário V. Possa e Adão B. da Luz, 1991.
50. Design of Experiments in Planning Metallurgical Tests - Roberto C. Villas Bôas, 1991. (esgotado)
51. Eletrorecuperação de Ouro a partir de Soluções Diluídas de seu Cianeto - Roberto C. Villas Bôas, 1991.
52. Talco do Paraná - Flotação em Usina Piloto - Salvador Luiz M. de Almeida, Adão B. da Luz e Ivan F. Pontes, 1991.
53. Os Novos Materiais e a Corrosão - Roberto C. Villas Bôas, 1991.
54. Aspectos Diversos da Garimpagem de Ouro - Fernando Freitas Lins (coord.), José Cunha Cotta, Adão B. da Luz, Marcello M. da Veiga, Fernando Freitas Lins, Luiz Henrique Farid, Márcia Machado Gonçalves, Ronaldo Luiz C. dos Santos, Maria Laura Barreto e Irene C. M. H. Medeiros Portela, 1992. (esgotado)
55. Concentrador Centrifugo - Revisão e Aplicações Potenciais - Fernando Freitas Lins, Lauro S. Norbert Costa, Oscar Cuéllar Delgado, Jorge M. Alvares Gutierrez, 1992.
56. Minerais Estratégicos: Perspectivas - Roberto C. Villas Bôas, 1992.
57. O Problema do Germânio no Brasil - Roberto C. Villas Bôas, Maria Dionísia C. dos Santos e Vicente Paulo de Souza, 1992.
58. Caracterização Tecnológica do Minério Aurífero da Mineração Casa de Pedra-Mato Grosso - Ney Hamilton Porphírio e Fernando Freitas Lins, 1992.
59. Geopolitics of the New Materials: The Case of the Small Scale Mining and New Materials Developments - Roberto C. Villas Bôas, 1992.
60. Degradação de Cianetos por Hipoclorito de Sódio - Antonio Carlos Augusto da Costa, 1992.
61. Paládio: Extração e Refino, uma Experiência Industrial - Luis Gonzaga S. Sobral, Marcus Granato e Roberto B. Ogando, 1992.
62. Desempenho de Ciclones e Hidrociclones - Giulio Massarani, 1992.
63. Simulação de Moagem de Talco Utilizando Seixos - Regina Coeli C. Carrisso e Mário Valente Possa, 1993.
64. Atapulgita do Piauí para a Indústria Farmacêutica - José Pereira Neto, Salvador L. M. de Almeida e Ronaldo de Miranda Carvalho, 1993.
65. Caulim: um mineral industrial importante - Adão B. da Luz e Eduardo C. Damasceno, 1993.
66. Química e Tecnologia das Terras-Raras - Alcídio Abrão, 1994.
67. Tiouréia e Bromo como Lixiviantes Alternativos à Cianetação do Ouro. Roberto de Barros E. Trindade, 1994.



NÚMEROS PUBLICADOS NA SÉRIE TECNOLOGIA AMBIENTAL

1. Poconé: Um Campo de Estudos do Impacto Ambiental do Garimpo - Marcello M. da Veiga, Francisco R. C. Fernandes, Luiz Henrique Farid, José Eduardo B. Machado, Antônio Odilon da Silva, Luis Drude de Lacerda, Alexandre Pessoa da Silva, Edinaldo de Castro e Silva, Evaldo F. de Oliveira, Gercino D. da Silva, Hélcias B. de Pádua, Luiz Roberto M. Pedroso, Nelson Luiz S. Ferreira, Saete Kiyoka Ozaki, Rosane V. Marins, João A. Imbassahy, Wolfgang C. Pfeiffer, Wanderley R. Bastos e Vicente Paulo de Souza (2ª edição), 1991. (esgotado)
2. Diagnóstico Preliminar dos Impactos Ambientais Gerados por Garimpos de Ouro em Alta Floresta/MT: Estudo de Caso (versão Português/Inglês) - Luiz Henrique Farid, José Eduardo B. Machado, Marcos P. Gonzaga, Saulo R. Pereira Filho, André Eugênio F. Campos, Nelson S. Ferreira, Gersino D. Silva, Carlos R. Tobar, Volney Câmara, Sandra S. Hacon, Diana de Lima, Vangil Silva, Luiz Roberto M. Pedroso, Edinaldo de Castro e Silva, Lais A. Menezes, 1992.
3. Mercúrio na Amazônia: Uma Bomba Relógio Química? - Luis Drude Lacerda e Win Salomons, 1992.
4. Estudo dos Impactos Ambientais Decorrentes do Extrativismo Mineral e Poluição Mercurial no Tapajós - Pré-Diagnóstico - Rita Maria Rodrigues et al., 1994.
5. Utilização do Aguapé no Tratamento de Efluentes com Cianetos - Marcus Granato, 1995.
6. Are Tropical Estuaries Environmental Sinks or Sources? - Egbert K. Duursma, 1995.
7. Assessment of the Heavy Metal Pollution in a Gold "Garimpo" - Saulo Rodrigues Filho e John Edmund L. Maddock.

ACOMPETITIVIDADE
DA INDÚSTRIA
BRASILEIRA DE ALUMÍNIO:
AVALIAÇÃO E PERSPECTIVAS

4

James H. H. White

MCT CNPq CETEM

NÚMEROS PUBLICADOS NA SÉRIE
QUALIDADE E PRODUTIVIDADE

1. Qualidade na Formulação de Misturas - Roberto C. Villas Bôas, 1992.
2. La Importância del Método em la Investigación Tecnológica - Roberto C. Villas Bôas, 1992.
3. Normalización Minerometalúrgica e Integración Latinoamericana - Rômulo Genuino de Oliveira, 1993.

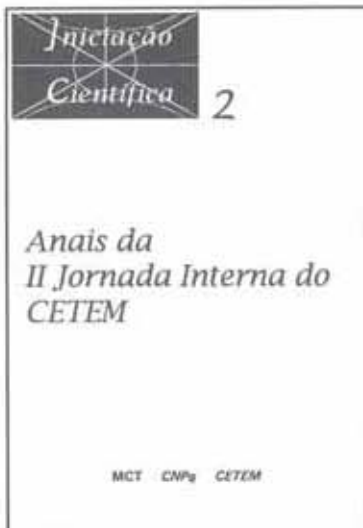
SUSTAINABLE DEVELOPMENT:
MATERIALS TECHNOLOGY AND
INDUSTRIAL DEVELOPMENT IN BRAZIL

Roberto C. Villas Bôas

MCT CNPq CETEM

NÚMEROS PUBLICADOS NA SÉRIE
ESTUDOS E DOCUMENTOS

1. Quem é Quem no Subsolo Brasileiro - Francisco R. C. Fernandes, Ana Maria B. M. da Cunha, Maria de Fátima Faria dos Santos, José Raimundo Coutinho de Carvalho e Maurício Lins Arcoverde, (2ª edição) 1987.
2. A Política Mineral na Constituição de 1967 - Ariadne da Silva Rocha Nodari, Alberto da Silva Rocha, Marcos Fábio Freire Montysuma e Luis Paulo Schance Heler Giannini, (2ª edição) 1987.
3. Mineração no Nordeste - Depoimentos e Experiências - Manuel Correia de Andrade, 1987. (esgotado)
4. Política Mineral do Brasil - Dois Ensaio Críticos - Osny Duarte Pereira, Paulo César Ramos de Oliveira Sá e Maria Isabel Marques, 1987. (esgotado)
5. A Questão Mineral da Amazônia - Seis Ensaio Críticos - Francisco R. C. Fernandes, Roberto Gama e Silva, Wanderlino Teixeira de Carvalho, Manuela Carneiro da Cunha, Breno Augusto dos Santos, Armando Álvares de Campos Cordeiro, Arthur Luiz Bernardelli, Paulo César de Sá e Maria Isabel Marques, 1987. (esgotado)
6. Setor Mineral e Dívida Externa - Maria Clara Couto Soares, 1987.
7. Constituinte: A Nova Política Mineral - Gabriel Guerreiro, Octávio Elísio Alves de Brito, Luciano Galvão Coutinho, Roberto Gama e Silva, Alfredo Ruy Barbosa, Hildebrando Herrmann e Osny Duarte Pereira, 1988. (esgotado)
8. A Questão Mineral na Constituição de 1988 - Fábio S. Sá Earp, Carlos Alberto K. de Sá Earp e Ana Lúcia Villas-Bôas, 1988. (esgotado)
9. Estratégia dos Grandes Grupos no Domínio dos Novos Materiais - Paulo Sá, 1989. (esgotado)
10. Política Científica e Tecnológica no Japão, Coreia do Sul e Israel. - Abraham Benzaquen Sicsú, 1989. (esgotado)
11. Legislação Mineral em Debate - Maria Laura Barreto e Gildo Sá Albuquerque (organizadores), 1990.
12. Ensaio Sobre a Pequena e Média Empresa de Mineração - Ana Maria B. M. da Cunha (organizadora) 1991.
13. Fontes e Usos de Mercúrio no Brasil - Rui C. Hasse Ferreira e Luiz Edmundo Appel, (2ª edição) 1991.
14. Recursos Minerais da Amazônia - Alguns Dados Sobre Situação e Perspectivas - Francisco R. C. Fernandes e Irene C. de M. H. de Medeiros Portela, 1991. (esgotado)
15. Repercussões Ambientais em Garimpo Estável de Ouro - Um Estudo de Caso - Irene C. de M. H. de Medeiros Portela, (2ª edição) 1991.
16. Panorama do Setor de Materiais e suas Relações com a Mineração: Uma Contribuição para Implementação de Linhas de P & D - Marcello M. Veiga e José Octávio Armani Pascoal, 1991.
17. Potencial de Pesquisa Química nas Universidades Brasileiras - Peter Rudolf Seidl, 1991.
18. Política de Aproveitamento de Areia no Estado de São Paulo: Dos Conflitos Existentes às Compatibilizações Possíveis - Hildebrando Hermann, 1991.
19. Uma Abordagem Crítica da Legislação Garimpeira: 1967-1989 - Maria Laura Barreto, 1993.
20. Some Reflections on Science in the Low-Income Economies - Roald Hoffmann, 1993. (esgotado)
21. Terras-raras no Brasil: depósitos, recursos identificados e reservas - Francisco Eduardo de V. Lapiro Loureiro, 1994.
22. Aspectos Tecnológicos e Econômicos da Indústria de Alumínio, Marisa B. de Mello Monte e Rupen Adamian, 1994.
23. Indústria Carbonífera Brasileira: conveniência e viabilidade - Gildo de A. Sá C. de Albuquerque, 1995.
24. Carvão Mineral: Generalidades e Aspectos Econômicos - Regina Coeli C. Carrisso e Mario Valente Possa, 1995.



NÚMEROS PUBLICADOS NA SÉRIE
INICIAÇÃO CIENTÍFICA

1. Anais da I Jornada Interna do CETEM, 1994.
2. Anais da II Jornada Interna do CETEM, 1994.

PUBLICAÇÕES AVULSAS EDITADAS PELO CETEM OU EM CO-EDIÇÃO

1. Programação Trienal: 1989/1991. Centro de Tecnologia Mineral (CETEM/CNPq), 1989.
2. Manual de Usinas e Beneficiamento. Centro de Tecnologia Mineral (CETEM/CNPq), 1989.
3. Garimpo, Meio Ambiente e Sociedades Indígenas. CETEM/CNPq/EDUFF, 1992.
4. Programação Trienal: 1992/1994. Centro de Tecnologia Mineral (CETEM/CNPq).
5. Impactos Ambientais. SPRU/USP/CNPq, 1993.
6. Relatório de Atividades de 1993. Centro de Tecnologia Mineral (CETEM/CNPq), 1994.