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An Alternative Flotation Process for Apatite Concentration of the Itataia Carbonaceous Uranium-Phosphate Ore

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AN ALTERNATIVE FLOTATION PROCESS FOR APATITE CONCENTRATION OF THE ITATAIA CARBONACEOUS URANIUM-PHOSPHATE ORE

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Melbourne, March 2015

Agribusiness in Brazil

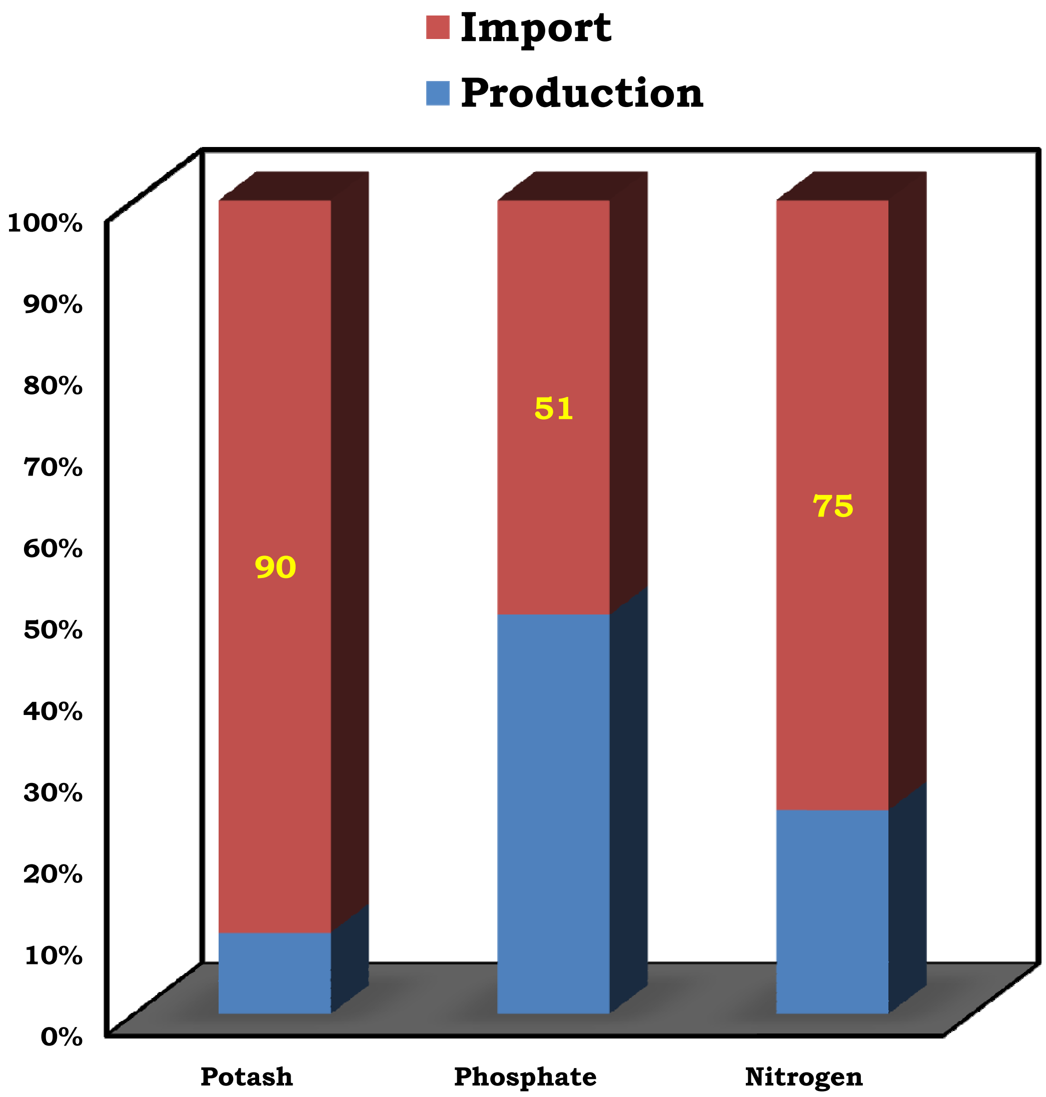
- **Grain production (2013) = 188 million ton**
- **Planted area (2013) = 53 million hectares**
- **(2013) 23% Gross domestic product = US$ 454 billion**

Projections for international trade (2022)

Product	Production (million ton)		Market share (%)	Position
	Brazil	World		
Corn	18,6	138,7	13,4	4º
Soybean (grain)	63,8	144,3	**44,2**	1º
Soybean (oil)	2,4	10,8	22,2	2º
Soybean (bran)	16,9	73,9	22,9	2º
Cattle	1,9	8,1	23,3	2º
Pork	0,8	6,3	12,4	4º
Chicken	4,8	9	**52,9**	1º

Sources: Ministério da Agricultura, Pecuária e Abastecimento – USDA (United States Department of Agriculture) - CNA

Brazilian fertiliser industry supply



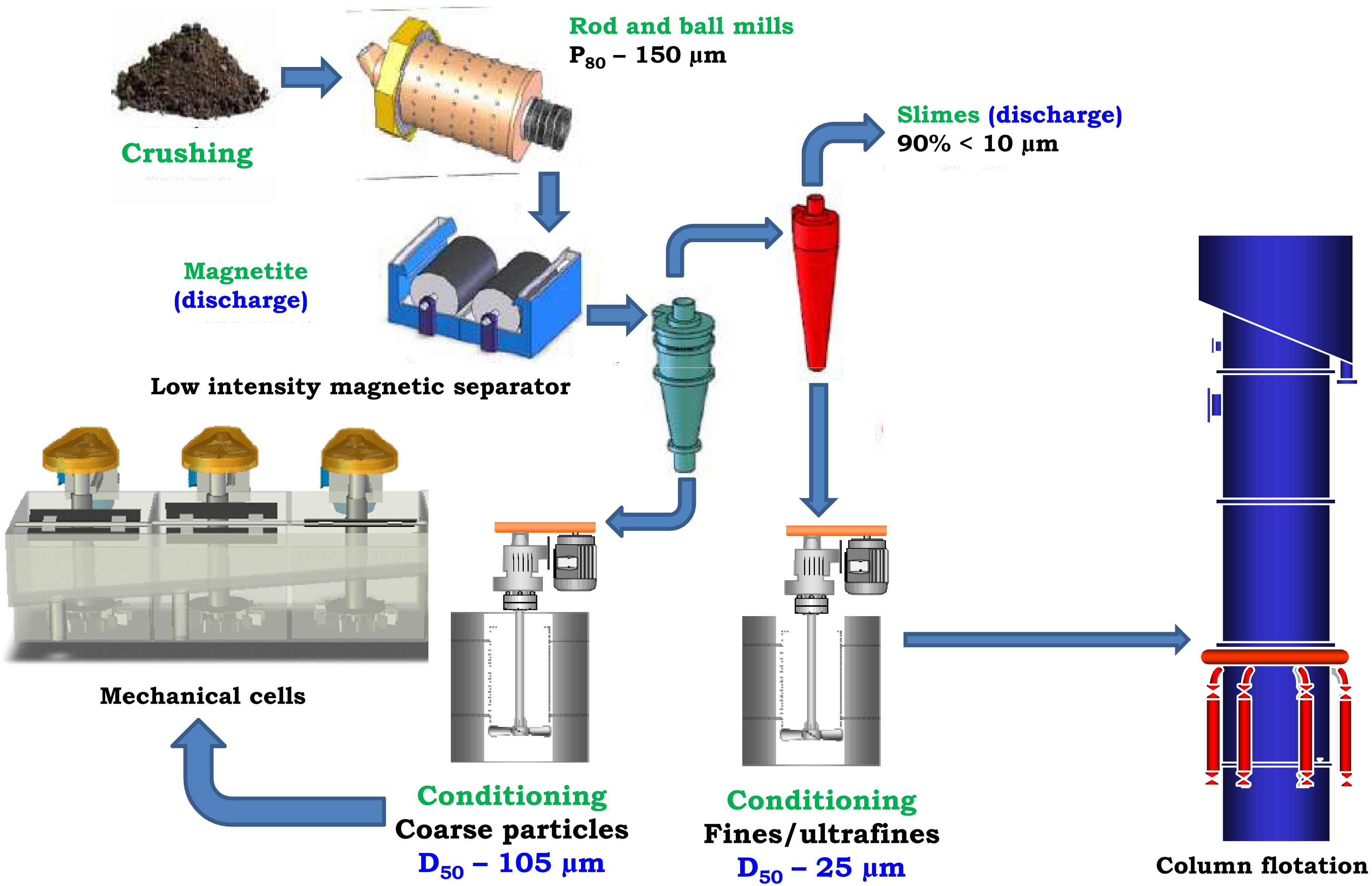
Fertiliser demand in Brazil will grow twice as fast as overall global demand

Brazil = 5.3% y.y 2000-2012

Brazil = 5.3% y.y 2000-2012

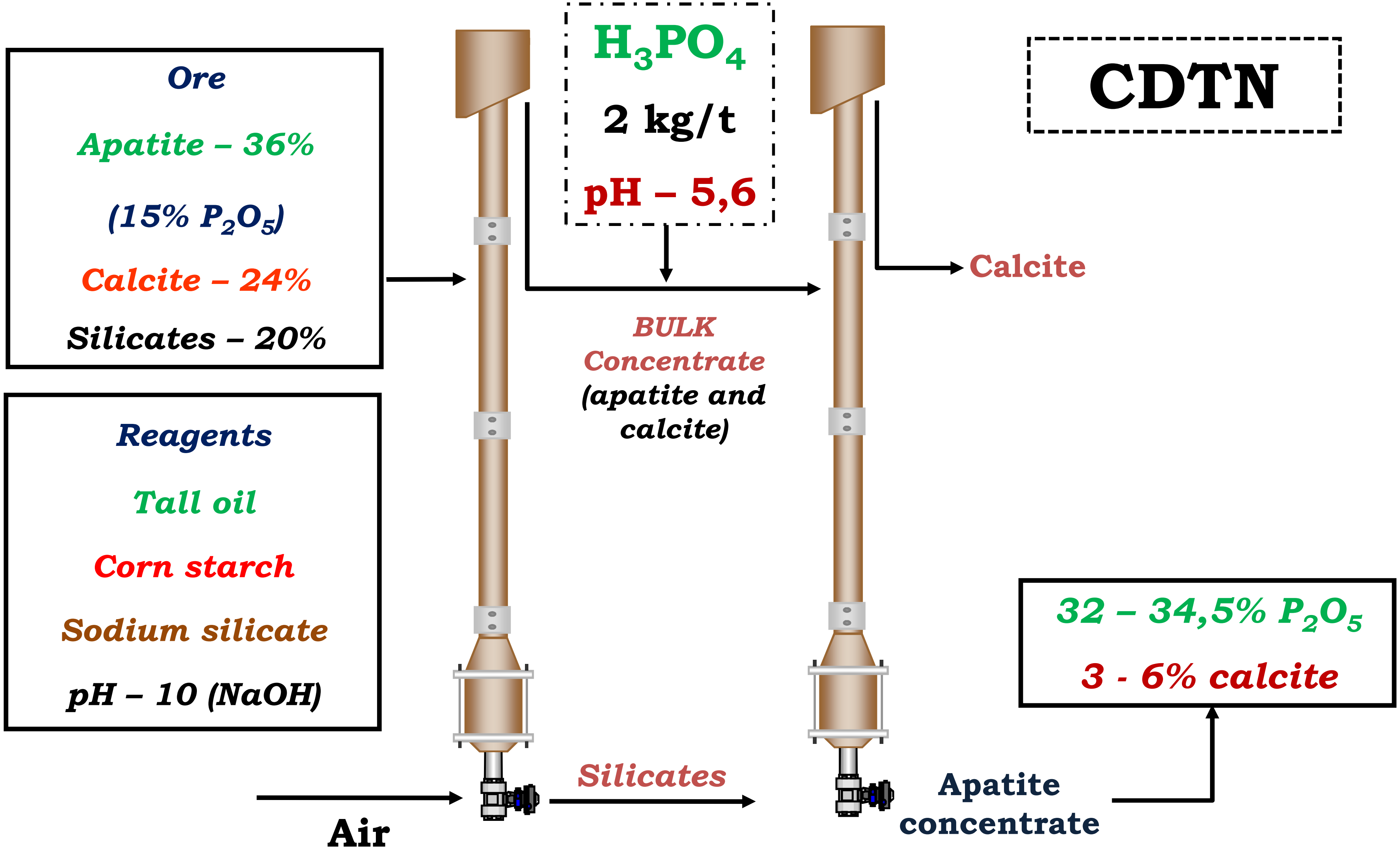

Venezuela
Colombia
Guyana
French Guiana
Suriname
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Santa Quitéria – INB and Galvani
Salitre – Vale
Catalão – Vale and Copebrás
Araxá – Vale
Tapira – Vale
Cajati – Vale

Typical flowsheet



Phosphate-uranium ore (Itataia - CE)

80´s years

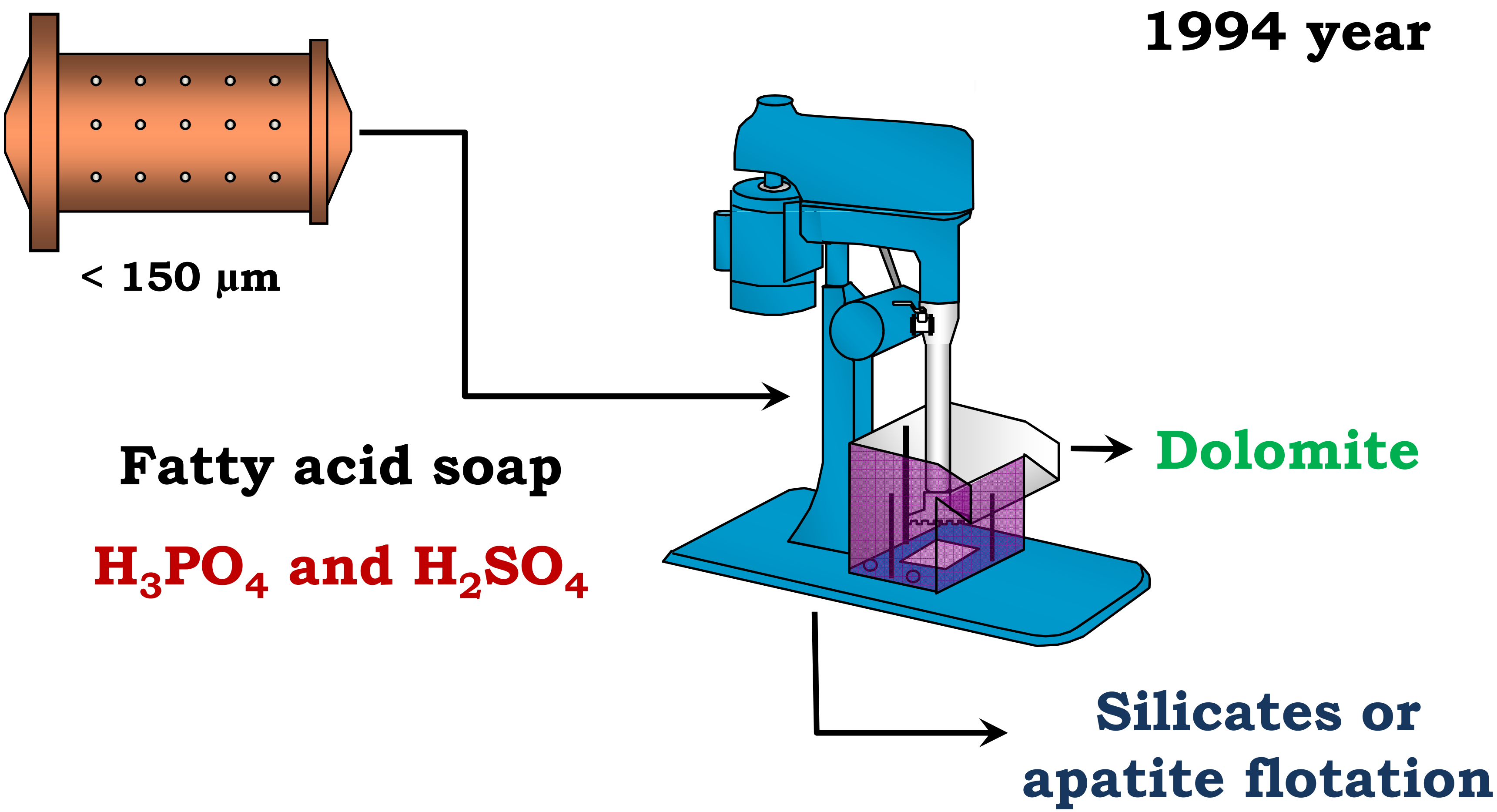


CLDRI Process

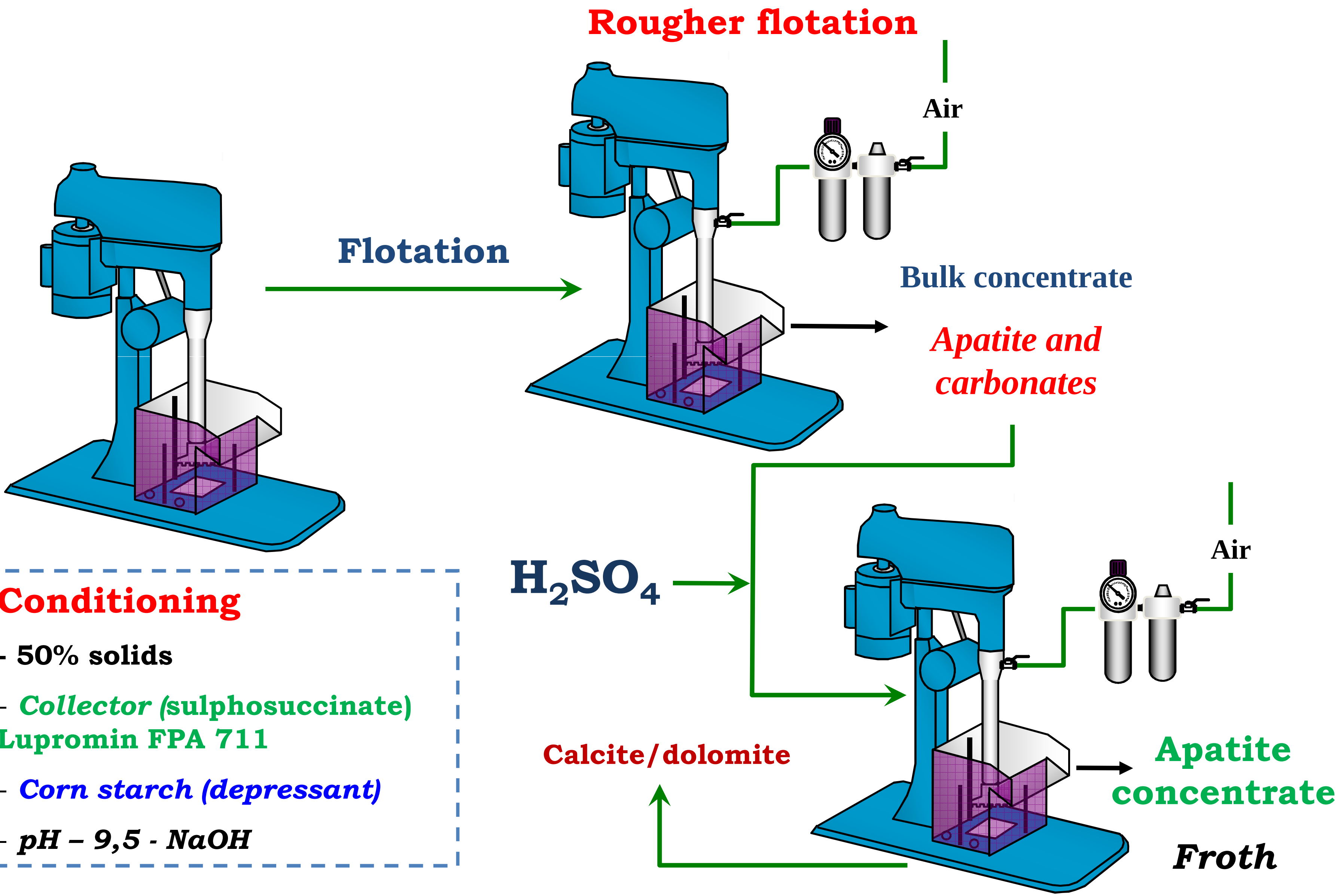
Chinese Lianyungang Design and Research Institute

Florida Industrial and Phosphate Research Institute (FIPR)

University of Florida



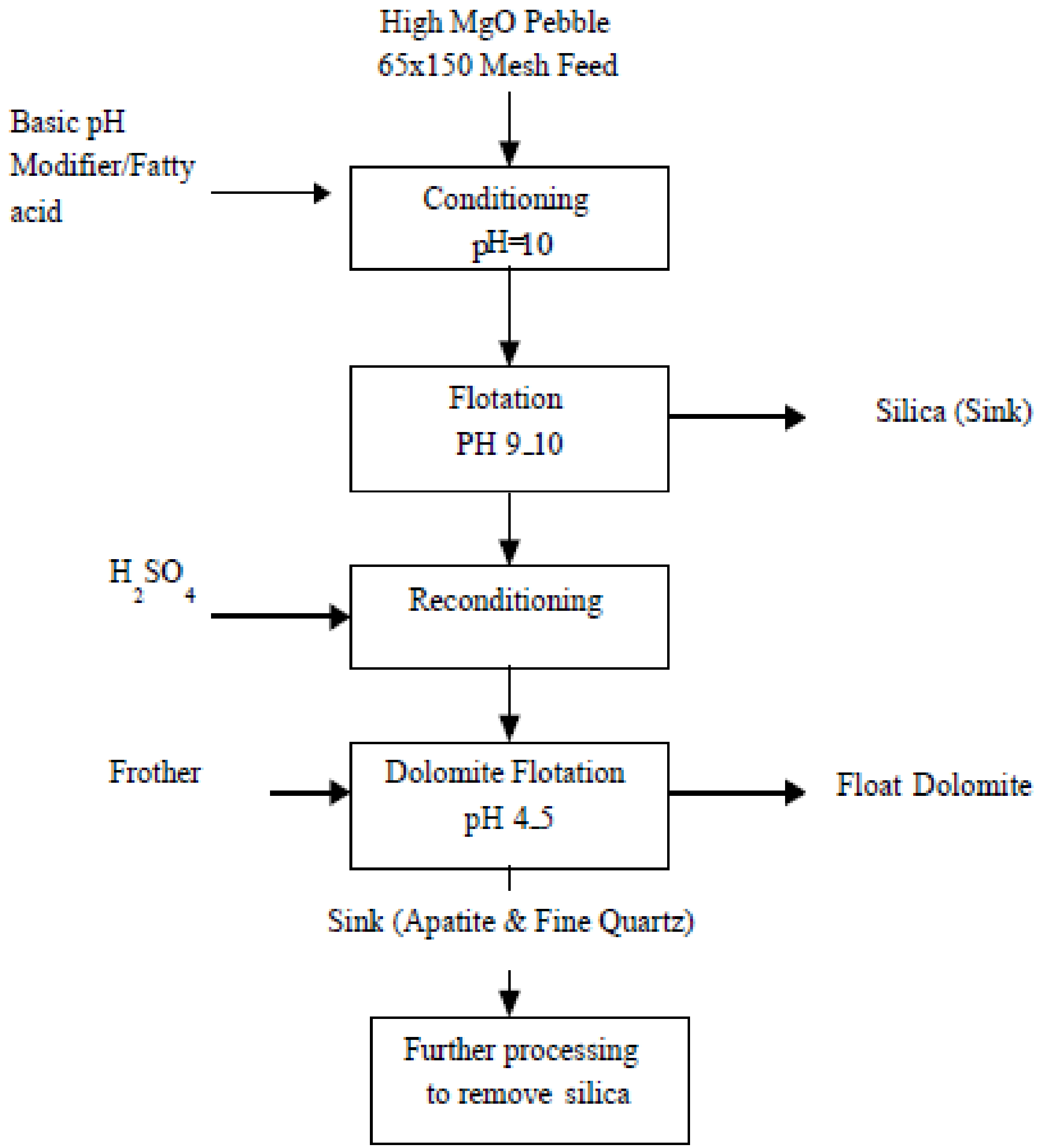
Siliceous carbonate phosphate ore from Catalão (Goiás)



Conditioning

- 50% solids
- *Collector* (sulphosuccinate) Lupromin FPA 711
- *Corn starch (depressant)*
- *pH – 9,5 - NaOH*

Two stage conditioning process



Role of Carbon Dioxide in Flotation of Carbonate Minerals

A. K. BISWAS
Department of Metallurgical Engineering, Indian Institute of Technology, Kanpur

Manuscript received 23 *June* 1966

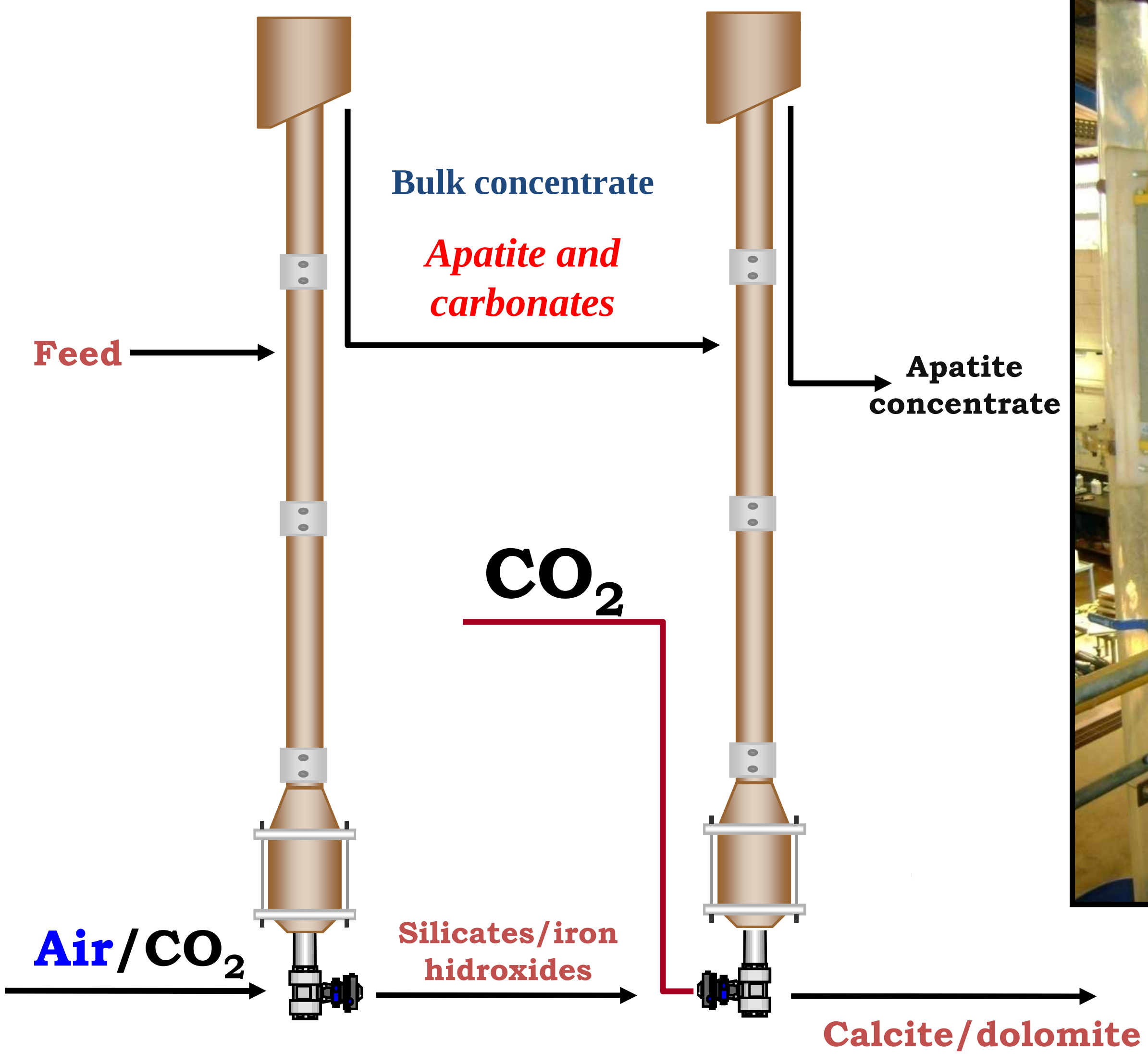
The use of carbon dioxide in place of air improves the flotation recovery of calcite and magnesite at low collector (sodium oleate) concentration. With siderite and rhodochrosite, the recovery is almost of the same order with both air and carbon dioxide. The improvement in flotation recovery brought about by carbon dioxide is not related solely to the lowering of *p*H. Specificity of reaction of carbon dioxide with the surface cation of the carbonate mineral is indicated.

Fundamental Studies on the Role of Carbon Dioxide in a Calcite Flotation System

by V. T. Sampat Kumar, N. Mohan, and A. K. Biswas

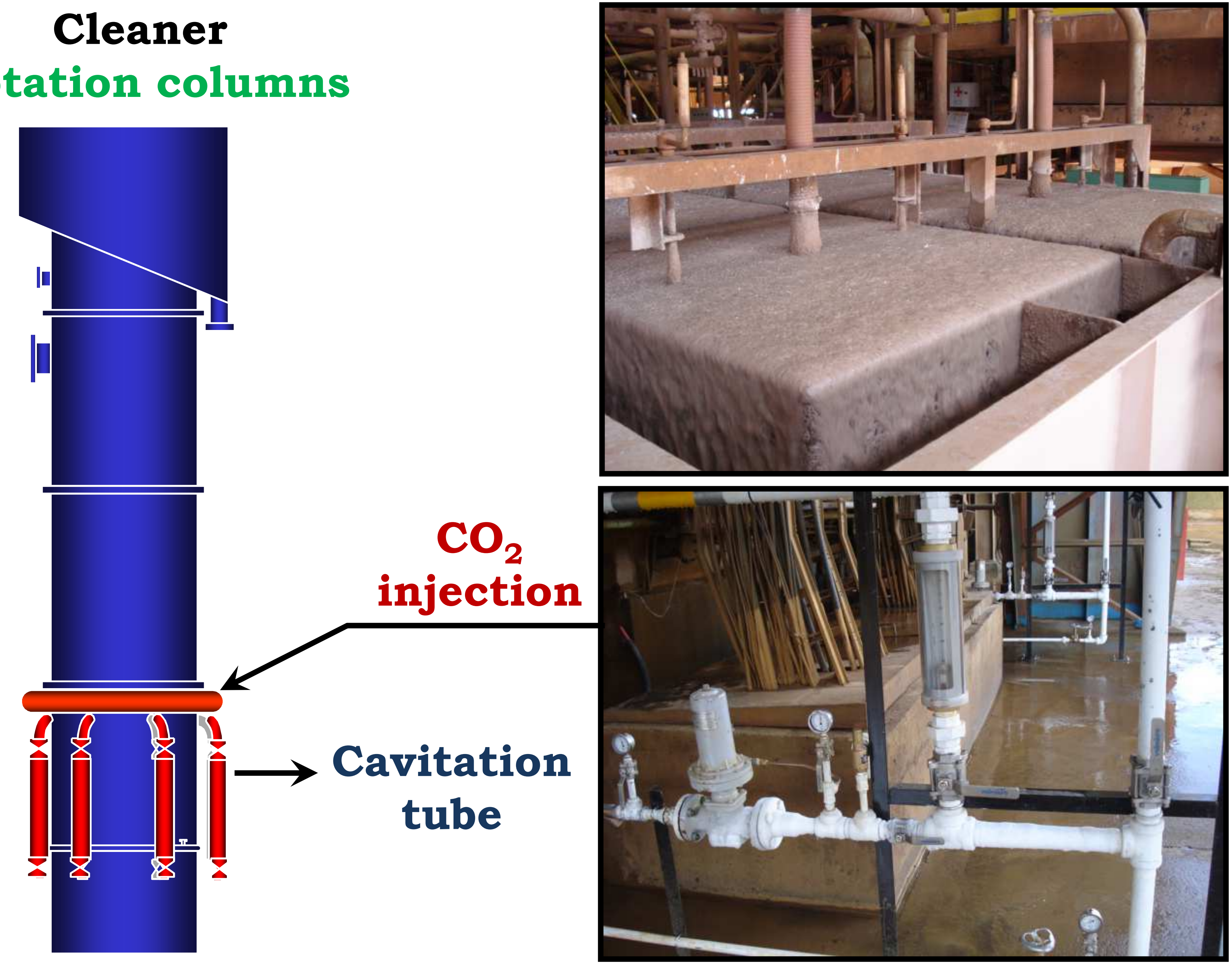
Transactions SME/AIME, Vol. 250, No. 3, September 1971, pp. 182-186

Carbonic gas applyed in flotation of phosphates ores (Brazil)

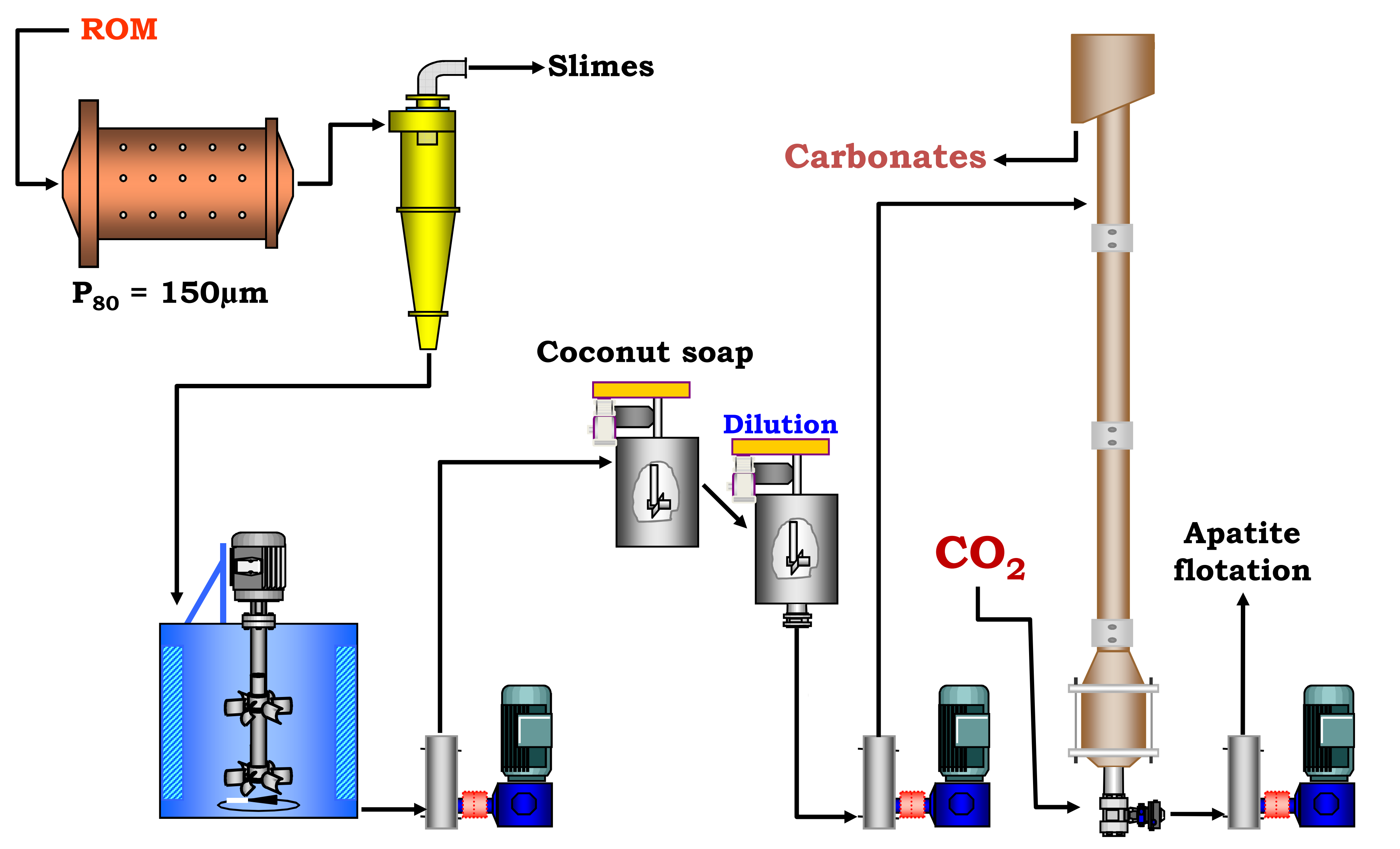


Catalão´s Mine

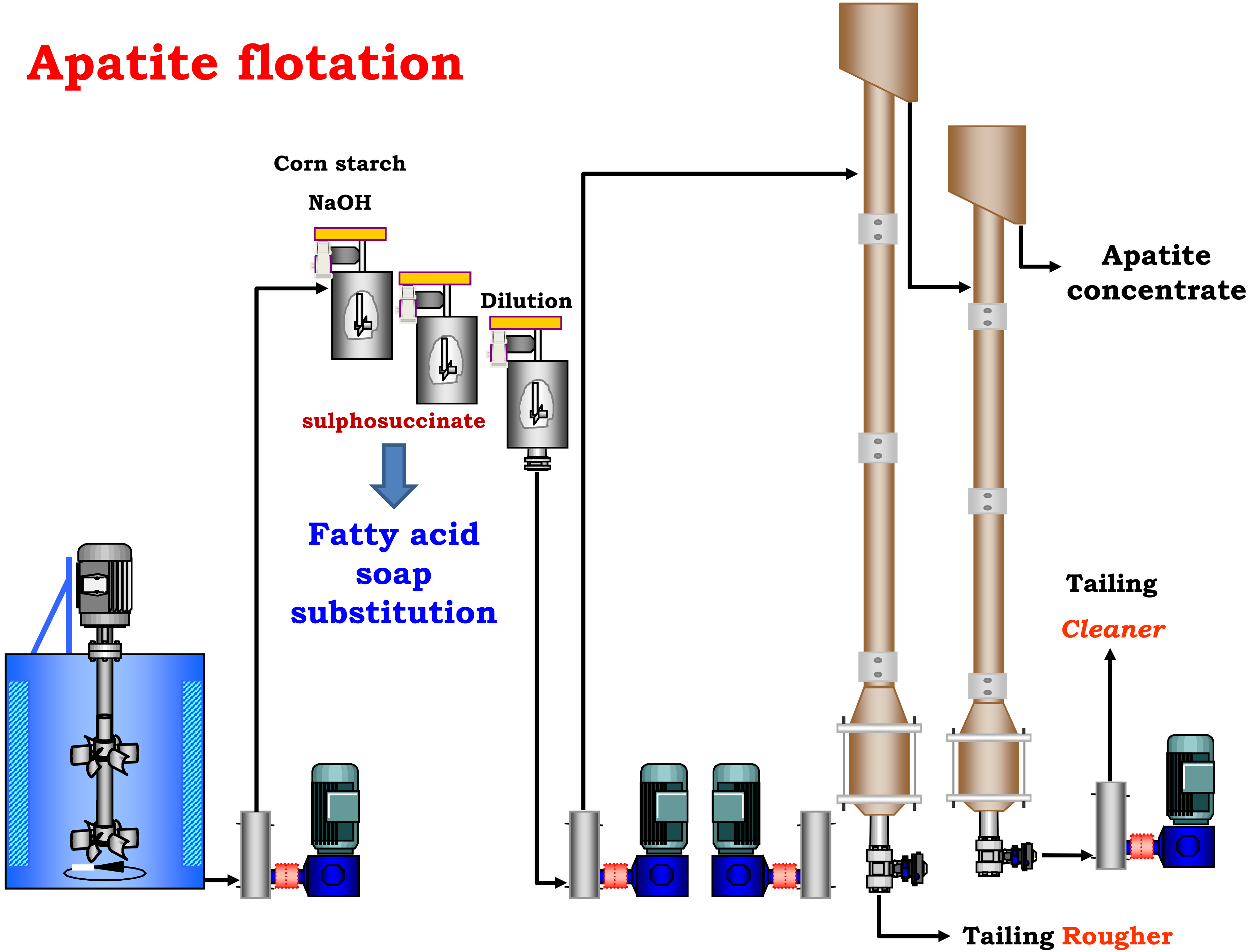
Cleaner
Flotation columns



Barreiros´s Mine - Araxá



Apatite flotation



Experimental

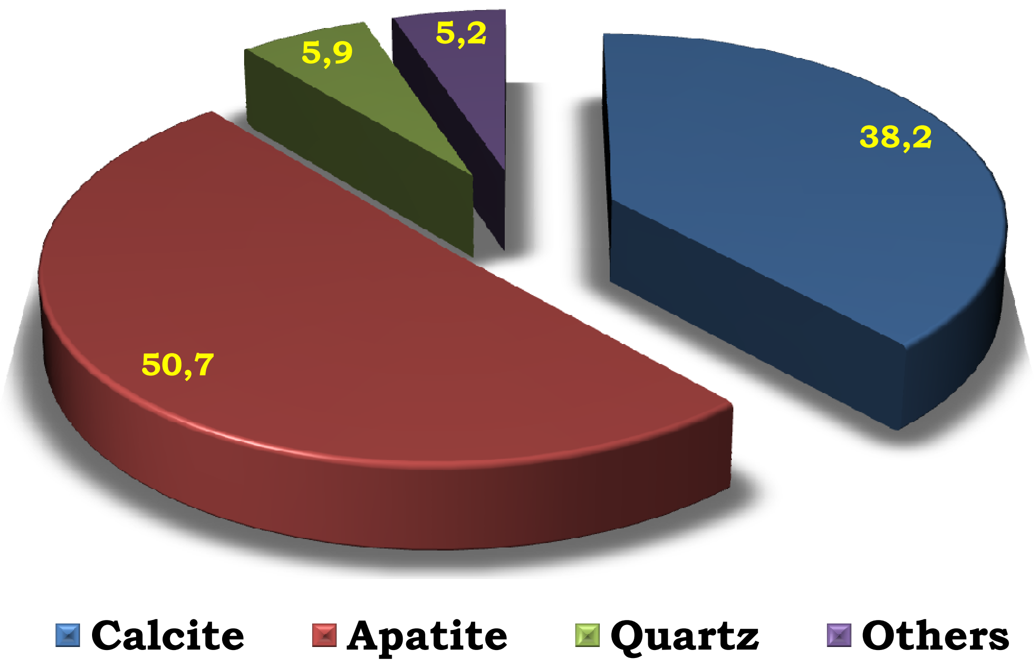
Ore sample – 1 ton



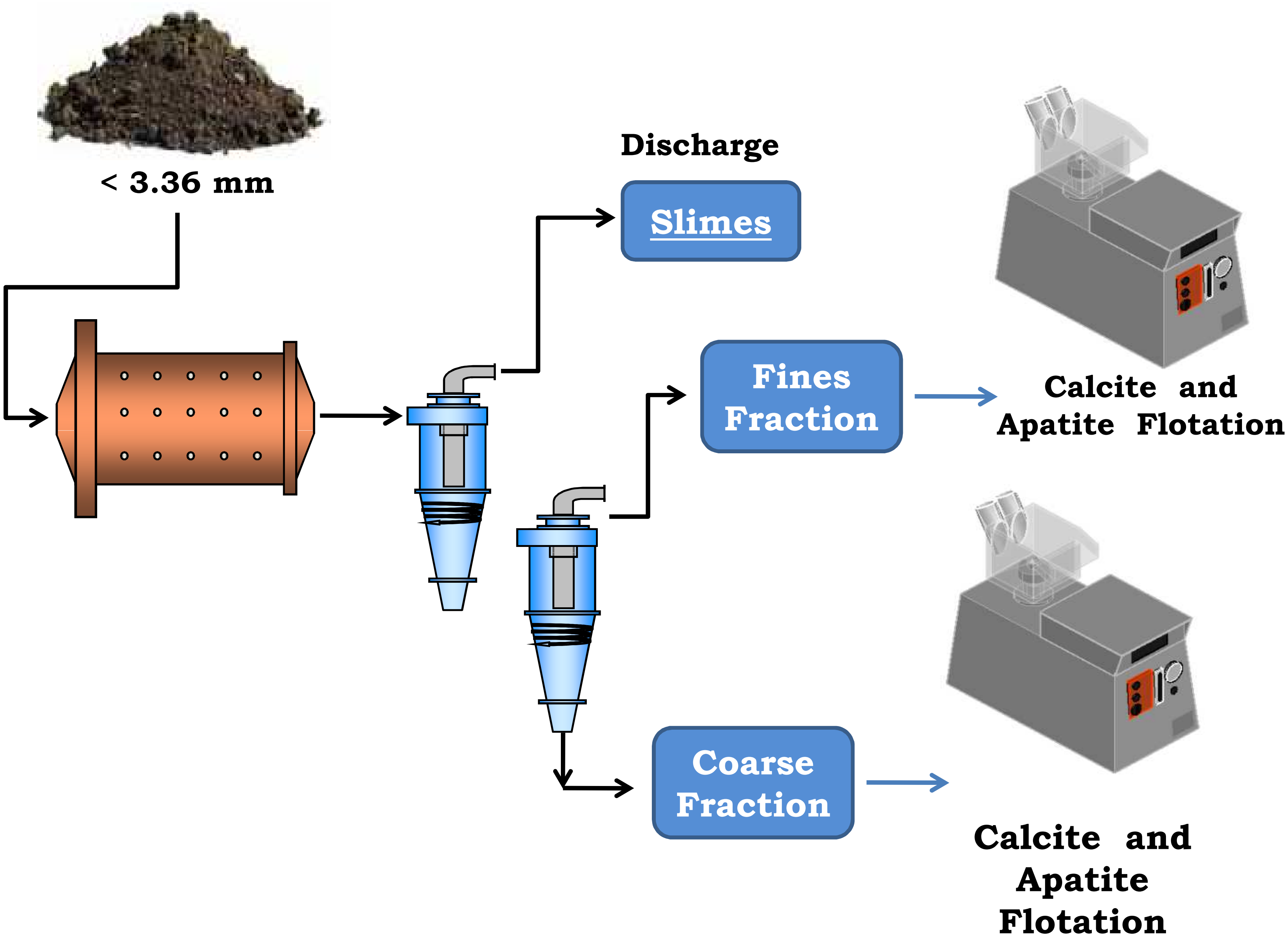


Chemical and mineralogical characterization

CaO/P_2O_5	Grade (%)						
	P_2O_5	CaO	Fe_2O_3	SiO_2	MgO	Al_2O_3	TiO_2
2,8	16,7	47,6	2,5	8,7	0,6	2,9	0,2

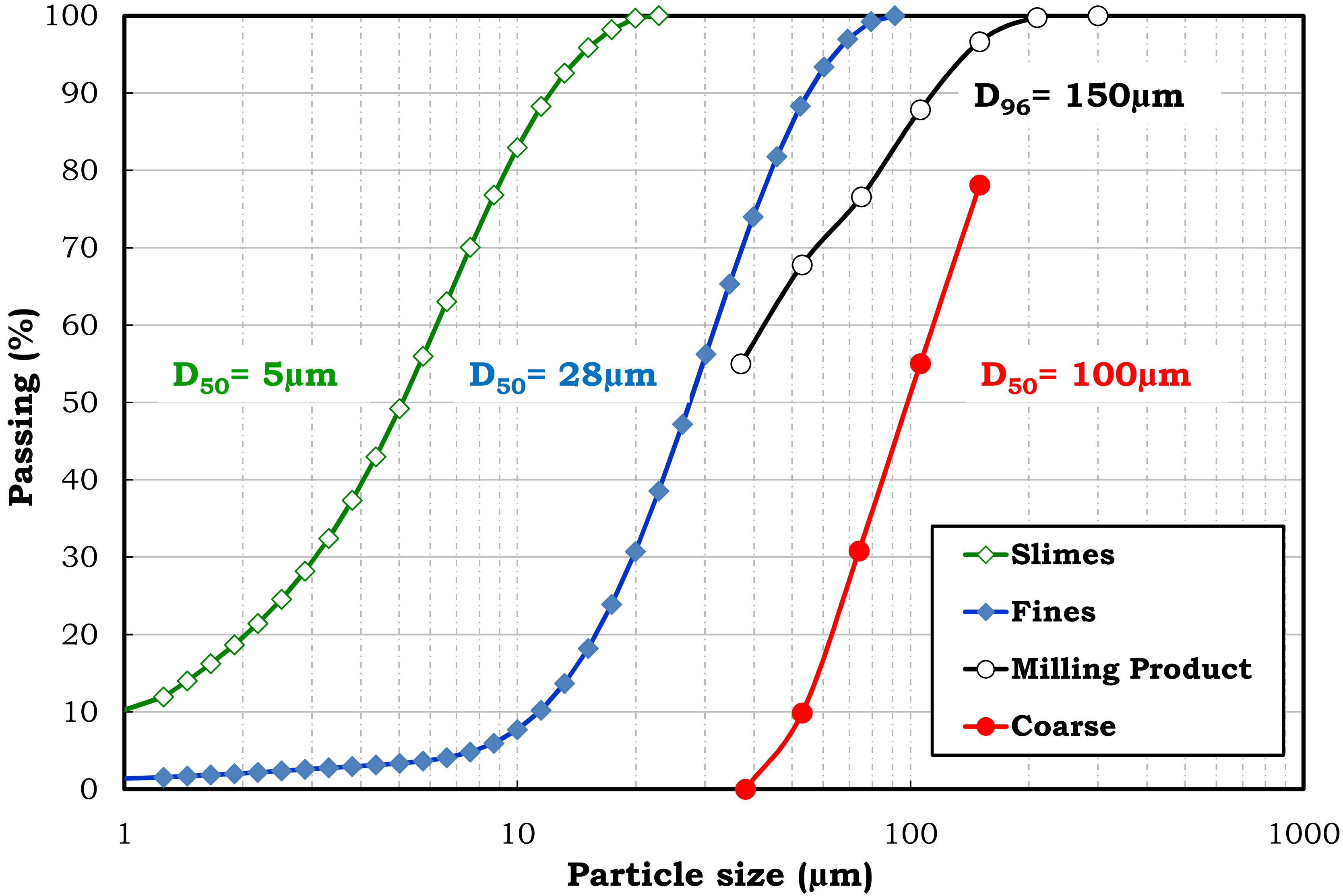


Flowsheet



< 3.36 mm
Discharge
Slimes
Fines Fraction
Calcite and Apatite Flotation
Coarse Fraction
Calcite and Apatite Flotation

Particle size distribution



Mass Balance
Preparation

Flux	Recovery (%)		Grade (%)				
	Mass	P_2O_5	P_2O_5	CaO	Fe_2O_3	SiO_2	Al_2O_3
Slimes	18,2	16,4	14,7	42,1	3,2	10,5	4,0
Fines	*35,4*	*34,7*	*16,0*	*48,6*	*2,2*	*8,0*	*2,8*
Coarse	*46,4*	*48,9*	*17,2*	*53,0*	*2,2*	*6,1*	*1,3*

Calcite flotation

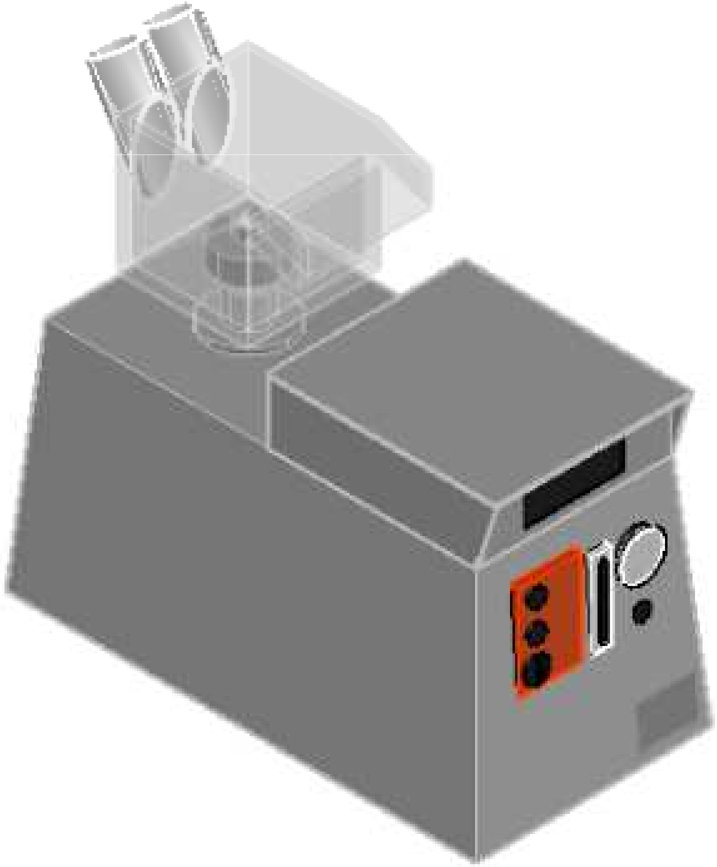
- *Coconut soap (calcite collector)*
- *CO_2 – bubble generator*
- *pH – 5.8*

Apatite flotation

- *Sulphosuccinate (apatite collector)*
- *Corn starch (depressant)*
- *pH – 11 (NaOH)*

Conditioning = 50%$_{w/w}$ (coarse) – 40%$_{w/w}$ (fines)

Flotation = 25%$_{w/w}$

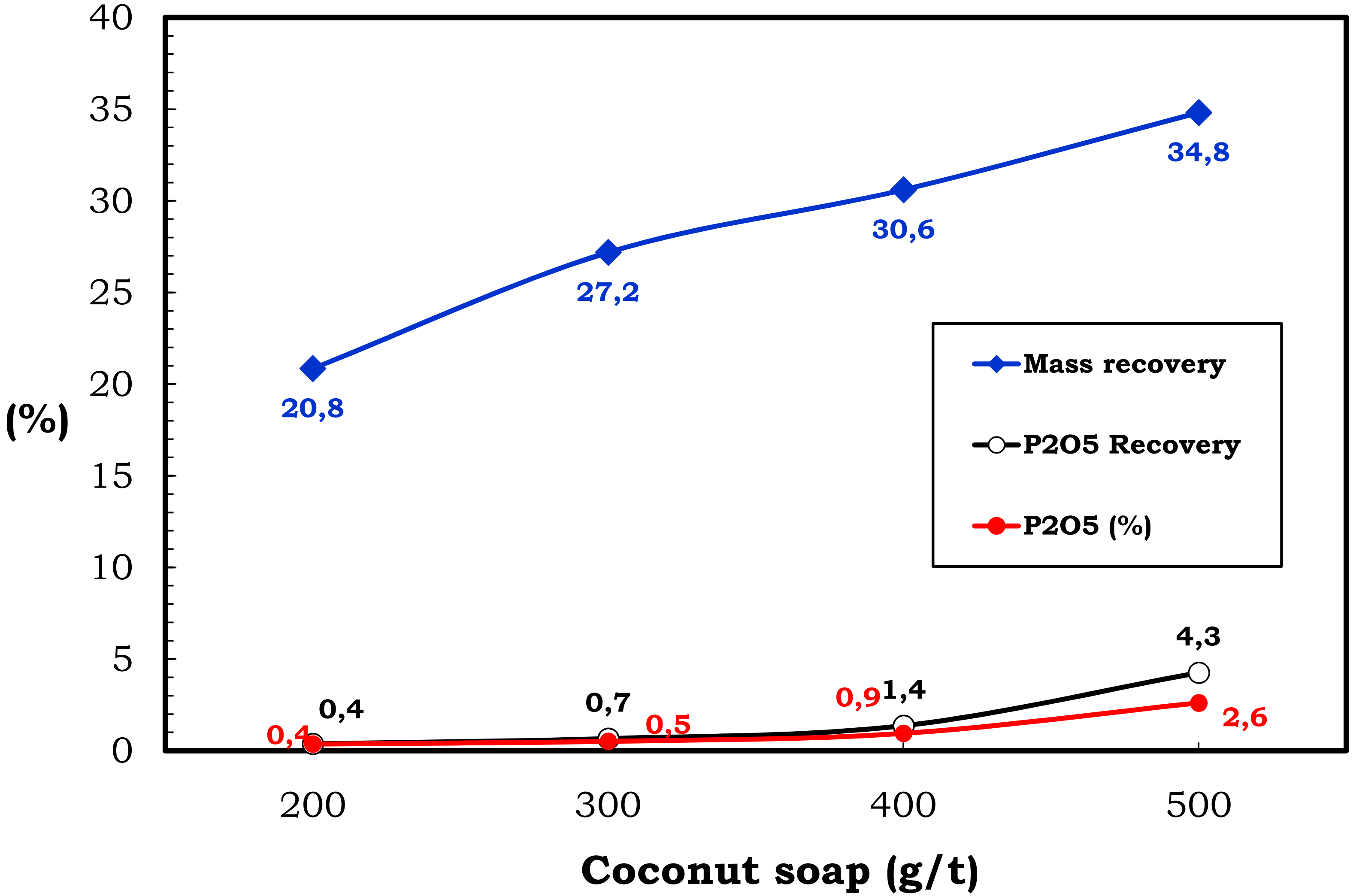


Results

Calcite flotation – Coarse fraction

Effect of the collector dosage – Calcite concentrate

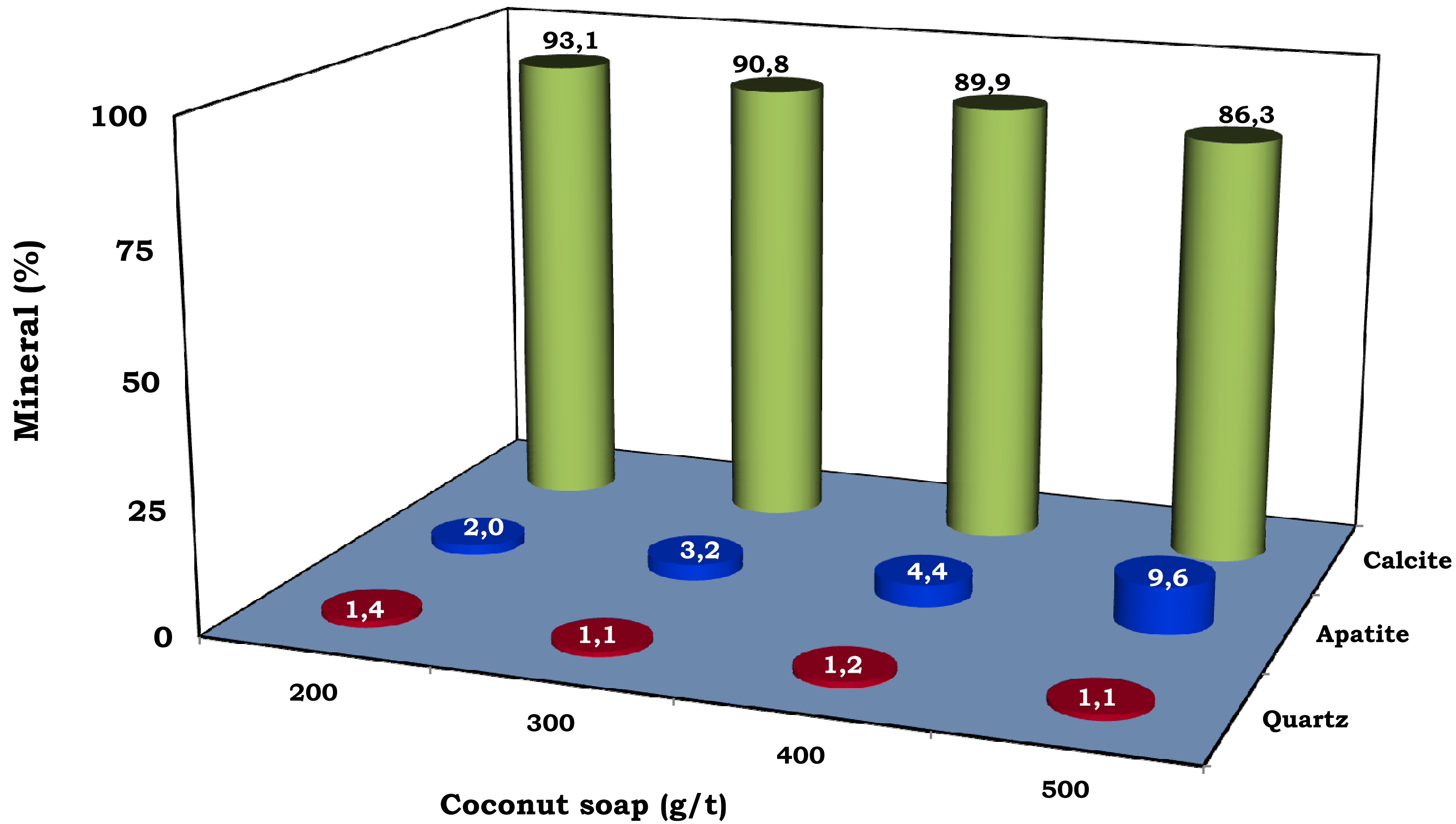
Mass recovery; P_2O_5 recovery and P_2O_5 grade



Calcite flotation – Coarse fraction

Effect of the collector dosage – Float

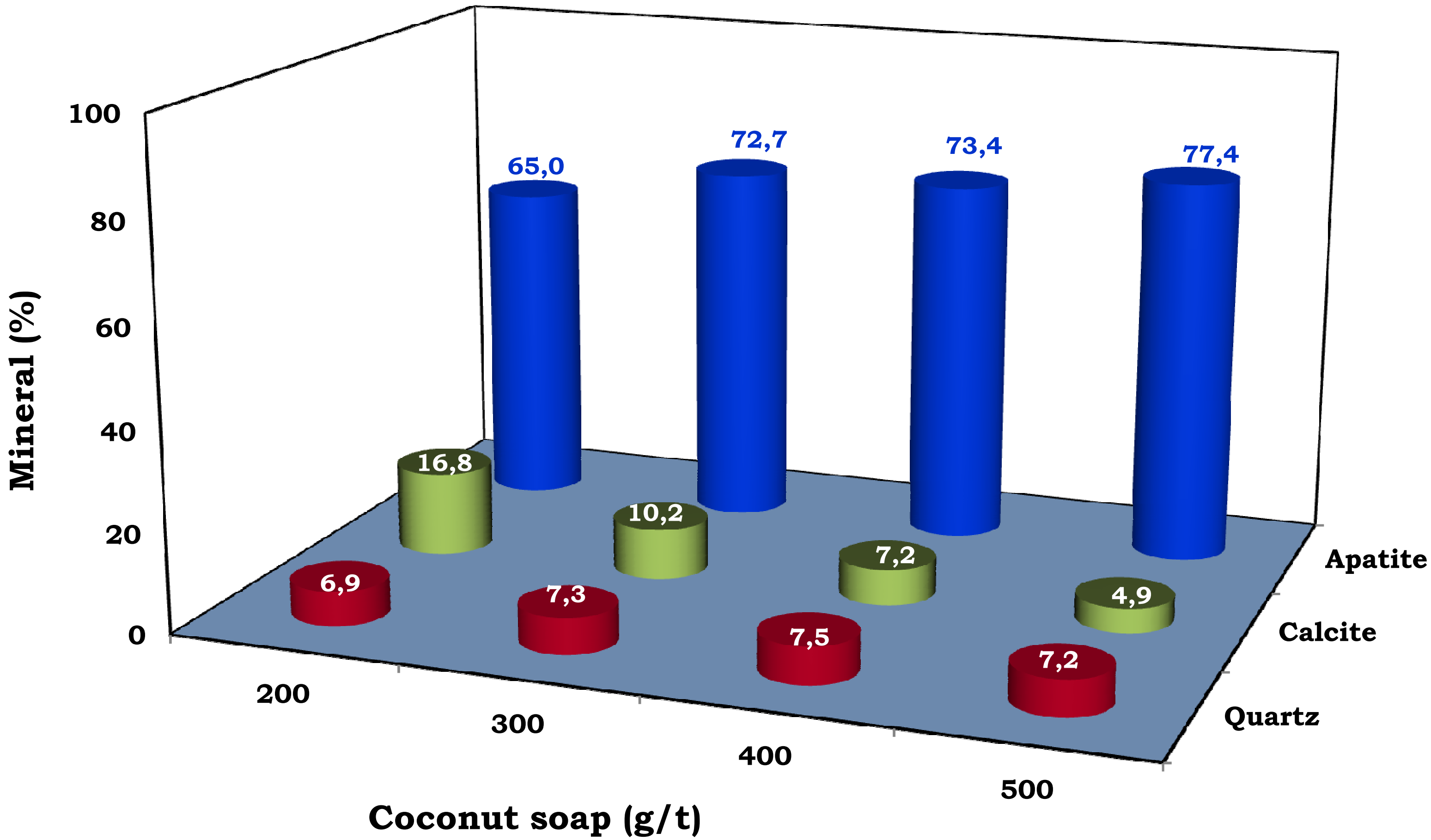
Mineralogical composition



Calcite flotation – Coarse fraction

Effect of the collector dosage – Sink

Mineralogical composition

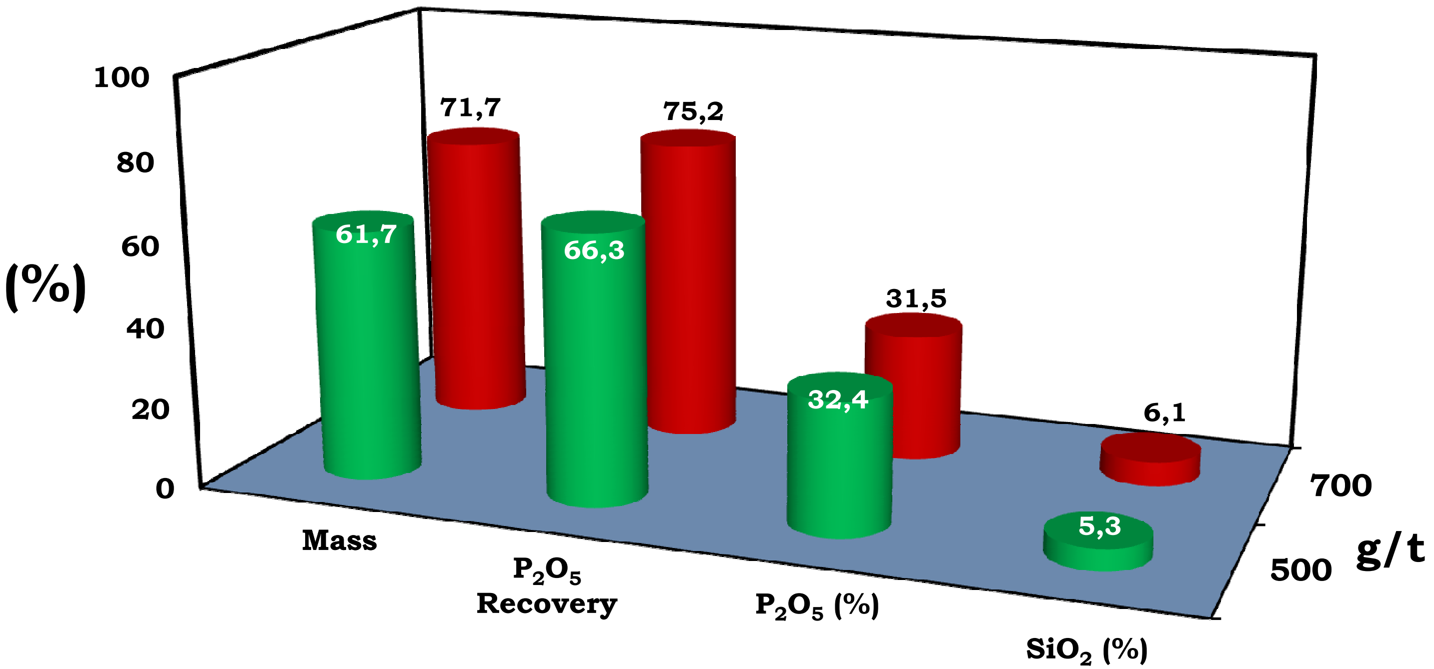


Apatite flotation – Coarse fraction

Effect of the collector dosage (sulphosuccinate)

Feed

CaO/P_2O_5	Grade (%)				
	P_2O_5	CaO	Fe_2O_3	SiO_2	Al_2O_3
1,55	30,0	46,4	2,5	10,3	1,8



Collector g/t	Grade (%)				
	P_2O_5	CaO	Fe_2O_3	SiO_2	Al_2O_3
500	26,6	38,9	3,3	18,3	3,6
700	26,4	36,4	3,4	20,9	4,1

Tailings

Apatite flotation – Coarse fraction

Scavenger

Corn Starch = 300 g/t
Sulphossucinate = 500 g/t
pH = 11,0

Feed

Grade (%)				
P_2O_5	CaO	Fe_2O_3	SiO_2	Al_2O_3
26,6	37,0	3,4	19,4	4,3

Concentrate

R P_2O_5	Grade (%)				
	P_2O_5	CaO	Fe_2O_3	SiO_2	Al_2O_3
65,5	32,9	42,8	2,3	11,3	6,3

Balance coarse fraction

Mass recovery = 28,6%

P_2O_5 recovery = 42% - *85% flotation*

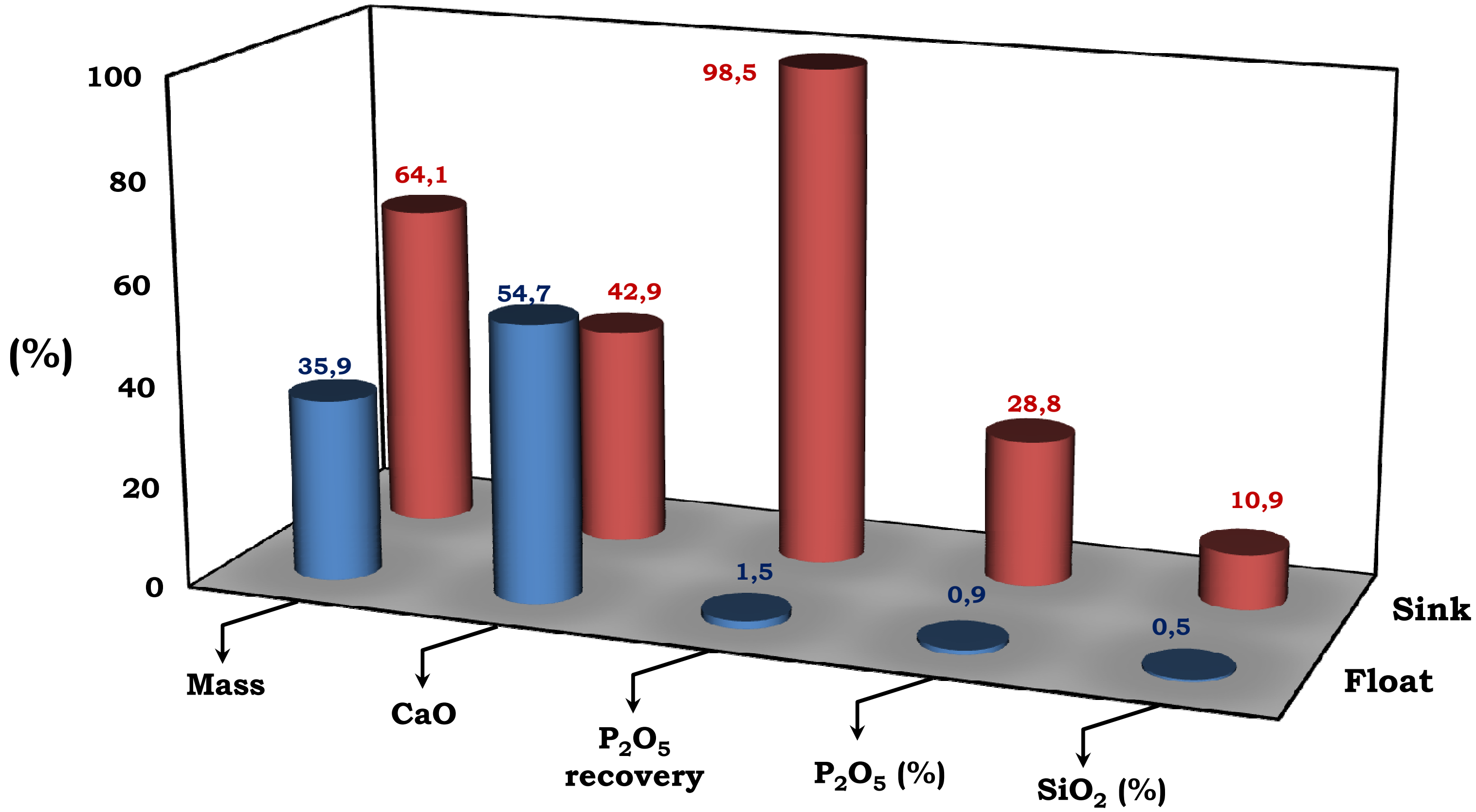
P_2O_5 grade = 32%

SiO_2 grade = 7,1%

Calcite flotation (fines fraction)

500 g/t collector

2 L/min CO_2



Apatite flotation (fines fraction)

Corn starch = 700 g/t

Sulphosuccinate = 700 g/t

pH = 11

Flux	Recovery (%)		Grade (%)				
	Mass	P_2O_5	P_2O_5	CaO	Fe_2O_3	SiO_2	Al_2O_3
Feed	100	100	28,5	44,6	2,7	11,2	3,5
Concentrate	*66,2*	*76,9*	*33,2*	*53,4*	*1,9*	*3,7*	*1,1*
Tailings	33,8	23,1	19,5	27,5	4,2	25,8	8,1

Balance fines fraction

Mass recovery = 15%

P_2O_5 recovery = 26,31% - *75,7% flotation*

Calcite concentrate Apatite concentrate

Global balance

Mass recovery = 43,6%

P_2O_5 recovery = 68%

P_2O_5 (%) = 32,4%

SiO_2 (%) = 6,0%

Final remarks

The use of carbon dioxide in combination with coconut soap showed high selectivity on separation between apatite and calcite in the Itataia´s phosphate ore;

This carbonate flotation process concept based on use carbon dioxide and coconut soap as carbonates collector was applied in others two differents carbonaceous phosphate ores from Brazil (Araxá and Catalão) with very good results;

Quartz flotation must be avaliated in replacement of apatite flotation in the sink fraction of calcite flotation.

This work is dedicated to the Mining Engineer Lauro Akira Takata

Acknowledgments

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To all institutions that support research in Brazil

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