

SPRINGER BRIEFS IN EARTH SCIENCES

Marco Keersemaker

Suriname  
Revisited:  
Economic Potential  
of its Mineral  
Resources

 Springer

# **SpringerBriefs in Earth Sciences**

SpringerBriefs in Earth Sciences present concise summaries of cutting-edge research and practical applications in all research areas across earth sciences. It publishes peer-reviewed monographs under the editorial supervision of an international advisory board with the aim to publish 8 to 12 weeks after acceptance. Featuring compact volumes of 50 to 125 pages (approx. 20,000–70,000 words), the series covers a range of content from professional to academic such as:

- timely reports of state-of-the art analytical techniques
- bridges between new research results
- snapshots of hot and/or emerging topics
- literature reviews
- in-depth case studies

Briefs will be published as part of Springer's eBook collection, with millions of users worldwide. In addition, Briefs will be available for individual print and electronic purchase. Briefs are characterized by fast, global electronic dissemination, standard publishing contracts, easy-to-use manuscript preparation and formatting guidelines, and expedited production schedules.

Both solicited and unsolicited manuscripts are considered for publication in this series.

More information about this series at <http://www.springer.com/series/8897>

Marco Keersemaker

# Suriname Revisited: Economic Potential of its Mineral Resources

 Springer

Marco Keerseemaker  
Faculty of Civil Engineering  
and Geosciences  
Delft University of Technology  
Delft, The Netherlands

ISSN 2191-5369 ISSN 2191-5377 (electronic)  
SpringerBriefs in Earth Sciences  
ISBN 978-3-030-40267-9 ISBN 978-3-030-40268-6 (eBook)  
<https://doi.org/10.1007/978-3-030-40268-6>

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2020

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

*A no ala sani gowtu san brinki  
Sranan odo*

# Preface

It has been an eventful start of the century for Suriname's mining industry: we have witnessed the closure of its bauxite and alumina industry as well as the development of two world-class gold mines and the recent kick-off of the South American Exploration Initiative or SAXI, which will hopefully lead to more developments. As one of the last employees of BHP Billiton Maatschappij Suriname, I was closely involved in the departure of my employer after another failed attempt to develop the Bakhuis bauxite project. That was a painful experience for me and my colleagues.

During my time in the country, I occasionally visited the archives of GMD and BHP Billiton archives and saw numerous publications and maps on the mineral exploration work done in the past. Local and foreign scientists spent many years exploring the interior and identified several mineral occurrences of a range of commodities. Some of these documents from the period after the Second World War are still the most recent reports available and I often wondered if there was a chance that under current market circumstances, any of them would possibly be economic.

Besides my years in Suriname, I have also spent almost a decade working on mines and mine projects (gold, manganese, bauxite and iron ore) in West Africa, which shares a geological history with the Guianas. The difference in mineral endowment and economic mining activities is significant, which strengthened my belief that there must be hidden opportunities in Suriname.

Professor Wong et al. were the last to review in 1998, but the recently commenced South-American Exploration Initiative (SAXI) is putting the spotlight back on Suriname's geology and I considered it an appropriate time to have another look at historic research by experienced and knowledgeable geoscientists and to give my updated interpretation as a mining engineer with an economic perspective in the hope that the country can benefit from our combined contributions.

Delft, The Netherlands

Marco Keersemaker

# Acknowledgements

The author would like to thank Dr. Mike Buxton, Prof. Salomon Kroonenberg and John Sew A Tjon for reviewing the manuscript and for their contributions, which helped to improve the quality.

Further thanks go to:

- Prof. Jan Holtrop who donated his collection of reports from his years as researcher in Suriname and who inspired me to make good use of it.
- Dr. Leo Kriegsman and Arike Gill of Naturalis Biodiversity Center for assisting with identification of minerals and allowing access to their mineral archive.
- Dr. Emond de Roever for information on Bakhuis.
- Elsevier and Cambridge University Press for granting permission to use images.
- Janice Rossen for her thorough editing of the draft text and last but not least:
- Ingeborg Ligtenberg for her support and positive energy.



# Contents

<b>1</b>	<b>Introduction</b> .....	1
<b>2</b>	<b>Geology of Suriname</b> .....	3
	2.1 Precambrian: Stratigraphy and Formations .....	5
	References .....	6
<b>3</b>	<b>A Brief History of Exploration Work</b> .....	9
	3.1 Geochemical Survey .....	10
	3.2 Exploring for Bauxite and Gold .....	11
	References .....	13
<b>4</b>	<b>Modeling Economic Potential: Minimal Resource Parameters</b> .....	15
	4.1 Concept of the Proven and Probable-Formula .....	15
	4.2 Investment Capital Estimates .....	16
	4.3 Mine Development .....	16
	4.4 Cashflow Profile .....	16
	References .....	17
<b>5</b>	<b>Gold</b> .....	19
	5.1 West Africa as Reference .....	20
	5.2 Gold-Producing Operations in Suriname .....	22
	5.2.1 Rosebel Gold Mines .....	23
	5.2.2 Merian .....	23
	5.3 Economic Model for Gold .....	24
	5.3.1 Hounde Gold Project—Burkina Faso .....	24
	5.3.2 Gold Price .....	25
	5.3.3 Operating Costs and All-in Sustaining Costs .....	26
	5.3.4 Royalties and Taxes .....	27
	5.3.5 Proven and Probable Reserves .....	27
	5.3.6 Results .....	27
	References .....	29

<b>6</b>	<b>Bauxite</b> .....	31
6.1	Geology .....	32
6.2	History .....	32
6.2.1	Bakhuis .....	33
6.3	Future Options .....	35
6.3.1	Bauxite Export .....	37
6.3.2	Guinea .....	37
6.3.3	Australia .....	38
6.3.4	Suriname .....	38
6.3.5	Beneficiation .....	39
6.3.6	Alumina .....	40
6.3.7	Non-metallic Bauxite .....	40
	References .....	42
<b>7</b>	<b>Base Metals</b> .....	43
7.1	Copper .....	43
7.1.1	Exploration Results .....	43
7.1.2	Economic Evaluation .....	46
7.1.3	Kalongwe Copper Project .....	47
7.2	Lead/Zinc .....	49
7.2.1	Exploration Results .....	50
7.2.2	Economic Evaluation .....	50
7.3	Nickel .....	50
7.3.1	Exploration Results .....	51
7.3.2	Economic Evaluation .....	52
7.3.3	Nickel Laterite .....	53
	References .....	53
<b>8</b>	<b>Other Metallic Minerals</b> .....	55
8.1	Chromium .....	55
8.1.1	Exploration Results .....	55
8.1.2	Economic Evaluation .....	56
8.2	Iron .....	57
8.2.1	Exploration Results .....	57
8.2.2	Economic Evaluation .....	57
8.3	Manganese .....	59
8.3.1	Exploration Results .....	60
8.3.2	Economic Evaluation .....	63
8.3.3	Nsuta Manganese Deposit .....	64
8.3.4	Matthews Ridge .....	65
8.4	Molybdenum .....	66
8.4.1	Exploration Results .....	66
8.4.2	Economic Evaluation .....	66
	References .....	67