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Economic Evaluations in Exploration

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Second Edition

With 68 Figures and 61 Tables

Springer

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To Helgard and Georg,
who asked if I was writing a book about bear hugs

Preface to the Second Edition

This textbook, now in its second English edition, is originally a translation of the German textbook "Rechnen für Lagerstättenkundler und Rohstoffwirtschaftler, Teil 1", also translated into the Chinese and Russian languages. Compared to the previous English and German editions the chapters have been updated with new examples and in many cases amended.

The textbook is intended for the economic geologist who deals with the evaluation of deposits at an early stage of development. Once an exploration project has reached the feasibility stage, the exact calculations that are necessary for a comprehensive technical and economic assessment will be performed by a team of geologists, mining engineers, metallurgists, and economists. In the early stages of exploration, however, any evaluator of deposits must be able to cover the whole spectrum himself.

Since only order of magnitude parameters are available at this early stage, the calculations can only yield order of magnitude results. Precise calculations would even be misleading, since the evaluation does not yet aim at accurate economic assessment but at making the right decision: should the investigation be abandoned or should it be continued at higher costs and with more detailed methods.

Therefore, this textbook offers rules for quick and easy calculations based on the application of approximate data. It hopes to provide both the student and the geologist in the field with a complete set of rules and methods enabling to perform a quick initial evaluation of the deposit without the support of specialists or computers – even if he is left to his own resources. To support the "how to do"-approach all rules for calculations are illustrated with examples. The textbook also points out mistakes and pitfalls the authors encountered when working for the exploration industry or gave seminars.

In addition, it is intended as a compendium. Every calculation can be done by hand or by a calculator. Since cost data vary from country to country, absolute figures are only given as examples, but advice is offered on how to adjust the available data to any particular case.

Ultimately, these calculations do little more than transform initial geological data, like reserves and grades, into a simple economic model that can then be used to decide, before committing further funds to the venture, whether an occurrence of mineralization has, or does not have, the promise of economic viability. This transformation of preliminary geological data into the final economic model is merely a routine mechanical procedure. Of importance is the quality of input which depends on the correct initial geological evaluation of tonnage and grades, reserves and potential! Therefore quality control in sampling and analytical procedures is a crucial aspect in the evalu-

ation of any exploration or mining project right from the start. This aspect is dealt with in the book Wellmer 1998 (Statistical Evaluation in Exploration for Mineral Deposits).

For a project evaluation frequently a geologist has to research data quickly. Here the internet is an invaluable tool. To help to find relevant data quickly often internet addresses are given in the text. In addition in Appendix F relevant possible sources of information with internet addresses are listed.

We should like to acknowledge our appreciation to B. Bognar, Friedberg, Germany and S. Schmidt, Cardiff, UK, who critically read the manuscript and made numerous suggestions for improvements including the spread sheet for density calculations in Appendix C, but shortcomings are, of course, the responsibility of the authors. We also thank E. Gschwindt, Luxembourg, M. Glasson, Perth, Australia, K.-H. Huck, Wolfach, Germany, P. L. Nelles, Bensheim, Germany, S. Schmidt, Cardiff, UK, and A. Schneider, Santiago, Chile, for support in up-dating the rules-of-thumb for interest rates and operating and capital costs, F. Barthel and H. Kaiser for information related to uranium, P. Buchholz, Hannover, Germany for research on various topics, U. and F. Dennert, Hannover for advice on probabilities, E. von der Linden, Dreieich, Germany, for advice on concentrate grades, W. Loer, Essen, Germany for uranium energy conversion factors, K. Stedingk, Halle, Germany, for the information of massive ore shoot grade control in the Grund mine, Germany and Mrs. B. Ogiolda, D. Lohmann and M. Zachcial, Bremen, Germany for information of sea freight rates. For technical support our special thanks are due to Mrs. D. Homberg, Mrs. M. Simon and Mrs. E. Westphale, Hannover.

Friedrich-Wilhelm Wellmer
Manfred Dalheimer
Markus Wagner Hannover, October 2007

Preface to the First Edition

This textbook is a translation of the German textbook "Rechnen für Lagerstättenkundler und Rohstoffwirtschaftler, Teil 1" published by the Ellen Pilger Publishing Company. Those passages in the German edition which were especially written for the German readership were transformed for English speaking readers. Compared with the German edition many chapters have been slightly amended. The main new additions in this English version are the chapter on linear optimization in Chapter 10.2 and Chapter 12 on the comparison of ore deposits.

The textbook is intended for the economic geologist who deals with the evaluation of deposits at an early stage of development. Once an exploration project has reached the feasibility stage, the exact calculations of the deposit, the technical and economic assessment will be performed by a team of geologists, mining engineers, metallurgists, and economists. In the early stages of exploration, however, any evaluator of deposits has to be able to cover the whole spectrum himself.

Since only order of magnitude parameters are available at this stage, the calculations can only yield order of magnitude results. Precise calculations would even be misleading, since the evaluation does not yet aim at accurate economic assessment but at making the right decision: should the investigation be abandoned or should it be continued at higher costs and with more detailed methods.

Therefore, this textbook offers rules for quick and easy calculations based on the application of approximate figures. It hopes to provide both the student and the geologist in the field with a complete set of rules and methods enabling him to perform a quick initial evaluation of the deposit without the support of specialists or computers – even if he is left to his own resources.

In addition, it is intended as a compendium. Every calculation can be done by hand or by calculator. Since cost data vary from country to country absolute figures are only given as examples, but advice is given on how to adjust the available data to any particular case.

Ultimately, these calculations do nothing but transform initial geological data like reserves and grades into an economic unit and decide if an occurrence of mineralisation can be regarded as an economically viable ore deposit. This transformation of preliminary geological data into the final economic unit is merely a routine mechanical procedure. Of importance is the quality of input which depends on the correct initial geological evaluation of tonnage and grades, reserves and potential!

I should like to acknowledge my appreciation to Dres. Bering (Hannover), Gschwindt (Bong Mine, Liberia), Kaiser (Erlangen), Kollwentz (Frankfurt), Sommerlatte (Zug) and Thalenhorst (Toronto) for initially reading the manuscript and making numerous suggestions for improvements, to G. Kater (Sydney) who supplied the niobium-tantalum data in Chapter 5.2., and to Dr. Heide (Meggen) for the advise on the Bond index. My special thanks are due to Mrs. U. Grawe (Melbourne) and Mr. B. Bognar (Frankfurt) for translating the German text into English.

Hannover, Spring 1989 FRIEDRICH-WILHELM WELLMER

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