Preface

This book was initiated by a survey that indicated the limitation of the 1990s literature with regard to published reports of applications of stochastic simulation in the mining industry. Many studies have used numerically simulated grade distributions to evaluate dilution factors, but almost none were published, because of lack of time or perhaps dedication. This statement may fire up those mining geostatisticians who are doing innovative work but did not care about publishing. They owe it to their ingenuity, to their clients if they are consultants, and to their students if they are teachers to document their thoughts and share their experience through publications with substance. Science progresses with wide open disclosure and debate, not with confidential notes or communications to forgettable forums, and certainly not with patented tradecrafts.

This book (re)introduces the concept of stochastic simulation as applied to evaluation of mineral reserves, more specifically evaluation of the impact of the support and information effects on mining dilution. The support effect relates to the difference in size between the volumes of the ore/waste units and the much smaller volumes of rock actually sampled that provide the sample data. The information effect relates to the difference in data quality and quantity between the time of reserves evaluation and that of grade control and actual mining. There are many other aspects of mine planning that affect the recoverable reserves, most prominently data accuracy and correct geological interpretation; these aspects are not covered in this book. Our goal is not to attempt a definitive essay on the science and art of mineral reserves evaluation, but to (re)introduce the stochastic simulation toolkit that provides a numerical framework for estimating many of the factors affecting mining dilution and reserves recovery.

Perhaps a good analogy to convey the potential of simulation is that of a wind tunnel where various designs of an aircraft wing are tested for resistance to turbulence. Our “wind tunnel” is a computer that stores various realizations of the spatial variability of mineral grades; our “aircraft design” is the suite of data acquisition, mine planning, and ore grade control processes that affect profitability; our “turbulence” is the set of unknowns: geological setting, grades, mining dilution, and so forth; and our “resistance” is the robustness of our planned mining operation in the face of all the above uncertainties. Stochastic simulation of mineral grades distribution followed by simulation of mining recovery processes has the potential of testing the adequacy of a mining project and tuning some of its parameters before commit-
ting a lot of time and money. The cost of conducting such a simulation is so minute compared to that involved in developing a new mining venture. We therefore submit that banks and regulatory agencies should require such an exercise before delivering any green light.

Chapter I introduces the aspects of mining dilution that will be addressed with the simulation approach developed in Chapter II. To provide a yardstick for comparison, the traditional volume-variance correction for difference of support volumes is recalled in Chapter III. Short of an exhaustive “real” mining data set, two reference data sets have been generated from actual quasi-exhaustive topographic data in Chapter IV, and the ore selection process has been mimicked on both of them. We have tried to remain as general as possible, documenting methodology rather than presenting real case studies; this explains our decision not to introduce explicit grade units. In Chapter V, the proposed simulation approach is applied to the previous reference data sets. The availability of an exhaustive reference, which is sparsely sampled to mimic actual mining data, allows comparison of predictions with actual reference values. In Chapter VI, the volume-variance correction algorithm is applied to the same sample data used in the simulation approach. In Chapter VII, some conclusions and recommendations are suggested.

All the data (reference and sampled) used in the case studies of this book can be downloaded over the Internet from the following Web site:


All kriging and stochastic simulation programs used can be found in the Geostatistical Software Library.

Finally, we would like to acknowledge the many friends who reviewed the numerous preliminary drafts of this book: Clayton Deutsch, Roussos Dimitrakopoulos, Jaime Gómez-Hernández, Pierre Goovaerts, Sia Khorowshahi, Ricardo Olea, Harry Parker, and Mohan Srivastava. This book could not have been written without their help; their numerous constructive criticisms indicate that the book shortcomings are ours only.