
Geological Factor Analysis

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In geology, most problems involve multiple components. Factor analysis is one of the statistical techniques for examining the intrinsic relationships of inherently multivariate data.

The book, *Geological Factor Analysis*, is a joint effort by three scientists of different professional disciplines. The senior author is a statistician well known for his work in various factor solutions. The other two authors are geologists with wide experience in the applications of factor analysis in geology.

Chapter 1 begins with a hypothetical mining problem to illustrate the possible application of factor analysis in geology. Chapter 2 describes the basic mathematical and statistical concepts which will be used in factor analysis. The role of matrix algebra in factor analysis is clearly introduced. Chapter 3 explains aims, ideas, and models of factor analysis. Without knowledge of the multivariate distribution of the variables and the sampling scheme, results of factor analysis can only be applicable to the sample, and not to the population. This concept is usually ignored by users. Principal component analysis is distinct from factor analysis, and their differences are authoritatively discussed. Factor pattern and simple structure are also explained.

In Chapter 4, mathematical procedures for principle component analysis and 'true' factor analysis (a new but inadequate term) are discussed. The 'true' factor analysis includes a number of solutions such as principal factor, canonical factor, generalized least squares and maximum likelihood solutions. The last three solutions are not widely applied to geology. The merits of R-mode factor analysis are not adequately discussed in the single example given in Table 4 IV. What it did

with the factor loadings was to work on whether the loadings are positive or negative, and large or small. Interpretations from the analysis can be obtained by close examination of the correlation matrix (Table 4 IVa). The end-member concept plays an important role in geological data analysis. Q-mode factor analysis, designed for seeking end-members and natural groupings from a set of objects, is illustrated in Chapter 5. Comparisons of the Q-mode method, correspondence analysis and principal coordinates are discussed with one set of artificial data. In Chapter 5 and 6, the term 'principle component analysis' as defined in Chapter 4 is replaced by the term 'factor analysis'.

Chapter 6 gives an excellent presentation of the steps in factor analysis with a minimum of detailed mathematics. It will be of interest to those who wish to use the method, but are not interested in the mathematical foundations involved. The role of multivariate normality in the analysis deserves a greater discussion instead of reference to other papers. Geologists who wish to apply the technique to their work are recommended to read this chapter.

The last chapter cites eight published examples demonstrating that the technique can be used to solve many types of problems. Each example begins with a statement of the problem, followed by materials of the study, methods, and interpretations. In Section 7.6, an example is given to demonstrate one way of using the factor loadings for further numerical work, although the statistical assumption required has not been verified. The chapter is concluded by an overview of geological problems amenable to treatment by factor analysis.

In general, this book emphasizes computational steps, but does not provide enough real examples from which readers can walk through interpretations and gain experience from the authors. When the technique is applied to spatial or time series data, the nature of oblique factors has not been adequately discussed. In line 26 of page 59, the word 'factors' should be replaced by 'components'. This book does not have an index, and errors occur in references.

What is geological factor analysis? The answer is puzzling. On the whole, the book discusses application of factor analysis (principal component analysis in the sense discussed in chapter 4) in geology.

The book is a valuable reference for geologists from research organizations or industry with an elementary level of statistics. The high price, however, limits its use as a text book.

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Books Received

Muskeg and the Northern Environment in Canada,

edited by N. W. Radforth and C. O. Brawner (University of Toronto Press, 399 p., 1977, \$35.00). This is a compendium of papers presented at the 15th Muskeg Conference held in 1973. The book reviews what is known and draws attention to limitations in knowledge pertaining to muskeg in Canada.

Supplementary Metric Practice Guide

(for the exploration-production-gas processing-pipelines-oilsands sector of the Canadian petroleum industry, Second Edition 1977), edited by Peter Moore (published by Canadian Petroleum Association, 625, 404 Sixth Ave. S.W., Calgary, Alberta T2P 0R9, \$15.00, 1977)

The Newfoundland Journal of Geological Education

(A semi-annual publication for students of earth science by the Newfoundland Section of the GAC). Available free of charge from: Dr. R. V. Gibbons, Mineral Development Division, Department of Mines and Energy, 95 Bonaventure Ave., St. John's, Newfoundland A1C 5T7