



**A COMPUTER-BASED PROCEDURE FOR QUANTIFYING GEOLOGICAL DATA
FOR RESOURCE ASSESSMENT**

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INTRODUCTION

A computer-based procedure is described for quantifying geological data as a prelude to resource assessment. The method involves: (1) digitizing geological data, and (2) a series of programs to make quantitative estimates of areas and distances with geological significance. Procedures described are general in nature but in our immediate case are being applied to the Guichon Creek batholith (including the Highland Valley porphyry copper area) as a basis for resource assessment.

A common method of coding geological information for inclusion in quantitative resource assessment and exploration modelling is to superimpose a square grid on a geological map and record characteristics pertaining to each cell of the grid (see Agterberg, 1981). Such a procedure has been used by Kelly and Sheriff (1969) in their efforts to outline 20 mile by 20 mile cells in British Columbia, having a high mineral potential. At a different scale Sinclair and Woodsworth (1970) coded geological information from the Terrace area relative to a grid with a cell size of 2 miles by 2 miles. In a direct application to porphyry copper evaluation, Godwin and Sinclair (1979) developed a file of geological, geochemical, and geophysical data for the Casino porphyry copper-molybdenum deposit, Yukon Territory, relative to 400 foot by 400 foot cells of an exploration grid on the property. All the foregoing studies and many other comparable investigations have been directed toward a quantitative approach to resource evaluation in which some measure of value of a cell is related to geological and other variables coded for that cell. Types of geological variables recorded are generally found in the following categories:

- (1) percentage of a cell underlain by a particular rock type,
- (2) distance from cell centre to a specific geological feature,
- (3) spatial density values, for example, fracture density,
- (4) lengths of contacts, fractures, etc., in a cell, and
- (5) (projected) absolute areas of nearest specific rock units, etc.

Two problems in a manual approach to coding of geological information for cells of a grid are: (1) it is tedious and time-consuming, and (2) manual methods are prone to mechanical errors, many of which are not readily identifiable in normal editing procedures. To overcome these problems we have developed a computer-based approach for the estimation of geological and other variables for cells of a grid. This work is a prelude to a quantitative resource assessment of the Guichon Creek batholith and early results of this study will provide examples of our procedure.

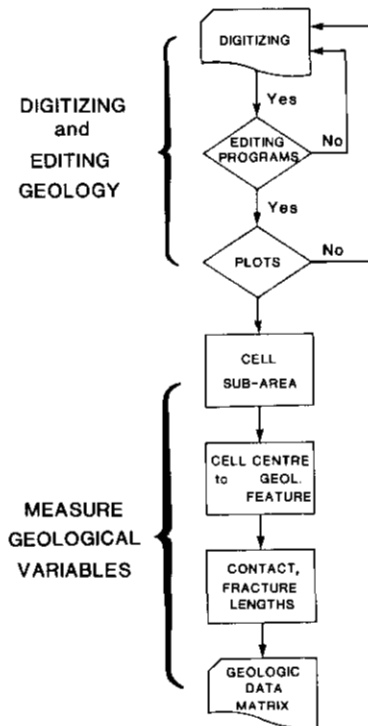


Figure 99. Flow chart illustrating the general computer-based system for generating a file of quantitative geological measurements as a prelude to resource assessment.

PROCEDURE

Our general system, as outlined in the flow chart on Figure 99, includes two main elements:

- (1) digitizing and editing of map information, and
- (2) development of a series of subroutines to make measurements relative to an arbitrary grid and digitized data.

The principal advantages of the methodology are its consistency and the ease with which a variety of editing procedures can be employed. An important feature is that new combinations of variables can be obtained rapidly if information is digitized, whereas normal methods would require an additional tedious effort of measurement. Perhaps most important is the fact that sensitivity of cell size on resource assessment is more feasible with a computer-based as opposed to a manual approach.

DIGITIZING GEOLOGICAL INFORMATION

The digitizing procedure is illustrated with reference to the Guichon Creek batholith resource assessment study. All phases and varieties of batholithic rocks were digitized using Preliminary Map 30 (B.C. Ministry

of Energy, Mines and Petroleum Resources, McMillan, 1978) which contains the most detailed and up-to-date geological information available on the scale of the entire batholith. The digitizing procedure was to outline each separate area of a given phase by a closed polygonal outline with as many points as necessary to honour the level of detail of the base map. Very small areas of younger or older rock were ignored.

Editing of digitized data involves a variety of procedures including: (1) separating digitized polygons with end-of-polygon flags, (2) collecting polygons representing the same geological unit into a single file, (3) closing the polygons, (4) reversing polygons if necessary so that all are digitized in consistent fashion (for example, counterclockwise), and (5) deletion of incorrect points in a polygon. The digitized polygons were then placed in a number of separate files, one for each geological unit and machine-drawn maps were prepared for each unit as a final editing step (Fig. 100). These maps were produced to the same scale as the base map and were compared visually (using a lighttable) with the base map.

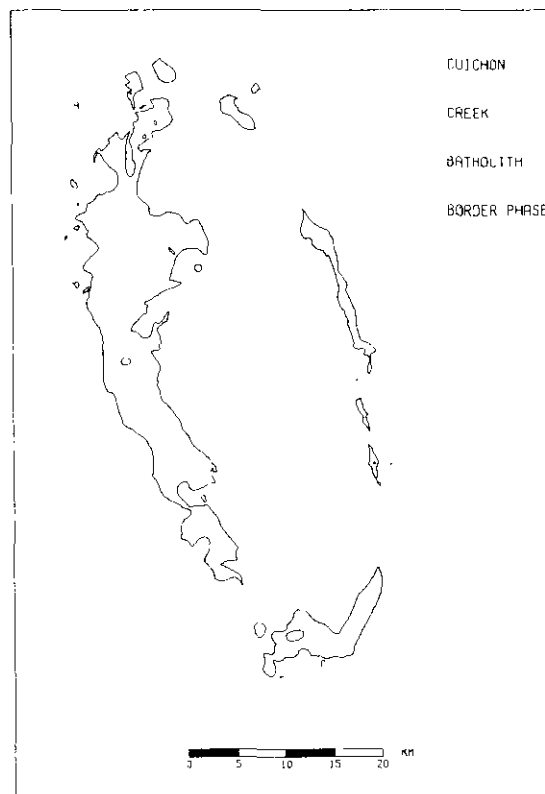


Figure 100. Computer-controlled plot of digitized areas underlain by the Border phase of the Guichon Creek batholith, central British Columbia. An 'A' near the northwestern corner of the map is centred on Ashcroft and a 'C,' just below the southernmost exposure, is centred on Craigmont pit. Data digitized from McMillan (1978).

MEASUREMENT OF GEOLOGICAL VARIABLES

Our computerized approach to resource assessment in which geological variables are referenced to systematic grid cells, depends on a series of computer programs designed to measure geological variables (Fig. 99). Some of the procedures are described briefly to illustrate the nature of variables that can be measured and to give some indication of the potential wide range of applications of our computerized approach.

- (1) Within cell area measurements. A grid of stipulated cell size is superimposed on a 'map' of single rock category and the proportion of each cell underlain by the rock type is calculated. The procedure used for one geological unit is to move systematically along each polygon recognizing the intersections with grid cell boundaries. The part of a cell area within a polygon is then determined. After all polygons have been treated in this manner, a set of cells remains for which no area estimates have been made. They are checked systematically and if the cell centre is within a polygon, an area of 100 per cent is assigned; otherwise an area of zero is assigned. If there are islands of other rock types within a polygon, the area occupied by these is subtracted automatically. The result is a file of the per cent of area of each cell underlain by a specific rock type. Repetition of the process for other rock units results in a quantitative file of geological 'areas' per cell.
- (2) Length of contacts (dyke, fracture, etc.) in a cell. Variables of this type are very straightforward to calculate from digitized contacts. Each polygon is examined and its intersection with grid cell boundaries used to define a segment of a polygon in which point-to-point distances will be summed to provide a length.
- (3) Distance from cell centre to a specific geological feature. This process involves checking whether a cell centre is within or outside the limits of a particular geological feature. If the centre is not enclosed in polygons of a particular geological feature, then the shortest distance from the cell centre to the nearest part of the nearest polygon is determined.

Programs to accomplish the foregoing types of measurement include the majority of variable types outlined in the introduction. Other useful types of quantitative measurements can be added as desired. We are presently generating a quantitative data base for the Guichon Creek batholith using a cell size of 2.59 square kilometres (1 square mile). This up-to-date geological data base will be merged with our existing file for geophysical and geochemical data based on the same grid size, and will provide the fundamental information for a resource assessment in the Guichon Creek batholith.

CONCLUSIONS

A computer-based approach to the quantitative measure of geological variables as a base for resource assessment has been established. The procedure involves two major components: (1) digitizing of geological features, and (2) a variety of programs designed to extract quantitative measurements of geological variables relative to cells of a reference grid. A variety of editing procedures are built into the system.

We are presently applying the procedures to an assessment of resources in the Guichon Creek batholith (including the long established porphyry copper area of the Highland Valley). Of course, the procedures and software are general in nature and potentially have much wider application not restricted to geological variables.

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REFERENCES

- Agterberg, F. P. (1981): Cell Value Distribution Models in Spatial Patterns Analysis, in *Future Trends in Geomathematics*, R. G. Craig and M. L. Labovitz, editors, *Pion Ltd.*, London, England, pp. 5-28.
- Godwin, C. I. and Sinclair, A. J. (1979): Application of Multiple Regression Analysis to Drill-Target Selection, Casino Porphyry Copper-Molybdenum Deposit, Yukon Territory, Canada, *Trans. Inst. Min. Met.*, Sec. B, pp. B93-B106.
- Kelly, A. M. and Sheriff, W. J. (1969): A Statistical Examination of the Metallic Resources of British Columbia, in *Proceedings of a Symposium on Decision-Making in Mineralization Exploration II*, A. M. Kelly and A. J. Sinclair, editors, Extension Dept., *University of British Columbia*, February 6, 7, 1969, pp. 221-243.
- McMillan, W. J. (1978): Geology of the Guichon Creek Batholith and Highland Valley Porphyry Copper District, British Columbia, B.C. *Ministry of Energy, Mines & Pet. Res.*, Prelim. Map 30.
- Sinclair, A. J. and Woodsworth, G. J. (1970): Multiple Regression as a Method of Estimating Exploration Potential in an Area near Terrace, British Columbia, *Econ. Geol.*, Vol. 65, pp. 998-1003.

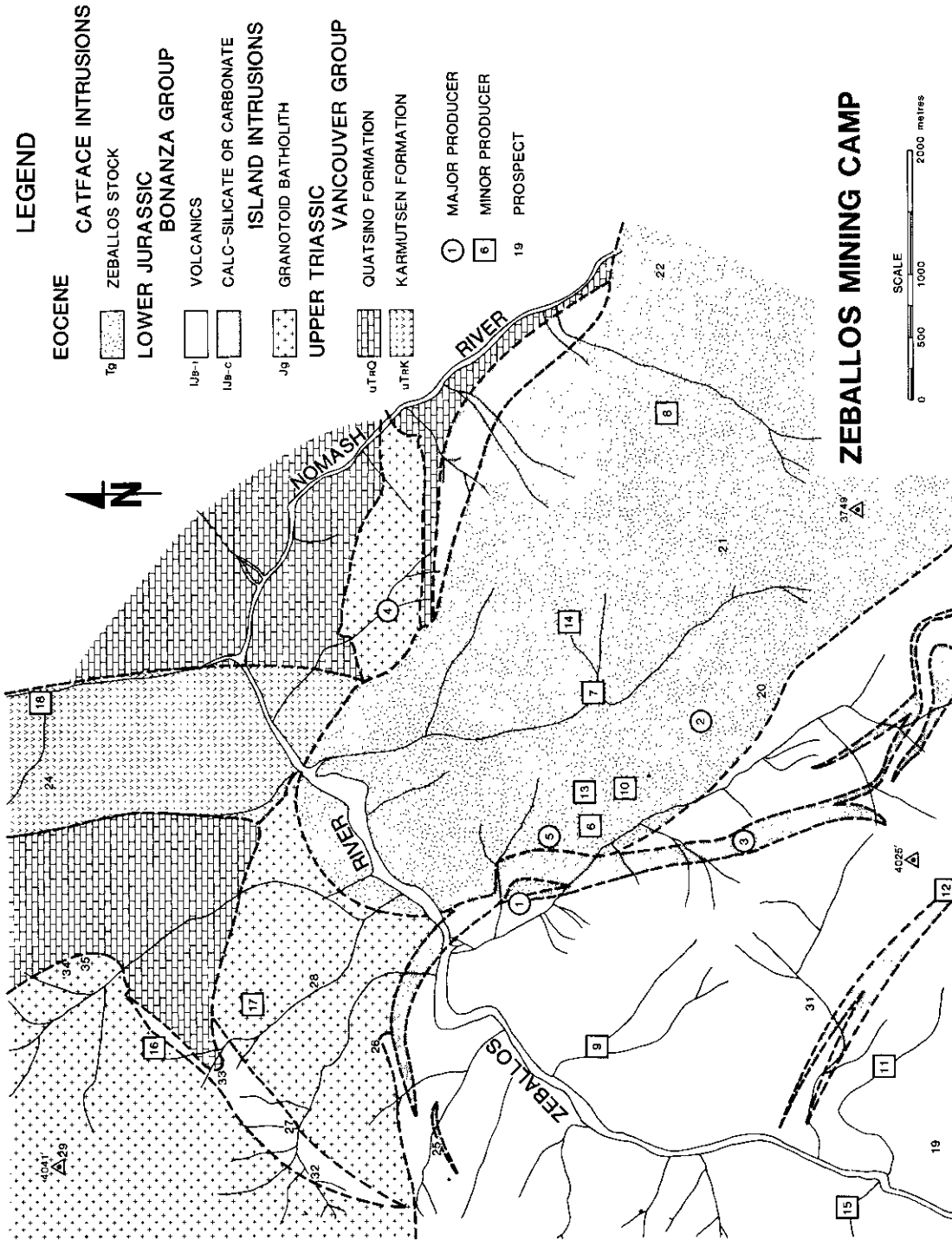


Figure 101. General geology and location of recorded mineral occurrences and past producers, Zeballos mining camp (after Stevenson, 1950).