



## Computer Applications in Mineral Exploration 1984

N. Gow  
100 Quebec Ave., #805  
Toronto, Ontario  
M6P 4B8

J.A. McCance  
113 Hendon Ave.  
Willowdale, Ontario  
M2M 1A6

Computers continue to affect fundamental exploration practice. The recent conference, Computer Application in Mineral Exploration (C.A.M.E.) 1984, provided an excellent opportunity for dialogue between (1) exploration personnel interested in the recent advances in the applications of computers; (2) user groups employing the presently available computer tools; and (3) those at the leading edge of exploration and computer technology.

The conference was international in outlook, with a significant number of registrants and a number of exhibitors from outside Canada. The successful organization of the conference in the few months available reflects the teamwork and commitment between the Organizing Committee and the five Toronto-based geoscience organizations which sponsored C.A.M.E. 1984. The driving force in arranging this conference was Terry Bottrill, who acted as Chairman of the Organizing Committee. Other members of the committee were Pat Sheahan, Konsult International Ltd.; Sandy Colvine, Ontario Geological Survey; Dave Jones, MPH Consulting Ltd; and Victor Wierzbicki, Consultant. The resources which were essential to the successful organization of the conference were provided by the Toronto Geological Discussion Group (Ray Goldie, rep); the Canadian Exploration Geophysical Society, KEGS (Zbynek Dvorak, rep); the Toronto Branch of the CIM (Alan Coope, rep); the Association of Exploration Geochemists (Bob Garrett, rep); and the Mineral Deposits Division of the Geological Association of Canada (Sandy Colvine, rep).

Organized into two parts, the conference included an exhibition and a series of lectures extending over one and a half

days. These were intended to introduce and highlight the poster sessions, displays and hands-on demonstrations prepared by thirty-one exhibitors. Of these exhibitors, nine represented university or government and affiliated provincial, federal or international research institutes, twelve represented Canadian geophysical manufacturers, contractors and consultants and the remaining ten exhibitors represented a variety of private enterprise endeavours in specific applications, including the fields of geochemistry, remote sensing, satellite image processing and data presentation and graphics.

The exhibits provided a major attraction, permitting delegates a great opportunity to review and discuss updates of our "conventional systems" in exploration technology.

The government and affiliated research groups continue to demonstrate their efforts to collate data in their files. The Gold Database and Mineral Deposit Inventory Database of the OGS, for example, and the Minsys Database of the EMR were displayed, respectively, as a hands-on demonstration and as a poster session. The recent work by these organizations in the bibliographical and informational database field has produced useable, easily accessible and flexibly formatted data that are available to groups of all sizes in the exploration community. Few companies can afford the pioneering efforts undertaken by these groups to develop these types of databases, and the work of government in laying a foundation of basic information for more scientific exploration continues to be appreciated.

The companies and other research groups involved in the collation and enhancement of remotely sensed data presented several systems now available to user groups which have previously only been available to large companies making very significant commitments in time and money for the purpose. These systems will become more essential as larger amounts of data are inventoried and the field explorationist finds the need to integrate large quantities of data from various phases of prior or ongoing exploration into targeting criteria.

Geophysical exhibitors demonstrated several of the new data acquisition systems and procedures which are readily becoming cost-effective field aids. Details of these highly sophisticated equipment packages developed by several manufacturers are beyond the scope of this article but are routinely reviewed in Peter Hood's annual review "Mineral Exploration: trends and developments" (see Canadian Mining Journal, January 1984). The "know-how" in the use of these systems was ably demonstrated with staff from Aerodat Ltd., Ques-

tor Surveys Ltd. and Dighem Ltd., who presented recent results and examples of both processing routines and model studies undertaken in a variety of airborne applications. Computerized ground geophysical systems involving the latest magnetometer devices and induced polarization instrumentation were demonstrated by E.D.A. Instruments Inc., Exploranium, Hunttec (78) Ltd. and Phoenix Geophysics Ltd. Similar state-of-the-art demonstrations in the treatment of geochemical data were exhibited by O.P. Lavin and Associates, Energy, Mines and Resources, and X-Ray Assay Laboratories Ltd. Lastly, MPH Consulting Ltd. and Derry, Michener, Booth and Wahl Ltd. demonstrated their capacity to supply integrated, computerized acquisition and interpretation services in the field.

Displays of graphics software illustrated some of the newer products available from such companies as DataPlotting Services. These techniques make data clearer, and aids such as "shadow" colouring of contour data were displayed. Efforts to make these graphics packages available for field usage, using microcomputers, were presented by a number of other exhibitors.

The lecture series was well attended. The talks were opened by Bill Houston of Systemhouse Ltd., who gave an overview of the impact of microcomputers on exploration. His talk highlighted several problem areas for explorationists and a suggested procedure for systems selection. Particular problem areas include the limited availability of off-the-shelf software for exploration-oriented applications, the substantial costs of software development and the incompatibility of some software and hardware options. These problems were addressed, with further solutions offered by many of the latter speakers.

A group of talks under the heading "Bibliographical and Information Databases" followed. Michael Scott of the Metals Economic Group discussed his company's "Minersearch Database". The system allows companies the opportunity to access a large amount of timely information concerning the U.S. mineral industry. James Macdonald of the OGS discussed the Survey's use of microcomputers as on-site aids to geological mapping and also discussed the various information databases assembled by the OGS. The next speaker, Eugene Garfield of the Institute for Scientific Information, spoke of the systems developed by the Institute to allow on-line information searches. Their use of "co-citation" clustering offers a new and valuable tool to all earth scientists (including explorationists). This technique allows a paid and complete search of the geological literature to retrieve references on specific topics.

The second session of talks covered "Satellite Image Processing". The two papers by Harris *et al.* and Aronoff *et al.* were complementary. The first dealt with the problems of developing techniques of data handling for remote sensing and of developing other techniques that would give results acceptable to the exploration industry. The benefits of systems similar to the Geological Analysis Aid Package (GAAP) and Multiple Co-Registered Data Sets offers explorationists a method of handling and assessing large amounts of data quickly. The second talk, by Aronoff of DIPIX Systems Ltd., dealt with the methodology to digitize geological information and the use of processing to refine data. Simsek Pala of the Ontario Centre for Remote Sensing discussed case histories of the use of satellite data in mineral exploration.

In the "Geophysical Field Techniques" session, three speakers demonstrated advances achieved in the use of fully computerized field equipment, while others introduced state-of-the-art developments in geophysical interpretation routines and graphic presentation formats. Dave Jones of MPH Consulting Ltd. gave clear examples of the new data acquisition, enhancement, presentation and interpretation capabilities provided during routine magnetic surveys, gravity surveys, electromagnetic surveys and induced polarization surveys. While some limitations still exist, it was apparent that a major advance in the use of complex calculations in the field has been achieved. This use of microcomputers in providing a high degree of infield processing and verification flexibility was also the topic of Ian Johnson of Scintrex Ltd. in discussing the application of induced polarization and Luminex technology in different exploration areas and in gold search tactics. John Baird, Scintrex Ltd., discussed the philosophy behind the IGS Integrated Computer Compatible Ground Geophysical System. Simplicity of field operation and economy in acquisition, processing and presentation are easily quantified in using the IGS system, as it is now possible to undertake multisensor ground surveys which eliminate the need for repeat traverses.

A similar discussion on the state-of-the-art use of intelligent menu driven software in a dedicated airborne data acquisition system, the UDAS 100, was presented by B. Pavlik, Urtec Ltd. Some problems in the standardization of software for the purpose of integrated information transfers remain in these systems. Lastly, S.W. Reford *et al.* of Patterson, Grant and Watson Ltd. introduced new computer software to permit geophysical interpretation schemes to keep pace with the increased accuracy and quantity of survey data. Two inversion

programs for multichannel electromagnetic interpretation and others used in the calculation of complex subsurface distributions of magnetic susceptibilities were reviewed. An interpretive presentation technique for improved analysis of subtle trends in gamma spectrometry results also was presented. The ability of the new micro-computer technology to provide flexible access to minicomputer and mainframe service bureaus for the purposes of large scale data presentation and interpretation was well demonstrated by these talks.

Four talks were presented under the heading "Data Presentation - Graphics". Wilf Parker of DataPlotting Services spoke of the routine applications of graphics in mineral exploration and the services offered by DataPlotting. Mary Ann Roberts of GEOMIN Computer Services Corporation discussed the systems offered by that Company. Pearson and Watt of Derry, Michener, Booth and Wahl, and Markham Data Inc. discussed the use of a TRS-80 Model 100 microcomputer in field applications using standard communications links between field and office. To complete the first day's talks, Bob Garrett of the GSC spoke of a new use of graphics that had been developed by the Survey to assist geochemical interpretation.

The first session of the second day, "Geochemical Techniques and Processing", was opened by Luciano Martin, who discussed some practical considerations for computer use in exploration geochemistry. Bonham-Carter and Goodfellow of the GSC discussed a mathematical method for evaluating stream geochemical data and used results from the Selwyn Basin area of the Yukon as an example. John Sirinuas of MPH Consulting Ltd. spoke of micro-computer methods developed by MPH to treat litho-geochemical data. Owen Lavin of O.P. Lavin and Associates spoke of the principles involved in the use of computers in treating geochemical data. In particular, his talk emphasized the time and cost of computer processing and analysis relative to sample collecting and assay costs. A discussion of Q'Gas and other computer programs offered by his company was left to his exhibit.

In the final session, "Geological Modelling, Integrated Systems", Peter Kowalczyk of Placer Development Ltd. discussed the problems encountered and the success achieved in the introduction of microcomputers in exploration within Placer. In particular, Peter emphasized the controlled distribution of programs to different offices and the efforts to standardize software and hardware between offices. It is considered that Placer has an enviable position in our industry because of this commitment to fundamental changes involving computers. Champigny *et al.* of International Geo-

systems Corporation discussed their GEOLOG System and described its use in regard to the Schaft Creek deposit in Northern British Columbia and the Rich Gulch deposit in California. Jean Marc Belisle of Geostat Systems International Inc. spoke of his company's experiences in downloading large programs from a main frame computer to a microcomputer. Finally, Eric Weiland of Computing Association International spoke of their Earth Science Information System (ESIS), an integrated system for the effective handling of exploration data.

In addition to the technical talks, there were two presentations given during the conference lunches. The first was by Mike Horder of BP Minerals International Ltd., who spoke of his ideas on the use of computers in the corporate structure and, in particular, of his concept of an information centre. The second talk was presented by Bill Green of Placer Development Ltd., who spoke of Placer's success in introducing computer technology in the exploration department. The differences in corporate size have clearly affected the approach of each of the two companies to the introduction of computers, and this was well demonstrated by both speakers.

A number of general conclusions could be drawn from the discussions and displays at the conference. First, it is apparent that there are three basic reasons for the continued application of computer technology in the years ahead: a) reduction in costs through the automation of manual functions; b) increased timeliness of results and the attendant efficiencies in the allocation of time, money and effort to routine exploration projects; and c) the development of more comprehensive and integrated databases and expanded interpretation capabilities through modelling and data analysis. Secondly, the amount and method of computerization will vary from company to company depending on the size and specific requirements of each of the organizations. In larger companies the ability to pass tasks through a hierarchy of computers to a head office main frame appears to offer great flexibility with data treatment and graphics. Thirdly, it is clear that ongoing developments will make available in the foreseeable future a comparable system acceptable to small companies and individual consultants. This will involve, with time, improvements in hardware and software and may involve the formation of cooperative work-sharing networks as an alternative to independent practice for the smaller companies and consultants.

A disappointment at the conference was the reticence of many of the speakers to discuss the cost effectiveness of their products in understandable terms. Such discussion is necessary before the majority

of explorationists will commit the necessary funding for the installation of computer systems into routine exploration programs. Similarly, the presentation of more case histories, including the application of computers in successful exploration ventures, will prove to be the best recommendation for their further use.

The conference provided an excellent opportunity for members of today's exploration community to become familiar with the current applications of computers in exploration and with the systems designed and developed by companies and by the government. Because of the fundamental changes in managing exploration activities embodied in computerization and the rapidly changing software and hardware available in microcomputing endeavours, it seems necessary to maintain the dialogue initiated by C.A.M.E. 1984. To this end, tentative plans are under discussion to hold a similar conference in Toronto in 1986.

For those who were unable to attend the conference, copies of the excellent seventy-six page Program and Extended Abstracts volume are available for \$10.00 Cdn. (pre-paid, postage and packing included) from Patricia Sheahan, Konsult International Inc., 44 Gemini Road, Willowdale, Ontario M2K 2G6. This volume covers the conference in far greater detail than is possible in this report, and its purchase is recommended.

## Geological Association of Canada Special Paper 26, 451 p. & maps.

# Glacial Lake Agassiz

Edited by J.T. Teller and Lee Clayton

For thousands of years, Lake Agassiz was the largest lake in North America, and deposits extend over nearly a million square kilometers of central North America. Sedimentation, from the Great Lakes and St. Lawrence region to the Gulf of Mexico to the Arctic, was influenced by Lake Agassiz.

This new book provides an overview of Lake Agassiz, summarizing all major aspects of the lake - its history, stratigraphy and post-glacial legacy. A large colored map of the lake and related glacial margins is included. Each chapter is a synthesis of a particular major component of the lake and is written by one or more of the recognized experts.

### Contents

#### Introduction

- 1 An Introduction to Glacial Lake Agassiz  
*J.T. Teller and Lee Clayton*
- 2 Geological setting of the Lake Agassiz Region  
*J.T. Teller and J.P. Blumie*
- 3 Lake Agassiz-Discovery and a Century of Research  
*J.A. Elton*
- 4 Maximum Extent and Major Features of Lake Agassiz  
*J.T. Teller, L.H. Thorpe, L.A. Dredge, H.C. Hobbs and B.T. Schreiner*
- 5 Quaternary Stratigraphy and History in the Southern Part of Lake Agassiz Basin  
*M.M. Fenton, S.R. Moran, J.T. Teller and Lee Clayton*
- 6 Lake Agassiz in Saskatchewan  
*B.T. Schreiner*
- 7 Lake Agassiz and the Late Glacial History of Northern Manitoba  
*R.W. Klassen*
- 8 Character and Development of Northern Lake Agassiz and its Relation to Keweenaw and Hudsonian Ice Regimes  
*L.A. Dredge*
- 9 Paleocology of the Southern Part of the Lake Agassiz Basin  
*A.C. Ashworth and A.M. Cavers*
- 10 Paleocology of the Central and Northern Parts of the Glacial Lake Agassiz Basin  
*J.C. Rucher*
- 11 Inlets and Outlets  
*The Sheyenne River: Its Geological History and Effects on Lake Agassiz*  
*J.A. Brophy and J.P. Blumie*
- 12 Late Wisconsinan Floods and Development of the Souris-Pembina Spillway System in Saskatchewan, North Dakota, and Manitoba  
*A.E. Kehew and Lee Clayton*
- 13 Assiniboine Delta and the Assiniboine-Qu'Appelle Valley System - Implications Concerning the History of Lake Agassiz in Southwestern Manitoba  
*R.W. Klassen*
- 14 River Warren, the Southern Outlet to Glacial Lake Agassiz  
*C.L. Matsch*
- 15 Drainage Relationship of Glacial Lake Arcton and Upham and Early Lake Agassiz in Northeastern Minnesota  
*H.C. Hobbs*
- 16 The Lake Agassiz-Lake Superior Connection  
*J.T. Teller and L.H. Thorpe*
- 17 Chronology of Lake Agassiz Drainage to Lake Superior  
*Lee Clayton*
- 18 Correlation of Glacial Lakes in the Superior Basin with Eastward Discharge Events from Lake Agassiz  
*C.W. Drexler, W.R. Farrand and J.D. Hughes*
- 19 Holocene Climate and Hydrology of Lake Manitoba  
*W.M. Last and J.T. Teller*
- 20 The Origin of Reticulate and Orbicular Patterns on the Floor of Lake Agassiz  
*J.D. Mallard*
- 21 Postglacial Peatlands of the Lake Agassiz Plain, Northern Minnesota  
*H.E. Wright and P.H. Gleser*
- 22 Postglacial Dispersal of Lower Vertebrates in the Lake Agassiz Region  
*K.W. Stewart and C.C. Lindsay*
- 23 Paleo-Indian Prehistory of the Glacial Lake Agassiz Region in Manitoba, 11,500 to 6,500 B.P.  
*L.F. Pettigrew and A.P. Buchner*

NOW  
AVAILABLE