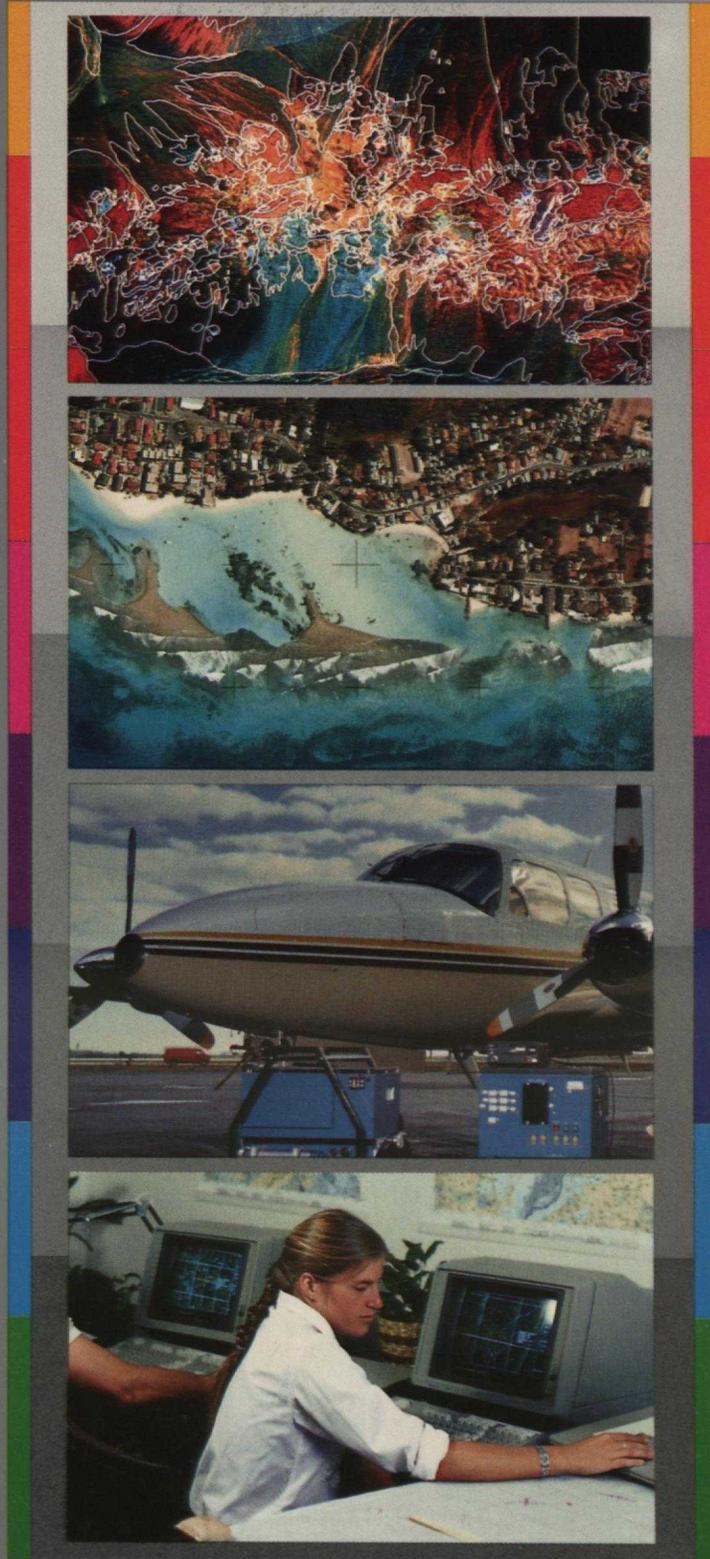


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# REMOTE • SENSING

## PRODUCTS AND SERVICES FOR WORLD MARKETS



Canada

For further information concerning remote sensing technology, products and services, please contact:

Advanced Technology Market  
Development Division (TTT)  
Department of External Affairs  
125 Sussex Drive  
Ottawa, Ontario  
Canada K1A 0G2  
Telex: 053-3745 TTT

Printed in Canada, 1987

At Expo '86, Canada welcomed the world and showcased Canadian leading-edge remote sensing technology. ▶

# REMOTE • SENSING

## PRODUCTS AND SERVICES FOR WORLD MARKETS

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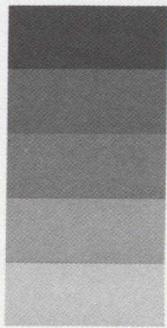


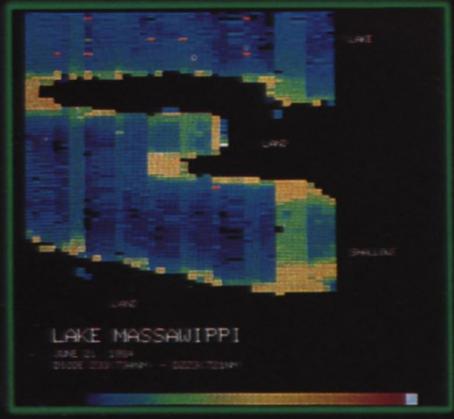
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Canada is a world leader in the development of new technologies for remote sensing. The fluorescence line imager is an outstanding example.\*

\*Reproduced with permission of the Department of Fisheries and Oceans.

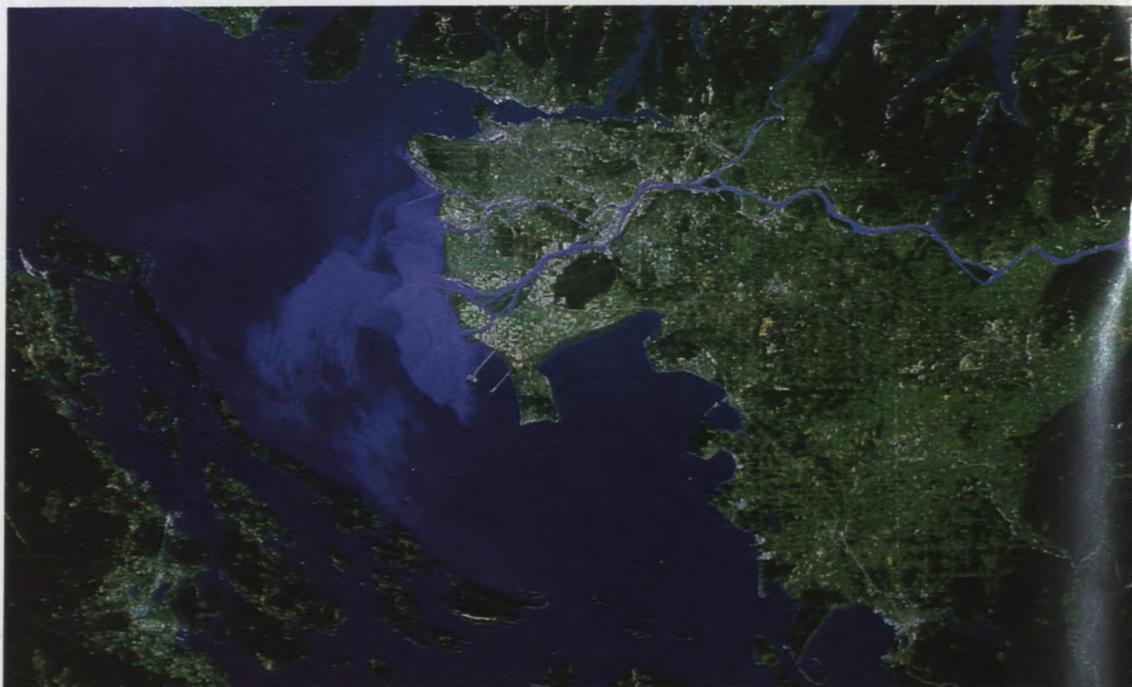
Remote sensing by airborne and satellite collection systems, a means of observing and measuring the environment, is an essential method for managing vital resources everywhere in the world. With this tool, environmental changes can be monitored for applications such as crop and forest management, land-use planning and water resource control.

The instruments carried aloft by earth observation satellites and aircraft are capable of doing what the human eye and ordinary photography cannot. They can gather information instantly from vast areas of land and water, from great heights, in all weather conditions. And these instruments — cameras, infrared scanners, lasers and radars — produce images in such detail that planners and resource managers now have new capabilities to analyze, evaluate, compare and make decisions.

Canada is a leader in the development of this advanced technology and in the design and manufacture of systems for its application. Much of Canada's effort is aimed at making the technology affordable and accessible to decision-makers in developing countries.

This guide outlines Canadian capabilities — in industry and in government, and in the two working together. It introduces the reader to Canadian firms that can provide the latest in advanced equipment to solve the most challenging problems in remote sensing technology.

With its background in research and development, its practical experience in providing systems to suit diverse clients, its skills in training and education, Canada offers technology and expertise that are appropriate, applicable and affordable.



**Capable and experienced  
... throughout the world**

Private remote sensing companies in Canada have sharpened their skills and technologies during a generation in which they have risen to the challenge of finding, developing and managing this country's vast natural resources.

Forty years ago, large areas of Canada had still not been surveyed in detail. At that time the Canadian government made a crucial decision: it contracted out to newly forming private firms the task of aerial photographic surveying of most of the millions of square kilometres of Canada's land mass. Equipped only with the technology left over from wartime operations, Canadians, like other nations entering new eras of discovery, created their own particular expertise, moving from a standing start to the top of this new field.

A domestic industry was built on that government decision, and beginning in the 1950s, Canada became the first country to export its newly acquired technologies, techniques and services to more than 100 other nations throughout the world. Since that time, Canada has been in the forefront of developing airborne sensors, satellite data ground stations, data processing and image analysis technologies since the launch of the first U.S. TIROS weather satellites in the 1960s and LANDSAT earth resources satellites in the 1970s. Canadian companies are now among world leaders in manufacturing equipment for gathering and interpreting remote sensing data.

With the coming of the "space age" and new ways of "looking" at the earth, Canada became the third nation in the world with the capabilities and determination to design and build its own communications satellites and the instruments they carried.

**LANDSAT-5 image of Vancouver, Canada, processed on the MacDonald Dettwiler MERIDIAN System.**

Holding these key skills, Canadians have become international leaders in airborne and spaceborne technologies.

In Canada, remote sensing is being used to manage the country's extensive resources and to monitor environmental changes. It has taken ingenuity and adaptability to the difficult climatic conditions and varied terrain of Canada to develop the efficient systems, installations and services that Canadian firms now offer to the world.



### Essential tools and services

Remote sensing systems and services are the tools for resource managers to do their jobs more efficiently, less expensively and faster than ever before, and also to carry out tasks previously thought impossible. Above all, these tools provide planners and managers with the accurate and up-to-date information needed for analysis, interpretation, forecasting and making the right decisions.

### Information power at your service

The products and services of Canadian companies have put "information power" at the service of national needs in agriculture, forestry, fisheries, exploration, freshwaters and oceans, land-use monitoring and environmental management of all types.

Those same systems, products and services, adapted to local needs and accompanied by the necessary training, have been bought by governments and corporations in countries worldwide. As well, Canada's international aid programs have offered these new capabilities to dozens of nations whose resource needs are sometimes overwhelmed by their economic circumstances.

"Made in Canada" equipment and services have also been tested and proven in international markets in developed countries with advanced technologies of their own. Canadian firms are successful in the United States, Europe and throughout the Pacific, as well as in developing nations in Africa, South America and Asia. This book highlights some of the outstanding Canadian achievements in remote sensing technology and provides details of individual companies' capabilities and performance.

**INTERA** combines theoretical expertise and practical experience, leading to innovations.



Canada has joined the 12 European Space Agency nations as a full partner in the design and construction of ERS-1, scheduled for launch at the end of the 1980s. With microwave sensors, this satellite will be used primarily for experiments in ocean, ice and weather surveillance. The Gatineau station will be expanded to receive and process ERS-1 data.

### National co-operation

The CCRS, through an effective national committee network, ensures that remote sensing in Canada is co-ordinated among government departments and with agencies in the provinces and territories, many of which have their own remote sensing centres. There are 12 applications and technology oriented working groups with representatives from all sectors — government, industry and the universities.

### Private sector encouragement

As the lead agency, CCRS has from the beginning stimulated and fostered the development of private sector capabilities in manufacturing and services.

### Main activities

The major areas of CCRS activities which support the national program are the following:

**Applications.** New uses for remote sensing data are developed and demonstrated. Projects are undertaken in co-operation with users.

**Satellite operations.** Satellite data are received, processed and distributed.

**Airborne operations.** Specially equipped aircraft are operated for Canadian scientific investigators.

**Research and development.** New data analysis methods, new sensors and data acquisition systems are developed. Funding is provided to the private sector for hardware and applications development.

**User services.** Facilities and technical information are made available to users on a routine basis.

### Applications

CCRS scientists co-operate with user groups to develop suitable ways for applying remote sensing data to the management of Canada's renewable and non-renewable natural resources. Applications in forestry, agriculture, land use, water resources, mineral exploration, oceanography, Arctic ice reconnaissance and the environment are being further developed and demonstrated.

Working space, where resource managers can use the latest sophisticated analytical equipment, is provided at the centre's data analysis laboratories, and is available to all users who cannot otherwise access it in private industry. Visiting scientists from government agencies and the private sector work closely with the experienced scientific and technical staff at CCRS.

Equipment available includes conventional analogue photo-interpretation installations and computer-controlled systems for analysis of satellite and airborne data.

CCRS's Prince Albert satellite receiving station receives LANDSAT MSS, TM, SPOT and NOAA data, and fully processes all data.

### Satellite data products

The Prince Albert and Gatineau stations receive and process satellite data into photographic image or digital computer forms and distribute these products to users. Among these products are the following:

**Black and white or colour images.** Typical products include black and white images of any one of the spectral bands. Colour composites, which combine three of the spectral bands into one colour image, are also available.

**Digital data.** Data are provided in digital form on magnetic tape that is compatible with the user's computer — known as a computer-compatible tape or CCT.

**Geocoded products.** For users who wish to superimpose satellite data directly over conventional maps, the satellite image is projected onto a flat surface, using the standard map projection of the National Topographic System of Canada. A high-precision product, known as a "geocoded CCT" is produced. The product can be entered readily into a digital database or can be used to generate a map-compatible image.

Geocoding also facilitates the comparison of images of the same site obtained on different dates, possibly from different satellites, or in combination from satellites and aircraft. Any change from image to image can be detected and analyzed. Geocoding now allows the combination of data from as many sensors as desired, each sensor providing unique information.

**Enhanced products.** Users interested in the visual analysis of satellite data can have images processed to bring out specified features. Enhancements have been produced for forestry, geology and rangeland applications.

### Research and development

CCRS maintains a strong research effort in data acquisition systems and sensor development, data processing, data analysis and applications development. Research work is usually conducted in co-operation with private industry. This continuing association has resulted in a generation of high-quality, world-class products supported by CCRS research and development (R&D).

Research projects are conducted in association with potential end users and often receive the support of other interested federal and provincial agencies. Industry's participation continues to be encouraged since it facilitates the ongoing process of commercial development of promising applications.

Areas of interest include agriculture, forestry, geological exploration, surveys and mapping, ice reconnaissance, fisheries, water resources and environmental monitoring.





*Education and training in remote sensing application, processing and interpretation are of crucial importance . . .*

— UNESCO, 1986

Satellite and airborne instruments are effective tools for resource managers in both developing and developed countries, as long as people have the knowledge to apply the growing volume of information. The needs of users range from practical training in processing, interpretation, operation and maintenance of equipment to university-level education in several related disciplines. Canada puts as much emphasis on the long-lasting transfer of education and on the training of people as it does on the science and technologies of remote sensing.

The Canadian Remote Sensing Training Institute (CRSTI) is a non-profit clearing house for information on the educational programs and training courses available throughout Canada. CRSTI also can provide the details of Canadian and international funding that is available to support such training and to assist individuals who wish to participate.

CRSTI is sponsored by the Government of Canada, by participating Canadian companies and by the educational institutions that offer courses relevant to remote sensing and resource management.

The staff of the institute will respond immediately to any enquiries. Whether or not Canada or a Canadian company already has some involvement in the applicant's remote sensing needs, CRSTI will provide objective and comprehensive information.

### Service is free

There is no charge for CRSTI services. There is no cost for making an applicant's needs known to any or all of the Canadian institutions and organizations that are available for help. The client will get service and information to match individual interests.

Canadian universities and colleges nationwide have provided the institute with detailed listings of their programs. Training courses offered by private companies in the remote sensing industry are also included. The resulting database can be accessed immediately by contacting CRSTI in Ottawa directly (see below for details).

Class involved in part of the three-week training session in Beijing, China.

Available information includes

#### Courses

*Student qualification requirements*

*Training levels achievable*

Proficiency certificate

Diploma

Post-graduate diploma

*Calendar timing and duration*

*Course loading capacity*

*Language(s) of courses*

*Instructor experience*

Level and specialty

qualifications

*Hardware available*

*Fees*

*Tuition plus textbooks and material*

Free materials or supplies

*Student living accommodation*

Availability and costs

*Applicable research information*

*Brochures*

*Course curricula*

For more information, please write, telex or telephone:

The Executive Director

CANADIAN REMOTE

SENSING TRAINING

INSTITUTE

P.O. Box 8321,

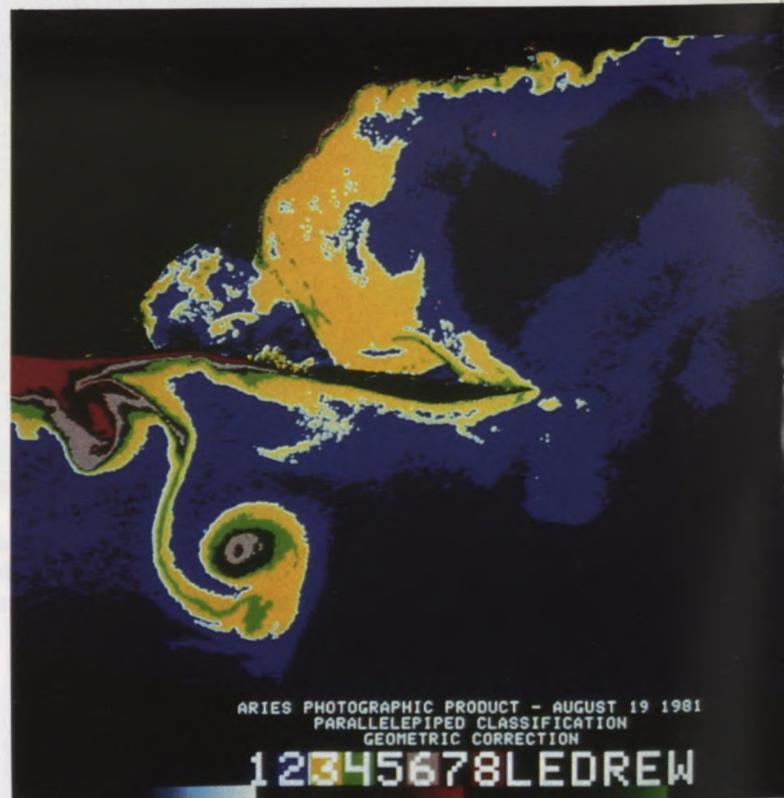
Ottawa Terminal

Canada K1G 3H8

Tel : (613) 993-9874

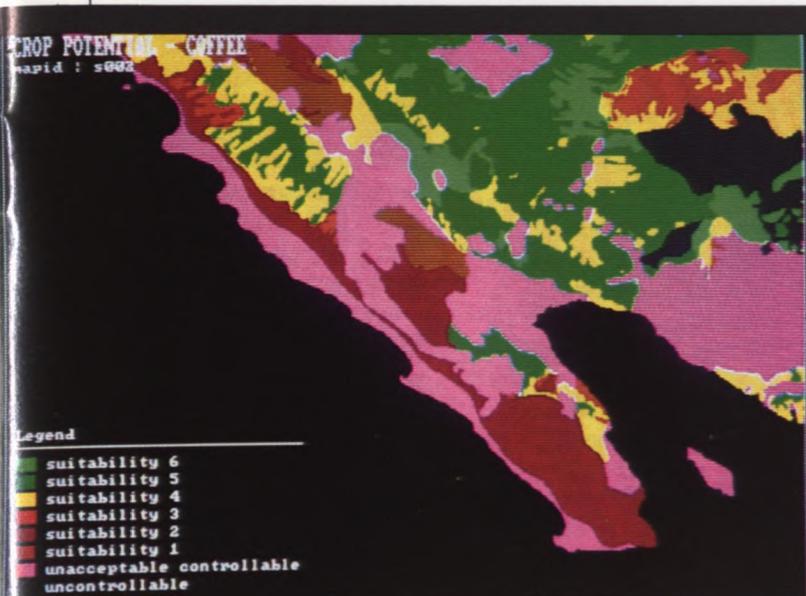
Telex: 053-3777

Sediment patterns from LANDSAT MSS in Lake Erie, Ontario. Processed by Dr. E. LeDrew, University of Waterloo, on a Dipix ARIES system.



ARIES PHOTOGRAPHIC PRODUCT - AUGUST 19 1981  
PARALLELEPIPED CLASSIFICATION  
GEOMETRIC CORRECTION

12345678LEDREW



**Productivity from the land**

Food. Food for people. Feed for livestock. The production of agricultural products for export. Agriculture is the core renewable resource in every country. Often, it is the most difficult national activity to manage effectively. Through remote sensing, agricultural managers can now have new and powerful levels of control at their fingertips.

Analysis, planning and management are all dependent upon information. Soils, crops, acreage planted, moisture, crop health and diseases, weather, market conditions and timing of harvests, stress analyses — information on these factors and conditions is essential to generating improved productivity from the land.

**Getting the picture is now possible**

The new tools for agriculture now include the application of remote sensing techniques to every-day and longer-range decision-making and fore-

Canadian systems and software are in use worldwide for display and interpretation of remotely sensed and conventionally acquired data.

**Indonesia: Southern Sumatra.** Suitability of terrain for coffee growing.

casting. Data obtained from aerial and satellite overflights are verified against known conditions at ground level. The results provide information on a scale not previously possible. An entire nation can be "mapped" repeatedly in this way. So too, the valuable information from an individual farm holding or even a single field can be displayed and interpreted.

Repeated flights and subsequent images from satellites enable vital comparisons to be made. Decisions can be made in time for critical action to be taken.

Different crops reflect light in different ways. Even the same crop reflects light differently, depending on its stage of growth and on its health. Revisits show the changes. The ability to display, manipulate and interpret those changes puts power in the hands of the agricultural manager.

**The technology is affordable**

Affordable desk-top microcomputers and analysis systems, including advanced Canadian-developed, special-purpose software, provide complete facilities for operational resource management applications.

Data from many sources can now be integrated. These include topographical surveys, geophysical inventories, field data, satellite and airborne source information. Production and interpretation of complex images are now a working reality for solving agricultural problems.

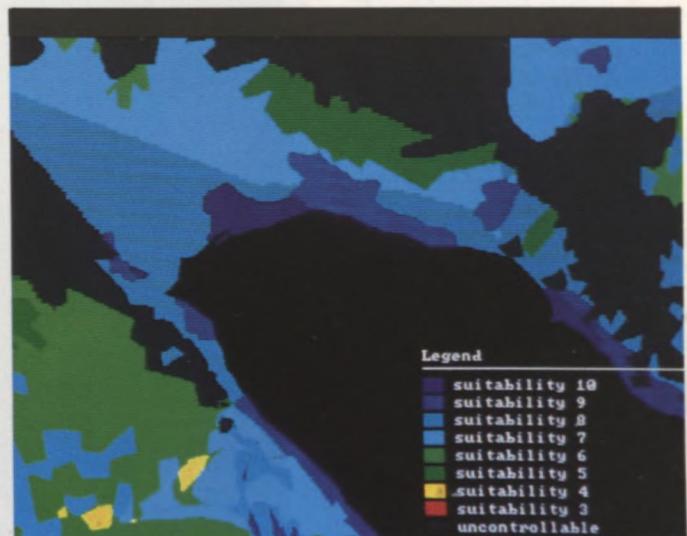
**Canadian experience and know-how easy to access**

Canada is one of the world's most productive agricultural producers and exporters. That leadership is maintained by constant research at all levels of the agricultural process — including testing the new remote sensing systems and techniques with a broad range of crops and in a variety of climatic and topographic conditions.

The development of full agricultural potential is still beyond the domestic capabilities and conventional mapping technologies of many countries. Canadian companies are at work throughout the world in helping to provide solutions.

Among the range of applications for which Canadian systems, software and services are available are main crop inventories; early acreage estimates; automatic inventories and updating; early yield prediction; forage production estimates; soil utilization; crop optimization; disaster quantification; crop stresses evaluation; desertification; drought; groundwater; salinity stress; shrub encroachment; wetlands classification; erosion potential; irrigation mapping; and management information for crop producers.

**Indonesia: Southern Sumatra.** Suitability for rice growing.



Understanding the goal of agricultural self-sufficiency, Canadian firms can deliver the technology and equipment needed, whatever the particular application.

### Managing the living forests

The living forests of the world are in crisis — in developed and developing countries alike. The problems of abuse, of forest degradation, of short-term industrial exploitation, of desertification, of topsoil gone downstream forever, are all too familiar. Acid rain is carried on the winds across international borders, leaving an imprint of ruin. Less than one-third of the world's surface is now tree-covered. Trees are being cut at an accelerating rate.

The long-term solutions, called for by the United Nations, lie in integrating forestry with agriculture, in improving yields from lands already cleared for human settlement, in planting new forests, and in planning the use of the land. This huge task is just beginning on a worldwide basis.

Canada is a leader in forest industries, accounting for more than two-thirds of the world's trade in forest products. Remote sensing plays an increasingly important role in Canada's own forestry resources management. Of all the management tools available, remote sensing is becoming one of the most versatile and effective.

### Seeing the trees and the forest

Conventional aerial photography has been and remains a key source of forestry data. Now, however, the combination of available satellite data and incredibly detailed information from the new remote sensing instruments flown aboard aircraft is enabling forest resource managers to see the trees as well as the forest. Large-scale forest management is becoming a practical reality.

Remote sensing is applicable to a growing number of needs, including forest type mapping; forest health monitoring; diseases inventories; species mapping; fire hazard monitoring and fire mapping; timber volume estimates; and clearance monitoring and cut-over mapping.

### Transforming national capabilities

The move towards intensive forest management requires the use and integration of multiple data sources. Microcomputer-based Geographic Information Systems (GIS) provide readily usable and integrated theme or derived maps. Off-the-shelf and Canadian-developed database management software products and systems have transformed manipulation of map files. Such factors as soil surveys, vegetation, surficial geology, landform and other spatial data are easily included. New information on a real-time basis can be incorporated at will.

Thus, advanced technologies and techniques from Canada and Canadian companies are making science-based and technical information accessible to for-

estry managers in more than 60 countries to date. Assistance programs, including essential training and education, are providing the means to build a future for forestry management, at every level from the grass roots to major national programs. Creation of the needed institutional frameworks is also supported.

The more powerful new remote sensing instruments, the ever more comprehensive information from numerous satellites, the systems to handle the growing flow of information, and the services to put it all in place are all now available from Canada.

Forest clear cuts, logging roads and related management details are readily available from Thematic Mapper images.



## Land uses . . . satisfying the planner's need to know

Land-use activity mapping through remote sensing enables professional planners and decision-makers to study how land is used, how uses change over time, and how such uses have an impact on the environment. It permits orderly planning of future applications that are compatible with present activities.

Remote sensing data users save money, in comparison with traditional methods, and benefit from greatly increased efficiency. Remote sensing imagery is much less costly than that achieved with ground methods. It is easier and faster to interpret than black and white photos at similar or even much larger scales.

The result is more accurate land-use classification maps in permanent form. Nearly instantaneous views of land-use activities over large areas are provided. An added benefit is that a single set of remotely sensed images can serve a wide variety of uses. Biophysical mapping, surficial geology, forest type mapping, environmental impact assessment and vegetation damage assessment are but a few examples.

### Consequences of human settlement

As populations grow, as people migrate, competition is created for available lands. Riverbanks and coastal shorelines become the scenes of conflict, regardless of their specific suitability for settlement and exploitation. Urban areas expand to devour valuable farmlands and forests.



Land is the basic resource, the finite asset. The land-use planner must see to its protection, to the allocation of resources, must choose sites for specific development, create essential services, provide for disposal of wastes. And the planner must analyze present and future stresses on water supplies.

Remote sensing has become the planner's best new tool.

Canadian development of more powerful and reliable instrumentation, systems and software continues to make remote sensing for land-use inventories, planning and updates more accessible to users in other countries.

Land-use and land-core information at the edge of cities is easily mapped from this Thematic Mapper image of Windsor, Canada, and Detroit, U.S.A.

Remote sensing image analysis and airphoto interpretation are combined for a wide range of applications in land-use management. (Photo from Hunter and Associates.)

### Research, testing and operational applications

The methods developed in Canada have been thoroughly researched, tested and evaluated during years of operational applications. The Canadian remote sensing industry competes successfully in the delivery of its services, instrumentation and products to many countries.

Both new and experienced users can match their information requirements within the range of proven Canadian capabilities.

## Mineral exploration . . . seeing what lies below

The search for minerals buried beneath the earth's surface involves governments, large corporations and, even today, individual prospectors with the willingness to "rough it" in the isolated regions of the world. This hunt for resources continues. Today, pixel-by-pixel analysis of remotely sensed images has been added to the geologist's pick, and to conventional aerial magnetic and electromagnetic surveying, as a remarkable tool for exploration.

Structures and materials that are hidden beneath the topsoil or the sands or the vegetation can be indicated or revealed from satellite data, which can then be supplemented with current regional aerial data. New techniques of multistage, multi-spectral interpretation have led to great advances in image enhancement and information extraction. Canadian geologists

MacDonald Dettwiler's MERIDIAN produces this ratio analysis image with digitized geological map overlay (Tonopah, Nevada, U.S.A.).

and remote sensing professionals have devised some ingenious approaches to the computer processing of satellite data, and in the use of small-scale colour infrared and high-resolution radar data.

### Commercially proven

Exploration companies in Canada have made very good use of the methodology developed by the Canada Centre for Remote Sensing in the application of satellite data to geology in a variety of environments. Several Canadian firms are highly capable of undertaking this type of analysis on a commercial basis.

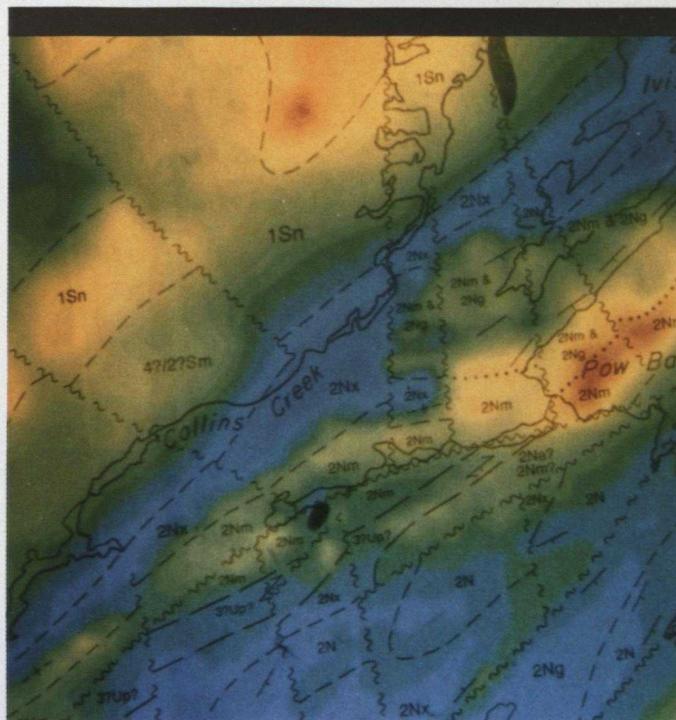
Canadian-developed, programmable multispectral imagers and multidetector electro-optical imaging systems are now available to make new surveys cheaper, faster and more accurate. The new equipment can be flown in small aircraft. It features real-time airborne data processing, high radiometric sensitivity, variable spatial resolution and variable scan rates.

Imagery can be geo-coded with existing databases. Canadian geometric correction software systems permit accurate positioning. Several levels of Side-Looking Airborne Radar (SLAR) systems and Synthetic Aperture Radar (SAR) systems, built in Canada, are being used worldwide for geological and geophysical exploration. These are cost-effective alternatives to conventional aerial photography, and in addition, have a wide range of other applications, including suitability for military markets.

Volcanic thermal and geothermal resources can be identified through remote sensing. This technology is finding further applications in non-metallic mineral exploration. Structural mapping for tectonic evaluation, for identification of exposed surfaces and surface-influencing anomalies, for surface geomorphology and for erosion phenomena — all have become routine.

As in other areas, Canadian firms have extensive experience at home and abroad. Services, systems, software and instrumentation have been developed to high standards of performance.

Gregory Geoscience's PROCOM-2 is an economical optical transfer device that helps resource analysts to scan, enlarge and integrate multiple sets of data of many types, shown here for mineral exploration.

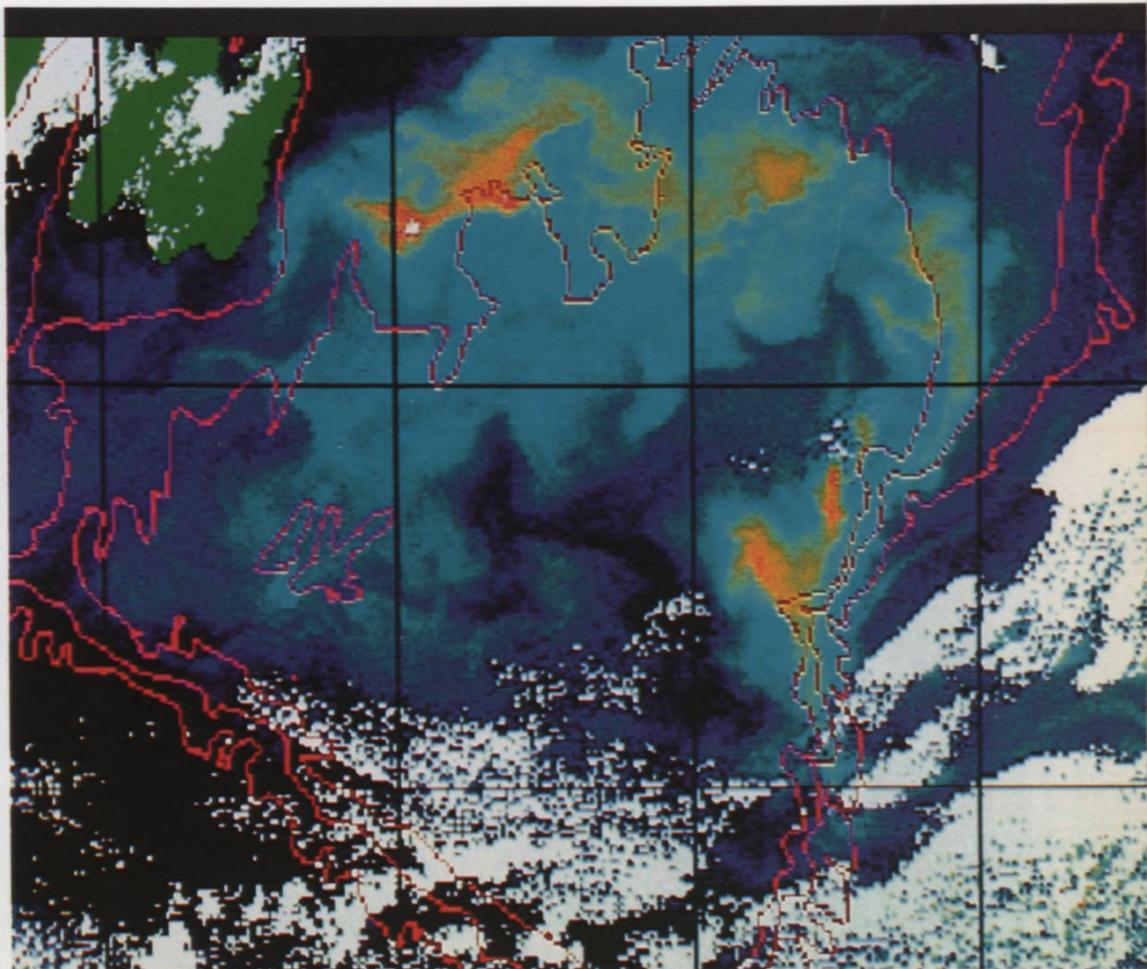


## Looking at the sea

Canada is an oceanic nation. For more than 100 years, Canadians have had to deal with the special problems of a small population with the world's longest coastline. Activities in locating, developing and exploiting resources, from often remote and hostile environments in three oceans, have produced cost-effective solutions. In the process, Canadians have learned to be flexible, to adapt technology for the job at hand, and to design appropriate methods for each task. From the tropics to mid-latitudes and the high Arctic, Canadians continue to put their skills and experience to work on behalf of others who are not yet able to do it all for themselves.

With the establishment by coastal states of Exclusive Economic Zones (EEZ), many are looking seawards to obtain more resources and to add to their traditional fisheries. The tools and techniques of airborne and spaceborne remote sensing are now speeding up the process of surveying and monitoring coastal and deeper-water zones. The secrets of the oceans can be displayed for a wide variety of critical applications and ocean resources development.

Using such tools as multispectral imagers and lasers developed in Canada, infrared radiometers and scanners mounted in aircraft, Canadian companies are flying missions in many countries. When this new information is combined with data from satellites, guesswork is almost eliminated.



Water's colour "signature" — obtained by capture of as many as 288 colours in up to 8 spectral bands — gives information on the availability and distribution of phytoplankton, the primary food for marine life. This is shown through chlorophyll fluorescence. Marine plant abundance and animal distribution are identified with great accuracy. Sea surface temperature can be interpreted for water column stratification and circulation. Inorganic sediments and land-originated dissolved materials are measured to locate and trace water masses and currents. Maps or images of water colour variations can also be used to infer biological productivity at higher trophic levels.

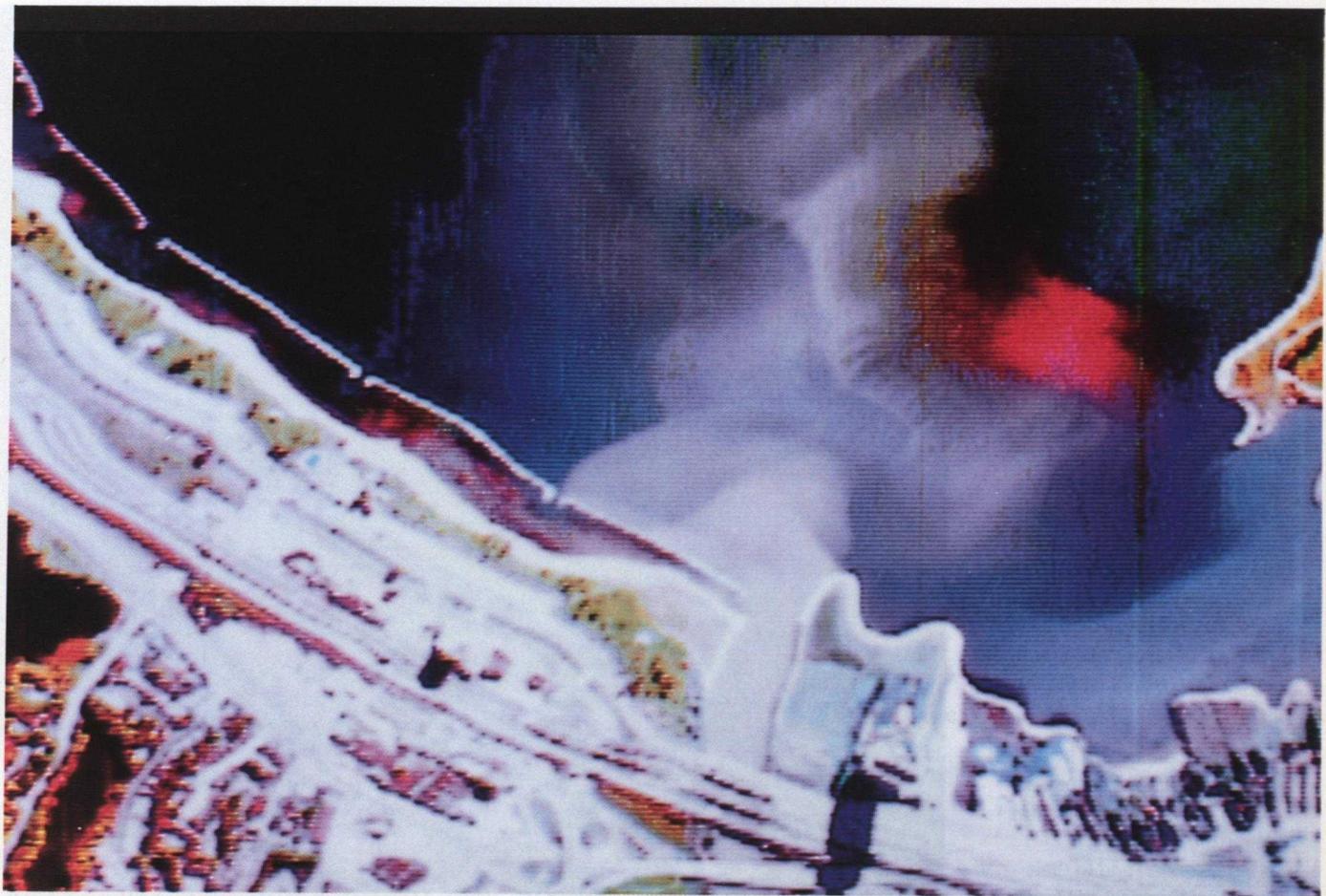
World recognition for Canada's oceanographic skills is matched by outstanding accomplishments in hydrography and cartography. The new EEZs of the world in most cases are not surveyed to modern standards — charts from the nineteenth century are still in use. Canada is one of the few countries with international capabilities in nautical charting and has the willingness to share these skills and technologies with others.

In Canada, the laser beam is being flown to carry out coastal hydrographic surveys — faster and more cheaply than ever before. The work of years can be carried out in months. Laser radar, often termed Lidar (Light Detection and Ranging), is used to detect particles hundreds of

The colour signature of water in this photo from Borstad reveals phytoplankton and inorganic sediment concentrations off the east coast of Canada.

times smaller than are detectable with radar. Not only accurate water depths but also water quality can be measured, from ships or aircraft. Other applications include atmospheric diagnostics, pollution monitoring, terrain profiling, wave height measurement and range finding.

These newest remote sensing instruments and services are typical of the cost-cutting innovations that Canada offers the world.



## Water is life

The availability of freshwater resources is what determines the choices that can be made in every sector of society. No community can be established without this resource. Growing cities always need more of it. Every industrial development requires a guaranteed supply of water. Agriculture depends on its availability.

Canada is blessed with about 20 per cent of all the available freshwater supplies on earth. Its rivers were the highways for settlement — huge waterway systems, such as the Great Lakes and the St. Lawrence Seaway, reach deep into the North American continent. One province alone has more than 250 000 lakes.

This abundance inspired the creation of a very large and diversified scientific, engineering and technical capability to harness water resources and to manage freshwater supplies. Canadians were pioneers in aerial surveying of the country's waters, only some of which are within reach of those who wish to use them.

At the earliest opportunity, Canada took advantage of the new information available from satellite overflights. Government led the way by providing the ground receiving stations and the core of the technical capabilities to receive, process, display and interpret the flood of images.

A private industry was born as a result of the transfer of technologies and the funding of continuing research and development into spaceborne and airborne instruments. A stream of innovations produced user-friendly hardware and software for water managers to take control of solving their own problems.

### Widespread applications

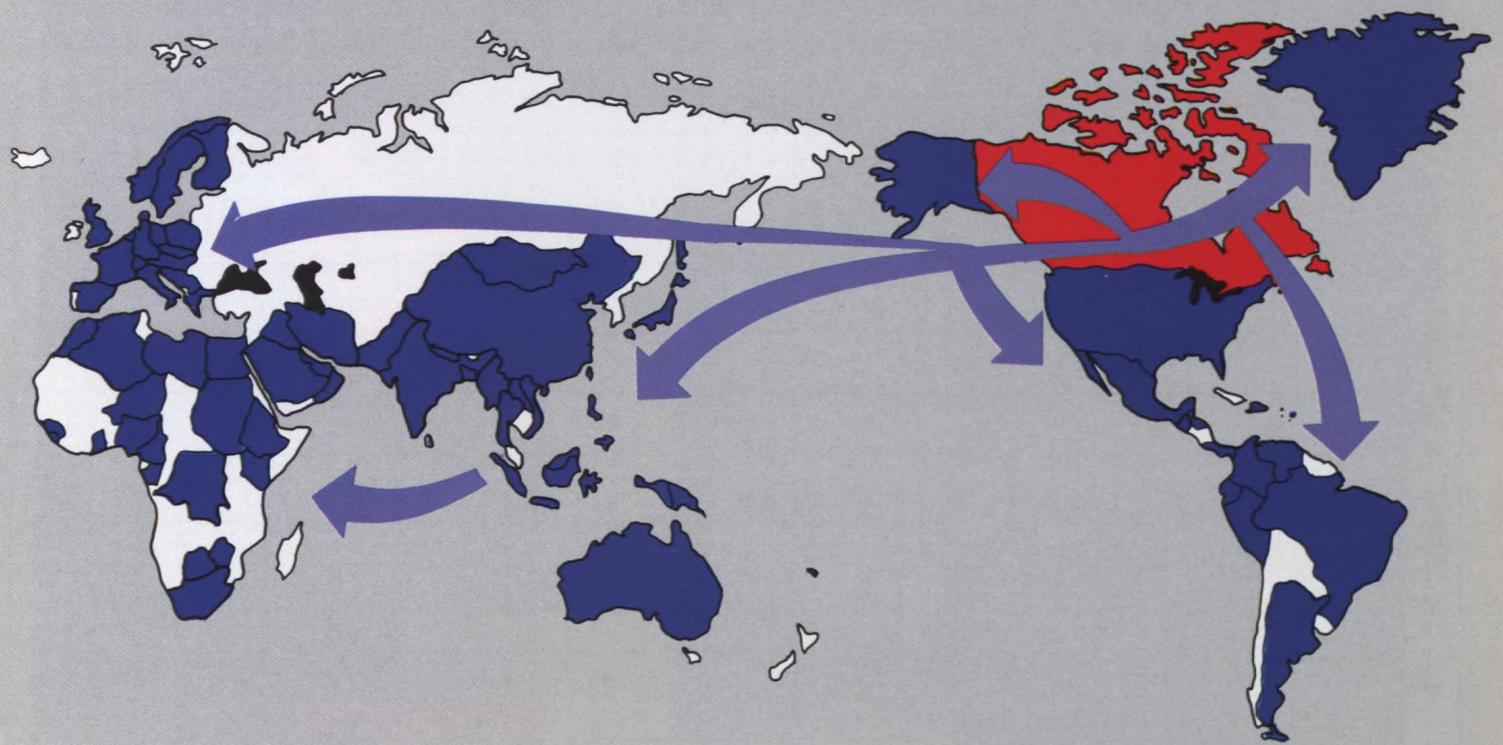
The expertise of Canadian remote sensing companies in the entire field of water resources is being exported to every continent. Applications range from entire national water resource assessments to watershed planning at the local level. Such challenges as erosion, sedimentation, flood analyses, shoreline changes and coastal zone management can now be met with the assistance of remote sensing techniques. Indeed, remote sensing can be said to be the technology that has made water resource management a practical reality on an affordable scale.

MONITEQ's software extracts concentrations of chlorophyll, suspended solids and dissolved organic materials from water colour, shown in this enhanced image of a river discharge into a lake.

# LISTING OF COMPANIES BY FIELD OF EXPERTISE

	Consulting	Manufacturer	Research and Development	Services	Software Development and Products
AMÉNATECH INC.	•			•	
ARCTIC SCIENCES LTD.	•	•	•	•	
BARRINGER RESEARCH LIMITED		•	•	•	
BERCHA GROUP	•			•	
BORSTAD, G.A., ASSOCIATES LTD.	•		•	•	•
CANADIAN ASTRONAUTICS LIMITED	•	•	•	•	
COLES NIKIFORUK PENNELL ASSOCIATES LTD.	•		•	•	
DENDRON RESOURCE SURVEYS LTD.	•			•	
DIGIM (1983) INC.	•			•	•
DIPIX SYSTEMS LTD.	•	•		•	•
GREGORY GEOSCIENCE LIMITED	•	•	•	•	
HORLER INFORMATION INC.	•		•	•	
HUNTER AND ASSOCIATES/AQUARIUS FLIGHT INC.	•			•	
INNOTECH AVIATION (1986) LIMITED	•			•	
INTERA TECHNOLOGIES LTD.	•		•	•	•
ITRES RESEARCH LIMITED		•	•	•	
KENTING EARTH SCIENCES INTERNATIONAL LTD.	•		•	•	•
KNUDSEN ENGINEERING LIMITED		•	•		
MacDONALD DETTWILER AND ASSOCIATES LTD.		•	•		•
MONITEQ LTD.	•	•	•	•	•
MPB TECHNOLOGIES INC.	•	•	•	•	
NORDCO LIMITED	•		•	•	•
NORTECH SURVEYS (CANADA) INC.				•	
OCTOGRAPHE INC.	•	•	•	•	•
OPTECH INCORPORATED	•	•	•	•	
PAMAP GRAPHICS LTD.	•		•	•	•
PCI INC.	•			•	•
Ph.D. ASSOCIATES INC.	•		•	•	
PRAIRIE AGRI PHOTO LTD.	•			•	
ROY BALL ASSOCIATES LTD.		•	•	•	•
SED SYSTEMS INC.	•	•	•	•	•
SPAR AEROSPACE LIMITED		•	•		
TERRA SURVEYS LIMITED	•		•	•	
TYDAC TECHNOLOGIES INC.	•		•	•	•

COUNTRIES TO WHICH CANADA HAS EXPORTED REMOTE SENSING PRODUCTS AND SERVICES



AMÉNATECH INC.

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Contact: Guy Fouquet, Eng. M.Eng., Director

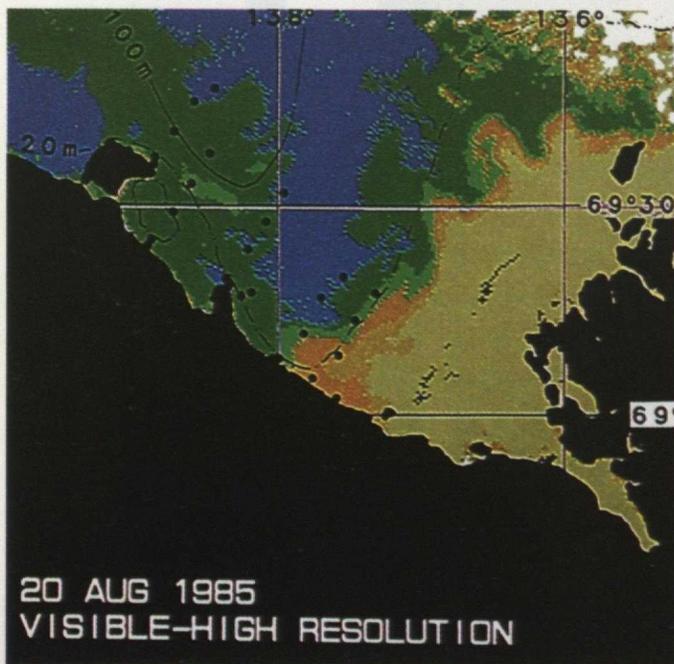
**Company background.**

Aménatech inc. is a firm of development and environment consultants employing more than 50 chemists, geomorphologists, urban planners, remote sensing specialists, agronomists, engineers and other professionals. In its consulting and research activities, remote sensing methods are used for cartography and resources evaluation in the fields of agriculture, forestry and energy. Aménatech has technical resources for data treatment and cartography (DMAS and GICS systems), and laboratories for work in the chemical, microbiological and geotechnical fields. As a corporate subsidiary of the S.M. Consulting Groupe inc., Aménatech inc. can call on

more than 200 other specialists and has taken part in projects in Algeria, Bangladesh, Cameroon, Britain, Pakistan, Saudi Arabia, Thailand, the United States and Zaïre.

**Services.** Aménatech offers consulting services in the areas of design and implementation of remote sensing programs, with practical matching of data needs and available technologies; and evaluation and monitoring of remote sensing programs. The company provides image interpretation and mapping services in the fields of agriculture, energy, forestry, oceans, environmental analysis, land use, map making, terrain analysis, water quality and cartography.

Typical visible- and thermal infrared-band imagery products give convenient, easy-to-interpret representations of surface water reflectance and temperature. (Photos from Arctic Sciences Ltd.)



ARCTIC SCIENCES LTD.

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Tel: (604) 656-0177  
Telex: 049-7476 ALL ROUTES SID

Contact: Dr. John R. Marko, Director, Remote Sensing and Ice

**Company background.** Arctic Sciences Ltd. specializes in analytical and technical services for the marine environment.

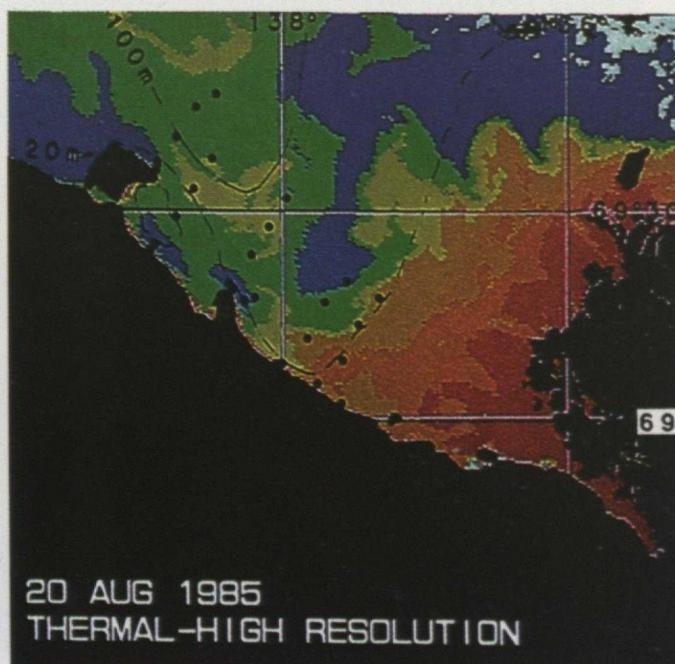
A subsidiary, Oceanprobe Systems Manufacturing Inc. (OSMI), facilitates the generation and marketing of commercial products derived from the parent organization's R&D programs. Most of these products currently involve the application of acoustics to environmental parameter measurement at distances as great as several kilometres.

**Research.** The company's involvement in satellite-based remote sensing began in 1977 when it pioneered the use of satellite imagery and satellite-tracked drifters to study sea-ice and iceberg behaviour in Baffin Bay, Lancaster Sound, the Arctic Archipelago and in the Beaufort Sea. Its research programs have been directed at problems of both practical and environmental significance, i.e., oil spill trajectory prediction, as well as at addressing funda-

mental questions on the large-scale properties of sea-ice and ocean circulation.

**Projects.** Typically, company projects use remote-sensing data to provide answers to specific questions about the marine environment. Recent projects have involved (1) the mapping of surface-water temperatures and suspended-sediment levels to test theories of marine mammal behaviour; (2) the derivation of a new method of predicting low-latitude iceberg severity from mid-winter satellite imagery of northern ice packs; and (3) the evaluation of the possible impacts of upstream dam construction on the clearance of coastal ice.

These studies have been carried out with satellite imagery in its original computer-compatible magnetic tape medium as well as from degraded, but much more numerous, hardcopy imagery products. Company R&D efforts have led to particularly economical and accurate techniques for processing the latter imagery forms.



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Contacts: John Davies, President  
 Andrew Murray, Senior  
 Vice-President

**Company background.** As well as a high-technology research and development firm, Barringer is a hydrocarbon and mineral exploration company whose skills include geochemistry, electro-optics, electromagnetics, magnetics and atmospheric physics. The company's research and development efforts have resulted in patented and proprietary instruments, instrument systems and techniques for use in airborne and ground exploration, environmental monitoring, process control and metal detection.

Currently, the areas of greatest interest are the use of ground geochemistry, identification of hydrocarbons offshore, electromagnetic airborne identification of hydrocarbons and minerals

onshore, and the development of analytical techniques and high-technology products with multiple market uses.

**Achievements and products.** Barringer offers its clients the following major products and services:

- world's leading remote sensor for SO<sub>2</sub> and NO<sub>2</sub> (the acid rain gases) in use worldwide — COSPEC;
- airborne laser fluorosensor for monitoring oil pollution on water;
- reflectance instruments, ratioing radiometer HHRR and reflectance spectrometer REFSPEC for plant stress studies, and geological exploration;

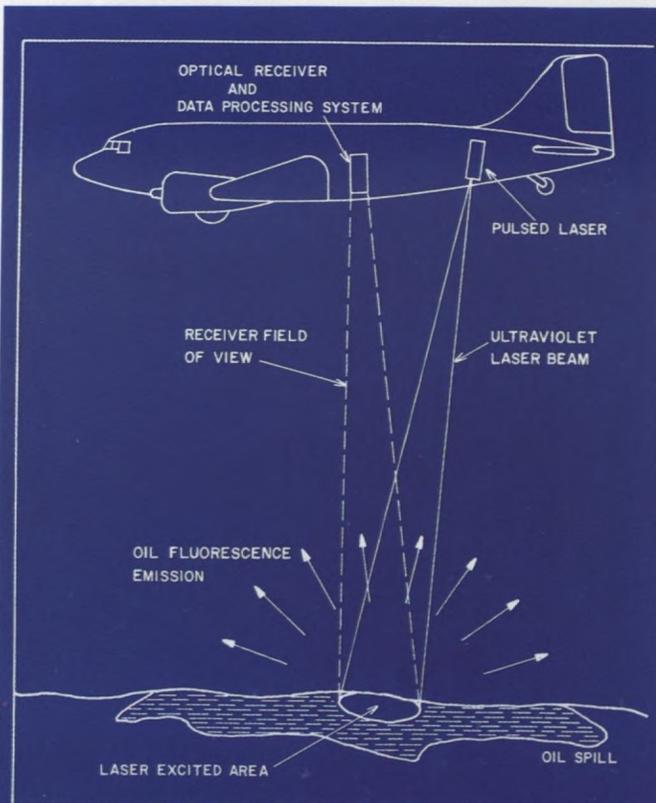


FIG. PRINCIPLE OF OPERATION OF AIRBORNE LASER FLUORENSING SYSTEM

- gas filter correlation spectrometer (GASPEC), used in the Space Shuttle to monitor global carbon monoxide;
- priority pollutant analysis;
- infrared gaseous imagery for remote mapping of target gases.

■ Mark III airborne laser fluorosensor system.

■ Principles of operation of an airborne laser fluorosensor.

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 Telex: 03-827666 BERCHA CGY

Contacts: Dr. F.G. Bercha, President  
 V.L. Shaw, Vice-President  
 B.J. Griffin, Associate

Branch offices: Melbourne, Australia and  
 Jakarta, Indonesia

**Company background.** The Bercha Group of companies forms an integrated service entity providing data acquisition, project management, engineering, and environmental analysis services to clients in the private and public sectors on a worldwide basis.

**Services.** The Bercha Group of companies specializes in the acquisition, processing and automatic analysis of remote sensing information on earth, atmospheric, and ocean resources in a variety of climate and habitat conditions, ranging from those characterizing the equatorial tropical regions to those associated with the Arctic and Antarctic. Through an associated aviation company, the group has access to, and is experienced with, a diverse range of airborne sensors covering the entire remote sensing spectrum from active and passive microwave to the visual and ultraviolet. The group has on staff specialists in the acquisition and interpretation aspects of remote sensing systems, including airborne radar (SLAR, SAR), infrared scanners, aerial cameras, magnetometers, laser profilometers, FLIR, multispectral cameras and scanners, scatterometers, passive microwave radiometers and satellite data; airborne analogue and digital recording and decoding; real-time downlink, ground station reception; and the associated processing services to generate meaningful information from the data records.

**Applications.** Included in applications are ice and iceberg surveillance and mapping, forestry and vegetation mapping, structural geology, geomorphology, drainage analysis, monitoring of coastal and alluvial swamps and associated flood phenomena, forestry and logging impacts, agricultural mapping and terrain analysis. Real-time capabilities enable preliminary maps to be transmitted to ground stations within seconds of acquisition utilizing a UHF downlink system. The group has operated successfully for many years and has carried out surveys in Australia, Fiji, Indonesia,

Brunei, Papua New Guinea, Taiwan, Nigeria, Equatorial Guinea, Guatemala, the United States, Canada, and the Arctic regions.

In the environmental analysis area, the companies have utilized a variety of data sources to supplement their own data gathering capabilities, including LANDSAT and NOAA satellites, as a basis for solution of resource management problems, engineering site optimization, agricultural planning, resource mapping, and economic analysis. The companies have worked worldwide with particular emphasis on the northern and

equatorial regions, where they have been particularly successful because of their innovative high-technology approaches to solutions in frontier resource mapping and industrial development projects.

The Bercha Group is able to provide a comprehensive range of services from data acquisition to data analysis and information interpretation, and a variety of multidisciplinary consulting services ranging from professional engineering to mathematical simulation.



Colour-enhanced digital radar (SLAR) image of rock structures from an aircraft at approximately 3 650 m (12 000 ft.) over Sarawak, Malaysia.

100-Marine Technology Centre  
9865 West Saanich Road  
Sidney, British Columbia  
Canada V8L 3S1

Tel: (604) 656-5633

Contact: Dr. G.A. Borstad, President

**Company background.** G.A. Borstad Associates Ltd. is a Canadian company specializing in research, development and application of airborne and satellite remote sensing techniques, software and sensors for fisheries and oceanographic use. The firm exports its consulting, analysis and project services.

Borstad's development of airborne mapping techniques for phytoplankton, sediment and temperature and its joint work with the Canadian Department of Fisheries and Oceans on remote detection of chlorophyll have contributed to the development

of a new fluorescence line imaging spectrometer. This spectrometer has gained international attention as the prototype of the next generation of spacecraft sensors.

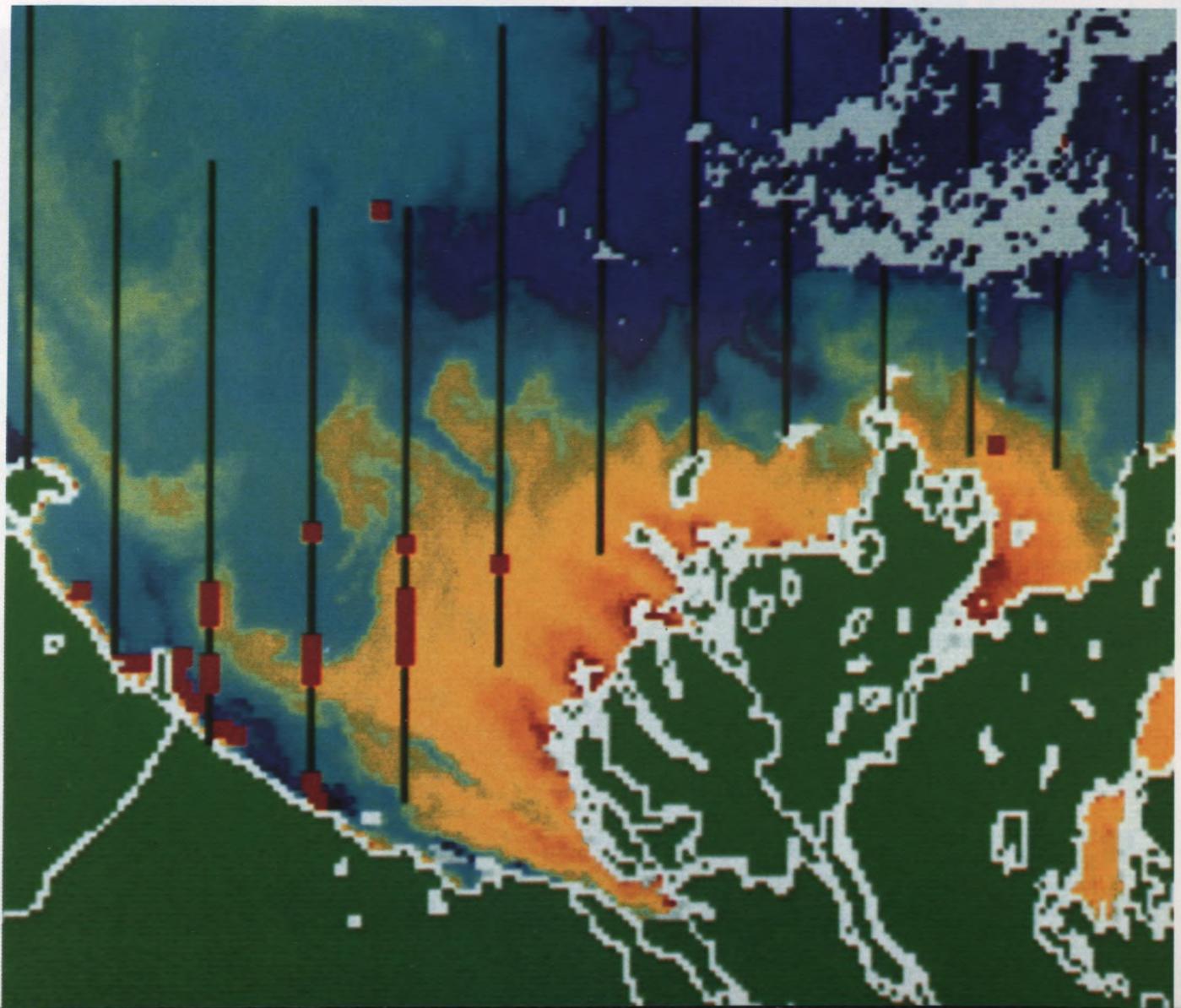
**Projects.** Borstad Associates has been conducting descriptive biological and physical oceanographic studies of large, remote and poorly known areas using aircraft and satellites. Airborne and satellite mapping projects have been carried out in the Canadian and American Arctic and off the British Columbia and Newfoundland coasts, in support of ecological and oceanographic

studies. One recent project developed automatic mathematical techniques to track ice movement in the Beaufort Sea and beyond using series of co-registered NOAA AVHRR images. This technique can be applied to in-water features as well. Current committed projects are for Australia, Peru and China and include training.

**Oceanographic analysis services.** The company has developed near real-time satellite oceanographic analysis and offers this service. Clients value the ability to obtain a map while they are at sea since it allows them

to rationalize their sampling procedure and save expensive ship time. This technique could be easily extended to commercial fisheries where appropriate support exists, such as a NOAA or GOES receiving station, or a small (\$30 000 Cdn) direct readout station.

Maps of water colour variations are used to infer biological productivity, used here for bowhead whales along the Arctic's Yukon Territory coast.



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Contact: Vinit Nijhawan, Marketing and  
Sales Manager, Space Systems

**Company background.** Canadian Astronautics Limited (CAL) is a diversified company engaged in developing and manufacturing a wide range of high-technology products and providing systems engineering services. Founded in 1974, CAL's rapidly growing capability is supported by a 4 994 m<sup>2</sup> (53 000 sq. ft.) office, laboratory facility and a 2 954 m<sup>2</sup> (30 000 sq. ft.) production facility.

CAL's expertise in signal processing has made the company the leading supplier of satellite-aided search and rescue (SARSAT) ground stations. The stations operate with the international search and rescue satellites for emergency location of distressed aircraft and vessels.

The laboratories, which include cleanrooms for aerospace hardware assembly, are equipped to support analogue and digital electronic development, antenna and radio frequency (RF) development, and computer facilities for signal processing and process control work. CAL also has access to environmental laboratories, antenna ranges and failure analysis laboratories.

Furthermore, CAL provides a full capability for "Mil Spec" drawings, documentation and quality assurance (QA) inspection in support of hardware production.

**Products.** Among its varied products, the company has the following to offer:

**Advanced systems** — Signal processing systems include an image processing system for LANDSAT Thematic Mapper satellite images, an acoustic processing system to measure polar ice thickness, a family of radiation measuring dosimeters, and SARSAT ground stations.

**Radar systems** — CAL is active in the development of airborne synthetic aperture radar (SAR) and side-looking airborne radar (SLAR) for mapping, ice reconnaissance, geophysical exploration and environmental monitoring applications. CAL has developed phased array and microstrip antennas for microwave landing system applications and has capability in thin film microwave integrated circuit components.

**Space systems** — Cell procurement, battery fabrication, and battery testing are just three areas of CAL's spacecraft power systems capabilities. In other space hardware areas, the company has supplied a high-resolution far ultraviolet solid state camera system which is flying aboard the Swedish Viking satellite. The company has supplied a large deployable helical antenna for the British Skynet 4 series of military communications satellites and a space shuttle scientific payload to be used for scientific investigations of the ionosphere. CAL is also developing an upper atmosphere wind velocity and temperature measuring interferometer.

Real-time hard copy display of CAL's SLAR 100 System operating on board the Canadian Atmospheric Environment Service's de Havilland Dash-7 reconnaissance aircraft.

**Military systems** — The company has developed a capability in military electronics. Product developments include a software programmable sonobuoy processor, a fast switching millimetre wave source and the TASS threat simulator system.



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CNP. ASSOC

Contacts: Brian Allan, P.Eng., Director  
Terence Yasui, Remote Sensing



**Company background.** Coles Nikiforuk Pennell (CNP), a private firm of independent petroleum consultants, employs 75 professional and technical staff whose expertise and experience enable it to achieve a high standard of performance. CNP offers consulting, computer and digital mapping services, and has export experience in Australia, the United States, Britain, Sri Lanka and Italy. The company has recently entered the remote sensing field and has developed software to manipulate and enhance digital LANDSAT data.

**Services.** The services provided by CNP in the remote sensing field include, but are not limited to

- surface hydrological mapping
- geological interpretation
- engineering applications

Raw LANDSAT data for Slave River delta in Canada's Northwest Territories.

- forest resource assessments
- cultural land use analysis

**Research, development and applications.** R&D activities include generating graphics by extracting vectors representing specific features derived from digital LANDSAT data.

**Applications and end products** of remote sensing are digital map databases derived from satellite data and digital mapping applications for resource planning, design and evaluation.

**Company facilities** in use are the PRIME 9955 minicomputer system and the AUTO-TROL graphics computer system.

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Contact: Leo Sayn-Wittgenstein,  
PhD., RPF, President

**Company background.**

Dendron Resource Surveys Ltd., a forestry consulting company established in 1978, has a strong background in research with emphasis on the quantitative aspects of forest resource management. Computer applications, aerial surveys and remote sensing are areas of special expertise.

**Equipment.** Dendron is well equipped with photogrammetric, mapping and computing equipment, a state-of-the-art geographic information system, digitizers and a plotter. Staff has extensive experience in using large computer systems and is frequently consulted on computer applications.

**Experience.** With its broad background of practical experience, Dendron has exported its capabilities to Indonesia, Gabon, Sudan, Peru, Haiti and the United States. Among larger projects undertaken were the Forest and Biomass Inventory of Prince Edward Island, a forest inventory in Alberta, Canada, and

the establishment of photogrammetric/computer systems for the British Columbia Ministry of Forests in Canada. Complex research assignments are common.

**Services.** Dendron offers its services in the design and implementation of remote sensing programs; matching of data needs and technologies; technology transfer and enhancement; evaluation and monitoring of remote sensing programs; and image interpretation and mapping.

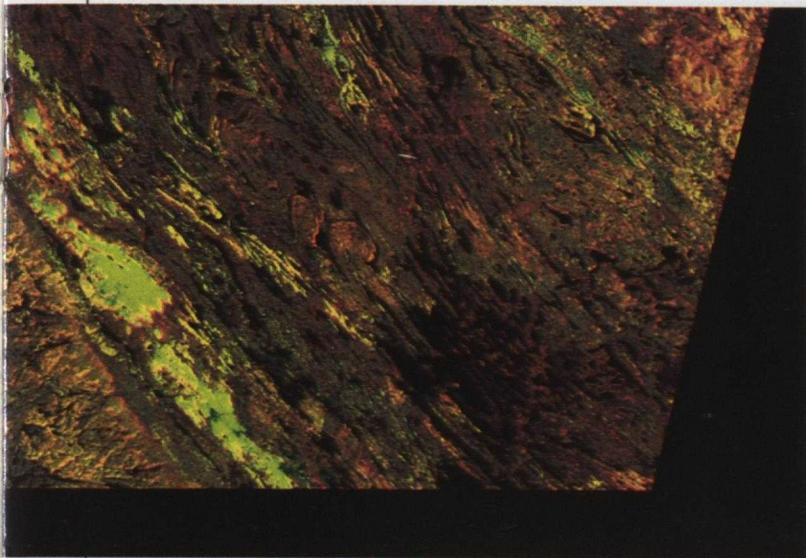
The company applies its image interpretation and mapping skills in the fields of agriculture, forestry, energy, environmental analysis, water quality, exploration geology, land use, terrain analysis, route selection, map making and cartography.

Dendron pioneered the use of large-scale sampling photographs in the qualitative and quantitative description of insect damage, wood volumes, logging residues and similar surveys.



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Telex: 055-61250 LAVALIN MTL

Contact: Guy Rochon, Eng., M.Sc., President  
Branch offices: Through Lavalin International  
Inc., worldwide



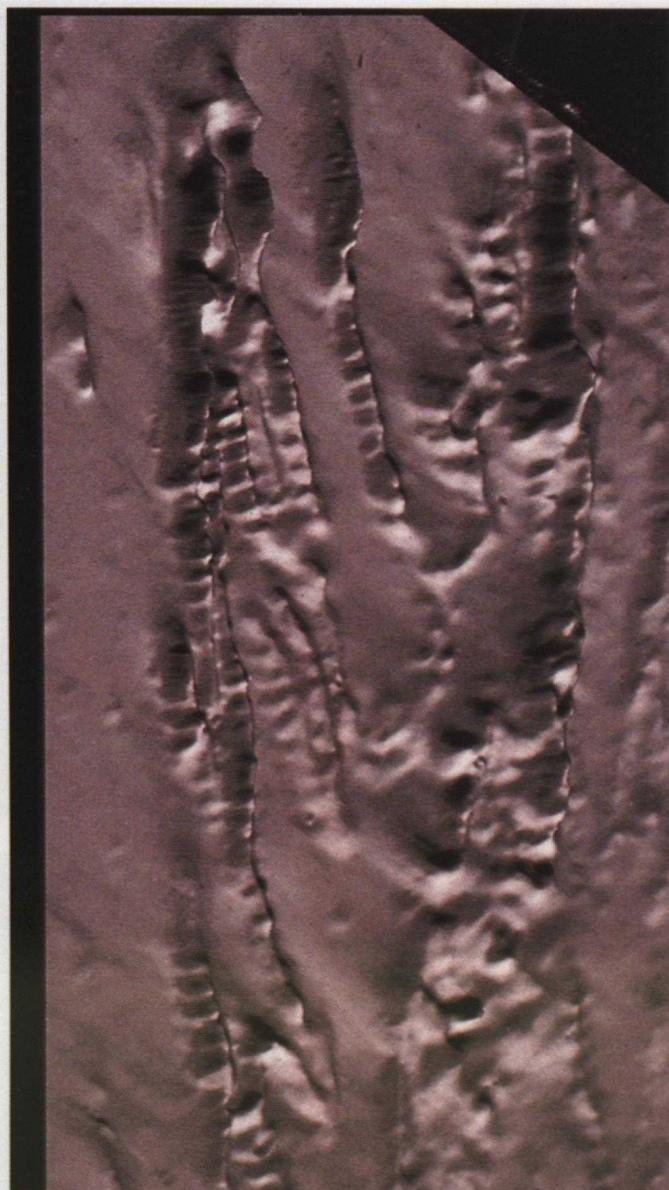
**Company background.** Digim (1983) Inc., founded in 1979, has been an associate company of the Lavalin Group since 1983. Lavalin International Inc. is responsible for the Canadian-owned engineering organization's operations worldwide. As a part of one of the largest engineering and consulting groups in the world, Digim has access to some 50 specialized divisions, 5 000 professionals, highly trained technicians and support personnel readily assembled into integrated teams to carry out multidisciplinary assignments. Digim specializes in the digital processing of remote sensing data. Having highly developed software at its disposal, the company is able to offer state-of-the-art technology in this field. The expertise of its personnel is recognized worldwide.

**Activities.** Digim's main fields of activity are linked to satellite imagery:

- distributor for SPOT (France's satellite) of standard products as well as added-value products;

#### Enhanced LANDSAT MSS scene, northern Quebec.

- development of turnkey systems for information management of natural resources, including transfer of technology and training of personnel;
- enhancement of remote sensing images;
- integration of multisource data — topographical surveys, geophysical inventories, field data, LANDSAT, HCMM, MEIS-II, DAEDALUS images, etc.;
- production of complex images — relief images, stereoscopic images, mosaics;
- digital analysis and interpretation of remote sensing images — base and thematic mapping, calculation of ground cover statistics;
- development of software to improve the quality of remotely sensed images;



#### Total magnetic field relief enhanced by artificial lighting.

- specialized services in base cartography — needs studies, project planning, system design for cartographic production, start-up of these systems and their operation and personnel training;
- creation of atlases of enhanced LANDSAT images;
- environmental monitoring;
- use of remote sensing techniques for mineralogical research.

**Export experience.** Digim has export experience in Bénin, Niger, France and Thailand. For more than 40 years Lavalin personnel have carried out significant assignments in more than 80 countries. Permanent offices are maintained in Africa, Asia, Europe and Latin America with additional project offices in various countries throughout the world.

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Contact: R.T.C. Cobbold, Vice-President,  
Marketing  
Branch office: Dipix Inc., Columbia,  
Maryland, U.S.A.

**Company background.** Dipix specializes in advanced display and processing technology for image analysis. The company manufactures an innovative line of electronic display systems and image analysis systems, and provides extensive software packages to support both image processing and a wide range of applications. Dipix systems have been installed in a growing number of cities and major centres throughout the world, with users in universities, research organizations, survey and exploration companies, and various government mapping and remote sensing agencies.

**Products.** Since the design of the first Dipix image analysis system, company products have been built with the end user in mind. Dipix design engineers listened to applications users. They asked for image display flexibility, processing speed, software functionality, expandability, simple operation, and system support as the main criteria for any display and image analysis system. With these criteria in mind, Dipix designed and built the first ARIES turnkey image analysis system. It has since expanded this product line to include the full family of turnkey systems, including the ARIES-III display, advanced high-resolution display and processing systems, and multi-user software and applications-specific software packages.

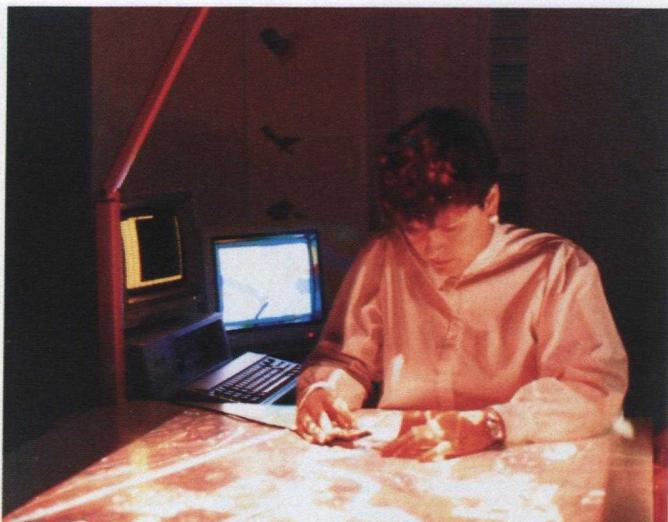


China is a major customer for the Canadian image analysis and interpretation systems offered by Dipix.



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Contacts: A.F. Gregory, President  
H.D. Moore, Vice-President, Operations  
J.G. Guerette, Marketing Manager



**Company background.** Incorporated in 1973, Gregory Geoscience Limited specializes in analysis of remote sensing, correlative data and field observations; development of visual and digital techniques to meet specific needs for information; manufacture, sales and servicing of new instruments for image analysis (e.g., PROCOM-2); and the operation of a computerized system for retrieving information about techniques of remote sensing.

**Experience.** The staff of Gregory Geoscience Limited have a broad range of skills and experience in remote sensing, geology, geophysics and geography; land cover, agriculture, water and forests; mineral exploration; temperate, arid, tropical and Arctic regions; visual and automated interpretation; and digital analysis. Interpretive and/or field experience has been acquired in such diverse countries as Australia, Cameroun, Canada, Ethiopia, Kuwait, Nigeria, Panama, Sierra Leone and Venezuela. In particular, the company has mapped extensively from LANDSAT images for all geographic regions of Canada and has completed change detection and/or map revision for about 40 per cent of the country.

Canadian companies combine technologies for user convenience. Here Gregory's PROCOM-2 is linked with TYDAC's SPANS Spatial Analysis System.

**Services.** Gregory Geoscience Limited provides services in these areas:

**Mapping and monitoring** — interpretive mapping using LANDSAT and collateral data; geological mapping and selection of exploration targets; monitoring snow and ice; mapping crops, forest fire damage, transporta-

tion networks and land use; detailed spatial analysis and modelling using in-house GIS.

**User assistance** — selection of remotely sensed data for client's use; literature searches; consultation, planning and training with respect to the use of remote sensing. General services are provided publicly through RESORS, a computerized information retrieval system that the company operates for the Canada Centre for Remote Sensing. Specialized services may be purchased from the company.

**Research and development** — feasibility studies; literature reviews; development of cost-effective techniques for deriving information; development of systems for image analysis and integration of collateral data.

**Products.** The PROCOM-2 is an economical optical transfer device designed to scan and enlarge one set of data and integrate it with a second data set. It will accept a broad variety of transparent data sets. This includes, but is not limited to, LANDSAT RBV, MSS and TM; NOAA; SPOT HRV; large format camera and metric camera space photos; low, medium and high

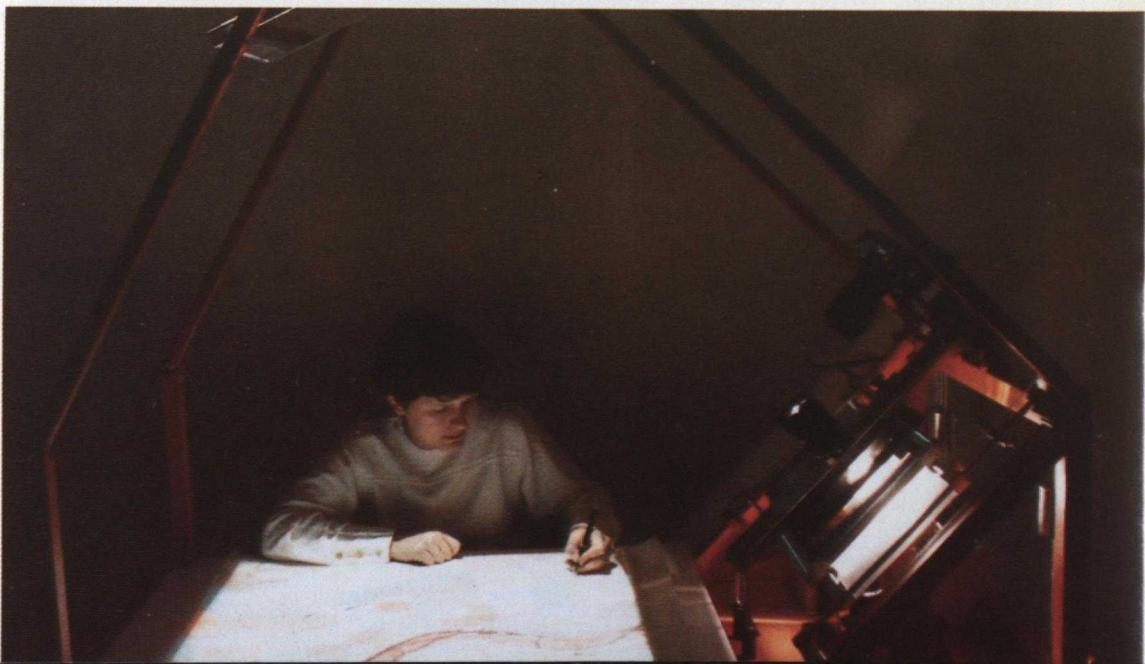
altitude air photos; 35 and 70 mm slides; airborne and spaceborne SAR; SLAR; X-rays, microscope slides and thin sections. The system has gained wide acceptance as a practical tool for resource mapping.

The Spatial Analysis System (SPANS\*) is a microcomputer-based geographic information system (GIS) for visually and numerically displaying the target environment, exploring relationships among spatial data sets, identifying locations that meet specified criteria, making spatial trade-off decisions, and estimating impacts through predictive modelling.

**Training.** The company offers courses on the various aspects of remote sensing and its applications. Courses are tailored to the requirements of the client.

\*SPANS is a product of TYDAC Technologies Inc., Ottawa.

Applications of PROCOM-2 are limited only by the operator's imagination.



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Contact: Dr. David N.H. Horler, President



A geometrically corrected Thematic Mapper image over Ottawa, Canada, produced by CCRS. Autumn colouration may be seen in the forests north of the city.

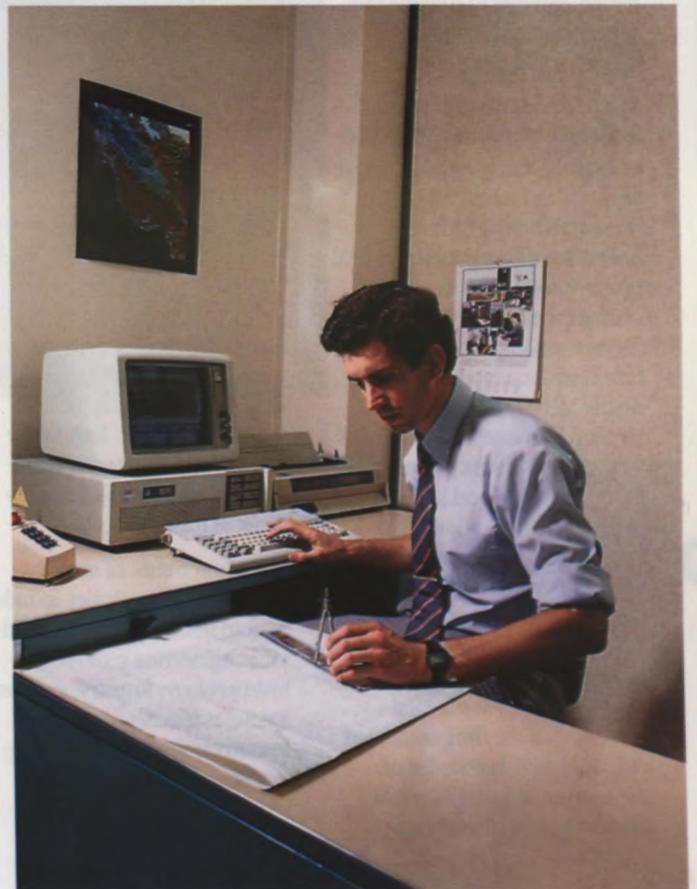
**Company background.** Horler Information Inc. is a consulting company specializing in remote sensing and related technologies. The firm helps clients make practical use of remote sensing data through a wide range of services.

**Consulting.** For organizations that wish to develop their own capabilities in remote sensing and geographic information systems, Horler Information Inc. provides independent consulting services relating to system purchase, system integration, and the integration of the technology into organizational management structure. The company advises on the establishment of remote sensing programs and takes part in their implementation. Emphasis is placed on the practi-

cal uses of the technology and on the development of personnel through training.

**Image analysis and interpretation.** Horler Information Inc. also provides image analysis and interpretation services by skilled professionals to deliver to clients the information needed for specific purposes. The company has experience in a wide variety of applications including agriculture, land use, forestry and geological exploration. Horler Information Inc. is committed to maintaining a leading position in developing the practical applications of remote sensing and is actively involved in research and development. The company serves a wide variety of clients in governments, industry and international development agencies.

Canadian consultants have a wide expertise with all remote sensing data types and in the growing range of applications.



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Contacts: Garry T. Hunter, President,  
Hunter and Associates  
Gregory M. Wickware,  
Vice-President,  
Hunter Associates

Hangar 9  
Buttonville Airport  
Markham, Ontario  
Canada L3P 3J9  
Tel: (416) 475-2885

Contacts: David G. Edwards, President,  
Aquarius Flight Inc.  
Branch office: Aquarius Flight Inc.,  
Jakarta, Indonesia

**Company background.** Hunter and Associates is an integrated multidisciplinary resource management, environmental systems planning and engineering consulting firm offering a wide range of professional consulting services to both the public and private sectors.

Established in 1977, the firm offers its clients modern equipment and up-to-date technology. Staff are capable of providing a wide scope of services using a multidisciplinary approach to problem solving, and emphasizing personal communication and contact in the daily execution of work. Hunter and Associates has considerable experience in managing multidisciplinary research-and-design teams of varying sizes both within Canada and offshore. Services range from initial conceptualization, research, planning, feasibility and design, through to construction supervision, project management, and user training.

**Specializations.** Hunter and Associates specializes in the use of airphoto interpretation, image analysis, and advanced remote sensing technology for coordination of environmental field research leading to resource management policy recommendations and implementation. The firm is well equipped to efficiently identify and resolve physical land-use planning issues and to assess development feasibility both on a local and on a regional basis. In addition, Hunter and Associates has developed expertise in environmental assessment ecological land classification, coastal zone management and forest resource surveys. The environmental awareness of the firm, combined with a working knowledge of the tourism industry, is a relatively rare expertise. Hunter



Colour infrared image of the Slamet Volcano, Java.

and Associates is a leader in applications of microcomputer-based geographic information and image analysis systems.

Working relationships have been established and maintained with highly qualified and specialized associates across Canada and in international settings. These people provide the firm with a specific local knowledge as well as additional geographic and technical diversity. Technology transfer and counterpart staff training are important components of many projects.

**Principal fields of activity.** Hunter's main activities include remote sensing and image analysis; engineering geology/hydrogeology; forestry; environmental assessment/natural resources; watershed planning; pipelines and energy; human settlements; coastal zone management; tropical shorelines; recreation and tourism.

**Aquarius Flight Inc.** Aquarius, an affiliated company, specializes in aerial photography, airborne exploration and remote sensing in support of mapping, and in land-use capability studies and world resource development. Aquarius personnel provide a special combination of extensive experience and state-of-the-art aircraft, camera and remote sensing equipment for each client's individual and frequently unique requirements.

**Principal fields of activity.** Aquarius is active in these fields: aerial photography (black and white, colour or infrared film); very large scale aerial photography; multispectral imagery (video or line scan); photographic laboratory (including portable facilities); remote sensing (including thermal imaging);

airborne profile recording (APR); air survey installation design and aircraft conversion; photo crew training; and project management and planning.

The principals of Aquarius have extensive experience on overseas projects.

# INNOTECH AVIATION (1986) LIMITED

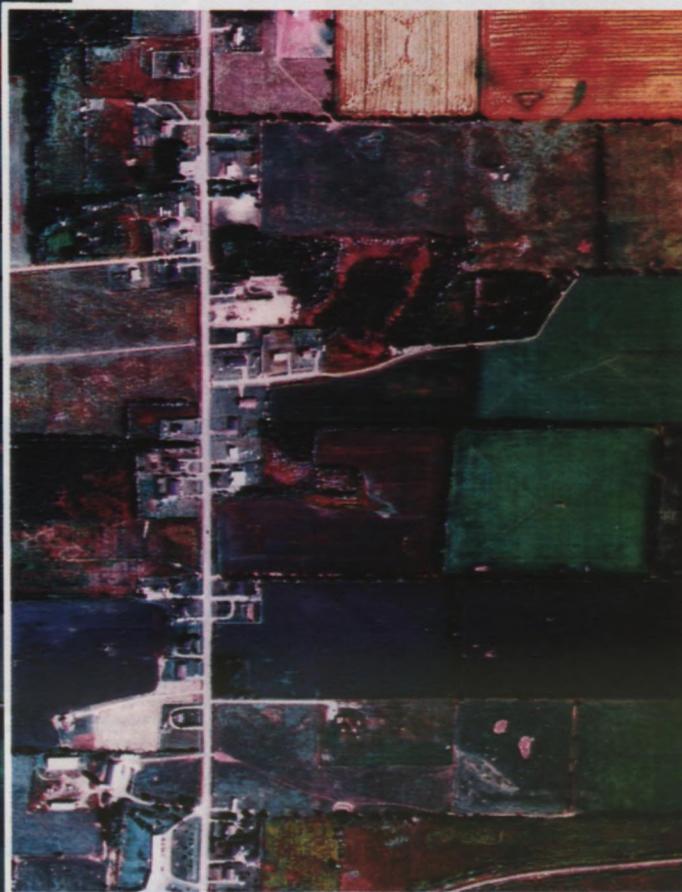
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Telex: 05821856 INNOTECHAV MTL

Contact: Mr. T.F. Colahan, Vice-President,  
Contract Services and Operations



A high-resolution enlargement from the strip.



Imagery acquired from an airborne pushbroom sensor, the Multispectral Electro-optical Imaging Scanner (MEIS), mounted in a CCRS aircraft operated by Innotech Aviation.

## Company background.

Innotech has been under contract to the Canadian federal government since 1975 to provide aircraft maintenance and flight operations for the remote sensing centre of the Department of Energy, Mines and Resources.

As part of a "Transfer to Industry" program, the aircraft and sensors have been made available to the private sector for commercial utilization.

**Services.** The Canada Centre for Remote Sensing through this "dry leasing" agreement has made it possible for Innotech to offer remote sensing coverage by a family of sensors not normally available to companies involved in aerial survey or remote sensing. Aircraft include a CV-580, a Falcon 20 and a DC-3. Sensors available range from a C and/or X band synthetic aperture radar (SAR) in the CV-580 to the multispectral scanner (MSS) and the pushbroom imager (MEIS 2) in the Falcon 20.

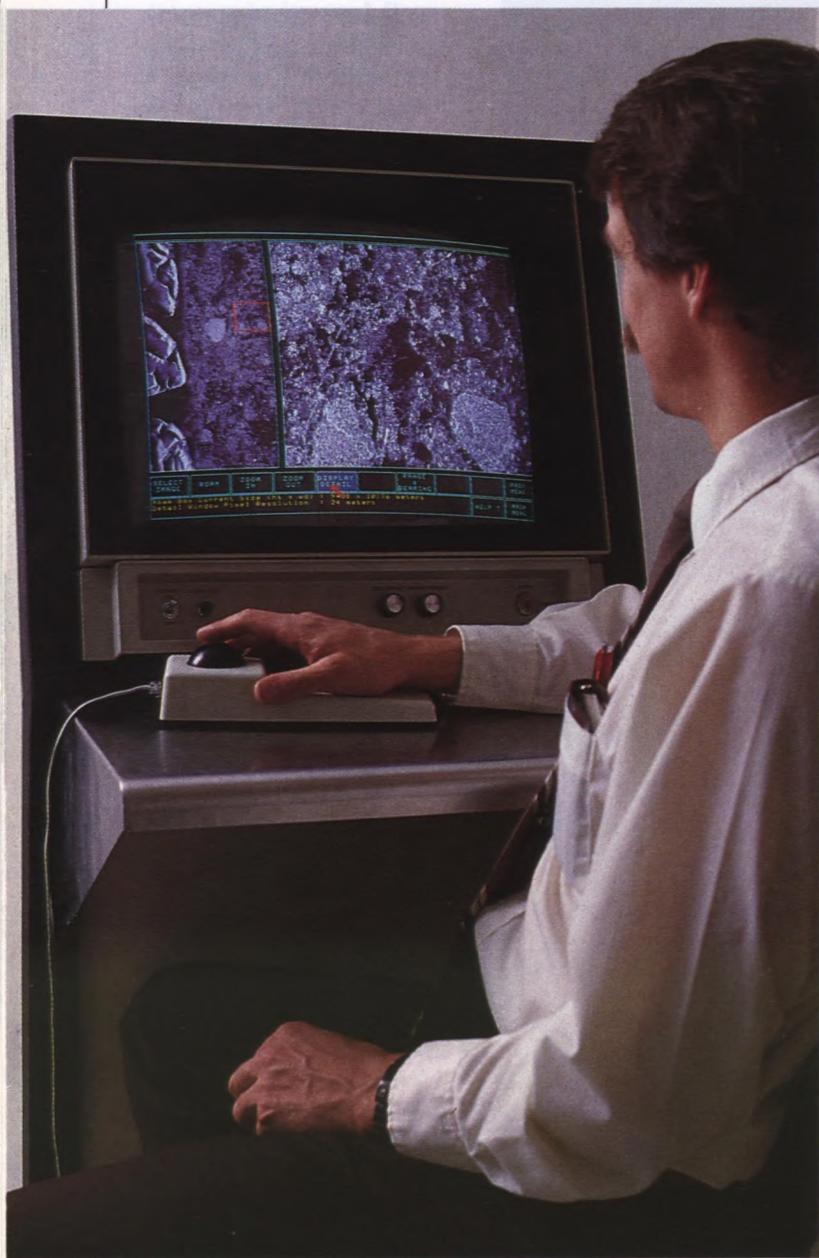
Charges for this service are normally based on aircraft flight hours and the sensor package required.

Through this program, commercial remote sensing projects have been carried out domestically in Canada and internationally throughout the world.

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Contact: Marc Wride, Vice-President,  
Marketing

Branch office: INTERA Technologies Inc.,  
Austin, Texas, U.S.A.



**Company background.** INTERA is an established remote sensing company offering services in

- data acquisition and processing
- interpretation and image analysis
- data enhancement
- applications research
- system research and development
- system configuration
- workshops and training

INTERA owns and operates multiple airborne sensor systems and aircraft for data acquisition and specializes in custom sensor work, as well as large mapping programs.

**Sensors and systems.** INTERA has organized and conducted airborne mission research campaigns for the application of imaging radar in Europe, Japan, Canada and the United States. Current activities include major imaging radar data acquisition programs in Canada, Indonesia, Papua New Guinea and the United States. The radar program data is acquired using STAR-1, the digital airborne synthetic aperture radar (SAR) developed by INTERA to map both sea

**INTERA'S STAR System is the new generation of synthetic aperture radar (SAR), used for ocean surveys, ice surveillance and land-use mapping.**



**INTERA combines theoretical expertise and practical experience, leading to innovations.**

**An INTERA STAR-1 airborne X-band SAR image with 6 m x 12 m resolution, near Harrisburg, Pennsylvania, U.S.A. Topographic maps can be made from these images.**

ice and terrain. When collecting ice imagery, the image data are processed and radio down-linked in real-time to a surface operation base. INTERA developed STAR-VUE, a custom system to receive, store and manage STAR-1 data for tactical operation.

Recent innovations and applications of radar imagery include an operational topographic mapping capability and production of digital terrain models. INTERA is currently producing digital mosaics from STAR-1 data. Applications of the data include geologic mapping, forest change detection and land-cover mapping in addition to ice surveillance.

INTERA has configured and applied various other sensors in airborne platforms including thermal scanners, laser profiling systems, radar altimeters and photographic systems.

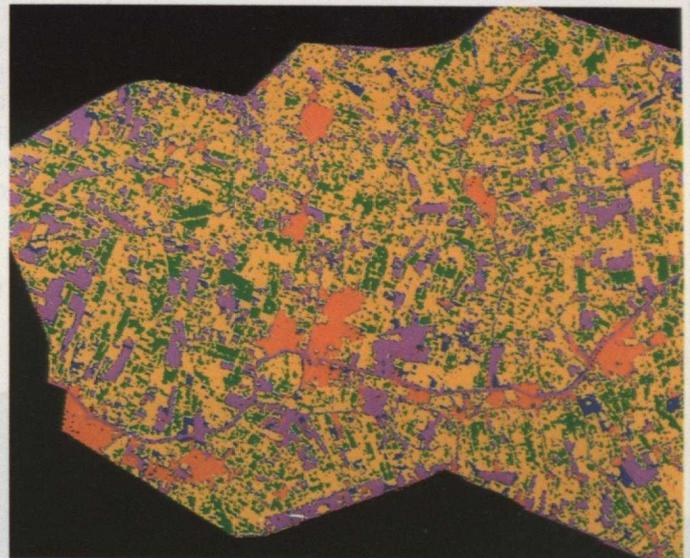
INTERA's scientists and consulting staff are researchers, system managers, image analysts and programmers, who develop, evaluate, operate and maintain various digital image analysis systems (STAR-VUE, RIDS, CIAS, LDIAS, ARIES, PERCEPTOR). These systems are used extensively by government and non-government agencies for applications of remote sensing data which include LANDSAT TM and MSS, SPOT, SEASAT, airborne SAR, airborne MSS and MEIS. INTERA staff have used these systems for more than 12 years for research and applications projects and to train national and international scientists. Company staff also evaluate new remote sensing data sources as they become available (i.e., MEIS, FLI, SAR) by participating in field and data acquisition programs, developing applications and methodologies.



**INTERA'S STAR System is a breakthrough in radar technology, uniting a lightweight, digital synthetic aperture radar (SAR) and a high-performance, fuel-efficient turboprop aircraft. The system combines all-weather capability with the advantages of real-time data processing, hard copy output and wide swath.**

**Joint ventures.** The company is experienced in establishing joint venture arrangements with other organizations worldwide. INTERA's depth and breadth in remote sensing technology allows the company to offer a full range of services, data integration capability, and flexibility in responding to a client's requirements.

**Training.** Remote sensing courses, workshops and training are offered by INTERA professionals to national and international agencies.



**LANDSAT TM imagery used for land use inventory, agricultural monitoring and change detection in the Nile Delta of Egypt in areas of valuable and limited agricultural lands. Orange shows urban; purple, wet fields/canals; blue, infrastructure/fields; yellow, crops (berseem); green, crops (wheat).**

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Calgary, Alberta  
Canada T2E 7H7

Tel: (403) 274-7440

Contact: Dr. Clifford D. Anger, President

**Company background.** ITRES was founded in 1979 to develop and commercialize applications of emerging solid state imaging technology. Its president, Dr. Clifford D. Anger, is active in the development and use of imaging technology in the Canadian and U.S. space science programs.

**Research and development.** ITRES has focused on the development of CCD-based digital imaging systems and subsystems for specialized optical, infrared, and X-ray applications involving airborne remote sensing, space science, astronomy, and non-destructive materials testing. ITRES has also carried out feasibility and design studies for a low-cost laser fluorosensor for airborne detection of offshore oil spills.

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Tel: (613) 521-1630  
Telex: 053-4173 KENSCI OTT

**Company background.** Kenting Earth Sciences International Ltd., one of Canada's largest resources mapping and development companies, owns and operates three fixed wing aircraft equipped with a variety of aerial photography and geophysical exploration equipment. The firm has been involved for more than 35 years in the following fields of activities in Canada and overseas.

**Aerial photography, field surveys, and cartography.**

Aerial photography is produced at scales ranging from 1:2 400 to 1:100 000 and processed in the firm's photolab facilities. The field survey department performs a wide range of services for engineering requirements. The combination of precision airborne photography and ground measuring equipment finds applications in geodetic surveys, photogeological mapping, route locations and preliminary designs for highways, railroads, pipelines, transmission lines, and others. Topographic mapping is prepared at scales ranging from 1:500 to 1:250 000. Conventional or digital mapping, monochrome or colour, is produced in-house. Kenting has always been at the forefront of new developments and, using equipment such as Calcomp flatbed table, Calcomp drum plotters, Wild RAP com-

Contacts: Joseph Sauvé, President  
Robert Stemp, Vice-President  
Don Fitzsimmons, Vice-President  
John Michael, Manager of  
Photogrammetry

Branch offices: Kenting Africa Resources  
Services Limited, Kano, Nigeria

puter-assisted plotting system or Kern MAPS 200, has already carried out many digital mapping contracts. Kenting also operates the largest number of stereo-plotters in the Canadian private sector with production offices in Ottawa and Toronto, Ontario, and St. John's, Newfoundland. A full range of remote sensing capabilities is available in narrow band and multispectral photography, infrared photography and scanning, laser profiling and satellite imagery interpretation.

**Airborne geophysical exploration.**

The company's experience in this field includes high or low sensitivity magnetometer, spectrometer and electromagnetic surveys, and vertical gradiometer capabilities. Kenting has also designed and built a new generation of equipment called the Kenting Digital Surveys System (KDSS). It is a computer-based highly accurate airborne survey tool that simultaneously records several types of geophysical data such as radiometric, magnetic and electro-magnetic. Kenting has flown more than 25 million km in mineral and oil exploration surveys.

**Resources department.**

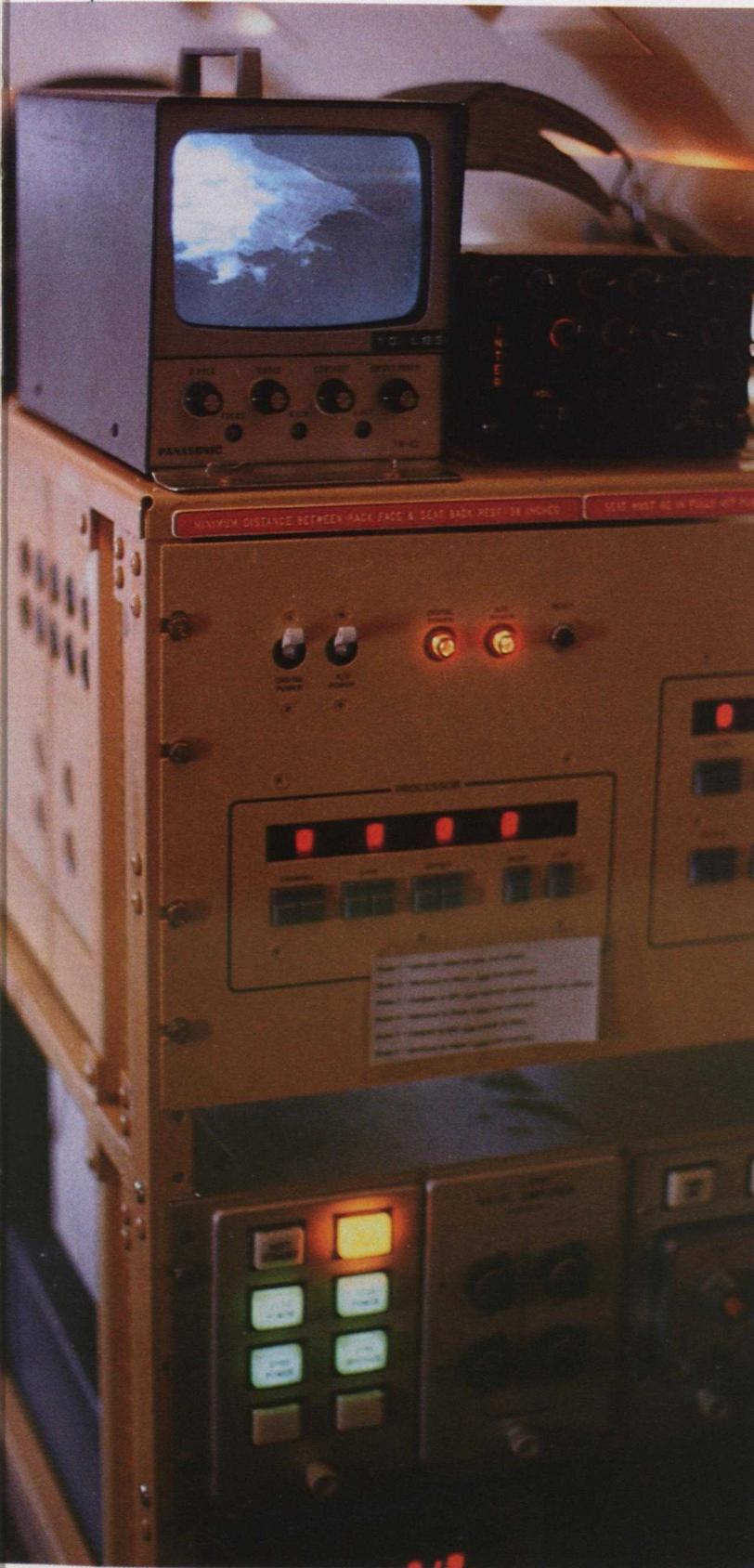
Kenting's team of specialists has on many occasions identified development projects, subjected them to analysis and produced feasibility reports to international lending agency standards. The capabilities include integrated rural development, photo interpretation, soil mapping, land-use and land-capability mapping, geological and geomorphological studies, surface and ground-water studies, forestry and reforestation, erosion, regional planning and integrated river basin studies.

Kenting's Piper Navajo aircraft is shown in gradiometer configuration.



## KNUDSEN ENGINEERING LIMITED

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Tel: (613) 267-1165  
Contact: D.C. Knudsen, President



### Company background.

Knudsen is engaged in the design and manufacture of advanced digital electronic systems and related products. Two specialized, but expanding markets have been targeted for initial emphasis: airborne remote sensing systems and underwater acoustic systems. Although seemingly unrelated, the two fields share a great deal of technology, particularly in the areas of digital signal processing and image enhancement and display. Both products effectively utilize the expertise and experience of Knudsen Engineering's technical staff.

Although long-range emphasis is on product development and manufacturing, the company also performs contract research and development — including field work, particularly as related to Arctic conditions and ice-covered waters. Clients include the Canada Centre for Remote Sensing, ESSO Resources, Litton Systems, the Environmental Protection Service, and through subcontracts, Dome Petroleum, Gulf Canada and the Arctic Pilot Project.

**Products.** Currently, Knudsen Engineering Limited offers two products for the international remote sensing market: the ALICE Display and the ALICE Processor System. Both are state-of-the-art digital electronic systems for application to airborne linescan imagers. The company is now supplying ALICE digitizers to Daedalus International of Ann Arbor, Michigan, for incorporation into its airborne linescanners.

The ALICE Color Display is a high-performance image enhancement and display system designed specifically for airborne remote sensing, applicable to both rotating mirror and push-broom linescanners as well as side-looking and synthetic aperture radar systems. ALICE generates a real-time, in-flight video presentation of the data produced by a digital linescan imager and its firmware-based architecture provides an impressive array of scan conversion, annotation, and image enhancement features.

The ALICE Processor is a digitizer and digital signal processing system designed for rotating mirror airborne linescan imagers. Up to 12 channels of analogue video are digitized, radiometrically and spatially corrected and transmitted to a digital recording system.

Both ALICE products are ideally suited for several areas of remote sensing including oil spill reconnaissance, agricultural remote sensing, search and rescue, and forestry.

ALICE, a state-of-the-art digital electronic system, supplying real-time display, verification and image analysis during an airborne linescanner data acquisition over an offshore gas well blow-out.

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**Company background.**

MacDonald Dettwiler, founded by Dr. John MacDonald and Vern Dettwiler in 1969, is the largest privately owned Canadian high-technology company in western Canada. The firm specializes in high-quality digital information handling technologies, and sets industry standards in remote sensing, airborne and spaceborne synthetic aperture radar systems and digital film recorders.

The company currently employs more than 500 people in its two Richmond locations. More than half of these are highly skilled professionals in the fields of electrical engineering, computing sciences, physics, mathematics, meteorology and other related disciplines. These professionals form the core of an experienced team, capable of taking on a wide variety of challenging remote sensing tasks designed to solve customer problems and fill their current and future needs.

MacDonald Dettwiler is organized into three divisions. The Systems Division serves international markets in remote sensing satellite ground stations, image processing systems, satellite mapping and synthetic aperture radar (SAR) systems. The Electro-Optical Products Division manufactures precision digital film recorders for the electronics industry and the graphic arts market. The Airborne Radar Division manufactures a real-time digital SAR system for the military surveillance/ reconnaissance market and the civilian ice-reconnaissance and radar mapping markets.

Contacts: Alex Klopfer, Executive Vice-President, Electro-Optical Products Division  
Bernie Clark, Manager, Systems Division

Branch offices: MacDonald Dettwiler Technologies Inc., Anaheim, California, U.S.A. ;  
MacDonald Dettwiler & Associates, Malaysia

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Telex: 36226 HISCO MA

**Achievements and products.**

The history of MacDonald Dettwiler has been a series of technological achievements and world "firsts." In 1974, the company designed and built the world's first complete LANDSAT ground station packed into a 3 m x 12 m (10 ft. x 40 ft.) trailer, for the Canadian government. In 1978, in close competition with the Jet Propulsion Laboratory, the company produced the first digitally processed synthetic aperture radar satellite image from SEASAT data. In 1979, it designed the first airborne digital radar processor for the Canada Centre for Remote Sensing. And 1981 saw the development of the Color FIRE 240 digital film recorder which received an IR-100 award in 1982. (The IR-100 awards are given to the top 100 new industrial designs

developed each year.) In 1986, the Systems Division introduced MERIDIAN, a satellite mapping system featuring fully automated digital terrain model and mapping production.

Complete LANDSAT ground station systems have been designed and built for the governments of Canada, Sweden, Australia, Thailand and Indonesia. Major subsystems have gone to Japan, Saudi Arabia, India and NASA. Weather satellite ground station and processing systems have been supplied to the governments of Canada, Malaysia, Hong Kong, the Philippines, Denmark, Indonesia and Peru.

As a follow-on to the FIRE and Color FIRE 240, which have become the preferred high-resolution film recorders in the worldwide remote sensing

community, MacDonald Dettwiler serves the electronics industry with the FIRE 9000. It is currently the fastest and most accurate laser photoplotter for printed circuit board production on the market. The company also markets a digital pre-press proofer based on the same technology, the FIRE 300, capable of delivering digital images in 10 minutes. The success of the FIRE technology is based on the combination of engineering that yields high-value products, markets, and service that is responsive to customers' needs.

**LANDSAT-5 Thematic Mapper image of mountainous region of British Columbia. Left overlay classifies forest cover for type, age, height and site class. Right overlay shows rivers, roads, power lines and topographic features.**

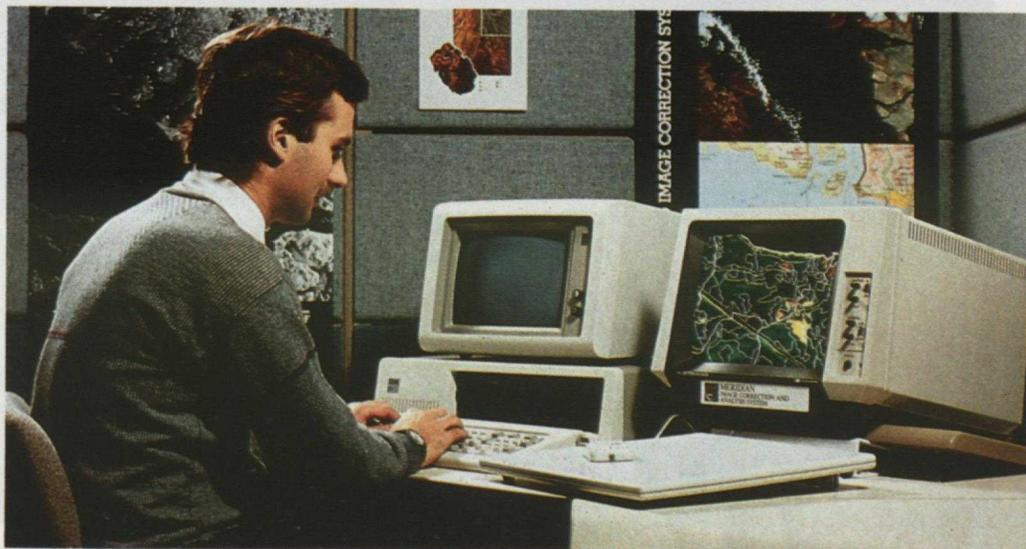


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 Dr. R.L. Green, Director  
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 Contact: Frank Smith, President

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 Contact: John West, Vice-President



Digital elevation model from satellite images taken at two viewing angles shows a 3-D perspective for geological and mapping applications.

**MERIDIAN** is the world's first operational end-to-end satellite mapping system, with powerful image processing and mapping graphics functions at low cost.

The Systems Division has undergone rapid growth in 1986. Marketing, sales and service offices have been opened in Ottawa, London, Washington and Kuala Lumpur. New offices to service present and future Electro-Optical Products Division customers have also been opened in the U.S. and Europe.

**Current projects.** Current major developmental programs include a prototype digital weather forecasting system for the U.S. Air Force, the Automated Weather Distribution System (AWDS), due to be delivered in early 1987. In Europe, MacDonald Dettwiler is the prime

contractor for the ground segment of the European Space Agency's ERS-1 satellite project. As part of a consortium of major European aerospace firms, the company is responsible for the design and integration of the ground station located in Kiruna, Sweden. This project is scheduled for completion in 1989. In Canada, the company has a major contract with the Canada Centre for Remote Sensing to upgrade existing ground station facilities at Prince Albert, Saskatchewan. MacDonald Dettwiler exported 46 per cent of its remote sensing products in fiscal 1985. Canadian content as a percentage of the export sales was approximately 90 per cent.

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Contact: Victor Ward, Ph.D., Vice-President

### Company background.

MONITEQ, an innovative high-technology company, specializes in the development and application of electro-optical remote sensing instruments for a wide range of resource management, mapping and environmental applications. The company provides both the hardware to acquire the data and the software to subsequently analyze it. Complete contract research and development capabilities allow the company to satisfy customer requirements. Consulting services are also offered. MONITEQ has exported its products and services throughout the world.

**Products.** MONITEQ's products include the following:

**PMI** — The airborne programmable multispectral imager (PMI) developed by MONITEQ measures the low radiance light fields characteristic of water scenes. It has very high spectral resolution (2.5 nanometres) over 288 bands. The imager is based on two-dimensional CCD technology and has been operational since 1983. PMI provides shallow water depth mapping, bottom type classification and various water quality parameters. Among its land applications are geobotanical and geological mapping, and vegetation, stress, forestry and crop management. Defence use includes border surveillance, camouflage detection, trafficability studies and mapping.

**AIR II** — The airborne imagery acquired with the PMI can be accurately positioned with a MONITEQ-developed geometric correction software system, AIR II, allowing different flight lines to be co-registered and imagery integrated with existing geocoded databases.

**GASPILS** — Another MONITEQ airborne remote sensor, GASPILS, measures hydrocarbons and other gases with absorption features in the thermal infrared (IR). Applications include gas pipeline and oil spill monitoring, chemical warfare agent detection, chemical leakage and perimeter monitoring.

The Canadian-developed Fluorescence Line Imager (FLI), or programmable multispectral imager, represents a major advance in capabilities for shallow water depth mapping, bottom type classification, water quality parameters, geobotanical and geological mapping, and vegetation, stress, forestry and crop management.



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 Telex: 05-823509 MPB TECH MTL

**Company background.**

Federally incorporated in 1976, MPB Technologies Inc. specializes in high-technology systems and products and in contract research and development. The company occupies a modern 2 800 m<sup>2</sup> (30 000 sq. ft.) building in Dorval, Quebec. Integrated into the building is a modern library, a central computer room, a machine shop, laboratories and production area.

MPB Technologies Inc. develops and produces remote sensing devices using the microwave and millimetre wave region of the electromagnetic spectrum. These include both passive sensors (radiometers) and active sensors (radars and scatterometers).

**Products research and development.**

A ground-based radiometer receiving at six frequencies from 22 GHz to 58 GHz has been built for use by Canada's Atmospheric Environment Service (AES) in determining humidity profiles in the atmosphere. An airborne imaging radiometer is being developed for the Ice Centre of AES. This receives on two polarizations at each of two frequencies, 37 GHz and 90 GHz, using a scanning beam, and

Contacts: Dr. M.P. Bachynski, President  
 Dr. A.K. Ghosh, Director,  
 Program Development

produces map-like displays of the surface below the aircraft in pseudo-colour. In addition to presenting brightness temperature maps, special algorithms are used to derive maps of first-year ice fraction, multiyear fraction and total ice fraction.

A C-band scatterometer was designed and built for the Canada Centre for Remote Sensing where it has been operational for three years. The scatterometer is a completely solid state 5.7 GHz CW (continual wave) dual polarized, airborne homodyne radar. It transmits a five-watt CW signal in a fan beam with horizontal or vertical polarization selectable by the operator. This illuminates a strip of the earth's surface directly beneath the aircraft with a two-way 3 db beam width of 120° along-track and 3° cross-track using separate transmit/ receive antennas. Coherent demodulation produces IF (intermediate frequency) signals in phase quadrature, giving unambiguous fore/aft Doppler information. The real-time signal processor has selectable filter circuits for remote sensing over land and sea.

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 St. John's, Newfoundland  
 Canada A1B 3T2  
 Tel: (709) 364-1200  
 Telex: 016-4596 NORDCO SNF  
 Contact: Frank Smith, President

**Company background.**

NORDCO is the largest, independent, multidisciplinary firm in Canada specializing in marine research and resource development. Its main computer is a DEC VAX 11/750 with 15 workstations, including an ARIES III image display and analysis system.

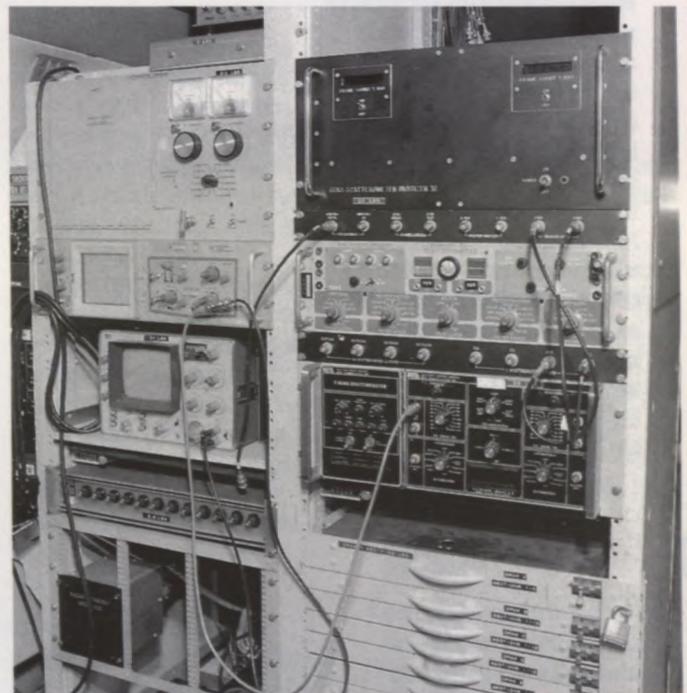
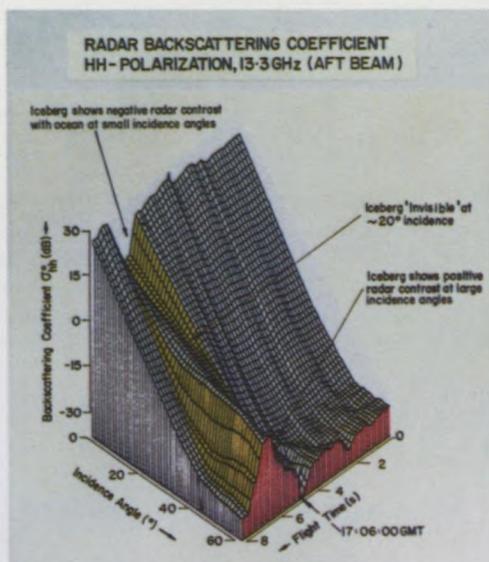
**Services.** NORDCO offers substantial computing and image processing capabilities for applications in sea surface temperature mapping, utilizing the AVHRR on the NOAA series of polar orbiting satellites, and in enhancing digitized sidescan sonar imagery.

NORDCO is involved in the acquisition, compilation and interpretation of data on coastal geomorphology, oceanographic process, biological resources and socio-economic factors for

assessing coastal development planning and effective resource management. Major elements are ice research, geophysical and geological services. "Geo" services are marketed through a subsidiary, the consulting consortium of Geonautics Limited whose member companies have 300 specialists.

Consulting services include remote sensing organization; design and implementation of remote sensing programs for public or private agencies; matching of data needs and available technologies; evaluation and monitoring of remote sensing programs; and technology transfer/enhancement.

Applications services are provided in forestry, hydrology, geomapping; land-uses mapping; ice; and oceans.



Scatterometer results over an iceberg, used to calibrate an airborne radar.

MPB's scatterometer on board the CCRS aircraft is used to calibrate radars and do radar meteorology by inferring wind speed and direction over the ocean.

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**Company background.** Nortech Surveys, a high-technology surveying and navigation company, has been offering services worldwide for some 10 years. Operating from its Head Office in Calgary, it has operational offices established in London, U.K.; Muscat, Oman; and Sydney, Australia. The company has export experience in 22 countries throughout the world and offers training in Canada and on site.

**Services.** Each office provides a complete range of services including inertial positioning for geodetic and photo, airborne laser terrain profiling for route surveys and corridor mapping, and GPS positioning for marine and airborne navigation and high accuracy geodetic control. In addition, Nortech has experience in the integration and implementation of unique surveying systems, particularly for airborne profiling, rig positioning and aircraft navigation. These high-technology services are augmented by Nortech's abilities in traditional land surveying and marine positioning. Equipment owned by Nortech includes Ferranti inertial systems, JMR transit receivers, TI and Trimble GPS (global positioning system) receivers, ARGO and Del Norte radio positioning systems, as well as a host of conventional surveying equipment and portable desk-top computers.

Contacts: A. Hittel, Chief Executive Officer  
T. Crago, Vice-President  
Branch office: Nortech Surveys (UK) Ltd.,  
London, U. K.

Applications include structural mapping for tectonic evaluation, surface geomorphology and erosion phenomena; mapping and cartography for land-use inventories and geographic information systems; and real-time ice surveillance.

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Contact: Hervé Audet, President

**Company background.** OCTOGRAPHE, founded in 1985, works in the development and marketing of methodologies, software and systems, and processed images, as well as in consulting or production services in the fields of application of remote sensing and map digitization. OCTOGRAPHE makes a major contribution to computer-assisted image interpretation with its OCTIMAGE system. OCTIMAGE is a combination of hardware and software that permits the loading, manipulation and storage of digital images for the purpose of extracting geographical information.

**Products and Services.** OCTOGRAPHE is part of the SURVAIRLAB Group, thus giving it access to a large pool of resources and expertise in land-related activities. Some of the companies also part of SURVAIRLAB are the following:

- Hauts-Monts Inc. executes mandates in aerial photography and radar mapping. Radar mapping is the ideal method of aerial surveying in dense forests or jungles.
- Société Cartonumérique S.C.Q. Inc. executes mandates in photogrammetry and in digital mapping.

- SAIG Inc. carries out research and development and marketing of computer-assisted mapping software. SAIG Inc. has three products of current interest:

- Numerigraphe for digital mapping;
- Sylvographe for forestry engineering; and
- Volugraphe for volumetric studies.

- Cartech Inc. executes mandates in photo interpretation in forestry and other land-use applications.

OCTOGRAPHE and other SURVAIRLAB companies have a blend of resources and experience that offers unique solutions to problems.



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Contact: Bill Matvichuk, Marketing  
Manager

**Company background.** Optech Incorporated has been operating since 1974 in the field of applied laser and electro-optical technology. The Toronto-area company specializes in laser radar systems and has designed and built a variety of such systems for industrial, government and university users.

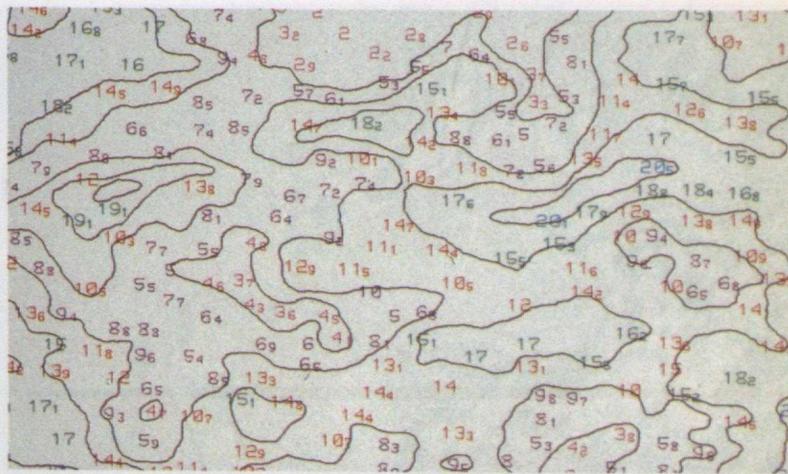
Optech offers a number of standard manufactured units and also will develop customized systems to meet particular requirements. Employing its extensive capability in modern laser technology, the company has built systems using solid state, injection and gas discharge lasers, including excimers. Having extensive experience with computers and microprocessors, Optech can provide fully computerized systems when required. In addition, company personnel have many years of experience in the development of ruggedized laser systems for field use in vehicles and aircraft.

Laser radar systems have been delivered to customers in several countries and are now being used for a variety of tasks including atmospheric diagnostics, pollution monitoring, hydrographic surveys in coastal waters and water depth sounding, terrain profiling, wave height measurement and range finding.

**Products and services.** The company offers these products and services:

- laser radar systems manufacturing
- custom electro-optical systems
- consulting and design services
- R&D and engineering services

**Laser radar systems.** Laser radar, often termed lidar, is a recently developed application of laser technology in which the scatter of light pulses is used to measure properties of a remote target. Lidar (light detection and ranging) operates on the same principle as radar but uses laser



An enlargement from the world's first commercially produced hydrography chart using airborne laser technology. Laser by Optech; operation by Terra.

light waves in place of radio waves. In lidar, a laser source emits a very short, high-intensity light pulse and a telescope sighting along this beam picks up any of this light that bounces back from objects in its path. Various electronic devices measure and record the backscattered light signal.

With the wavelength of the laser light radiation being hundreds of times shorter than the wavelength of radio waves used in conventional radar, lidar is able to detect particles hundreds of times smaller than those detectable with radar. Consequently, for atmospheric measurements, lidar is capable not only of detecting the microscopic pollutant particles but also of measuring the presence of various molecular species in the air. For distance measurement, the ultra-short pulse length and very narrow beam dimension permit spatial resolution much better than is possible with other methods.

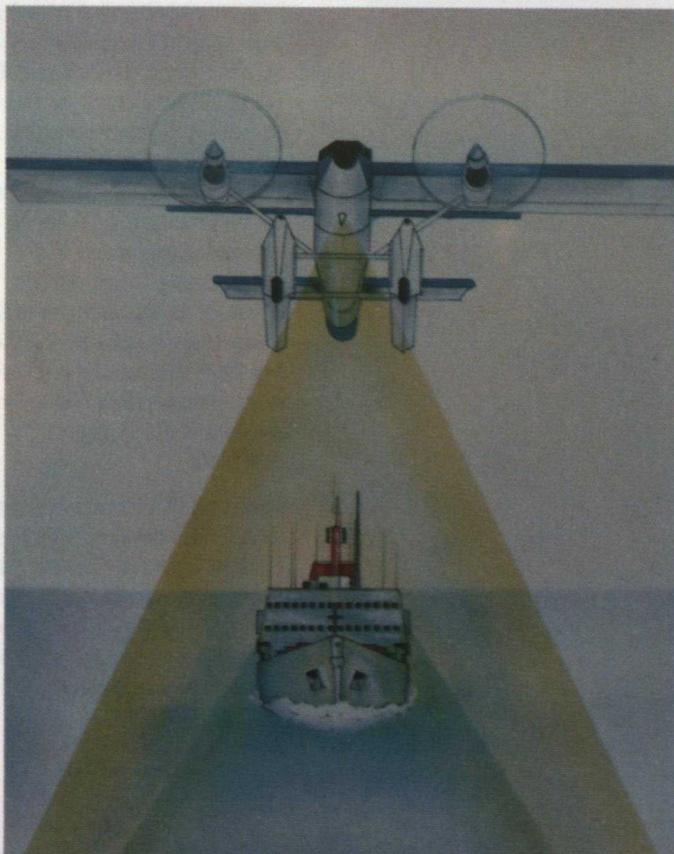
Lidar techniques also can be used to probe under water. Light returned to the telescope can be

Optech's LARSEN, a newly developed Canadian laser-based, powerful, fast and cost-effective tool for hydrographic surveying of shallow coastal and inland waters.

used to accurately measure water depth and to indicate the turbidity or clarity of water to help determine water quality. As these systems can be operated from aircraft as well as ships, lidar offers a unique capability for high speed and large area coverage of water resources.

**Projects and activities.** Optech is active in many varied projects that include the following:

- development of airborne laser instrumentation for altimetry, terrain profiling and water depth measurement;
- assessment of atmospheric monitoring from satellites;
- evaluation studies of laser absorption systems for detection of atmospheric pollutants;
- design and construction of a two-channel ultraviolet lidar system for Raman and differential absorption measurements of maritime atmospheres;
- analysis of atmospheric perturbations on infrared ranging and imaging systems.



## PAMAP GRAPHICS LTD.

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Contact: Dr. Pamela Sallaway, President

## PCI INC.

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Contacts: Murray Strome, President  
Emery Miller, Secretary  
Ed Jurkevics, Sales Manager



**Company background.** PAMAP Graphics Ltd. is a high-technology company specializing in software development and information processing of land-use management and resource planning applications.

PAMAP has gained wide recognition, both nationally and internationally, in the application of remotely sensed data. Its products reflect the company's belief in the future of this data source.

The PAMAP geographic information system (GIS) has been designed to interface with image analysis systems.

**Resource management.** PAMAP's experience in resource management encompasses the following areas:

- image analysis
- geographic information systems
- land-use management
- computer-assisted mapping
- thematic mapping
- digital terrain modelling

The PAMAP geographic information system offers superb capabilities in data capture analysis.

**Research and development.** PAMAP maintains its role as a leader in the processing of geographic information via a very active research and development program. Together with agencies such as the Canada Centre for Remote Sensing and the British Columbia Ministry of Forests in Canada, the company is researching the areas of resource management in search of applications for remotely sensed data.

**Company background.** PCI, a wholly Canadian firm incorporated in 1982, has a staff of 25. The company develops computer software and computerized equipment for the analysis of digital image data, seismic and mapping data for use in resource management, environmental monitoring, geophysical exploration, land-use planning, weather data analysis, cartographic and other mapping. PCI has developed a unique set of software tools to simplify the interface between the scientific user and the computer. These tools can also greatly improve the productivity of computer programmers engaged in the development, modification or conversion of large, complex scientific applications software systems.

**Products.** The company developed the product EASI/PACE, a turnkey image analysis software package designed to be highly transportable so that it can be used on several different computer systems with a wide variety of image display devices.

The PAMAP geographic information system provides all of its mainframe functionality on microcomputer.

As an adjunct to EASI/PACE, PCI created the scientific software development tool EASI/IMP. It provides the utilities to assist programmers in developing complex scientific software systems more effectively, isolating machine dependent features to gain the transportability of EASI/PACE, and in isolating the application programmer from man-machine interaction considerations. This product provides automatic on-line HELP and manual generation from in-code documentation, and consistent user interface and error handling. EASI/IMP led PCI (in co-operation with Roy Ball Associates of Ottawa) to develop IMAVISION, a low-cost, turnkey image analysis system based on the IBM PC-AT.

PCI has recognized the strong tendency to couple digital image analysis capabilities with the rapidly growing use of geographic information systems (GIS) for resource management. All levels of government, as well as private industry engaged in resource management and environmental monitoring, are changing their operation from paper map base to digital information systems. To take advantage of this trend, PCI is now implementing a series of GIS to operate on modern computing equipment. Three levels of the product will be released: an enhancement to the image analysis software in October 1986, followed by two versions of stand-alone GIS to be released in the spring of 1987 and 1988.

**Services.** PCI has recently initiated service-oriented activities. Using in-house equipment, it is offering resource management consulting services, digital image analysis services and an expanded range of training courses.



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**Company background.** Ph.D. Associates Inc. is a consulting and services company primarily involved in scientific applications of computing in the field of ground-based, airborne and satellite sensing, instrument control, data processing and imagery analysis.

**Research.** In conjunction with Canada's Atmospheric Environment Service, Ph. D. Associates Inc. has been conducting research into the utilization of passive microwave satellite data for the remote sensing of soil moisture.

**Services.** The company also specializes in satellite applications for monitoring of the oceans, including wind speed measurements over the open ocean for short-term climatological forecasts, for marine operations, and for snow cover and sea ice measurements.

Applications also include land uses and hydrology; data processing, analysis and management; system programming; software maintenance; operational support; and instrumentation control.

Prairie Agri Photo's colour infrared aerial photography enables grain and fruit producers to assess strengths and weaknesses of their crops quickly and easily.

Contact: Frank E. Bunn, Ph.D., President

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Carman, Manitoba  
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**Consulting.** The company offers consulting services on remote sensing organization, and image interpretation and mapping for agriculture, environmental analysis, route selection and water quality.

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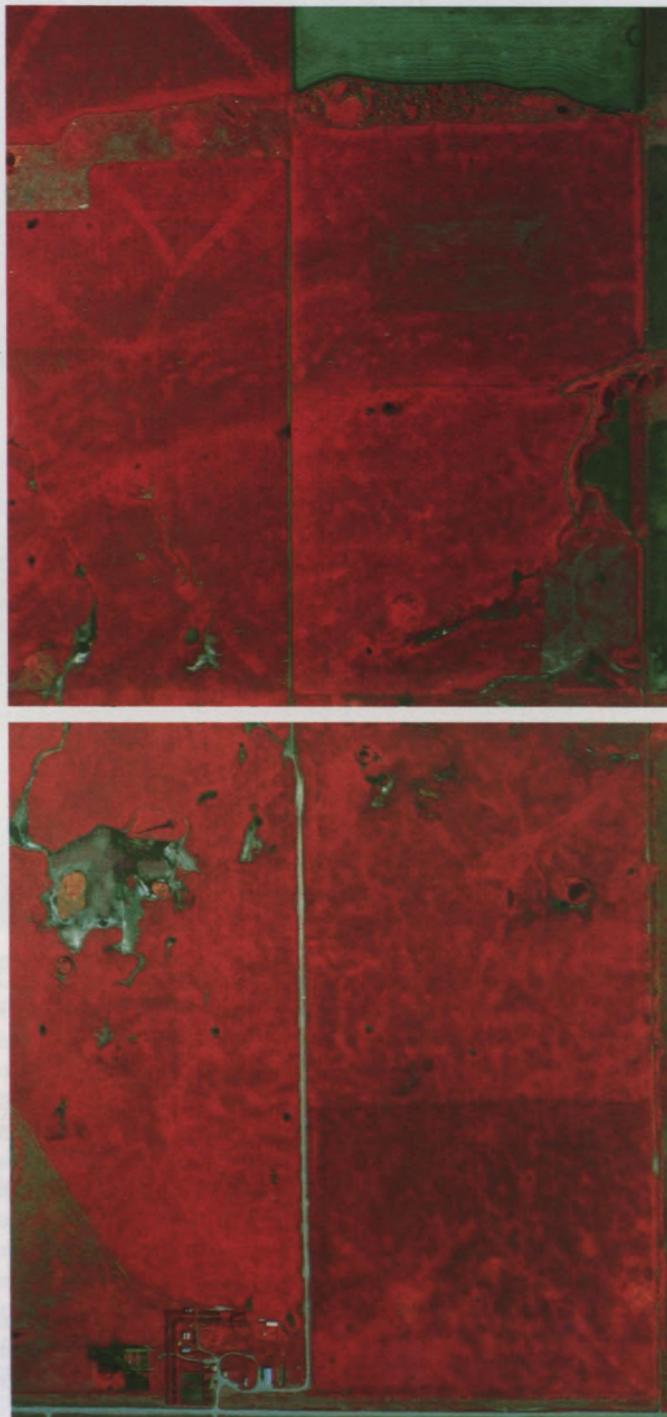
**Company background.** Prairie Agri Photo specializes in infrared aerial photography and "scenic" aerial photography. Founded in 1975 by its present owner, Jack McKinnon, the company has experienced a steady growth pattern over the decade.

Contact: Jack McKinnon, President/Director  
Branch office: Prairie Agri Photo Inc.,  
Winterhaven, Florida, U.S.A.

**Facilities and equipment.** Its assets include its home-office building with administrative facilities and full dark room capabilities, a Cessna 172 aircraft, four Hasselblad 70 mm IR camera systems, and three 6 cm x 7 cm Pentax medium format systems.

**Services.** The company uses infrared aerial photography to enable grain and fruit producers to assess their crops' strengths and weaknesses quickly and accurately. An infrared photo can indicate fertilizer response, weed infestation, poor drainage, soil differences, and other features. It is used as a management tool to improve productivity. In Florida, Prairie Agri Photo offers its infrared capabilities to professional managers of vast tracts of citrus trees. A manager responsible for assessing the health of a million orange trees can get a quick and efficient tree count and identify every ailing tree by using the company's relatively inexpensive infrared aerial photography services.

Prairie Agri Photo also offers consulting services on the design and implementation of remote sensing programs; on practical matching of data needs and available technologies; and on decisions related to technology transfer. The company offers image interpretation and mapping services in the fields of agriculture and environmental analysis. Land-use applications include main crop inventories, early acreage estimates, forage production estimates, soil utilization, crop optimization, disaster quantification, crop stresses evaluation, drought, salinity stress, shrub encroachment, wetlands classification, and management information for crop producers.



## ROY BALL ASSOCIATES LTD.

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Contact: John Amyot, Vice-President,  
Marketing and Sales



**Company background.** Roy Ball Associates Ltd. (RBA) is a Canadian owned and managed company founded in 1978 to provide systems analysis and applied research services to governments and private industry. A commitment to customer satisfaction and service has resulted in rapid company growth and diversification.

Today, RBA has the systems expertise, software and hardware design engineering knowledge and the manufacturing capability to provide state-of-the-art technological system solutions and highly engineered quality products. The company's expertise lies in real-time computer sys-

tems for data acquisition and control; image processing and pattern recognition; and signal processing.

**Activities.** Current activities are concentrated in the following application areas:

- digital communications
- electronic warfare
- remote sensing
- electronic security systems
- seismology
- military image processing

**Engineering services.** The company offers these specialized services:

- systems engineering and applied research
- custom software development
- custom equipment design and manufacture

**Products.** RBA's products include the following:

**IAS 1000** — inexpensive but powerful microprocessor-based image analysis system;

**SPS 3000** — signal processing system based on INTEL's Multibus architecture with special design high-speed simultaneous sampling D/A and A/D interfaces.

**IMAVISION** is a personal-computer-based system with quality image analysis for training, research, development and production.

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Sensing Department  
Kent McKerlie, Director of  
Marketing  
Doug Bassett, Manager,  
Aerospace Systems Department



SED's research finds new ways to make technology serve customers' needs.

**Company background.** SED Systems Inc., an advanced-technology systems engineering company, offers unique capabilities and comprehensive experience related to remote sensing technology. These include turnkey ground stations, telemetry, tracking and command systems, real-time software, meteorological data reduction systems, scientific instruments and sensors for spaceflight, and remote sensing services and products.

**Services.** Remote sensing services include the continuous operation of Canada's Prince Albert Satellite Station (PASS) over the past 15 years. This contract, to the Canada Centre for Remote Sensing, has assured the reception of quality remote sensing data from LANDSAT, NOAA and SPOT and the distribution of a variety of photographic and digital products to meet the needs of the Canadian remote sensing community.

Through co-operation with the Saskatchewan Research Council, SED is currently pursuing the production of value-added information products, derived from satellite remote sensing data.

**Products.** SED's first ground station contract, the conversion of a radar laboratory into PASS, helped bring remote sensing to Canada in 1971. Since then, SED has built over 40 earth stations, primarily for satellite communications applications, and installed them around the world, from the Canadian Arctic to the tropics of Brazil.

The first atmospheric test instrument (WAMDII: a Michelson imaging interferometer) to fly aboard the Space Shuttle in 1989 is being designed and built by SED while a Suprathermal Ion Mass Spectrometer (SMS), another SED design, will be the first foreign instrument on a Japanese spacecraft, EXOS-D.

**Projects.** SED has played a major role in such projects as the joint surveillance systems (JSS), search and rescue satellite (SARSAT), Canadian patrol frigate (CPF), Anik A, B, C, and D, satellite business systems (SBS) and, of course, LANDSAT. Among the company's key customers are Hughes Aircraft, Paramax Electronics (SPERRY), Telesat Canada, Spar Aerospace, Raytheon, INMARSAT, the Canadian departments of National Defence and Energy, Mines and Resources, and others.

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Contacts: Ron Neville, Director, Program  
Development  
John D. MacNaughton,  
Sr. Vice-President, Marketing  
and Technology

**Company background.** Spar Aerospace Limited commenced operations as a public company in January, 1968, following the acquisition of the Special Products and Applied Research (SPAR) Division of The de Havilland Aircraft of Canada Limited.

The company is engaged in the design, development, manufacture and servicing of systems and products for space, defence, communications, aviation and teleoperator markets. Spar employs more than 2 000 people, including about 600 engineers and technicians — one of the largest technological groups in the private sector in Canada. Sixty per cent of Spar employees are shareholders in the company.

In 17 years of growth, Spar has gained international recognition as an advanced-technology company, and has achieved financial stability by balancing the steady sales base of its gears and transmissions and aviation services operations with businesses serving the fast-growing markets of space and communications. Company revenues for 1985 were \$223 million.

**Business interests.** Spar's business interests are mainly concentrated in the following fields:

**Communications** — Spar has worked on more than 230 projects worldwide for satellite earth stations, subsystems and components.

**Defence** — The company's defence sector has achieved international recognition in the field of military electro-optics.

**Aviation** — Spar is an industry leader in the production of high-precision aerospace gears and transmissions. Spar also repairs and overhauls aircraft and helicopter components and sells aviation products and accessories.

**Teleoperator systems** — The Canadarm, Spar's most widely known product, deploys payload from NASA's Space Shuttle. Spar is the world leader in the design and development and manufacture of "man in the loop" remote manipulator systems.

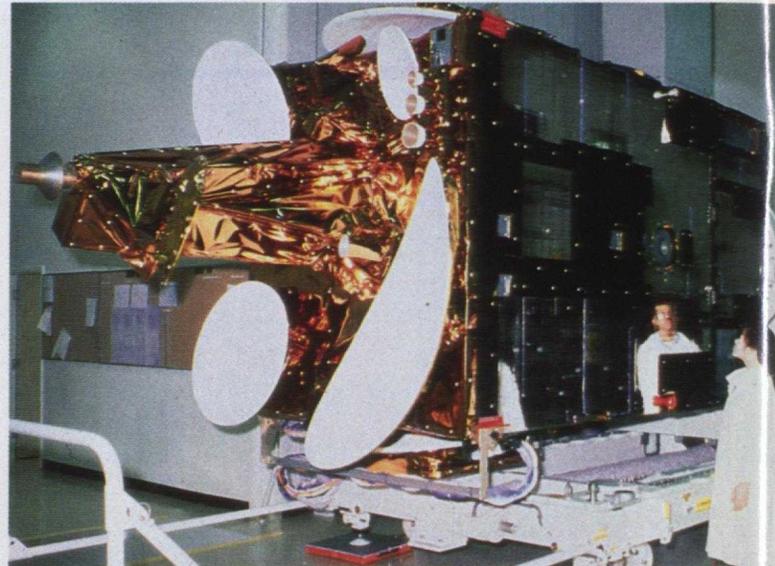
**Activities in space.** Spar's interests are varied and include the following areas:

**Satellites and subsystems** — Spar is the principal supplier in Canada and a major international manufacturer of satellites and satellite subsystems, for communications and remote sensing markets.

Spar and its predecessor companies have contributed to the design and manufacture of 50 satellites and subsystems, including the fabrication of structures, payloads and products for Canadian and international satellites including Anik-A, B, C and D for Telesat Canada; Satcom for RCA; TDRSS for TRW; Olympus for BAe/European Space Agency; and Palapa B and INTELSAT VI for Hughes.

In 1982, Spar was awarded a US \$125 million prime contract to provide two satellites and a related ground control system for EMBRATEL, the Brazilian government-owned telecommunications company.

**Remote sensing from space** — Spar has a \$14.4 million prime contract from the Department of Energy, Mines and Resources to design and develop radar sensing technology for the proposed RADARSAT satellite.



Major members of this industrial team include British Aerospace PLC, Canadian Astronautics Ltd., Canadian Marconi Company, ComDev Ltd., SED Systems Inc. and Telesat Canada. The RADARSAT satellite launch is planned for the early 1990s.

Spar has a long history of contributing to the European Space Agency's remote sensing programs. Spar participated in the Remote Sensing Preparatory Program in technology developments for radar altimeter and data link modems and antenna. Spar is supplying the transmission subsystem for the ERS-1 program.

**Research and development** — Research and development has played an important role in Spar's growth, and expenditures on R&D have averaged approximately 13 per cent of sales over the past five years. Almost one-quarter of Spar's engineering staff devotes its time to R&D projects. In 1984, the company concluded a definition study for the National Research Council of Canada on potential Canadian involvement in the U.S. Space Station.

Spar has worked on more than 230 projects worldwide for satellites and satellite subsystems, for communications and remote sensing markets.

Support for basic research is important to the success of an advanced technology company. Spar's major effort is an advanced research program in artificial intelligence and robotics, undertaken in early 1984, with an initial three-year grant of \$750 000 to the Canadian Institute for Advanced Research to sponsor research at three Canadian universities. The company has seconded four of its most experienced engineers to work with the institute's researchers on this important project. Spar is co-sponsor of an antenna engineering professorship for a five-year period at McMaster University in Hamilton in an effort to help alleviate a critical national shortage in this specialized field of engineering, and provides engineering design courses at the University of Toronto and at McGill University in Montreal.

## TERRA SURVEYS LIMITED

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Terra Surveys Limited,  
Georgetown, Guyana



**Terra is one of Canada's largest resource mapping and geophysical exploration firms, with experience in many countries. It provides consulting, engineering and technical services in the photogrammetric, hydrographic and geophysical fields.**

### **Company background.**

Established in 1966, Terra Surveys Limited provides consulting, engineering and technical services in the photogrammetric, hydrographic and geophysical fields.

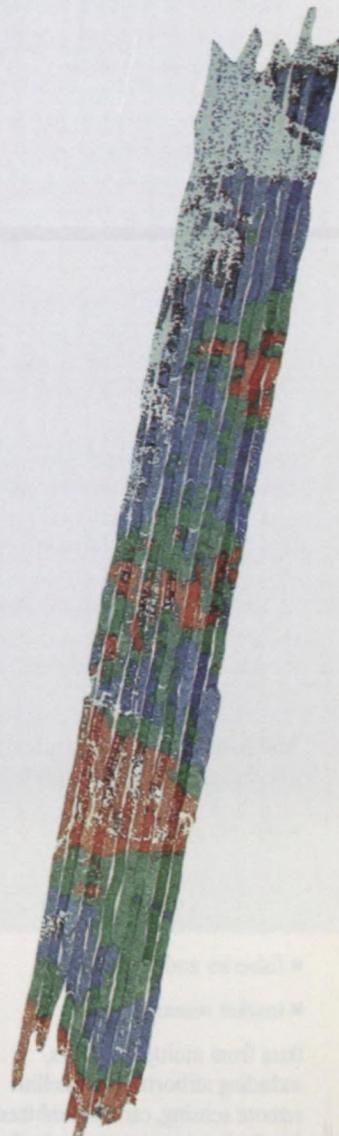
Terra is one of Canada's largest resource mapping and development organizations. Its shareholders are the professional and technical staff who are directly involved in the firm's

day-to-day operations. The firm provides surveying, mapping and engineering services for integrated study projects in rural and urban development, agriculture, forestry and hydrology and in the fields of transportation, distribution and communication. Equipped with modern air survey cameras, ground and airborne geodetic survey units, precise photogrammetric instrumentation, a complete photographic laboratory and an up-to-date data processing facility, Terra provides specialized photogrammetric systems engineering and consulting services to engineering companies, the mineral and petroleum industries, national and local governments and to international development fund agencies.

**Services.** The Hydrographic Division of Terra Surveys Limited provides a complete surveying service in all waters — offshore, coastal, inland and Arctic. Its proven capabilities in collecting and compiling hydrographic data are applicable to projects as follows: charting, drill site investigations, port and harbour development and maintenance, pipe and transmission line crossings, water inventory, marine park development and environmental assessments.

Terra's activities in the field of acquisition of hydrographic data have expanded considerably with the recent development of the LARSEN 500 Scanning Lidar Bathymeter. This system developed by the Canadian Hydrographic Service, the Canada Centre for Remote Sensing, the Department of Supply and Services, Optech Incorporated, and Terra Surveys Limited provides a rapid and effective airborne laser method for the collection of sounding information to water depths of 40 m.

The consulting, engineering and technical services of Terra Surveys Limited are available throughout the world.



**The world's first commercially produced hydrography chart using airborne laser technology. Laser by Optech; operation by Terra.**

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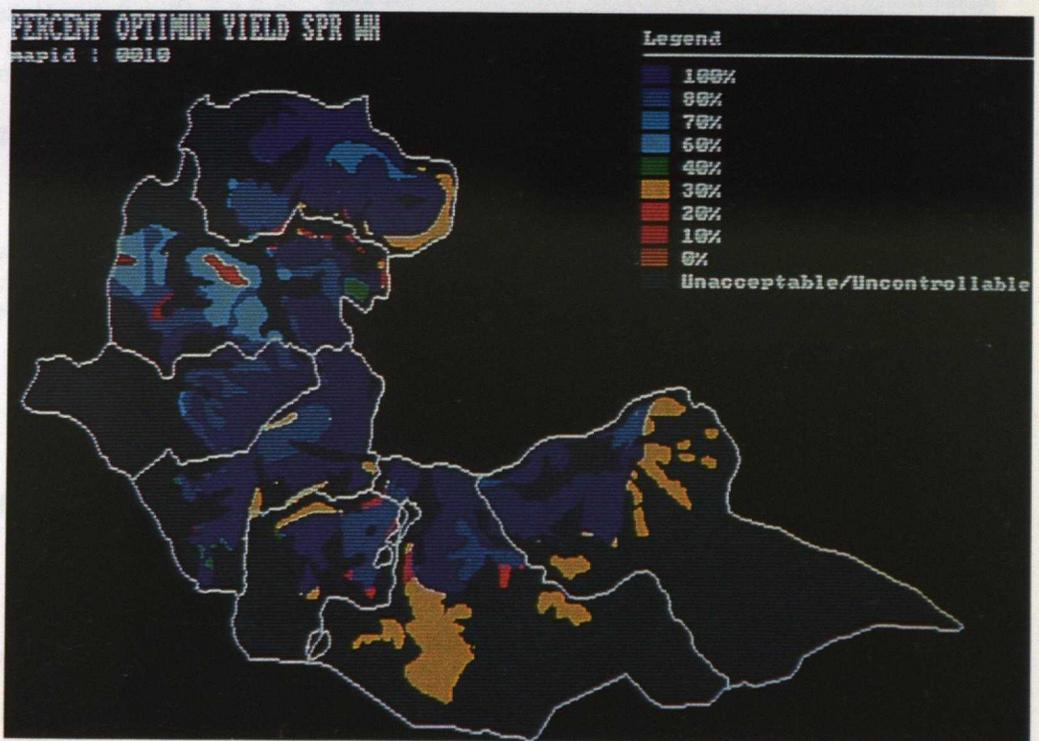
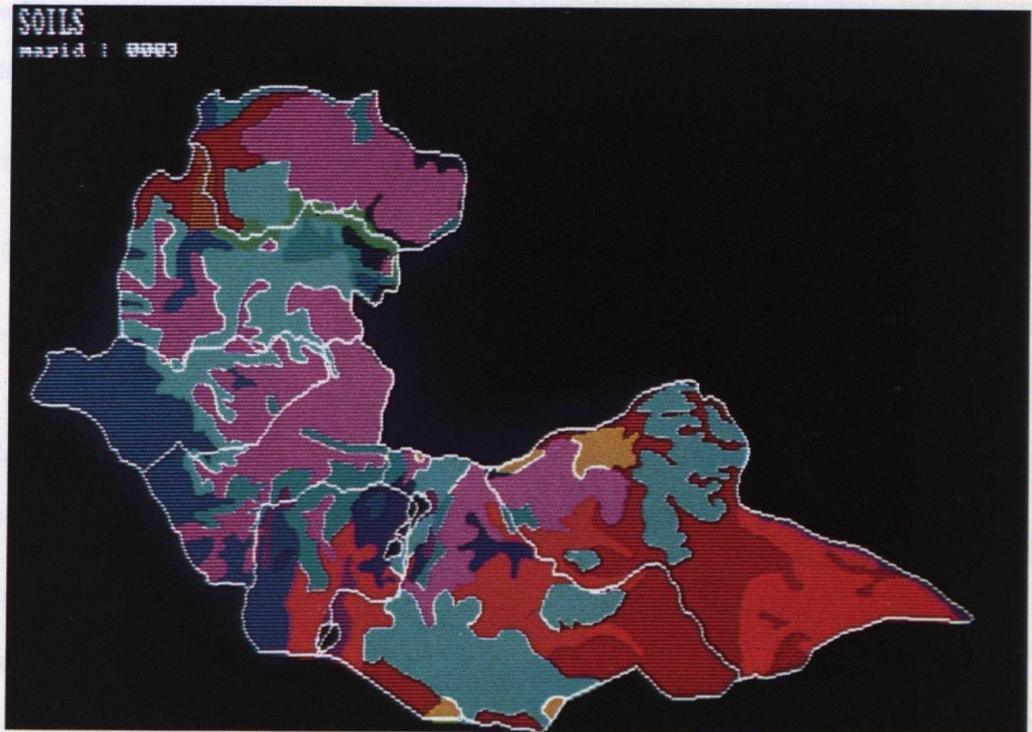
Contact: Giulio Maffini, President  
 Branch offices: TYDAC Technologies Inc.,  
 Clearwater, Florida, U.S.A.;  
 TYDAC Technologies Inc.,  
 Bristol, U.K.

**Company background.** TYDAC Technologies was established in 1982 and is now a wholly owned subsidiary of the MONENCO group of companies. Since its beginning the company has been involved with the development and application of micro-computer-based geographic information systems. TYDAC is now marketing software products and services directly and has embarked on an extensive research and development phase. A Beta site testing program was initiated in 1985-1986 and sales, including exports, of the TYDAC Spatial Analysis System (SPANS) began in the summer of 1986.

**Products.** The company has developed a spatial analysis system that operates under MS DOS for the family of IBM PC compatibles. SPANS is designed for a wide range of analysts who use georeferenced thematic data for decision-making, including these applications:

- land use planning
- environmental analysis
- agriculture and forestry
- energy planning
- resource development
- fisheries and oceans
- market research

Data from multiple sources, including airborne and satellite remote sensing, can be combined for display. A major strength of the system is its ability to perform various analytical operations such as overlay analysis, potential mapping and spatial modelling. SPANS can also be linked to external packages that operate in the IBM PC environment, such as database management and statistical packages, to perform list processing and numeric operations.



**Services.** In addition to selling software, TYDAC provides training and consulting services and rental/leasing arrangements for hardware.

In Southwestern Ethiopia, TYDAC's systems and software have been used to determine estimated yield as percentage of optimum for spring wheat, using soil and climatic criteria.



 The first geometrically corrected SPOT image. Produced by CCRS over Toronto, Canada.



## NOTES

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### A Solutions and services

#### Business solutions

Data from multiple sources, including internal and external sources, can be analyzed for insights. A range of insights of the system is the ability to analyze various data from various sources, including internal and external sources, for various purposes, including financial modeling, risk analysis, and linked to external data sets that operate in the ERP environment, such as data from management and financial packages, to perform for processing and business operations.

Business to business (B2B) provides planning services and arrangements for

in the business world. TASC's systems are designed to help you to identify the most profitable areas of your business, to help you to identify the most profitable areas of your business, to help you to identify the most profitable areas of your business.

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