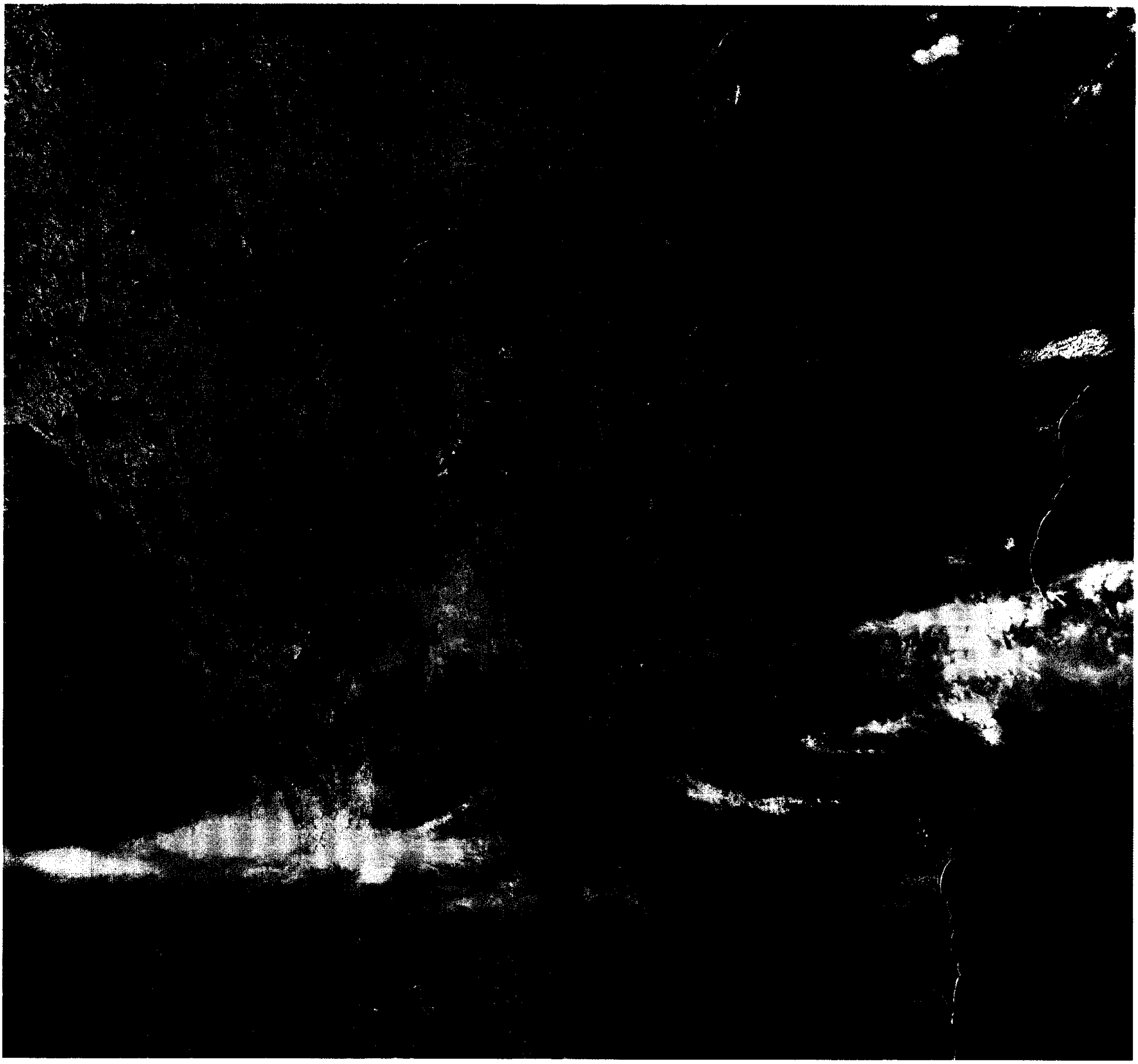
Australian Landsat Station

DIVISION OF NATIONAL MAPPING
DEPARTMENT OF RESOURCES AND ENERGY

NEWSLETTER

FOR THE REMOTE SENSING INDUSTRY



CONTENTS

COVER STORY

Canberra Bushfires

After a two year drought in most of south-eastern Australia, rain finally came in March 1983. Subsequent frequent rains resulted in a tremendous vegetation bloom which lasted into the summer of 1984/85. By the start of 1985 the Canberra region had commenced drying out and the countryside was laden with a tremendous fuel load of tall dry grass.

On 1 March 1985 disaster struck when fires, fanned by very strong westerly winds, began their uncontrolled rage through the Canberra region that lasted for several days. Millions of dollars were lost in property, feedstock and fences, while thousands of sheep, cattle, horses and other livestock were burned alive.

Only days later, on Tuesday, 5 March 1985, while some of the fires were still burning, Landsat 5 scanned path 90 of the world wide reference system (WRS) covering a 185 km wide track connecting Bundaberg with Canberra and Hobart. At an altitude of 700 km the satellite passed over Canberra at 9.20 a.m. to provide the tell-tale story.

As the satellite came over, images provided by the spacecraft's Multi Spectral Scanner (MSS) were transmitted to the ALS data receiving facility at Alice Springs, where they were recorded on high density computer tape. The image data was flown to Canberra that same evening for processing at the Data Processing Facility (DPF). The first images of the fires were released to relevant authorities on Wednesday afternoon.

From the known wind directions and the shape of the fire scars, Police and fire authorities can in most cases easily identify where the fires started. Relevant organisations now have a permanent record, telling which properties were affected by these fires and to what extent owners may be eligible for assistance or claim insurance.

With the aid of LANDSAT images, bushfire risk has been assessed in many parts of Australia. The National Parks and Wildlife Service for instance uses LANDSAT images for fuel load assessments and other applications even in the remotest parts of Australia. Authorities in Victoria and South Australia are still acquiring Images in relation to the disastrous Ash-Wednesday fires in February 1982.

OUR FIRST COLOUR ISSUE

At the Australian Landsat Station we are very pleased to be able to bring this, our first colour issue of the ALS Newsletter, to you. While saying this we gratefully acknowledge the special efforts and support by the many contributers who prepared and submitted their work for publication in this issue. We say special effort, because we are very much aware how difficult it is to find the time to actually sit down and write up your work, while you are already flat out doing a lot more than you can readily handle now. We are most grateful for your support in communicating to others the successes, limitations and new developments in the applications of remote sensing data and we hope that through your efforts others may follow suit and help make the ALS Newsletter a forum for the free exchange of ideas and information for the remote sensing industry in Australia.

We aim to publish twice yearly. There were some teething problems with our new word processor for this issue but hopefully, these have been resolved. By the time we come to the next issue we hope to be able to utilise some author—supplied floppy discs (when available). Current facilities permit Wang O.I.S. and T.O.M. Data 3500 imput from 5.25 inch discs.

Contributions: Limited human resourses at the ALS make it impossible to read and write on all relevant remote sensing news. If you come across any information of significance to the Australian remote sensing data users please send us a copy of the article or, better still, write one yourself and send it to: *The Editor, ALS Newsletter, PO Box 28, Belconnen A.C.T 2616.* We also invite organisations actively involved with remote sensing or associated activities to discuss with us the possibility of having set aside 1–2 pages for news on their organisation. For enquiries please ring John Bruyn on 062–524409.

Next issue: A number of papers have been promised for our next issue but it is expected that financial constraints will force us to put limitations on it's size. So please, send your paper in early! We are currently working towards a *deadline of 30 April 1986* for publication in June 1986.

Format: As we aim to conform to standards that apply to most professional publications, you are kindly requested to include in your paper an abstract, introduction, body of the paper with sub-headings, conclusions, acknowledgements and references.

Editing: Due to the fact that remote sensing data is used in a very wide range of scientific disciplines, ALS staff may be insufficiently qualified to edit the contents of your paper. Editing by a peer or supervisor before you send it in, with a word of thanks in the acknowledgements, may be an appropriate way to overcome this limitation.

Acknowledgement: I wish to express my thanks to Jill Rees and Linda Smith for their efforts and assistance in the preparation of this edition of the ALS Newsletter.

John Bruyn

LANDSAT COMMERCIALISATION GOES AHEAD

A contract between the US Department of Commerce and the Earth Observation Satellite Company (EOSAT) for the commercial operation of the Landsat system was signed on 26 September 1985.

The contract follows lengthy negotiations between the US Department of Commerce and the final contender for the LANDSAT system, the Earth Observation Satellite Company (EOSAT) and fulfils a long standing desire of the Reagan Administration for the operation of Landsat by private enterprise. (See ALS Newslewtter, Dec. 1984, p.4.)

Signing of the contract transfers the day-to-day system operation of landsat 4 and 5 from NOAA (National Oceanic and Atmospheric Administration) to EOSAT. The contract further binds EOSAT to:

- provide LANDSAT 6 and 7 on orbit
- develop and operate ground system services and data processing
- market LANDSAT data worldwide on a public non discriminatory basis
- leave unchanged system access and data distribution fee level for current MOU (Memorandum of Understanding) signatories
- honour LANDSAT MOUs currently signed with NOAA and extend these during the lifetime of LANDSAT 4 and 5

With the availability of Landsat 6 and 7, EOSAT will assume overall program management responsibility and new agreements will be negotiated to cover programme participation beyond Landsat 5.

The follow-on spacecraft will be provided by RCA Astro-Electronics with instrumentation to be supplied by Hughes/Santa Barbara Research Centre.

This final step in the commercialisation of LANDSAT will put this American remote sensing system on a similar footing to the SPOT Image Corporation and allows EOSAT and SPOT Image to compete on the rapidly growing international remote sensing market.

EOSAT's (draft) Commercial LANDSAT Pricing Schedule reveals the following price structure:

			Price US Dollars			
Product	*Size(mm)*	*Approx. Scale(mm) (full scene)*	*Black & White*		*False Colour*	
			MSS	*TM*	*MSS*	*TM*
Transparency	185 x 185	1:1 000 000	80	150	150	360
Paper	185 x 185	1:1 000 000	50	100	100	300
Paper	371 x 371	1: 500 000	100	170	200	400
Paper	742 x 742	1: 250 000	150	250	350	500
MSS Master generation charge:			$US 200			
TM Master generation charge:			$US 300			
MSS CCT (4 bands):			$US 660			
TM CCT (7 bands):			$US3300			

(Prices from WRSL, V5, No. 4, Sept '85)

SPOT-1 LAUNCH

Following the in-flight failure of a third-stage hydrogen propellant feed system valve in Europe's Ariane V15 launcher, the Ariane 3 was destroyed by ground safety officers during launch on 12 September 1985.

Ariane's payloads, the GTE Spacenet's Spacenet F3 and the European Space Agency/Eutelsat ECS-3 were both destroyed in the process.

As a consequence the long awaited launch of France's high resolution/stereo imaging Earth resources satellite SPOT, which was scheduled for 15 November 1985, has been postponed.

Although initial speculations following the Ariane-3 loss gave new launch dates for early December 1985, the first official news from CNES/SPOT Image received at the Australian Landsat Station on 8 November 1985 gives a new launch date of Sunday 12 January 1986, 1.44 a.m. Universal Time (12.44 Eastern Summer Time) from the French Guiana Space Centre.

ALS NEWS

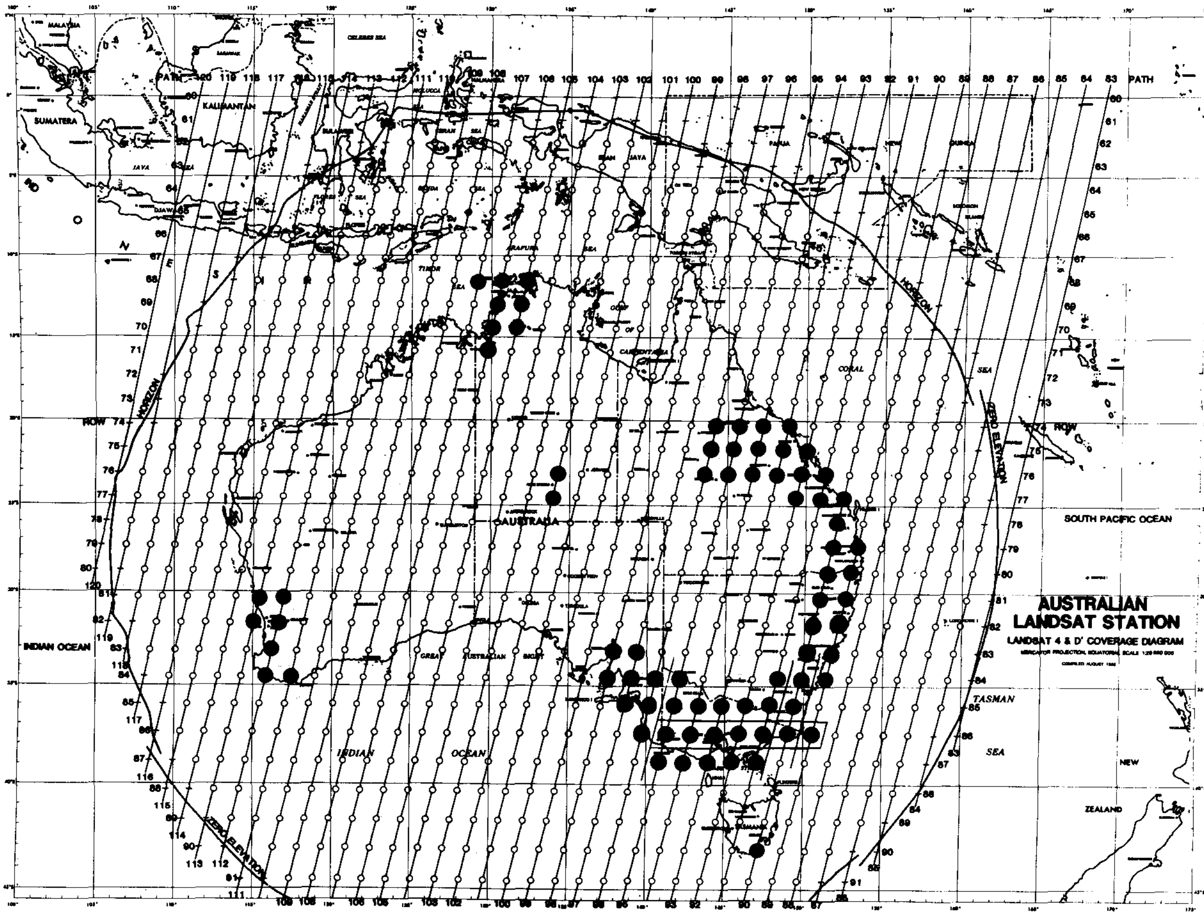
THE ALS PRECISION PRODUCTION SYSTEM (PPS)

For many applications, a final product that conforms to map accuracy standards is often desirable.The PPS is designed for the production of such precision imagery which the ALS now offer as standard products.

While Bulk products are accurate to the level of spacecraft parameters the PPS can provide high accuracy products based on refining radiometric and geometric correction parameters, using surveyed points called GCPs (Ground Control Points). The development of a GCP library has received considerable impetus since responibility for the ALS was transferred to the Division of National Mapping in March 1984. The small but increasing library is illustrated in Figure 1.

The PPS allows for a continuous range of digital image scales ranging from 1:1,000,000 to 1:100,000, imaging of arbitrary subscenes, selectable tick mark spacing or gridding in (UTM) northings and eastings or (LL) latitudes and longitudes. PPS products are available as colour and black and white images.

Mike Linney



Landsat-4, 5 WRS scene identification map. Black dots indicate the scenes for which GCP's have been obtained and precision images can be made.

COHERENT NOISE COMPARISON

A persisting problem with the imagery from Landsat 4 Multispectral Scanner is the presence of low level coherent noise embedded in the data. Landsat 5 Multispectral Scanner had filters added to the detector outputs to reduce the level of coherent noise. Landsat 2 and Landsat 3 Multispectral Scanners did not, as far as we are aware, have a coherent noise problem.

The Processing Facility at the Australian Landsat Station made attempts to remove the coherent noise from the Landsat 4 data. Whilst the complete removal of the noise was not possible, the software tools developed did allow the effects of the noise to be reduced, and allowed some characterisation of the noise to be made.

A simple test was devised to analyse a common scene from the above Landsats to test for the presence of coherent noise, and if found, to compare it to the Landsat 4 coherent noise.

A table summarises the result:—

	LS4	LS5	LS2
Frequency	905	847	None identified
Amplitude	5.8	0.12	None identified

The frequency and amplitude are relative and show that the coherent noise is present on Landsat 5 but with a very much reduced amplitude (showing that the filters are effective?) and interestingly at a different frequency. No coherent noise could be identified for Landsat 2.

Robert Denize

SPACECRAFT STATUS

Landsat 5

- Landsat 5 is the prime operational spacecraft in the Landsat series,
- The spacecraft is providing full operational support of TM and MSS imaging.
- Coherent noise of a very low amplitude is present in the MSS data.
- A rocket engine module translation thruster has failed, resulting in a loss of redundancy only. Orbit adjustments are performed with back-up thrusters.
- An anomaly exists in the Ku band transmission link, due to the failure of a travelling wave tube amplifier last August. The back-up transmitter for the Ku-band is now used for the relay of data through the Tracking Data Relay Satellite System (TDRSS) from areas where no receiving facilities are available.

Landsat 4

- acquisition of MSS data occurs on special customer request only.
- Landsat 4 MSS data has a coherent noise problem which is of limited significance to most applications.

THE GOOD NEWS AND THE BAD NEWS

To satisfy the few pessimists amongst our readers, and for chronology's sake, we shall start with the bad news:

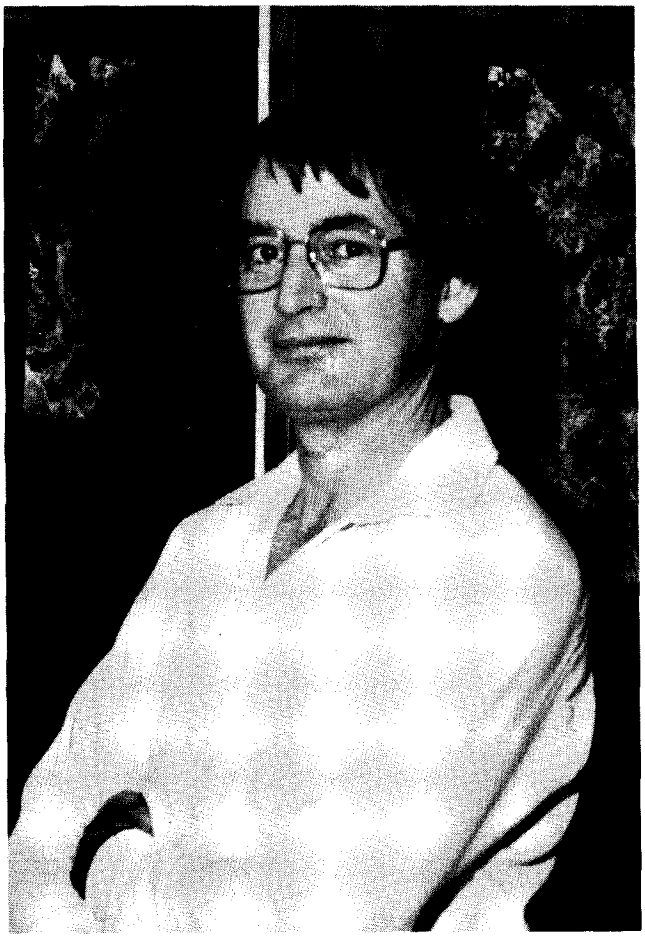
Our Digital Engineer Robert Denize, has left the ALS to further his career as Satellite Advisor to the Saudi Arabian Meteorological and Environmental Protection Administration (MEPA) on behalf of the AOPC (Australian Overseas Project Corporation).

Robert came to the ALS from the Canberra Deep Space Communications Complex, Tidbinbilla, where he was involved with digital ranging on NASA planetary exploration projects. His contribution in getting the ALS on its feet and in post-installation improvements has been invaluable.

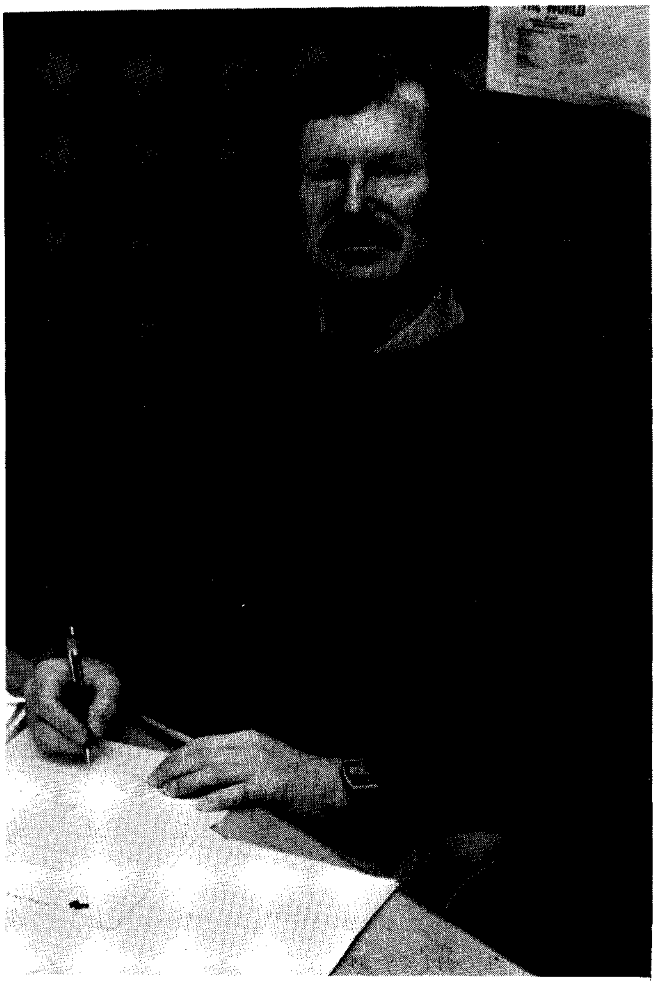
Being a Master in Engineering and with photography as a hobby and , he was able to solve problems and make improvements at the level of the often poorly understood computer-photographic interface. Through his efforts, combined with those of other specialists both from within and outside the ALS, Robert made a major contribution in the development of the high quality of ALS products, which now rank amongst the best in the world.

Here at the ALS we gratefully acknowledge the contribution Robert made and wish him the best of Aussie-Luck in years to come!

The good news is that the person who vacated Robert's new position in Saudi Arabia is Robin Buckley, our new Digital Engineer. While in the process of completing his Master of Engineering thesis at the University of NSW, Robin is preparing to give his best to the second phase of the ALS—the TM, SPOT, AVHRR Upgrade of ALS facilities, when this takes place.



Robert Denise, former ALS Digital Engineer



Robin Buckley in his new office at the ALS.

Indeed, with Australian and overseas experience in software and hardware development of computer image analysis and display equipment as well as photography and tracking of amateur radio satellites as hobbies,Robin should be well suited to the position of Digital Engineer at the ALS.

RETIREMENT

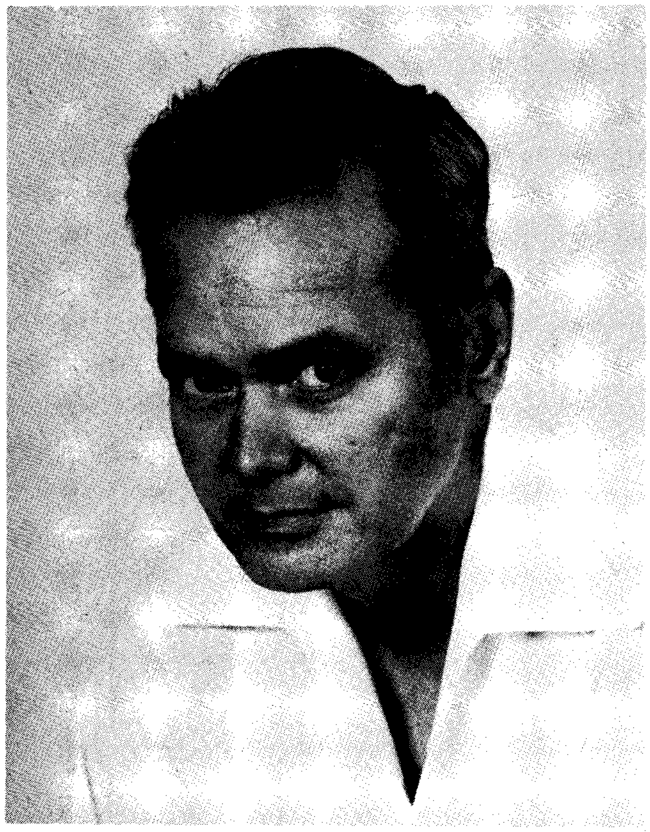
Mr W. "Bill" Kempees

The Chief Engineer at the Australian Landsat Station, Mr Bill Kempees, has announced his intention to retire on 29 November 1985.

After a thirteen year career in the Dutch Navy as Marine Engineer and Radar expert Bill came to Australia in 1953.

In subsequent years Bill held various engineering positions before entering the Space Tracking Industry in 1961, when NASA, the US Space Agency was establishing its facilities in Australia. Bill became involved in the tracking of Space missions such as Mercury, Gemini and Apollo while serving at Ground Stations Woomera, Muchea WA, Carnarvon, Orroral Valley and Honeysuckle Creek before joining the Australian Landsat Station in April 1979.

As Chief Engineer of the ALS for the Operations and Maintenance Contractor, Fairey Australasia Pty Ltd, Bill Kempees led the Station from a temporary office with a staff of three, and no equipment, to the present highly efficient and professional operation. Much of the high reputation of the Australian Landsat Station and the development of quality products is due to Bill's knowledge, experience and drive.



Bill has also taken a leading role in the developing of specifications for the proposed upgrade of the ALS for reception and processing of Landsat Thematic Mapper and SPOT image data. His expertise and experience will be sorely missed when this project gets underway.

Apart from having been a most competent professional engineer and an efficient manager in ALS operations, Bill Kempees has also been a valued collegue and personal friend for many years. On behalf of the remote sensing community, ALS staff—past and present, and former collegues from his NASA days, I thank Bill for his invaluable contribution and wish him well in his retirement.

Don Gray
Station Director

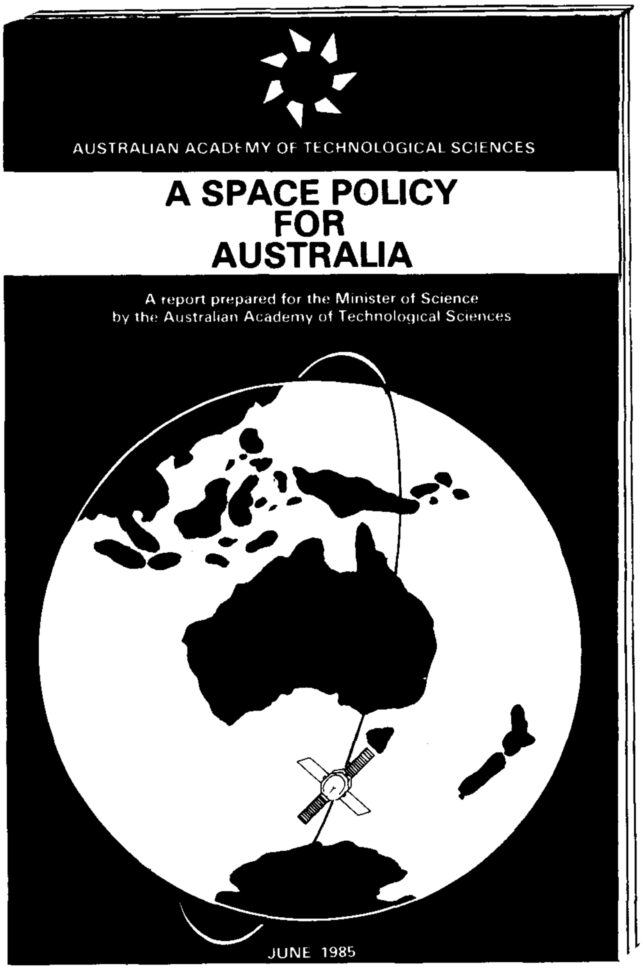
MADIGAN REPORT

In relation to the proposed upgrade of ALS facilities to receive and process Landsat-TM and SPOT data, as well as other remote sensing and space related activities, some very good news came with the release last June of the report by the Space Science and Technology Working Party of the Australian Academy of Technological Sciences under chairmanship of Sir Russel Madigan, OBE, FTS.

The report was prepared for the Minister of Science, and following are some excerpts from the Executive Summary including all of the sixteen recommendations:

"It has been estimated that, by 1995, Australia's annual expenditure on space services will be between $370m and $500m. Yet unless firm action is taken by the Government—action which both supports, and is supported by Australian industry—there is an overwhelming probability that the great majority of this expenditure will be made overseas."

"Most developed, and several developing countries have recognised the importance of participation in space programmes as a significant factor in shaping their industrial future."



The Madigan Report, released June 1985

"Even with a concerted effort by government and industry, and with careful selection of market areas, there can be no guarantee of commercial success. But without that effort it is certain that Australia will be sitting on the sidelines in the fastest growing international market area."

Benefits: "Australia's sparse population, vast earth and ocean area, and economic dependence on natural resources and agriculture, render satellite technology perhaps of greater potential value to Australia than any other country. We are a present and growing user of spacecraft of economic, social, and defence importance, and these interest must be maintained and protected."

"The particular advantage of involvement in space R & D is that it alone combines many of these technologies under conditions where best performance only is mandatory and where the product can fulfil national needs in a variety of essential applications such as communications, meteorology, and remote sensing."

"A national space policy needs to be instituted to give the stability and continuity of government commitment, which industry and the scientific and technological community require in order to develop their plans and build up the capability essential to the success of a space programmme."

Recommendations

(1) "Australia should as a matter of urgency establish a national space policy to facilitate the achievement of an appropriate industrial, technological, and scientific structure for Australia's participation in space."

(2) "In the communications market Australia should, in the near term, concentrate on the ground-station equipment sector."

(3) "The major market thrust of Australian space activities should be in the remote-sensing sector, involving both hardware and software."

(4) "Research institutions and educational establishments should arrange to co-ordinate and consolidate their space capabilities in order to contribute effectively to development of Australian space science and technology."

(5) "The Government should take the leading role in facilitating the development of Australian space science and technology capabilities through the 1980's."

(6) "Australia should actively pursue the possibility of international collaboration in space and, in particular, of joint space initiatives with countries in the East Asian region."

(7) "A major component of the national space

programme should be government-funded R & D contracts placed within Australian industry."

(8) "The first phase of the national space programme should have the objective of achieving in industry the capability to participate in complex spacecraft either as subcontractor or with prime-contractor responsibility for a major system."

(9) "The space segment of the national space programme should be directed towards development of eart-resources spacecraft equipment suitable for inclusion in other nations' spacecraft or at some future time in spacecraft of Australian origin."

(10) "Australia should built on its expertise in reception, image processing, andanalysis of remote-sensing data with a view to:

- developing significant exports of hardware, software, and ground receiving equipment; and
- becoming a regional centre for provision of processed data and images, and for training in remote-sensing techniqes."

(11) "The government should ensure a continuing Australian capability to receive the latest types of earth-observation satellite data, and in particular should allocate funds at the earliest opportunity for:

- the upgrading of the Australian Landsat Station; and
- the upgrading of Bureau of Meteorology receiving facilities."

(12) "Space science should be a continuing component of the annual budget for the national space programme."

(13) "Australia should participate in international space science and application programmes relevant to Australia's requirements as a means of being involved in state-of-the-art developments."

(14) "The Government should accept a commitment over the next five years of up to $100m to finance:

- participation in a number of space projects in which Australia would have a significant design and construction resposibility; and
- associated basic research, general administrative costs, and appropriate support facilities."

(15) "An independent Statutory Authority, with its own Board of Management, should be created to:

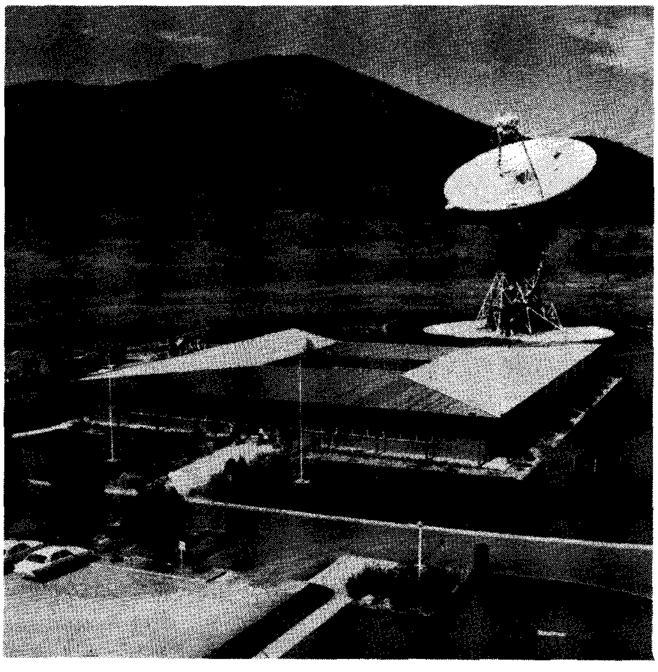
- advise the Government on space R & D policies and priorities;
- co-ordinate and manage the national space programme;
- liaise with research institutions, user groups, government departments, and other agencies to establish long term developmental requirements;
- formulate and implement a co-ordinated and cohesive series of space projects in accordance with the national space policy;
- place government-funded contracts in industry, research establishments, and centres of higher education; and
- interface with the major overseas space organisations."

(16) "The national space programme should be reviewed at the end of the fourth year of operation."

TASMANIA TO GET ORRORAL VALLEY ANTENNA

NASA has donated a 26-metre antenna, located at the Orroral Valley Tracking Station in Australia, to the University of Tasmania. The Orroral Valley Station ceased operations in December 1984.

The antenna had been used in a variety of international programs including the Skylab Program, the Apollo Soyuz Test Project and the Space Shuttle Program. NASA offered to provide assistance for the dismantling and transfer of the antenna to Hobart, Tasmania, Australia.



Orroral Valley Antenna on location at tracking station

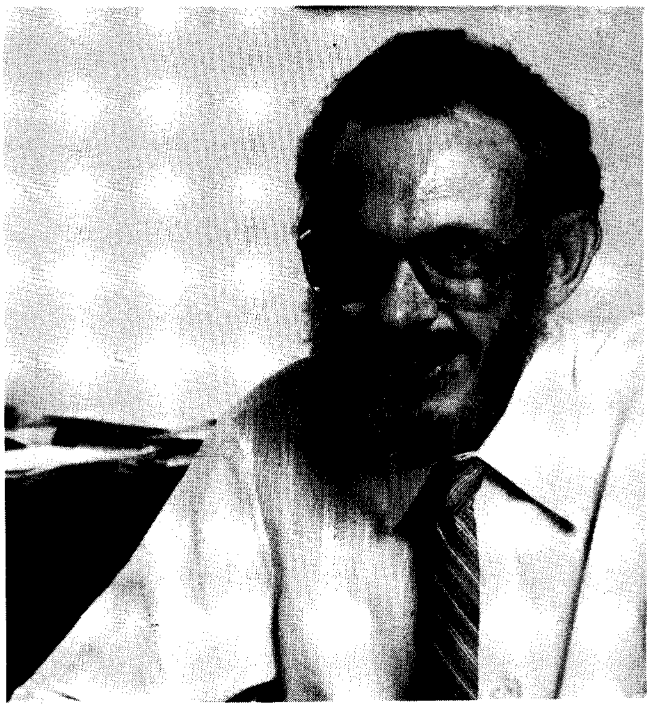
The University of Tasmania's Physics Department, one of Australia's major centres for astronomy and astrophysics, will use the antenna as part of its teaching and research activities. One of the planned uses for the antenna is in operation with the Australian telescope presently under construction in New South Wales. This application will dramatically improve the telescope's performance.

The antenna also will be available for very long baseline interferometry in conjunction with other instruments, a system which uses a number of separate antennas to construct a radio telescope with a high resolution capability. Using the antenna for interferometry will assist geodynamics and geophysical research by obtaining more accurate measurements of the Earth's surface and will contribute to the data base on the Australian continent.

NASA may use the antenna for its geodesy, geodynamics and astronomy projects in the future.

CSIRO SPACE RESEARCH

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) has set up an Office for Space Science and Applications (COSSA) to coordinate and expand it's activities in space research and development. COSSA is under the direction of Dr Ken Mc Cracken, former chief of CSIRO's Division of Mineral Physics, and a well known advocate of Australian involvement in the space industry.



Dr Ken McCracken, Chief of COSSA

The establishment of the new office follows Dr Mc Cracken's involvement in earlier space related activities during the sixties and seventies and a continued involvement in remote sensing while at Mineral Physics, before embarking on a 2 months fact finding mission with Ms Cristine Astley Bowden of CSIRO and Mr Stan Schaetzel of Hawker de Havilland, to a number of oveseas countries during the middle of last year. As members of the Space Science and Technology Study Group, the team visited several EEC countries, as well as India, Japan, Canada and the USA.

The Space Research Office was established, largely as a result of the study group's recommendations and following the recognition that Australia's space effort is lagging badly in the research and development area.

By the end of 1985 Australia is expected to have spent about $500 million on operational systems such as Intelsat and Aussat, with little of the satellite equipment having been manufactured in Australia. Similarly, equipment needed to upgrade the ALS to receive remote sensing data from the current generation of satellite instruments such as Landsat-TM and SPOT-HRV, is likely to have only limited Australian content.

The 1984–85 FY spending of Australia on space research and development was at about 33 cents per head of population, while countries such as France, Sweden, Germany, Japan and Canada spent from around $4—$10 and the USA around $33 per head of population per year. According to CSIRO estimates, the annual Australian expenditure on space related technologies is expected to be in the vicinity of $500 million p.a. (1984 values) by 1995. Even if only half of this money would be spent on Australian technology, it would provide around 10 000 man years of employment.

At present, Australian manufacturers find themselves in a "catch 22" situation; a company can get a contract to build space technology components if it has succesfully done so before — No previous experience, No job! — for in space technology best performance only, is mandatory.

Following Cabinet approval, CSIRO/COSSA will spend $3.3 million during the 1985-86 FY, including re-deployed funds, while an additional $2.6 million will be spent by the Department of Industry Technology and Commerce. These figures are expected to rise substantially towards the end of the decade. It is intended that approximately 70% of CSIRO's space activity contracts go to Australian industry.

If funding goes ahead at the rates CSIRO expects, the CSIRO space program will contribute to

- the development of an Australian industrial competence in space technologies;
- the development of specific high value-added space technologies; and
- the use of space technologies in applications appropriate to Australia's needs.

While space related technologies are evolving rapidly and assume major significance throughout the world, it provides a new impetus to those economies that are not only willing to participate, but also do something about it. Canada may be mentioned as an example, where the Federal Government's commitment to space for the next two financial years is almost $223 million p.a.. Canada's Minister for Space, Mr D.J. Johnston pointed out, that the Canadian space industry sells more than the government spends on space.

It is not just space related design and manufacture that would benefit from an increase in Australia's research and development effort; it would also stimulate the aerospace, communications, computing, electronic and instrument manufacturing industries, as well as providing opportunities for software development and system integration techniques. These are areas where we have significant and increasing local needs, and for which there is a rapidly growing market throughout the world, particularly in the Asia—Pacific region.

AUSTRALIAN JOINT VENTURE WITH NASA

An aircraft, believed to be the most advanced airborne remote-sensing facility in the world, will visit Australia for a 30-day survey, starting early October 1985, and covering sites in almost all states.

The major instruments to be used in the survey are the NS001 Thematic Mapper Simulator, the Thermal Infrared Multispectral Scanner (TIMS) and the new highly discriminative 128 channel Airborne Imaging Spectrometer (AIS).

The instruments will collect digital image data at resolutions varying from 2.5 metre to 20 metre pixels and covering swathes of terrain from a few hundred metres to 15 kilometres.

The C-130 Hercules NASA aircraft, with the above three instruments, has never been used outside the US before and according to Dr Ken McCracken, Director of the CSIRO Office for Space Science and Applications (COSSA) and Prof. Roye Rutland, Director of the Bureau of Mineral Resources (BMR), the project will collect data that could not be obtained any other way in this decade.

The project, for which the overall resposibility lies with COSSA, was organised by Dr John Huntington of CSIRO's Division of Mineral Physics, and involves private enterprise, government agencies and of course the US National Aeronautics and Space Administration (NASA), the owners of both the aircraft and the instruments. The major contributors to the $400 000 data acquisition phase of this project are CSIRO/COSSA and the Department of Resources and Energy (through BMR and the ALS). The overall cost for the two year research project is estimated at $1.3 million.

NASA will provide the C-130 Hercules remote sensing aircraft as well as a 19 member crew for air and ground operations, starting early October 1985. In addition, the CSIRO research Fokker Friendship with it's own advanced remote sensing scanners, will be used for part of the project.

The Joint Scanner Project will collect data for research on a diverse range of topics such as groundwater hydrology, soil salinity, wetlands and rangelands mapping, forrestry, soil degradation processes, lithological mapping and the detection of mineral deposits. The data collected should allow for the development of new techniques for geological mapping, especially of surface materials, and would supplement newly developed image processing and conventional map production methods, as well as improving the content and precission of geological maps.

In addition, several CSIRO and BMR projects will determine the most effective form of scanner to be used by the Australian minerals industry in the detection of the surface expression of mineral deposits.

The Madigan report on a Space Policy for Australia has urged the development of an Australian space industry, with the major market thrust of Australian space activities to be in the remote sensing sector, involving both hardware and software. This joint scanner project is an important step towards proficiency in remote sensing from space. The instruments that we will use in space in the 1990's will be designed on the basis of the experience gained in this aircraft project.

The parties involved in the NASA joint scanner project are 5 CSIRO Divisions and COSSA, 3 BMR Divisions, WA Department of Lands, Qld Departments of Mapping & Surveying and Water Resources, the NSW Soil Conservation Commission, the Australian Survey Office, the Defence Research Centre, the SA Centre for Remote Sensing, the British Environmental Research Council, BHP, CRA, Western Mining, ESSO, BP, Sumitomo, the ALS and the University of NSW Centre for Remote Sensing.

Information will be gathered on salinity in the Murray Valley and in Western Australia; irrigated and non-irrigated crops in the Townsville and Burdekin regions of Queensland; the extensive die-back in WA eucalypt forests; and alteration halos often associated with in situ mineral occurrences such as gold, copper and tin.

For it's part, the ALS will investigate the data over a Natmap test site just south of the Denham Ranges, east of Rockhamton. The ALS will also act as the repository and archive for the original raw data and provide limited use of the ALS Image Writing Service to the principal investigators.

NASA's C-130 Hercules special remote sensing research aircraft

THE AUSTRALIAN LIAISON COMMITTEE ON REMOTE SENSING BY SATELLITE (ALCORSS)

The Australian Liaison Committee on Remote Sensing by Satellite (ALCORSS) was established as a permanent body in June 1980 to foster consultation, co-operation and liaison among users of remote sensing data and as a formal channel by which advice on user needs would be transmitted to the Department responsible for the operation of the Australian Landsat Station.

The functions of the ALCORSS Committee have been defined as follows:

(a) to advise the Department of Resources and Energy on matters relating to the operation of the Australian Landsat Station;

(b) to examine and recommend on the national need for data manipulation and interpretation processes;

(c) to encourage collaborative research and applications programs in the field of remote sensing;

(d) to maintain continuing liaison with other committees and agencies with interests in remote sensing;

(e) to encourage improvements to and, as appropriate, co-ordination of remote sensing methodologies and equipment;

(f) to monitor programs of education and training in remote sensing;

(g) to encourage the collection, storage and dissemination of information relating to remote sensing;

(h) to consider any other matters appropriate to the stated objective of the committee.

The Australian Landsat Station provides the Secretariat support for ALCORSS and is the vehicle whereby its views and recommendations of the Committee are conveyed to the Department of Resources and Energy.

Membership of ALCORSS comprises representatives of the Commonwealth, the six states and Northern Territory, Industry, Universities, Colleges of Advanced Education and CSIRO. The present nominated members representing the various states/ organisations are as follows:

States/Territory

New South Wales:	Mr. C. Champion
Victoria:	Dr. P. Rudman
Queensland:	Mr. K. J. Davies
Western Australia:	Mr. W. Henderson
South Australia:	Mr. J. Douglas
Tasmania:	Mr. R. G. Roberts
Northern Territory:	Mr. T. Menzies

Organisations/Institutions

Universities:	Assoc. Prof. J. Richards
Colleges of Advanced Education:	Dr. E. Clerici
CSIRO:	Dr. K. McCracken
INDUSAT (Industry):	Mr. M. C. Aubrey

Chairman	Secretary
Mr. C. Veenstra	Mr. D. J. Gray
Director	Station Director
Division of National Mapping	Australian Landsat Station

Each of the members represents a constituency of users and potential users of remote sensing and it is through them that ALCORSS activity encourages input and advice that will benefit the remote sensing industry.

Further information on ALCORSS may be obtained by writing to:

Mr. D. J. Gray
Secretary
ALCORSS
PO Box 28
BELCONNEN ACT 2616

The Australian Landsat Station Newsletter will in future be used to inform the remote sensing sector of the more significant views of ALCORSS.

INTERNATIONAL NEWS

LANDSAT TO ASSIST IN ANTARCTIC SATELLITE DATA LINK

A six-member team from NASA's Goddard Space Flight Centre is helping to establish the first satellite data link from the South Pole. The link will make possible the realtime collection of scientific data from the Pole, which was not possible in the past. The effort is in support of a joint programme with the National Science Foundation (NSF); the Applied Research Laboratory (ARL) of the University of Texas, Austin; the National Oceanic and Atmospheric Administration (NOAA); plus a number of other government, private and educational institutions.

To establish a realtime communications link by any means other than by satellite would cost as much as $35 million, compared with approximately $250,000 via satellite. Hard line connections from the Pole have been ruled out. A microwave system of 36 stations across the polar plateau, the crevasse-riddled glaciers, the trans-Antarctic Mountains and the frozen Ross Sea would prove extremely difficult, because of the severe winter weather which brings temperatures of -84# o# C and winds as high as 320 km per hour. Currently, scientific data collected from the Pole during the winter months must be stored and shipped out by aircraft during the Austral Summer (1 Nov.—1 Feb.).

The new system will use existing polar-orbiting satellites to relay data from the pole to McMurdo Sound, and re-transmit the data to a geostationary satellite which in turn would transmit the information to the continental US. This routing must be used because signals from the transmitter at the Pole (90 deg. south latitude) are too far below the horizon to be acquired by a geostationary satellite. The McMurdo station, however, is located on the edge of Antarctica (77 deg. south latitude), and is barely in view of the geostationary orbit.

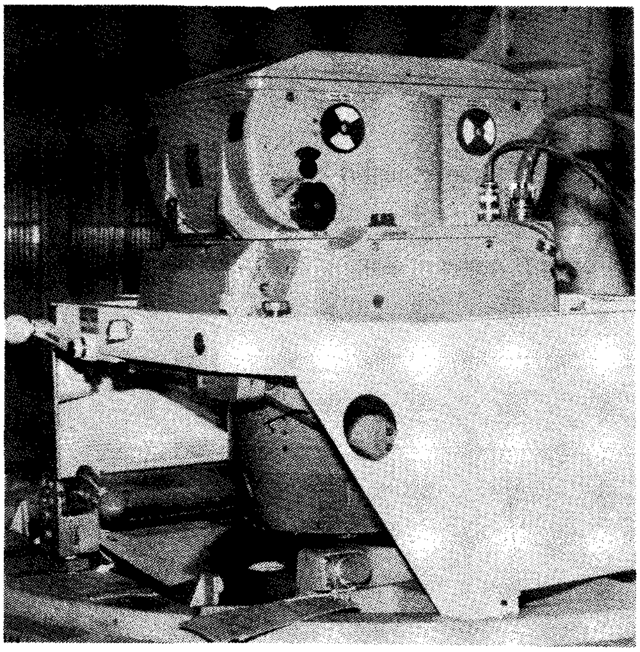
The link with polar orbiting Landsat 4 and 5 with Dynamics Explorer 1 (DE-1) and with Nimbus 7 will allow reliable transmission of routine, high-volume data from scientific investigations being conducted at the Pole currently by approximately 20 different institutions. Ham radio communications can be used from the Pole, however, it is not suitable for transmitting scientific data from Antarctica.

NASA News — 21/12/1984

REFLIGHT FOR METRIC CAMERA

Readers of ESA's Earth Observation Quarterly No. 5 (March 1984) will recall that a re-flight of the Metric Camera had been agreed in principle between NASA and ESA as compensation for the unfavourable illumination conditions of the first flight, due to the two months delay in the launch of STS9-Spacelab 1.

The re-flight opportunity has now been firmly identified as the EOM-1 mission, currently planned for September 1985. As there is no longer a direct ESA/NASA interface (as there was for Spacelab-1), the ESA role has been assumed by BMFT and their agents, DFVLR. However, to maintain continuity towards the experimenters a special arrangement has been negotiated between BMFT and ESA.



Metric Camera

This continuity should enable the International experimenter team to complete the task of data validation and exploitation. Thanks to technical improvements in the flight hardware—namely implementation of forward motion compensation and the use of three film magazines (black & white, infrared and colour) in place of the two previously flown—all the original objectives should be met and surpassed.

If you wish to obtain information and images from the first flight, a microfiche catalogue and price details of all products are available from:

ESA-Earthnet Programme Office	DFVLR-Hauptabteilung
ESRIN, Via Galileo Galilei	Angewandte Datentechnik
1-00044 Frascati	D-8031 Wessling
Italy	F.R. of Germany

LANDSAT WORLD WIDE STATUS

ARGENTINA: The Argentinian Landsat Station, which is operated by Commision Nacional de Investagacione Espaciais (Argentina), currently only acquires MSS. An upgrade for TM is expected, although no official decision has yet been made. TM upgrade would involve a capability to receive 200 scenes per cycle and 5-6 scenes on film/CCT output per day. CNIE is offering custom precision products such as a national forest thematic map, and is expanding its image processing services to applications such as medical x-rays and electron microscopy. AVHRR data is processed on an experimental basis.

AUSTRALIA: The current capability of the ALS is for routine processing of Landsat 5 MSS only, and some Landsat 4 MSS acquisitions on special request. In recognition of a world trend and a healthy interest in AVHRR data, the ALS has as an experiment tracked, recorded and decoded AVHRR data; discussions are underway towards meeting user requirements. The photolab has expanded its services to provide third generation negatives, and prints from customer negatives, while the computer room does image writing from customer CCTs. Colour microfiche are available as image catalogue. An Atlas of cloud free images covering the entire continent is being generated. The TM-SPOT-AVHRR upgrade study has been completed and a functional specification has been written. The specification calls for an acquisition capability of up to 50 TM scenes (185x185km) and 310 HRV scenes (60x60km) per day. The design output level in the form of CCTs or film is 1 full TM, 5 quarter TM and 5 HRV scenes per 8 hour day. It is expected that a call for bids for the upgrade will be issued during 1985-86.

BANGLADESH: Proposals for a United Nations aid program call for LANDSAT/SPOT remote sensing reception and processing capabilities to be installed.

BRAZIL: The Brazilian Landsat Station, operated by The Instituto de Pesquisas Espaciais (Brazil), is routinely acquiring Landsat 4 MSS and Landsat 5 TM; some Landsat 5 MSS is acquired of special areas. The TM system was accepted in February 1984 and since March 1984 INPE has been capable of producing fully geometrically and radiometrically corrected data. Routine processing is to quick look format, with full processing in response to user requests. Brazil has as first priority to get a complete coverage of 385 scenes and additional coverage with support of neighbouring countries. The output capacity is up to 12 system corrected scenes per day; precision processing will be available in late 1985 at the rate of 1 scene per day.

CANADA: At the Prince Albert Satellite Station (PASS) TM and MSS are acquired on a regular basis. TM acquisition includes Western Canada and a large part of the US. NOAA acquires Eastern Canada and exchanges HDDT's with CCRS. TM processing currently is with "pseudo" system corrections on quarter scenes. The TM bulk processing system and MOSAICS will be fully operational by 1986 for geocoded precision processing of up to 25 subscenes per day. Canada plans to acquire data directly from SPOT, ERS-1 and Radarsat through PASS and an eastern station which is under development near Ottawa, as well as supporting other missions on a lower priority basis. CCRS has an active marketing program including commercial advertisements and technology support to Provincial Government agencies to expand the user base.

CHINA: In May 1984 the export licence for a processing facility 100km from Beijing was granted to the US contractor, SASC. Following the US acceptance tests, scheduled for July 1985, the station is expected to be ready on site in about October 1985. Photo processing will be on site. The desired acquisition level is up to 20 TM scenes per day and initially a CCT and film output of 2 scenes per day, to be increased at a later stage.

EUROPE (ESA): Landsat 5 MSS and TM are acquired routinely at Kiruna (Sweden) and Fucino (Italy), as well as limited MSS coverage with Landsat 4. The Maspalomas Station (Canary Islands) has acquired MSS data in support of CEC projects for processing in Fucino. Further modifications to the Maspalomas Station for acquisition of AVHRR, TM and SPOT data, as well as on-site "quick look" processing, are planned. ESA's Earthnet offers a variety of processing levels while photographic images are limited to resampled quarter scenes. At Fucino up to 10 raw data TM CCTs are produced from an acquisition of up to 50 scenes daily, while Kiruna provides up to 10 system corrected TM CCTs: Colour composite production is under study and MSS quick look prints are used for TM evaluation. The microfiche data catalogue has been discontinued. Promotional programs include provision of data for pilot projects in ESA-member countries, in exchange for a report in one year.

INDIA: The Indian Landsat Station, operated by the National Remote Sensing Agency routinely acquires Landsat 5 MSS and TM data. Currently TM data is archived in raw form awaiting the checking of Indian-developed TM processing hardware and software. Availability of film products and CCTs with bulk processing, including scan line reversal, is expected by mid 1985. Night-time TM acquisition, starting early November, has been requested. Modifications to the MSS processing system, planned for this year, will increase capacity from 16 scenes per day to 30. The launch of the Indian Remote Sensing Satellite, IRS-1, is scheduled for launch in mid 1986.

INDONESIA: The Indonesian Landsat Station operated by Indonesian National Institute of Aeronautics and Space near Jakarta currently has MSS capability only for bulk and fully corrected CCTs and film images, TM-SPOT upgrade negotiations are in process with a target completion date of mid 1986.

JAPAN: The Japanese Landsat Station, operated by the National Space Development Agency, routinely acquires and processes MSS and TM data. Data sales have varied, but are near their historic maximum of 1981. The data are primarily used for R&D projects at this stage. TM acquisition is aimed at complete coverage of Japan with output products in the form of CCTs and film with bulk or precision corrections at 3–4 scenes per day. The Japanese Marine Observation Satellite is scheduled for launch in 1986.

NEW ZEALAND: Government approval has been received for TM-SPOT receiving and processing facilities. Reception of satellite data will be under the auspices of the Post Office while the processing will be looked after by the Division of Information Technology of the Department of Scientific and Industrial Research (DSIR). The New Zealand facilities are expected to be operational by mid 1987 with capabilities to receive data over part of Australia's east coast.

PAKISTAN: MSS/TM reception capability is expected to commence by late 1986 to acquire complete coverage of Pakistan. Operational bulk/precision processing is expected to commence by March 1987 at the rate of 2–3 scenes per day for output as CCT or film.

SAUDI ARABIA: Saudi Arabia signed an MOU with NOAA in September 1984. The Saudi Arabian National Centre for Science & Technology—SANCST—began construction at a site 120km south-west of Riyadh. Acquisition capabilities will be for Landsat (MSS, TM), SPOT, NOAA Metsats, and data from the COSPAS-SARSAT system for Search and Rescue. Canada, the US and France have all assisted in the Saudi program. The contract for the Saudi system was awarded to the General Electric Co. of the US last April. SANCST is also acquiring two aircraft with pushbroom scanners to complement its satellite remote sensing activities.

SOUTH AFRICA: The Council for Scientific and Industrial Research program supports Landsat-MSS and Meteosat, as well as tracking support for Centre National d'Etudes Spatiales (France) programs. The proposed TM upgrade has been delayed due to foreign exchange problems. Satellite Remote Sensing Centre intends to provide complete TM coverage of Southern Africa, and to output one bulk or precision corrected scene per day on film or CCT. Since 1978 over 10,000 data products have been distributed, of which about 40% went to users outside South Africa. As from late 1984 all available NOAA-7 data, day and night passes from 3°S–50°S and 1°E–51°E, are being archived at the SRSC on HDDT.

THAILAND: The Thai Landsat Station, operated by the National Research Council of Thailand currently receives MSS data routinely. Government approval to upgrade to X-band is expected in 1985–86.

U S A: Both MSS and TM are acquired routinely from Landsat 5. Due to the partial disablement of the spacecraft, only MSS is acquired from Landsat 4. Data acquisition is scheduled through US groundstations, Canada (PASS) and TDRSS-East. TDRSS-West, formerly scheduled for launch on Mission S1-E of the Shuttle, has been postponed until September 1985 at the earliest.

Since the launch of Landsat 4, the US has acquired from it over 32,000 MSS scenes and almost 7,500 TM scenes.

From Landsat 5, since its launch on 31 March 1984, a further 17,000 MSS scenes and 32,000 TM scenes were acquired.

The total world acquisition of Landsat 4/5 MSS scenes stands at over half a million, while despite the loss of Landsat 4 TM capability, TM acquisition has soared to over 105,000 images.

RADARSAT UPDATE

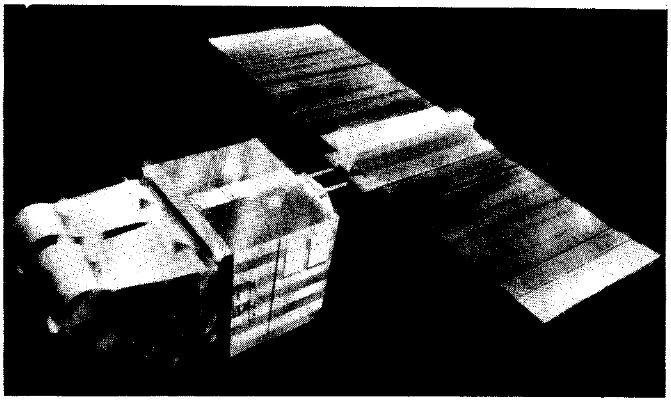
A contract with Spar Aerospace Ltd. for the $14.7 million Phase B of RADARSAT was signed in Toronto on December 4, 1984. Phase B, the Program Definition Phase, is an important stage covering the next two years, during which the system definition of the spacecraft and its synthetic aperture radar will be developed. Further contracts with Canadian industry during Phase B will provide system definition of the ground segment of the program.

These contracts will lead to firm system specifications and program plans for RADARSAT and to accurate cost estimates for the development and production phases of the program. Phase C is expected to commence in two years time, leading to a launch in 1990.

A significant impact on the operation of RADARSAT after the satellite is in orbit may result from the decision to design the spacecraft to make it suitable for in-orbit servicing;that is, the satellite will be able to descend from operational orbit altitude (1000 km) to Shuttle altitude (240 km), where it will be grappled by the Canadarm and berthed in the shuttle bay. Satellite units having degraded or failed in operation can be replaced, fuel tanks replenished, and sensor instruments upgraded. The satellite will then climb back to its operational orbit altitude. This capability provides a safeguard against premature failure of the satellite in orbit and offers the prospect of continuing the operation of RADARSAT for years beyond its nominal 5-year life.

SPOT 3 AND 4 DEFINITION STUDIES UNDER WAY

For the past two years, CNES has been examining the possibilities and conducting technical studies on the SPOT follow-on program for the post SPOT 1 & 2 period. It is already clear that the SPOT 3 and SPOT 4 definition studies must take full account both of certain technological advances and of the development of new applications for satellite-based remote sensing imagery without neglecting the need to ensure the best possible



SPOT (Artist Impression)

continuity of service relative to SPOT 1 and 2. It also seems desirable to extend the useful lifetime of SPOT satellites to reduce the impact of space segment amortization on the overall financial equilibrium of the system.

These preliminary conclusions led CNES to indicate a SPOT 3,4 design concept feasibility study based on the following proposed modifications to the SPOT 1,2 design:

- useful lifetime to be increased to 4 years;
- addition of a 20 m resolution shortwave Infrared channel (in the vicinity of 1.5–1.7 μm) to the two HRVs;
- upgrading of channel B2 (0.61–0.68 μm) to a 10 m sampling interval, as a replacement for the current panchromatic channel, to ensure inbuilt precision geometric registration of multispectral channels (with 20 m sampling intervals) and the 10 m interval channel;
- possible inclusion in the payload of a wide-angle instrument for global vegetation monitoring.

Decisions on the proposed improvements are scheduled to be taken in mid-1985 following the completion of the feasibility study. However, top priority will be given to continuity of service, while at the same time allowing for improvements of the space segment performance and easing up image processing on the ground.

The current timetable calls for a hardware procurement start in 1986 and a SPOT 3 launch in mid-1990 at the earliest. The governing factor in this proposed schedule is the time required to develop new linear array sensors capable of operating in the mid Infrared.

G. Brachet
Chairman and Chief Executive Officer
SPOT IMAGE

NOAA COMMEMORATES 25 YEARS OF EARTH OBSERVATION

April 1, 1985, marked the silver anniversary of the first weather satellite, TIROS-1, an occasion which led Congress recently to pass a joint resolution commemorating the 25 years of service that TIROS and its successors have provided to the world.

Four generations of polar-orbiting weather satellites and three generations of geostationary platforms have entered operational service for the Department of Commerce and NOAA in the last 25 years. In that time, they have evolved into a system of environmental satellites that also monitor snow and ice cover, fruit frost and vegetation vitality, forest fires, volcanic eruptions, sea surface temperatures, and ocean currents.

More than 120 countries make regular use of US weather satellite data products, and 9 countries are active partners in the system's operation.

NOAA's already active international role promises to grow as the observation of all kinds of phenomena and resources on the Earth's surface becomes more routine world-wide. International co-operation will be essential to meet many objectives. With Canada, ESA, Japan, and the United States planning to invest more than 1 billion dollars in ocean satellites alone, over the next 7 years. Proper co-ordination will be mandatory to maximize the net value of these programs to participating nations. Both governmental and private sector entities will derive major benefits if such co-ordination is successfully achieved.

For more than 2 years NOAA has been working to foster a new international partnership that could ease its funding burden in relation to the polar-orbiting meteorological satellites. In November 1984, this effort culminated in a group meeting of representatives from Australia, Canada, the Federal Republic of Germany, France, Italy, Japan, Norway, the United Kingdom, the European Community (EC), the European Space Agency (ESA), the US Department of State, NASA, and NOAA. The meeting unanimously endorsed the need to maintain two observational meteorological platforms in space and the desirability of expanding international participation.

The United Kingdom, for example, has made a firm proposal to expand the role it plays in satellites and will more than double its contribution in the future. France has made a firm proposal to expand the capability of its data collection and platform location system, and is studying further collaboration. France and Canada reaffirmed their intention to continue to provide search and rescue hardware. Italy has agreed to investigate the provision of a microwave imaging device.

Canada has agreed to investigate the provision of a global ozone-measuring instrument. The Federal Republic of Germany has proposed investigating the delivery of one or more of four possible instruments.

One of the most exciting possible future directions is to join forces with NASA's space station program. President Reagan has announced the United States' intention to build a space station and to have it operational by the 1990s. The space station program may provide the ideal opportunity to create a global observation system with strong international participation and great dividends for the entire world.

NASA's space station contains an element that has the potential to revolutionize earth observations—astronaut-tended meteorological platforms in sun-synchronous, near-polar orbit, serviced from the space station. There will be many foreseen benefits—and probably some unforeseen—from the space station itself. But observations of the land, ocean, and atmosphere by associated polar platforms is where the potential is clearest.

LANDSAT DATA USERS NOTES
No. 33, April 1985

NASA MOVES AHEAD WITH SPACE STATION

Following the selection of six industry teams for definition and preliminary design of elements for a permanently manned Space Station, NASA has awarded contracts extending for a 21 months period.

It is intended that the Space Station be operational by the mid 1990s and will be capable of growth in size and capabilities, for use well into the 21st century.

Current plans call for a low Earth-orbit at close to 500km altitude and a 28.5 degree inclination with the equator. The Station will have a power supply of 75 kilowatts and support about 6–8 people, as well as two or more free flying platforms.

The launch of Space Station elements and subsequent ferrying between Earth and the station will be done using the Space Shuttle.

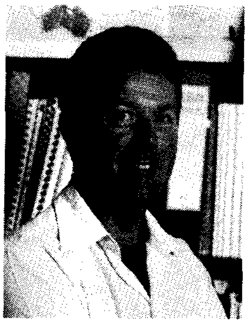
A major objective of the Space Station program is to bring about international participation in building and usage.

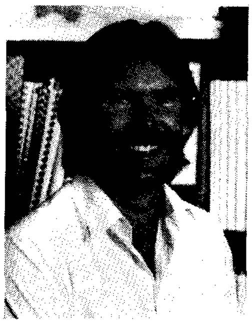
The European Space Agency (ESA), Canada and Japan have indicated interest in participating in the program. This will be at their own expense while NASA will co-ordinate the whole project.

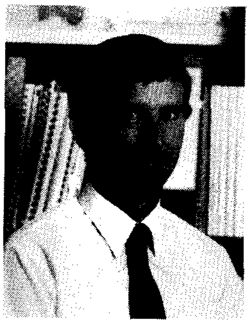
FEATURES

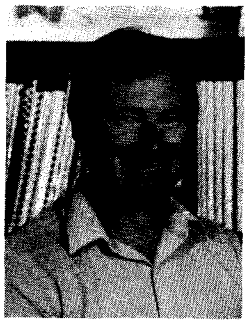
REMOTE SENSING APPLICATION CENTRE (RSAC), PERTH, W.A.

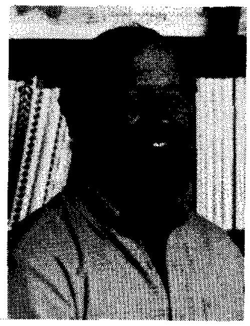
Since 1976, the Surveyor General, Division of the Lands and Surveys Department has been responsible for the co-ordination of remote sensing activities in the State Government Departments of Western Australia. In order to fulfil this responsibility, a Remote Sensing Applications Centre (RSAC) was established. Staffed by specialists in the application of remote sensing, the centre provides information on earth observation


Dr Peter Davison


John Kay

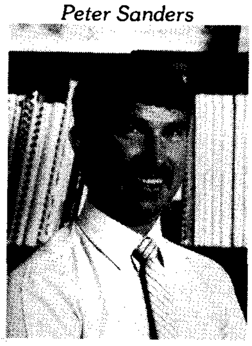

Peter Sanders

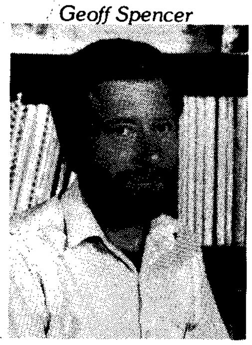

Geoff Spencer


Bill Holman


Henry Houghton


Greg Mlodawski


Richard Stovold


Robert Shaw

satellite data, airborne scanner data and aerial photography for use in resource management and environmental monitoring.

In addition to its role as an applications and information centre, the RSAC also serves as a Reference Centre for the Australian Landsat Station (ALS) and thus holds full sets of the ALS micro image and micro data catalogues. As one of its key functions, the centre acquires satellite and airborne scanner data in digital format. Non-digital data such as aerial photographs can be digitised through use of the OPTRONICS P-1700 Photomation System, a video digitising camera or on an Intergraph workstation.

Image analysis on the recently purchased I^2S Imaging Processing System is made possible through the support of a VAX 11/730 computer and tape drive. The system is designed for real-time multi-spectral or multi-temporal processing and with the incorporated software it is capable of all main image processing tasks including pre-processing of the data, image enhancement, and full image analysis. The image analysis system output includes photographic images written on an OPTRONICS P-1700, 35mm slides of the I^2S monitor screening A3 size colour inkjet plots from a TEKTRONIX 4691 plotter and digital tapes in raster format for data base transfer.

The people involved with this operation are the Remote Sensing Co-ordinator, Henry Houghton, who as the person responsible for the formation of the RSAC in 1983-84, is now in charge of the overall management of the centre. With a wide range of experience in resource inventory projects, the Senior Applications Officer, Bill Holman, is assisted by John Kay in the application of remote sensing techniques to agricultural surveys, by Geoff Spencer in rangeland management applications and by Richard Stovold in agricultural land suitability investigations and subdivision design of rural land releases.

Research Officer, Dr. Peter Davison, a specialist in cosmic ray physics, takes care of the maintenance and operation of the image processing/generating hardware and software, while Research Officer, Greg Mlodawski, is on secondment from the Department of Conservation and Environment to assist in a wetlands and waterlogging project. The responsibility for the preparation and scheduling of work on the image generating system lies with Data Analyst, Peter Sanders, who also looks after product ordering and the digital data library maintenance.

Clerical assistance, typing and other office duties are most elegantly and skillfully provided by Linda Bowden, while in the field we are supported by the person responsible for field equipment, Senior Survey Assistant, Robert Shaw. A recent addition to our staff is Ken Leighton, who as surveyor in charge of the current rangeland survey, has the responsibilities for survey co-ordination, land systems interpretation and final map production.

Key Resource projects

Some of the major projects the Centre is currently involved in are:

1. Salinity Mapping—the mapping of primary and secondary salinity at regional scale using multi temporal Landsat data. The project is a combined exercise with the CSIRO and WA Department of Agriculture. This exercise is to be extended to investigate the use of airborne scanner data (courtesy of Geoscan) along with other available data sets.

2. Rangeland Monitoring (WA LIBRIS)—a joint project with the WA Department of Agriculture, Drs. Dean Graetz and Norm Campbell of the CSIRO. The aim of the project is to extend the LIBRIS concept to pastoral land in Western Australia. The correlation of satellite data with ground sampling in a blue bush shrubland will aid the assessment of range condition by remote sensing techniques.

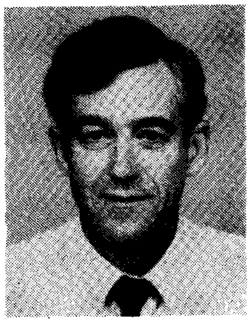
3. Soil Conservation Districts—a joint project with the Department of Agriculture aimed at providing Landsat imagery less than 2 weeks from overpass to District Agricultural Advisors and members of Soil Conservation Districts. The product supplied is a precision processed 1:100 000 scale colour composite with cadastral contour and drainage transparent overlays. Images will be provided over a two year period, three times each year, to determine the useability of the data for resource management and monitoring.

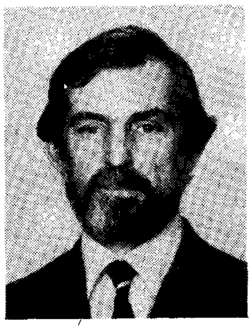
4. Catchment Studies—an investigation currently underway to assess the use of the Centre's Image Processing Equipment to overlay Landsat and other data sets to obtain clearing histories within water catchments in the South West of WA. This project is being undertaken for the W.A Water Authority.

5. Fire Behaviour Monitoring—this project, instigated by the Department of Conservation and Land Management (formerly the Forests Department) of Western Australia, involves the analysis of data from the Aquarius Project, gathered using the CSIRO airborne infrared scanner. Data sets taken at various stages during the fire are being registered, analysed and passed to an Intergraph workstation for further manipulation by the Department of Conservation and Land Management.

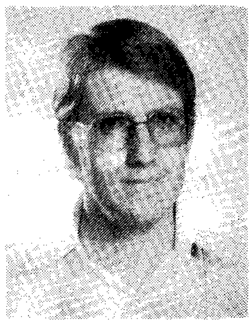
THE UNIVERSITY OF NEW SOUTH WALES CENTRE FOR REMOTE SENSING

The Centre for Remote Sensing was established by the University of New South Wales in 1981 to provide training and research facilities in remote sensing. It is a multidisciplinary unit forming part of both the faculties of Engineering and Applied Science. The participating schools from these faculties, including Electrical Engineering and Computer Science, Surveying, Geography and Applied Geology, contribute to the operation and training programs of the Centre and also provide access to resources and staff expertise.

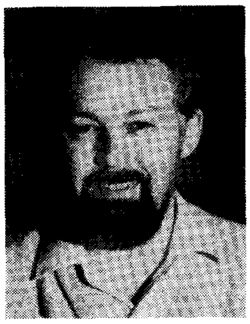

Assoc. Prof. J. Trinder

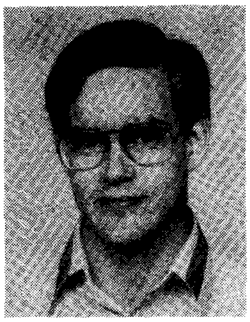

Dr Bruce Froster


Ms Evelyn Gibbons

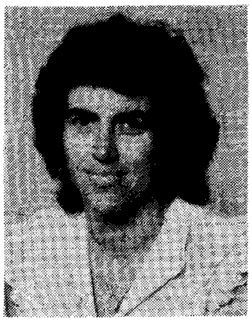

Dr Geoff Taylor

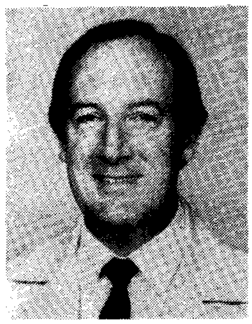

Mrs Moo Song


Dr Tony Milne


Mark Hall


Ms Leanne Bischof


Ms Karen Osborne


Assoc. Prof. J.A. Richards

The Centre is responsible for the administration of the University's remote sensing Masters Degree and Graduate Diploma programs, the operation of short courses, and the co-ordination of research in remote sensing technology and applications.

Facilities include a Dipix Aries II image analysis system, while in addition participating schools make available a variety of analog image analysis and photogrammetric facilities. The Centre also operates an undergraduate teaching laboratory in image analysis based on Apple micro-computers.

To maintain the multidisciplinary character, the academic staff are members of or affiliated with the principal participating schools. The Director of the Centre for Remote Sensing is Associate Professor John Richards from the School of Electrical Engineering and Computer Science. His main areas of expertise and interest are image enhancement and classification techniques, and the applications and processing of synthetic aperture radar image data. The Deputy Director, Dr. Bruce Forster, is from the School of Surveying; his main area of interest is in the mapping of the urban fringe region of cities using high resolution visible, infrared and microwave imagery. Dr. Tony Milne from the School of Geography has a major interest in vegetation mapping in semi-arid regions, particularly the Mallee areas of Australia. Dr. Geoff Taylor from the School of Applied Geology has a principal interest in mapping structural geology using remote sensing techniques including the use of spaceborne radar. Associate Professor John Trinder is also with the School of Surveying and has been actively involved in investigating the mapping potential of remote sensing image data since the inception of the Landsat program.

The Centre's Image Analysis Laboratory is used by staff for research and teaching and by students for project work. The Dipix image analysis system is also available to outside users. The laboratory manager is Leanne Bischof, an electrical engineer, who also works on software development for the Dipix. The Centre is currently establishing high quality film writing facilities with Mark Hall, a Research Assistant, in charge of this development. Karen Osborne, also a Research Assistant, participates in general research programs and assists with short course preparation and operation. On the administration side of the Centre, Evelyn Gibbons is the Administrative Assistant in charge of short course organisation and accounts. All secretarial work for the Centre is carried out by Moo Song.

A Lansat Reference Centre has recently been established within the Centre for Remote Sensing with examples of all ALS products available. 1:500,000 prints for all of Tasmania, Victoria, New South Wales and most of Queensland are on display and a microfiche catalogue for Australia from September 1979 onwards is available.

Visits to the Centre can be arranged and further information on courses or consulting work may be obtained by contacting the Director on (02) 697 4964.

REMOTE SENSING ACTIVITIES IN THE AUSTRALIAN SURVEY OFFICE

Introduction

The Australian Survey Office is the Commonwealth's central surveying service authority and is responsible for land, engineering and topographic surveys for Commonwealth purposes. As part of the service to client departments and authorities, the Survey Office provides digital image processing facilities for the analysis and enhancement of airborne and satellite data in the form of:

- a bureau service whereby clients have access to ASO image processing equipment and assistance from Survey personnel;
- support for client's in-house remote sensing systems, including pre-processing of data and the plotting of imagery;
- the transfer of remote sensing technology to other Commonwealth organisations, the Australian surveying and mapping industry and, where it agrees with foreign policy, to developing countries, particularly in the ASEAN and South Pacific regions.

History

The Australian Survey Office has been actively involved in remote sensing activities for over 25 years, firstly through its aerial survey program and more recently with the analysis and enhancement of satellite imagery. The first practical involvement was a collaborative project with the Australian Federal Police. This research project was to determine if Landsat satellite data could be successfully used for detecting illicit crops. The results proved encouraging and the AFP now regularly monitor large areas using satellite imagery to detect cannabis plantations. Other early projects included the use of Landsat imagery as a valuable source of information in the planning of the Darwin to Alice Springs railway corridor. Imagery covering the entire route was used to locate likely sites for the mining of blue metal, used for ballast. The location of these sites was an important factor in the planning of the route.

The most extensive project to date has been the mapping of the entire Great Barrier Reef. Situated along the north-eastern coast of Australia, the Great Barrier Reef extends 2000 kilometres from north to south and covers an area of approximately 350,000 km^2. It consists of a broken maze of some 2500 individual reefs and 71 cays and forms the world's largest and most complex expanse of living coral reef. Maintaining a correct balance between its protection and preservation on the one hand and the reasonable utilization of its resources on the other is a challenge in planning.

The Great Barrier Reef Marine Park Authority (GBRMPA) is the agency responsible for recommending declarations of sections of the park and for developing zoning plans and regulations. Faced with the need to rapidly acquire information relevant to these objectives, the Authority looked to the use of satellite imagery as a valuable source of information.

Brian Package

In response to a request from the Marine Park Authority, CSIRO, Division of Water and Land Resources, with assistance from James Cook University and the Australian Survey Office, developed the BRIAN package (Barrier Reef Image ANalysis). This system is unique and was specifically developed for shallow water mapping applications; however, it also includes sophisticated techniques for vegetation classification and general image processing. The BRIAN software is written in standard FORTRAN and is running on a PRIME mini computer at the ASO. The major components of the system, as it operates at the ASO, include a Ramtek 9460 high resolution screen, 600 M byte disk drive and large format Applicon ink-jet plotter.

Products

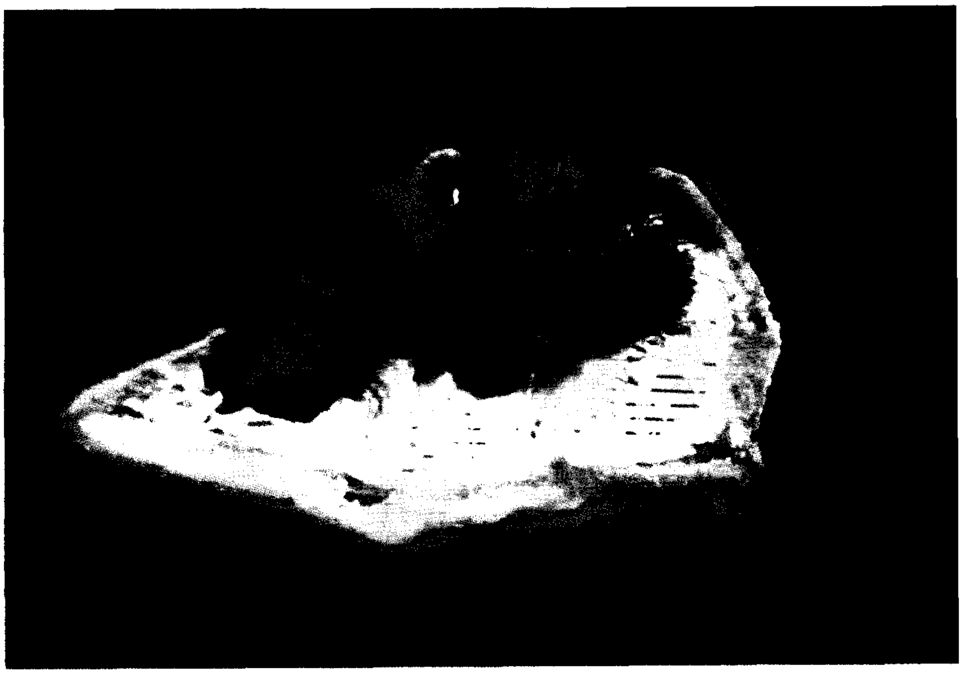
For the Great Barrier Reef project, the Survey Office is producing four standard enhanced images, each having a specific theme. There are two working scales, 1:250,000 and 1:100,000.

Rectified Image

In most cases, users of the imagery not only want to know what they are looking at, but the geographical location of the area of interest. In order to achieve this, the satellite orbital and optical distortions have to be removed and the resultant image registered to a geographical co-ordinate system, in this case the Australian Map Grid. The accuracy of the rectification for each image depends on the number and distribution of accurate ground control points available. At present, the resampling of the satellite image to fit the map projection is done at the final plot stage.

From the work done on the GBR project and others, it has been shown that Landsat MSS images can be geometrically rectified so that they satisfy the stringent National Map Accuracy Standard for 1:250,000. That is:. . . 90% of good independently chosen ground control points must fall within 0.5mm of their known grid

False colour composite image of Ashmore Reef



Depth of Penetration image of Ashmore Reef

0-0.5 metres

0.5-5 metre

5-15 metres

range of Commonwealth applications. In addition to the BRIAN system, the ASO has recently taken delivery of a Dipix Aries III image processing package. This represents state-of-the-art image processing hardware and software. The system includes a high resolution digitising camera which enable graphics data to be integrated with satellite imagery. It also allows for the digital analysis of analog data such as aerial photography. The inclusion of an array processor means that many processing tasks such as smoothing, resampling and ratioing can be achieved in near real time. The combination of the BRIAN and Dipix systems will enable the ASO to offer a more efficient and general image processing service to Commonwealth Departments and Authorities.

If there are inquiries regarding the digital image processing facilities offered by the Australian Survey Office, please contact Peter Holland (062)525996 or Peter Guerin (062)527081 for further details.

number of other Commonwealth Departments and Authorities. These projects have included mapping isolated reef areas in the Timor and Coral Sea for the Australian National Parks and Wildlife Service, shallow water mapping in Papua New Guinea as part of an aid program, and vegetative land cover classification for the Department of Defence.

As a service organisation, the ASO has the capacity to provide digital image processing facilities for a diverse

Acknowledgements

The ASO acknowledges the very important role the Division of Water and Land Resources, CSIRO, has played in the establishment of the image processing facilities at the Survey Office. Dr. David Jupp and his team developed the BRIAN package and have continued to support the ASO activities by providing expert advice and assistance. We are most grateful for their continued support.

INTERIM REPORTS

SHUTTLE IMAGING RADAR (SIR-B) OVER AUSTRALIA

Colin J Simpson

Remote Sensing Group
Division of Continental Geology
Bureau of Mineral Resourses Geology & Geophysics
Canberra, A.C.T.

Table 1
SIR-B Operating Characteristics

Description	Value
Orbital altitudes	352, 274, 225 km
Orbital inclination	57 deg
Mission length	8.3 days
Wavelength	23.5 cm
Frequency	1.28 GHz
Polarization	HH
Pulse length	30.4 ms
Bandwidth	12 MHz
Optical recorder bandwidth	6 MHz
Minimum peak power	1.12 kW
Antenna dimensions	10.7 x 2.16 m
Antenna gain	33.2 dB
Look angles	15 to 60 deg
Swath width	20 to 50 km
Range resolution	14 to 46 m
Azimuth resolution	30 to 30 m (4-look)
Digital data rate	45.6 and 30.4 Mbits/s
Total digital data	65 h
Total optical data	8 h

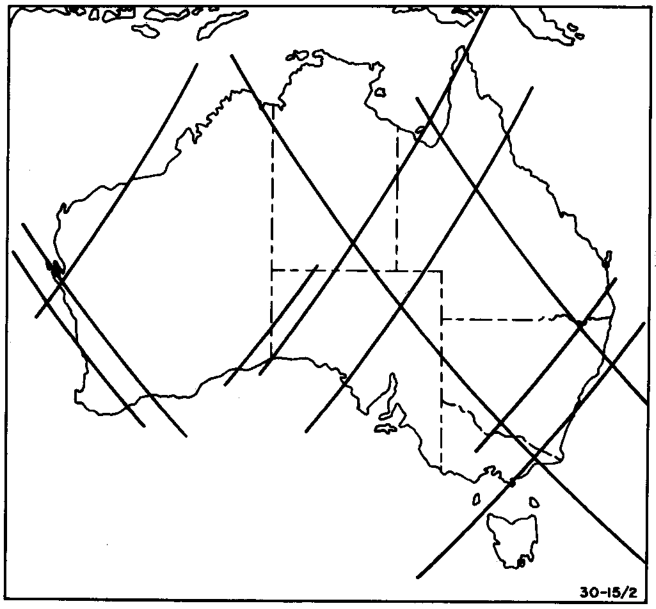
The Shuttle Imaging Radar (SIR-B) mission was carried out during Space Shuttle Mission 41-G from 5–13 October 1984. SIR-B was the third in a series of NASA spaceborne radar experiments that began with the launch of Seasat in 1978 and was followed by SIR-A in 1981. No Seasat radar images were recorded over Australia during its relatively short life, and three optical recording radar imaging passes were acquired over Australia during the SIR-A mission.

SIR-B differed from the prior radar missions in that it was the first space radar system having the capability to acquire both optical and digital radar data, and having a moveable antenna that allowed the radar incidence angles to be selected between 15 and 60 degrees. Some characteristics of the SIR-B are shown in Table 1.

To evaluate the SIR-B data NASA approved 45 separate scientific investigations to be conducted by scientists in 14 countries including 3 Australian teams (ALS Newsletter, April 1984, p7).

Delay in the Shuttle launch eliminated the first two planned radar passes. Shortly after launch the mission suffered a series of mishaps which seriously affected the scheduled SIR-B acquisition program. These problems, involving both the Tracking and Data Relay Satellite (TDRS) and the TDRS link antenna on the Shuttle, resulted in considerable loss of radar data. Preliminary post-flight estimates by the SIR-B Principal Investigator, Dr. Charles Elachi, indicate that of some 50 hours of planned digital data acquisition only about 8 hours were recorded. As a result approximately 20% of investigators are unlikely to get data over their specified target sites.

Four optical and 9 digital data passes were recorded over Australian sites on the SIR-B acquisition passes shown in Fig. 1. Multiple coverage was acquired on some passes. All descending passes (heading NW to SE) were recorded as optical data, and ascending passes (heading SW to NE) were recorded as digital data. Data are being processed into images and CCTs at the Jet Propulsion Laboratory (JPL), Pasadena, California.



The radar image in Fig.2 (provided by the University of NSW Centre for Remote Sensing) shows part of a SIR-B data-take over the Gosford region. The radar beam was directed from the northwest (i.e. in the direction of the ILLUMINATION arrow) and those hill slopes facing the radar beam, image brightest. The geometric arrangements of residential development areas are readily identified as are manmade features, especially the bridges crossing water bodies. Water shows as very dark or black because the obliquely illuminating radar beams can not be reflected from smooth horizontal (or near-horizontal) surfaces back to the radar receiver onboard the spacecraft. The imagery has been enlarged to about 1:154 000 scale from a much smaller negative received from JPL. Researchers in Australia will be attempting to refine and enhance the digital radar data to derive the clearest possible imagery, and also to merge the SIR-B radar with digital Landsat data to produce composite images which may contain more thematic information than is available from each individual data set.

Readers interested in general information on space radar, and its possible applications, are referred to articles in:Time, 6 December 1982, p64.; Scientific American, December 1982, pp54–61.; National Geographic, September 1983, pp316–321.

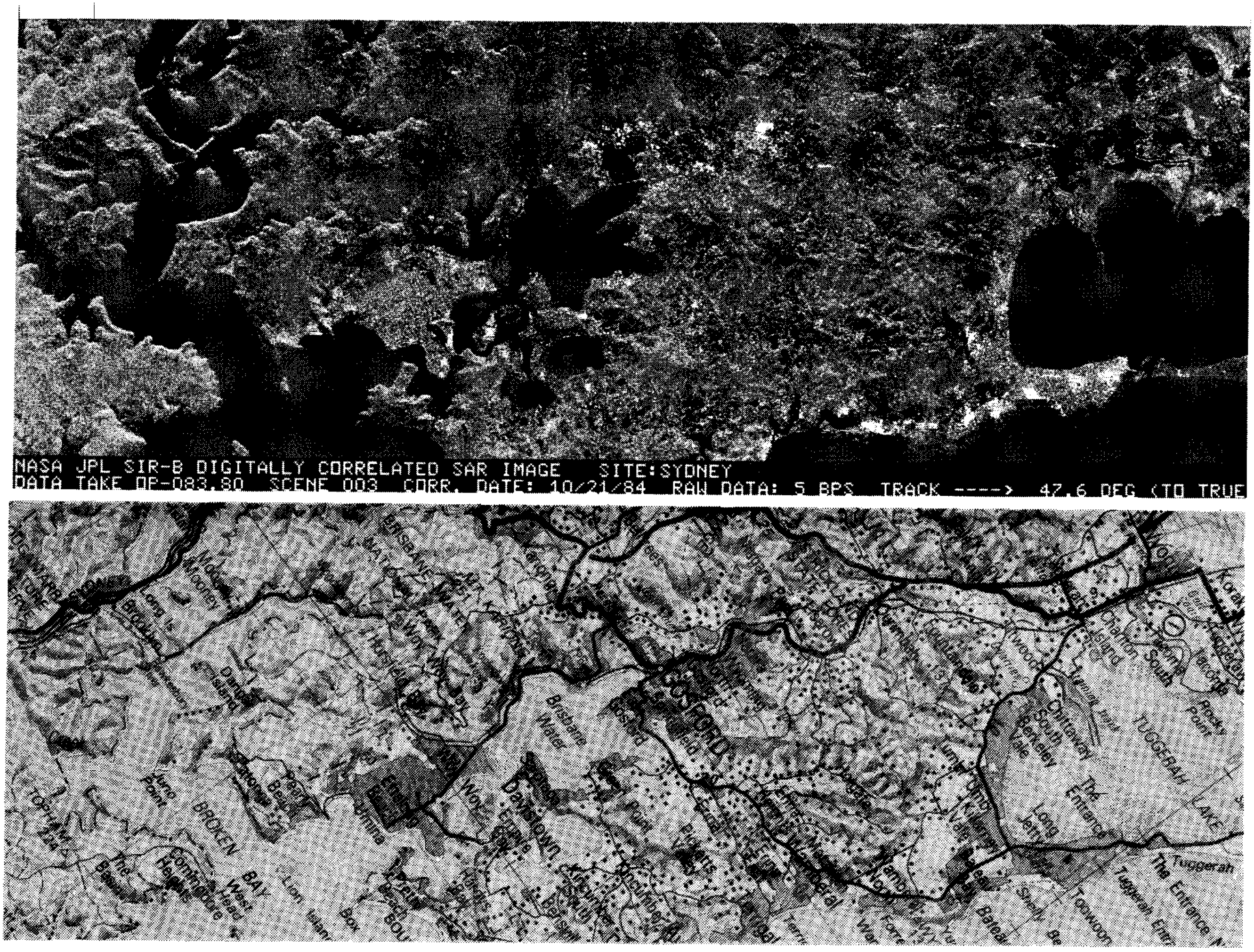


Fig. 2 — *Part of the SIR-B data-take over Gosford, N.S.W. Image scale approx 1:154 000.*

QUESTIONNAIRE

Background

There are three different future satellite imaging radar programs being planned at this time (Canada, European Space Agency, Japan) in addition to NASA's ongoing research program (SIR-C). There are several airborne imaging radar systems that are presently available that can be commercially contracted for survey work. Also, there is already a large amount of previously acquired radar imagery that can be purchased for immediate use.

The Geosat Committee is undertaking a global survey of radar image data users and potential users in keeping with its basic goals to stimulate R&D and to implement technology transfer by fostering better communications between data users and system operators for mutual education and encouragement. The following questionnaire is a significant step toward that objective. We hope you will be willing to assist in the furtherance of civil remote sensing by responding quickly (The Geosat Committee guarantees anonymity of participants' identity).

Please mark all blanks that apply

1. Have you used radar imagery from:
......Airborne Systems? ......Satellite Systems?

2. The radar imagery was:
A.......Individual Strips I.......Very Useful
B.......Mosaicked Coverage II.......Useful
C.......Digital Tape III.......No Help
D.......Interpreted Map

3. Do you plan to use radar imagery from:
A.......Airborne Systems? B.......Satellite Systems?

4. Your country of residence is ....

5. Your organization is:
Government....... Academia.......
Private Sector with annual gross income of less than:
$1m....... $1-100m.......
$100m-$1b....... More than $1b.......
Other (please specify)..

6. The targets of interest to your organisation are:
A. ......Oil and Gas.
B. ......Minerals.
C. ......Hydrology.
D. ......Engineering/Environmental.
E. ......Agriculture/Forestry.
F. ......Oceans/Ice.
G. Other (please specify)...................................

7. The geographic areas of interest to your organization are:
A. ......Africa.
B. ......Asia.
C. ......Australia.
D. ......Europe.
E. ......North America.
F. ......Polar.
G. ......South America.
H. ......Other (please specify)....................................

8. Where did you find **this** questionnaire?..........................

9. Would you participate in a higher-level, technically-detailed survey of users' needs, planned systems specifications, data formats, etc?
......Yes. ......No.

10. Please list on a separate sheet the specific questions/information that you believe should be part of such a future technically-oriented questionnaire.

Please return completed questionnaire to:
The Geosat Committee
153 Kearny, Suite 209, San Francisco, CA 94108
Ph: 415/981-6265; Tlx: 910 372 2043 GEOSAT SFO)

Thank you for your participation.

A STUDY OF LINEAMENTS AND MINERALISATION NORTH OF MOUNT ISA

G.W. Tassell

Remote Sensing Services Pty Ltd. — Technical & Field Surveys Pty Ltd.
Crowsnest, N.S.W. 2065

Abstract

Results of a lineament analysis of the Kennedy Gap 1:100 000 geological sheet using a Landsat false colour composite image were correlated with published geology, magnetic and structural maps as well as occurrences of uranium and copper in an attempt to recognize relationships between these forms of data and establish controls on mineralisation. A significant preliminary finding is the location of mineralised areas along approximately north-trending zones and in particular at the intersection of such zones with lineament zones trending approximately 040°.

Introduction

In order to test the effectiveness of Landsat lineament analysis as a tool for mineral exploration, Remote Sensing Services Pty. Ltd. (the interpretation branch of Technical and Field Surveys Pty. Ltd.) is conducting a research project covering the Kennedy Gap 1:100 000 sheet, north of Mount Isa. Of special significance, from an exploration point of view, is the extent of correlation between Landsat's geo-spectral information and a mineral exploration data base such as the one compiled by Technical and Field Surveys Pty. Ltd. (T.F.S.). The following paper serves to illustrate some of the preliminary findings. Further evaluation of the area is continuing and is to include detailed reprocessing of geophysical data and the results of lithological and metallogenic analysis.

Geological Features

The Kennedy Gap 1:100 000 sheet (fig.1) covers the north-eastern corner of the Mount Isa 1:125 000 sheet. Principal structures include the NNW-trending May Downs Fault and Twenty Nine Mile Fault Zone, the N.E.-trending Mount Gordon Fault Zone and the meridional Mount Isa and Hero Faults, Waggaboonyah Syncline and Leander Anticline (fig.2).

Fig. 1. — *Geology of Kennedy Gap Sheet (reduced from published 1:100 000 scale map).*

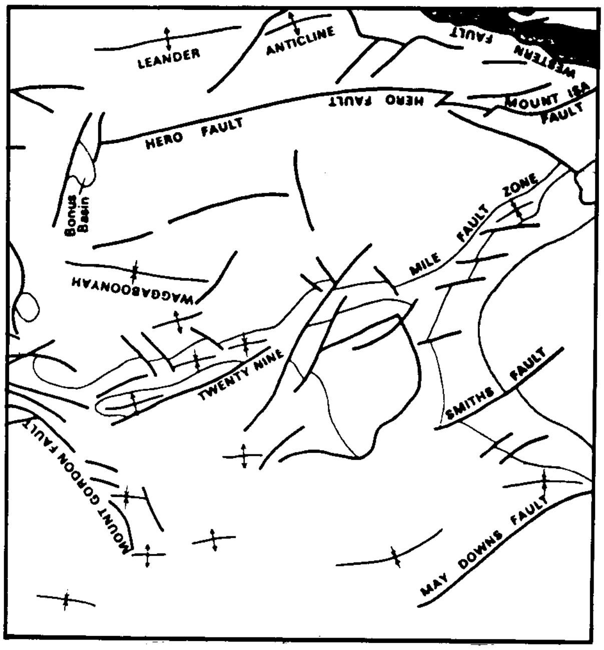


Fig. 2. — *Structural sketch map (from published 1:100 000 geology map).*

Uranium and copper occurrences, for example, are most commonly associated with the Proterozoic Gunpowder Creek Formation, Eastern Creek Volcanics and Leander Quartzite which dominate the eastern half of the study area (figs.1,4).

Lineament Analysis

Lineaments were identified visually (as opposed to computer interpretation) from a 1:250 000 scale false colour composite print of the Mount Isa Landsat scene (fig.3). The lineaments were digitised and plotted by computer as a 1:250 000 scale transparent overlay (fig.5) with accompanying frequency rose diagram. Lineament intersections were incorporated by means of computer plotted density contours, based on a 2.5km square grid (fig.6). Dominant lineament zones were interpreted from

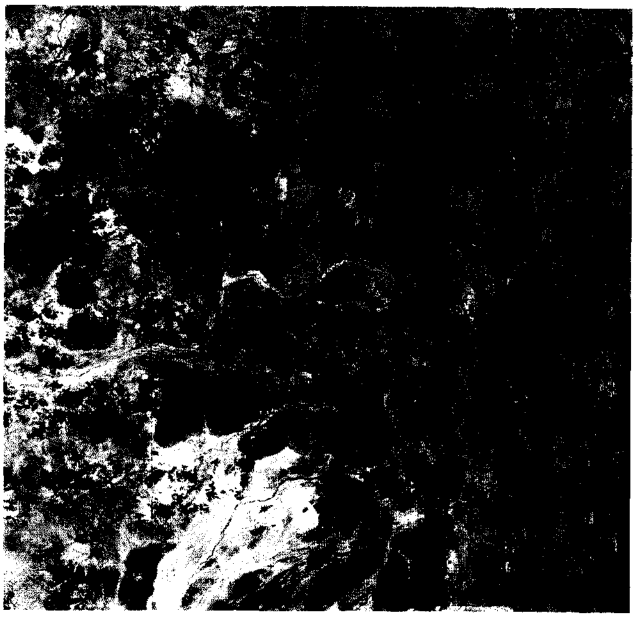


Fig. 3. — *Landsat false colour composite. Path-row 106-74, 22.2.1980.*

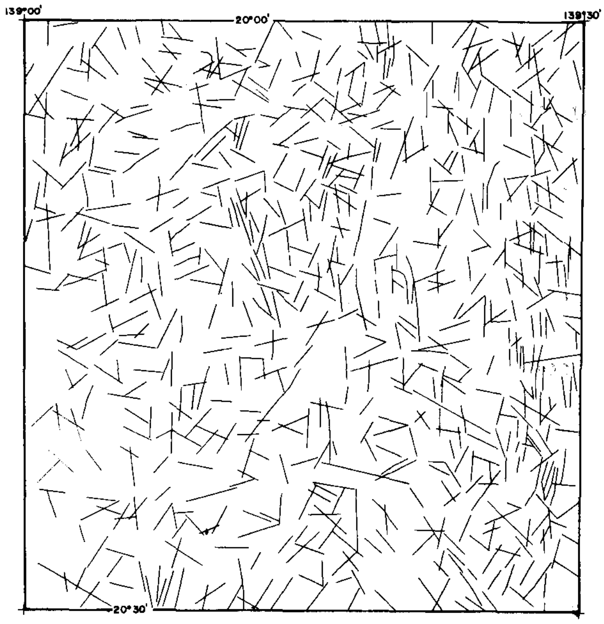


Fig. 5. — *Lineaments derived from Fig. 3. Frequency rose diagram is shown below.*

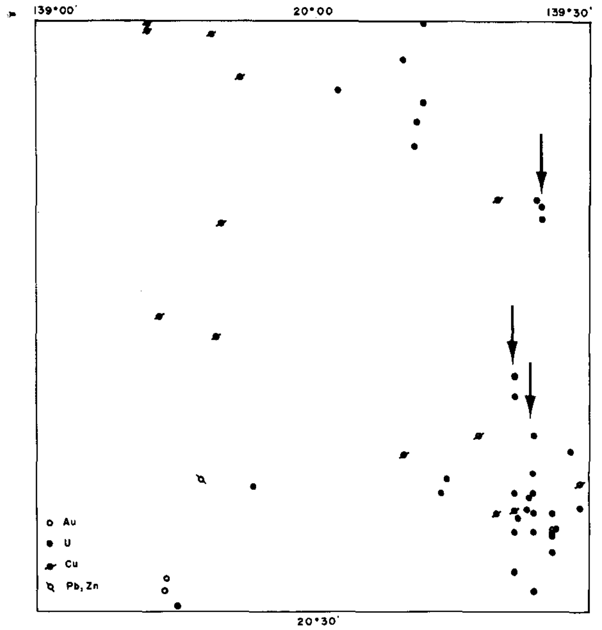


Fig. 4. — *Distribution of uranium and copper occurrences from Technical and Field Surveys' records. Arrows indicate alignment of occurrences.*

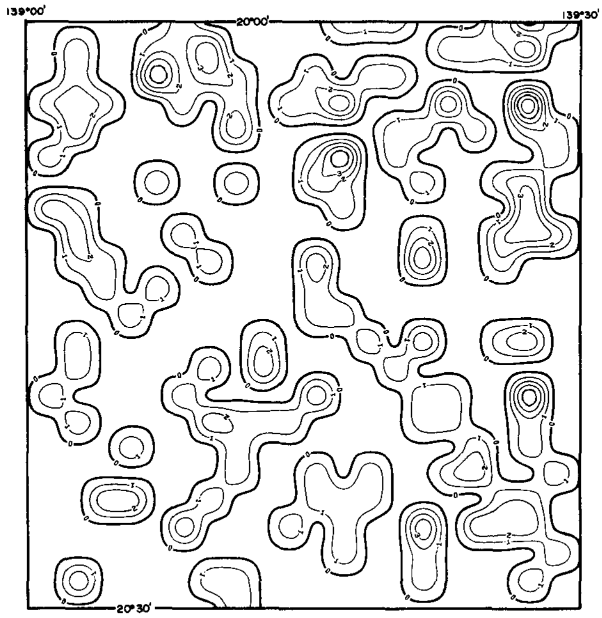


Fig. 6. — *Contours of density of intersection of lineaments in Fig 5.*

fig.5 and are depicted on fig.7.

Mineral Occurences

Occurrences of uranium and copper were extracted from the T.F.S. database and plotted on a single overlay. These two elements were chosen as their high frequency of occurrence in the relatively small area enabled generalisations to be readily drawn.

Correlations and assessment

The plans of uranium and copper occurrences and those from the lineament analysis were compared with the geology map, magnetic contours and the structural sketch map. Of the generalisations deduced the following selection illustrate the effectiveness of a logical, systematic approach.

1. A strong correlation exists between mineral occurrences and N.E.-trending lineaments or mapped faults.
2. Mineral occurrences do not coincide directly with areas of high lineament intersection density but are generally located in areas adjacent to such highs.
3. Outcrops of Eastern Creek Volcanics coincide with intersection lows whereas the Leander Quartzite coincides with intersection highs.
4. Mineral occurrences in the S.E. corner of the study area appear to be related to three distinct approximately meridional trends which are parallel to and lie on either side of a well-defined fault

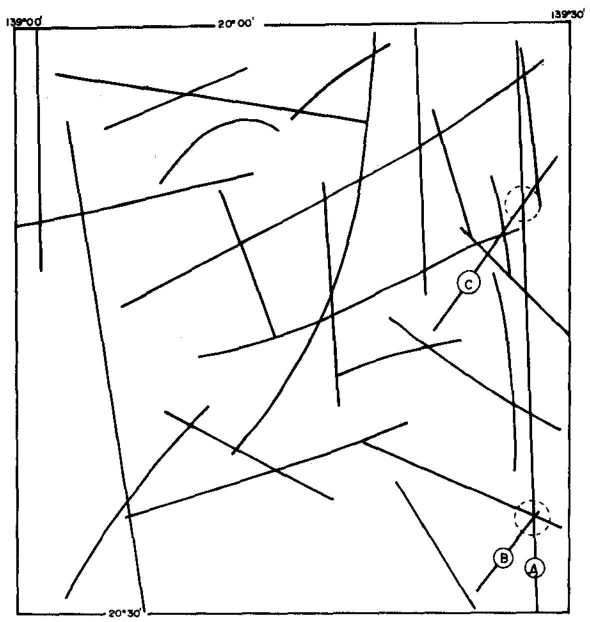


Fig. 7. — *Dominant lineament zones from Fig 5.*

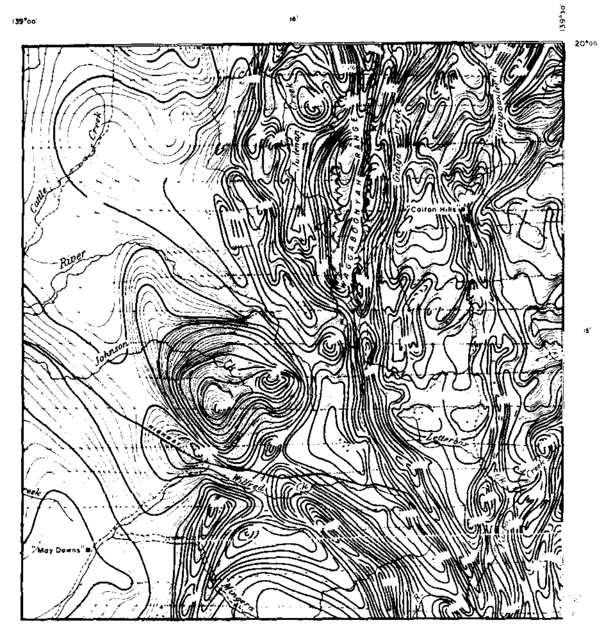


Fig. 8. — *Magnetic contours (reduced from published 1:250 000 scale map).*

(figs.1,4).

5. Lineament zone A (fig.7) and the Hero Fault (fig.2) appear to constitute limiting boundaries of the more densely mineralised areas in the eastern half of the study area.
6. The intersections of zone A (fig.7) with zones B and C (trending approx. 040°) coincide with well mineralised areas.
7. Extension of zone A to the south shows that it passes through the orebodies of Hilton and Mount Isa, each of which occurs at the intersection of zone A with a lineament zone trending approximately 040°. All of these zones are readily apparent on the full Mount Isa Landsat image.
8. A distinct magnetic lineament (fig.8) occurs parallel to and slightly west of zone A.

Conclusions

The approximately meridional lineament trend (zone A) appears to have had considerable influence on mineral distribution in the eastern portion of the Mount Isa sheet.

Areas along this trend and meeting one or more of the following criteria would appear to constitute suitable exploration targets.

(a) Intersected by approximately 040° trending lineament zones (or perhaps individual lineaments).

(b) Lithologies such as those of the Eastern Creek Volcanics, Leander Quartzite or Urquhart Shale (Mount Isa district).

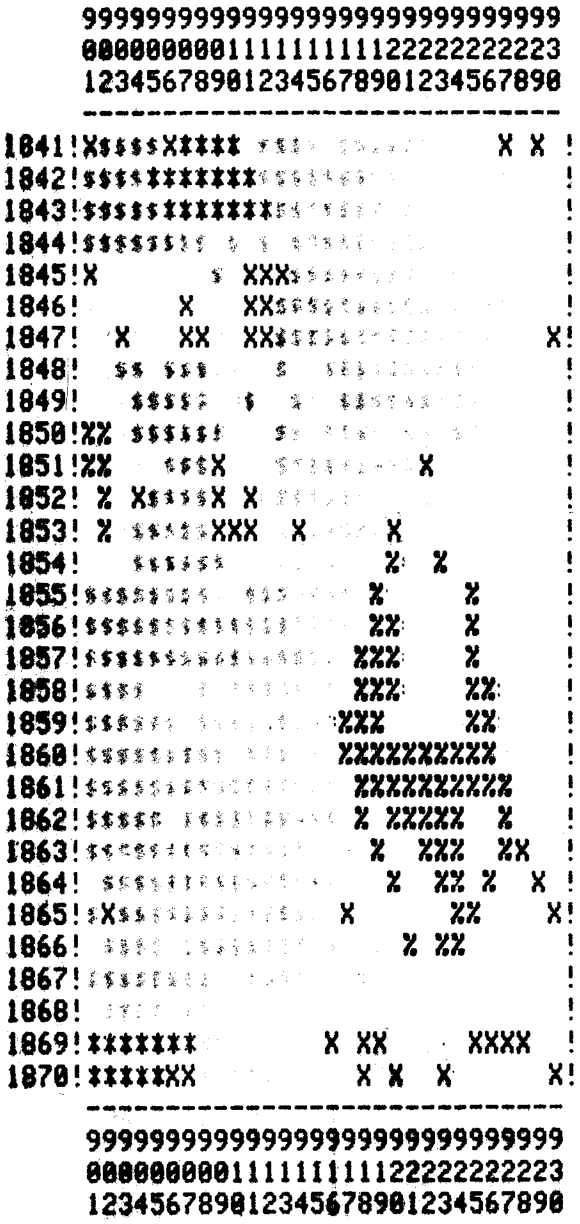
(c) Adjacent to areas of high lineament intersection density.

APPLEBLIP: DIGITA IMAGE PROCESSING ON AN APPLE INTERIM REPORT

Alan D. Jones
Geography Department,
University of New England
Armidale, N.S.W. 2351

The development of digital image processing systems has created problems for educational institutions in providing interactive hands-on experience for students. The traditional stand-alone systems such as the DIPIX and COMTAL are expensive to install and few tertiary institutions are likely to install one let alone multiple systems. Instructing large numbers of students on a single system is inefficient both in terms of staff time and the use of expensive equipment for initial instruction.

One solution which has been widely used has involved the use of suitable software on a mainframe computer. While this would not normally involve the use of a colour monitor, it has proved effective and efficient for initial instruction in image enhancement and classification. An alternative solution which is of more recent origin has been the use of small microcomputers such as the Apple II. Several universities in the United States have reported on their experiences with



Dangar's Lagoon — 29 Dec. 1979.

Class	Symbol	Pixels
Water	#	38
Reeds	%	68
Cleared Land	*	30
Woodland/Native Pasture	#	104
Improved Pasture	$	565
Pixels classified more than once (X)		45
Pixels not classified		50

microcomputers and an image processing system, APPLEPIPS, is available commercially. This system in its basic version allows the creation of pseudo colour images and a parallelipiped classifier. A more advanced version contains other classification algorithms.

At the University of New England a special requirement is the need to develop a system for use by external students. Commercially available software is normally too expensive to provide multiple copies, particularly for distribution to external students. A possible solution was to attempt to convert software running on the University's DEC 20/60 computer to run on an Apple II microcomputer. The Apple II was selected as being the microcomputer most readily accessible to students. Fortunately the programs on the DEC 20/60 had been written in BASIC and the initial task of conversion into Applesoft BASIC was not too difficult.

The size of image to be processed was limited by the width of the Apple VDU and the size of the memory. The software was developed to run on a 48K Apple II+ to permit its use on older Apple II microcomputers. It was also desired to hold the data for all four bands in memory for as many programs as possible. The size of image is therefore limited to 30 pixels by 30 lines. In addition, the software had to be usable with a monochrome monitor and either a single or double disk drive.

When the programs were initially tested the classification programs took up to 45 minutes to run with five classes on a 30 by 30 image. This led to the investigation of a compiler to speed up the programs. This phase proved to be the most time consuming, but was worthwhile in that the slowest program is now completed in under 6 minutes, a considerable improvement in processing speed.

As currently configured, the programs are contained on two disks and are menu driven to lead the user from program to program. The first disk contains programs for image creation, enhancement and training, while the second has the classification programs. Both disks contain utility programs for file handling and printing. A third disk contains the digital data.

LAND COVER MAPPING USING LANDSAT

D.R. de Kantzow

Faculty of Agriculture

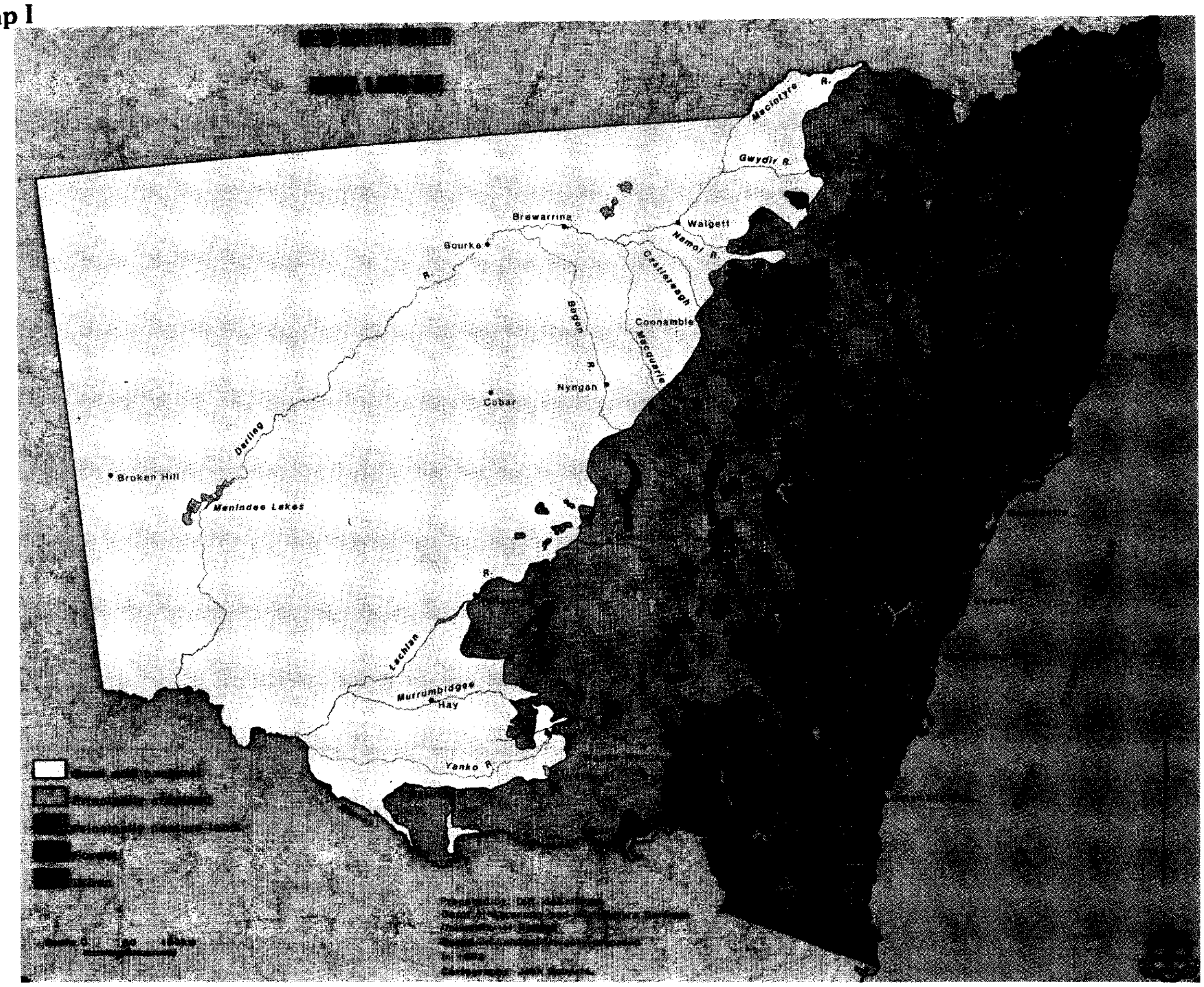
University of Sydney, N.S.W., 2006

Introduction

The availability of Landsat scenes in digital form has resulted in the production of a great many maps, using computers to classify the image. One is tempted to suggest that many of these maps are so small in scale that a simple tracing of a photographic image might have been more appropriate for the purpose, that is, much cheaper and faster. There is also a tendency to examine a small area at a scale which is so large that the pixel size of the Multispectral Scanner (MSS) leads to inaccuracies. There is a danger that this may be seen as a fault of the technology, when in fact it is a case of the wrong tool being used for the job.

Accompanying this paper are two maps which test

Map I



A land use classification produced from Landsat images recorded on 29 December 1979, 6 June 1980 and 28 August 1980. Beresfield is between Newcastle and Maitland in the Hunter Valley of New South Wales.

the capability of Landsat products at each end of the range. A very small scale map of the whole of New South Wales was produced by tracing prints from a browse file, and a large scale map of a complex area near Newcastle was produced from an analysis of three digital tapes of the scene.

Map I: Land Cover in New South Wales

The Australian Landsat Station (ALS) produces and distributes a microfiche version of the images recorded by each set of Landsat overpasses. Until early 1984 these microfiches were produced from a full set of 'quick-look' black and white prints of the infrared band (band 7) printed at a scale of 1:1,000,000. These prints were then stored as a "browse file" at the ALS. Many images are available for each scene. Autumn and Spring scenes, which demonstrate land preparation and crop growth, are repeated three or four times each season and problems such as cloud cover or an occasional poor image are easily overcome. This allows agricultural land cover details to be incorporated into a tracing of the standard Natmap 1:1,000,000 map in a very rapid and satisfying fashion.

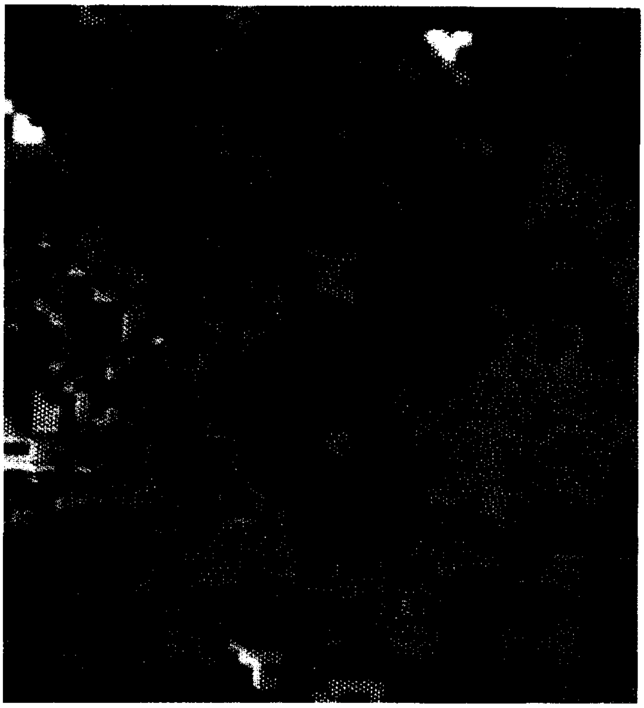
The map sets out the extent of urban and forested land, pasture land which shows only limited signs of cultivation, regularly cultivated land (generally known as the "wheatbelt") and semi-arid pastoral land.

The "wheatbelt" is of particular interest as it has a tendency to expand. In this case the eastern boundary was easily identified, as cultivation ceases quite sharply where the ground slope increases. The south-western boundary is also sharp as significant cereal production is only made possible by irrigation and ceases along the boundaries of irrigation areas. The north-western border is less distinct and a thin scatter of well separated wheat paddocks does occur for a small distance to the west of the line chosen.

The result of using this technique is an up-to-date map which is quickly and cheaply produced. The example is Map I. This sets out the situation for 1983; it took only one and a half man days to trace and another one and a half days for cartography. It is sufficiently accurate for broad-scale planning, and certainly more informative than most land cover maps in common use.

Map II: Land Cover at Beresfield

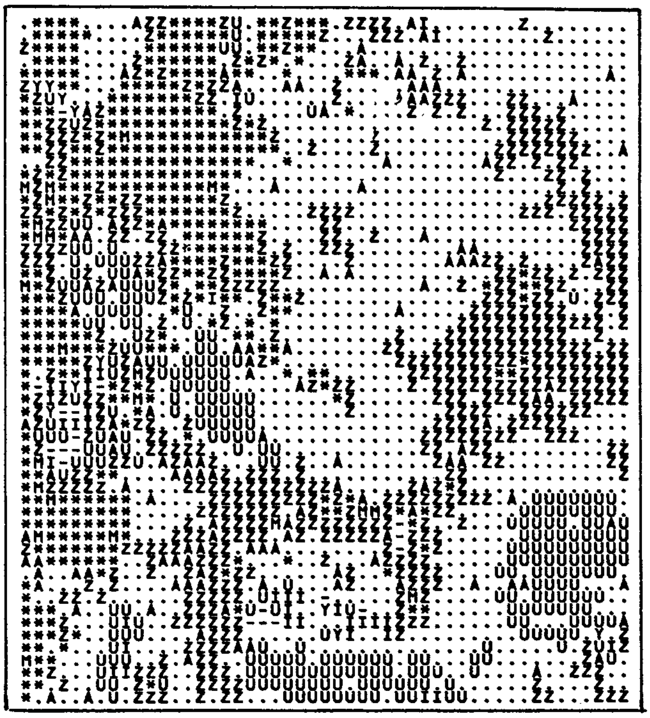
Map II was produced by using three digital images which were recorded on December 29th, 1979, June 8th, 1980, and August 28th, 1980. This was a drought period during which the season-to-season contrasts are especially valuable in mapping differences in productivity



The coloured classification map presented here is of a filtered classification, that is, a single pixels have been coverted to the class of one of the surrounding eight pixels.

LAND USE	KEY: Symbol	KEY: Colour	STATISTICS: Area (ha)	STATISTICS: %
PASTURE	.	Brown	716	42
SWAMP	Z	Fawn	401	23
FOREST, Dryland	*	D. Green	275	16
URBAN	U	L. Blue	190	11
AGRICULTURE	A	L. Green	83	5
INDUSTRY	I	Yellow	22	1
FOREST, Wetland	M	Purple	14	1
WATER	-	Blue	12	1
SAND	Y	White	6	-
TOTAL			1719	100

Character Map



Air Photo

Original scale 1:16 000
Now approx. 1:32 000

A character map of the Beresfield classification and an aerial photography of the area taken on the day of the first satellite pass used in the classification and adjusted to the same scale.

in agriculture and were less marked than usual. Test classifications using only two or just one of these images showed that any Summer plus Winter image combination was useful, but the June plus August images together or a single image did not give an acceptable result. Some fifty-five land-cover classes were established to produce the classification for this sample area. These were then combined to give the nine classes illustrated.

To establish the accuracy of the classification an aerial photograph, taken on 29th December 1979 (the same day as the first Landsat overpass) was obtained and covered with a pixel-scale grid. This allowed a pixel-by-pixel comparison to be made with an unfiltered character map of the classification (Map III). The stratified sampling technique put forward by Fitzpatrick-Lins (1981) was used. To obtain a 95% confidence level in the accuracy of assessment, 220 samples representing all classes, were taken.

The result was 77.3% correct by classified pixel, the majority of the "misses" being border pixels and occurred especially where the class was small and scattered, as were the "industrial" and "water" classes. From a visual inspection a more promising classification result than this might be expected, so a planimeter was used to measure the photograph. The result of this comparison is presented in Table I.

Land Cover	*Planimeter*		*LANDSAT*	
	ha	%	ha	%
Open Country	1033	69	1057	70
Forests (Wetland & Dryland)	232	16	243	16
Urban	184	12	165	11
Industrial	45	3	19	1
Water	7	—	12	1
Sand	2	—	7	—
	1503	100	1503	100

Table I

A comparison of the areas of land cover classes assessed by classifying Landsat data (3 images) and by aerial photograph interpretation with a planimeter.

The aerial photograph covers a slightly smaller area than the classified sample, and consequently the totals for Map II and Table I are slightly different.

Several observations may be made about this classification:

1. Although the pixel-by-pixel comparison gave an accuracy of only 77.3%, the areas of the land covers measured by using Landsat were very similar to those measured by planimeter.
2. The errors, if the visual assessment of the aerial photograph is taken as being perfect, occurred mainly in the smaller blocks of pixels.
3. Landsat had a distinct advantage when mapping the agricultural component of the scene. While wetland and farming activity were detected by Landsat, they could not be discerned on the aerial photograph.

In conclusion, it is suggested that the Landsat MSS has performed satisfactorily at this scale, but that the extent of small and dissected land covers represented in the classification presented is probably close to the limit of this scanner's usefulness.

References

Fitzpatrick-Lins, K.—"Comparison of sampling procedures and data analysis for a Land-Use and Land-

Acknowledgement

The generous assistance of the N.S.W. Department of Environment and Planning, IBM (Aust.) Ltd. and the Australian Landsat Station made these projects possible; Mr. John Roberts drew Map I.

PRELIMINARY GEOLOGICAL INTERPRETATION OF SHUTTLE RADAR IMAGERY OF THE AMADEUS BASIN

G.R. Taylor, G.J. Lynne*, J.A. Richards***
* School of Applied Geology
**Centre for Remote Sensing

University of New South Wales
Kensington, N.S.W. 2033

Abstract

A multi disciplinary group at the University of New South Wales is undertaking a broad assessment of the utility of space-borne radar remote sensing image data for a number of mapping and classification applications. Co-ordinated by the Centre for Remote Sensing, the study includes urban monitoring, topographic mapping, information extraction and arid-zone studies. Preliminary geological interpretations within the latter topic are described here.

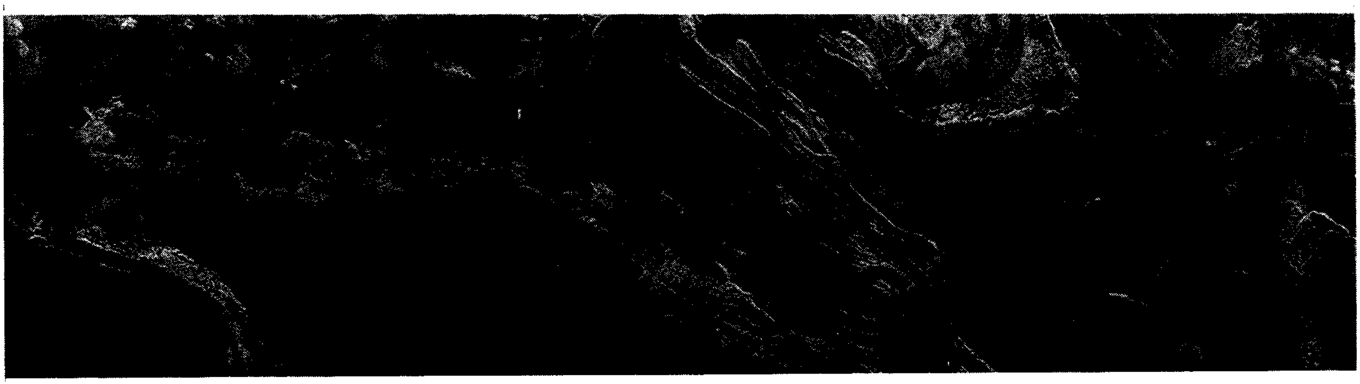


Fig. 1A. — *Part of SIR-B data-take AU084.60*

Introduction

The SIR-B experiment was carried on board the Space Shuttle Challenger launched on October 5, 1984. Due to persistent problems with the Ku-Band antenna and the radar antenna itself, many of the planned data-takes were not acquired and the power of the transmitted and received signal was much reduced. As a result, three of the four planned data-takes for the Amadeus Basin were not recorded and no penetration of surficial cover was observed.

The unprocessed SIR-B imagery (Fig. 1A) has a disappointingly low dynamic range and is dominated by speckle effects. However it does represent topography well. It therefore facilitates the digital integration of a data source representing topography (SIR-B) with one reflecting the spectral properties of the rock and ground cover (Landsat). Figure 1B is a composite registered SIR-B and Landsat principal component image. The SIR-B data may therefore be viewed as a convenient substitute for high resolution digital terrain data. Whilst this falls far short of its original objectives, a greatly increased amount of geological data can be extracted from the combined image compared to that extracted from the Landsat alone. It is hoped that the SIR-B reflight planned for early 1987 will demonstrate the surface roughness, multi-incidence angle and penetration aspects of radar imagery.

Geological interpretation

SIR-B data take AU 084.60 crosses the arid western margin of the Simpson Desert in central Australia. This is an area where NNW trending seif dunes and redistributed aeolian sands abut against stoney plains, plateaux, and isolated sandstone ranges. The area is underlain by folded and faulted metamorphic and igneous rocks of the Australian Pre-Cambrian Shield. Marine transgressions in Upper Proterozoic, Palaeozoic, and Mesozoic has resulted in the desposition of sedimentary rocks over much of the area.

Rainfall in the area is usually extremely erratic and unreliable with a summer maximum and a lower winter peak giving a mean average of 14 to 18cm per year. However, heavy rain and flooding occurred immediately prior to the SIR-B overpass, saturating the surface sands and alluvium and significantly reducing the ability of the sensor to penetrate to any depth. The flora of the test area is typical of that found in arid conditions, consisting of a variety of hardy, drought resistant species fixing ancient dunes and sparsely covering rock outcrops.

Structural Analysis

Recognition of bedding traces and dip directions

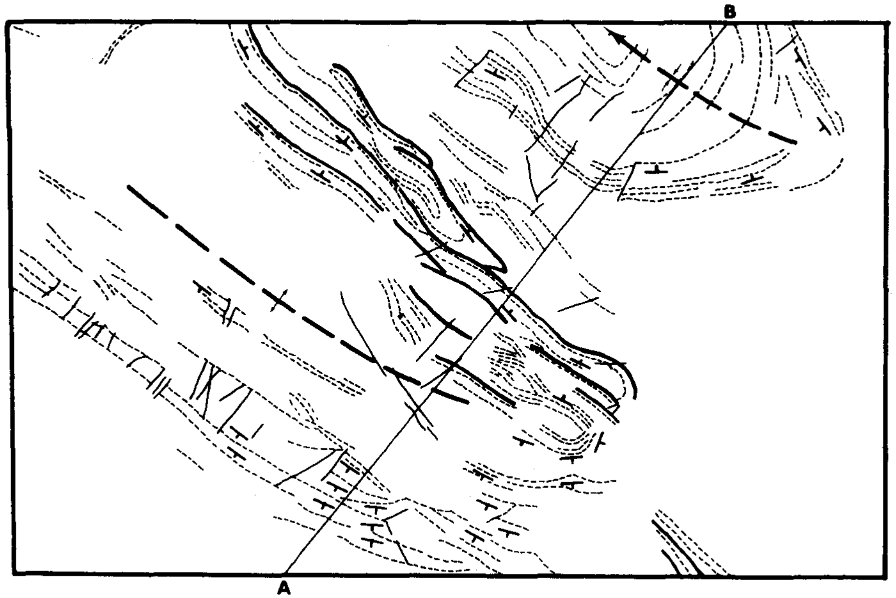


Fig. 2A. — *SIR-B structural interpretation*

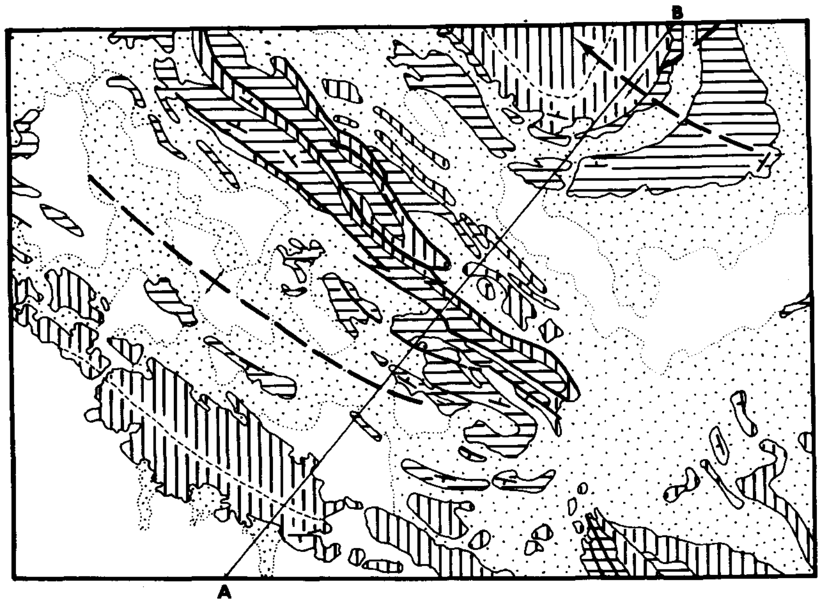


Fig. 2C. — *BMR 1:250 000 published geology*

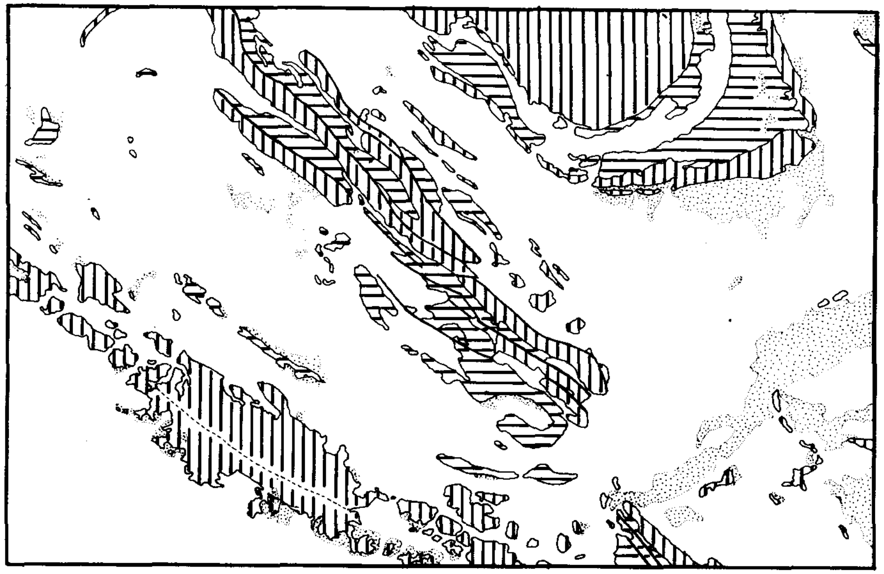


Fig. 2B. — *SIR-B/Landsat geological interpretation*

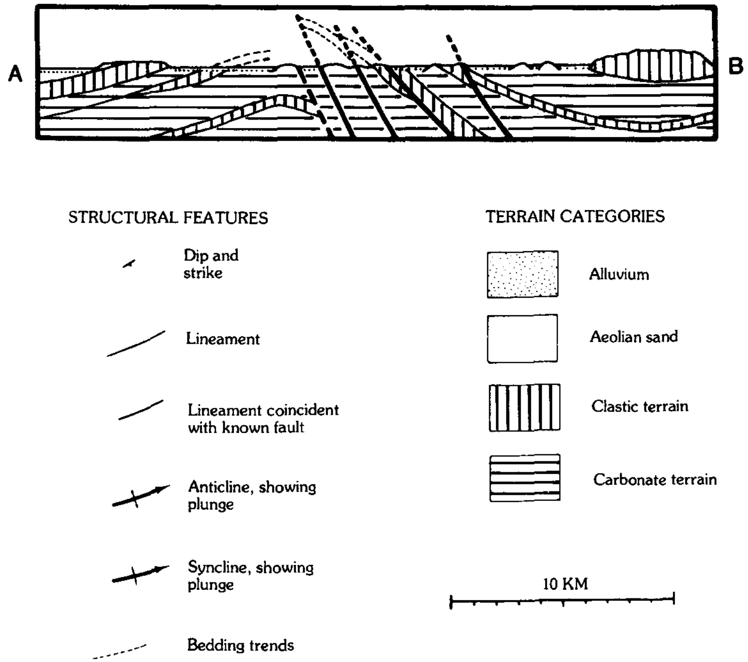


Fig. 1B. — *Registered SIR-B and Landsat Principal Component image. Radar—red, PC1—green, PC2—blue*

allows several regional geological structures to be recognised. Bedding traces of outcropping sedimentary rocks have been mapped on Figure 2A as a series of broken lines. Dip directions (Figure 1A) are generally toward the top right of the image, that is, toward the radar antenna. The extensive dipslopes have bright signatures and the scarps, which are in the radar shadow, have dark signatures. The affect of the layover problem in biasing interpreted dip surfaces towards those facing the antenna is currently being evaluated. Arcuate patterns of bedded strata interpreted from the SIR-B imagery (Fig. 1A) have been plotted on Figure 2A. Dip directions interpreted from the radar imagery, and confirmed in the field, define a plunging syncline in the upper right, and an anticline in the lower center of the imagery (Fig. 2A). In the Amadeus SIR-B imagery (Fig. 1A) most lineaments are expressed as scarps or small linear valleys. In Figure 2A, lineaments are designated by a thin unbroken line. Lineaments that correspond to faults established by reference to published geological maps are mapped as a solid line (Ranfordet al, 1964).

Lithological Mapping

The clear expression of topographic characteristics and textural variations due to differing surface roughness conditions on the SIR-B imagery, in combination with digitally registered Landsat MSS Principal Component data (Figure 1B) has allowed four broad terrain categories to be recognised (Figure 2B). These are (a) clastic terrain formed on clastic rocks and recognisable by the topographic expression of resistant strike ridges and spectral signature recorded by the Landsat MSS sensor; (b) carbonate terrain which has a more subdued outcrop morphology than the clastic rocks and distinctive spectral characteristics recorded by the Landsat MSS sensor; (c) aeolian sands terrain where both dunes and redistributed aeolian sands can be recognised on the basis of subtle textural differences from variations in surface roughness, and their distinctive Landsat MSS signatures; (d) alluvial terrain composed of outwash fans derived from clastic rocks that can be clearly distinguished by the bright backscatter return from characteristic rough surfaces. Smooth surfaced deposits of river alluvium produce a dark radar signature and are also clearly distinguished by their distinctive Landsat MSS signature.

Conclusions

Despite the SIR-B experiment falling far short of its intended operating parameters, the integration of digital radar data with other data sources such as Landsat is clearly going to be of great value in geological exploration. Work currently in progress suggests that various spatial filtering algorithms may greatly reduce the speckle effect and assist in the recognition and delineation of lithology related pattern elements from SIR-B imagery.

Acknowledgements

We would like to express our thanks to Esso Australia for substantial financial support and to Magellan Ltd. for much logistical support in the field and for access to original geological mapping which has formed the basis of our interpretations.

LANDSAT AND NUMBUS IMAGERY AID STUDIES OF GEOLOGICAL STRUCTURES

P.E. O'Brien, A.T. Wells

Division of Continental Geology
Bureau of Mineral Resources, Geology &Geopysics
Parkes, A.C.T. 2600

Introduction

Earth scientists have long realized the value of Landsat imagery in the study of the earth's structure. By allowing the geologist to "stand back" from the earth's surface, Landsat can reveal many large crustal features not easily recognised by conventional methods of geological mapping. Geologists of the Bureau of Mineral Resources, Canberra have taken this approach one step further by using even smaller scale images produced by the Nimbus Coastal Zone Colour Scanner, as well as Landsat imagery, in a study of the Clarence-Moreton Basin in north-eastern New South Wales and south-east Queensland. The project is part of a joint study of the basin involving B.M.R. and the Geological Surveys of Queensland and New South Wales.

Basin Study

The Clarence-Moreton Basin is an elongate trough filled with sedimentary rocks ranging in age from about 200 to 130 million years old that underlies large parts of south-east Queensland and north-eastern New South Wales. Figure 1 shows a Landsat mosaic of the south eastern part of the Clarence-Moreton Basin. The satellite imagery was employed in the early stages of the project to identify major features in the basin and surrounding rocks that might have had a bearing on the geological history of the basin. These features are now being studied on the ground.

The study used two sets of images. The first set was a product of the Coastal Zone Colour Scanner (CZCS) aboard the Nimbus 7 satellite. Nimbus 7 orbits at an altitude of 954 km and the CZSC scans a swath 1636 km wide with 825 metre pixels. Australian data from the CZCS were received irregularly, depending on priorities, at the Orroral Valley satellite tracking station near Canberra during those overpasses within acquisition range. Personnel at the Australian National University's Research School of Physical Sciences reformatted the data before B.M.R. used them. Data have also been purchased from NOAA in the U.S.A. Hard copies of the CZCS images at 1:1,000,000 scale using Bands 1, 4 and 5 were produced by C.S.I.R.O. Division of Water and Land Resources using an Applicon colour ink-jet plotter. The second set of images consisted of Landsat black and white prints of Band 7 at scales of 1:1,000,000 and 1:250,000 and false colour composite images (Bands 4, 5 and 7) at 1:1,000,000 scale.

Several major features stand out on the different images and their interpretation is underway using a number of geological and geophysical techniques. Though designed for sensing ocean waters, the CZCS images have proved useful in identifying major structures in the Clarence-Moreton Basin not previously recognised, even on Landsat-MMS images.

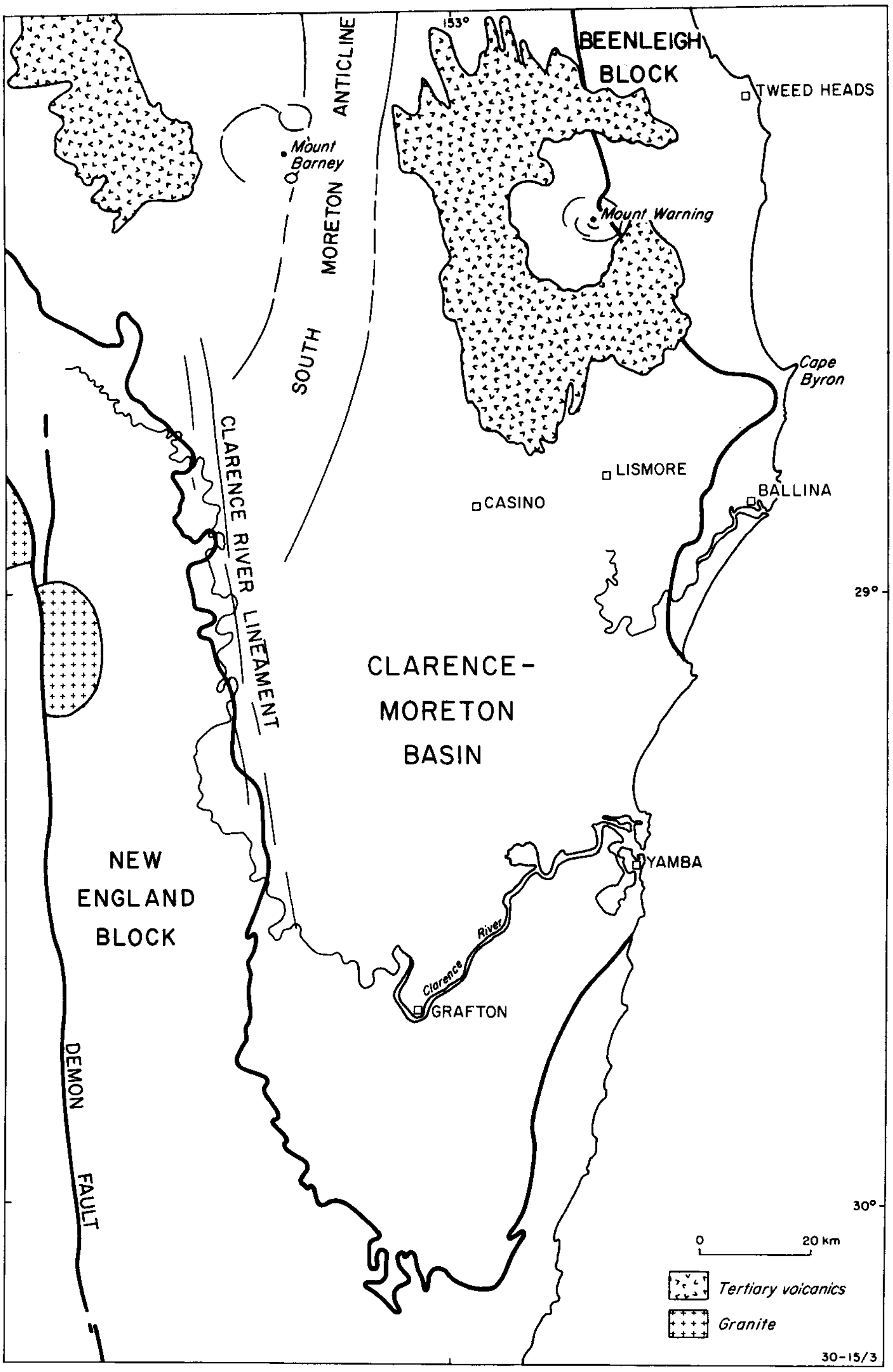
Figure 2 shows some of the major features that may be seen on the images. The Demon Fault is a significant fracture along which the rocks on opposite sides moved about 17 km (relative to one another) some 200 million years ago. Toward the northern end of the fault a distinctive granite body has been bisected by the fault and the two pieces moved apart. The South Moreton Anticline is a ridge of uplifted rocks running through the Clarence-Moreton Basin. Previously the anticline was best known in the Queensland part of the basin but the imagery now confirms that it continues south into New South Wales where it stops against the Clarence River Lineament. This Lineament had not been recognised during conventional geological mapping and was first detected on the CZCS images. Its location and the way the South Moreton anticline ends against it suggests that it may reflect a buried fracture system that controls the western limit of this part of the Clarence-Moreton Basin. It also may have had a significant influence on the basin's development.

Mount Warning and Mount Barney are the exposed throats of very large volcanoes which were active some 13 to 18 million years ago. They appear on Landsat as small circular features surrounded by larger ones that reflect doming of the adjacent rocks caused by the molten rock pushing its way to the surface. Mount Warning and Mount Barney were surrounded by enormous cones of lava and volcanic ash which have now been partly eroded away to reveal the volcanic centres. The approximate extent of these remnant volcanic piles is sketched on Figure 2 (Tertiary volcanics).

As well as the major features shown on Figure 2, the imagery reveals a host of smaller structures. Their arrangement provides clues to the structure and history of the Clarence-Moreton Basin, a knowledge that helps to determine the possibility of finding oil and gas in the basin.

Figure 1

Figure 2



STRUCTURAL EVALUATION OF LANDSAT IMAGERY FOR PETROLEUM EXPLORATION

A Case History from the Eromanga Basion Region, Southwest Queensland

B. R. Senior, J. G. Wilson

Australian Photogeological Consultants
Campbell, A.C.T. 2601

Abstract

Identification of possible hydrocarbon-bearing structures in Landsat imagery was achieved across wide areas of the Eromanga Basin through geomorphological appraisal of landforms and landscape interrelationships. Duricrusted landforms in this region were gently displaced, tilted and folded during a crustal-shortening episode

which occurred approximately 25 million years ago. As a result, the present distribution and drainage patterns established in these indurated landforms closely mirrors stronger deformation within the underlying Eromanga and Cooper Basin sequences. Since the illustrated interpretation was made in late 1983 several of the Landsat-interpreted structures have been independently identified by seismic surveys and confirmed by exploration drilling.

Introduction

During the past two years the authors have been involved in extensive Landsat image interpretation and photogeology for the detection of structural hydrocarbon traps in the Eromanga Basin region of eastern-central Australia. Identification of possible hydrocarbon-bearing structures, particularly anticlines, was achieved over wide areas through geomorphological appraisal of landforms and landscape interrelationships. Because the interpretation of geological structure is a three-dimensional objective, the appraisal of structurally-related landforms is obviously best carried out on stereo-scopic imagery or photography. In the Eromanga region, however, no such imagery is available, and blanket-use of available stereoscopic aerial photography (scale 1:83 000) is prevented by time and cost factors related to the large expanse of the basin (1.7 million square kilometres) and the excessive number of aerial photographs that would be required. On the other hand, the use of Landsat images for structural interpretation (apart from lineaments) depends on the existence of discernable two-dimensional relationships between land-patterns and bedrock morphology. Fortunately the tectonic history and geomorphic development of the Eromanga Basin have resulted in such relationships being recognisable in much of the basin, notwithstanding the poor bedrock outcrop and the relatively small scale of the usual images (1:1 million to 1:250 000). As a consequence, Landsat structural reconnaissance, aided whenever appropriate by photogeological detail, has proved valuable for early target selection, and for optimal planning of seismic surveys.

Interpretation

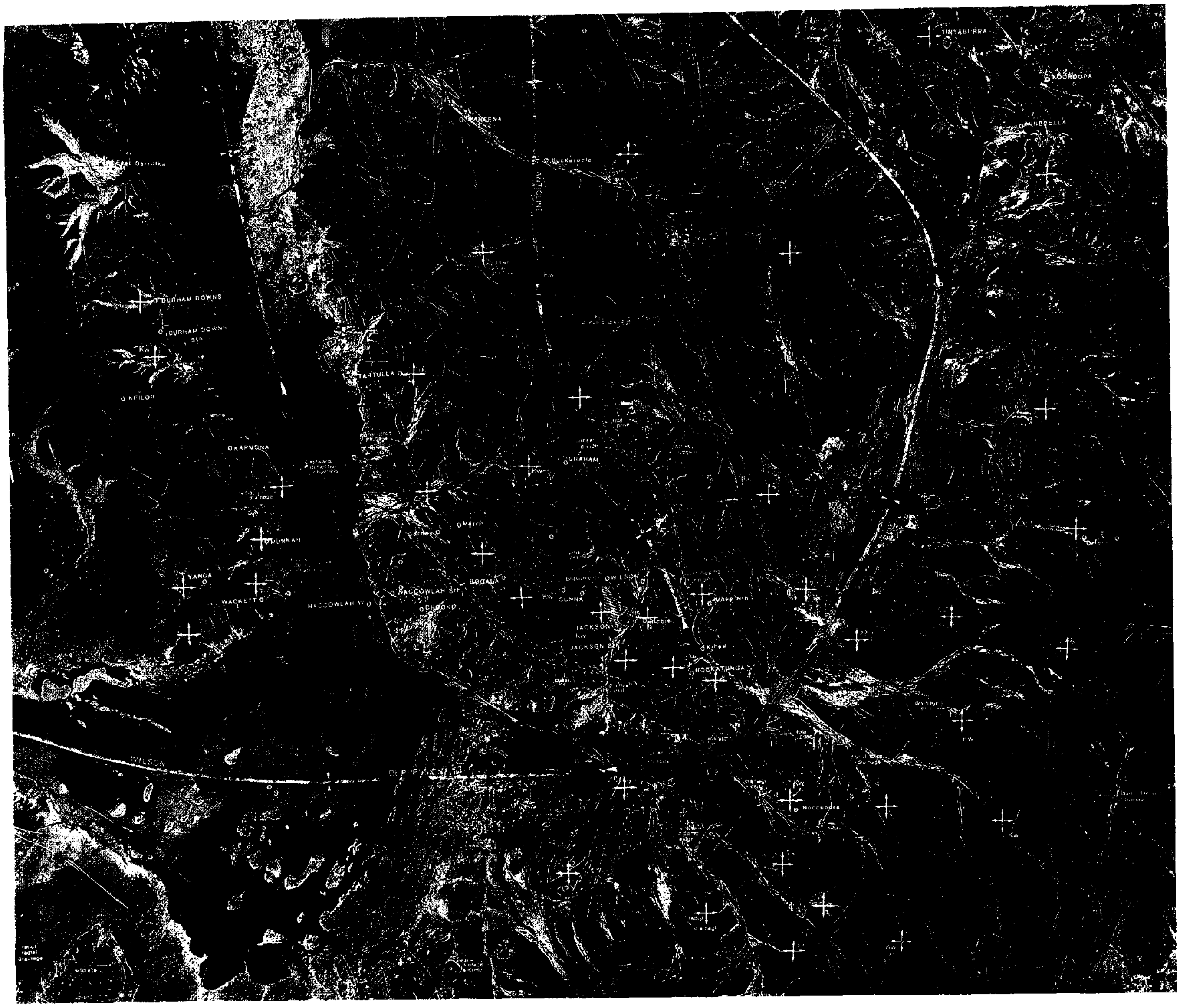
The Landsat-4 image (illustrated) is centred about the Jackson Oil Field in southwest Queensland (centre of image). To the west lies the complex channel network of Cooper Creek, which merges south-wards to a broad confluence (Wilson Depression), which is joined by the southwesterly-directed Wilson River. Major drainage systems are flooded following unseasonal heavy winter rain. These alluvial low-lands are separated by scarp-bounded low plateaus, and stony plains, which collectively form part of the north-trending Grey Range. To the west and southwest are sandplain and dunes which fringe the Sturt Stony Desert.

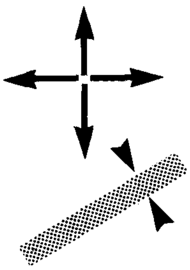
The white linework in this image is an interpretation of geological structure as deduced from geomorphic evidence. In this region major drainage systems tend to occupy structurally downwarped areas (synclines), and some structurally elevated areas are coincident with erosional landforms, which in many places have evolved to form recognisable structurally-related landform assemblages. An example is the Jackson Anticlinal trend (centre of image) which shows as a dark-toned soil plain, which is surrounded by scarp-bounded, flat-topped, duricrust-capped uplands. The soil plain (identified by the symbol Kw) is coincident with the northwesterly trend of this anticlinal axis. These dark soils correspond with an area of Cretaceous sedimentary rock where former duricrust has been removed by erosion. Towards the eastern end of this feature the axis merges with that of such as gathering of drainage towards narrow exits located along the southern fold limb, formation of deltas on the downstream side of the exits, and embayments along the rather less well-defined northern fold limb. "Microdrainage" patterns ("micro" only at the scale of the imagery) and duricrust embayments help identify individual sites of maximum structural amplitude (crossed arrow symbols) of which the area around the Jackson Oil Field forms a fine example. The relatively recent phase of fold activity in this region may be gauged from the area of ponded drainage to the north, which has resulted from arching of the duricrust along the Kihee Anticlinal trend.

The key to the recognition of folds and faults in this region stems from the widespread preservation of weathered rock profiles which are collectively known as "duricrusts". These duricrust profiles, which are up to 80 metres thick, are extensive and formed during wet and humid climatic regimes, which occurred approximately 70 and 30 million years ago. Sedimentary rocks at the surface at these times were deeply weathered and selectively hardened due to infiltration and cementation by iron and silica oxides. Gentle fold movements in more recent times have folded, warped, and displaced these duricrusts. As a result, their present-day distribution, and drainage patterns established in them, closely mirrors deformation within underlying sedimentary rocks. Many, but not all, of the larger folds and individual fold closures within them are clearly recognisable in the Landsat synoptic view.

Discussion

At the time this structural interpretation was prepared (September-October, 1983), the area west of the Cooper Creek, and the central portion of the image around the Jackson Oil Field, were relatively well known from the activities of petroleum exploration companies. East of about 142°30′E however, the hydrocarbon potential of the Eromanga Basin sequence was just starting to be recognised, and only reconnaissance exploration data had been acquired. Because of the previously discussed physiographic relationships observed in the vicinity of existing oil and gas fields,





Anticlinal closure

Synclinal trend

Linear Feature

p poorly defined
m Moderately strongly defined
s strongly defined
f probable fault
Kw Winton Formation

discerned in the Landsat imagery and confirmed under the stereoscope, it was possible to draw upon this knowledge and apply it to less well known portions of the Eromanga Basin region.

The interpretation of the illustrated image has been generally confirmed and a close relationship exists between Landsat-delineated surface closures and structures identified independently through seismic surveys. Names printed in upper case are hydrocarbon discoverys; the remainder are dry or non-commercial wells drilled near significant Landsat features. Names italicized, in the following list, are hydrocarbon bearing structures which were drilled after the Landsat interpretation was completed in October 1983. Structures which show a positive correlation are:

East Barrolka, *Tintaburra*, Durham Downs, *Durham Downs South, Tartulla, Yanda, Munkah,* Wackett, Kihee North, Jackson, Jackson South, *Richie,* Kihee North, Orient, Nockatunga, Noccundra and Orientos North. Others such as *Buckaroola, Minedella, Carney, Merri, Bogalla,* Kihee and *Wippo* lie along projected fold axes.

Much greater difficulty was experienced in identifying Landsat surface closures in depositional landscapes. However, exploration drilling in these areas was generally less successful with exceptions being oil discoveries at *Watson South*, Naccowlah and *Chooko*. The Naccowlah area does, however, support some well-defined curvilinear trends, possibly indicative of a partly concealed surface feature.

Following widespread Landsat interpretation on behalf of various petroleum exploration companies, a series of physiographic models are now in existence which provide "type" examples to which diagnostic, surface morphological features may be related. As a consequence, many more surface anticlines would now be identified in the illustrated image than was possible during the time when it was first annotated. It has also become evident that when complex or economically interesting sub-areas of this scene and other areas are examined photogeologically, there is a considerable increase in the numbers of smaller anticlines identified. The detailed landform analysis that is possible under the stereoscope is one reason, aided by the larger scale and better spatial resolution of the aerial photographs. In this connection the stereoscopic, relatively high-spatial-resolution orbital imagery promised by the French SPOT system during 1986, and synthetic aperture radar (SAR), are both expected to be a valuable tool for more detailed structural mapping within this basin, using applied geomorphology.

Acknowledgement

The Landsat and photogeological interpretations to which reference was made were undertaken by Australian Photogeological Consultants, Canberra.

Selected Bibliography

Senior, B.R. Landform development, weathered profiles and Cainozoic tectonics in southwest Queensland. *Ph.D. thesis, University of New South Wales*, Sydney, (unpublished), 1978, 238pp.

Idnurm, M. and Senior, B.R. Palaeomagnetic ages of Late Cretaceous and Tertiary weathered profiles in the Eromanga Basin, Queensland. *Palaeogeography, Palaeoclimatology, Palaeoecology*, vol.24, 1978, p.263–277.

Wilson, J.G. and Senior, B.R. Hydrocarbon exploration in the Amadeus and Eromanga basins in Central Australia—case studies of the relative utilities of satellite image interpretation and photogeology in regions of different tectonic and geomorphic development. *International Conference on Prospecting in Areas of Desert Terrain, Morocco*, 1985. Inst. Min. Metall., London, p.249–261.

SEMINARS

REMOTE SENSING — CURRENT STATUS AND APPLICATIONS SEMINAR

South Australian Institute of Technology, Adelaide, 27-28 June 1985

Keynote address presented by Dr K. McCracken, Director of CSIRO Office of Space Science Application (COSSA).

(abridged)

The Madigan report will have a major impact on our use of space and particularly on remote sensing in the very near future in Australia. But first of all let me place this in historical perspective. We have been using remote sensing for a long time. It was used in the first World War from balloons and aircraft; Western Mining were using it in the 1930's in the Kalgoorlie area and I suspect there were other mining companies using it before then. Remote sensing from many points of view for the last 20 years, has not been about precision mapping, but has been about the *measurement of change*, and I think this is one of the aspects that remote sensing will always retain.

So what are we using remote sensing for? First let us understand what we are doing when we talk about satellite remote sensing. We have a technology now for which the cost of data from a point in the middle of the Simpson Desert is exactly the same cost as data in the middle of Adelaide, i.e. the cost per square kilometre of whatever parameters we are getting is identical for any point within Australia. So where we have had inhibitions or impediments in our utilisation of environmental data, agricultural data, etc. because of infrastructure costs (the cost of getting the data from back of Bourke) that whole impediment is gone in one swoop by using a satellite.

Now let us look at that repetitive coverage. We have different needs: meteorology is of course an important part of remote sensing and those of us who are used to thinking of LANDSAT will do well to think in terms of the meteorological satellites which are free (right now) and exhibit tremendous time repetitiveness. With meteorology we need data every 15 minutes of some applications; in management of oceans, daily information is probably necessary. Different specialities might need different time frames with different times of of the year or different times of the decade, so we have to recognise that there is a need for these different time frames.

First of all there is a satellite at an altitude of 36,000 miles-GMS (Japanese meteorological satellite). Then there is a small 'flock' of remote sensing satellites in so-called polar orbits, LANDSAT type satellites and radar satellites. That conglomeration together is much more powerful than any one of them by itself. The GMS satellite sits in geo-stationary orbit over New Guinea, and peers at the Earth all the time. The next meteorological satellite, of course, is the Polar Orbiting satellite which has on-board it the detector AVHRR (Advanced Very High Resolution Radiometer), with applications in fishing, etc.

No one will argue that accuracies of the temperatures are as good as you can get if you go out there with a boat, but with a boat you will only get 2 or 3 measurments along a single line. More precise, but giving you absolutely no information on structure or spatial extent and may result in some horribly undersampled information. The real point of remote sensing from satellites, and from aircraft, is that we replace high precision low density information with somewhat less precise but much better sampled data. It may be used in a Search and Rescue exercise to locate where a boat would have gone by virtue of the ocean currents, and of course it has many other applications because we have a spatial structure, a velocity structure, as well as temperature.

Now let us talk of radar. Radar satellites have been flown. Seasat lasted 91 days in 1978 of course there have been radar systems on shuttle. The University of New South Wales has done some marvellous work of integrating LANDSAT and shuttle imagery. The important thing about radar is, that it is an active system not a passive system, and it has substantial advantages—it sees through clouds. Radar is a technology which we will have with us in 1989 when European Radar Satellite ERS-1 is launched; With scatterometers, where the radar energy comes from the satellite, one can interpret the seascape and how high the waves are, as well as their velocity and their direction, from the reflecting signal from the rough surface of the water; and one can do that now on a matrix of every 5km all over the ocean's outside of Australia. If you think about it, if you are in the business of weather or oceans, this new-found ability for sea state and temperature is going to be vital, so radar will be very important off-shore as well as on-shore, as it also sees other parts of the topography which are not so well seen by satellites like LANDSAT. So I think we should watch radar very intently. It has the same promise I believe, if not more, as LANDSAT.

While talking about our friend LANDSAT with its use in agriculture, it is a fact, that clever processing is vital: clever processing can enhance the value of that image greatly. We in Australia have developed our ability to enhance as well, if not better, than most of the World. The reason is fairly clear—Australia as seen from space is a very bright continent the original LANDSAT imagery was rather badly over-exposed—we had to learn to dig into that to enhance the signal and to get rid of the 'noise'. We have built an extremely good LANDSAT station, arguably the best one in the World, so I think the research that was done before LANDSAT station came in has given us all good imagery, on top of that we have a very good ability in enhancing.

One of the interesting success stories from LANDSAT is the so-called hydrographers passage. We must be very careful to say it wasn't only LANDSAT; it was that plus aircraft, plus the people in boats, but together we now have a new shipping passage through the Great Barrier Reef and when we start asking what is the value of remote sensing that's a very good example of the problems that our 'bean counters' will have when they tell us that the user must pay. Well, how do you make the user who is currently in his or her cradle pay for the fact the 30 years from now that channel will still be permitting us to land coal in Asia at a much lower price than we could otherwise—in other words keeping us in the business? The sort of long term value of discoveries such as this are the most important—I don't think the short term value of remote sensing is important—it's the monitoring and the stopping of degradation of our arid land and monitoring our agricultural lands that's the real value, and that is very hard to figure out how to charge the user. My own view is that we shouldn't, it's a National as well as a State responsibility.

The Future

Now let me talk a lttle about where we might be going. Satellites are not the only platform; aircraft systems are vital often to follow up or to apply to different types of problems. We have two (or have had) absolutely state-of-the-art operational aircraft scanners in Australia—one is the one operated by National Safety Council of Victoria, and the other was operated by Hunting Geophysics of the UK—and both of them have churned out a great deal of very high resolution thematic map data.

In the experimental area there has, of course, been the Miess Scanner with which John Douglas was very involved. We will in the next decade certainly see spectrometry (spatial spectrometry) as an important part of what we do from aircraft and from spacecraft. Now we in Australia will be participating in a joint experiment with the Jet Propulsion Laboratory of NASA when that aircraft will be flown over a number of our test sights in October/November. We will be using scanning-radiometers which will be looking at the ground in up to 128 different channels; this is all good research to answer the question what should we do in future? It will, of course, produce one heck of a problem— any of us who has used LANDSAT knows there is a data digestion problem (Thematic Mapper is 10 times worse than LANDSAT MSS) and if we start talking of not 7 channels but 64 channels there is another factor of 10, so one of the problems that technologists have yet to solve is how we handle that data. My prediction is we will solve that and we will be seeing smarter systems in spacecraft; we will start interpreting the data partially in the spacecraft but we will also have a lot of smart systems on the gound and that terrible data flow, the real problem will not be interpreting but getting it from the spacecraft or aircraft to the ground. The data transmission problem will probably be the most fundamental one that we've got to live with.

Let me just finally speak in terms of where Australia will be going in future, and I just want to mention that over the last year or so there has been a very major shift, I think, in our national appreciation of space and space technology. I think I would be right in saying that one of the reasons for that has been a fairly wide-spread understanding of the fact that this farcical situation of being *the country that has got the most cost return from its LANDSAT station* is the country that has not yet decided to upgrade to a thematic mapper. That, to my way of thinking, is Gilbert and Sullivan.

The realisation that you cannot run the development of new technology by having to go to Cabinet every time you want to go to the toilet has got through to people and we've had a very high level committee look at the question of application of space technology in Australia. Their report hit the streets on Monday—this is the so-called Madigan committee—their first recommendation is that there will be a space policy and that is the best news I've heard for a long time. This meeting will be interested to know that of 16 recommendations 3 or 4 of them very clearly are to do with remote sensing. *Madigan, in fact, decided that the most important of the space technologies for Australia to be involved in is in fact remote sensing. He comes down very clearly on that. One of the recommendations that will also please us is the Government should ensure a continuing Australia capability to receive latest types of earth observation satellite data and in particular to allocate funds at the earliest opportunity for the upgrading of LANDSAT station and the upgrading of the Bureau of Meteorological receiving facilities.* I couldn't have said it better if I'd written it myself.

Now the point is that there have been reports in the past which have gathered dust that have become door stops—Madigan asks or recommends and expenditure of $100 million over the next 5 years that is a usual growth curve type of situation up to an asymptote of about $60–70 million per annum, not all for remote sensing o: course, but to do with communications, remote sensing, and so on. As some sort of Canberra watcher I would say that our chances of that happening are extremely good and I haven't heard any technical people yet saying 'Oh he got it all wrong'. I think the Madigan committee has got it right; they have come down on the side of important technologies which all of us will be using and our children will be using; they have come down recognising that space technolgies like remote sensing are very important for Australia and have come down with a realistic level of monetary expenditure. The government wants public comment and I hope we can give them public comment as to that it's good report and, as I say, I have good reasons to believe it will proceed. Lets try whatever way we can to help it on its way.

So what would a space policy give us? Well first of all it will give us the space policy we need under the control of technical people who actually can anticipate where we are going. People who could have anticipated that we should have been into ERS–1 three years ago but with shear unadulterated good luck got back into it. But we don't have to depend on good luck. We need to plan to have the technology, we need (with the right parameters) to get our industry involved and all of these other things. 50% of our space expenditure is on the ground not up there in space, and so that's very a important area I believe for technological development for our industry. Quentron and other companies like them are doing a good job in this area and all I can say is "more power to you".

I would just like to now go from the near future to the immediate future and say what's going to be happening in the 1990's. What I wish to speak about upgrading is the following: right now we use a meteorolgical satellite in the polar sun-synchronous orbit, we use LANDSAT or SPOT in the same polar sun-synchronous orbit, we will be putting a radar satellite into a polar sun-synchronous orbit. Then we have a job putting the data back together again even though they are in the same orbit and taken from rougly the same point in space, small differences mean that one pixel doesn't sit on top of another pixel and in addition to the distortions due to wobble. How do we relate that pixel on radar to that pixeel on SPOT and that pixel on AVHRR? Well, one of the really important technologies for the next couple of years is this transferring of pixels from one source, to pixels of another source and in particular going to what are called Geocoded Data Bases, where we effectively take our data from whatever satellite it was obtained and put it on to Lambert Conformal or whatever the mapping grid is we're using; turning our imagery into a form of map on our conventional grids and then we'll be able to move backwards and forwards very easily.

Looking to this problem that is inherent in having three different satellites of course; the answer is let us put RADAR, AVHRR and LANDSAT all on the one satellite. Now that is where one of the major thrusts of the space industry around the World is right now. This is what is called the Polar Platform, which is part of the space station concept and the Polar Platform is in fact something in which the European space agency in particular is very interested.

The point of the Polar Platform is it will be sun-synchronous and it will be precisely the platform which would be used for all three of those remote sensing technologies, plus Search and Rescue, plus a few others (data platform relay, and so on). I suspect that we are going to find that what we will be using in the future has a polar orbit, and we also have to expect to have to pay to use it. The 'free lunch' era of remote sensing is almost over. We know that with LANDSAT and SPOT it is perhaps less recognised that the Americans tried to commercialise the meteorological satellites three years ago—there was a World-wide outcry saying "you can't do that". They replied "yes we can do it, but we won't commercialise our next satellite—we just won't build any more", which is a good way to solve the problem. So, what we will be seeing, we will be paying for. In my belief we will be paying good money, as we pay for INTELSAT spacecraft communication; we'll pay money for a partnership in remote sensing satellites and it is important that (as well as use the data) we get an industry in Australia; we will be building parts of the spacecraft instrumentation.

So Ladies and Gentlemen, that is where I see remote sensing is now; that's where I see it going to.

Thank you.

Opening Address — Professor J. G. F. Holden Mapping and Remote Sensing

(abridged)

As you have gathered from the introduction I have spent a considerable part of my working life as a mapping surveyor and as a photgrammetrist, so I hope you will forgive me for confining my opening remarks to mapping aspects of remote sensing. The name E H Thompson has been mentioned, in my estimation the outstanding photogrammetrist of his generation, a man devoted to precision in mapping and, a man who in his work had seen production mapping accuracies in photographic terms advance from hundreds of micromillimetres to near-micron precision. It is little wonder that towards the end of his career he took a somewhat jaundiced view of the new arrival—remote sensing.

Take for example his editorial in the Photogrammetric Record of April 1970:

"All of us who earn our living by surveying the earth will agree that, in the present state of the art, it is absurd to suggest that it is possible to use satellite photography for topographic mapping". "It is claimed that an orbiting satellite is an up-to-date mapping tool. The irony is that it is perhaps 400 years too late, for many of the maps needed in the 16th century could have been made very efficiently from satellite photography."

Note that Thompson was writing two years before the launch of Landsat 1 which operated for 5½ years without serious malfunction, producing ¼ million scenes of 32 billion square kilometres of the surface of the Earth. Thompson was therefore basing his remarks on the manned orbital photographic missions of Gemini and Mercury and the simulated MSS missions of Apollo 7 and 9 which were in any case immeasurably superior in terms of image resolution to those of Landsat.

What attitudes do the mapping community take today?

Already after only 15 years we are seriously considering the use of remotely sensed data for original mapping at scales as large as 1:50,000. F J Doyle, the leading proponent of the Large Format Camera for use in shuttle missions, in a paper presented at ITC in the Netherlands in December 1983 states:

"It must be noted that reliable indentification of cultural features, such as roads, railroads, and buildings, which are normally shown on line maps at any scale, requires a ground resolution of 3 to 5 m/line pair or 1.2 to 2 m/pixel. If the sensor used for image mapping does not provide this level of resolution, cultural features will not be adequately respresented unless they are derived from other source material.

G. Konecny is more optimistic. From experiments with small scale aerial photography digitised on the Optronics scanner using varying pixel sizes corresponding to values between 1 and 100m on the ground, he concludes that "to detect objects (that have) to be shown on a 1:50,000 map (houses, streets) pixel sizes of about 3 metres are required in case of monocular observation and 6 metres in case of stereoscopic observation."

Working Group 3 of Commission I of ISPRS reported on mapping from space-borne imager at the 1984 Congress in Rio:

"The conclusions of the committee report are that it is now possible to deploy an electro-optical space system which will materially contribute to the mapping of the earth's surface at scales as large as 1:50,000 and with 20m contours. The systems will be cost effective compared with conventional mapping and will produce global coverage on a repetitive basis. After careful consideration of possible modes, the committee opted for a system based on Itek's Mapsat design, with the following basic parameters:

Orbit—919km altitude

Sensors—linear arrays; three optics looking 23° forward, vertically and 23° aft

Spectral bands—blue green (0.47 to 0.55 μm), red (0.57 to 0.67 μm) and near infrared (0.76 to 1.0 μm)

Resolution—variable up to 10m pixels"

How close are we in reality to the sort of resolutions specified? The answer is very close—we certainly expect to obtain a 10m ground sampling interval in the panchromatic mode for nadir viewing from the French SPOT satellite.

Why are the mappers now so interested in remote sensing after some prolonged hesitations? Many people are under the impression that in Australia we have in the last 20 years virtually solved our national mapping problems with nearly continental-wide coverage of contoured topographic mapping at 1:100,000, with very much larger scales available in quantity in all developed areas and in particular in Metrolpolitan regions. Nothing could be further from the truth. What has been achieved is a national archive of spatial data which can become out of date as rapidly as it was acquired. I can see no solution to the problem of maintaining this archive and revising this data except through the extensive use of the new generation of Remote Sensing data which will be available very shortly. I believe this data will be our principal revision source in the next decade.

At present the Australian Landsat Station (ALS) with its Data Acquisition Facility (DAF) at Alice Springs simply does not have the capability to acquire any of this data directly. It is understood that upgrading the facility to receive X-band data at very high transmission rates, with possibility of receiving both Thematic Mapper and SPOT data, would involve funding of the order of $15 million at present. The facility would then be virtually spacecraft independent, with possibility for future updates such as reception of MOMS data, at very low further cost.

This deficiency of capability should be a matter of grave concern to the entire scientific community in Australia, particularly to the mapping industry, a concern which should now be expressed in the utmost endevours to persuade Federal Government of the critical nature of denying funds for upgrading.

AGENDA

AUSTRALIAN DATES

18-22 November 1985
"Advanced Remote Sensing for Geologists and Geophysicists"
Australian Mineral Foundation
Adelaide

26-29 November 1985
URPIS 13
"Land Information Systems, Planning and People"
Australian Urban and Regional Information System Association
Adelaide

11-13 December 1985
SHORT COURSE
Remote Sensing for Civil Engineers and Planners
Centre for Remote Sensing
University of New South Wales
Kensington NSW

2-5 February 1986
"Air-Sea Interaction and its Consequences"
The Royal Meteorological Society
Sydney

16-21 February 1986
Eighth Australian Geological Convention
"Earth Resources in Time and Space"
Flinders University
Adelaide

10-21 March 1986
SHORT COURSE
"Geolological Interpretation of Aerial Photographs and Satellite Images"
Australian Mineral Foundation
Adelaide

11-15 August 1986
Fourth Inernational Kimberlite Conference
Geological Society of Australia
Perth

24-28 August 1986
Conference on Agricultural Engineering, 1986
The Institution of Engineers, Australia
Adelaide

24-30 August 1986
"Sediments Down-Under"
12th International Sedimentological Congress
Canberra

25-27 November 1986
"River Basin Management"
Hydrology and Water Resources Symposium 1986
Griffith University
Brisbane

1987 (early)
LANDSAT'87
Adelaide

OVERSEAS DATES

16-20 December 1985
Third International Colloquium on Spectral Signatures of Objects in Remote Sensing
ISPRS
Bourg-Saint-Maurice, France

12-23 April 1986
Third International Conference on Optical and Electro-Optical Applied Science and Engineering
SPIE
Innsbruck, Austria

14-17 July 1986
10th International CODATA Conference: The Computer Handling and Dissemination of Data
International Council of Scientific Unions
Ottawa, Canada

8-9 January 1986
Remote Sensing Applications in Geomorphology and Hydrology
University of Reading
Whiteknights, Reading
Berks, UK

31 January 1986
Symposium on Geotechnical Applications of Remote Sensing and Remote Data Transmission
American Society for Testing and Materials
New Orleans, USA

12-13 March 1986
RADAR-86
IEEE 1986 National Radar Conference
Insititute of Electrical and Electronics Engineers
Los Angeles, Calif., USA

18-20 March 1986
33rd International Congress on Electronics
26th International Meeting on Space
JOINT CONFERENCE
Rome, Italy

1-10 April 1986
Inner and Outer Space—Limitless Horizons for the Surveyors
18th Congress of FIG
Toronto, Canada

5-8 May 1986
10th Canadian Symposium on Remote Sensing
"Technology For Value"
Edmonton, Canada

18-24 May 1986
Fifteenth International Symposium on Space Technology and Science
Tokyo, Japan

May 1986
Second Conference on Satellite Meteorology/ Remote Sensing and Applications
AMS
Williamsburg, USA

10-13 June 1986
CLEO '86 OSA/IEEE Conference on Lasers and Electro-Optics
San Francisco, USA

16-20 June 1986
SPACECOM 86
International Conference and Exposition on the Commercialization and Industrialization of Space
Montreux, Switzerland

3-9 July 1986
XXVI COSPAR 86 Conference
ESPACE 86 Exposition
Toulouse, France

25-29 August 1986
COMMISSION VII-ISPRS
International Symposium on Remote Sensing
Enschede, The Netherlands

6-12 September 1986
Symposium on Remote Sensing in Glaciology
International Glaciological Society
Cambridge, England

8-11 September 1986
IGARSS '86, International Geoscience and Remote Sensing Symposium
Zurich, Switzerland

Fall 1986
ASP Fall Technical Meeting—Special Session: Remote Sensing Solutions to Engineering Problems in New Frontier Areas
Anchorage, Alaska

14-19 September 1986
Auto-Carto London 1986
London, England

Thematic Conferences on Remote Sensing for Exploration Geology have been scheduled for Reno, Nevada, during autumn of 1986, and Houston, Texas, during autumn 1987.

Newsletter

The Australian Landsat Station Newsletter is published and distributed free of charge and in the interest of exchange of information related to the ALS product user community and the remote sensing industry.

Comment concerning ALS products, services, systems and related remote sensing activities are the responsibility of this Station and is subject to change with changes in its operational status. Reference to other publications, to data applications and interpretations to services and systems, to research programs and notices is made at the discretion of the ALS and is published in good faith.

The Australian Landsat Station welcomes contributions and comments from readers with a genuine interest in remote sensing or remotely sensed data.

Interested persons/organisations are kindly requested to complete the application slip.

If you have moved please let us know your new address so we may amend our mailing list.

All correspondence should be directed to:

ALS Newsletter
PO Box 28
BELCONNEN ACT 2616
AUSTRALIA

ALS Newsletter

SEND TO: Australian Landsat Station,
PO Box 28, Belconnen, ACT
Australia, 2616

Please amend your mailing list for future issues as folows:

NAME: ....

Please use block letters

ORGANISATION: ....

ADDRESS: ....

.... Postcode ....

PREVIOUS MAIL ADDRESS: ....

.... Postcode ....

INTEREST: General ☐ Professional ☐

Please tick appropriate box

APPLICATIONS: ....

DATE: ....

LANDSAT PRODUCTS

Processed satellite images and related products are available from the Australian Landsat Station, where these are made as colour and monochrome photographic prints at a range of scales and sizes, as well as photo transparencies of full scenes and sub-scenes. Pre-processed image data is also available on Computer Compatible Tape (CCT) in 800 and 1600 BPI format for user analysis and application. Precision rectified images are available as photographic products with some user selected image enhancements and radiometric/geometric corrections.

For selection of images and cloud assessment, data and colour image catalogues are available in microfiche form. These may be subscribed to annually for any number of fiche or the complete set, for each Landsat cycle. Australian Landsat Station products may be ordered from either of the ALS facilities in Canberra and Alice Springs, or through a number of Browse Centres located throughout Australia.

ADELAIDE
Mapland
Department of Lands
12 Pirie Street
Adelaide SA
ph 08-2272675

ALICE SPRINGS
Australian Landsat Station
CSIRO Compound
Heath Road
Alice Springs NT
ph 089-523353

BRISBANE
Sunmap
Aerial Photography Section
Dept of Mapping and Surveying
11th Floor, Watkins Place
288 Edwards Street
Brisbane QLD
ph 07-2247876

MELBOURNE
Map Sales
Dept of Conservation Forests
and Lands
25 Spring Street
Melbourne VIC
ph 03-6513024

SYDNEY
Lands Department
Map Sales
Lands Department Building
23-33 Bridge Street
Sydney NSW
ph 02-20579

SYDNEY
Technical and Field Surveys
250 Pacific Highway
Crows Nest NSW
ph 02-4383700

HOBART
Tasmanian Government Publication Centre
134 Macquarie Street
Hobart TAS
ph 002-303382

CANBERRA
Australian Landsat Station
22-36 Oatley Court
Belconnen ACT
ph 062-515411

PERTH
Central Map Agency
Department of Lands and Surveys
Cathedral Avenue
Perth WA
ph 09-3231349

DARWIN
Survey Mapping Division
Dept Lands and Housing
Moonta House,Mitchell Street
Darwin NT
ph 089-897572

MELBOURNE
Air Photographs Pty Ltd
625 Burwood Road
Auburn VIC
ph 03-821966

ALS REFERENCE CENTRES

A new concept in dissemination on ALS data was announced with the introduction of designated Reference Centres. Each centre holds a full range of ALS image samples and a complete set of the data and colour micro image catalogues. In addition, each reference centre holds a range of other reference material and relevant information, and will establish a comprehensive library of images covering the ALS acquisition area.

At each centre, professionals with expertise in a range of disciplines are available for consultation, to demonstrate, give advise and provide guidance in analytical and interpretive techniques of remote sensing data. Most have on location, or have access to image analysis equipment and all have professionals who are familiar with ALS data.

The following organisations have been selected to be ALS designated Reference Centres:

ADELAIDE
The South Australian Centre for Remote Sensing
Inovation House
First Avenue
Technology Park
The Levels SA 5095
Phone (08) 260 0134

BRISBANE
Department of Mapping and Surveying
Research and Development Branch
Watkins Place
288 Edward Street
Brisbane QLD 4000
Phone (07) 224 4881

PERTH
University of Western Australia
Department of Geography
Nedlands WA 6009
Phone (09) 380 2696

PERTH
Western Australian Institute of Technology
Department of Mapping and Surveying
Kent Street
Bentley WA 6102
Phone (09) 350 7566

SYDNEY
University of New South Wales
Centre for Remote Sensing
Geography and Surveying Building
Barker Street
Kensington NSW 2033
Phone (02) 697 4964

TOWNSVILLE
The Economic Geology Research Unit
C/-Geology Department
James Cook University of North Queensland
Townsville QLD 4811
Phone (077) 814 796