DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1974/70

THE AUSTRALIAN ERTS-1 PROGRAM

by

W.J. PERRY

RECORD 1974/70

THE AUSTRALIAN ERTS-1 PROGRAM

by

W.J. PERRY

THE AUSTRALIAN ERTS-1 PROGRAM

Australian participation in Earth Resources Technology Satellite Program of the United States National Aeronautics and Space Administrations (NASA) was organized by a Federal Government inter-departmental committee known as ACERTS, chaired by Dr N.H. Fisher, Director of the Bureau of Mineral Resources. Represented on ACERTS are CSIRO (Head Office and Divisions of Mineral Physics and Land Use Research), Department of Science, Department of Minerals and Energy (Bureau of Mineral Resources and Division of National Mapping including Geographic Section), Department of Primary Industry (Forestry and Timber Bureau), Departments of Supply, Environment and Conservation, Northern Territory, and Defence (Army Office).

State Government authorities were invited to take part in the program through the State Premiers, Universities through their Vice-Chancellors, and private companies by means of a ministerial press statement.

The summaries below were prepared from the reports submitted to NASA through ACERTS by the investigators listed, in fulfilment of the requirements of a formal agreement between the Department of Science and NASA, under which NASA provided imagery from the satellite, and Australian scientists in their turn evaluated the imagery of selected areas in terms of their particular interest. The summaries are grouped into categories in accordance with NASA practice.

The following notes on the imagery are included to provide background information for those unfamiliar with the program.

Footnote Enquiries relating to ERTS-1 imagery of Australia should be made to the Director, Division of National Mapping, P.O. Box 667, Canberra City, A.C.T. 2601, through whom copies of the imagery may be ordered. More than 80% of Australia is covered at least once by imagery taken between August 1972 and March 1974. The Division maintains a 'browse file' of 1:1,000,000 prints for inspection.

ERTS-1 was launched on July 23, 1972 into a near-polar circular orbit at an altitude of about 915 km. The orbit was so arranged that the ground track crossed Australia in a direction 10 degrees or so west of south. Owing to the rotation of the earth, the traces of consecutive orbits on the earth's surface were separated by 25.8 degrees of longitude (2870 km) at the equator. Imagery was acquired between 9 a.m. and a few minutes after 10 a.m. local time, as the spacecraft was heading south. Each day the ground track moved westward so that it overlapped the track of the previous day by approximately 10%. Ground coverage continued westward until after 18 days the whole earth had been viewed once and repetitive coverage began.

All the imagery reported on by Australian investigators was taken with a multispectral scanner in four spectral intervals, referred to by NASA as follows: band 4, 0.5-0.6 micrometers; band 5, 0.6-0.7; band 6, 0.7-0.8; band 7, 0.8-1.1. Data acquired over Australia were stored by tape recorder in the satellite, and later transmitted to ground receiving stations when the spacecraft was over the U.S.A. There the data were converted to imagery which was sent by air to the Division of National Mapping and thence distributed to the Australian investigators. This imagery was received in the form of 70 mm black and white positive and negative transparencies at the scale of 1:3,369,000. On the ground each image covers a square with sides of 185 km. Investigators commonly required enlargements of separate bands to at least 1:1,000,000 scale for study. The term 'colour composite' in the report summaries refers to imagery prepared by combining three of the four bands through appropriate coloured filters (usually band 4/yellow filter, band 5/ magenta, and band 7/cyan) thus producing a product that simulates colour infrared photography.

Australian ERTS-1 Final Reports

Agriculture/Forestry/Range Resources

Organization	Author	Title
C.S.I.R.O. Division of Land Use Research	R. Story G.A. Yapp A.T. Dunn	Evaluation of ERTS-1 Imagery for Natural Resource Survey and Mapping
Queensland Department of Primary Industries	J.A. Mullins	The Feasibility of Using Space Imagery in the Preparation of Land Inventories and Technical Guides
University of Adelaide Waite Agricultural and Research Institute	B.G. Clare	Diseases of Cereals and Pasture Plants
Soil Conservation Service of N.S.W., Sydney, N.S.W.	F.R. Higginson K.A. Emery	Studies in Soil Erosion in Western, Eastern and Coastal N.S.W.
Department of Agriculture of South Australia	M.R. Till	Soil and Vegetation changes
C.S.I.R.O. Division of Land Resources Management, N.S.W. and W.A.	R.D. Graetz R.A. Perry	An Evaluation of the Efficiency of ERTS-1 Imagery to Research in Australian Rangelands
C.S.I.R.O. Division of Soils, South Australia	K.H. Northcote	Evaluation of ERTS-1 Imagery by Reference to Ground Information from Previous Surveys
C.S.I.R.O. Division of Soils, South Australia	G. Blackburn	Evaluation of ERTS-1 Imagery with Respect to Soils, Land Use and Geomorphology by Reference to Ground Information from Previous Detailed and Reconnaissance Surveys
C.S.I.R.O. Division of Irrigation Research N.S.W.	E.S. Trickett	Initial Evaluation of ERTS-1 Imagery of the Murrumbidgee Irrigation Area of Australia with Special Reference to Detailed Aerial Photography
Forestry Commission of New South Wales	J.H. Green R.H. Squire	The Evaluation of ERTS-1 Multi-Spectral Scanner Imagery in the Investigation of Forest Resources in N.S.W.

Organization	Author	Title
Department of Primary Industries, Forestry and Timber Bureau	M.L. Benson	A Multidisciplinary study of Earth Resources Imagery of Australia
Forests Commission of Victoria	D.W.M. Paine	Assessment and Management of Forest Resources
Woods and Forests Department, South Australia	N.B. Lewis	South Australian Forested Lands Survey and Classification

Land Use Survey and Mapping

Organization	Author	Title
Australian National University Department of Biogeography and Geomorphology	B.G. Thom R.F. McLean N. Wace J.M. Bowler J.N. Jennings	Plant and Landform Patterns in Various Parts of Australia
Department of Minerals and Energy, Division of National Mapping	L.G. Turner T.W. Plumb	Suitability of ERTS-1 Imagery for Topographic, Bathymetric, Geographic and Resources Mapping
James Cook University, North Queensland	D. Hopley	Effects of Cyclonic Storms 1972/73 Season.

Mineral Resources/Geological Structure/Landform Surveys

Organization	Author	Title
University of Queensland Department of Mining and Metallurgical Engineering	R.L. Whitmore	Monitoring of Mining and Processing Operations
University of Queensland Department of Geology	E. Heidecker	ERTS Image characteristics of Boundaries to Western Parts of the Lolworth-Ravenswood Block and Broken River Rift, North Queensland
International Nickel Australia Ltd	J.F. Huntington	Studies in Small Scale Geological Mapping as a Tool for Base Metal Exploration in Australia and Papua New Guinea
Department of Mines Geological Survey of Tasmania	E. Williams M. McClenaghan	Evaluation of Large Scale Structures and Rock Distribution Patterns in Tasmania

Organization	Author	Title
Department of Minerals and Energy, Bureau of Mineral Resources, Geology and Geophysics	W.J. Perry C. Maffi C.J. Simpson P.W. Crohn	Geological Investigations of Earth Resources Imagery of Australia
Department of Geology and Geophysics, University of Sydney	D.W. Emerson	Small Scale Geological Investigations on the Eastern Margin of the Yilgarn Block, W.A.
Department of Mines, Geological Survey of Victoria	B.R. Thompson	Studies in Small Scale Geological and Structural Mapping
James Cook University of North Queensland, Geology Department	W.C. Lacy R.G. Taylor	Distribution, Control and Recognition of Areas of Bulk-Low-Grade Copper and Tin Mineralization
"	P.J. Stephenson	Mapping of Basalt Areas and Volcanic Features and Structural Analysis.
James Cook University of North Queensland, Geography Department	D. Hopley	Geomorphology of Coastal Reef Features
James Cook University of North Queensland, Geology Department	W. Sugden	Barrier Reef Sedimentation
"	R.A. Henderson	Regional Studies of Cambrian Formations
C.S.I.R.O. Division of Applied Geomechanics	K. Grant	Terrain Classification and Evaluation for the Purpose of Engineering and Urban and Rural Planning
Pacminex Pty Limited Sydney N.S.W.	W.J. Langron R.D. Walker	Use of ERTS in Detailed Metalliferous Exploration
C.S.I.R.O. Division of Mineralogy	J. McAndrew	ERTS-1 Imagery of Granite - Gneiss Complexes in South Australia
University of Melbourne School of Geology	E.B. Joyce	Evaluation of Available ERTS-1 Imagery for the Production of a Geomorphic Map of Southeastern Australia
Department of Mines, Geological Survey of South Australia	B.P. Thomson	ERTS-1 Imagery and Small Scale Mapping Studies in South Australia
Western Mining Corporation Ltd Western Australia	E.S.T. O'Driscoll D.McP. Duncan	Comparative lineament Studies

Organization	Author	Title
The Zinc Corporation Limited New South Wales	I.R. Johnson	Small Scale Geological Mapping Broken Hill Area
C.S.I.R.O. Division of Mineral Physics	K.L. Burns	Geological Structures and ERTS Imagery
Geological Survey of Queensland	I.H. Wilson	General Geological Structure and Landform Survey of Northwest Queensland
Anaconda Australian Inc., Mt Isa, Queensland	D. Dunnet	Comparison of Remote Sensing Methods in Structural Studies of the McArthur Basin
Geological Survey of Western Australia	J.H. Lord	Regional Geological Studies - Kalgoorlie, W.A.
University of Western Australia Department of Geology	H.A. Doyle	Study of Seismic Zones in Australia
Australian Selection (Pty) Ltd Marrickville, N.S.W.	N.J. Marshall	Regional Geologic Mapping in Western Australia
Geological Survey of N.S.W. Sydney, N.S.W.	E. Scheibner	ERTS-1 Geological Investigations of New South Wales
C.S.I.R.O. Division of Mineralogy	D.R. Hudson W.E. Ewers	Geological Evaluation of ERTS Imagery in the Kambalda-Mt Keith Nickel Belt

Water Resources

Organization	Author	Title
Victorian State Rivers and Water Supply Commission Major Works Branch	D.T. Currey	Water Resources Investigation, Flooding, Victoria, Australia
Engineering and Water Supply Department, South Australia	J.S. Gerny	ERTS Data in Regional Water Resources Investigation of the Southeast of South Australia
Australian Groundwater Consultants Pty Ltd, Victoria	C.D. Ellyett J.S. Hancock	The Applicability of ERTS Imagery to the Study of the Hydrological Resources of an Arid Terrain
Department of Fisheries, South Australia	S.A. Shepherd	Hydrology and Benthic Topography

Interpretation Techniques Development

Organization	Author	Title
C.S.I.R.O. Division of Mineral Physics N.S.W.	M.J. Duggin	Study of Atmospheric and Surface Variations Affecting Analysis of Multispectral Data from ERTS

AUSTRALIAN COMMITTEE FOR ERTS
FINAL REPORTS ON ERTS-1 INVESTIGATION
DISCIPLINE SUMMARIES

AGRICULTURE/FORESTRY/RANGE RESOURCES

Agriculture

ERTS-1 imagery is regarded as a valuable addition to conventional techniques in land use studies, but it cannot be used alone; some land system boundaries can be delineated, but conventional aerial photography is needed for plotting land units. The same limitation applies to erosion studies of coastal sand dunes and semi-arid rangelands. The imagery is not satisfactory for soil series mapping, and direct identification of vegetation is difficult. Diseased wheat and sub-clover could not be identified, and the particular investigator considered that even if resolution could be improved, the satellite passes are too infrequent for successful studies of plant diseases. One investigator found that false colour composite transparencies are easiest for interpretation of land use, but provide no more information than the separate black and white bands; of these, bands 5 and 7 are preferred by two investigators. One investigator concerned with soil type, land use and geomorphology found bands 5 and 7 more useful than false colour composites. Two investigators, concerned respectively with land use and soil erosion, would prefer stereoscopic imagery.

In the Murrumbidgee Irrigation Area, New South Wales where rice and horticultural crops are grown under irrigation, it was found that the resolution of ERTS imagery is insufficient to replace aerial photography, and the 18-day cycle too infrequent for the imagery to be used as a management tool, even if it could be assured that cloud-free

images could be obtained on each pass.

Forestry

ERTS-1 imagery appears to be suited for rapidly mapping vegetation zones over large areas in certain regions, for forest resources inventory work, assessment of burnt areas and the effects of mans' activities (new clearings etc). A simple classification is emvisaged to locate areas for more detailed consideration in subsequent stages of multistage sampling surveys. In Victoria, colour composite transparencies provided a higher degree of interpretive detail than the black and white bands. Land use categories could be recognized, vegetation types mapped and age classes in conifer plantations classified. Further work is required to evaluate the effects of seasonal changes both for interpretation and mapping of vegetation types, and for studies of fire hazard prediction. No insect or pathogen indications were visible on the imagery supplied.

LAND USE SURVEY & MAPPING

Three investigating groups concerned with observing changes in patterns over time were not able to conduct experiments in this field because of lack of sequential imagery (probably due to cloud cover). One group noted however, that patterns of snow cover, areas of water, extent of bushfires and location of mobile sand bodies are readily apparent on ERTS imagery. For another group ERTS imagery has provided immediate benefits as a planning medium for bathymetric and Antarctic surveys, and as an interim measure for completion of Antarctic maps. This group expressed the view that if imaging systems on future ERTS programs can provide stereoscopic coverage, greater advantages for mapping purposes would result, particularly in Antarctica.

MINERAL RESOURCES/GEOLOGICAL STRUCTURE/LANDFORM SURVEYS

Many investigators expressed the view that ERTS imagery has a useful role complementary to conventional techniques in regional geological mapping. It does not replace conventional aerial photography, but used as an adjunct to air photos, the imagery has provided information such as the extension of previously known geological features, particularly lineaments, the joining of discontinuous lineaments in areas of poor outcrop, and the discovery of new lineaments, both rectilinear and curvilinear. One investigator felt that the location of long lineaments could assist in the broad definition of prospective areas for mineralization, but noted that he knew of no evidence yet that ERTS has indicated a body of mineralization directly. Another advocated the application of the study of lineaments to mineral exploration, a third noted that in North Queensland the major mineralized districts appear to occupy zones of intersections of major cross linears, and in the Alice Springs area a fourth found no significant correlation between lineaments and the location of known mineral deposits. Several investigators noted that the imagery gives only a broad guide to rock distribution, because rock boundaries can rarely be followed continuously. Major geomorphic features are readily apparent, but one investigator stated that the geomorphic regions derived from ERTS imagery need much checking against other available information before their accuracy can be determined. He considered that the main value of the imagery in geomorphic mapping will be in the initial stages of studying an area, or as illustrative or teaching material. An investigator concerned with terrain evaluation for engineering and for urban and rural planning purposes, concluded that the imagery is not useful for these purposes. Strip-mining operations were identified satisfactorily by another investigator, but various stages of extraction or rehabilitation of disturbed areas could not be distinguished.

Three investigators favoured stereoscopic imagery, and two of these found that low sun-angle imagery provided more information on geological structure than high sun-angle imagery. Several investigators preferred band 7 for structural studies, and bands 5 and 7 for general geological information; however, in South Australia band 6 was considered most suitable for lineament studies. One investigator found colour composite prints most useful for geological interpretation in northern Australia.

WATER RESOURCES

ERTS-1 imagery is useful for determining the extent of surface water (band 7 in particular), and information on certain parameters of water quality, namely colour and turbidity, can be gained from a study of the reflectivity in each wavelength band.

In a flood investigation in Victoria, flood flowpaths could be traced by the differing reflectance characteristics of sediment-laden water (colour composite imagery, bands 4, 5 and 7), and flood boundaries were successfully mapped.

In South Australia, zones having common hydrologic behaviour in terms of topography and groundwater conditions were mapped from ground information. ERTS data corroborated the mapping, and also indicated anomalous areas requiring further ground investigation.

The imagery was judged to be useful in the search for water in arid terrain, by providing evidence that certain areas may have greater potential than others, and thus reducing the amount of ground work necessary.

In a South Australian study of near shore water movements, although gross surface currents were deduced from movements of turbid water, ERTS imagery did not add significantly to knowledge of coastal currents.

INTERPRETATION TECHNIQUES DEVELOPMENT

Experiments were performed to determine the coefficient of variation in the spectral reflectance of targets on a small scale; a typical value for sandstone outcrops for a 30 cm integration area was 0.16. The coefficient of variation in scene radiance from such a target seen by ERTS would be between 0.16 and 0.17, but lay between 0.16 and 0.20 for 25 nm and 50 nm band passes. The report recommends that more solar irradiance measurements in ERTS bandpasses be made at many latitudes, seasons and in many atmospheric environments in order to predict more completely the atmospheric contribution to spectral scene radiance variation; and that the coefficient of variation in spectral reflectance using ERTS bandpasses be measured for various targets of different albedo using different integration areas.