GEOGRAPHIC SCIENCE TEAM

PRESENTED BY: NEVIN BRYANT

GEOGRAPHIC SCIENCE

CONCERN:

EARTH AS THE HOME OF MAN

PURSUITS:

IDENTIFICATION, MAPPING, AND UNDERSTANDING THE SPATIAL DISTRIBUTION, USE AND INTERRELATIONSHIP OF PHENOMENA

RATIONALE FOR LAND USE/LAND COVER

- LAND USE/LAND COVER DATA REQUIRED TO ANALYZE SPATIAL PATTERNS AND THEIR DYNAMICS
  - BASIC EARTH SURFACE PHENOMENA
  - SURFACE EXPRESSION OF CRITICAL INTERFACE BETWEEN MAN AND THE EARTH PHYSICAL SYSTEM
- POTENTIAL USES:
  - BASE LINE
  - TREND ASSESSMENT
  - PREDICTIVE MODELS
- NEXT STEP:

  LEVEL III CLASSIFICATION = QUANTUM STEP
  - MSS & TM SUPPORT LEVEL I & II
  - ACHIEVABLE

RATIONALE FOR GEOMORPHOLOGY

- GEOMORPHOLOGY IMPACTS MAN'S USE OF THE LAND
  - BASIC EARTH SURFACE PHENOMENA
  - STUDY OF FORM, COMPOSITION AND LONG-TERM PROCESSES (DECADES)

- POTENTIAL USES:
  - LAND CAPABILITY AND SUITABILITY
  - ENVIRONMENTAL IMPACT ASSESSMENT
  - PROCESS MODELS

- NEXT STEP:
  - INTERNALLY CONSISTENT, AREALLY EXTENSIVE DATA FOR QUANTITATIVE PROCESS ANALYSIS
  - ACHIEVABLE

RATIONALE FOR CARTOGRAPHY

- MAPS PRODUCTS 1:25,000 - 1:250,000 SCALE REQUIRED WORLDWIDE
  - 50 PERCENT OF LAND AREA IS NOT MAPPED TOPOGRAPHICALLY AT SCALES OF 1:100,000 OR LARGER
- POTENTIAL USES:
  - SURVEY AND MANAGEMENT OF RESOURCES
  - GEO-REFERENCED DATA BASES
  - DIGITAL TERRAIN DATA
- NEXT STEP:
  - GLOBAL CARTOGRAPHY SYSTEMS MEETING NATIONAL MAP ACCURACY STANDARDS AT 1:25,000
  - DIFFICULT

STATE-OF-THE-ART

- GEOGRAPHIC INFORMATION SYSTEMS UNDER DEVELOPMENT
  - REMOTE SENSING DATA
  - TERRAIN DATA
  - ANCILLARY DATA

- LAND USE/LAND COVER
  - LEVEL I AND II ACHIEVABLE WITH MSS AND TM
  - LEVEL III OBTAINED FROM HIGH RESOLUTION PHTOTGRAPHS UTILIZING LIMITED SPECTRAL REGIONS
  - DYNAMICS OF PHENOMENA LARGELY IGNORED

STATE-OF-THE-ART (CONT.)

- GEOMORPHOLOGY
  - MSS AND TM USEFUL IN DELINEATING PHYSIOGRAPHIC REGIONS
  - HIGH RESOLUTION AERIAL PHOTOGRAPHY PROVIDES THE QUANTITATIVE DATA FOR PROCESS ANALYSIS
- CARTOGRAPHY
  - MSS CAN PROVIDE 1:250,000 HORIZONTAL PLANIMETRY
  - TM UNTESTED
  - FILM CAMERAS/5M RESOLUTION PROVIDES 1:50,000 HORIZONTAL PLANIMETRY (SKYLAB)

PRIORITIZED SUMMARY OF GEOGRAPHIC SCIENCE DATA GAPS

1. BASIC SPECTROMETER DATA (NOTE EXPERIMENTS)
   - SYSTEMATIC VARIATION IN SPATIAL RESOLUTION
   - NARROW WAVEBANDS; 0.3 - 12.4 MICRONS
   - VARIOUS CLIMATIC REGIMES AND ENVIRONMENTAL CONDITIONS
   - VARIOUS SEASONS

2. SPATIAL FREQUENCY INFORMATION ON COVER TYPES

3. ANALYZE INTERACTION OF SPATIAL RESOLUTION, TARGET HETEROGENEITY, AND SPECTRAL SIGNATURES FOR COVER TYPES

PRIORITIZED SUMMARY OF GEOGRAPHIC SCIENCE DATA GAPS (CONT.)

4. DEVELOPMENT OF CLASSIFICATION APPROACHES THAT MAXIMIZE UTILITY OF HIGHER RESOLUTION DATA

5. TIME SERIES DATA ACQUISITIONS WITHIN CLIMATIC REGIMES TO ASSESS BOTH SEPARABILITY OF COVER TYPES AND LAND COVER CHANGES

6. ACCURATE REGISTRATION AND RECTIVICATION

   - G/S DATA BASE DEVELOPMENT
   - ANCILLARY DATA INTEGRATION
   - STEREO AND OFF-NADIR DATA ACQUISITIONS

7. DATA FROM VERY STABLE PLATFORMS FOR CARTOGRAPHIC APPLICATIONS

SUMMARY OF CANDIDATE EXPERIMENTS

I. LAND USE/LAND COVER

- URBAN/SUBURBAN LEVEL III LAND USE DESCRIMINATION
- URBAN VS. RURAL COVER TYPE DESCRIMINATION AND CHANGE
- SURFACE MINING OPERATIONS DESCRIMINATION & RECLAIMATION MONITORING

II. GEOMORPHOLOGY

- PROCESSES INFLUENCING PERIGLACIAL LANDFORMS
- "CATOSTROPHIC" EVENTS EFFECT UPON LANDFORMS
- SEMIARID AND ARID LANDFORMS SPECTRAL AND SPATIAL CHARACTERIZATION AND ASSOCIATIONS
- DRAINAGE NETWORK AND DRAINAGE BASIN ANALYSIS

III. CARTOGRAPHY

- COMPARISON OF FILM, AREA-AND LINE-ARRAY DATA
- INTERRELATIONSHIPS BETWEEN TOPOGRAPHY, SUN ELEVATION AND AZIMUTH, AND VIEWING DIRECTION AS RELATED TO INFORMATION EXTRACTION

SUMMARY OF DATA REQUIREMENT FOR EXPERIMENT

I. LAND USELAND COVER

	URBAN LEVEL III	URBAN VS. RURAL III	SURFACE MINING III
FIELD SURVEYS	CRITICAL	CRITICAL	CRITICAL
SPECTRORADIOMETRY	CRITICAL	CRITICAL	CRITICAL
COLLATERAL DATA	YES	YES	YES
HIGH RES. PHOTOGRAPHY	CIR & PANCHROMATIC B&W	CIR	CIR
TEMPORAL REGISTRATION	(DYNAMICS 2 PIXELS)	(DYNAMICS 2 PIXELS)	(DYNAMICS 0.5 PIXEL)
RECTIFICATION	YES	YES	YES
BASE LINE SPATIAL RES.	5M	5M	5M
SPECTRAL REQ. **	0.4-12.4	0.4-12.4	0.4-12.4
TEMPORAL RES.	TIME SERIES	TIME SERIES	TIME SERIES
TERRAIN DATA *	N/A	N/A	YES
SPECIAL REQUIREMENTS	DIURNAL ACQUISITIONS	DIURNAL ACQUISITONS	VARIATION IN LOOK ANGLES

* EITHER EXISTING DTM OR FLIGHT EXPERIMENT

** SPECIFIC BANDS TO BE DETERMINED

SUMMARY OF DATA REQUIREMENTS FOR EXPERIMENTS

II GEOMORPHOLOGY

	PERIGLACIAL	ARID	CATOSTROPHIC EVENTS	DRAINAGE
FIELD SURVEYS	CRITICAL	CRITICAL	CRITICAL	CRITICAL
SPECTRORADOMETRY	CRITICAL	CRITICAL	CRITICAL	CRITICAL
COLLATERAL DATA	YES	YES	YES	YES
HIGH RESOLUTION PHOTOGRAPHY	CIR	NATURAL COLOR	NATURAL COLOR OR CIR	NATURAL OR CIR
TEMPORAL REGISTRATION	N/A	N/A	0.5 PIXEL CAPABILITY	N/A
RECTIFICATION	YES	YES	CRITICAL	CRITICAL
BASE LINE SPATIAL RES.	5M	5M	5-30M	5M
SPECTRAL REQ.**	0.4-12.4	0.4-12.4	0.4-12.4	0.4-12.4
TEMPORAL RES.	3 FLIGHTS JUN-SEPT	EACH SEASON	EVENT DEPENDENT	EACH SEASON
TERRAIN DATA*	YES	YES	YES	YES
SPECIAL REQ.	NOON OVERFLIGHT	HIGH & LOW SUN ANGLES	EVENT DEPENDENT	NONE

* EITHER EXISTING DTM OR FLIGHT EXPERIMENT

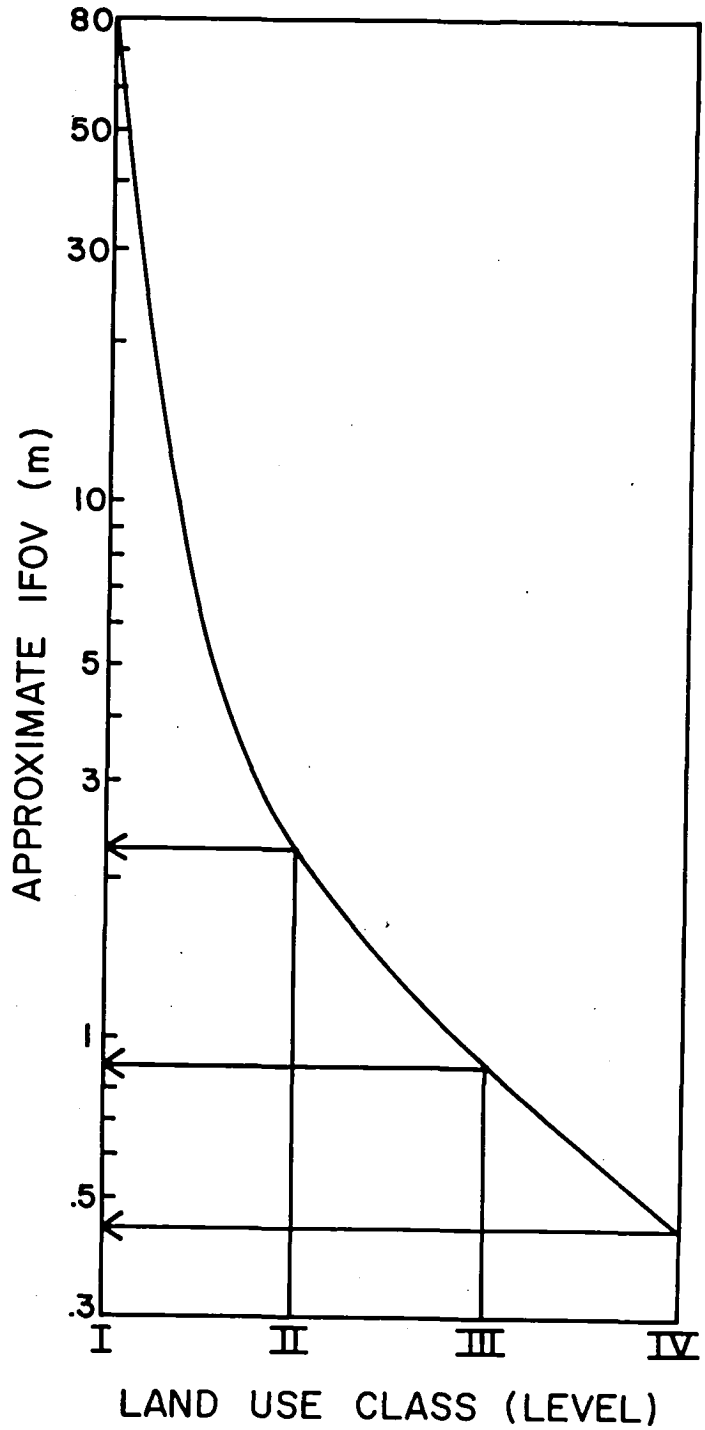
** SPECIFIC BANDS TO BE DETERMINED

SUMMARY OF DATA REQUIREMENTS FOR EXPERIMENT III CARTOGRAPHY

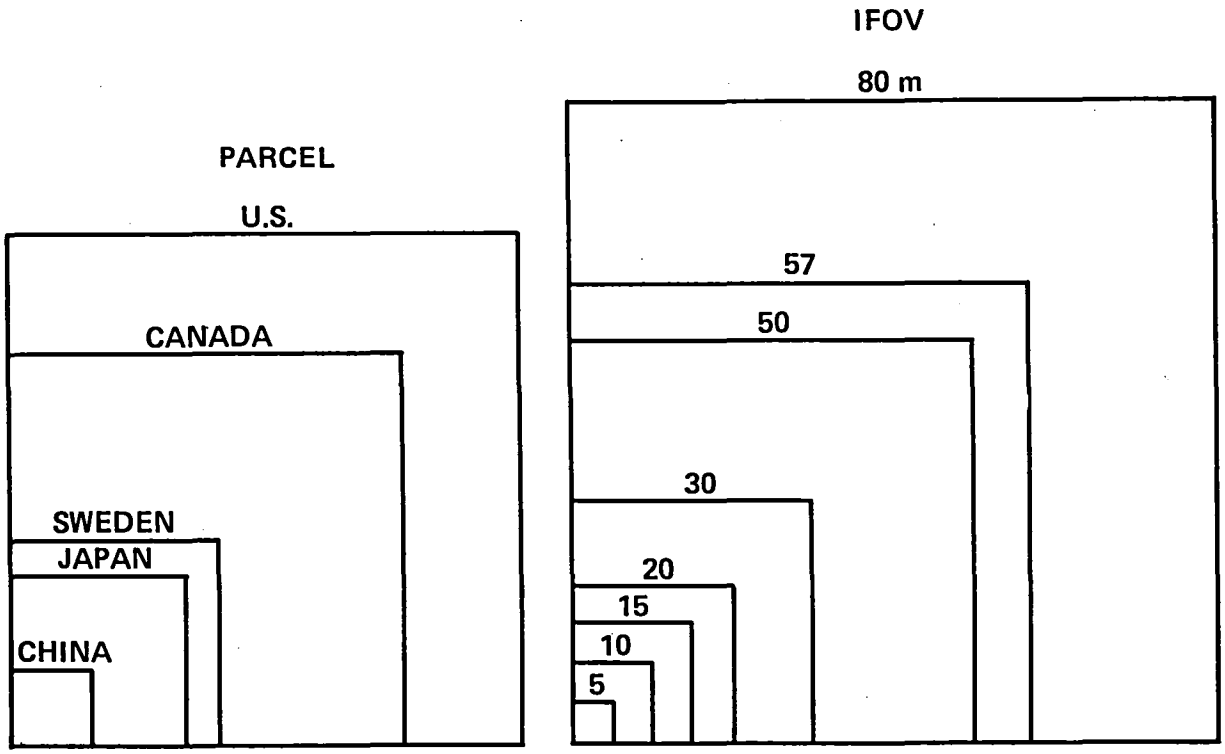
	SENSOR COMPARISON	INTERRELATIONSHIP ANALYSIS
FIELD SURVEYS	YES	N/A
SPECTRORADIOMETRY	N/A	N/A
COLLATERAL DATA	YES	YES
HIGH RES. PHOTOGRAPHY	B&W VISIBLE AND IR	B&W VISIBLE AND IR
TEMPORAL REGISTRATION	N/A	N/A
RECTIFICATION	CRITICAL	CRITICAL
BASE LINE SPATIAL RES.	2M	2M
SPECTRAL REQ.	VIS & NIR	NIV & NIR
TEMPORAL RES.	N/A	N/A
TERRAIN DATA	STEREO PAIRS	STEREO PAIRS
SPECIAL REQUIREMENTS	EXTREMELY STABLE PLATFORM	EXTREMELY STABLE PLATFORM

Land use and land cover classification system for use with remote sensor data

Level I		Level II	
1	Urban or Built-up Land	11	Residential.
		12	Commercial and Services.
		13	Industrial.
		14	Transportation, Communications, and Utilities.
		15	Industrial and Commercial Complexes.
		16	Mixed Urban or Built-up Land.
		17	Other Urban or Built-up Land.
2	Agricultural Land	21	Cropland and Pasture.
		22	Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas.
		23	Confined Feeding Operations.
		24	Other Agricultural Land.
3	Rangeland	31	Herbaceous Rangeland.
		32	Shrub and Brush Rangeland.
		33	Mixed Rangeland.
4	Forest Land	41	Deciduous Forest Land.
		42	Evergreen Forest Land.
		43	Mixed Forest Land.
5	Water	51	Streams and Canals.
		52	Lakes.
		53	Reservoirs.
		54	Bays and Estuaries.
6	Wetland	61	Forested Wetland.
		62	Nonforested Wetland.
7	Barren Land	71	Dry Salt Flats.
		72	Beaches.
		73	Sandy Areas other than Beaches.
		74	Bare Exposed Rock.
		75	Strip Mines. Quarries, and Gravel Pits.
		76	Transitional Areas.
		77	Mixed Barren Land.
8	Tundra	81	Shrub and Brush Tundra.
		82	Herbaceous Tundra.
		83	Bare Ground Tundra.
		84	Wet Tundra.
		85	Mixed Tundra.
9	Perennial Snow or Ice	91	Perennial Snowfields.
		92	Glaciers.



SOURCE: WELCH (1978)

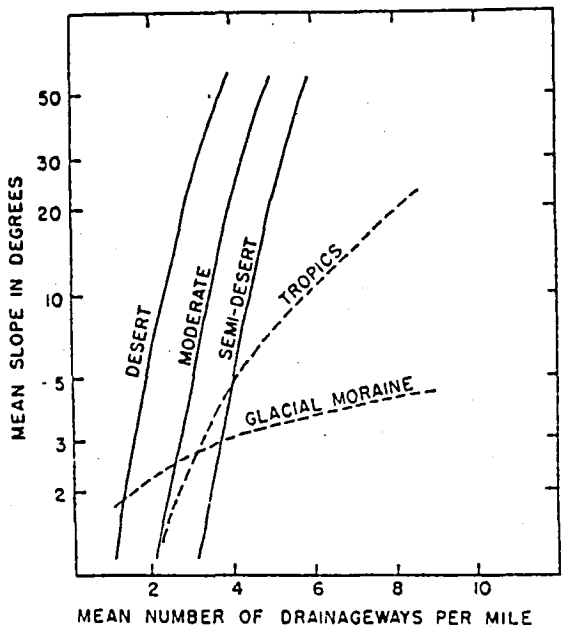


THE AVERAGE URBAN LAND PARCEL SIZES IN DIFFERENT COUNTRIES COMPARED TO IFOV's OF 5 TO 80 M. SPATIAL RESOLUTION REQUIREMENTS WILL VARY WITH GEOGRAPHIC REGION.

SOURCE: R. WELCH, UNIVERSITY OF GEORGIA

Classification of geomorphological features (*after Tricart, 1965*).

Order	*Units of earth's surface in km²*	*Characteristics of units, with examples*	*Equivalent climatic units*	*Basic mechanisms controlling the relief*	*Time-span of persistence*
I	10^7	continents, ocean basins	large zonal systems controlled by astronomical factors	differentiation of earth's crust between sial and sima	10^9 years
II	10^6	large structural entities (Scandinavian Shield, Tethys, Congo basin)	broad climatic types (influence of geographical factors on astronomical factors)	crustal movements, as in the formation of geosynclines. Climatic influence on dissection	10^8 years
III	10^4	main structural units (Paris basin, Jura, Massif Massif)	subdivisions of the broad climatic types, but with little significance for erosion	tectonic units having a link with paleogeography; erosion rates influenced by lithology	10^7 years
IV	10^2	basic tectonic units; mountain massifs, horsts, fault troughs	regional climates influenced predominantly by geographical factors, especially in mountainous areas	influenced predominantly by tectonic factors; secondarily by lithology	10^7 years
		limit of isostatic adjustments			
V	10	tectonic irregularities, anticlines, synclines, hills, valleys	local climate, influenced by pattern of relief; adret, ubac, altitudinal effects	predominance of lithology and static aspects of structure	10^6–10^7 years
VI	10^{-2}	landforms; ridges, terraces, cirques, moraines, debris, etc.	mesoclimate, directly linked to the landform, e.g. nivation hollow	predominance of processes, influenced by lithology	10^4 years
VII	10^{-6}	microforms; soli fluction lobes, polygonal soils, nebka, badland gullies	microclimate, directly linked with the form, e.g. lapies (karren)	predominance of processes, influenced by lithology	10^2 years
VIII	10^{-8}	microscopic, e.g. details of solution and polishing	micro-environment	related to processes and to rock texture	



Morphometry of major climatic regions (After Peltier, 1962).

U.S. NATIONAL MAP ACCURACY STANDARDS

A. HORIZONTAL - 90% OF WELL-DEFINED POINTS SHALL BE PLOTTED (AT THE MAP SCALE) TO WITHIN ± 0.5 mm OF THEIR CORRECT POSITION, e.g.,

MAP SCALE = 1:100,000
± 0.5 mm AT MAP SCALE = ± 50 m ON GROUND

THUS, 90% OF POINTS MUST BE WITHIN ± 0.5 mm ON THE MAP AND ± 50 m ON THE GROUND.

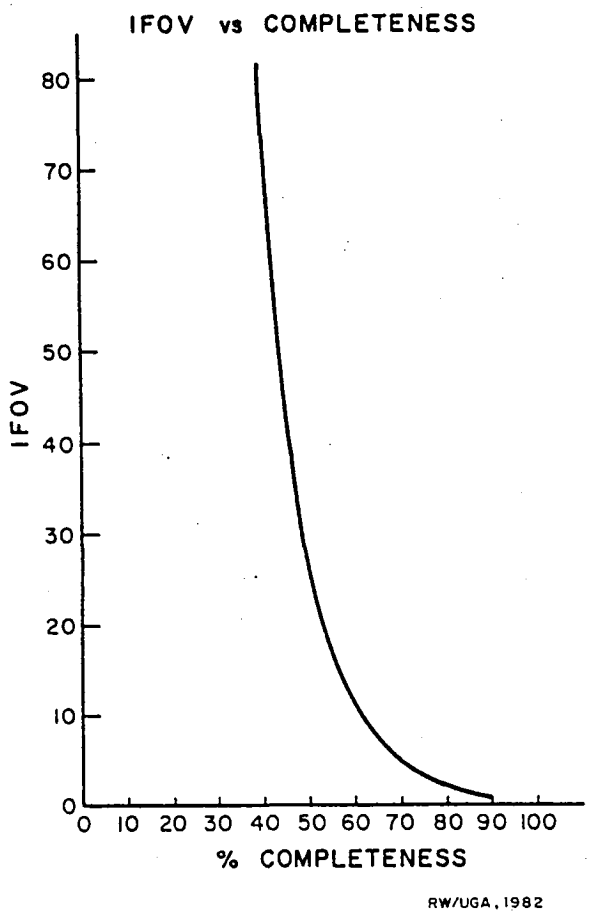
B. VERTICAL - 90% OF THE ELEVATIONS DETERMINED FROM CONTOURS SHALL BE CORRECT TO WITHIN 1/2 THE CONTOUR INTERVAL (C.I.), e.g.,

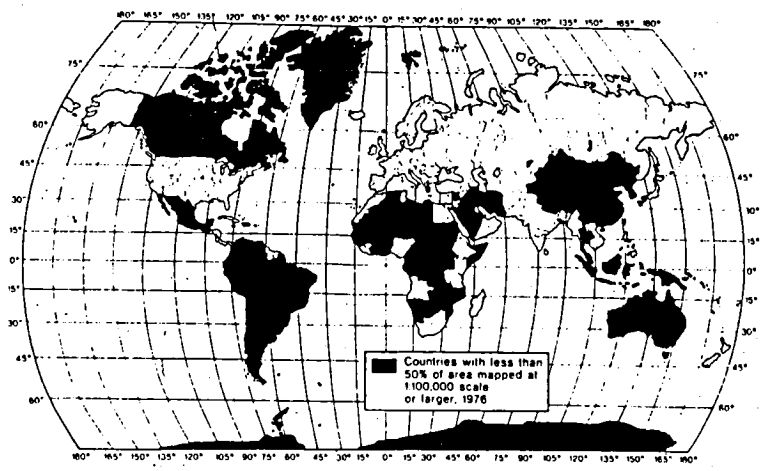
C.I. = 100 m

THUS, 90% OF ELEVATIONS REFERENCED TO CONTOURS SHALL BE CORRECT TO WITHIN ± 50 m.

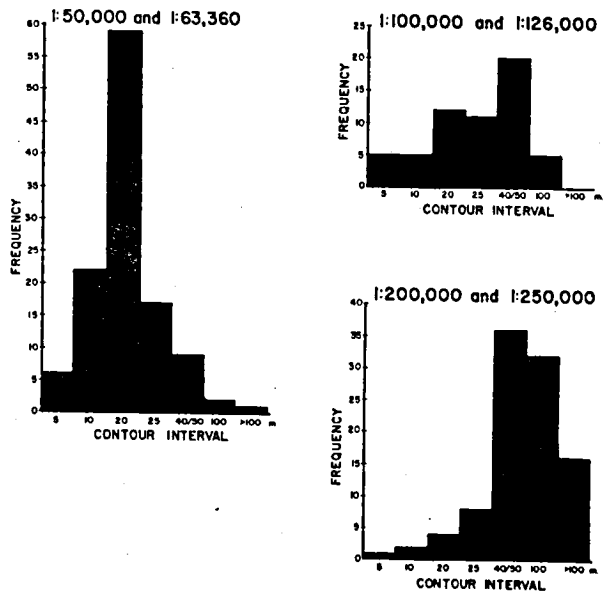
ACCURACY OF GROUND CONTROL POINTS OBTAINED FROM MAPS MEETING NMAS

SCALE OF MAP	HORIZONTAL RMSE	CONTOUR INTERVAL	(C.I./3.3-C.I./2)
1:250,000	75 m	100 m	30-50 m
1:200,000	60	100	30-50
1:100,000	30	50	15-25
1:50,000	15	20	6-10
1:25,000	7.5	10	3-5


IFOV vs COMPLETENESS
IFOV
80
70
60
50
40
30
20
10
0
0 10 20 30 40 50 60 70 80 90 100
% COMPLETENESS
RW/UGA, 1982



THE SHADED AREAS REPRESENT COUNTRIES OR REGIONS WITH 50 PERCENT OR LESS OF THEIR AREA MAPPED AT 1:100,000 SCALE OR LARGER IN 1976 (UNITED NATIONS, 1976).



HISTOGRAMS OF CONTOUR INTERVALS FOR TOPOGRAPHIC MAPS AT SCALES OF 1:50,000, 1:100,000, AND 1:250,000 (UNITED NATIONS, 1976)

GEOGRAPHIC SCIENCE WORKSHOP
MULTISPECTRAL IMAGING SCIENCE WORKING GROUP

Dates: April 28-30, 1982

Location: Mariott Hotel
711 East Riverwalk
San Antonio, Texas 78205
(512) 224-4555

SCHEDULE

I. Wednesday afternoon, April 28, 1982 Salon A

Introduction

1:00-1:30pm	R. Whitman N. Bryant	Objectives of Working Group Objectives of Workshop
1:30-2:15	G. Vane	Background on MLA Systems.

Justification and Requirements

2:15-3:00pm	R. Witmer	Level III Land use/Land Cover Classification Requirements.
3:00-3:45pm	R. Welch	National Map Accuracy Standards for Planimetry and Elevation Determination.
3:45-4:30pm	J. Estes	Geomorphology (Landform and Drainage Elements Detection.)

State of the Art

4:30-5:00pm	F. Sabins	Spatial and Spectral Resolution for Landform and Drainage Element Detection.
5:00-7:00pm	Dinner	
7:00-7:30pm	J. Clark	Spatial and Spectral Resolutions in an Urban Environment.
7:30-8:00pm	D. Williams	Summary of TMS Results.

8:00-8:30pm	D. Quattrochi	Spatial and Spectral Resolutions in Strip Mine Recognition.

II. Thursday, April 29, 1982 The Buoy Room

8:30-9:00am	Organization of and Charge to Working Groups.
9:00am-12:00noon	Break out into panels for initial discussions on requirements and state of the art.
12:00noon-1:00pm	Lunch
1:00-2:30pm	Panel writeups on requirements and state of the art.
2:30:4:30pm	Viewgraph reviews on requirements and state of the art by panel chairmen with general discussion.
4:30-5:30pm	Initial discussion on critical gaps in scientific knowledge and definition of candidate remote sensing experiments to further develop knowledge.
5:30-7:00pm	Dinner
7:00-9:00pm	Panel writeups on knowledge gaps and candidate experiments.

III. Friday, April 30, 1982 Salon A

8:30-10:00am	Viewgraph reviews of knowledge gaps and candidate experiments by panel chairmen with general discussion.
10:00am-12:00noon	Panels edit and expand upon general discussion for workshop documentation.
12:00noon-1:00pm	Lunch
1:00-3:00pm	Panel chairmen present highlights and select key summary tables, illustrations, and graphs.
3:00pm	Executive Summary Draft (N. Bryant and R. Whitman).

Panel: Cartography (R. Welch chairman)

Areas of Concern: Spatial and geometric resolution requirements for photographic/analog or digital photogrammetry from spaceborne MLA sensors. Of particular concern are the impacts of National Maps Accuracy requirements upon MLA system precision to determine planimetry/orthophoto mapping and elevation at various scales (1:250,000 to 1:24,000). An analysis of relief effects upon off-nadir viewing should also be made.

Panel Members:

Mr. Fred Billingsley
JPL

Dr. Steven Guptill
USGS

Dr. Roy Welch
Univ. of Georgia

Dr. Albert Zobrist
JPL

Panel: Land Use/Land Cover (R. Witmer chairman)

Areas of Concern: Spatial and spectral resolution requirements for photo interpretation and/or multispectral pattern recognition of cultural surface cover. Of particular interest are the recognition of man-made structures in urban and urban fringe regions. Other topics of interest include the delination of and detection of changes in the landscape created by man's activities, such as strip mines, roads and railroads, and utility right of ways.

Panels Members:

Mr. Jerry Clark
JPL

Mr. Leonard Gaydos
USGS

Dr. Robert Holz
Univ. of Texas

Dr. John Jensen
Univ. of South Carolina

Mr. Dale Quattrochi
NSTL

Mr. Darryl Williams
GSFC

Dr. Richard Witmer
USGS

Panel: Geomorphology (J. Estes chairman)

Areas of Concern: Spatial and spectral resolution requirements for photo interpretation and/or multispectral pattern recognition of geomorphic elements. Of particular interest would be glacial and pariglacial landforms, eolian and coastal landforms, and karst topography, Manmade landform elements, such as berms, dikes, and levees should also be considered. Drainage elements of particular interest would include perennial and intermittent stream beds, flood plains, and alluvial fans. Manmade drainage elements, such as canals, diversion channels, and spreading basins should also be considered.

Panel Members:

Dr. Nevin Bryant
JPL

Dr. John Estes
Univ. California Santa Barbara

Dr. Charles Hutchinson
Univ. of Arizona

Ms. Leslie Morrissey
ARC

Charge to Panels:

Thursday Morning

1. Develop a position statement on the basic scientific rationale for the panel's areas of concern noting the potential role future missions with improved spatial and spectral resolution can play in supporting advancement of the discipline.

2. Develop a position statement on anticipated requirements, and the role for improved spatial and spectral resolution on future missions.

3. Outline the current state of the art in the application of remote sensing imagery (0.3-12.4 microns) to area of concern. Use the Wednesday discussions as a point of departure. Note the available reference material.

Thursday Afternoon

4. Identify areas where critical gaps in our knowledge of the potential contribution to be made by MLA spaceborne sensors.

5. Propose experiments that should be conducted to test and document areas of concern regarding the potential for MLA imaging systems. This should include synthetic and standardized data sets, airborne, shuttleborne, and free-flyer experiments. Note the spatial and spectral resolution requirements and repeat visit cycle requirements that should provide the most valuable information content. Note the probable nature of data use (i.e. digital modelling, photo-interpretation, multispectral classification).

6. Identify research tasks that the panel feels should be pursued to enhance near and medium range capabilities. Recommend levels of effort (man-years, dollars) and task duration. Prioritize the research tasks.