Type II Progress Report

Period ended November 30, 1972

a - Title - ERTS Data User #119 - Effective Use of ERTS Multisensor Data in the Great Plains

b - Principal Investigator number - Victor I. Myers UN-642

c - Problems impeding progress -

1. Frame No. 1023-16440 covering the Centerville study area and taken on August 15, 1972, has not been received. Data analysis cannot proceed until transparencies of the four wavelength bands for this frame are received. (cropland)

2. The ERTS imagery used to date has been photographed in late summer and in the fall season. Although this imagery appears to be quite useful in differentiating soil associations and/or land systems, it is felt that the photos that will be taken of our area in April, May and June will have maximum usefulness for our purposes. Therefore, although time of taking the imagery is not a problem that can be solved now, it should be mentioned that better results will probably be possible with April, May and June imagery. (land systems)

3. The above also applies to vegetation analysis, and the imagery to be taken in June and July probably will have the greatest usefulness for that purpose. (rangeland)

4. Clouds have obliterated vital parts of the scene in South Dakota so that it is difficult to carry through on some delineations and analyses. (Cropland, land systems and rangeland)

d - Accomplishments

1. Rangeland

(a) No new ground truth data were taken in October or November. Preliminary work has been initiated to train the machine classifier using imagery from areas with known ground truth. Progress has been made toward obtaining soil and vegetation maps of western South Dakota for more generalized ground truth over large areas. Additional personnel will be utilized for more intensive analysis and interpretation after January 15, 1973.

2. Cropland

(a) Even though the Centerville study area was partially obscured by clouds on August 5, the imagery was examined visually to determine if crop identification from ERTS imagery with a reasonable degree of accuracy is possible. It was determined that this is possible.

(b) Similar ERTS imagery covering portions of north central Nebraska was displayed on Spatial Data at various resolutions to determine the best resolution at which to digitize the ERTS imagery. Conclusive results have not yet been achieved.

3. Land Systems

(a) One ERTS photo from southwestern South Dakota has been analyzed in terms of soil associations. It is labeled the Martin photo and a copy is attached and called figure 1.

Soil Associations have been drawn upon the photo. Figure 2 is a line tracing from the ERTS photo of the Soil Association Map, and figure 3 is a line tracing of the same scale of the present published Soil Association Map for South Dakota (AES Info Series No. 3, January, 1971 - Agricultural Experiment Station, SDSU, Brookings, and USDA, Soil Conservation Service, Huron).

An inspection of figure 2 shows that the following Soil Associations are visible on the ERTS photo (MSS-5):

(1) The Sand Hills (164) distinguished by a dappled gray and white pattern caused by thin sandy soils with sparce vegetation in a rough circular or linear alignment - no streams are apparent except for an east-west trending long narrow valley (59) along the north side of the delineation. The entire area is best suited for grass and this is what it is used for.

(2) The Martin Tableland (30). An area of deep silty clay loam soils on nearly level to gently undulating topography. The area is recognized by a checkboard pattern of dark to light tones. This area is used for winter wheat in a fallow system.

(3) The Sandstone Tableland (42A) and north-facing escarpment (42). The ERTS photo shows that these two soil associations can be delineated. They are not delineated on AES Info Series No. 3 but the photo clearly shows that there are thinner soils and a dense drainage network on Area 42 caused either by steeper slopes, overgrazing or a combination of the two. Neither area is in cultivation

and likely never has been, but it is clear from the ERTS photo that there are two soil associations rather than one in this area.

(4) The Siltstone Tableland (26). This area is differentiated on the gray pattern, indicating grassland, mottled with scattered small dark gray squares indicating occassional fields. The streams flow generally in a straight line indicating at least a moderate slope to the north. The soils present are rolling silt loams of moderate depth which in this climatic area calls for use as grassland.

(5) The Eroding Siltstone Tableland (59, 69A). A combination of loosely cemented sediments, a semiarid climate, short-rooted grasses and a "wall" or base-level difference have combined to produce an area of barren soil parent materials on steep slopes (69) and partly vegetated badland basins (69A). Also clearly visible in the midst of the eroding badlands is the Cuny Table (55) which is an erosional remnant similar to Area 26 except that the texture of the soil has been modified by the addition of eolian sand. No vegetation grows on Area 69 but some areas of good grassland occur in 69A. Area 55 is excellent grassland. These areas can be separated on the ERTS photo more precisely than has been done in the past.

(6) The Residual Clay Plain (47). A grassland area distinguished on the basis of a uniform gray tone. The soils are fine textured, of fairly shallow but uniform depth, and occur on a gently rolling smooth upland.

(7) Eolian Clay Plain (28). A gently undulating area which has been or is being cropped to winter wheat. The texture of these soils is not as fine as in area 47 and the slopes are not limiting for machinery. The area is distinguished on the basis of the small squares and rectangles of the winter wheat fields.

(8) Sandy Loam Plain (54). The coarser texture of the soils of this area is indicated by the white mottles apparent against the gray tone of the photo. These soils are subject to erosion and occur on rolling terrain and so are used for grassland, primarily.

(9) Limestone or Sandstone Bedrock (41). The small streams apparent in this area are configured in a haphazard manner indicating very shallow soils or rock outcrop on irregular topography. The land use here is as grassland.

(10) Mountain Valley. The presence of a valley in the mountains indicates a less resistant rock formation. The soils here are thin to moderately shallow loams from Triassic shales. The soils are used mostly for grass.

(11) Irrigated Stream Bottom and Terrace (39). This is the Angostura project of sandy to clayey soils.

4. Data Analysis

(a) Mode-seeking techniques in N-dimensional feature space are being prepared, and techniques to delineate large areas of similar geological conditions are being considered.

(b) The data from the 35 mm transparencies which contain ground truth data were digitized and classified. The results for a three-class problem were only 48 percent correct.

e - Significant Results

1. Rangeland -

(a) Significant results are expected in the spring following more intensive data analysis during February and March, 1973.

2. Cropland

(a) Because the appropriate imagery has not been received, there are no significant results to report at this time.

3. Land Systems

(a) One unique advantage of ERTS imagery for delineating soil associations is the large area that can be scanned with one photo. Although soil associations usually are published at scales of 1:500,000 or 1:1,000,000, the delineations are drawn on much larger scale maps covering small pieces of the scene and then pieced together. When constructing a map in this manner it is very difficult to keep areas in proper proportion. Alluvial areas usually are drawn even though narrow and eventually appear on the published map swollen out of proportion to other soil areas. The ERTS imagery puts alluvial areas into their proper size.

(b) A second unique feature of ERTS imagery is that a soil association map constructed with its aid assures that the cartographic level of the associations is more nearly the same. Most soil association maps built up from large scale photos carry along an assortment of small delineations which are meaningful at larger scales but not at the 1:1,000,000 or

1:500,000 scale. An example of this is the plethora of delineations in the northwest part of fig. 3 - (the published soil association map) around the Black Hills. This kind of detail seems excessive for a map of this scale.

(c) A third unique feature of ERTS imagery is that the actual shape and configuration of a soil associations is apparent. The actual convoluted nature of badlands delineations is apparent and stands clearly in contrast to the smooth line delineating Soil Association 42 from 26 and 42A in figures 1 and 2. This is the actual shape and configuration of these delineations at what should be publication scale.

(d) A fourth unique feature of ERTS imagery is that significant new delineations may become apparent which were missed when constructing soil association maps from conventional large scale photos. An example of this is that delineation 42 apparently should be separated from 42A (figures 1 and 2). This separation was not made on the published soil association map. Delineation 42 has many white areas indicating thinner soils and also has a fine network of streams. Both areas are in range but the carrying capacity of area 42 would be significantly lower than that of 42A. It is estimated that Area 42 would be mostly in the "shallow" rangesite while 42A would be mostly in the "silty" rangesite.

f - Published articles - none

g - Recommendations - none

h - Changes in standing order forms - none

i - Image description forms - These forms have been completed on the basis of visual analysis only at this point. The forms are attached as enclosure 1.

j - Data request forms - A data request form was forwarded on November 16, 1972. A copy is attached as enclosure 2.

k - Other information -

[a] Objective of contract - To determine the effective use of ERTS multisensor data in the Great Plains.

[b] Summary of work performed -

1. Rangeland

User information desired from remote sensing include maps of land forms; drainage patterns; major kinds of ecosystems;

range sites; range condition classes; degree and pattern of use; herbage residue; stage of maturity; nutritional value categories; patterns of rainfall; hail; burned areas; snow cover; animal or human disturbance; stored water; soil water regime; and accelerated erosion. Sequential mpas containing these data maps would permit measurement of change in these parameters and the prediction of herbage production, stocking rates, and livestock marketing patterns. Suitability of different areas for multiple uses could be assessed and the impact of different uses determined. Such data would be extremely useful in public or private planning on a regional or local basis.

Examination of ERTS imagery indicates that the items underlined in the previous paragraph probably can be determined using photointerpretation techniques, whenever the scale of these features is sufficiently large. Feasibility of determining items with dotted underlining from sequential multispectral satellite imagery is being investigated using a six stage sampling scheme with satellite imagery as stage 1, aircraft imagery (NASA RB57, SDSU Remote Sensing Institute, and Michigan C-47) with different scales as stages 2, 3 and 4 and flash-illuminated 35mm high speed Ektachrome stereograms of ¼ meter square plots (oblique and vertical) with a subsample clipped and vacuumed to determine herbage and mulch standing crops as stages 5 and 6. In addition, land use has been recorded, scenic stereograms taken near the center of the flight lines and maps of geology, soils, vegetation, and range analysis are being assembled.

First pass ERTS coverage of the 4 rangeland flight lines was very incomplete and partly cloud covered. Second passage coverage is still incomplete and imagery obtained is partly cloud covered. Third pass coverage is complete and cloud free except for the area immediately surrounding the Cottonwood Range and Livestock Research Station where the most intensive ground truth data were collected. Fourth pass imagery is largely cloud-covered but fifth pass imagery is complete and cloud-free.

Only preliminary evaluation of the satellite and aircraft imagery has been made. More complete evaluation is planned after January 15, 1973.

2. Cropland

(a) Aerial and ground surveys have been conducted for portions of Clay, Brookings, Hamlin, and Spink Counties to locate areas to be studied. Based on these surveys, an 8 mile by 12 mile area south of Centerville, South Dakota in Clay County has been selected as the intensive study area.

(b) Ground truth for all study areas was collected on August 15, 16, and 17.

(c) The percentage of the intensive study area planted to each crop is being measured on aerial photographs taken from 10,000 feet.

(d) A data analysis plan has been prepared and will be followed as soon as Frame No. 1023-16440 is received.

3. Land Systems

(a) Soil Associations visible on ERTS imagery have been delineated on an ERTS photo from southwest South Dakota. This photo is being analyzed on the SADE system. Density slicing alone seems incapable of displaying the principal soil associations since each association is composed of about the same range of density. The associations differ from each other in the configuration of the densities each displays. Now an attempt is being made to have these unique configurations recognized by the analysis system.

4. Data Analysis

(a) A study to determine the usefulness of taking ground truth data with a 35mm camera is in progress. The ground truth is the percentage cover of bare ground, mulch and various categories of vegetation in test sites. The procedure is to digitize the 35 mm transparency 4 times; each time with a different optical filter. The 4 filters used are the neutral, red, green and blue. The next step is to use the K-class classification algorithm to classify the ground truth data contained on the 35mm slide. Only 48 percent of the data was correctly classified.

(b) The delineation of eroding Badlands, tableland in Badlands, rolling silty soils, steep sandy loams, nearly level Badlands, rolling loams, nearly level silty soils, sand hills and subirrigated meadow by data processing techniques implemented with software is under investigation.

(c) The Signal Analysis and Dissemination Equipment, SADE, is currently in operation to aid in the digitization and display of data from the imagery. There are 83 subroutines which are in use for the following general functions:

Digitization
Data or tape measurement
Data processing
Classification
Display
Diagnostics

Some of these subroutines have been used in the previous tasks, but additional new subroutines will be necessary.

[c] Conformance - All work to date has conformed to contract work schedule.

[d] Analysis of work progress - With the exception of problems noted earlier in this report, progress to date has been satisfactory.

[e] Efforts to achieve reliability - These are continuing efforts which will be emphasized as additional imagery becomes available for analysis.

[f] Adequacy of funds - Modification number 3 of contract NAS5-21774 has added $2500 to the original contract sum. A copy of modification number 3 is attached as enclosure 3.

[g] Significant changes in contractors personnel - none.

[h] Planned work -

1. Rangeland

Mapping units of interesting areas delineated on airborne Ektachrome IR imagery will be evaluated with 1) 35 mm stereogram controlled by clipping, 2) landscape 35mm stereograms and 3) descriptions of the areas. Machine classifiers will be trained on the mapping units and classification will be extended to larger areas on photographic imagery and scanner data. These classified areas will be used to train the machine classifier on high altitude NASA imagery and extend the classification to a wider area. Extended classification of the NASA imagery will be used to train the machine classifier on ERTS imagery and the classification extended to other parts of the ERTS frame. Further classification will be attempted directly with ERTS data using maps of geological materials, soils, vegetation and range analyses as ground truth. The analyses plans described are to be implemented after January 12, 1973.

2. Cropland

(a) During the next reporting period the following procedure will be followed if the appropriate imagery is received. The portions of the transparencies corresponding to the Centerville study area will be digitized by SADE. The training fields for the classifier will be located on a computer printout of the study area. The mean transmission values of the training samples will be determined from this same computer printout. The mean transmission values for each of the crops for each of the four

wavelength bands will constitute the signature for the crop for a particular point in the growing season. Computer classification will then be performed on the study area. Digitization and classification will be done at different times in the growing season.

(b) The changes in the crop's signature as the growing season progresses will be used to develop a computer program to aid in the classification of crops. This proposed program will take into account the changes in the crop's signature due to different stages of maturity.

3. Land Systems

(a) Work planned for the next reporting period will be a continuation of the work reported above. It is anticipated that, in time, the soil associations of the entire state can be analyzed.

4. Data Analysis

(a) The plan for future accomplishments is to use the mode-seeking and K-class classifier algorithms to improve upon the percent of correct recognition of the ground truth data contained on 35mm transparencies. Additional subroutines for data analyses and handling will be written for use with the SADE system.

19AUG72 C N42-57/W102-37 N N42-57/W102-34 MSS 5 D SUN EL51 AZ134 192-0376-N-1-N-D-2L NASA ERTS E-1027-17065-5 01

ERTS IMAGE DESCRIPTOR FORM

(See Instructions on Back)

NDPF USE ONLY
D _____
N _____
ID _____

DATE _____

PRINCIPAL INVESTIGATOR Victor I. Myers

GSFC _____

ORGANIZATION Remote Sensing Institute (Land Systems)

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	Agricult.			
1 027 17 06 5 M	✓			Soil

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

MAIL TO ERTS USER SERVICES
CODE 563
BLDG 23 ROOM E413
NASA GSFC
GREENBELT, MD. 20771
301-982-5406

GSFC 37-2 (7/72)

ERTS IMAGE DESCRIPTOR FORM

(See Instructions on Back)

NDPF USE ONLY
D
N
ID

DATE December 20, 1972

PRINCIPAL INVESTIGATOR Victor I. Myers

GSFC

ORGANIZATION Remote Sensing Institute (Rangeland)

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
1045170635				Badlands Dormant vegetation Grass Grassland Grazing Land Mature vegetation Pasture Prairie Rangeland Steppe Vegetation
1081170645				Badlands Dormant vegetation Grass Grassland Grazing Land Mature vegetation Pasture Prairie Rangeland Steppe Vegetation

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

MAIL TO ERTS USER SERVICES
CODE 563
BLDG 23 ROOM E413
NASA/GSFC
GREENBELT, MD. 20771
301-982-5406

GSFC 37-2 (7/72)

ERTS IMAGE DESCRIPTOR FORM

(See Instructions on Back)

NDPF USE ONLY
D
N
ID

DATE December 20, 1972

PRINCIPAL INVESTIGATOR Victor I. Myers

GSFC

ORGANIZATION Remote Sensing Institute (Cropland)

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
104116435				cropland grassland cumulus cirrus river
1077164405				clouds
1095164425				cropland grassland river
1060164915				cropland grassland lake river
1042164855				clouds cropland grassland river
1114165005				clouds snow
1025165455				cropland grassland clouds

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

MAIL TO ERTS USER SERVICES
CODE 563
BLDG 23 ROOM E413
NASA GSFC
GREENBELT, MD. 20771
301-982-5406

GSFC 37-2 (7/72)

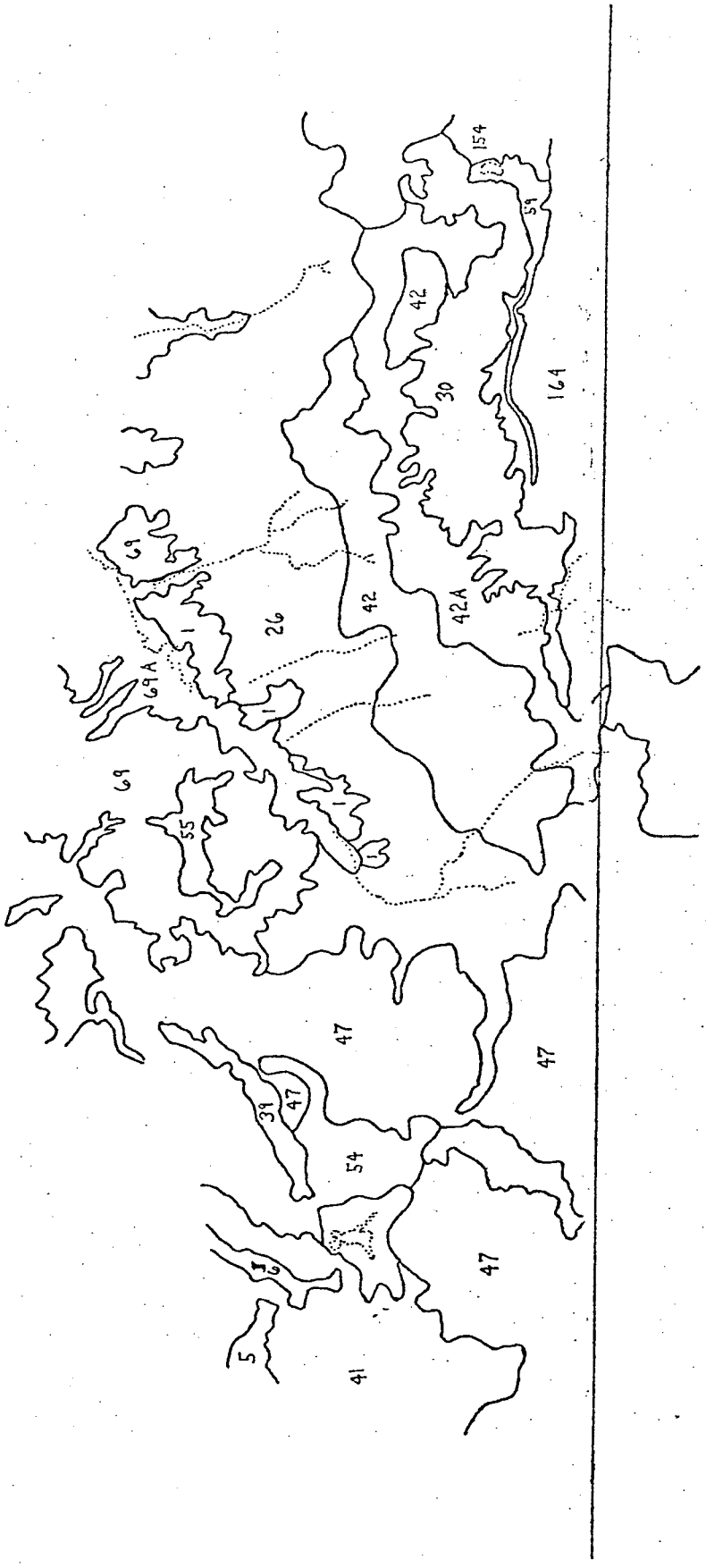
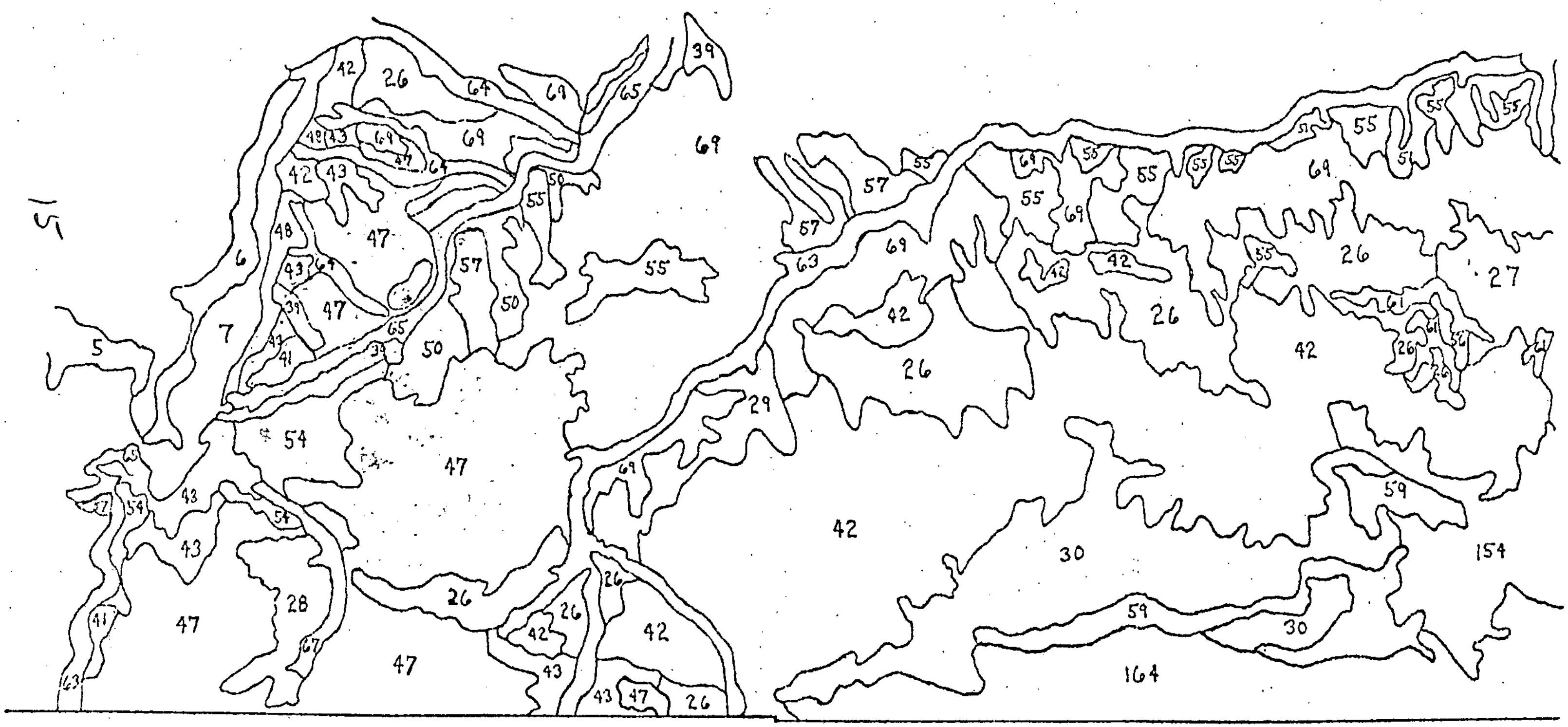


FIGURE 2

FIGURE 3


5
6
7
26
42
64
69
65
39
55
47
50
57
54
43
28
47
26
42
29
57
63
69
42
26
55
26
27
42
59
154
30
164
59
30