Paper G 21

GEOLOGIC EVALUATION AND APPLICATIONS OF ERTS-1 IMAGERY OVER GEORGIA

S. M. Pickering and R. C. Jones, *Georgia Geological Survey, Department of Natural Resources*

ABSTRACT

ERTS-1 70mm and 9"x9" film negatives are being used by conventional and color enhancement methods as a tool for geologic investigation. Prints at 1:500,000 and 1:250,000 scale are made, gridded with latitude and longitude, and distributed to each of our field geologists for regional and local studies. These black-and-white working products are supplemented with color enhancements, made by addcol and density slicing. The Georgia Geological Survey has also prepared several state mosaics and regional interpretations from ERTS which have been widely used by state and local government.

Geologic mapping and mineral exploration by conventional methods is very difficult in Georgia. Thick soil cover and heavy vegetation cause outcrops of bed rock to be small, rare and obscure. ERTS imagery, and remote sensing in general have helped delineate: 1) major tectonic boundaries; 2) lithologic contacts; 3) foliation trends; 4) topographic lineaments; and 5) faults. The ERTS-1 MSS imagery yields the greatest amount of geologic information on the Piedmont, Blue Ridge, and Valley and Ridge Provinces of Georgia where topography is strongly controlled by the bedrock geology Seven band imagery taken at low sun angle near the winter solstice (Dec. 21) is greatly superior for discriminating lineations and landforms.

Coastal Plain geology from MSS imagery may be inferred from land use and drainage patterns. Imagery taken during wet, winter condition seems best for southeastern Coastal Plain studies.

Color enhancement analysis using 5 and 7 band negatives gives more visual contrast and allows the greatest amount of geologic discrimination.

ERTS imagery, and general remote sensing techniques, have provided us with a powerful tool to assist geologic research; have significantly increased the mapping efficiency of our field geologists; have shown new lineaments associated with known shear and fault zones; have delineated new structural features; have provided a tool to re-evaluate our tectonic history; have helped to locate potential ground water sources and areas of aquifer recharge; have defined areas of geologic hazards; have shown areas of heavy siltation in major reservoirs; and by its close interval repetition, have aided in monitoring surface mine reclamation activities and the environmental protection of our intricate marshland system.

No NASA or other federal funds are involved in our remote sensing program. We would, however, like to gratefully acknowledge the assistance of the EROS Mississippi Test Facility in simplifying our standing order with the National Data Center, and in encouraging our use of their imagery enhancement equipment.

INTRODUCTION

Since shortly after launch in the summer of 1972, the Georgia Geological Survey has maintained a standing order for all clear weather MSS imagery of our state. Our standing order provides us with all 8-1 or better quality 70mm and 9x9 inch negatives, from which prints at 1:500,000 and

1:250,000 scale are made. Each print is gridded with latitude and longitude and copies are provided to each field geologist for regional and local studies.

These black and white working products are supplemented with color enhanced imagery derived by density slicing or a color additive viewer. Color products are useful in the recognition of particular features and for magazine articles or presentations of public interest. Our agency has also prepared state mosaics of bands 5, 6, and 7, and various regional interpretations which have been widely used by schools, universities, and state and local government for natural resource inventory and land use planning purposes. An ERTS interpretative atlas of the entire state for MSS bands 5 and 7 has been prepared and is currently in press.

Geologic Applications:

Geologic mapping and mineral exploration by conventional methods is very difficult in Georgia. Thick soil cover and vegetation cause outcrops of bedrock to be small, rare, and obscure.

Satellite imagery, and other remote sensing tools and techniques, have provided a powerful tool to assist geologic research and have significantly increased the efficiency of our efforts. For the past year the Georgia Geological Survey has been engaged in regional mapping for the new state geologic map. ERTS images enlarged to compatible mapping scales have increased our field efficiency by at least 25%. There are a number of areas where data from ERTS imagery has allowed a notably higher level of precision than has been available with any amount of field work on the ground. The following examples demonstrate how the imagery is being used as a tool for solving geologic problems in Georgia.

Major faulting is commonly apparent on MSS 5, 6, and 7 imagery in the form of topographic lineaments and zones of abrupt vegetation change. The Warwomen Shear (Fig. 1) has been noted

Figure 1

as a small structure in northeast Georgia, thought to be associated with the major Brevard Fault Zone. This 7 band frame shows that the shear is a part of a major fault zone connecting the Ashland and Brevard Faults. This relationship was not previously known.

The Cartersville Fault, shown in Fig. 2, is the prominent fault which separates the Paleozoic sediments from the crystalline rocks of the Piedmont. As such, it has been recognized and mapped since the 1840's. ERTS images indicate that what was regarded as a single fault is actually a series of overlapping thrust plates, and that there is at least one area where an abrupt fault does not exist.

Figure 2

Figure 2 also shows a tight elongate fold in high grade metamorphic rocks, the Murphy syncline. The pure marble deposits which allow our state to lead the nation in marble production are localized in the axial areas of cross-folds in this structure. This ERTS image is allowing a re-evaluation of the tectonic history of the area, and is of great interest to marble exploration.

In Figure 3, the Red Mountain Formation, a Silurian sandstone, in the Paleozoic area of northwest Georgia, is folded into a complex pattern of tight, plunging anticlines and synclines, which can for the first time be viewed as a structural unit, rather than as single folds.

Figure 3

Pennsylvanian sandstone capping Lookout Mountain is cut by a series of cross faults which have never been mapped (Fig. 4). This area of rapidly developing second homes has no extensive source of surface or ground-water, and these faults may localize zones of aquifer recharge.

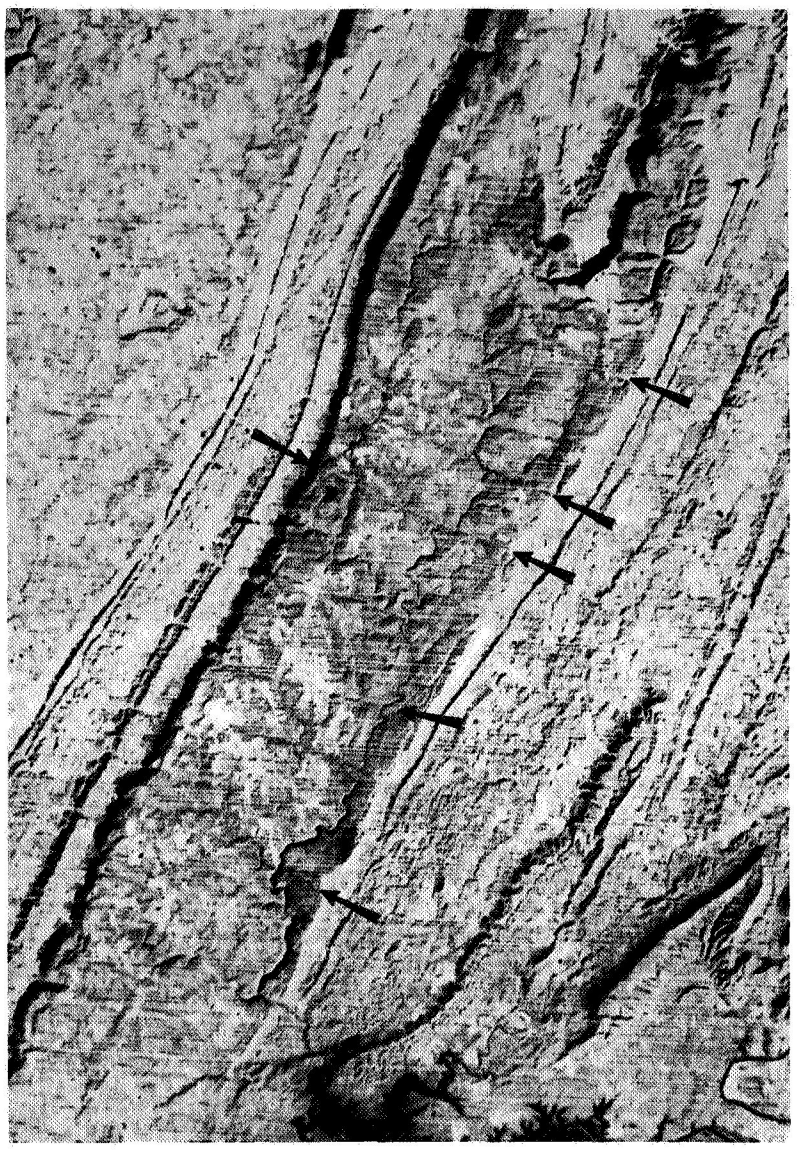

Figure 4

Large areas of southwest and northwest Georgia are troubled by the collapse of limestone caverns, which cause limesinks as much as 700 feet in diameter and 100 feet deep. These limesinks are of great concern if they occur in developed areas or are used as areas of refuse disposal, allowing pollutants a direct entry to the aquifer Late winter band 7 ERTS images (Fig. 5)

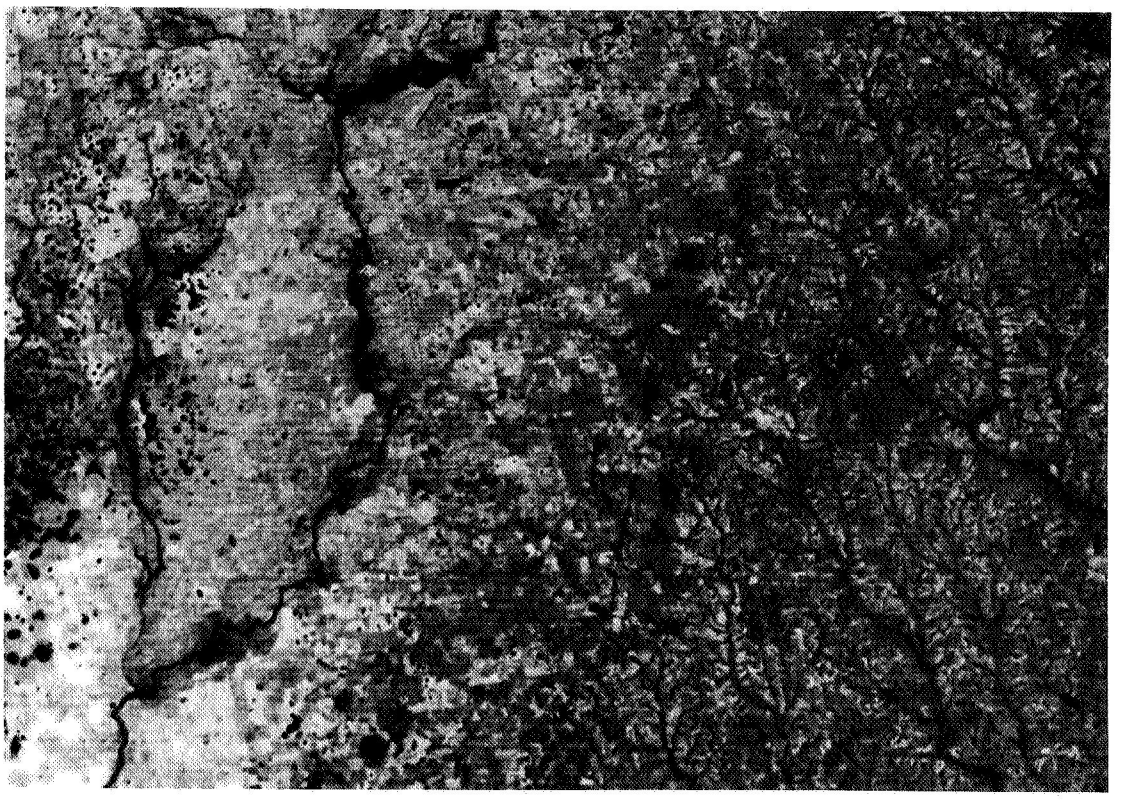

Figure 5

enable our Geological Survey to make a limesink inventory map of these areas. Similar interpretative techniques were used to construct a farm pond inventory of Georgia, mapping all open water bodies as small as 4.0 acres.

Aquifer recharge is evident in winter band 7 imagery (Fig. 6) along rivers at areas where they cross permeable cavernous limestone. This ERTS image shows the water saturated alluvial valleys of the major rivers clearly Where the rivers cross aquifer recharge zones (at A), the alluvium is well drained by underground recharging, and therefore light in tone. This image makes it possible to map both floodplain and areas of aquifer recharge along our rivers.

Figure 6

ERTS images of the Georgia Coast (Fig. 7) offer spectacular definition of our Sea Island Section and intervening marshland. These marshes have been recognized by biologists as among the most productive nutrient systems on earth. The 1971 session of Georgia's General Assembly passed a strict marshlands protection Act which limits filling, dredging, and development in this area. Without remote sensing techniques, it is very difficult to define a consistent boundary for our salt marshes which will be legally acceptable.

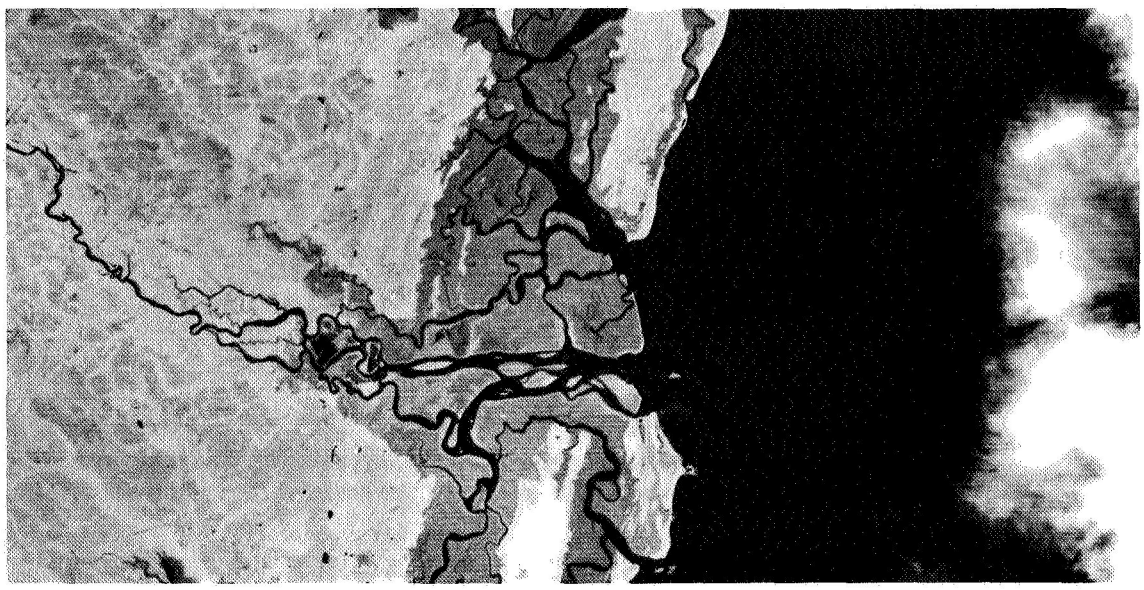

Figure 7

The immense organic productivity of the coastal marshlands is a direct product of the complex network of tidal circulation and drainage. Detail of a small portion of 5 band imagery allows classification and study of tidal flow (Fig. 8). The rich suspended nutrient washed from the marsh is carried to the fishing and shrimping grounds of the open ocean by a system of currents not previously well known.

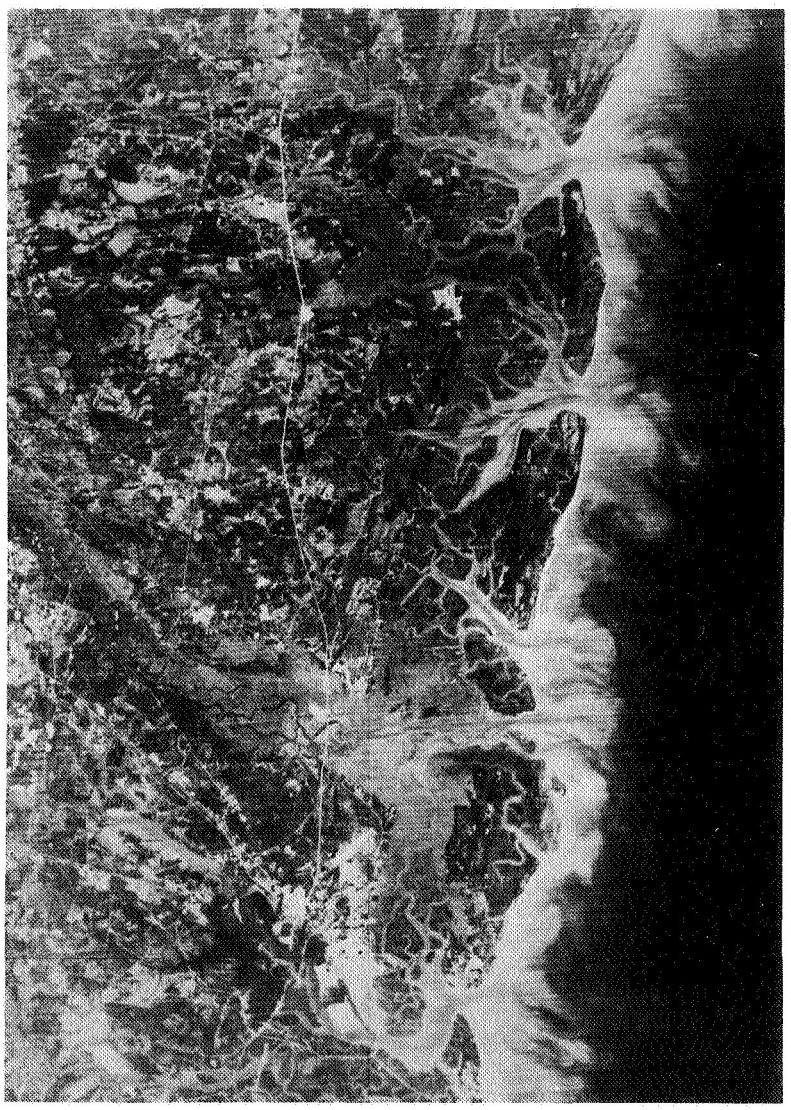

Figure 8

The Okefenokee Swamp is the largest elevated warm swamp on the North American continent and one of the most prolific of our nation's wildlife preserves. The origin of the swamp has never

been well understood. This detailed 7 band image (Fig. 9) gives a new perspective to our studies. It is evident that the swamp was a shallow Pleistocene marine bay during a time of higher sea level. A major longshore bar, Trail Ridge, developed along the east side of the bay and restricted drainage as sea level gradually lowered, thus impounding water behind the bar forming the present day swamp. ERTS imagery allows for the first time, a study of the gross morphology and drainage patterns of the swamp.

Figure 9

Wet weather 7 band imagery has allowed a new survey of the shallow elliptical depressions known as "Carolina bays" (Fig. 10). ERTS data have tended to support speculation on the extra-terrestrial origin of these features, which range in size from a few hundred feet to three miles. It may be only coincidence that the bays are elongated toward the Georgia tektite strewn area. Five Carolina bayfields have been identified from ERTS imagery over Georgia.

Figure 10

Long trains of striking parabolic dunes as much as four miles in size have been identified along several rivers in southeast Georgia. Such windblown sand features have not been previously described in the humid eastern United States (Fig. 11).

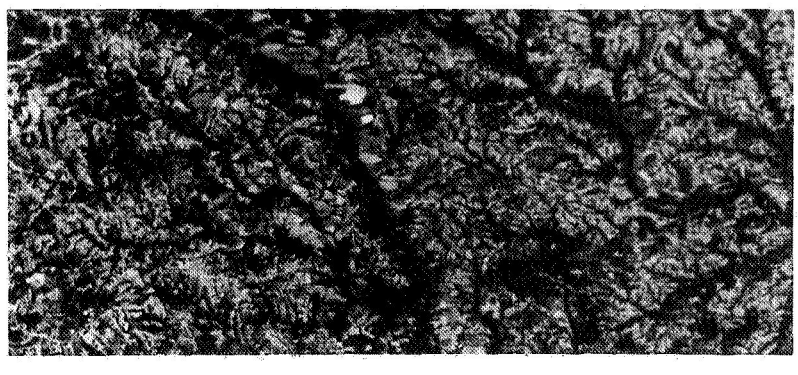

Figure 11

Commonly, unusual land use by man can result in a feature apparent on ERTS imagery which resembles a major geologic structure (Fig. 12). This large circular feature along the Georgia-South Carolina border resembles a major caldera or collapse structure. It is actually land under federal ownership at the Savannah River Nucleat Plant. Since the Atomic Energy Commission's only concern is plutonium production rather than farming, their land has grown up in forest, in contrast to the surrounding cultivated area.

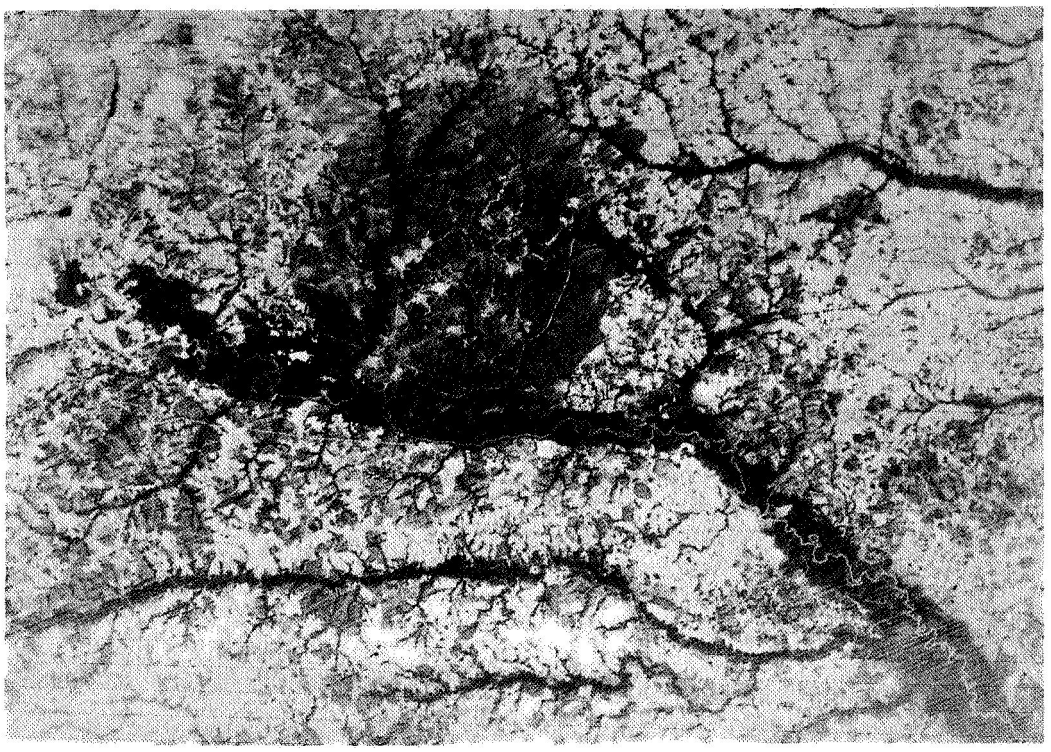

Figure 12

The Department of Natural Resources of the State of Georgia requires reclamation of all mined land in the state within one year of completion of mining. The monitoring of this industry, which produces over one-quarter billion dollars each year, is a major task Figure 13 shows the extent of Georgia's kaolin mining district, which produces over $150,000,000 in industrial clays yearly Each pit is clearly discernable as a white spot, and reclamation efforts may be readily evaluated. This ability results in considerable savings in enforcement costs, and provides an inexpensive, impartial referee in disputes.

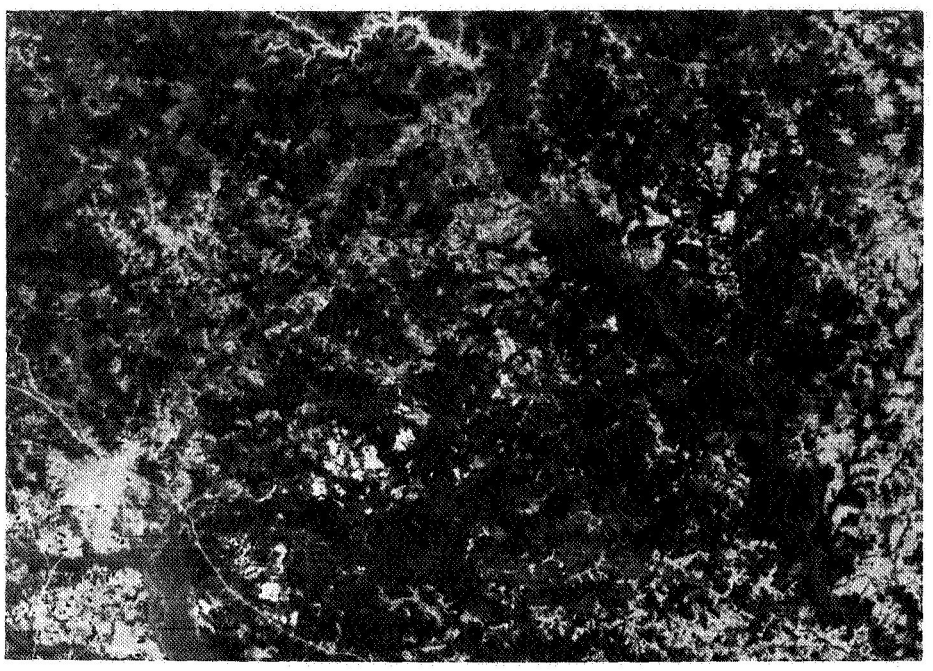

Figure 13

The ERTS system has provided a valuable tool and a new perspective for natural resources research in Georgia. It would be a considerable setback to Georgia's remote sensing program if continuous satellite coverage of our part of the United States were interrupted