N73-28256

Paper E 2

ERTS-1 INVESTIGATION OF ECOLOGICAL EFFECTS OF STRIP MINING IN EASTERN OHIO

Phillip E. Chase, *The Bendix Corporation, Ann Arbor, Michigan,*
Wayne Pettyjohn, *Ohio State University, Columbus, Ohio*

ABSTRACT

Evidence is presented of ERTS capability to detect, map and monitor the effects of strip mining. Both enlarged ERTS imagery and statistically processed outline maps and imagery of stripped earth and standing water are compared to aerial photos of a strip mine near Coshocton, Ohio. The outline maps and decision imagery are at present limited to forming a disruption map of recently mined and unreclaimed earth and the resultant standing water within the mined area. It is planned to prepare a map of the reclaimed areas (reclamation map) within the stripped area and to detect and identify ecological effects such as vegetation kills and stream sedimentation external to the stripped areas.

1. INTRODUCTION

During recent years the expansion of industry in the United States has created an increasing demand for fuel. Newspapers almost daily record grim near and long-term shortages of oil reserves and limitations in distribution and storage. Coal is a major fuel source in both Appalachia and Ohio, and the new demand for it will increase the already extensive area of underground and strip mining in the region.

Strip mining is on the increase in Appalachia. From 1940 to 1963 strip mining has increased from 9 to 34% of the Appalachian coal production (US bureau of Mines, 1963). For five states - Kentucky, Maryland, Ohio, Pennsylvania, Tennessee - strip mine production accounted for over one-third of the production, and for two - Ohio and Maryland - over 60%. The increase in stripped acreage in five counties in Ohio, as shown in Table 1, is typical. The area encompassing stripping (as well as continuing underground mining) is shown in Figure 1 (Breseckei and George, 1966). The deposit area is approximately 50,000 square miles.

2. TEST AREA IN OHIO

The area encompassed by this investigation includes five counties in the coal mining region of the dissected Allegheny Plateau in east-central Ohio. The counties, which comprise nearly 3,000 square miles, include, from west to east, Muskingum, Coshocton, Guernsey, Tuscarawas, and Belmont. They lie in a hilly region along the western flank of Appalachia and are bounded on the east by the Ohio River. Their location within Appalachia is shown in Figure 1. A mine east of Coshocton is the example shown in this paper.

TABLE 1
COUNTY DATA OF STRIP MINING, IN ACRES*

	Coshocton	Belmont	Guernsey	Tuscarawas	Muskingum
County Total	349,000	343,000	332,000	353,000	424,000
1914-1947	622	2,254	355	4,956	1,604
1948-1971	16,818	21,042	4,014	18,039	12,280
Total Area Affected	17,440	23,296	4,369	22,995	13,884
Percentage Total Area Affected	5.00	6.79	1.31	6.51	3.27
Total Reclaimed	13,390	11,443	3,705	14,885	7,699

*Data taken from Division of Forestry and Reclamation, Ohio Department of Natural Resources (March 1, 1972).

3. GEOLOGY OF THE AREA

Although only a very small part of the area was glaciated, extensive deposits of outwash fill the valleys of the major rivers and a few of their tributaries. Elsewhere bedrock crops out, striking in a northeast-southwest direction and dipping about 25 ft/mile to the southeast.

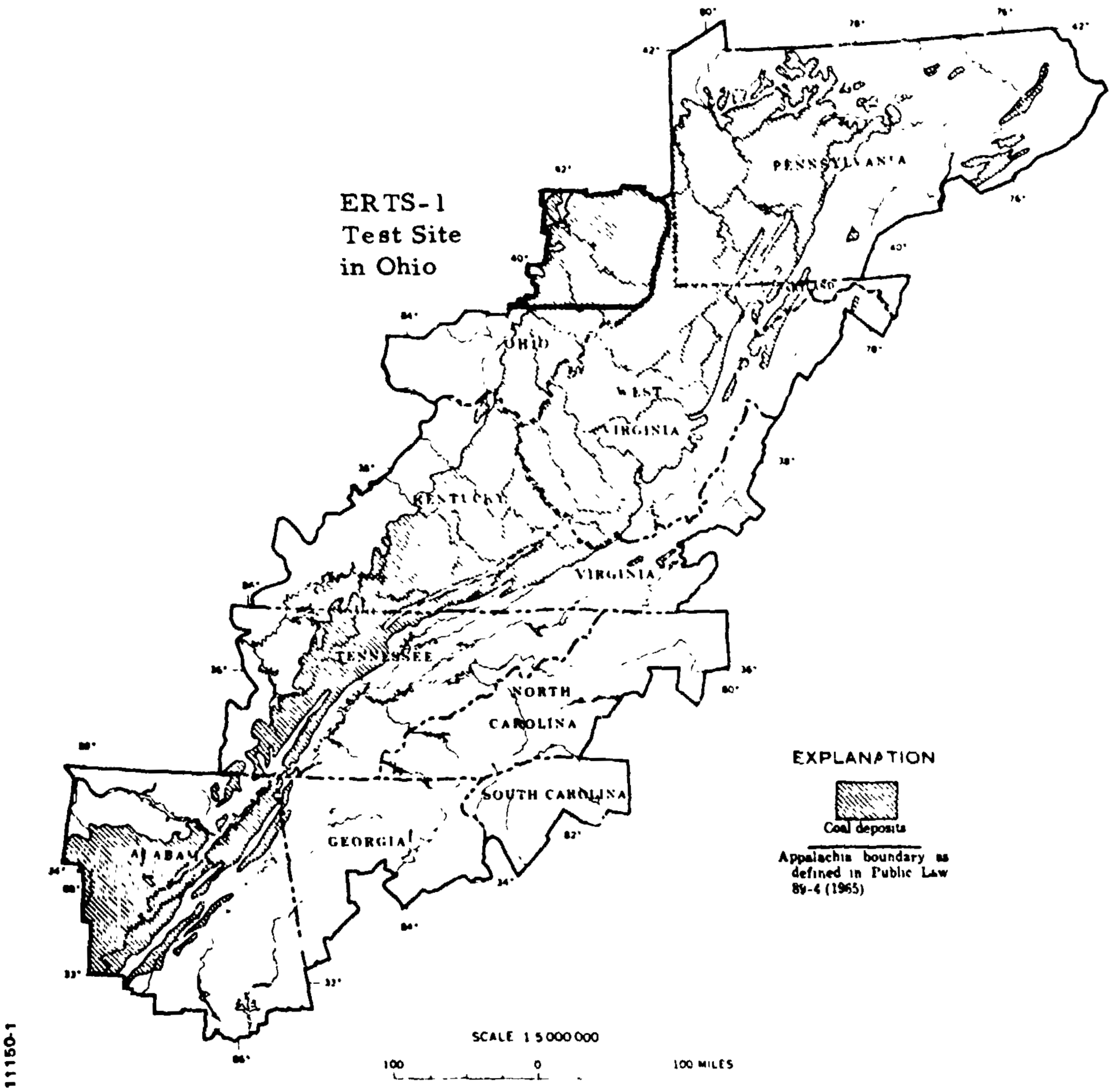


Figure 1 Location of Coal Deposits (1)

The oldest rocks crop out in the western part of Muskingum and Coshocton Counties; eastward the rocks become progressively younger. All of the exposed bedrock represent Paleozoic strata that range in age from Mississippian to Permian. They include the shale, sandstone and limestone of the Logan and Maxville units of Mississippian age; the Pottsville, Allegheny, Conemaugh and Monogahela Formations of Pennsylvania age, consisting of shale, sandstone, limestone and coal beds; and the deposits of shale, sandstone and coal forming the Dunkard Group of Permian age, which covers much of Belmont County. These exposed strata range in thickness from about 610 feet in Coshocton County to about 1100 feet in Belmont County.

4. THE STUDY PURPOSES

The primary purpose of the study is to demonstrate that ERTS-1 data can be used to prepare two types of maps. The first is the disruption map that quite simply maps stripped areas and standing water between the spoil banks and the high wall. The second is a map of the progress of reclamation of the stripped area. Often reclamation consists only of an attempt to revegetate the stripped area.

A secondary purpose is the monitoring of strip mine impact on the land and water resources exterior to the stripped area. Two types of impact are vegetation kill and stream pollution from acid mine drainage. Another type is heavy stream sedimentation from erosion.

The accomplishment of the primary purpose would be a long step toward a major benefit of ERTS.

5. ERTS-1 IMAGERY AND DISRUPTION MAPPING

One significant result is the relative ease with which ERTS-1 will monitor new and unreclaimed stripping activities in Southeastern Ohio and in all of Appalachia. The widths of the contour strips of new or unreclaimed stripped areas are listed in Table 2 by ERTS-1 band numbers. This measurement is obtained from comparison of the ERTS-1 scene to areal photos (Figure 2).

TABLE 2
MINIMUM DIMENSION OF STRIP MINES BY BAND
(WIDTH OF A STRIPPED CONTOUR IN FEET)

Band 4	Band 5	Band 6	Band 7
400	200	250	250

The strip mines stand out well enough to be easily identified without other graphic aids (photos or maps). Since the shape is quite distinctive, detection of other areas in Appalachia without other graphic aids appears possible for a trained photo interpreter. (See Figure 3A).

Standing water within the strip mined area stands out in either bands 6 or 7. (See Figure 3B). Areas of several acres are visible. Significant increases in surface extent of water in stripped areas should be detectable on a comparative basis. However, geometric control in the change detection process would have to be carefully maintained.

An alternate approach to the preparation of disruption maps is mapping from the CCT. There are several possibilities for the preparation of automatically classified maps. The first type is the decision imagery of stripped earth and standing (or other) water as shown in Figures 4A and 4C, respectively[2]. A second possibility is probability imagery that shows earth and water each in one separate scene.[2] A third alternative is an outline map of the particular thematic classification such as earth and water in Figures 4B and 4D, respectively.

This mine east of Coshocton has features - turned earth and water - that are readily seen in the imagery and readily classified. It is neither the easiest to classify nor the most difficult and without question the capability to map strip mine disruption from ERTS is near at hand. It must be kept in mind that disruption of this nature is easiest to identify and most desirable to monitor from an ecological view point.

6. RECLAMATION MAPPING

Reclamation mapping is a monitoring task that is more complex than disruption mapping. Reclamation is the leveling of the spoils bank, removal of standing water (when necessary), and planting the area that remains. The difficulty arises from degree of success of reclamation in percentage cover and from the variety of vegetation used (vetch, pine

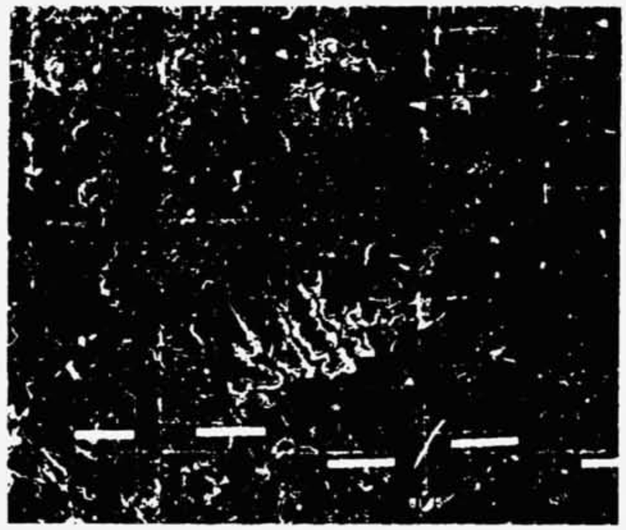
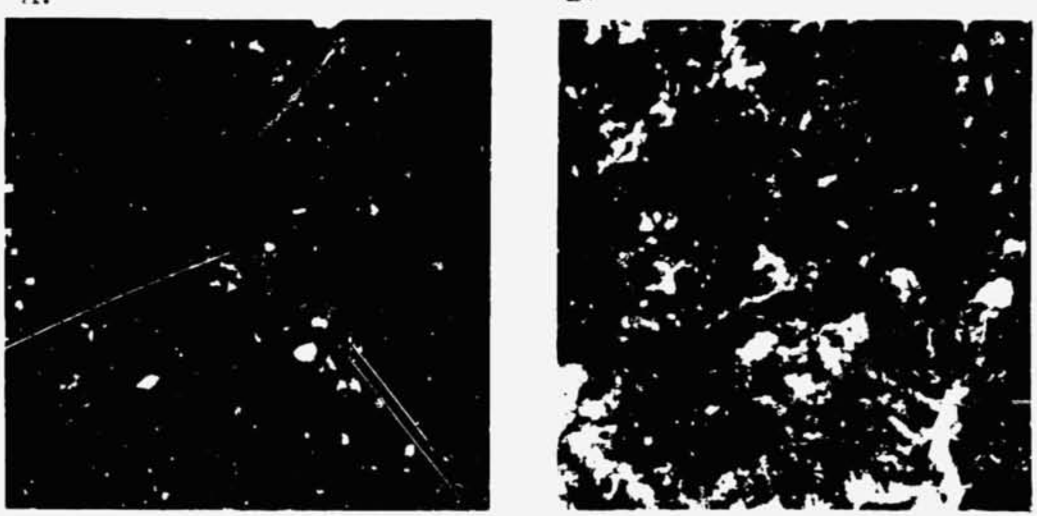


Figure 2 Aerial Photo

A.

B.



Band 5 Bare Earth

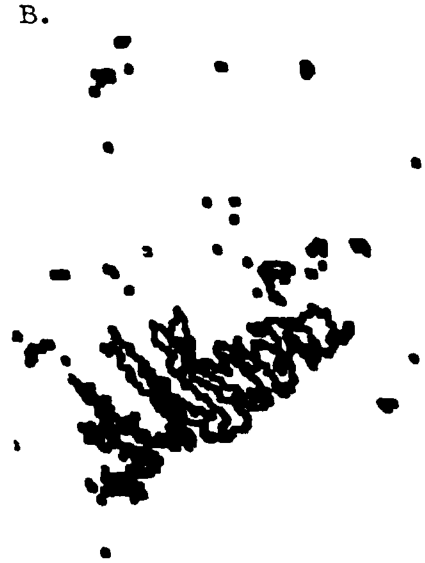
Band 7 Water

Figure 3 Scene 1084-15415

A.

Decision Imagery of Stripped Land - 4 Bands 1:500,000

B.

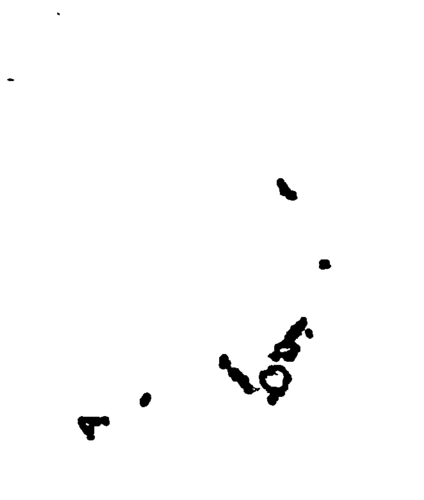


Cal Comp Outline of Stripped Land - 4 Bands 1:125,000

C.

Decision Imagery of Water - 4 Bands 1:500,000

D.



Cal Comp Outline of Water - 4 Bands 1:125,000

Figure 4 Decision Imagery and Cal Comp Plots of Stripped Land and Standing Water - Scene 1029-15361 August 21, 1972 trees, black locust and natural recovery). The statistical techniques using the CCT described for disruption mapping will be employed to develop reclamation maps. Reclamation has been conducted northeast and adjacent to the strip-mine shown in these figures. It is barely observable in the imagery. Preliminary processing of the CCT enhances the presence of reclamation.

7. ACID DRAINAGE & SEDIMENTATION

The secondary effects of acid mine drainage and stream sedimentation resulting from erosion is the most difficult task underway. A possible example for detailed study is the water system shown in Figures 3A, 4B and D. The apparent headwaters appear to be an area poorly vegetated and varying in extent of standing water (swamp). Ground observation and measurement and multispectral scanner data from an aircraft will be obtained and used to determine the feasibility of ERTS to detect and identify such secondary effects external to the disrupted area.

8. SIGNIFICANT RESULTS

The first significant result is that now disruption maps can be made automatically from the CCT on an operational basis at Bendix. Secondly reclamation maps will be produced in the same way in the near future. The accomplishment of these steps is a prerequisite to developing an ERTS strip mine monitoring operation.

In the course of this work it can be shown through ERTS data of the Coshocton East Mine that in the past year a dammed body of water of about 5 acres has appeared, apparently little or no stripping has occurred, and that no additional reclamation is apparent in the more recently stripped areas.

9. REFERENCES

(1) Biesecker, J. E. and J. R. George, 1966. "Stream Quality in Appalachia as related to Coal-Mine Drainage, 1965. USGS Circular 526, Washington, D. C.

(2) Chase, P. E., Conrod, A., and E. Imhoff, 1972. "Location of Sawdust in the Penobscot River by a Multispectral Scanner", Proceedings of 8th International Symposium on Remote Sensing, Ann Arbor, Michigan (To be published). Available as Bendix Report BSR 3457, Ann Arbor, Michigan.