EFFECTS OF SELECTED RECLAMATION METHODS ON MINESOIL PROPERTIES A PROGRESS REPORT

by

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INTRODUCTION

A properly reclaimed surface mine will have the following attributes: (1) no acid mine drainage, (2) a stable soil and subsoil, (3) adequate amounts and diversity of vegetation and (4) a potential for productive land use. All of these attributes, to some degree, are dependent upon "topsoil" quality. Therefore, all surface mine operators and reclamation scientists should be concerned about soil properties.

An integral part of most mining operations in West Virginia is the segregation, stockpiling and subsequent regrading of the original "topsoil". This "topsoil" is usually a combination of all surface material that can be easily removed by bulldozers and/or scrapers. The resulting soil cover has chemical and mineralogical properties that are similar to the original, undisturbed soil, but physical and biological properties may be drastically different because of the disturbance.

Some native soils of the West Virginia coal fields are shallow (less than 3 feet deep) and acid (pH below 5.0). They may also be deficient in essential plant nutrients. The A horizon is generally less than 15 cm (6 inches) thick, making segregation of this layer very difficult. Therefore, some coal operators are using alternative "topsoils" where laboratory analyses indicate that the potential productivity of these materials will be equal to or better than the original soil. However, very little documented evidence is avail-able to show the actual effects of these other materials on the establishment and growth of vegetation.

The control of acid mine drainage is the major reclamation concern of both surface mine operators and the regulatory authority (Department of Natural Resources) in West Virginia. A number of innovative techniques to control or eliminate acid mine drainage are being evaluated by both coal mine operators and professional research scientists. Some of these new methods or techniques may affect the soil properties within the rooting zone of some plants. Studies to determine the effects of these new methods or techniques on soil properties have been initiated.

The objective of this paper is to discuss the progress of the soil science projects within the broader Acid Mine Drainage Technical Advisory Committee (AMDTAC) study.

THE "PRONG SITE" STUDY

This study was developed to evaluate the recommendations of the Surface Mine Drainage Task Force (1979) for handling of acid producing overburden. Additional information about the study is presented in the first AMDTAC newsletter (AMDTAC, 1983).

Prior to mining, 15 soil pits were excavated. The soil profiles were described, and each described horizon was sampled for chemical and physical analyses. All of the analyses have been completed, but the data have not been thoroughly analyzed. Therefore, data are not presented in this report.

After mining and regrading, the minesoils will be described, sampled and analyzed to determine the effects of mining on the soil properties.

TOPSOIL SUBSTITUTE STUDY

Some West Virginia native soils are shallow to bedrock, non-fertile and/or have a low pH. In some cases, when these poor soils occur in areas to be surface mined for coal, the operators request a topsoil variance so that some other overburden material of superior quality may be used as the final soil covering.

One surface mine that was granted a topsoil variance is located in Upshur County. At this site a sandstone strata was selected to be crushed and used as the plant growth medium. Initial results of vegetative growth at the site are encouraging. However, during one AMDTAC visit it was noticed that some vegetation was not growing as well as expected. This vegetation appeared to be stressed from lack of moisture or from low fertility. Since alternative topsoils are being used in several mining areas of the state, a study to more thoroughly evaluate the effects of using the sandstone was developed.

Initially, plots were to be established at the mine site, However, problems have arisen that negate that possibility. Therefore, it was decided that minesoil containers would be established at the Division of Plant and Soil Sciences Farm at Morgantown, WV.

The containers are 30 cm (12 inches) in diameter, and the final minesoil profiles will be 90 cm (36 inches) deep. The minesoil profiles will include the following:

1. Acid spoil only.
2. Acid spoil with a covering of crushed sandstone that is 15 cm (6 inches), 30 cm (12 inches) or 45 cm (18 inches) thick..
3. Acid spoil with a covering of original soil. (Covering thickness will be the same as presented in number 2)
4. Acid spoil with covering of 1:1 mixture of crushed sandstone and original soil. (Covering thicknesses will be the same as presented in number 2).

Each treatment will be replicated three times. A standard rate of fertilizer will be applied, and lime will be added as needed. All of the minesoils will be seeded with a standard grass-legume mixture, and mulch will be applied. Growth of vegetation will be evaluated at the end of the first and second growing seasons.

In preparation for this study, samples of the crushed sandstone, topsoil and spoil were collected and analyzed (Tables 1-4). Generally, the sandstone was chemically better than either the topsoil or the spoil at the site (Tables 1-3). Exchangeable acidity and aluminum analyses (Table 2) indicate that the topsoil would need heavy lime applications for optimum plant growth, but the sandstone should need no lime. The concentration of organic matter in all of the materials was very low, but the topsoil values were approximately double the sandstone values (Table 3).

Physical analyses of the materials (Table 4) indicate that the topsoil has more clay than either the spoil or the sandstone. As a result, the moisture retention difference (MRD) is greater. MRD is an indication of, but not equivalent to, the plant available water holding capacity of the soil. At this time we do not know if the differences in water holding capacities will significantly affect the germination and growth of the vegetation. These effects will be evaluated as the study progresses.

SOIL-OVER-PLASTIC STUDY

In an attempt to reduce the costs of treating acid mine drainage, a company in Upshur County has covered a 50-acre portion of an acid-producing site with a 20-ml thick plastic sheet (Nicholas and Foree, 1982). The sheet was covered with soil ranging in thickness from 45 cm (18 inches) to 90 cm (36 inches). The soil layer is necessary for establishment of vegetation and for protection of the plastic sheet from ultraviolet rays. These ultraviolet rays would make the plastic brittle and cause it to disintegrate.

In an effort to determine the effects of this plastic liner on the soil properties, three transects were established across the site. At predetermined points on each transect, soil profiles were described and sampled for selected physical and chemical analyses. These analyses have been completed but the data have not been analyzed. Soil samples will also be taken during the third year of the study to determine if changes have occurred.

The evaluation of soil properties includes water relationships. An important aspect of both soil stability and growth of vegetation is the ground water level above the plastic. In order to monitor the ground water levels, 10 shallow wells were installed on two of the transects (Table 5). Each well was installed to a depth of approximately 15 cm (6 inches) above the plastic. Ground water levels are being measured, and some water analyses have been completed, but the data are inconclusive at this time.

SUMMARY

Soil science studies have been initiated on three surface coal mines in Upshur County. These studies are an integral part of the larger AMDTAC stud Analyses of initial soil samples from each of the sites have been completed. The data have not been thoroughly analyzed so no firm conclusions can be drawn. All data presented in this report are preliminary. As additional data are collected and studied, new conclusions may be developed.

TABLE 1: ACID-BASE ACCOUNT OF SAMPLES COLLECTED FOR THE TOPSOIL STUDY

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SAMPLE	FIZZ	COLOR	%S	$CaCO_3$ EQUIVALENT TONS/1000 TONS OF MATERIAL MAX. FROM %S	AMT. PRESENT (NP)	MAX NEEDED (pH 7)	EXCESS
Sandstone							
Graded, non veg.	0	10YR 6/2	0.37	11.6	9.9	1.7	
Graded, non veg.	0	10YR 6/2	0.19	5.9	11.4		5.5
Stockpile, older	0	10YR 7/2	0.06	1.9	15.3		13.4
Stockpile, younger	0	2.5Y 7/2	0.06	1.9	4.4		2.5
Topsoil							
Graded, vegetated	0	10YR 6/3	0.12	3.8	0.3	3.5	
Stockpile	0	2.5Y 7/4	0.01	0.3	-1.5	1.8	
Stockpile	0	2.5Y 7/4	0.01	0.3	-1.3	1.6	
Spoil							
Graded, non veg.	0	10YR 6/3	0.10	3.1	1.1	2.0	
Graded, non veg.	0	2.5Y 7/4	0.15	4.7	0.8	3.9	
Graded, vegetated	0	10YR 7/2	0.01	0.3	0.8		0.5

TABLE 2: Exchangeable Bases, Aluminum, and Acidity of Samples Collected for the Topsoil Study.

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SAMPLE	Paste pH	KCl Exch. Al	KCl Exch. Acidity	NH_4OAc Exch. Ca	NH_4OAc Exch. Mg	NH_4OAc Exch. K
		- - - - - - - meq/100g - - - - - - -				
Sandstone						
Graded, non veg.	7.2	0	0	2.02	1.21	0.11
Graded, non veg.	7.8	0	0	1.48	0.81	0.09
Stockpile, older	7.9	0	0	2.20	0.69	0.08
Stockpile, younger	7.3	0	0	1.12	0.85	0.09
Topsoil						
Graded, vegetated	4.4	1.0	1.5	1.78	1.56	0.11
Stockpile	4.3	4.4	4.5	0.18	0.08	0.17
Stockpile	4.7	2.2	2.8	0.24	0.20	0.08
Spoil						
Graded, non veg.	5.8	0	0.1	0.70	0.70	0.06
Graded, non veg.	4.3	0.3	0.8	0.74	1.00	0.04
Graded, vegetated	4.7	1.7	2.1	1.90	1.59	0.24

TABLE 3: Organic Carbon and Micronutrients in Samples Collected for the Topsoil Study.

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SAMPLE	ORGANIC CARBON	DTPA EXTRACTABLE Fe	Mn	Cu	Zn
	%	------	-ppm-	------	
Sandstone					
Graded, non veg.	0.25	21.5	2.7	4.1	1.5
Graded, non veg.	0.25	22.3	3.0	3.9	0.9
Stockpile, older	0.13	19.8	2.3	2.4	0.9
Stockpile, younger	0.17	23.5	3.9	3.6	0.9
Topsoil					
Graded, vegetated	0.46	67.0	83.0	4.9	6.3
Stockpile	0.80	32.8	11.4	5.1	1.1
Stockpile	0.25	16.7	11.8	3.1	0.7
Spoil					
Graded, non veg.	0.34	26.3	21.0	2.5	0.9
Graded, non veg.	0.25	--	--	2.9	1.6
Graded, vegetated	0.88	46.5	10.5	14.5	8.4

TABLE 4: Texture and Moisture Retention Difference (MRD) of samples Collected for the Topsoil Study

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SAMPLE	MRD* % by wt.	Texture**
Sandstone		
Graded, non veg.	8	Sandy loam
Graded, non veg.	7	Sandy loam
Stockpile, older	8	loamy sand
Stockpile, younger	9	loamy sand
Topsoil		
Graded, vegetated	10	loam
Stockpile	15	silty clay loam
Stockpile	14	clay loam
Spoil		
Graded, non veg.	8	sandy loam
Graded, non veg.	9	sandy loam
Graded, vegetated	10	clay loam

*MRD = Moisture held between tensions of 1/3 and 15 bars

**Texture determined by the "feel" method.

TABLE 5: Depth to PVC Liner and Observation 10 Well Bottom

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Well No.	Depth to Plastic (inches)	Depth to Well Bottom (inches)
1-1	>18	18
1-2	>22	22
1-8	19	13
1-9	27	21
1-11	27	21
2-1	30	24
2-2	>26	26
2-5	21	15
2-6	30	24
2-8	30	24

REFERENCES

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