PRONG SITE STUDY: 1) DEMONSTRATION OF THE EFFECTIVENESS OF CURRENT 'MINING PRACTICES AND IDENTIFICATION OF DEFICIENCIES

by

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Background

Based on the prevailing ideas and levels of understanding of the occurrence of acid mine drainage, the West Virginia Acid Mine Drainage Task Force, in cooperation with the academic, professional and industrial sectors, formulated a series of guidelines to prevent acid mine drainage. Incorporated in the mine plan, these guidelines call for the placement of acid forming material on top of a 20-30 foot porous pad of inert sandstone (raising the toxic material above the water table), capping the problem material with a clay seal, scraping the pavement and subsequent liming, blending imported lime at rates designed to make up the base deficiency (as determined from overburden analyses), and placing-, a suitable substrate at the surface to enhance the reclamation efforts. Each of these recommendations is directed toward an aspect of the acid producing geochemical mechanism and is designed to limit or mitigate the acid reactions.

However, various degrees of success have been observed at the nine sites where the Task Force recommendations have been implemented. The reasons for the success or failure of these techniques, in the prevention of acid waters, may be related to the imprecision of the overburden analytical tool (i.e., failure to adequately identify acid/alkaline strata), breach of the clay seal thereby permitting infiltrating waters to contact acidic material, uncertainties of the hydrologic regime within the backfill and the inefficient segregation and isolation of acid material.

Between August, 1982 and the Spring of 1983, the Enoxy Coal Company mined and reclaimed a hydrologically isolated ridge approximately 15 acres in size. This prong shaped area was mined in its entirety and all highwalls were removed. Due to the configuration of the site and the control afforded in this operation, this site provided an excellent setting to field test, under controlled conditions, some of the new mining and reclamation techniques advocated by the West Virginia Acid Mine Drainage Task Force as well as others developed by members of the Acid "line Drainage Technical Advisory Committee. The techniques to be tested include

1) the effectiveness of clay seals and their ability to contain acidic leachates, 2) the effectiveness of admixing alkaline ameliorants, 3) the efficacy of bactericides (anionic surfactants) and bactericide impregnated rubber pellets, 4) the identification of the sources of water within a backfilled mine site and their respective contributions to mine drainage seeps, and 5) a demonstration of the predictive capability of various overburden analytical techniques.

Methodology

Prior to mining, two cores were drilled on the property from the ground surface to ten feet below the base of the coal, to determine the rock characteristics at the mine site. These cores were split in half; half was analyzed at the University of South Carolina and the other half was divided between ENOXY and West Virginia University. The samples at South Carolina were analyzed for total sulfur and alkaline production potential, tested by simulated weathering (leaching) tests, and microscopically examined. At W.V.U. the samples were analyzed by the acid-base accounting method.

During the backfilling operation, the Prong site ridge was separated into three approximately equal size areas by constructing two clay dikes on the pavement (see Figure 1). Each dike was oriented parallel to the dip and was approximately four to six feet wide and five to ten feet high. As the remainder of the backfill was constructed, the clay dikes served to prevent water from migrating laterally along the pavement from one section to another. Seeps emanating at the toe of the Site would reflect water quality of that particular section.

In all three sections, the pavement floor was scraped clean of coal and limestone (#10 block sand) was applied at a rate of approximately 39 tons/acre on the pavement surface. Inert material was placed on the pavement as a pad and the toxic material was placed above the pad. Within the toxic material quick lime was spread in two layers, the first at about the middle of the toxic zone at a rate of nearly 10 tons/acre and again on the surface of the toxic material at a similar rate.

At this stage of the backfilling process, prior to sealing the toxic material with a clay cap, all three sections were covered with thirty-three pounds of potassium bromide (KBr). The control section (I) was then covered with a compacted clay layer. The other two sections (II and III) were treated with bactericide prior to sealing with the clay cap. in each of Sections II and 111, 275 gallons Of sodium lauryl sulfate were applied to the toxic material. Section II was then sealed with a clay cap. Section III had an additional treatment prior to sealing; two thousand pounds of rubber pellets, impregnated with slow release sodium lauryl sulfate, were distributed over the surface.

After the completion of the clay seals, three to five feet of sandstone were placed on top of the cap. Within this material, thirty-three pounds of potassium iodide (KI) were evenly distributed in each section. Finally, the area was covered with topsoil, agricultural lime was incorporated at approximately 10 tons/acre for vegetation purposes, and the site revegetated. The sequence of

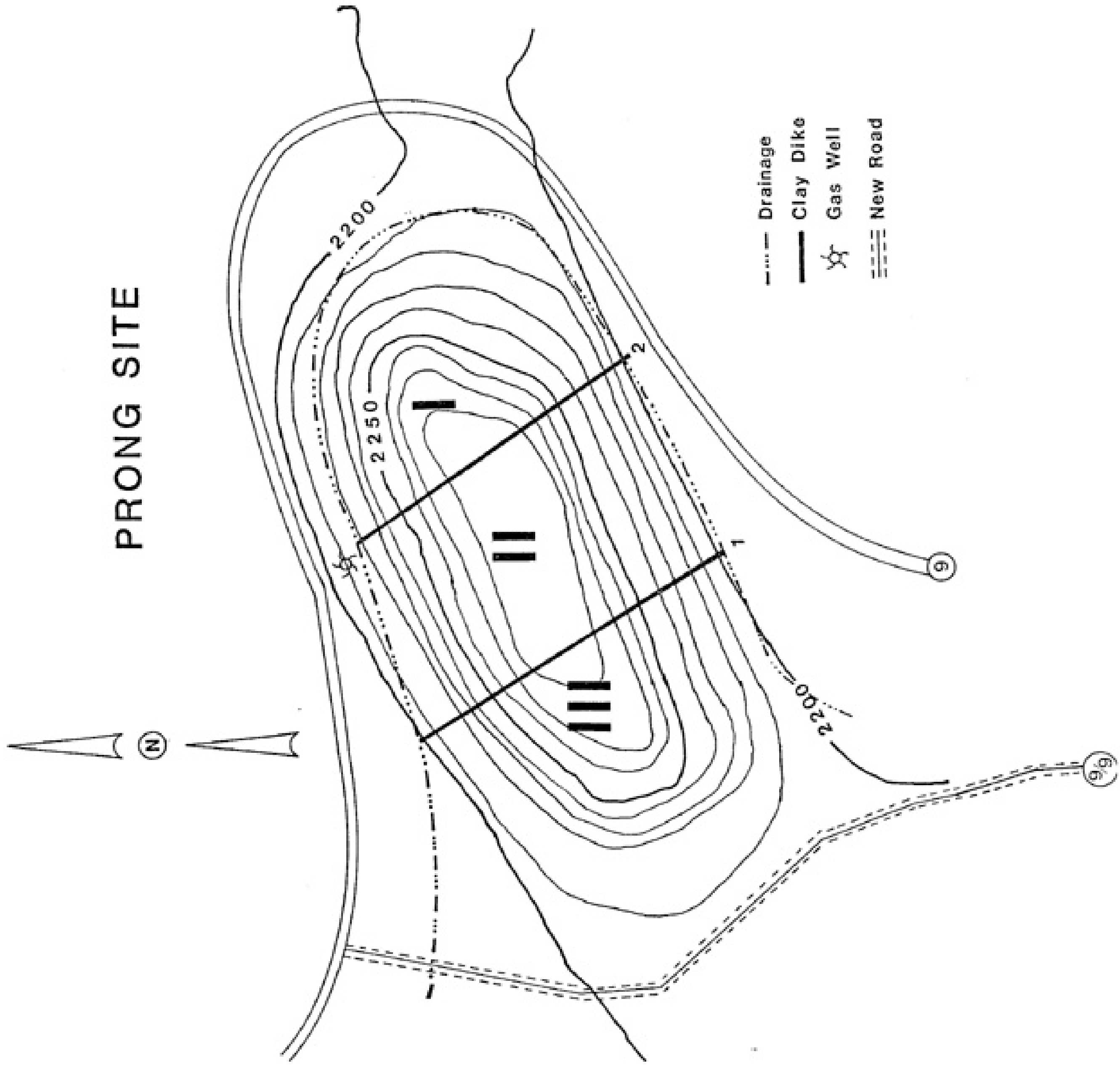

Figure 1 - Generalized Topographic Map of the Prong Site Showing Approximate Locations of Clay Dikes

Figure 1 - Generalized Topographic Map of the Prong Site Showing Approximate Locations of Clay Dikes backfilling and treatment is detailed in Figure 2.

Around the periphery of the mined ridge, a drainage ditch was constructed to intercept all surface water runoff and seeps from the reclaimed area. The ditch allows individual seeps to be monitored as they occur, as well as the total discharge from each section.

In the Fall of 1983, a well was drilled and -as probes (to monitor the pore gas composition) were installed and sealed at various depths by Dr. R.P.L. Kleinmann.

Results

The results from the samples collected from the two continuos cores indicated that one core (847), although not readily apparent from a physical standpoint, was more chemically weathered than the other (846). Core 847 was drilled toward the eastern and outslope end of the prong while core 846 was drilled toward the western end of the site which was, prior to mining and realignment of the county road, connected to a much larger acreage of land.

This advanced chemical weathering was apparent in all analyses (the total sulfur and alkaline production potentials are given in Table 1), but was especially pronounced in the leaching studies. In the weathered core 847, the leaching tests indicated that the top thirty feet of core were inert, there was then a three foot low acid producing interval, followed by seven feet of inert material. The remaining fifteen feet to the top of the coal were either low acid between 2 and 30 mgs of acid per 50 days per 100 grams), or inert (2 mgs of acid per 50 days). In core 846, the acid production from the strata above the coal was much greater. There were only three inert units in the upper portion of the core; from 11 to 19 feet, from 21 to 28 feet and from 44 to 47 feet. The remaining strata to the top of the coal, located at 57 feet, were acidic with several units between 100 and 200 mgs acidity per 100 -/per 50 days.

There are several coal seams in each core; the 5 feet of pavement (binder) below the upper coal in both cores were highly acidic and the next 3 feet to the top of the second coal were either very low acid or inert shale. The remainder of the material below the second coal, as well as the pavement of the bottom coal, was highly acidic.

The results of the weathering tests served as a guideline to ICCC for overburden handling. The top twenty feet of core, which included 10 to 15 feet of sandstone beneath the weathered horizons, were inert in both cores and used. as pad material. The toxic material was placed on top of the pad, covered with clay material from the uppermost portion of the core, and 2 to 4 feet of inert material from the upper horizons were placed over the clay and covered with topsoil.

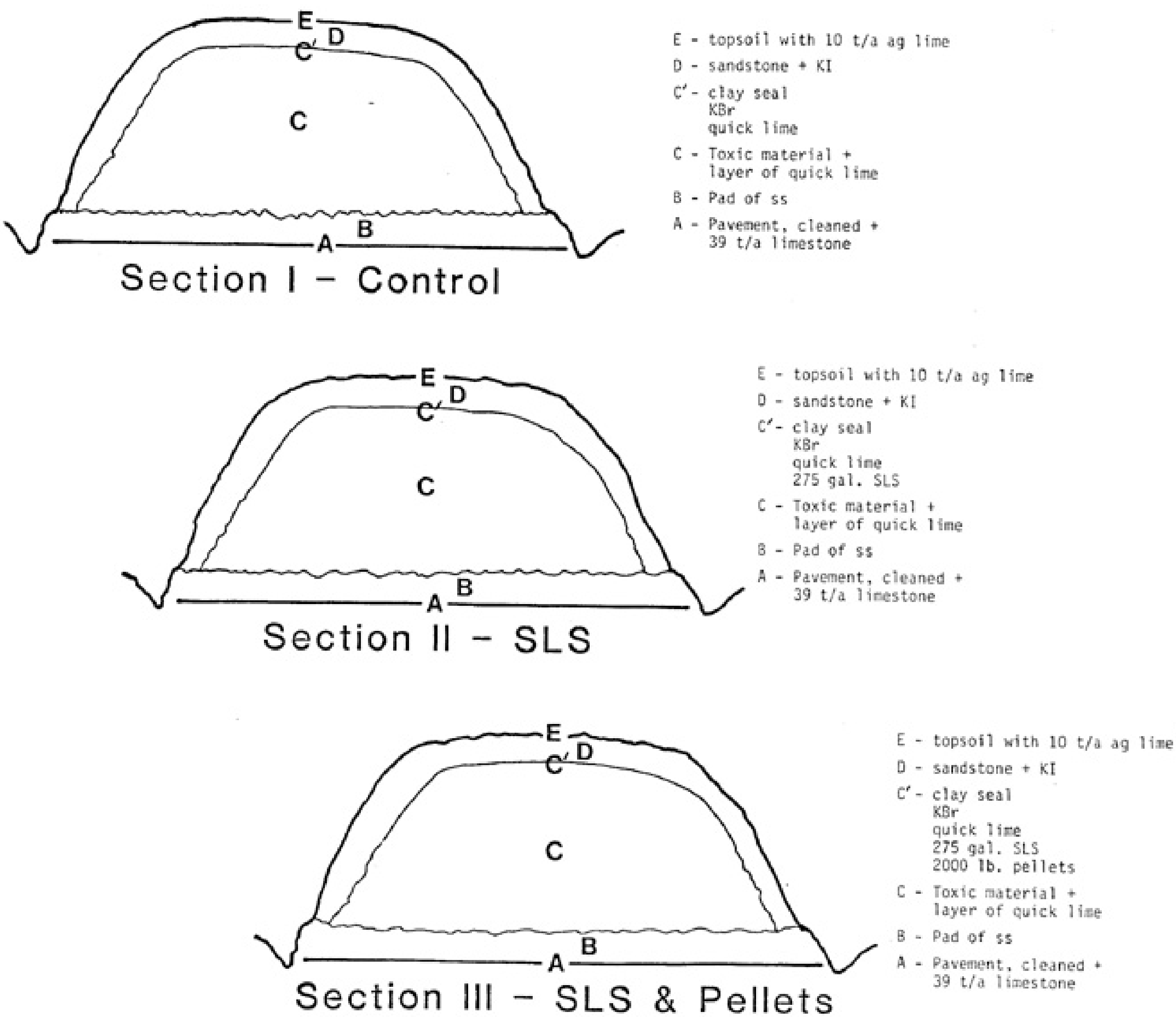

Figure 2 - Generalized Cross-Sections of the Three Areas of Prong Site Detailing Variations in C′ Layer

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Table I

Percentage Sulfur and Alkaline Production Potentials (APP) for for 2 cores from the I.C.C.C. Prong Site

Sample	Percentage Sulfur	A.P.P. (mg CaCO3/500 mg)
846 - 1	0.01	1.4
2	0.02	1.2
3	0.02	0.8
4	0.26	1.0
5	0.02	0.6
6	0.02	1.2
7	0.49	0.6
8	0.51	0.8
9	1.07	0.8
10	0.17	1.2
11	0.72	1.1
12	0.48	2.0
13	0.16	1.2
14	0.94	1.1
15	0.71	9.0
16	0.56	1.8
17	2.57	0.2
18	0.38	0
19	1.30	0
20	4.20	1.0
21	0.19	0
22	0.02	1.5
23	0.02	1.7
24	1.77	0
25	0.37	0.75
26	1.29	-0.8
27	0.04	+0.3
28	0.00	-0.3
29	0.01	0.3
847 - 1	0.01	0
2	0.02	1.8
3	0.02	1.5
4	0.00	1.5
5	0.00	1.5
6	0.14	1.8
7	0.01	1.3
8	0.00	1.0
9	0.40	2.7
10	0.53	2.0

11	0.00	1.0
12	0.01	1.5
13	0.56	0
14	0.13	1.3
15	0.00	1.5
16	0.01	1.5
17	2.47	0.5
18	0.22	0.25
19	0.03	0
20	0.01	0
21	0.01	0.5

In order to evaluate the hydrology of the backfill and the effectiveness of the seal, the water passing through the backfill is being monitored. The assessment of the migration of water through the backfill is being studied by two techniques. First, the KBr and KI serve as ground water tracers and are monitored on a weekly basis in the seeps which have developed at the toe of the spoil. These tracers are being used to determine when or if the toxic material has been intercepted by recharge events and the internal flow paths of the backfill.

Second, these indicators will be complemented by stable oxygen isotope tracers. Each rainfall event has a specific 160 to 180 ratio and these ratios remain approximately constant as the water infiltrates through the spoil and emerges as a seep. By monitoring the rainfall for the 160/ 180 ratio a distinct pattern will be discerned with time. Monitoring the seeps for these ratios can then be used to determine the travel times of -round water flow. Evaluation of halide and isotope data can be used to identify the sources of water that comprise the seeps (surface water vs. ground water), the effectiveness of the seals and the probable acid and alkaline sources within the mine complex.

A rainfall collection and monitoring station has been installed at the ENOXY* mine site. Following each precipitation event, rainwater samples are collected and preserved for isotope analysis. Splits of the rain samples are also being collected and analyzed for the chemical constituents to provide background geochemical data for the site. The quality varies from mildly acidic (about 10 mg/l acidity) to slightly alkaline (up to 6 alkalinity). The large variation was expected because of the liming operation at ENOXY. The powdered lime which is applied at the site is often airborne and rain contacting the particulate matter becomes neutralized and alkaline.

The KI and KBr tracer studies have already identified the main source of water in the seeps during the early stage of hydrologic reestablishment. Rainwater infiltrates through the topsoil and the material above the pad, picking Up iodide. The water then moves along the upper surface of the less permeable clay seal and is discharged in the seep. Iodide levels in the seeps and discharges indicated that by the Spring of 1933 this was the primary direction of water movement and source of the seeps. The complicating issue which remains to date, is the acidic quality of the discharges. This would indicate that either acidic material was used to cover the clay seal or that the integrity of the clay seal had been breached and that the acidity was the result of migration of water through the toxic zone. A third possibility is that the limestone on the pavement did not produce the iron hydroxide coating and that the pavement is producing the acidity. Very minor amounts of bromide have been detected occasionally in the seeps, but not in the concentrations which would be expected if the clay seal had been breached and the toxic material below the seal were the sole source of acidity in the seeps and discharges. These questions may be resolved when the results of the isotopic studies are evaluated in conjunction with the halide tracers.

*Island Creek Coal Company (ICCC) became ENOXY Coal during the middle of the project period.

The main seeps which have developed to date are from the control section I and not from sections II or III. At this time it would be premature to evaluate the effects of bactericide treatment in those sections.