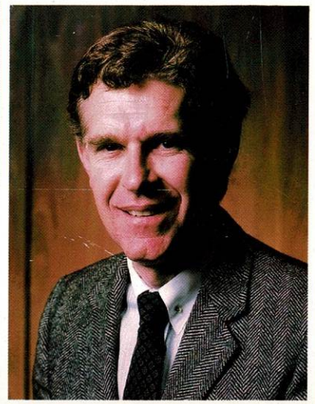
Green Lands
West Virginia Mining
and Reclamation Association
1624 Kanawha Blvd., East
Charleston, WV 25311

Address Correction Requested



"Sized up from the K series . . . and sized down from the L series. The new Cat N Series tractor is the size more operators ask for."

Bob Fredrickson
Sales Manager, Walker Machinery

The N Series from Caterpillar offers you the reliability, durability and power found in all our track-type tractors. Yet it adds the flexibility you need when you're looking for equipment.

The N Series features the elevated sprocket design for firm support and superior ground clearance. Traction, balance and flotation have all been improved to increase stability. And the operator's compartment has been designed for comfort and easy operation.

The N Series is fully backed by Walker Machinery, providing the service and parts assistance you expect, whether it's in the field or in our shop.

Call Walker today to find out more about this powerful, versatile new series of tractors. The N Series — the shape of the future.

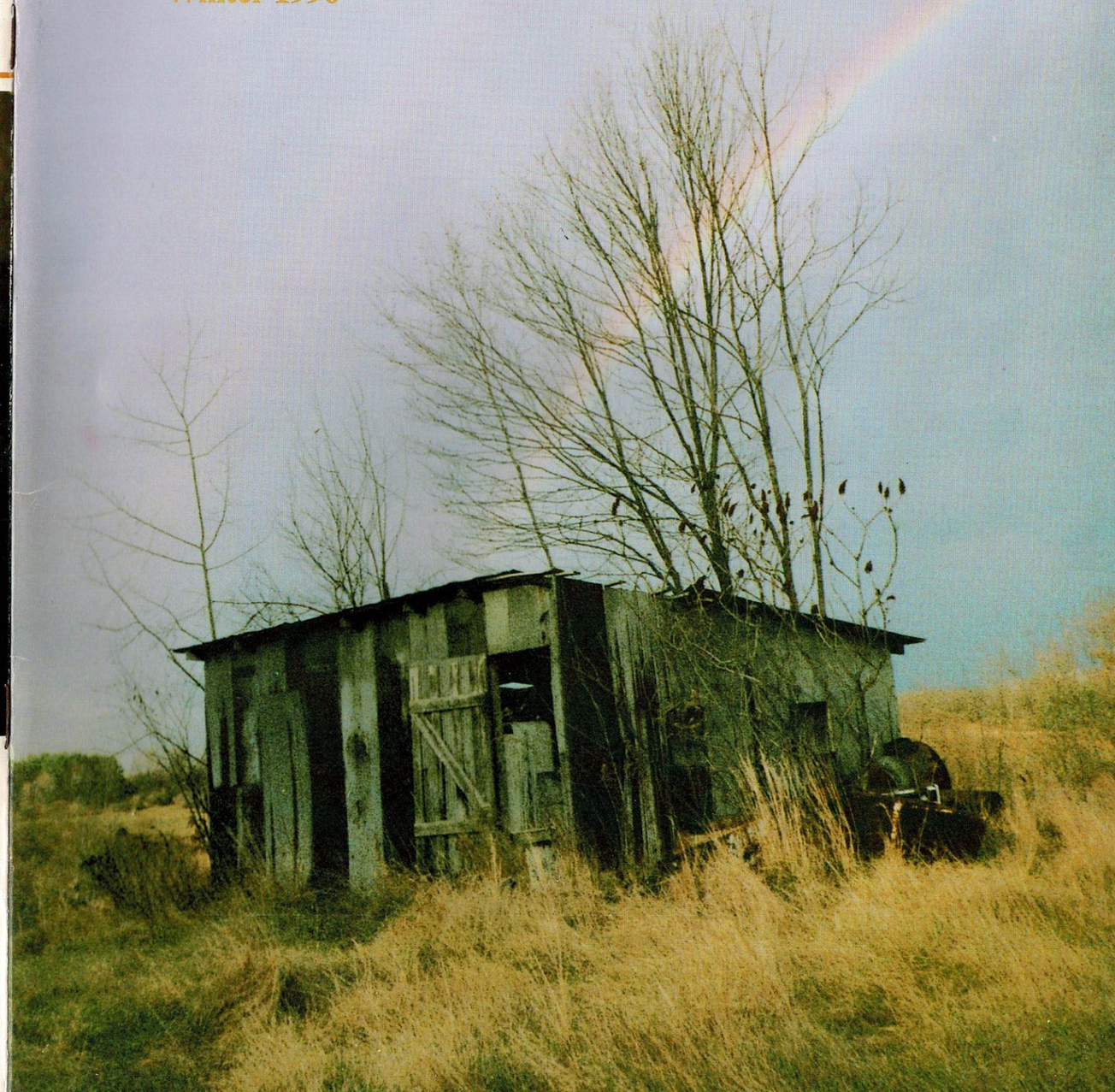
Walker CAT

CHARLESTON	**304-949-6400**
PARKERSBURG	**304-424-0200**
BECKLEY	**304-253-2706**
SUMMERSVILLE	**304-872-4303**
LOGAN	**304-752-0300**
HUNTINGTON	**304-526-4800**
JACKSON, OHIO	**614-286-7566**

Walker and Caterpillar. For ***On the Job*** Security.

Green Lands

Winter 1990



Index to Advertisers

Green Lands

Volume 20 Number 1

Green Lands
is a quarterly publication of the
West Virginia Mining & Reclamation Association,
with offices at 1624 Kanawha Boulevard East
Charleston, West Virginia 25311
(304) 346-5318

Our Cover
Green Mountain Co. worked around this hunting shelter as it restored the "Webster Refuse" site to its natural condition. More West Virginia AML sites in our cover story, beginning on page 19.

NORTH AMERICAN GREEN

Shown Actual Size

Control Erosion In Heavy Rains. Conserve Moisture When There Is No Rain.

North American Green offers a variety of Erosion Control Blankets to suit a variety of situations:

Just Roll It On

Starting at the top of the slope to be covered just unroll the Blanket. The Blanket should never be stretched so that contact with the soil can be maintained. Follow the simple instructions included with each roll.

Staple It Down

As you unroll the Blanket, staple it firmly to the ground using North American Green Surelock. Generally one staple per square yard will be sufficient. Under adverse conditions more staples might be required. Staple patterns are illustrated in the installation instructions.

Let Nature Do The Rest

North American Green Erosion Control Blankets create an ideal environment for seed to germinate. Because the Blankets are so well constructed, they help prevent the loss of moisture through evaporation, yet because the Blankets are porous, the ground will accept additional moisture through rainfall.

North American Green Products

S75	Straw Blanket for moderate runoffs 4:1	**C125**	100% Coconut Fiber Blanket for extreme conditions and ditches.
S150	Straw Blanket for heavy runoffs 3:1	**P-300**	100% Nylon Permanent Ditch Liner
SC150	Straw/Coconut Fiber Blanket for heavy runoff 2:1		
SCC225	Straw/Coconut Fiber Blanket with seed for heavy runoff 2:1		

Write or call North American Green for more information on the complete selection of Erosion Control/ Revegetation Blankets.

Take the guess work out of erosion control.

CONTACT DISTRIBUTOR'S NEAREST BRANCH

KANAWHA STEEL & EQUIPMENT COMPANY

GENERAL OFFICES
3000 Sissonville Drive
Charleston, W.Va. 25332
P.O. Box 3203 Area Code 304 343-8801

BRANCH
Highway 70 East
Madisonville, Ky. 42431
P.O. Box 144 Area Code 502-821-2634

BRANCH
Old Route U.S. 23 North
Wise, Virginia 24293
P.O. Box 1437 Area Code 703 328-8096

BRANCH
Route U.S. 25 East
Middlesboro, Ky. 40965
P.O. Box 8 Area Code 606 248-2054

BRANCH
106 North Bridge Street
New Martinsville, W.Va. 26155
P.O. Box 288 Area Code 304 455-3430

BRANCH
1517 Mellwood Avenue
Louisville, Ky. 40201
P.O. Box 32 Area Code 502 589-6278

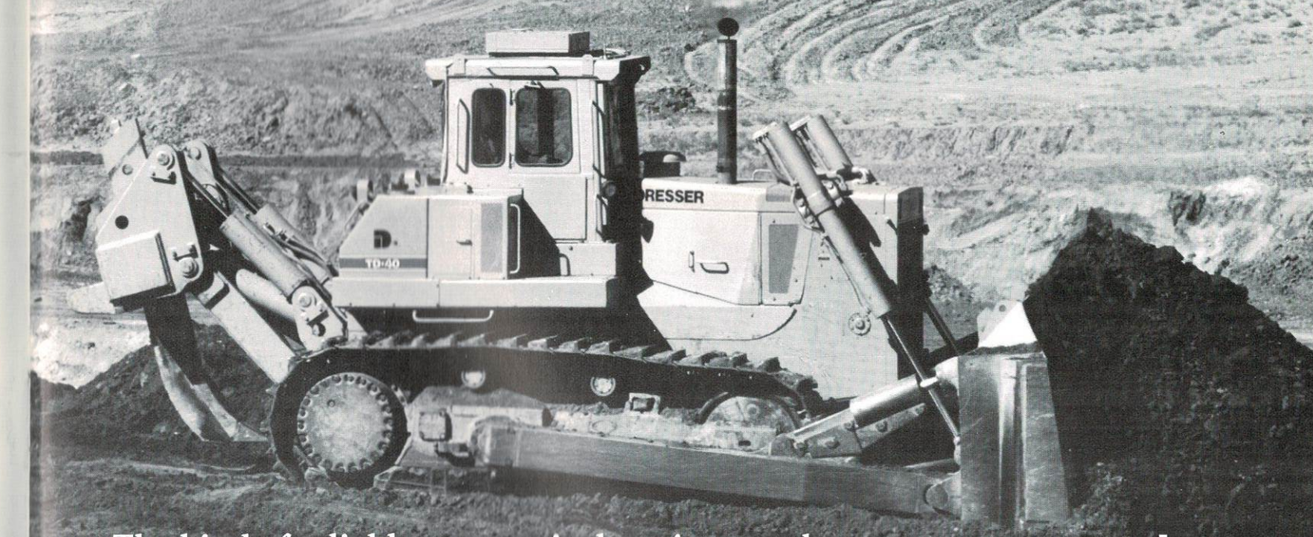
BRANCH
Route U.S. 23 North
Prestonsburg, Ky. 41653
P.O. Box 126 Area Code 606 886-8123

NORTH AMERICAN GREEN

14649 Highway 41 North
Evansville, IN 47711

To succeed in today's rough economic climate you have to get out and dig. Be a little sharper. A little tougher. A little faster. Attitude makes the difference. And attitude is what sets Anderson a cut above. We do it all. We rent, sell, rent to buy and service a wide arsenal of quality equipment for the coal industry. No one does it better. The Anderson name has more than 50 years of service to the coal industry behind it. We keep a first-hand dirt sense for what the industry is looking for. That's why every unit we handle is a high-performance, high productivity machine. Ingersoll-Rand blasthole rigs. Dresser PAY ® loaders, graders, scrapers, end dumps, draglines, dozers, and much more.

THE WHOLE NINE YARDS.



The kind of reliable, economical equipment that gives a full days work for every 8 hours on the job.

And behind Anderson's equipment we have the finest, fastest service in the business. Our customers expect big things from Anderson. And we deliver. We're here for the long haul.

Anderson of West Virginia

BECKLEY CHARLESTON JANE LEW

WVMRA signs wetlands pact with Ducks Unlimited

WVMRA has signed an unprecedented agreement with Ducks Unlimited, Inc. with the objective of creating wetland habitat for waterfowl and other wildlife species through the reclamation of mined land throughout West Virginia.

The signing ceremony took place January 12 during the West Virginia Mining Symposium in Charleston.

This is the first statewide agreement in the nation between the mining industry and the well-known conservationist organization.

Under terms of the Memorandum of Understanding, Ducks Unlimited will provide biological expertise to Association members in their mine reclamation activities.

In turn, WVMRA will "promote and encourage the design, construction, and maintenance of wetland habitat" in the course of the reclamation process.

"This agreement represents an important first step toward the creation and restoration of thousands of acres of vitally important wetland habitat in the Atlantic Flyway, and we are very enthusiastic about having the opportunity to work with the mining industry in this effort," said Matthew B. Connolly, Jr., DU's executive vice president.

"Not only does it provide for the establishment of critical habitat to benefit wildlife, but it also provides a viable, environmentally sound method for the reclamation of mining lands. Such cooperative ventures between conservation groups and representatives of other sectors are essential if we are to succeed in stemming the loss of North American wetlands."

Some 12,000-15,000 acres of recently mined land are reclaimed annually in West Virginia, and an additional 2,000-3,000 acres are reclaimed each year through the industry funded Abandoned Mine Lands program.

The industry in West Virginia has paid over $300 million into the AML fund since its inception in 1977. "All of this," according to Association President Ben Greene, "makes West Virginia's reclamation effort the most intensive in the nation. This agreement is a logical extension of the commitment we have traditionally made to the environment."

Office of Surface Mining Director Harry M. Snyder, in town for the signing ceremony and the closing luncheon of the Symposium, also lauded the agreement, calling it "a significant step toward the achievement of President Bush's promise of 'no net loss of wetlands' during his administration. We hope that OSM can be as successful in generating this type of agreement as DU and WVMRA have been. I applaud both groups."

A diverse group lent their time and support to the Memorandum of Understanding between WVMRA and Ducks Unlimited. From left to right are WVMRA President Ben Greene, WVMRA Board Chairman Paul Hutchins, West Virginia DoE Commissioner George Dials, West Virginia DNR Director Ed Hamrick, West Virginia Delegate Sam Love, OSM Director Harry Snyder, DU Director of Federal Liaison John Smolko, DU West Virginia Major Donor Chairman Sandy Latimer, DU West Virginia State Chairman Michael Hoeft, and DU Regional Vice President Larry Leese.

Ducks Unlimited - A tradition of conservation

Ducks Unlimited was founded in 1937, when the Dust Bowl conditions of the Great Depression brought waterfowl populations in North America to an all time low.

From a modest beginning of some 6,700 supporters with $90,000, DU has grown to be the world's largest private sector wetlands and waterfowl conservation organization.

Current membership stands at over 500,000 members who have raised more than a half-billion dollars to implement the conservation of 5.3 million acres throughout North America. More than 4,800 wetland projects have been constructed to the benefit of some 600 wildlife species.

DU concentrated its first efforts in Canada, addressing the need for protected upland breeding and nesting sites and shallow brood-rearing ponds. In the1970's, the organization turned its attention to Mexico, in order to secure wintering habitat. In the 1980's, DU began wetland construction in the U.S. to provide waterfowl with wintering grounds and stopover sites along the migration corridors. There are now active DU projects in all 50 states.

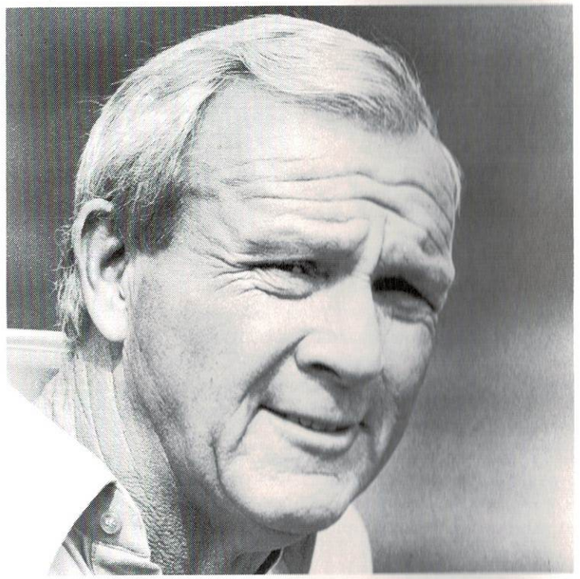
Today, DU is the acknowledged leader in wetlands conservation and construction. Altogether, more than 600 species of waterfowl and other wildlife benefit from DU's 4,800 plus projects, and its management of more than five million acres.

For membership information, contact Ducks Unlimited, One Waterfowl Way, Long Grove, IL 60047, (708) 438-4300.

Join the Drive for Energy Security

Golfing Great Arnold Palmer on Energy Awareness:

"Hello, I'm Arnold Palmer. You know, it's a natural human trait to try to forget bad experiences like bogies. There are some bad experiences that we Americans have shared that we should never forget. Remember the 1973-74 oil embargo? That one cost our economy 300 billion dollars. The Iranian oil shutdown of 1979 caused shortages that cost our economy alone a half trillion dollars. But today, our dependence on foreign energy is again accelerating too fast and we're getting hooked on the same unstable sources that brought us our 1970s shortages. We can cut our energy risks only by developing and using our own abundant energy resources; otherwise, we could again lose the ball on energy supply in the world's largest sand trap—the troublesome Middle East."



American Energy to Secure America's Future

For more information contact:
The Jefferson Energy Foundation
1111 Sixteenth Street, N.W., Suite 202
Washington, D.C. 20036
(202) 857-4781

Three functions in one

Charleston will host major coal meeting

Charleston will host three major mining events in one this April.

Billed as "The 1990 Mining and Reclamation Conference," the event combines two annual conferences with a special exhibition.

The American Society for Surface Mining and Reclamation, a national organization which shifts its annual meeting from east to west each year, planned its 1990 conference for Charleston.

The West Virginia Surface Mine Drainage Task Force conducts an annual symposium, usually in Morgantown. It was decided to move that event to Charleston to coordinate it with the ASSMR gathering.

Then *Coal* magazine and Industrial Presentations proposed that their "Appalachian Surface Mining and Reclamation Exhibition" be held in conjunction with the other meetings.

Thus, Conference Chairman Dr. Jeff Skousen of West Virginia University was able to announce one of the largest and most extensive coal-related gatherings ever held in West Virginia. "This agreement, I think, will benefit all parties," Skousen commented. "The overall conference has been strengthened with a broader program and a greater number of exhibitors. Of course, the real winners in this arrangement will be those who attend the conference."

The three-day meeting (April 24-26) has the backing of a wide range of coal-related organizations from industry, government and education. This list of sponsors includes ASSMR, the West Virginia Surface Mine Drainage Task Force, the National Mine Land Reclamation Center, West Virginia University, WVMRA, *Coal People* magazine, the federal Office of Surface Mining, the U.S. Bureau of Mines, *Coal* magazine, and Industrial Presentations.

Technical Sessions

The tentative program includes 23 separate sessions, roughly divided into two primary areas. One is "Applied Technology and Research," which will cover acid mine drainage, reclamation for improved land use, abandoned mine lands (general), wetlands (general), ecology of disturbed areas, revegetation (general), reclamation policy issues, overburden analytical work, postmining land use, abandoned mine land revegetation, wetlands (U.S. Bureau of Mines), minesoil productivity, forestry, and mining, reclamation and the media. With one exception, all papers presented in these sessions will be published in a "Proceedings," and will be distributed to each registrant at the beginning of the conference.

The papers presented at the special session entitled "Ecology of Disturbed Areas," will be published by the U.S. Forest Service at a later date.

The other major area, organized by *Coal* magazine, is that of "Mining Operations." Included in these sessions will be mountaintop mining, highwall mining, loader and dozer maintenance, a coal export workshop, contour mining, blasting, and regulatory issues. These papers will be published separately and made available to participants at a minimal cost from the *Coal* magazine/Exhibition registration desk.

Field Trips

A six-day pre-conference field trip is planned, in addition to three one-day post-conference tours.

The six-day trip will begin in Knoxville, TN on Wednesday, April 18, with stops in North Carolina and Virginia, and concluding in Charleston on Monday. Tour stops will include active mining operations, AML sites, valley fill construction, mountaintop removal, revegetation of refuse, and research sites for overburden mixture, forest reestablishment, and composted sludge application.

On Friday, April 23, following the conference, a one-day tour is scheduled to Hobet Mining Co., near Madison, WV, for a discussion of reclamation and revegetation and a demonstration of overburden removal with Hobet's famed "Big John" dragline.

Two other one-day tours are being planned. One will visit an active AML site and one which has been completed. The other will emphasize acid mine drainage as well as chemical and biological methods to treat acid discharges.

Exhibition

Exhibits will be handled by Industrial Presentations. There will be approximately 75-80 exhibitors set up in the Civic Center Coliseum, featuring mining equipment, mining and reclamation consultants, research and regulation agencies, and other mining related products and services.

Exhibit space is still available through Sam Posa, Industrial Presentations, Inc., 12371 E. Cornell Ave., Aurora, CO 80014, (303) 696-6100.

Special Activities

An informal reception will open the conference on the evening of Monday, April 23.

ASSMR - Task Force Symposium - Appalachian Exhibition

The 1990 Mining & Reclamation Conference

On Tuesday, a special evening dinner and dancing cruise will be held on one of Charleston's local sternwheelers. The cost will be $25.

The ASSMR Awards Luncheon will be held in the North Hall of the Civic Center at noon on Wednesday. West Virginia Congressman Nick Rahall and OSM Director Harry Snyder have been invited to speak. Awards for outstanding reclamationist, researcher, and special reclamationist will be presented. Cost of the luncheon is $10.

A spouse's program will offer visits to the West Virginia State Capitol, as well as museums and other historic sites in the area.

Accommodations and travel

The Charleston Marriott and the Holiday Inn-Civic Center, both conveniently located across the street from the conference site, have reserved blocks of rooms. Contact the Marriott at (304) 345-6500 and the Holiday Inn at (304) 345-0600. USAir will provide discounts of 5-35% on airfare to Charleston. Arrangements may be made by calling 1-800-334-8644 and referring to "Gold File #495506."

Registration

The conference fee for those registering before March 30 will be $75. After that date, the fee is $90. Members and employees of the sponsoring organizations may deduct $25 from the conference fee.

Registration includes admission to all sessions, workshops, and exhibits, a copy of the ASSMR/Task Force Proceedings, receptions, Tuesday and Thursday luncheons, and daily coffee breaks.

The cost for the tours is $150 for the six-day tour, and $25 each for the one-day events.

For further information, contact Conference Chairman Jeff Skousen at 1106 Agricultural Science Building, West Virginia University, Morgantown, WV 26506 (304) 293-6256.

Pioneer Construction Co.

Contractors for
the Burke R & R Project in Preston County,
the Berry Branch Project in Raleigh County,
among other AML projects

is proud to be part of the
Abandoned Mine Lands program.

The excellent personnel of the AML section
of WV-DoE have been of immeasurable
assistance in our efforts.

In participation with AML projects, we are utilizing
the dollars collected from the West Virginia coal
industry to make our state more beautiful.

Pioneer Construction Co.
P. O. Box 1672
Widen, WV 25211
(304) 332-5522

Cover Story

photo by Don Beightol

West Virginia's AML Program

photo by Danny Pritt

The Webster Refuse Project in Preston County, completed by **Green Mountain Co.** In the right center of this aerial photograph is the hunting shelter shown on the cover. This structure was preserved at the request of the landowner.

AML program keeps coal dollars flowing back to West Virginia

Congress is on the verge of breathing new life into the Abandoned Mine Lands program with the passage of a re-authorization package designed to extend the program through 2007. AML fees have been collected from coal companies, nationwide, since 1977, when the Surface Mining Control and Reclamation Act levied 35¢ per ton on surface mined coal,15¢ per ton on underground production, and 10¢ per ton on lignite.

Under the original provisions of the Act, the program would expire in 1992, though accumulated funds could carry reclamation work for another five years or so. Collections are projected to total over $3 billion by that date.

Congressmen and senators from western states have opposed the extension, on the basis that work in those states should be completed by the time current available funds are expended. The bill easily won approval from the House of Representatives in October with a concession to the western delegation, providing a 50% reduction in the fees from any state which can demonstrate that all AML work has been completed.

Any such reduction would be granted only if the Secretary of Interior finds that no significant competitive advantage would result. Senate passage and subsequent presidential approval are expected.

HR 2095, as passed by the House, contains some changes in the allocation of funds. Current law authorizes states to deposit 10% of its annual state-sharing funds into a special trust fund to be used for additional work after the program expires. The new bill allows States to use that money to establish an acid mine drainage abatement and treatment fund.

Another change would specifically transfer 20% of the (Interior) Secretary's fund to the Soil Conservation Service for use in the Rural Abandoned Mine Program. Currently, RAMP may receive "up to 20%" of those funds, but is guaranteed nothing.

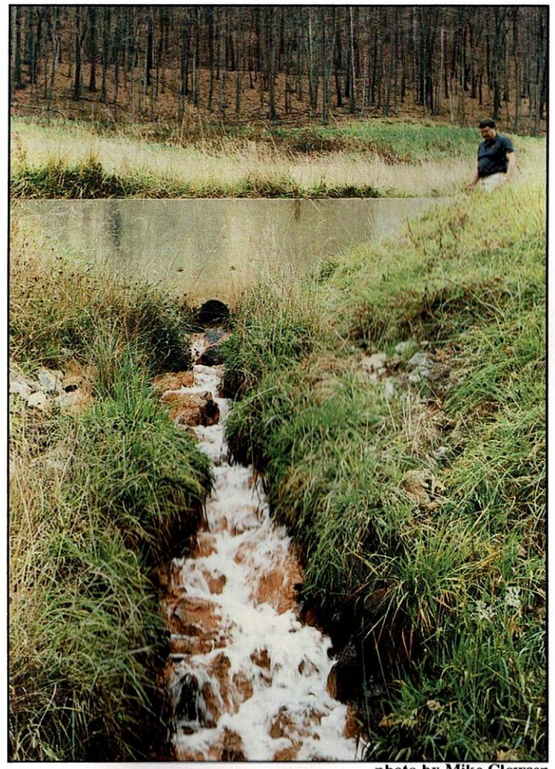


photo by Mike Clowser

Earthmovers Unlimited
Meridan Drainage - Barbour County

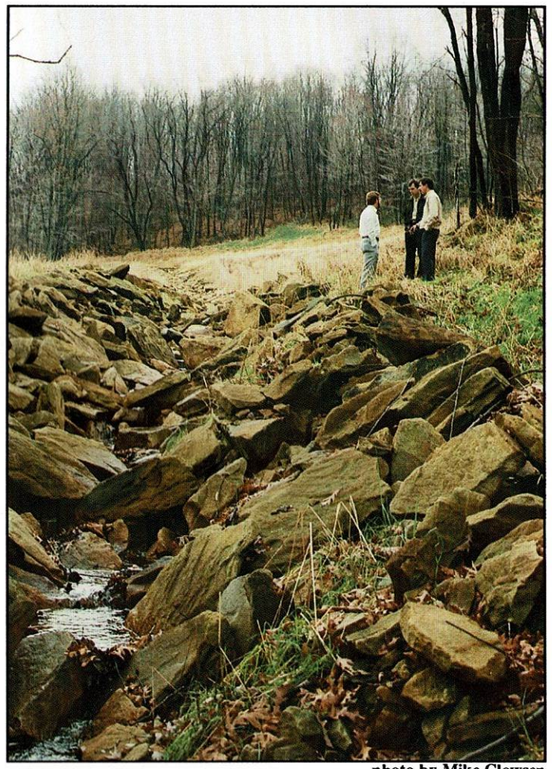


photo by Mike Clowser

Pioneer Construction
Burke R & R - Preston County

The bill would also alter the eligibility of small operators under the Small Operators Assistance Program. Originally, a small operator was defined as those producing less than 100,000 tons per year. The re-authorization package raises the small operator limit to 300,000 tons per year.

To date, West Virginia coal companies have paid more than $300 million into the fund. At current production levels, that's about $25-30 million a year.

Under the cumbersome formula enacted in 1977, the West Virginia Department of Energy can get roughly 50% back for use on state projects.

So, if DoE can win grants from OSM in the neighborhood of $15 million a year, then West Virginia is doing about as well as can be expected.

Results in recent years have been encouraging. In 1987, DoE's AML program contracted for 38 projects at $21.9 million. In 1988, the figures jumped to 62 projects and $30.1 million. Last year, the program funded 30 projects at $18.6 million. If the 1990 grant is approved as submitted, West Virginia will have another $21.2 million to work with.

In an "old coal" state like West Virginia, the AML program is generating a lot of benefit. The identified inventory of Priority 1 & 2 sites is enough to justify continued projects for the foreseeable future.

Of the countless taxes on coal and coal production, AML is perhaps the most satisfying in terms of return on dollars invested.

Totally funded by the coal industry, AML is generating employment for mining and reclamation companies while simultaneously improving the environment.

The following pages are a tribute to the work of WV-DoE's AML staff, as well as to the companies which are doing the excellent work depicted here.

photo by Danny Pritt

A. L. King, Ltd. - Canebrake - McDowell County

photo by Danny Pritt

A. L. King, Ltd. - Iroquois - Wyoming County

photo by Danny Pritt

Pioneer Construction - Berry Branch - Raleigh County

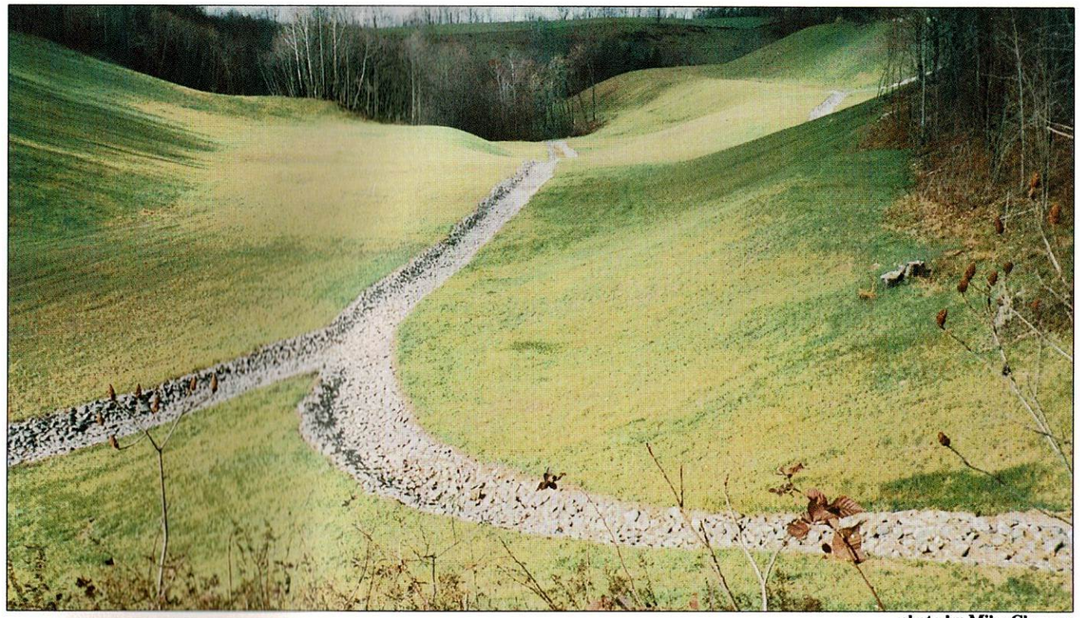
photo by Danny Pritt

Garcie R. Marker & Sons - Rolfe Refuse - McDowell County

photo by Danny Pritt

North American Reclamation - Harding - Randolph County

photo by Mike Clowser



Breckenridge Corp. - Weltner (Ramp Project) - Monongalia County

photo by Mike Clowser

photo by Don Beightol

Wayne K. Baker - Acme - Preston County

photo by Danny Pritt

Battle Ridge Corp. - Hazy Creek - Raleigh

photo by Danny Pritt

Green Mountain Co. - Sabine - Wyoming County

photo by Danny Pritt

Green Mountain Co. - Glenn's Run - Ohio County

A NEW DIMENSION OF PRODUCTION

DEMAG

Mannesmann Demag has developed the most advanced line of large Hydraulic Shovels and Backhoes in the industry and is setting the standard of production on mining and mass excavation projects throughout the world.

From the 5.8 cu. yd. H65 to the 34 cu. yd. H485 you can rely on Demag's technologically advanced design to provide maximum production through such features as:

- Proven single-engine drive
- Unique "hydropilot" 3-circuit hydraulic system with summation capability and maximum-load governor
- High-capacity, wear resisting buckets
- Superior design and structural strength of undercarriage and superstructure
- Modular main components permit easy access for maintenance and replacement

With over 80 years experience supporting large mining and construction equipment, you can depend on Beckwith Machinery Company to provide unmatched dealer support.

Beckwith's parts and service capabilities remain unsurpassed with Beckwith's 84,000 sq. ft. parts distribution facility in Delmont, PA, backed by Mannesmann Demag's parts facility in Bensenville, IL. You can be assured of getting parts when you need them. Beckwith's eight full-service branch locations, in Pennsylvania and West Virginia, and Mannesmann Demag's new service center just outside of Charleston, WV, can deliver prompt shop or field service day or night. Our more than 350 trained mechanics, averaging 15 years work experience, have the specialized repair equipment and tools to put your equipment back to work fast.

When your excavation requirements demand a Hydraulic Shovel or Backhoe in the 5.8 cu. yd. to 34 cu. yd. class, specify Demag, a new dimension in production.

DEMAG PRODUCT LINE

- 5.8 cu. yd. H65
  Loads 35 Ton and On Highway Trucks
- 7.5 cu. yd. H85
  Loads 35-50 Ton Trucks
- 10.0 cu. yd. H121
  Loads 50-85 Ton Trucks
- 13.6 cu. yd. H135-S
  Loads 50-85 Ton Trucks
- 16 cu. yd. H185
  Loads 85-120 Ton Trucks
- 21-25 cu. yd. H285/H285-S
  Loads 120-190 Ton Trucks
- 34 cu. yd. H485
  Loads 170-240 Ton Trucks

BECKWITH Machinery Company

P.O. Box 8718
Pittsburgh, PA 15221
(412) 327-1300 Telefax (412) 327-9318

MANNESMANN DEMAG

Construction Machinery Division
476 Country Club Drive
Bensenville, IL 60106
(708) 766-4431
Telex: 214-909 Telefax (708) 766-7549

A.L. King, Ltd.

Contractors for the
Iroquois Project in Wyoming County
and the Canebrake Project in McDowell County

Wishes to thank the West Virginia Department of Energy, and to thank all those who have played a part in the successful implementation of the West Virginia Abandoned Mine Lands program.

KANAWHA STONE
A.L. KING, LTD.

P. O. Box 503
Plant Road
Nitro, WV 25143
(304) 755-8271

Green Mountain Co.

Contractor for

the **Webster Refuse** Project in Preston County,
the **Sabine Project** in Wyoming County, and
the **Glenn's Run** Project in Ohio County

Offers its congratulations to West Virginia's coal industry,
and to the West Virginia Department of Energy
for the cooperation and dedication which has
allowed our AML program to function
for the benefit of the state and the
mining and reclamation industries.

Rod Clay, President
Green Mountain Company

Charleston, WV 25361
(304) 925-0253

Garcie R. Marker & Sons, Inc.

Contractor for the Rolfe Refuse Project in McDowell County

Takes great pride in being part of the outstanding
West Virginia Abandoned Mine Lands Program.
We offer our thanks and best wishes to the
dedicated personnel of the West Virginia
Department of Energy for their role in
making the AML program the
most effective in the nation.

Garcie R. Marker & Sons, Inc.
Rt. 8 - P.O. Box 511-B
South Charleston, West Virginia 25303
(304) 744-0590

Petroleum Products, Inc.

"Oil Is Our Product--
Service Is Our Business"

Distributor of Quality
CHEVRON Products

Fuels, Lubricants, Greases,
Motor Oils, Hydraulic Oils,
Technical Consulting

Pat Graney, III
President

Sales Manager/
Technical Consultant
Thomas P. Taylor

PETROLEUM PRODUCTS, INC.
PP inc.
304-253-7386
304-752-3900
BECKLEY-LOGAN

Beckley Location
(304) 256-3000
G. R. (Bob) Maynard
General Manager

Logan Location
(304) 752-3900
John M. Ford, II
General Manager

Fullen

Fertilizer Company, Inc.

Fertilizer
Hydromulch
Seeds

Custom Fertilizer Formantion
Soil Testing & Quality Delivery Service

Contact
Tim Fullen

P.O. Box 172
Union, WV 24983
(304) 772-3088

MT. STATE BIT SERVICE, INC.

P.O. BOX 4300, MORGANTOWN, WV 26505
(304) 296-1783

- COMPLETE LINE OF EXPOSIVES
- COMPLETE LINE OF ACCESSORIES
- CONTRACT DRILLING SERVICES
- CONTRACT BLASTING SERVICES
- MIX PLANT FACILITIES FOR PACKAGING OF BAGGED ANFO AND WET HOLE STICKS WITH VARIOUS DENSITY AND ENERGY

MORGANTOWN, WV
HUNTINGTON, WV

GRANTSVILLE, MD
FAIRBANKS, PA

PROMPT & DEPENDABLE

The Development of the Acid-Base Account

by Jeff Skousen, Richard M. Smith, &
John Sencindiver - West Virginia University

Original Ideas

Acid-Base Accounting originated from ideas based on estimates of the composition of the earth's crust. These estimates were presented and discussed in many classic mineralogy or geology texts beginning in the 1930's.

The earth's crust generally is composed of a higher percentage of cationic elements (namely calcium, magnesium, potassium, and sodium) in reactive forms than the percentage of anionic or acid-producing elements (e.g. sulfur, chlorine, fluorine, and phosphorus).

Other abundant mineral elements (including iron, aluminum, silicon, and oxygen) are weakly dissociated or relatively inactive and have only a minor influence on acidity or alkalinity.

Therefore, these ideas suggested that the dominance of one or the other type of elements in the rock would dictate the future potential of that rock to produce acidity or alkalinity.

Some of the earliest documented work on reclamation of surface mined areas in West Virginia was directed at revegetation efforts (Smith and Tyner 1945, Tyner et al. 1948). These reports acknowledged the effects of spoil quality on plant growth.

It was apparent to coal operators and regulators that reclamation potential of surface mined areas (mainly with reference to plant establishment and growth) was directly connected to the quality of the overburden material placed at the surface. Many early surface mine operations turned the overburden upside down relative to its original position as the overburden was removed to reach the coal. Such an operation deposited the original surface material into the pit, and the material near the coal seam was placed on the surface.

The replaced surface material may have been a black or, more commonly, gray color which indicated unweathered material. In many situations, pyritic sulfur was found in rocks associated with the coal seam and, upon weathering, produced acid conditions in the soil and may have caused an acid mine drainage problem.

Spoil Classification Systems

Early reports in West Virginia identified three types of spoil material and distinguished these spoil types based on rock composition and degree of acidity. For example, type A spoil was very strongly acid spoil derived from geologic sections consisting of shales and sandstones with pyritic roof coals and black pyritic shales (Smith and Tyner 1945).

Such a system of spoil classification was of practical value for revegetation, and similar systems were subsequently developed for other coal mining areas including the mid-eastern coal region (Limstrom 1948), Pennsylvania (Davis 1965), and Eastern Kentucky (SCS 1973).

A spoil classification system proved useful for reclamationists to help determine lime and fertilizer rates, and to identify and seed plant species which are adapted to these specific minesoil conditions.

Knabe (1964) provided one of the earliest examples of characterizing alkaline versus acid minesoils. He refined the spoil type classification by placing a positive or negative number as a subscript. A positive subscript detailed the percent of $CaCO_3$ in the spoil material while a negative number expressed the percent of potential unneutralized SO_4 (the sulfides or pyrite was expressed as SO_4). For example, A_{20} was a spoil suitable for agriculture, with 20 percent unneutralized calcium carbonate in the material. A T-10 spoil type was toxic with as much as 10 percent of potential unneutralized SO_4. Later, Knabe reported that he used a method called an "base-acid balance" which balanced the sum of all bases against all present acids, acid-producing minerals (sulfides), and exchange capacity of cations (Knabe 1973). His system then, accounted for the ultimate quantity of acidity or alkalinity that could be produced in the minespoil upon weathering.

Dr. Richard Smith and his associates conducted extensive field research in the development of the Acid-Base Account.

Even though these minesoil classification systems were useful, a more important need was a method or technique that could distinguish, before mining, the materials in the undisturbed overburden that could be placed on the surface for revegetation and which materials should be buried beneath the rooting zone.

Overburden Analysis Before Mining

Soon after Knabe reported on his work, researchers at West Virginia University began developing a system for balancing the acid and alkaline producing potential of overburdens prior to disturbance.

WVU researchers first studied overburdens in Preston County, WV and defined the acid-producing potential of rocks associated with the Freeport and Kittanning coal seams (West Virginia University 1971).

As the work continued in other parts of the state, they quantified acid-neutralizing material in overburdens and developed the term neutralization potential (NP) (Smith et al. 1974). Further research outside Appalachia confirmed the usefulness and application of the Acid-Base Account (Smith et al. 1976), and final field and laboratory procedures for the Acid-Base Account were published in 1978 (Sobek et al. 1978).

As early as 1971, Smith and his associates at West Virginia University recommended that sulfur profiles and acid-neutralizing capacities should be determined for all stratigraphic sections from the surface down to the coal seam before mining. In this way, net acidity or alkalinity for each geologic layer was calculated and water and minesoil quality could be predicted for particular minesoils.

Laws and Regulations

The 1971 West Virginia surface mining and reclamation law required the operator to show in the permit "the presence of any acid-producing materials which, when present in the overburden, may cause spoil with a pH below 3.5 and prevent effective revegetation." Regulations promulgated to implement the law in succeeding years used the Acid-Base Account to determine the presence or absence of acid-producing materials in the overburden.

Prior to federal surface mining and reclamation laws in 1977, "topsoiling" was seldom practiced. Therefore, the Acid-Base Account was particularly useful in selecting overburden layers which should be placed on the surface as "topsoil." It was also used to help select materials for special uses (e.g., hard sandstones for rock cores in valley fills, clayey materials for impermeable barriers, etc.).

The Acid-Base Account was the first technology available to assess the chemical quality of overburdens prior to disturbance. As a result, the concepts of pre-mine planning for reclamation and special handling procedures were formulated.

Acid-Base Accounting and Water Quality

Overburden analysis came into widespread use with the passage of SMCRA in 1977. The law requires that an operator must identify in the permit any potentially acid-producing materials in the overburden and determine the probable hydrologic consequences of such materials after disturbance and reclamation. Since little research had been conducted on water quality prediction from disturbed areas, the coal industry and regulatory authorities applied

Sample Number	Bottom depth (feet)	Rock type	Fizz	Color	$CaCO_3$ equivalent - tons/1000 tons of material %S	Max. from %S	Amount present (NP)	Max. needed (pH7)	Excess	Paste pH
1	3	Soil	0	7/3	.035	1.09	3.52		2.53	4.4
2	6	SS	0	8/6	.029	0.91	-1.51	2.42		4.3
3	6	SS	0	8/2	.023	0.72	-1.59	2.31		4.6
4	14	SH	0	7/4	.009	0.28	-0.60	0.88		4.6
5	17	SS	0	7/4	.009	0.28	-0.09	0.37		4.7
6	20	SH	0	8/3	.011	0.34	-0.17	0.51		4.5
7	24	MS	0	7/1	.263	8.22	-0.94	9.16		4.8
8	28	MS	1	7/1	.179	5.59	78.33		72.74	7.8
9	35	MS	0	7/1	.028	0.88	15.77		14.89	7.9
10	39	MS	1	7/0	.140	4.38	39.71		35.33	7.8
11	55	MS	1	7/1	.278	8.69	25.25		16.56	8.0
12	49	SH	1	7/1	.079	2.47	25.76		23.29	8.1
13	51	MS	1	7/1	.665	20.78	32.45		11.67	7.9
14	44	SH	1	7/1	.610	19.06	25.88		6.82	7.8
15	58	SH	0	6/1	.355	11.09	17.78		6.69	7.3
16	59	SH	0	4/1	.800	25.00	3.80	21.20		4.2
17	64	Coal	*	*	*	*	*	*	*	*
18	67	MS	0	6/1	2.820	88.12	-2.78	90.90		3.5

Table 1. The Acid-Base Account, in this example, describes each major layer in the overburden by horizon thickness, rock type, fizz, color (value/chroma), percent sulfur, neutralization potential, and pH.

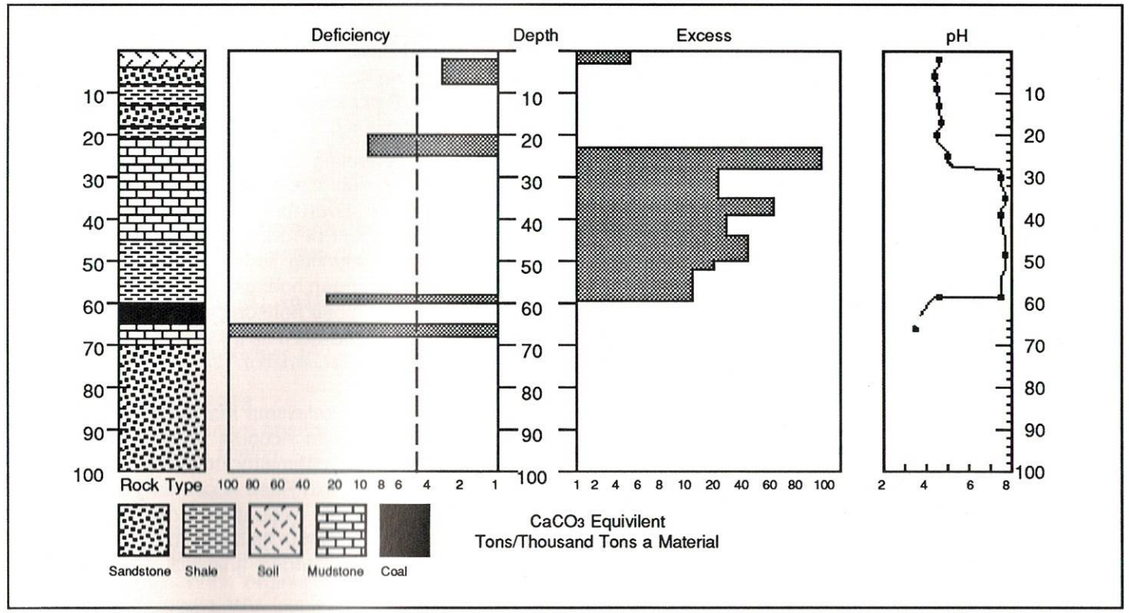


Figure 1. Graphic representation of overburden properties as measured by the Acid-Base Account. The figure illustrates some of the data in Table 1.

current overburden analytical methods and adapted the available methods to these purposes.

The Acid-Base Account, already widely used by this time as an overburden selection tool, was applied to predict post-mining drainage quality. Since then, there have been many discussions and much controversy concerning the ability of the Acid-Base Account to predict post-mining water quality (adapted from Erickson and Hedin 1988).

Acid-Base Account Principles

The Acid-Base Account was first described in detail in 1973 (Grube et al. 1973). Logging of overburden cores and/or observations of a fresh highwall are used to distinguish geologic layers. Each of the layers are identified by: 1) rock color; 2) rock hardness; 3) rock streak on ceramic plate; 4) rock grittiness; 5) rock layering; and 6) rock fizz. Toxic, potentially toxic, and alkaline-producing overburden layers are defined by three measurements: 1) pH; 2) total or pyritic sulfur; and 3) neutralization potential (Table 1).

While many other factors and complex interactions have an influence on the chemical production potential of rocks (including microorganisms, trace elements, depositional environments, forms of pyrite, rare catalytic agents, uncommon compounds, and lithologic peculiarities), it was felt that dominant rock properties would likely produce the most predictable response upon weathering.

Diagnosis of the prominent rock properties would also provide opportunities for solutions of the major problems related to coal overburden quality and resulting drainage.

The formation of acid from the oxidation of pyrites and other reduced sulfur compounds is well known. The equation shows that a material containing 0.1 % sulfur, all as pyrite, would yield upon complete reaction an amount of sulfuric acid that requires 6,250 pounds of calcium carbonate to neutralize one thousand tons of the material. When sulfur in the overburden rock is exclusively pyrite, the total sulfur content of the rock accurately quantifies the acid-producing potential (if it were all to react). When organic and/or sulfate sulfur are present in significant amounts, total sulfur measurements overestimate the amount of acid that will be formed upon oxidation.

The natural base (alkali and alkaline-earth cations, commonly present as carbonates or exchangeable cations on clays) content of overburden materials is important in evaluating the future chemical producing potential of the overburden.

In overburden containing alkaline and pyritic material, the soluble bases may be sufficient to neutralize the acid at a rate equal to or exceeding the rate of acid production. Higher alkalinities also help control bacteria concentrations and restrict ferric iron activity which are both known to accelerate acid generation.

Quantification of neutralizing bases and carbonates is accomplished by reaction with hydrochloric acid. A balance of the acid-producing potential and neutralizing bases present in the sample indicates the ultimate acidity or alkalinity that might be expected in the material.

An Acid-Base Account illustrates the ultimate acidity or basicity of different rock zones in the overburden (Figure 1). From the beginning, the aim of Acid-Base Accounting was to determine how much neutralizing material was needed in order to neutralize all of the strong acids that could potentially form in coal overburden materials, especially where pyritic materials were known to occur. Therefore, the value of 6,250 pounds of calcium carbonate per 0.1% sulfur is calculated by dividing the molecular weight of $CaCO_3$(100) by the molecular weight of sulfur (32).

That is, material containing 0.1% pyritic sulfur requires 3.125 tons (6,250 pounds) of $CaCO_3$ to neutralize the acid that could be formed from 1000 tons of the material. At 1% sulfur, 31.25 tons of calcium carbonate equivalent would be required to neutralize the acidity, and provide a margin of neutralization safety against sulfur percentages that may not all be pyritic and for pyritic sulfur that may not all react.

Three basic assumptions should be understood when using Acid-Base Accounting (adapted from Perry 1985). First, the values for potential acidity and neutralization potential represent maximum or ultimate quantities from whole rock analysis. Complete reaction of all pyrite and bases probably does not occur in a mine backfill, thereby affecting the total amount of acidity or alkalinity which is produced. Second, sulfur exists in three chemical forms in coal bearing rocks: sulfide, sulfate, and organic. Pyritic sulfur (sulfide) is the prominent acid producer. Total sulfur analysis generally overestimates pyritic sulfur content because all three forms are usually present. And third, Acid-Base Accounting recognizes only the ultimate amount of acidity or alkalinity that the rock will produce. Pyrite may oxidize faster or slower than alkaline materials. Reaction rates of pyrite and carbonates are not determined by this method.

Experience with Acid-Base Accounting has shown that

overburden layers which provide values greater than 5 tons per 1000 tons in the Max Needed column (the column which represents surplus acidity in the layer) produce acid, while values greater than 20 tons per 1000 tons in the Excess column (the column which represents excess alkalinity in the layer) usually produce alkaline drainage (Skousen et al. 1987). Layers between 0 and 5 in the Max Needed column or less than 20 tons in the Excess column may produce alkaline or acid discharges or they may be neutral (producing neither alkalinity or acidity). Where little or no pyrite exists, even with low amounts of neutralizing potential, little acid will be produced. Such low numbers in either column should raise suspicions during interpretation and cause a closer look at other measurements.

It is not wise to rely simply on one number in either the Max Needed or Excess columns to make a judgment. When questions arise, these rock layers, in many cases, require some other method or analysis to ascertain the rock's chemical production potential.

A common error when using the Acid-Base Account as a predictive method of AMD production occurs when the Max Needed and Excess columns are summed together for the entire overburden above the coal seam (the Max Needed column representing a negative number and the Excess column representing a positive number). Several studies have made AMD predictions based on the Acid-Base Account with overburden volume adjustments. Summing of the columns assumes thorough mixing of all overburden materials in a backfill, uniform rates of weathering of all materials, and water contact throughout the backfill. These assumptions are not valid.

Summary

Acid-Base Accounting balances maximum or ultimate potential acidity against total neutralizers in each overburden horizon sample. Even though the method has several assumptions that must be understood during interpretation, Acid-Base Accounting satisfies the requirement to identify which overburden horizons will or will not produce acid, and pinpoints those horizons which should be analyzed further. With accurate data and proper interpretation, practical mining and reclamation plans can be designed and implemented.

Despite the many criticisms that have been leveled against it, the Acid-Base Account is the preferred first measure of overburden chemistry for both the industry and regulatory agencies. Acid-Base Accounting is the fastest and easiest way to begin evaluation of overburden material. It should be used within its limits, in conjunction with other methods of overburden analysis, and with good common sense.

Acknowledgements

The authors would like to thank those who reviewed this paper and gave helpful suggestions. Special thanks go to Eric Perry, Andy Sobek, Walt Grube, John Freeman, and John Sturm.

References

Davis, G. 1965.
A Guide for Revegetating Bituminous Strip-Mine Spoils in Pennsylvania. Research Committee on Coal Mine Spoil Revegetation in Pennsylvania. NE Forest Experiment Station, Broomall, PA.

Erickson, P. M., and R. S. Hedin. 1988.
"Evaluation of Overburden Analytical Methods as Means to Predict Post-Mining Coal Mine Drainage Quality." pp 11-19. In: *Mine Drainage and Surface Mine Reclamation, Vol. I.* USDI, Bureau of Mines Information Circular 9183.

Grube, W. E., R. M. Smith, R. N. Singh, and A. A. Sobek. 1973. "Characterization of Coal Overburden Materials and Minesoils in Advance of Surface Mining." pp. 134-151. In: *Research and Applied Technology Symposium on Mined-Land Reclamation.* NCA/BCR. Pittsburgh, PA.

Knabe, W. 1973.
"Development and Application of the 'Domsdorf Amcliorative Treatment' on Toxic Spoil Banks of Lignite Opencast Mines in Germany." pp. 273-294. In: R. J. Jutnik and G. Davis (Eds.), *Ecology and Reclamation of Devastated Land. Vol. 2.* Gordon and Breach, Scientific Publishers, Inc. New York, NY.

Knabe, W. 1964.
"A Visiting Scientist's Observations and Recommendations Concerning Strip-Mine Reclamation in Ohio." *Ohio Journal of Science*, 64:132-157.

Limstrom, G. A. 1948.
Extent, Character, and Forestation Possibilities of Land Stripped for Coal in the Central States. Technical Paper 109, Central States Forest Experiment Station, Columbus, OH.

Perry, E. 1985.
"Overburden Analysis: An Evaluation of Methods." pp. 365-375. In: *Proceedings, Symposium on Surface Mining, Hydrology, Sedimentology, and Reclamation.* University of Kentucky, Lexington, KY.

Skousen, J. G., J. C. Sencindiver, and R. M. Smith. 1987.
A Review of Procedures for Surface Mining and Reclamation in Areas with Acid-Producing Materials. West Virginia University Energy and Water Research Center, Publication No. EWRC 871, Morgantown, WV.

Smith, R. M., W. E. Grube, T. A. Arkle, and A. A. Sobek. 1974
Mine Spoil Potentials for Soil and Water Quality. EPA-670/2-74-070.

Smith, R. M., A. A. Sobek, T. Arkle, Jr., J. C. Sencindiver, and J. R. Freeman. 1976.
Extensive Overburden Potentials for Soil and Water Quality. EPA-600/1-76-184.

Smith, R. M., and E. H. Tyner. 1945
Reclaiming Strip-Mine Spoil Banks. WVU Agricultural Experiment Station. Circular 53.

Sobek, A. A., W. A. Schuller, J. R. Freeman, and R. M. Smith. 1978.
Field and Laboratory Methods Applicable to Overburdens and Minesoils. EPA-600/2-78-054.

Soil Conservation Service. 1973
Kentucky Guide for Classification, Use, and Vegetative Treatment of Surface Mine Spoil. USDA, SCS, Lexington, KY.

Tyner, E. H., R. M. Smith, and S. L. Galpin. 1948.
"Reclamation of Strip-Mined Areas in West Virginia." *Journal of American Society of Agronomy.* 40: 313-323.

West Virginia University. 1971.
Mine Spoil Potentials for Water Quality and Controlled Erosion. USEPA, OWP, Project No. 14010, EJE.

Coal Calendar

February

27-28 **Interstate Mining Compact Commission Winter Business Meeting,** Omni Georgetown Hotel, Washington, D.C., contact IMCC, 459B Carlisle Dr., Herndon, VA 22070, (703) 689-2461.

March

12-14 **Short Course, "Mine Instructor Training,"** University Park, PA, contact R. L. Franz, Penn State University, 126 Mineral Sciences Bldg., University Park, PA 16802, (814) 865-7472.

20-21 **Mergers & Acquisitions Special Institute,** Hyatt Regency Columbus, Columbus, OH, contact Paul L. Dunkle, III, East Mineral Law Foundation, WVU Law Center, P.O. Box 6130, Morgantown 26506, (304) 293-2470.

26-28 **Short Course, "Fundamentals of Surface Mining,"** University Park, PA, contact R. L. Franz, Penn State University, 126 Mineral Sciences Bldg., University Park, PA 16802, (814) 865-7472.

April

5-6 **Eastern Mineral Law Foundation, Mine Safety Special Institute,** Mayflower Hotel, Washington, D.C., contact Paul L. Dunkle, III, East Mineral Law Foundation, WVU Law Center, P.O. Box 6130, Morgantown 26506, (304) 293-2470.

9-11 **Short Course, "Mine Cost Analysis and Control,"** University Park, PA, contact R. L. Franz, Penn State University, 126 Mineral Sciences Bldg., University Park, PA 16802, (814) 865-7472.

18-20 **Short Course, "Computer Modeling of Subsidence with SPASID,"** University Park, PA, contact R. L. Franz, Penn State University, 126 Mineral Sciences Bldg., University Park, PA 16802, (814) 865-7472.

23-26 **Short Course, "Elements of Mine Electrical Systems,"** University Park, PA, contact R. L. Franz, Penn State University, 126 Mineral Sciences Bldg., University Park, PA 16802, (814) 865-7472.

24-26 **The 1990 Mining and Reclamation Conference and Exhibition,** Charleston Civic Center, Charleston, contact Jeff Skousen, Conference Chairman, 1106 Agricultural Science Building, West Virginia University, Morgantown 26506, (304) 293-6256.

NOTE - This conference combines the following meetings:
7th Annual Conference, American Society for Surface Mining & Reclamation; 10th Annual Surface Mine Drainage Task Force Symposium; Appalachian Surface Mining and Reclamation Exhibition.

26-27 **Conference, "Comparative Economics of Clean Coal Technologies,"** Vista International Hotel, Washington, D.C., contact Pasha Publications, 1401 Wilson Blvd., Suite 900, Arlington, VA 22209, (703) 528-1244.

26-28 **Annual Meeting, National Independent Coal Operators' Association,** Holiday Inn North, Lexington, KY, contact NICOA, 1514 Front St., Richlands, VA 24641, (703) 963-9011.

30-2 **Short Course, "Groundwater Flow and Transport Modeling,"** University Park, PA, contact R. L. Franz, Penn State University, 126 Mineral Sciences Bldg., University Park, PA 16802, (814) 865-7472.

May

7-10 **American Mining Congress Coal Convention,** Cincinnati Convention Center, Cincinnati, OH, contact AMC, 1920 N St. NW, Washington, D.C. 20036, (202) 861-2800.

23-25 **11th Annual Institute, Eastern Mineral Law Foundation,** Omni Netherland Hotel, Cincinnati, OH, contact Paul L. Dunkle, III, East Mineral Law Foundation, WVU Law Center, P.O. Box 6130, Morgantown 26506, (304) 293-2470.

23-26 **American Mining Congress, Mining Convention '90,** The Fairmont Hotel, New Orleans, LA, contact AMC, 1920 N St. NW, Washington, D.C. 20036, (202) 861-2800