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HUMATE MINING IN NORTHWESTERN NEW MEXICO[1]

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INTRODUCTION

Humates are salts or esters of humic acid (Gary and others, 1972); however, the term "humate" is also used to describe humic acid-rich carbonaceous shale or claystone. The deposits of humate in New Mexico and several other States in the Rocky Mountains and Northern Great Plains generally contain partly coalified plant fragments, and are ordinarily associated with coal. All the humate mined in New Mexico is sold as a soil conditioner.

USES OF HUMATE

Humates are used principally as soil amendments, although the variety known as "Leonardite" has been utilized both as a dispersant and for viscosity control in oil-well drilling muds, as a stabilizer for ion-exchange resins in water treatment, as a source of water-soluble brown stain for wood finishing, and as a binder for briquets made from lignite char (Fowkes and Frost, 1960; Abbott, 1963; Odenbaugh and Ellman, 1967). Insofar as has been determined, none of the humate mined in New Mexico has been used for any but agricultural purposes.

Humates from New Mexico are sold to the agricultural industry in several States as a soil conditioner. (Humates do not meet the legal definition as a "fertilizer" in most States.) The proponents of the product claim, in general, that the application of crushed humate as a soil amendment will enhance productivity by (1) increasing the water-holding capacity which, in turn, aids in the retention of water-soluble chemical fertilizers in the soil, (2) improving the general physical characteristics of the soil, (3) making the soil easier to till, (4) controlling aggregation of the soil particles, and (5) acting as a carrier of plant nutrients including trace elements and water soluble inorganic fertilizers (Burdick, 1965; Sauchelli, 1944; Schnitzer and Poapst, 1967; and Freeman, 1968 and 1970).

APPLICATION AND BENEFITS

Farm Guard Products, Inc., which operates near Cuba, recommends that the crushed humate be applied (dry) at a rate of 400 to 600 pounds per acre, depending on soil pH. The initial application is expected to last 3 years, after which smaller annual applications are recommended to maintain productivity.

The benefits of the application of humate to various types of soils under a range of climatic conditions have not been completely determined and documented by experimental work. However, attributes claimed for the application of humates to soils are supported, in part at least, by research conducted by Schnitzer and Poapst (1967), Freeman (1968 and 1970), Freeman and Fowkes (1968), Owen (1972) and Schrib (1973). Useful bibliographies citing articles that describe some of the extensive research on humates and humic acids as soil amendments and fertilizer supplements performed in other countries are available in articles by Abbott (1963), Youngs (1963), Burdick (1965), Freethan and Fowkes (1968), Freeman (1970), and Cooley, Douglas, Rasmussen, Rasmussen and Theis (1970).

Large amounts of humate are now and will continue to be exposed during strip mining coal in northwestern New Mexico. Investigation and evaluation of the effects of varying amounts of humates on soil redevelopment and plant growth in this area would appear to be particularly timely because the relative efficacy of humates as beneficial amendments to earth being restored after disruption by coal strip mining is unknown (J. R. Gosz and C. T. Siemers, written commun., 1974).

SOURCES OF HUMIC ACID

Humic acid can be recovered in some quantity from peat, peat moss, some forest soils, lignite, and brown coal (Burdick, 1965). Concentrations of humic acids, and their salts (which are properly termed humates), expressed in terms of humic acid, have reached 70 percent by weight in some samples collected from the Upper Cretaceous coal-bearing sediments in northwestern New Mexico (J. W. Husler, written commun., 1974). There are economic deposits of humate-rich material in Arkansas, Florida, Louisiana, New York, North Dakota, Michigan, Minnesota, Texas, and Wyoming according to Burdick (1965). New Mexico obviously should be added to the list. However, over the past decade, despite the considerable interest indicated in exploration for humate in New Mexico, only a few major mines have been opened.

The name "Leonardite" has been given to a similar material high in humic-acid content associated with lignite in North Dakota and the adjacent or nearby States of South Dakota, Montana, Colorado, and Wyoming. A considerable amount of research has been conducted on "Leonardite" by the U.S. Bureau of Mines and others to determine the chemical properties and beneficial uses of this substance (Fowkes and Frost, 1960; Abbott, 1963; Youngs, 1963; and Cooley, Douglas, Rasmussen, Rasmussen, and Theis, 1970).

A number of small operations have opened—and most have closed—in the northwestern part of New Mexico. Wherever the rocks of the Cretaceous Fruitland Formation and Mesaverde Group, with their abundant zones rich in coal and carbonaceous material are exposed, there has been exploration. Investigations have been made near Gallup, near Crownpoint, near Madrid, and in the Cuba-San Ysidro area. For the most part the use of humate has been considered to be only marginally acceptable for agricultural uses in the past, but a substantial body of experimental evidence has been built up which indicates the value of humates in agriculture, and markets have been opening.

1 Publication approved by Director, U.S. Geological Survey

A problem remains in the fact that no widely accepted standards have been established for the composition and properties of the agricultural product. Various deposits over the country ranging from peat moss to coal, with wide variation in included constituents, have been mined and the product sold as "humus" or "humate."

MINES IN NEW MEXICO

Clod Buster Mine

The Clod Buster Mine, operated by Farm Guard Products, Inc., is located in the northwest quarter of sec. 9, T. 19 N., R. 1 W., along the old highway between Cuba and La Ventana (Fig. 1). The company holds leases on about 900 acres of

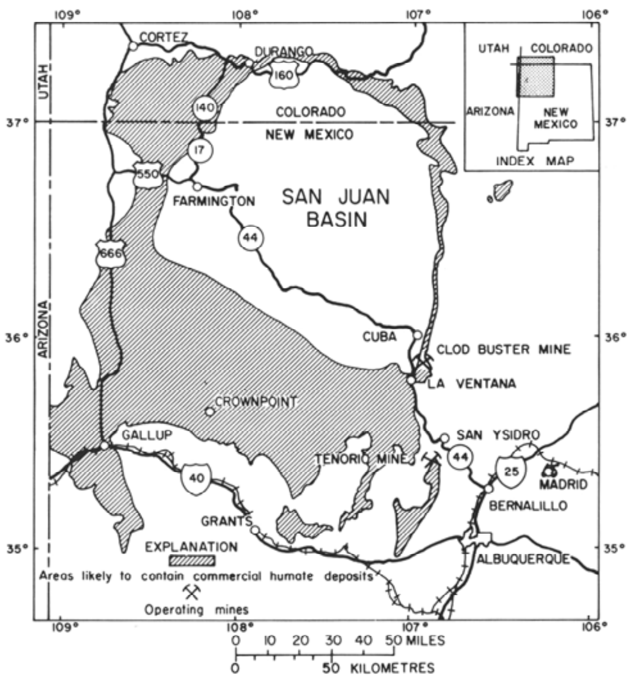

Figure 1. Locations of humate mines and areas likely to contain commercial humate deposits, northwestern New Mexico and southwestern Colorado.

Federal land at that location, and other acreage nearby. The mining operation began in 1965. Production is variable and depends largely on spot sales at this time. Capacity is 80 to 100 tons per day.

The humate-rich bed being mined is near the top of the Upper Cretaceous Menefee Formation (Figs. 2 and 3), associated with the persistent coal zone at the stratigraphic position of the San Miguel (Padilla) coal mines about 1.5 miles to the north. The humate-rich bed is similar lithologically to the brown "underclay," rich in plant fragments, that underlies most San Juan Basin coals. It differs from a typical underclay in that it is not bleached. The bed lies a few feet beneath a light grayish-brown sandstone unit assigned by Dane (Sears, Hunt, and Dane, 1936) to the La Ventana Sandstone Member of the Mesaverde Formation; current usage, however, considers it to be the La Ventana Tongue of the Cliff House Sandstone of the Mesaverde Group (Woodward and others, 1973). The exposure is in an east-facing cuesta along the eastern rim of the

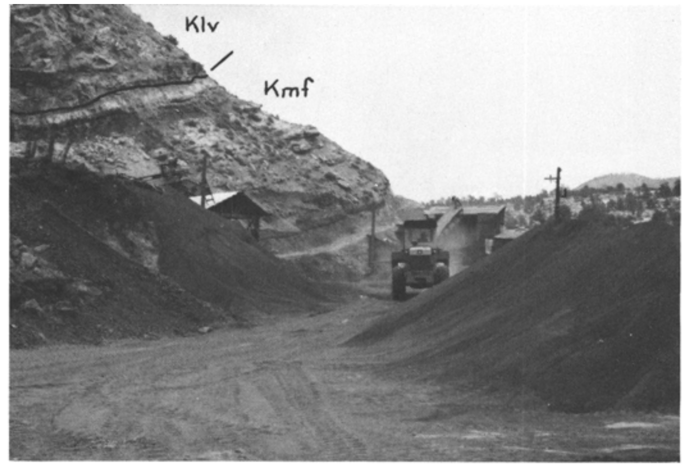

Figure 2. Photograph of Clod Buster Mine operated by Farm Guard Products, Inc. [Humate-bearing material is produced from near the top of the Upper Cretaceous Menefee Formation in sec. 9, T. 19 N., R. 1 W. Klv-La Ventana Tongue of Cliff House Sandstone, Kmf-Mennefee Formation.]

San Juan Basin. The strata in this vicinity dips 8 to 11 degrees in a nearly due west direction and the mine itself is in a gap in the cuesta.

Humate is surface-mined from beneath shallow overburden by a front-end loader, and crushed. It is shipped either in bulk or in sacks of 50- or 80-pound capacity. The material shipped is guaranteed to contain 15 percent or more humic acid. Some bulk shipments are loaded into railroad cars at Bernalillo, and some humate is liquified at the mine and shipped in that form.

Reserves on the company's holdings, based on 50 percent recovery, have been estimated at 155 million tons. The bed averages nearly 20 feet in total thickness, including sandstone stringers that are discarded in mining.

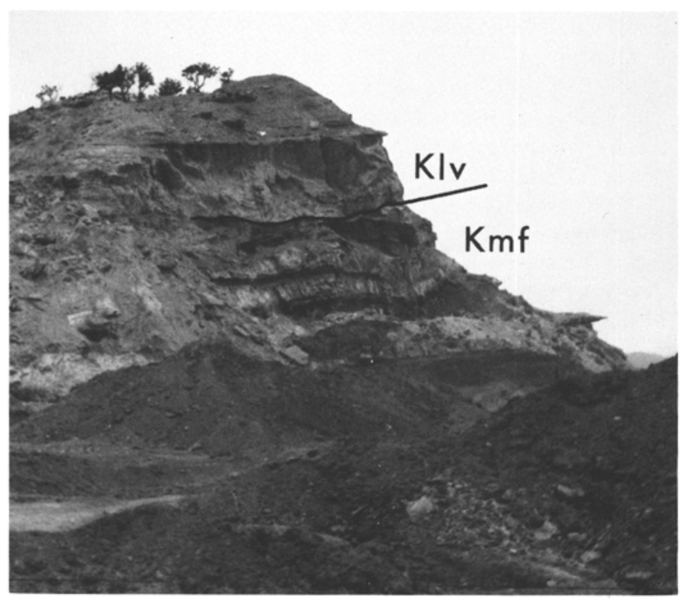

Figure 3. Photograph of outcropping Upper Cretaceous strata at Clod Buster Mine; view to north, beds dip 8-11° westward into the San Juan Basin. [Humate-bearing material is produced from near the top of the Upper Cretaceous Menefee Formation in sec. 9, T. 19 N., R. 1 W. Klv-La Ventana Tongue of Cliff House Sandstone, Kmf-Menefee Formation.]

Various clay minerals including kaolinite, illite, mixed layer illite-montmorillonite, possibly some montmorillonite [Na variety(?)] and chlorite have been identified in one sample obtained from the pit at the Clod Buster Mine (C. T. Siemers, written commun., 1974).

Tenorio Mine

The Tenorio Mine, in sec. 4, T. 14 N., R. 1 E., about 8 miles southwest of San Ysidro (Fig. 1), has been operated by Humus Organic Products, Inc. for about 8 years. The company holds leases on 640 acres of fee land at the mine site, and on 80 acres of Zia Pueblo lands nearby. Production has been increasing steadily; 1,200 tons were shipped in 1971, 2,400 tons in 1972, and 2,750 tons in 1973. Production for 1974 is projected at over 6,000 tons.

The Tenorio Mine is also in the coal-bearing upper part of the Menefee Formation, but at a considerably higher stratigraphic position than that of the Clod Buster Mine. The Tenorio humate bed is in that part of the Menefee section which is the landward equivalent of the La Ventana Tongue of the Cliff House Sandstone (Woodward and others, 1973; Shomaker, Beaumont and Kottlowski, 1971).

The fee leases are estimated by the company to contain proven reserves of 3,871,200 tons, based on a thickness of 15 feet. Reportedly, the thickness of the humate-bearing beds ranges from 17 to 28 feet. Additional reserves of some 10 million tons are thought to be potentially present. The reserve estimates assume surface mining with little or no overburden being removed.

The 80-acre Zia Pueblo lease is estimated to contain 35 acres of exposed humate material. Using an 80-foot thickness, 4,616,400 tons of proven reserves were estimated. The actual thickness is said to range from 85 to 120 feet. An additional 2,580,800 tons is thought to be present under more than 20 feet but less than 50 feet of overburden.

Humate has been mined from less than 2 acres, all in the fee acreage, during several years of intermittent production.

The run-of-mine material is trucked to Bernalillo, where it is crushed in a hammermill at the company's preparation plant. The product is shipped primarily by rail in bulk and sold principally to the agricultural industry in Iowa, Minnesota, and South Dakota.

A representative proximate analysis of the material shipped is listed as sample number 1 in Table 1. The company guarantees 50 percent humic acid content in the material shipped. Concentrations of trace elements are commonly determined and made available to those who may be interested. A representative composite analysis is given in Table 2.

World Humates, Incorporated

The most ambitious humate operation announced thus far is that of World Humates (Cohea, 1974). The company has not yet begun operation (April 1974) but has announced plans for initial production of 60,000 tons annually and eventually yearly output of 250,000 to 500,000 tons. The company is leasing some fee acreage, and is negotiating for additional Federal lands (about 3,000 acres), all in the vicinity of Cuba.

MARKET VALUE

Market value of humate is high compared with surface-mined coal or such similar products (with respect to mining and processing cost) as sand, gravel, and pumice. The U.S. Bureau of Mines (1974) reports the value of 1973 production to be on the order of $17 per ton; the authors arc aware of shipments at considerably higher prices. In all probability, prices are higher and less stable than they would be if the market were much larger. Fine to coarsely crushed humate is bagged and sold in the lawn and garden retail market in New Mexico for approximately $2.50 per 50-pound bag, an equivalent of $100.00 per ton.

Table 1. Proximate analyses of humate and humic acid-bearing materials. Values in percentage of initial weight of sample.[1]

Sample number	Moisture (water loss at 110°C)	Loss on ignition	Humic acid, soluble in 1 N NaOH	Humic acids	Carbon (approximate)
1 2/	10.46	56.89	41.12	56.12	-
2 3/	8.86	23.30	26.40	43.18	6.35
3 3/	4.79	14.09	2.82	4.44	3.84
4 3/	-	-	-	38.75	-
5 3,4/	-	-	16.4	24.0	-
6 3,4/	-	-	22.4	37.6	-
7 3/	19.68	-	36.38	39.28	-

1/ Analyses by John W. Husler, Chemist, Department of Geology, University of New Mexico
2/ Sample from Tenorio Mine, sec.4, T.14 N., R.1 E., Sandoval County, New Mexico.
3/ Sample from unknown locality in northwestern New Mexico.
4/ Composite sample.

CONCLUSIONS

The coal-bearing Upper Cretaceous strata of northwestern New Mexico contain many millions, and probably billions, of

Table 2. Representative composite analysis of trace elements in humate from the Tenorio Mine, sec. 4, T. 14 N., R. 1 E., Sandoval County, New Mexico.[1]

Element	Percent by weight	Element	Percent by weight
ZnO	0.007	SnO_2	0.0007
SrO	.0007	Au	not determined
K_2O	.70	TiO_2	.40
Na_2O	.65	B_2O_3	1.68
Li_2O	.004	WO_3	.01
CdO	.001	Cr_2O_3	.003
Bi_2O_3	.0015	CaO	.11
CuO	.0060	Al_2O_3	8.6
MnO	.008	SiO_2	20.7
MoO_3	.001	V_2O_5	.015
CoO	.0012	PbO	.05
AgO	.001	Mg	.14
NiO	.003	Fe_2O_3	2.46

1/ Analyzed by John W. Husler, Chemist, Department of Geology, University of New Mexico.

tons of humate. Limited amounts of humate that varies widely in quality are now being produced at two small strip mines near Cuba and San Ysidro in the eastern part of the San Juan Basin.

Enormous amounts of humate will be exposed during coal strip mining in the San Juan Basin. By 1985, coal production from strip mines is projected to be about 100 million tons per year. If the "underclay" associated with the mined coal beds proves to be usable humate-rich soil conditioner, and averages 1.5 feet thick, then on the order of 10 million tons of "humate" will be exposed each year. Additional research would be helpful in determining (1) the possible benefits of the humatc as a soil amendment in the surface-restoration processes at the coal strip mines, (2) the benefits of the application of humate of variable quality as a soil conditioner and fertilizer supplement for the agricultural industry, and (3) the optimum effectiveness of humates as soil amendments as related to various types of soils in differing climatic settings.

One of New Mexico's most abundant natural resources may have been neglected during the search for fossil fuels and base metals. The commercial value of these vast deposits can be ascertained through an investment in research that brings together the talents of the geologist, biologist, soil scientist, chemist, and economist as a team.

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