GEOLOGY AND MINERAL RESOURCES

COSSATOT-LITTLE MISSOURI PLANNING UNIT

OUACHITA NATIONAL FOREST

BY

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Arkansas Geological Commission

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INTRODUCTION

The Cossatot-Little Missouri Planning Unit of the Ouachita National Forest occupies the southwest corner of the Ouachita Mountain region of Arkansas and includes some of the region's most rugged terrain. Most of the topography of the Ouachitas is of the ridge and valley type. Many of the ridges can be traced for miles, and others are isolated irregular hills. The bedrock of this part of the Ouachita Mountains is essentially sedimentary rock; mostly shale, sandstone, novaculite, and chert with minor occurrences of limestone. Unconsolidated rocks are limited to: Surface and near-surface weathered rock; accumulations of slumped material on the lower slopes of ridges; and thin, shallow accumulations of sand, gravel, and cobbles in stream and river beds and valleys.

SURFACE FEATURES

The principal subdivisions of the Ouachita Mountain Range that lie within the Cossatot-Little Missouri Planning Unit are the Cossatot, Caddo, and Northern Mountains. The Cossatot Mountains occupy most of the southern half of the Planning Unit. They vary in breadth from a single narrow ridge to a series of parallel ridges 6 miles wide. The Cossatot Mountains are the highest of the novaculite ridges in Arkansas, a number of peaks standing more than 2,300 feet above sea level. The Athens Plateau borders the Cossatot Mountains on the south and west and is an area of more gentle relief. The surface is characterized by low, east-west trending hills and ridges that rise 150-250 feet above the adjacent valleys. The Caddo Mountains are the principal range in the northern and central portions of the Planning Unit extending

in a roughly east-west belt across it. They consist of parallel ridges which have an average height of 500 to 600 feet above the adjacent stream valleys and rise into a few peaks that stand 1,000 feet above the neighboring lowlands. Along the extreme northern portions of the Unit near Board Camp the Northern Mountains comprise a small east-west trending belt. There are several sharp crested ridges that rise some 300 to 400 feet above the adjacent valleys. The rocks of the Cossatot-Little Missouri Planning Unit were originally deposited as relatively flat layers of mud, sand, and silica in the waters of an ancient basin that once occupied the area. Subsequently, they were compressed and partially hardened by the weight of overlying sediments and the mud was converted to shale, the silica to novaculite or chert beds and the sands to sandstone beds. These beds were then subjected to intensive compressive forces that bent or folded them and at many locations ruptured or faulted them. During and following this long period of rock deformation the region was uplifted into mountain ranges and the forces of erosion began to modify the shape and height of these mountains. These erosional processes have reduced the mountains to their present configuration and, indeed, are still at work. The present land forms are a reflection of the underlying bedrock. The softer and the more highly fractured rocks, as shale, being more susceptible to erosion, form the valley floors, the lower hills and the lower slopes of the higher ridges, while the hard massive rocks like the novaculite form the core of the elongate high ridges. The intricate outcrop patterns displayed by the various rock types on the accompanying bedrock map is evidence of the extensive deformation (faulting and folding) of the rock layers in this area.

ROCK TYPES

On the accompanying bedrock map the various rock types have been identified by symbols. These symbols represent one or more geologic formations as follows:

Ms	-	Stanley Shale
N	-	Arkansas Novaculite
SO	-	Missouri Mountain Shale, Blaylock Sandstone and Polk Creek Shale
Obf	-	Bigfork Chert

The following paragraphs provide additional details on the type of rocks in these formations that could not practically be included in the map legend.

The Stanley Shale Formation (Ms) has a maximum thickness of 8,500 feet and is comprised mostly of brownish green to black shale. Sandstone constitutes about one-fourth of the formation and typically is fine-grained and hard where fresh, but it breaks down on weathering and forms a few prominent ridges. Thus, the Stanley Shale Formation typically is exposed in valleys, basins or low hills in the Planning Unit. Although there has been little, if any, commercially produced barite, small deposits are known in the Stanley on Viles Creek in the extreme southeastern corner of Polk County. Significant deposits of barite occur in the base of the Stanley in Montgomery County and Hot Spring County to the east of the Planning Unit; therefore, the lower part of the formation must be considered to have a potential for barite deposits.

The Arkansas Novaculite Formation (N), consisting predominantly of novaculite with subordinate, though considerable, amounts of shale, obtains a thickness of 950 feet in the southern part of the Planning Unit, 600 feet in the central part, and 200 feet along the northern border. Novaculite is a hard dense rock comprised essentially of silica, usually white in color, and resembling unglazed porcelain in general appearance and texture. The Arkansas Novaculite Formation throughout most of the area is divisible into three distinct divisions: a lower one of massive white novaculite, a middle division of dark novaculite layers interbedded with shale and an upper division of white thin-bedded novaculite. The Arkansas Novaculite in this part of the Ouachita Mountains crops out in narrow, more or less parallel, nearly east-west belts. The novaculite resists weathering, to a greater extent than the adjacent strata above and below, which causes it to stand out in sharp ridges. Novaculite is best known as a raw material from which whetstones are made and one quarry in Pike County has produced novaculite for this purpose. Manganese prospects are known to occur in both the upper and lower divisions of the formation at several localities in the Planning Unit and tripoli deposits occur in the upper division of the formation along the Polk-Howard and Montgomery-Pike County boundaries. Some copper mineralization is often associated with the manganese. Small barite occurrences are reported in the middle division of the Arkansas Novaculite in west-central Polk County and elsewhere in the area.

As noted, the SO symbol includes the outcrop area of three Formations: the Missouri Mountain Shale, the Blaylock Sandstone and the Polk Creek Shale. The Missouri Mountain Shale is about 50 feet thick along the southern border of the Planning Unit, reaches a maximum thickness of 300 feet in the central part of the Unit and 150 feet along the northeastern boundary. The Missouri Mountain lies between the Arkansas Novaculite Formation and the Blaylock Sandstone; it is typically a red or green shale or slate. It generally crops out in narrow valleys or on steep slopes. At a few localities in Polk County it has been quarried for interior use, ornamental stone, and slate granules. Some small barite occurrences are reported from the Unit in west-central Polk County.

The Blaylock Sandstone lies between the Missouri Mountain Shale and the Polk Creek Shale. It is about 1,000 feet thick in the southern portions of the area, about 10 feet thick in the central portions, and is absent in the northern portions. It is comprised of alternating thin brownish gray sandstone and gray shale layers. It forms rough rocky strips on mountain slopes and in narrow valleys. No significant economic mineral prospects have been noted in the Formation.

The Polk Creek Shale varies in thickness from 120 to 175 feet. It is a black shale, sooty in appearance in a few localities, and contains fossil graptolite imprints, a rare feature for most Ouachita Mountain rocks. It is exposed in narrow strips both on the mountain slopes and in valleys. There are no significant economic mineral prospects known to occur in the Polk Creek Formation.

The symbol Obf on the map depicts the distribution of the Bigfork Chert Formation in the Planning Unit. The Bigfork ranges in thickness from about 500 feet in the north to about 750 feet in the south. It is composed primarily of thin-bedded highly fractured gray chert (a hard dense rock comprised essentially of silica). The formation in some places contains some limestone and hard shale layers interbedded with the chert.

In contrast to the novaculite ridges the Bigfork Formation tends to form a line of irregularly shaped hills that trend in a general east-west direction. The Bigfork, because of its intense fracturing, is considered an important aquifer in the Ouachita Mountains. The minute jointing of the Bigfork Chert causes it to weather readily into finely broken material that accumulates at the base of hills and can be used directly as road metal.

MINERAL RESOURCES

The principal mineral resources of the Cossatot-Little Missouri Planning Unit are barite, clay, copper, manganese, slate, tripoli and whetstone. Some of the other mineral resources in the Unit are road material, quartz, iron, and phosphate. Development of the mineral resources in the Unit has been slow, the first prospecting and exploration starting in the late 1800's. Potential for future development is brighter, because of the shortages of our resources. The following is a brief discussion of the mineral resources of the Unit, including their occurrences, history, and potential.

Barite. A sulfate of barium, barite is a heavy mineral usually gray in color, granular to crystalline, occurring in beds, nodules, or veins in the lower Stanley Shale, the middle division of the Arkansas Novaculite and possibly in the Missouri Mountain Shale at several locations in and near the Unit.

Barite was first discovered in Arkansas in 1888 in Montgomery County apparently just to the east of the Unit. Since 1944 Arkansas has been at, or near, the top in barite production in the United States, mostly from a single large, but similar deposit near Magnet Cove in Garland County. The principal use of Arkansas barite has been in the manufacture of a weighting agent for drilling muds in the oil industry.

There has been little, if any, recorded production of barite in the Unit, but immediately to the east of Albert, Arkansas, in the Fancy Hill District in Montgomery County there has been some small-scale mining, particularly between 1957 and 1961. There are five barite deposits in the Fancy Hill

District that possibly could extend a limited distance westward into the Unit. These are the Fancy Hill in sections 19 and 29, T. 4 S., R. 26 W., Sulphur Mountain in sec. 29, T. 4 S., R. 26 W., and Cogburn in sections 32 and 33, T. 4 S., R. 26 W., which are bedded occurrences in the basal Stanley Shale. The other two deposits are the Polk Creek Mountain in secs. 11 and 12, T. 4 S., R. 27 W., and the Boone Springs Creek in sec. 24, T. 4 S., R. 27 W., which has small nodular beds and veins in the middle division of the Arkansas Novaculite.

The following is a list of the known significant barite occurrences within the Unit. The Viles Creek Prospect is in the SE¼ SE¼ of sec. 36, T. 4 S., R. 28 W., in the extreme southeastern corner of Polk County. A single lens of barite some 50 feet long and a foot thick was found in the northward dipping Stanley Shale. Small lenses of barite were prospected north of Gilliam Springs in sec. 16, T. 4 S., R. 30 W., Polk County, on the west bank of the Cossatot River. The lenses occur in vertically dipping shale in the middle division of the Arkansas Novaculite. The Hatfield Barite District in the western part of the Cossatot Mountains includes about 60 prospects which contain crystalline layers or veins of barite. A brief description of several of the larger prospects follows. The Bee Mountain Prospect in the SE¼ NE¼ of sec. 15, T. 5 S., R. 31 W., is along the south flanks and near the west end of this anticlinal mountain. A pit measuring 20 feet long, 10 feet wide, and 7 feet deep was dug, and a few tons of dark gray crystalline barite were removed. The barite layer varies from 6 to 14 inches in width and is interbedded with shale and novaculite. On Boar Tusk Mountain in the SE¼ NW¼ of sec. 23, T. 3 S., R. 31 W., excavations reveal both crystalline barite in fractures in novaculite and disseminated barite in shale. Samples of the shale contained an average of 22 percent $BaSO_4$. Some of the crystalline barite was nearly pure. Boulders as much as 30 inches wide were noted in the dumps. Several other small prospects are located to the southwest and east of the mountain and one of particular interest in the SW¼ NE¼ of sec. 22 reveals barite beneath a manganese interval.

The Two Mile Creek Prospects occur in the N½ NW¼ SE¼ of sec. 12, T. 3 S., R. 31 W., and in the SE¼ SW¼ of sec. 11, T. 3 S., R. 31 W., and lenses of crystalline barite are scattered through the middle member of the Arkansas Novaculite. The mineralized zone is about 40 feet thick, with an aggregate barite thickness no more than 5½ feet. Individual barite lenses are no more than 1 foot thick and not over 50 feet in length and they dip with the enclosing strata to the southwest at about 65°.

At the present there are no known commercial barite deposits in the Planning Unit, but it is thought that during times of peak oil well drilling and dwindling domestic supplies that some further barite exploration can be expected. Furthermore, it is not unlikely that deposits with economic potential will be found, whether they be on westward extensions of the Fancy Hill District herein described, or at some other locality. It is suggested that commercial deposits are more likely to occur in the basal Stanley Shale.

Clay. Clay deposits of weathered shale and slate from the Stanley Shale, Polk Creek Shale and Missouri Mountain Shale are found within the Planning Unit. The clay is restricted to the weathered surface, up to 10 feet in depth. Clay has been mined from the Stanley Shale in the past north of the Planning Unit around Mena and used to make common brick and sewer tile. There is no known production from within the Planning Unit, but clay deposits occur in the SW¼ NE¼, sec. 19, T. 3 S., R. 28 W., and the SW corner of sec. 24, T. 3 S., R. 29 W., in Polk County. Abundant reserves of this weathered shale and slate are available upon demand.

Copper. Copper mineralization occurs in the Arkansas Novaculite in association with the manganese. The copper-bearing minerals are turquoise, malachite, azurite, chrysocolla, chalcopyrite and native copper in fractured beds of the Arkansas Novaculite. The significant copper occurrences in the Planning Unit are in T. 3 S., Rs.28-30 W., T. 4 S., Rs. 27-28 W., and in T. 4 S., R. 31 W.

The first prospecting and exploration of copper began in this area in 1885 but development was slow and there is no recorded production. Malachite, chalcopyrite and native copper

have been found associated with the manganese at North Mountain Mine in the SE¼ NW¼ of section 10, T. 4 S., R. 27 W., in Montgomery County. In 1917 and 1922 an adit was dug northward some 600 feet into North Mountain. It has been reported that at 550 feet the adit crossed a 12 foot wide zone of native copper along bedding planes and fractures in the novaculite. Some attractive specimens of native copper are present in the mine dump.

In recent investigation of the novaculite across the southern part of the Planning Unit, copper concentrations up to 1.3% occur in the manganese oxide ores. No systematic evaluation has been undertaken, but investigation indicates the possibility of low-grade copper deposits. Wavellite and variscite occurrences in the northern part of the Planning Unit contain up to 1% copper. Most of these occurrences are in the Bigfork Chert. Since the copper is often associated with the manganese, it could prove a valuable by-product upon beneficiation of the manganese ore.

Manganese. Manganese deposits in the Planning Unit are found in both the upper and lower divisions of the Arkansas Novaculite Formation. The ore occurs as nodules, pockets, and short irregular veins varying from a fraction of an inch to rarely four feet in thickness. The ores occupy cracks in the rocks or form a cement between fragments of novaculite. The quantity of manganese ore that can be expected to occur in any one deposit is doubtlessly small and under normal market conditions probably would not support a profitable mining operation. The manganese deposits have only been worked in a rather small way intermittently from 1859 to the present day. Trenches, pits, adits, and shafts have been dug at more than 50 separate sites in the area. The following is a partial description of some of the more significant mines that were active during the 1950's.

North Mountain Mine in the SE¼ NW¼ of sec. 10, T. 4 S., R. 27 W., Montgomery County was first active in 1886 and last worked in 1958. Manganese occurs as fillings in a heavily fractured east-west trending band of upper, middle, and lower divisions of the Arkansas Novaculite which is overturned to the north at a steep angle. Veins up to a maximum of 8 feet in

width have been encountered in various adits and surface cuts. Copper, iron minerals, and small quartz veins are associated with the manganese. About 150 tons of milling-grade ore were produced in 1958.

The Lost Hatchet Mine in the SE¼ NW¼ sec. 36, T. 3S., R. 28 W., Polk County employed open pit mining operations to recover manganese ore during 1954. Psilomelane and lesser quantities of pyrolusite and manganite occur in a 50 foot wide zone in steeply dipping novaculite beds of the upper division of the Arkansas Novaculite which was mined to depths of 75 and 175 feet in two pits 100 and 200 feet long. Iron minerals and small quartz veins are associated with the manganese. It has been estimated that the deposit contains 50,000 tons of milling-grade manganese ore. The Lost Hatchet Mine has yielded more tonnage of ore than any other mine in Polk County.

The Coon Creek Mine in the SE¼ NW¼ sec. 13, T. 4 S., R. 28 W., Polk County had its most recent activity during the Fall of 1958. Other significant older mining operations and prospects occur in the general area. The Coon Creek workings consist of two sidehill open-cuts and several shallow pits with a 10-20 wide mineralized zone in or near a fault zone in southward-dipping massive, dense Arkansas Novaculite. The deposit also contains a bountiful suite of iron phosphate and some copper minerals. It has been estimated that some 2,000-4,000 tons of manganese are present at the deposit.

The Eagle Mountain Mine in the NW¼ SE¼ of sec. 25, T. 3 S., R. 30 W., Polk County had some small production in 1958. Manganese, generally of poor quality, was hand mined from several pockets about 8 feet wide and 50 feet long in massive, dense, highly fractured, steeply dipping, Arkansas Novaculite. The manganese has a rather high iron content.

The Hog Pen Mine in the SE¼ NW¼ sec. 5, T. 5 S., R. 26 W., Pike County had some small production in 1958. A 6-foot wide and 500-foot long mineralized area occurs in a vertically dipping, broken zone of hard, dense Arkansas Novaculite. The ore was mined through an inclined adit. It has been reported that a carload of ore from the property assayed 44.15 percent manganese, 0.34 percent phosphorous and 12 percent silica. See Tables 1, 2 and 3 for a brief summation of many of the manganese mines and prospects in the Planning Unit area.

TABLE 1. - Manganese mines and prospects in Planning Unit area - Montgomery County

Location	Active period	Unit	Type of deposit	Quantity produced and grade
SE¼NW¼ sec. 10, T. 4 S., R. 27 W.	1886-1958	North Mountain Mine	Fracture fillings in novaculite; psilomelane	150 tons 56%
Secs. 17-18, T. 4 S., R. 27 W.		Sugartree Mountain		

TABLE 2. - Manganese mines and prospects in Planning Unit area - Pike County

Location	Active period	Unit	Type of deposit	Quantity produced and grade
Cen S½N½ sec. 9, T. 5 S., R. 25 W.	1916	Fagan mine	Thin veins of sparse manganite with iron oxide.	
NE¼NW¼ sec. 8, T. 5 S., R. 25 W.		Bear Mtn. prospect	Psilomelane and manganite lenses along bedding	
NW¼SE¼ sec. 11, T. 5 S., R. 26 W.	1916	N.F. White prospect	Thin seams of psilomelane and manganite	
NW¼SW¼NW¼ sec. 10, T. 5 S., R. 26 W.	1916	Rattlesnake prospect	Few limonite and psilomelane veins. Maximum width 9 inches.	
S½NE¼ sec. 6, T. 5 S., R. 26 W.	1916; 1954	Still mine (Sausman adit)	Mostly wad, some psilomelane with disseminated manganite. Partly in clay. Partly veins.	45 long tons 45%

TABLE 2. - Manganese mines and prospects in Planning Unit area - Pike County (continued)

Location	Active period	Unit	Type of deposit	Quantity produced and grade
SE¼SE¼NE¼ sec. 6, T. 5 S., R. 26 W.	1916	Prospect No. 3	Psilomelane with minor wad and limonite in clay zone 7 feet wide.	
SW¼SW¼NW¼ sec. 5, T. 5 S., R. 26 W.	1916	Prospect No. 2	Small pockets and veins of wad mixed with clay. Total is very small part of the whole.	
SW¼NW¼ sec. 5, T. 5 S., R. 26 W.	1950's	Hog Pen Mountain	Fracture filling, psilomelane and pyrolusite.	100 tons
SE¼SE¼NW¼ sec. 6, T. 5 S., R. 26 W.	1916	Risner Mountain prospects	Very thin veins of psilomelane, limonite, and ferruginous manganese oxide	
SW¼SW¼ sec. 5, S½SE¼ sec. 6, T. 5 S., R. 25 W.	1950's	North American Manganese Co.	Pockets of psilomelane with inclusions of pyrolusite in novaculite.	
NW¼NE¼, E½NE¼ sec. 8, W½NW¼, SE¼NE¼, S½NE¼ sec. 9, T. 5 S., R. 26 W.		Joseph Kehr prospect	Psilomelane in breccia zone and narrow veins in fractures associated with faults.	

TABLE 3. - Manganese mines and prospects in Planning Unit area - Polk County

Location	Unit	Active period	Type of deposit	Quantity produced, short tons	Grade of ore, percent manganese
SE¼NW¼ sec. 13, T. 4 S., R. 28 W.	Coon Creek Mine	1942, 1956-59	Psilomelane in fractured novaculite. Some replacement.	50 concentrate	5-10
SE¼NW¼ sec. 36, T. 3 S., R. 28 W.	Lost Hatchet Mine	1956-59	Psilomelane in novaculite	10	6.77 *
Center W½SW¼ sec.27, T. 3 S., R. 30 W.	Ark. Development Co. mine (Ward mine)	1888	Veins, pockets of pyrolusite and psilomelane.	20 ore.	
NW¼SE¼ sec. 25, T. 3 S., R. 30 W.	Eagle Mountain mine	1956-59	Lenticular pocket in fractured novaculite	Small	
Parts of SE¼, sec. 19, SW¼ sec. 20, and NW¼ sec. 29, T. 3 S., R. 30 W.	Boar Tusk prospect		Fractured novaculite.	-	7.64
Parts of SE¼ sec. 27, N½ NE¼ sec. 34, S½S½ sec. 26, T. 3 S., R. 30 W.	American prospect		-------do-------	-	5.5-6.34

TABLE 3. - Manganese mines and prospects in Planning Unit area - Polk County (continued)

Location	Unit	Active period	Type of deposit	Quantity produced, short tons	Grade of ore, percent manganese
SE¼SE¼SE¼ sec. 5, T. 4 S., R. 30 W.	West Hanna Mountain (Bowen claim)		Psilomelane and manganite seams to 3 inches thick and 3 feet long in fractured novaculite.		
SW¼SW¼ sec. 1, T. 4 S., R. 30 W.	West Hanna Mountain (W. Allen claim)		Psilomelane and manganite seams to 3 inches thick in fractured lower novaculite.		
NE¼NE¼NE¼ sec. 10, T. 4 S., R. 30 W.	Prospect		Manganese ore in veins and pockets in novaculite.	-	37.96
SW¼NW¼SE¼ sec. 10, T. 4 S., R. 30 W.	---do---		----------do--------	-	10.35
Center N½N½ sec. 10, T. 4 S., R. 30 W.	---do---		----------do--------	-	3.48
SE¼NE¼SW¼ sec. 10, T. 4 S., R. 30 W.	---do---		----------do--------	-	6.17

TABLE 3. Manganese mines and prospects in Planning Unit area - Polk County (continued)

Location	Unit	Active period	Type of deposit	Quantity produced, short tons	Grade of ore, percent Mn
SE¼NW¼NW¼ sec. 10, T. 4 S., R. 30 W.	Prospect	-	Manganese ore in veins and pockets in novaculite.	-	2.12
SE¼SW¼SE¼ sec. 5, T. 4 S., R. 30 W.	---do---	-	--------do--------	-	.29
SE¼SW¼SE¼ sec. 5, T. 4 S., R. 30 W.	---do---	-	--------do--------	-	15.32
SW¼NE¼ sec. 6, T. 4 S., R. 29 W.	Sugarstick mine	1921, 1942 1952	Ore on bedding planes in novaculite.	18 carloads	40+
NE¼NW¼ sec. 33, T. 3 S., R. 29 W.	Dr. Scott claim and prospect	1951		22 tons	40+
SE¼NE¼ sec. 7, T. 4 S., R. 29 W.	Pickel Manganese prospect	-	Massive to concretionary psilomelane and pyrolusite, 4- and 6-foot zones in novaculite.	-	-
NW¼ sec. 29, T. 4 S., R. 28 W.	E. S. White prospect	-	Psilomelane in fractures and replacing novaculite.	-	5-10

* Largest producer in Polk County

The manganese resources of the area are incompletely evaluated but we can surmise that small deposits, possibly ranging up to 50,000 tons, of relatively high-grade ore are scattered over a rather large area. The aggregate tonnage potential is significant probably amounting to several hundred thousand tons containing 5-10 percent manganese. Improved milling techniques, such as blending of ores to provide a uniform feed, should lower the cost and improve the value of the product.

The manganese in this area prevently needs higher prices or government support to generally be commercially produced. However, its reserve should augment the United States supply in times of dire needs. Also the commonly associated copper minerals could prove an economic by-product upon beneficiation of the manganese ore. Thus, these deposits actually represent an invaluable economic resource.

Slate. Slate deposits in the Planning Unit are found in both the Missouri Mountain Slate and in the lower Stanley Shale. The Missouri Mountain Slate is buff, red, and green, usually soft but with some fairly hard and homogeneous. Its lack of resistance to weathering has mostly restricted its use to interior decorative purposes. Thickness will vary from 50 feet or less to 300 feet. In the Stanley Shale the slate is hard, gray to black, and contains some thin sandy or quartzitic layers. Horizons in the lowermost Stanley were known as Fork Mountain slate in the early development of the area. Building slate was quarried in the Planning Unit prior to 1900, with the last recorded production in 1964.

A company to the east of the Unit in Montgomery County is presently quarrying Stanley slates for the production of roofing granules. Upon demand the Stanley slates offer the same high quality product in the Unit area.

Tripoli. Tripoli is normally considered a finely granular, porous, comparatively soft silica of a cryptocrystalline character. It is used principally for an abrasive, polishing agent, and as a filter or additive. The high silica tripoli in the Planning Unit area occurs primarily in the upper division of the Arkansas Novaculite. The most significant deposits are in several complexly folded structures along the southern border of the Cossatot Mountains. Minor tripoli occurrences are also found in the lower division of the Arkansas Novaculite and the Bigfork Chert.

The tripoli mined is from weathered rock in the upper division of the Arkansas Novaculite and is composed of many, thin, interbedded layers which in places exceed 100 feet in thickness, with few, if any, highly resistant beds. It occurs generally on the sides of hills along the flanks of anticlines and synclines, and except in one area it generally has a steep inclination of dip ranging from about 45° to vertical. Upon pulverizing, the tripoli ranges in color from light-brown, creamy white to white, and ranges from about 0.01 to 0.001 millimeters in diameter. Tripoli has been mined intermittently in the area since the W. C. Ross Manufacturing Company of Little Rock obtained a few carloads in 1914 and 1915. Increased activity has taken place from 1963 to 1972 when four mines were sporadically operated and an estimated 32,000 tons valued from about $17 to $28 per ton were processed at Glenwood by the Caddo, Industrial, and Hercules Minerals Corporations. At the present time the deposits are mined sporadically by the Arby Industrial Minerals Corporation which hauls the material to Dierks, Arkansas, for processing.

The Pike County tripoli deposits occur in the NW¼ of sec. 6, T. 5 S., R. 26 W., and extend westward to about the center of sec. 5, T. 5 S., R. 27 W. The deposits are generally about 100 feet in thickness and occur in the upper division of the Arkansas Novaculite. Three open pit mines have been operated along this exposure and include:

(1). a pit in the NW¼ NW¼ sec. 6, T. 5 S., R. 26 W., has exposed over 100 feet of soft to somewhat resistant, mostly light brown, gently southwestward dipping, interbedded layers of tripoli. There is little significant overburden at the site and only a few thousand tons have been mined;

(2). another pit is located in the SW¼ NW¼ NE¼ sec. 1, T. 5 S., R. 27 W., and has exposed about 95 feet of brown to light brownish white, gently southward dipping, relatively thin, interbedded layers of tripoli. There is little significant overburden at the site. Several thousand tons of material have been mined;

(3). and a pit, trending east-west, on the south flank of a small mountain is in the NW¼ sec. 1, T. 5 S., R. 27 W., exposing about 90 feet or more of generally very light brown to creamy white to white, rather steeply southward dipping, tripoli. There are some problems with overburden at the site. Several thousand tons of material have been mined.

The Montgomery County deposit occurs on the south flank of an anticlinal mountain along the southern portions of sec. 31, T. 4 S., R. 27 W., in the upper division of the Arkansas Novaculite. The tripoli is very light brown to white and the interval is possibly over 90-100 feet in thickness and dips about 70° to the south. A nearly horizontal prospect tunnel was extended into the deposit in the NW¼ SE¼ SE¼ of sec. 31, but reportedly it was a gold prospect. This site has good tripoli potential, but has minor overburden problems. Also, there is rather poor access to the deposit.

The Polk County tripoli deposits occur mostly along two very narrow and small, anticlinal features along the southern portions of T. 4 S., R. 29 W. These deposits also occur in the upper division of the Arkansas Novaculite. The eastern occurrence begins in the NE¼ SE¼ SW¼ of sec. 25 and extends westward to the NE¼ SW¼ of section 26. A mine was opened on the southern portion of the small anticline in the NW¼ SW¼ of section 26. Several thousand tons of a brown to light brown tripoli were obtained from this exposed 105 feet of interbedded, soft to somewhat hard, vertically dipping tripoli. No overburden problems were encountered.

The other deposit begins immediately to the west in the NW¼ SE¼ of sec. 27 and extends in a very narrow belt to the extreme southwest corner of sec. 20, T. 4 S., R. 29 W. Thick, rather similar, tripoli intervals occur throughout both of these small structures and undoubtedly large quantities are present.

The tripoli deposits described herein constitute an inferred reserve of material likely over 75 million tons; which is about one-third soft and white, one-third white to cream and partially cemented, and one-third cream to buff being somewhat hard and porous but usually easily reduced by crushing.

The major undesirable features of the deposits are the 20 miles or so distance from the milling plant and railroad facilities. It is thought that the plentiful source of this high quality, low cost material should help make it competitive with other tripoli producers and also for other markets where it could be substituted for diatomite, pumice, talc, and other materials. A general increase likely can be expected in the production of tripoli in the Unit.

Whetstones. There are two commercial classes of abrasive grade novaculite, the hard, dense, rather translucent "Arkansas" stone and the softer and more porous "Ouachita" stone. In the past years most of the whetstones have been quarried from the Arkansas Novaculite and sometimes processed for market in the Hot Springs area of Garland County. In recent months supplies of whetstones reportedly have become more difficult to obtain in the Hot Springs area and the market demand has also increased. Thus, a quarry operation has been initiated in the NE¼ NW¼ sec. 6, T. 5 S., R. 26 W., Pike County for the somewhat porous "Ouachita" stone from a 50-foot thick interval dipping about 15° to the southwest in the upper portions of the lower division of the Arkansas Novaculite. This rock is being hauled to Hot Springs for final processing. Suitable high-grade supplies of whetstones are available in the area in portions of the Cossatot and Caddo Mountains. It is thought that some additional whetstone prospecting and quarrying should be anticipated in the area.

Other Mineral Resources.

(Rock Aggregate) Rock aggregate and road material have been produced locally from the sandstone, novaculite, chert, stream gravels and even the shale for the surfacing of roads. The sandstones of the Stanley have been quarried to the west and north of the Planning Unit for rock aggregate, riprap, concrete aggregate, and road material. Large quantities of sandstone are available in the Planning Unit. The Arkansas Novaculite and the Bigfork Chert have sustained commercial quarry operations adjacent to the Unit, and are readily abundant throughout most of the Unit. Sand, gravel, and cobble deposits are present along some of the streams and rivers. A large sand and gravel deposit is located in the NE¼ NE¼ NE¼ of section 7, T. 3 S., R. 31 W., in Polk County. These abundant deposits can provide rock aggregate, road material, and even building stone to meet local and most, if any, outside demands.

(Iron) Some very small, but often high-grade, occurrences of limonite and goethite (iron oxides) and less often pyrite and marcasite (iron sulfides) occur at places in pockets or veins in the Arkansas Novaculite and the Bigfork Chert. As previously reported the iron oxide is often intimately associated with the manganese deposits. Some small, low-grade, bog iron deposits occur in alluvium and soils, particularly near springs and small seeps.

(Iron Phosphate Minerals) Much interest has been generated in recent years by mineral collectors for the relatively rare iron phosphate minerals that occur in association with some manganese deposits in the Arkansas Novaculite, particularly in the Cossatot Mountains. The mineral assemblage includes the ferrous-ferric phosphate minerals laubmannite, rockbridgeite, lipscombite, beraunite, dufrenite and the new mineral kidwellite, and the ferric phosphate minerals strengite and cacoxenite. Some turquoise and small quartz crystals are also present. One of the more noteworthy localities is at the abandoned Coon Creek manganese mine in the SE¼ NW¼ sec. 13, T. 4 S., R. 28 W., Polk County.

(Phosphate) Widely separated layers, lenses, and nodules of low-grade black phosphate rich rock occur in the basal Stanley Shale adjacent to the area and likely are present here. Some minor quantities of phosphate are reported from the conglomerate intervals in the Arkansas Novaculite.

(Wavellite) The fracture-filling aluminum phosphate minerals wavellite (cats-eye) and variscite have been obtained at some sites in the Bigfork Chert and Arkansas Novaculite throughout the area by mineral collectors. Some of the occurrences east of Board Camp in the Northern Mountains have been rather extensively worked. They are also of interest because of small quantities of associated copper and vanadium.

(Quartz Crystals) Nicely formed, clear to milky quartz crystals, usually of small size, have been obtained from a number of veins scattered throughout the area. The more significant commercial quartz crystal operations are to the east and northeast of the area.

(Lead and Zinc) Traces of lead, zinc, and silver mineralization have been reported in quartz veins and in manganese deposits in the area, but no significant occurrences are known.

(Novaculite) There is some potential for using the high quality novaculite from either the Cossatot or Caddo Mountains for making several other products. One of these is ferro-silicon, which is used in the chemical industry and is mostly made from raw materials imported from Canada but could be rather easily obtained from this area.

WATER RESOURCES

Since water is so important in our daily lives, it was decided that a brief description of the water resources of the Planning Unit would be included.

Surface Water. The Little Missouri River, Cossatot River and Saline River with Shady Lake in sec. 31, T. 4 S., R. 28 W., are the best potential sources for a large surface water supply in the Planning Unit. Some of the smaller streams could provide an adequate surface water supply for economic development. The quality of water from most of the mountain streams is excellent and is suitable for most uses.

Ground Water. Ground water in the Planning Unit occurs in fractures, joints and separations along the bedding planes of Paleozoic Age rocks and to a very limited degree in thin alluvium along streams. The Bigfork Chert is typically highly fractured and is the best aquifer in the Unit. Other sources of ground water are the Blaylock Sandstone, the Arkansas Novaculite, and the Stanley Shale. Wells that yield 10 gallons per minute for a week are considered high yield wells in most of the Ouachita Mountains. Also of interest are the literally hundreds of relatively small springs that issue primarily from the Bigfork Chert and the Arkansas Novaculite exposures.

Ground water supplies are adequate in most areas for individual use, but should not be considered for developments or community water supplies where large quantities are needed. From analyses of wells by the U. S. Geological Survey, the ground water in the Ouachita Mountains is suitable for most domestic and farm uses.

Warm Springs. There are two known warm springs indicated in the Planning Unit. The Redland Mountain warm spring is about 100 feet above Self Creek in the SE¼ of sec. 11, T. 5 S., R. 26 W.,

Pike County, on the south flank of the Cossatot Mountains. This small spring issues from a crevice in steeply dipping novaculite layers in the uppermost division of the Arkansas Novaculite. In 1916 the temperature was recorded as 77°F.

Another warm spring is on the left bank of the Little Missouri River in the northern part of sec. 17, T. 4 S., R. 27 W., Montgomery County. A fairly good flow issues from several places within an area a few feet across about 15 feet above the river bank. This spring is indicated as occurring in the lower Stanley Shale. In August 1916 a temperature of 74°F. was recorded.

It is our suggestion that these warm waters are originating at some depth, are being heated by the geothermal gradient, and are finding their way to the surface through openings created by fracture and/or fault zones. There is a strong likelihood that other small warm springs will eventually be found in the area. Finally, it is our belief that these warm springs are interesting, but afford no perspective as a geothermal resource.

CONCLUSION

The Cossatot-Little Missouri Planning Unit of the Ouachita National Forest has potential for providing, often needed, mineral resources. The large number of known mineral occurrences in the area warrant further detailed investigation. As our economy changes each day and the market price of most metal and non-metals continue to rise, this area should draw the interest of geologists, prospectors, and mining companies. The information provided in this report and on the attached map is to assist the planner in regional planning. For the most part the information has been generalized, to give an overall view of the type of rocks in the Planning Unit, the mineral resources, and the history and potential of these resources. We believe that the mineral resources of the Unit should receive particular attention during the planning stages of the Land Management Program. We further suggest that on the site mineral investigations should be made by various groups before development or permanent restrictions are made on any property.