STATE OF ARKANSAS

ARKANSAS GEOLOGICAL COMMISSION

Norman F. Williams, State Geologist

GUIDEBOOK:
22nd FORUM ON THE GEOLOGY OF INDUSTRIAL MINERALS

Field Trip No. 1
Magnet Cove Intrusion, Novaculite (Tripoli and Whetstones), and Quartz Crystals
May 5th.

By

ARKANSAS GEOLOGICAL COMMISSION

With the assistance of:

Samuel A. Bowring
George W. Colton
Murray M. Harding
J. Michael Howard
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Prepared by

THE ARKANSAS GEOLOGICAL COMMISSION

3815 West Roosevelt Road

Little Rock, Arkansas 72204

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COMMISSIONERS

GEOLOGY OF MAGNET COVE*

by

Staff, Arkansas Geological Commission

Magnet Cove is an area of unusual petrologic and mineralogic interest that derives its name from the presence of magnetite in the surface soil and from its basin-like shape. The Cove is located in northern Hot Spring County, Arkansas about 12 miles east of the city of Hot Springs. U. S. Highway 270 between Malvern and Hot Springs passes approximately through the center of the Cove.

The Cove lies at the eastern end of the Mazarn synclinorium about 1½ miles from where the Tertiary sediments of the Gulf Coastal Plain overlap the folded Paleozoic rocks. The parallel or almost parallel ridges and valleys adjacent to the Cove area are the topographic expression of plunging anticlines and synclines. The ridges are even-crested and are arranged in an unusual pattern that has given the name Zigzag Mountains to this subdivision of the synclinorium.

The sedimentary rocks cropping out in the immediate vicinity of Magnet Cove are Late Devonian and Mississippian in age. The oldest rocks belong to the Arkansas Novaculite and consist of novaculite with some interbedded shale. Overlying the novaculite is the Stanley Shale of Mississippian age. Two K-Ar ages of 97±5 m.y. and 99±5 m.y. and a Rb-Sr age of 102±8 m.y. from biotites in the Magnet Cove intrusion, show it to be contemporaneous with the Potash Sulfur Springs body.

The Cove itself is an elliptical basin (fig. 1) with a maximum northwest-southwest diameter of about three miles and covers an area of about five square miles. The rim of the basin is broken through only at the two points where Cove Creek enters and leaves the Cove. The rim consists of an outer belt of light-colored nepheline syenites and an inner belt of phonolites. A large part of the Cove interior is covered by deep residual and alluvial soils that are presumed to be underlain by ijolite, a basic variety of nepheline syenite. Within the ijolite core are at least two large masses of carbonatite, one of which is exposed in the Kimzey calcite quarry.

There are three generalizations that may be made about the igneous rocks:

(1) They are all varieties of nepheline syenite.
(2) They contain a variety and abundance of titanium minerals.
(3) They become increasingly basic from the rim to the center of the Cove.

Several theories have been suggested for the emplacement of the Magnet Cove intrusives. J. F. Williams (1890) believed that the igneous rocks were formed during three different periods of igneous activity. The first period produced the basic nephelinitic rocks which constitute a large part of the interior basin. During the second period monchiquitic rocks filled the cracks in the first period rocks. The light-colored syenites of the Cove rim and numerous dikes were injected during a third period. H. S. Washington in 1900 suggested the differentiation of a magma in place.

R. L. Erickson and L. V. Blade of the U. S. Geological Survey made a detailed field and laboratory study of the Magnet Cove rocks. This project included the complete remapping of the Cove as well as intensive petrographic and geochemical studies of the igneous rocks. The work was published in 1963 as U.S.G.S. Professional Paper 425,

*Reprinted with revisions from: Stone, C. G., Howard, J. M., and Holbrook, D. F., 1982, Field guide to the Magnet Cove area and selected mining operations and mineral collecting localities in central Arkansas: Arkansas Geological Commission Guidebook 82-1, p. 23-24.

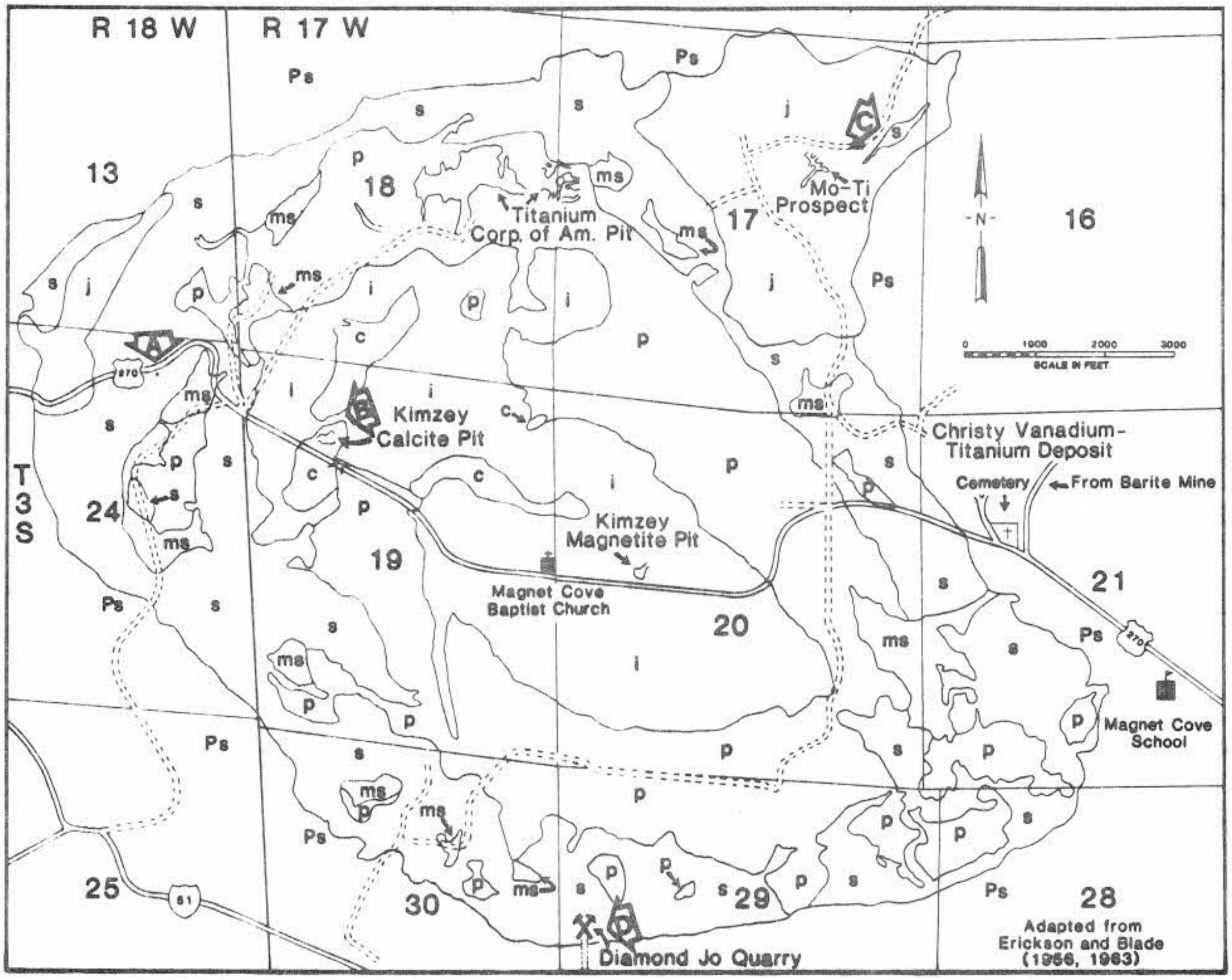

FIGURE 1 – BEDROCK GEOLOGY OF MAGNET COVE INTRUSIVE, ARKANSAS

LEGEND

CRETACEOUS

c	Carbonatite; residual and secondary phosphate rock derived from carbonatite.
j	Jacupirangite and subordinant sphene pyroxenite.
i	Garnet and biotite–garnet ijolite, undiff.; includes analcime–olivine metagabbro and minor lime silicate rock.
s	Garnet--pseudoleucite syenite, sphene–nepheline syenite, and garnet–nepheline syenite, undiff.; minor garnet–biotite melteigite and small dikes of sphene–garnet–nepheline syenite intruding jacupirangite.
p	Trachyte, phonolite, banded phonolite, and altered phonolite breccia, undiff.; small bodies of trachyte and tinguaite.

PALEOZOIC

ms	Metamorphosed sedimentary rocks.
Ps	Sedimentary rocks, undiff.; numerous igneous dikes are too small to be shown. An inner band, about 2000 feet wide, is a contact metamorphic zone.

Contact – approximate, indefinite, or gradational

Graded dirt road

Paved road

Open pit, trench, mine, or quarry.

Bridge

"Alkalic Igneous Complex at Magnet Cove, Arkansas". In revising the Cove map the authors used current terminology in naming the rock units and also made a number of significant corrections in the original map by Williams. The most important change was recognizing the band of rock lying on the Cove's inner rim, originally thought to be metasedimentary rock, as igneous rock – phonolite. They also correctly identified the so-called "tufa" in the Cove's interior as carbonatite residuum. In adapting this Geological Survey map for field trip use, many of the smaller rock units were necessarily omitted and similar rock types were combined into single units. For a more detailed examination of the rock types of Magnet Cove, the reader is referred to the U.S. Geological Survey Professional Paper.

A description of the rock names used on the geological map of Magnet Cove is included here as the terms are unfamiliar to many geologists:

Carbonatite –
Dikes and irregular bodies of coarsely crystalline calcite. Locally contains concentrations of apatite, monticellite, magnetite, perovskite, and black garnet.

Ijolite –
Fine- to coarse-grained rocks composed chiefly of nepheline, diopside and black garnet. Contains biotite in some places but does not have any feldspar.

Phonolite –
Fine-grained, gray to greenish-black rocks locally brecciated and banded.

Garnet-pseudoleucite syenite –
Light gray, medium-grained rock composed of white pseudoleucite, tabular feldspar, pyroxene and black garnet. The coarse-grained phase of this rock is composed of black garnet, nepheline, feldspar, and pyroxene.

The Magnet Cove intrusive complex and the surrounding host rock alteration zone, primarily the Arkansas Novaculite, have long been known for their unusual minerals. Over one hundred minerals are known to occur in the area. Some of the more outstanding minerals to the collector are: cyclic rutile eightling and sixling twins, paramorphs of rutile after brookite, brilliant lustered black brookite crystals perched on rusty smoky quartz crystals up to one foot long, plus black smoky quartz crystals, eighteen-inch-long aegirine crystals in pegmatite matrix (originally mistaken for tourmaline), pink eudialyte crystals, a variety of crystal forms of perovskite, clusters of octahedral magnetite, massive lodestone, black to dark brown melanite crystals intergrown with apatite needles, lime-green vesuvianite crystals, pyrite crystals coated with molybdenite, mica books to six inches across, and trapezohedral pseudoleucite crystals. The micromount collector visiting Magnet Cove should look for any rock containing cavities. Depending on the rock type, one may discover a variety of well crystallized minerals including kimzeyite (the only known location for this zirconium-bearing garnet), barite, pectolite, natrolite, labuntsovite, brookite, reticulated rutile, aragonite, diopside, orthoclase, brookite perched on rutile needles, aegirine, taeniolite (a lithium mica), and several newly discovered, not yet described species. The four localities to be visited are shown on the bedrock geologic map of Magnet Cove (fig. 1). With minor modifications, the stop descriptions are from Arkansas Geological Commission (1967).

Stop A. Crest of Cook Mountain – West Rim of Magnet Cove.

This stop is at the crest of Cook Mountain on the western edge of the Magnet Cove complex. From this point, you can see the low ridges that form the outer part of the complex. To the north and northeast there is a single ridge composed of sphene-nepheline syenite and garnet-pseudoleucite syenite. East and south of this point are two concentric ridges. The outer one is mostly garnet-pseudoleucite syenite and is continuous with the single ridge to the north and northeast. The inner ridge consists of trachyte.

Contacts are obscured here and only isolated outcrops can be seen. There are good exposures of sphene-nepheline syenite in the roadcut along the crest of the hill; and there is a sparsely exposed body of jacupirangite approximately 400 feet to the west. A small body of altered phonolite and breccia, which is a xenolith in garnet-pseudoleucite syenite, is located about 500 feet east of this point. This garnet-pseudoleucite syenite is exposed about 75 feet farther east. The areas between the outcrops provide a good example of saprolitic residual material. Remnant textures of the sphene-nepheline syenite are readily visible in the saprolite, particularly near the crest of the hill.

Sphene-Nepheline Syenite

Sphene-nepheline syenite comprises about seven percent of the exposed part of the Magnet Cove intrusive. At the crest of this hill the syenite is medium grained and exhibits megascopically identifiable pyroxene, hornblende, feldspar, nepheline, and sphene. Most of the syenite is equigranular, but some contains felsic phenocrysts. The syenite has a very heterogeneous texture and in places contains cognate and foreign xenoliths which are aligned parallel to an apparent flow lineation. About 300 feet east of the hill's crest is an outcrop of light gray sphene-nepheline syenite with a very fine-grained groundmass. Phenocrysts of green pyroxene and a few nepheline and alkali feldspar phenocrysts are visible in the rock. According to Erickson and Blade (1963) these two varieties of sphene-nepheline syenite are probably separate intrusions and the finer-grained rock is younger.

Stop B. Kimzey Calcite Quarry

This stop is near the center of the Cove, where carbonatite and eudialyte-nepheline syenite pegmatite are exposed. The carbonatite crops out along a north-trending zone about 3500 feet long and 500 feet wide and is best exposed here in the Kimzey calcite quarry (agricultural limestone) which is near the southern end of this zone. Other carbonatite is found in many parts of the central Cove. Erickson and Blade (1963) distinguished, during mapping, between carbonatite and residual phosphate, which was derived from the carbonatite by weathering.

The eudialyte-nepheline syenite pegmatite at this stop forms a small arcuate body that is concave southeastward. The pegmatite can be seen on both sides of U. S. 270 between the entrance to the Kimzey calcite quarry and the bridge over Cove Creek.

Carbonatite

Carbonatite occupies 1.8 percent of the exposed igneous complex and is considered to be a late stage of igneous activity (Erickson and Blade, 1963). The carbonatite consists largely of medium- to coarse-grained calcite and contains accessory minerals, which "...in approximate order of decreasing age, are apatite (light green), monticellite (brown), biotite, magnetite, pyrite, and perovskite (black)" (Fryklund, Harner, and Kaiser, 1954). Kimzeyite, a black zirconium garnet, was discovered at this locality (Milton and Blade, 1958, and Milton, Ingram and Blade, 1961).

Erickson and Blade (1963) note that "...inclusions of ijolite a few inches to more than 50 feet across" are found in the carbonatite. These xenoliths have peripheral alteration zones that consist of, from the border of the xenolith inward, magnetite, pyrrhotite, biotite, and idocrase (Fryklund, Harner, and Kaiser, 1954). The accessory minerals in the carbonatite are enriched somewhat in Ti, V, Nb, and rare earths.

Eudialyte-Nepheline Syenite Pegmatite

The eudialyte-nepheline syenite pegmatite covers less than 0.1 percent of the exposed area of the complex (Erickson and Blade, 1963). Erickson and Blade indicate that the pegmatite "...varies in texture from a fine-grained to very coarse-grained phanerite. The coarse-grained parts are well known for beautiful specimens of aegirine crystals up to 6 inches long, and ruby-colored eudialyte crystals up to 1 inch across. Williams (1891) has described in detail the mineralogy of the coarse-grained part. He mentions garnet, ilmenite, magnetite, nepheline, orthoclase, thomsonite, and wollastonite and describes aegirine, astrophyllite, brucite, eucolite, eudialyte, manganopectolite, microcline, natrolite, and sphene."

Stop C. Jacupirangite at Cove Creek

Jacupirangite, with assimilation derivatives of jacupirangite, and various dike rocks are exposed at this stop. Outcrops of the jacupirangite are rare in the complex and the two bodies of this rock that have been mapped were delimited by magnetometer surveys (ground magnetometer surveys show a high in excess of 10,000 gammas in the area) and panned saprolite concentrates (Erickson and Blade, 1963). There are two good exposures of jacupirangite along Cove Creek: one location is adjacent to the Mo-Ti prospect approximately 800 feet east of the bridge over Cove Creek and the other location, which is seen at this stop, is about 2000 feet east of the bridge. The contact between the Stanley Shale and meladiorite, an assimilation derivative of the jacupirangite, is exposed in Cove Creek about 1000 feet north of the northern limit of this outcrop.

The jacupirangite is cut by mafic and alkalic dikes. Some of the more noticeable ones at this outcrop include: (1) tinguaite— which forms a six-inch dike that runs approximately north-south along the east side of the creek and divides into three smaller dikes near the northern end of the outcrop; (2) pyroxene-biotite ijolite— as a four inch dike that runs east-west across the northern end of the outcrop and is cut by the tinguaite; (3) garnet-biotite melteigite— which is found near a small drill hole on the west side of the creek; (4) trachyte— cuts the garnet-biotite emlteigite dike near the drill hole; (5) fourchite— is found as a very fresh dike between three and five feet wide which forms a northeast-trending resistant unit in the creek bed approximately 200 feet downstream from the southern limit of the jacupirangite.

Jacupirangite

The jacupirangite covers 10 percent of the exposed area of the igneous complex. Erickson and Blade describe the jacupirangite as "typically a dark-gray fine-to-medium-grained phanerite that weathers to a dark brown or mottled reddish-brown and olive-green saprolite. Pyroxene is the chief constituent and always composes more than 50 percent of the rock. . . . The pyroxene crystals (salite), up to 10 mm long, appear to have formed as early crystal mush. . . . Magnetite-ilmenite grains as much as 6 mm across constitute about two to 25 percent of the rock. . . . Apatite, biotite, sphene, garnet and perovskite are always present, sometimes in proportions greater than 10 percent. Zeolite formed from the alteration of nepheline, calcite and cancrinite is common. Other accessory minerals include pyrite and pyrrhotite."

Stop D. Diamond Jo Quarry.

Follow an obscure road on the north side of the highway approximately 1000 feet to the Diamond Jo Quarry. At this stop there are excellent exposures of garnet-pseudoleucite syenite, nepheline syenite pegmatite, and metamorphosed Stanley Shale (Mississippian). The contact between the garnet-pseudoleucite syenite and the nepheline syenite pegmatite can be seen best at the top of the high wall to the northeast. Erickson and Blade (1963) suggest on the basis of chemical composition and spatial distribution of the two rock types that the nepheline syenite pegmatite is younger. The contact between the pegmatite and the wall rock is well exposed at the southeast edge of the quarry where it appears that the pegmatite was emplaced almost parallel to the bedding of the shale. Veinlets containing blue sodalite may sometimes be seen filling joint planes. Very little evidence can be found for a chill zone in the pegmatite which suggests that the country rock into which the pegmatite was emplaced had not cooled after emplacement of the garnet-pseudoleucite syenite.

Garnet-Pseudoleucite Syenite

The garnet-pseudoleucite syenite composes 21 percent of the exposed igneous complex and forms a nearly complete ring varying between a few feet and 2000 feet in width. According to Erickson and Blade (1963) the "typical fresh rock is light gray, medium grained, and composed of pseudoleucite, feldspar, black titanium garnet, pyroxene, and nepheline. Inclusions in the rock are abundant and include metamorphosed sediments and fine-to-coarse grained ijolite and melteigite fragments. Miarolitic cavities up to 3 inches across are common [on weathered faces]. . . . are generally automorphic, and include: tabular white orthoclase, needles of green aegirine, needles of colorless pseudowavellite, and short crystals of apophyllite . . . A coarser grained, more slowly cooled phase of the garnet-pseudoleucite syenite was mapped separately as garnet nepheline syenite and comprises about 3.5 percent of the exposed igneous rocks. . . . Earlier workers mapped this rock as part of the sphene-nepheline syenite but the presence of macroscopic garnet, absence of macroscopic sphene, and gradational contact with garnet-pseudoleucite syenite mark it as a coarser grained phase of the garnet-pseudoleucite syenite."

Nepheline Syenite Pegmatite

The nepheline syenite pegmatite occupies 0.2 percent of the area of the complex and forms small, irregular bodies near the outer contact of the igneous complex (Erickson and Blade, 1963). The rock contains ". . .barian sodic orthoclase (. . . as much as 30 mm long) with minor nepheline and cancrinite (interstitial). Black titanium garnet and zoned pyroxene are the chief mafic minerals and tend to be segregated in patches. Pyrite, calcite, and magnetite are accessory constituents. Blue sodalite and purple fluorite occur as thin skins, one-eighth inch thick, on vertical joint planes. Erickson and Blade (1963) note that the pegmatite, in contrast to the garnet-pseudoleucite syenite, contains no inclusions.

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CHRISTY VANADIUM - TITANIUM MINE*

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We wish to thank Mr. Don R. Owens, geologist for United Metals Corporation (Umetco), a subsidiary of Union Carbide Corporation, for permission to visit the mine and for his assistance.

The Christy deposit is located on the east rim of Magnet Cove (fig. 1 of preceding stop description) about half a mile northwest of the community of Magnet. Drilling by the U. S. Bureau of Mines in 1949 was undertaken to establish the extent of the titanium mineralization (brookite) in the deposit. The deposit lies on the top and partly on the south slope of an east-west ridge of metamorphosed Arkansas Novaculite. This ridge is the south limit of the Chamberlain Creek syncline, which is overturned so that the sediments dip about 45° south. A few hundred feet to the west of the deposit the syncline is truncated by a coarse-grained nepheline syenite intrusive. Analyses of core samples from the USBM project varied from less than 1% to a maximum of 26% TiO_2, averaging about 5% TiO_2 for the orebody. Appreciable percentages of V_2O_5 (1 to 2%) were encountered in several core samples. Union Carbide Corporation obtained leases on this property during their vanadium-titanium exploration program in Arkansas in the mid-1960's. The deposit was drilled out by Union Carbide shortly thereafter. A test pit, dug in 1975, was developmental work to allow testing of the ore for both amenability to their present mill at Wilson Springs and blendability of Christy ore with those of Wilson Springs. The Christy vanadium ore consists of geothite-rich clay and brookite and averages slightly less than 1% V_2O_5. In December, 1981 developmental work began for ore stockpile sites and water control ponds. Stripping of overburden to expose the orebody began in the Fall of 1983. Ore was mined until the Fall of 1985. Mining operations on this orebody have been idle since.

Minerals found with the vanadium ores, besides brookite, include smoky quartz, taeniolite, rutile, anatase, siderite, pyrite, and rarely eggonite ($ScPO_4 \cdot 2H_2O$).

Fryklund and Holbrook (1950) suggested that the Christy deposit was formed by the introduction of mineralizing fluids from the Magnet Cove intrusion into the folded and metamorphosed Arkansas Novaculite, with subsequent erosion and weathering of mineralized rock. In a recent investigation of TiO_2 polymorph-bearing vein deposits adjacent to the Magnet Cove intrusion, Viscio (1981) discovered adularia at the Hardy-Walsh brookite deposit (approximately 2 miles to the NNW) on the northern limb of the Chamberlain Creek syncline, suggesting that the brookite deposits adjacent to Magnet Cove may be an aborted initial phase of alkali metasomatism (fenitization) by late fluids from the Magnet Cove intrusion.

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TRIPOLI MINE IN ARKANSAS NOVACULITE*

We wish to thank Mr. Hewitt Harlow and Mr. Charles T. Steuart of the Malvern Minerals Company of Hot Springs for their assistance and permission to visit this presently inactive mine. The mine was operated primarily for tripolitic novaculite (Novacite®) in the Arkansas Novaculite. Tripoli is a microcrystalline silica (99.6%) used as a filler and extender in paints and plastics and as an abrasive.

The Arkansas Novaculite here is overturned to the southeast and the rocks are dipping 32°-45° to the northwest. The tripolitic novaculite is mined from the Upper Division of the Arkansas Novaculite, which is about 60 feet thick. It is overlain by the Middle Division (about 20 feet thick) and the Lower Division (about 400 feet thick). The Upper Division is white and friable with an average particle size of 7 microns. The Middle Division consists of a highly siliceous, carbonaceous black shale which the company mines and markets under the trade name Ebony® for use as an extender pigment and other purposes. Typical analyses of the Novacite® and Ebony® are:

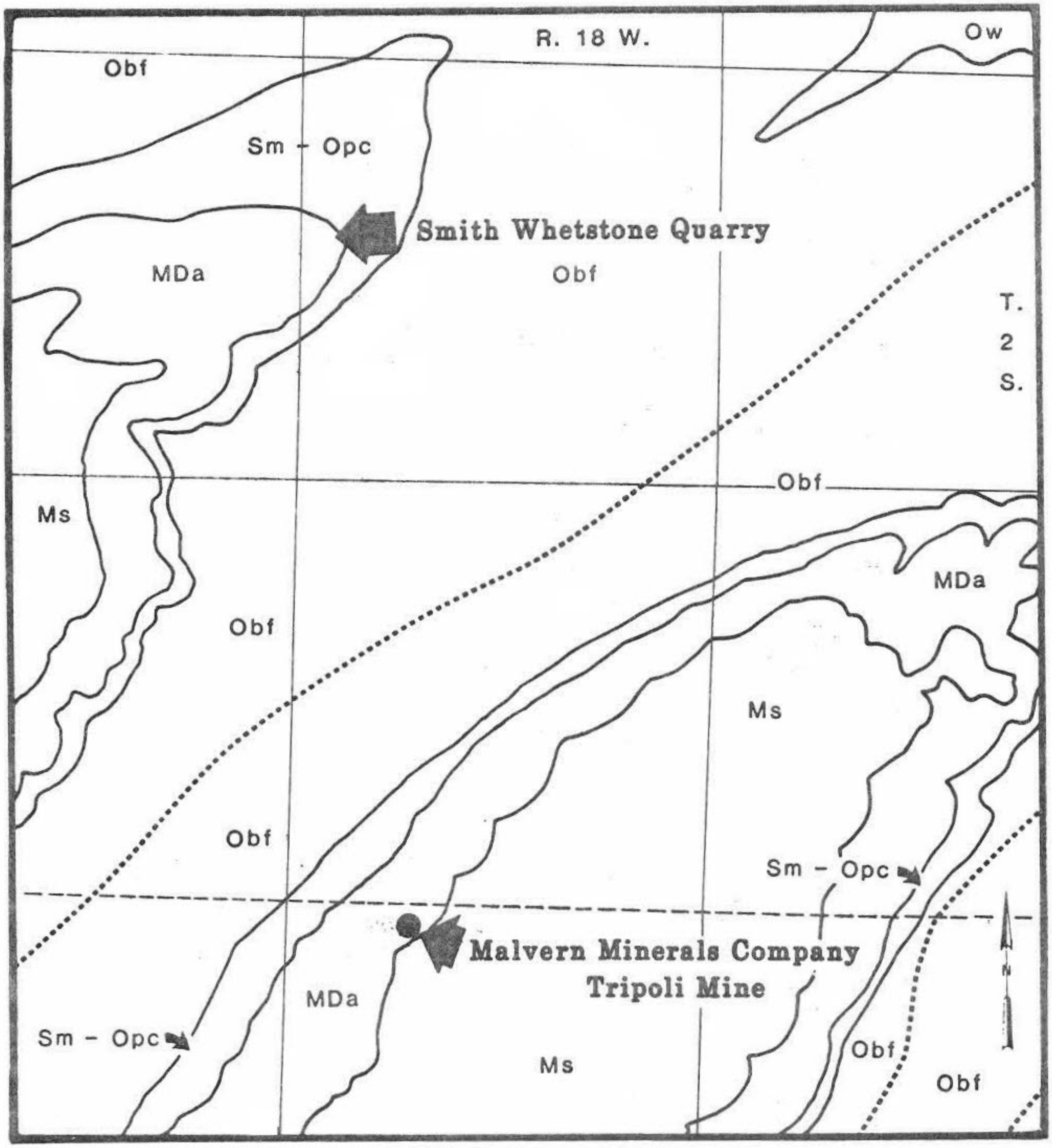
		Novacite®	Ebony®
Silica	SiO_2	99.45 %	60.40%
Carbon	C	0.00 %	3.37%
Sulfur	S	0.00 %	0.07%
Aluminum oxide	Al_2O_3	0.102%	22.40%
Ferric oxide	Fe_2O_3	0.039%	2.15%
Titanium oxide	TiO_2	0.015%	1.70%
Calcium oxide	CaO	0.014%	2.00%
Magnesium oxide	MgO	0.021%	0.38%
Loss of Ignition		0.190%	9.75%

The tripoli in the Upper Division is probably formed by the leaching of calcium carbonate cement from the novaculite. Scanning electron micrographic studies of the novaculite and tripoli by Keller et al. (1977) confirm that the silica has been slightly recrystallized at this locality and that polygonal triple-point texture is present.

At the top of the Lower Division there is about a 20-foot interval of sedimentary, slurried, boulder-like novaculite, minor sandstone, and other materials forming a very coarse conglomerate or breccia. Minor granitic fragments are present in similar rocks about ten miles to the north. Honess (1923) reported igneous and volcanic debris in the Arkansas Novaculite in the Broken Bow area of Oklahoma. These deposits likely represent slurries derived from submarine scarps and ridges to the north that, in part, had active extensional faulting and igneous activity in Devonian times. Richard Land of Amoco Production Company tentatively identified Middle Devonian conodonts from the shales about 18 feet stratigraphically below the boulder interval. Other interesting geologic features in or near the quarry are:

1. Secondary oxides, often forming manganese and iron dendrites, coatings, and other discolorations on fracture surfaces;
2. Unusual development of grooved-like curtains or sheets of tripoli on the wall face;
3. Some fractures filled with weathered to fresh igneous intrusive rocks (alkalic dikes, early Late Cretaceous);
4. Novaculite in the Lower Division that is of very high quality for whetstones, including both hard (Arkansas) and soft (Washita) types;
5. Minor thrust and tear faults with slickensides;
6. The ridge south of the quarry formed by the overlying Hot Springs Sandstone of the lower Stanley Shale. It is about 75 feet thick and is composed of quartzitic sandstone and shale with sandy chert-novaculite conglomerate, typically near the base;
7. Thin films of gorceixite (barium phosphate) coating novaculite fractures;
8. And minor amounts of chalcocite and pyrite.

*Reprinted from: Stone, C. G., Howard, J. M., and Haley, B. R., 1986, Sedimentary and igneous rocks of the Ouachita Mountains of Arkansas: A guidebook with contributed papers: Arkansas Geological Commission Guidebook 86-2, p. 66-68.



GEOLOGIC MAP EAST OF HOT SPRINGS

1000 0 1000 2000 3000 FEET

Ms	Stanley Shale	Obf	**Bigfork Chert**
MDa	Arkansas Novaculite	Ow	**Womble Shale**
Sm - Opc	Missouri Mountain Shale - Polk Creek Shale	....	Thrust Faults
		———	Contacts

STOP 3

SMITH WHETSTONE COMPANY'S PLANT AND QUARRY*

The Arkansas Novaculite consists mainly of an unusual type of rock, to which Schoolcraft, as early as 1819, gave the name "novaculite", a term now in general use. Although this kind of rock is uncommon in most areas, it is widely distributed in the Ouachita Mountains. The novaculite crops out in an almost unbroken trend from around Little Rock, in Pulaski County, Arkansas, westward to McCurtain County, Oklahoma, a distance of about 200 miles. Its greatest extent from north to south is in the eastern Ouachitas, where the distance between the northernmost and southernmost outcrop is more than 30 miles. Because of the great hardness of the novaculite, these belts stand out as steep, narrow ridges, the overlying and underlying formations forming the adjacent valleys. The novaculite is thickest in its southern outcrops, where the avarage thickness is about 700 feet. It thins toward the north rather rapidly. The novaculite itself is dense, homogeneous, highly siliceous, translucent on thin edges, and is commonly bluish white. At some places it is red, green, brown, yellow, and even black, the various shades being produced by carbonaceous matter or by iron and manganese oxides. When weathered the rock loses its calcium and manganese carbonate and becomes white and porous. The Arkansas Novaculite is Mississippian-Devonian in age and the interbedded shales often contain conodonts and other fossils.

There are only a few companies in Arkansas that produce whetstones from the Arkansas Novaculite and most of these are in the Hot Springs area. One of these is the Smith Whetstone, Inc. of Hot Springs, which has been operation for a number of years. The following is a summary (1971) of he operation by Aileen McWilliams:

"The first known use of the Arkansas novaculite was by the Indians, the tribes coming from far off to get the rock, taking it in the form of rough blocks to their camps where they shaped it into arrowheads, spear points, knives, plows, scrapers, and other implements. Thus novaculite chips may be found over large areas of the country. The name 'novaculite' is from a Latin word meaning 'sharp knife' and the conchoidal fracture of the rock makes it possible to shape it to a thin, keen edge.

But its more modern use is as a whetstone, the finest honing stone available, sold the world over as Arkansas oilstone. It has been quarried in the Hot Springs area since 1832 by only a few families or groups. One of these is the Hiram Smith family, now into its fourth generation of whetstone men. The company was founded in 1885 by James A. Smith, who turned it over in 1905 to his son, Archer. Archer's son, Hiram Smith, entered the business in 1938, at the age of 18. Up to 1962 the Smiths quarried the stone and shipped it in rough blocks to manufacturers in eastern United States, Europe and Japan for finishing. In 1962 Hiram learned the meticulous technique of finishing the stones himself and found a ready demand. Hiram Smith has now been succeeded by two sons, James and Richard."

The Smith Whetstone Company's brochure describes the processing of the novaculite blocks as follows:

"The rough Novaculite is cut by diamond saws, using large amounts of degradable lubricant as a coolant. Each stone is cut individually by hand, so the quality of each stone is graded many times during the cutting process. To properly cut whetstones, it often takes many, many months to learn the technique of diamond saw operation.

Each stone is lapped (smoothed) on horizontal grinding wheels using industrial grit as an abrasive. This process removes any ridges or saw marks on the stone. The edges of each stone are beveled on vertical grinding wheels to smooth any rough edges the stones may have. During this finishing process each stone is again graded for quality. Due to the hand cutting and finishing of each individual stone, tolerances will be plus or minus 1/16 of an inch."

According to personnel of Smith's Whetstone Company, a typical novaculite quarrying operation consists of:

***Reprinted with revisions from: Stone, C. G., Howard, J. M., and Holbrook, D. F., 1982, Field guide to the Magnet Cove area and selected mining operations and mineral collecting localities in central Arkansas: Arkansas Geological Commission Guidebook 82-1, p. 3 and p. 21.**

(1) Clearing the proposed site, and removing rough weathered rock;
(2) Drilling shallow shot holes with five-foot spacing on a 20' x 20' grid;
(3) Loading and shooting the hole with "lump coal" (black powder);
(4) Loading suitably sized blocks with a front end end loader;
(5) Splitting oversize blocks with hand tools;
(6) Removing excess material from the quarry floor with a front end loader or back hoe;
(7) Repeating the cycle.

The novaculite that is quarried occurs as rather thin, even beds of slightly weathered, white to light gray novaculite near the base of the Lower Division of the formation.

There are four grades of whetstone. Washita Stone is the coarsest grade, used by commercial knife sharpeners, butchers, sportsmen, wood carvers, and others who desire a quick keen edge. Much of this stone is of the rainbow type. Soft Arkansas is a general purpose stone for kitchen cutlery, hunting knives and pocket knives, producing a polished as well as keen edge. Most of this stone is gray or gray marbled. Hard Arkansas Stone, white or almost so, produces a fine polished edge. It is used by gunsmiths, dentists, surgeons, watchmakers, precision toolmakers, and finicky sportsmen. Hard Arkansas stones are the only stones for the precision sharpening and polishing of surgical instruments. Finest of all is Black Hard Arkansas Stone, used for polishing the final finish on edges already extremely sharp.

GEOMEX QUARTZ CRYSTAL MINE*

by

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We wish to express our deepest gratitude to Mr. Paul Thompson, geologist, and other personnel of the Geomex Company for letting us have access to their quartz crystal mine and for their invaluable assistance in the examination of these classic deposits.

Mining of quartz crystals in the Ouachita Mountains of Arkansas has been going on for many years, the first miners probably being the Indians who shaped them into arrowheads. Because of the clarity and perfect shape of many of the individual crystals and crystal clusters, the principal market over the years has been as specimens in both individual and institutional mineral collections. During World War II about five tons of clear quartz crystals from Arkansas were used in the manufacture of radio oscillators to supplement the production from Brazil. Currently quartz crystals are being used for: manufacturing fusing quartz, which has many chemical, thermal and electrical applications; for seed crystals (lasca) for growing synthetic quartz crystals; and, of course, for mineral specimens. It should be noted that the "Hot Springs Diamonds" for sale in the local rock shops and jewelry stores are cut from Arkansas quartz crystals.

Quartz veins are numerous and are found in a wide belt extending from Little Rock, Arkansas to Broken Bow, Oklahoma, in the central core area of the Ouachita Mountains. These veins, up to sixty feet in width, commonly contain traces of adularia, chlorite, calcite and dickite. In a few places lead, zinc, copper, antimony and mercury minerals are associated with the quartz veins. At relatively few localities however, do individual quartz crystals and crystal clusters attain the size and clarity requisite for mining.

In the Ouachita Mountains there is a close association of quartz veins with fault zones. It is believed that the quartz veins represent, in part, dewatering processes that took place along the fault zones. The increase in pore fluids may well have contributed to overpressuring and related conditions and enhanced the overall faulting and folding process. The quartz veins with their associated minerals are presumed to be hydrothermal deposits of tectonic origin formed during the closing stages of the Late Pennsylvanian-Early Permian orogeny in the Ouachita Mountains.

The Geomex Mine is also known as the Coleman Mine, West Chance Area, Dierks No. 4 Mine and Blocher Lead (fig. 1). The quartz crystals occur in veins in limy sandstone and conglomeratic sandstone beds of the Blakely Sandstone (Ordovician). Beds of conglomeratic sandstone exposed in the pit contain abundant weathered meta-arkose and granitic boulders, cobbles, and pebbles, and some clasts of limestone, chert and shale. It is likely that these sediments were deposited in submarine fan channels and were derived from a granite-rich terrane to the north-northeast. It has been postulated by Stone and Haley (1977) and a number of other workers that these exotic boulders are likely Precambrian in age. Some have expressed the opinion that they represent early Cambrian accumulations. The report (this volume, p. 33) by Sam Bowring on boulders from this pit and other sites indicates a Middle Proterozoic age. This area includes many thrust-faulted sequences with at least two major periods of folding resulting in differing

*Reprinted from: Stone, C. G., and Haley, B. R., 1984, A guidebook to the geology of the central and southern Ouachita Mountains, Arkansas: Arkansas Geological Commission Guidebook 84-2, p. 42-45.

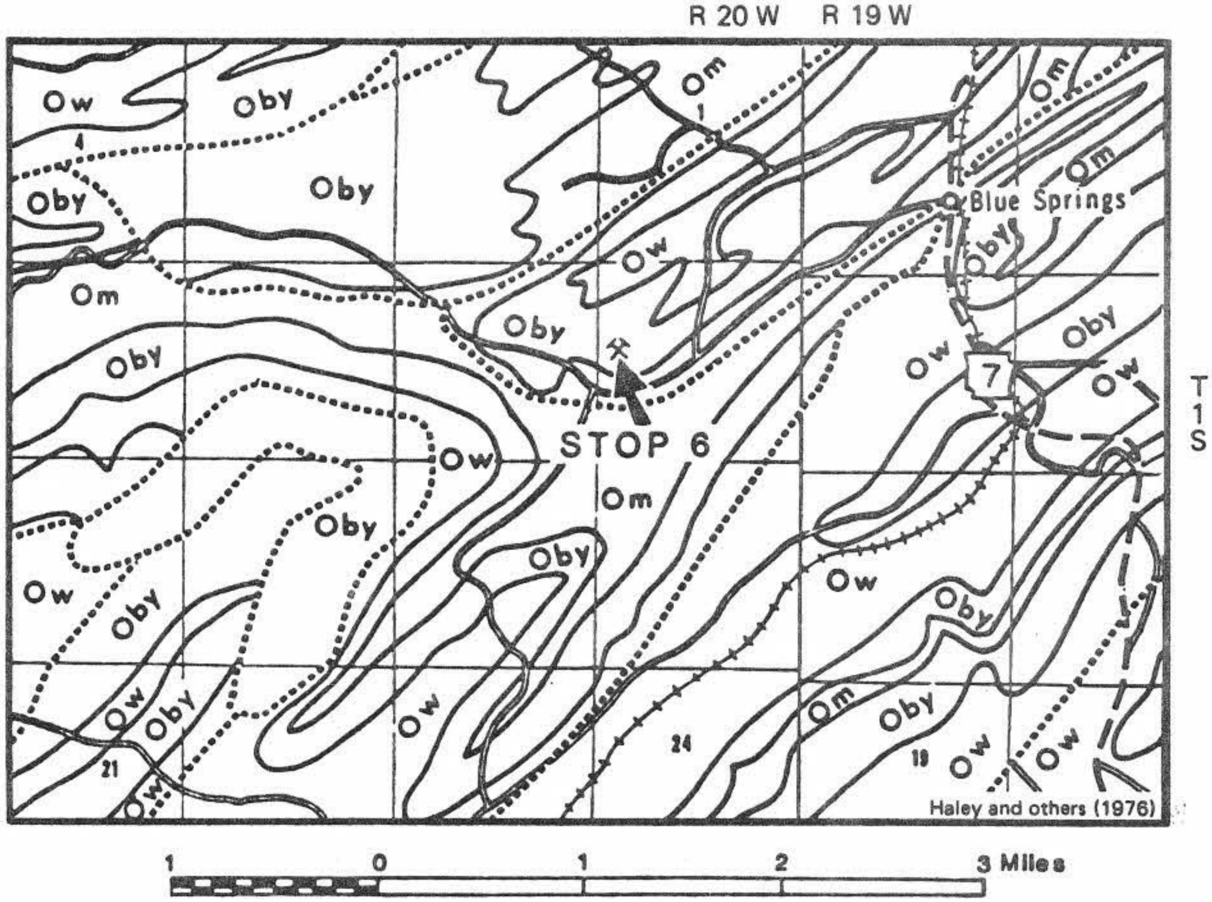

Figure 1. Geologic map of the Blue Springs area, Arkansas showing location of the Geomex Mine (stop 6).

attitudes in fold hinge lines and axial planes. The mine itself is situated on the nose of a large, complexly-deformed syncline.

The quartz crystal veins are fracture fillings with the larger and more productive cavities being located at the intersection of two veins. Mining operations are relatively simple, consisting initially of removing overburden and loose rock with a bulldozer to expose the crystal-filled cavities, and then removing the quartz crystals with hand tools. Individual quartz crystals up to five feet in length weighing as much as 400 pounds and clusters 15 feet in length weighing over five tons have been produced from these mines.

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Note:

The short article on the following page is reprinted here because it provides recent data on the age of the exotic granitic boulders from the Geomex mine.

U-Pb ZIRCON AGES OF GRANITIC BOULDERS IN THE ORDOVICIAN BLAKELY SANDSTONE, ARKANSAS AND IMPLICATIONS FOR THEIR PROVENANCE*

by

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The occurrence and origin of beds of granitic cobbles and boulders in the Ordovician Blakely Sandstone in Saline and Garland Counties, Arkansas, have been the subject of much discussion. Of particular importance in determining the provenance of the granite boulders and cobbles is their age. Paleozoic Rb-Sr whole-rock ages from these boulders are not interpreted as crystallization ages (Denison and others, 1977), and thus three samples of granitic boulders and one sample of arkosic sandstone were collected from three localities for U-Pb zircon age determinations.

At the Uebergang uranium prospect in northern Saline County, Arkansas, numerous boulders and cobbles of granite and quartzite occur within the Blakely Sandstone in addition to a few cobbles of gabbro and porphyritic andesite. One granite boulder yielded abundant euhedral, slightly discordant, zircons that have an age of 1284±12 Ma.

Two granite boulders were collected from the Blakely Sandstone at Coleman's (now Geomex) quartz mine west of Blue Springs, Garland County, Arkansas. One boulder, about 1 meter in diameter, is a coarse-grained granite which yielded abundant euhedral zircons that range from colorless to dark brown. Four fractions of both clear and brown varieties are moderately discordant and lie on a chord which yields an age of 1350±30 Ma. A boulder of medium-grained granite from the same outcrop yielded discordant zircons with an age of 1407±13 Ma.

Detrital zircons separated from a sample of arkosic Blakely Sandstone from northern Saline County yielded several distinct populations of zircons that range from round to euhedral. Preliminary analysis of both rounded and euhedral fractions indicates a source age for the zircons between 1300-1350 Ma.

Analysis of zircons from the Blakely Sandstone yields ages that range from 1286-1407 Ma, possibly corresponding to a 1350-1400 Ma terrane of epizonal granites and rhyolites that extends from the Texas panhandle through eastern Oklahoma (Thomas et al., 1984). Although there are no known exposures of Precambrian rocks in Arkansas, the 1350 to 1400 Ma old terrane has been extended into the subsurface of Arkansas based on aeromagnetic signatures (Thomas et al., 1984). The simplest interpretation of the age data derived from the Blakely Sandstone is that the granite boulders and arkose were derived from Precambrian basement to the north, perhaps along submarine fault scarps, as suggested by Stone and Haley (1977).

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***Reprinted from: Stone, C. G., and Haley, B. R., 1984, A guidebook to the geology of the central and southern Ouachita Mountains, Arkansas: Arkansas Geological Commission Guidebook 84-2, p. 123.**