AGES
Brochure Series 004

Magnet Cove

A synopsis of its geology, lithology and mineralogy.

Brookite crystal (1/2”) on quartz

By J. Michael Howard and Angela Chandler
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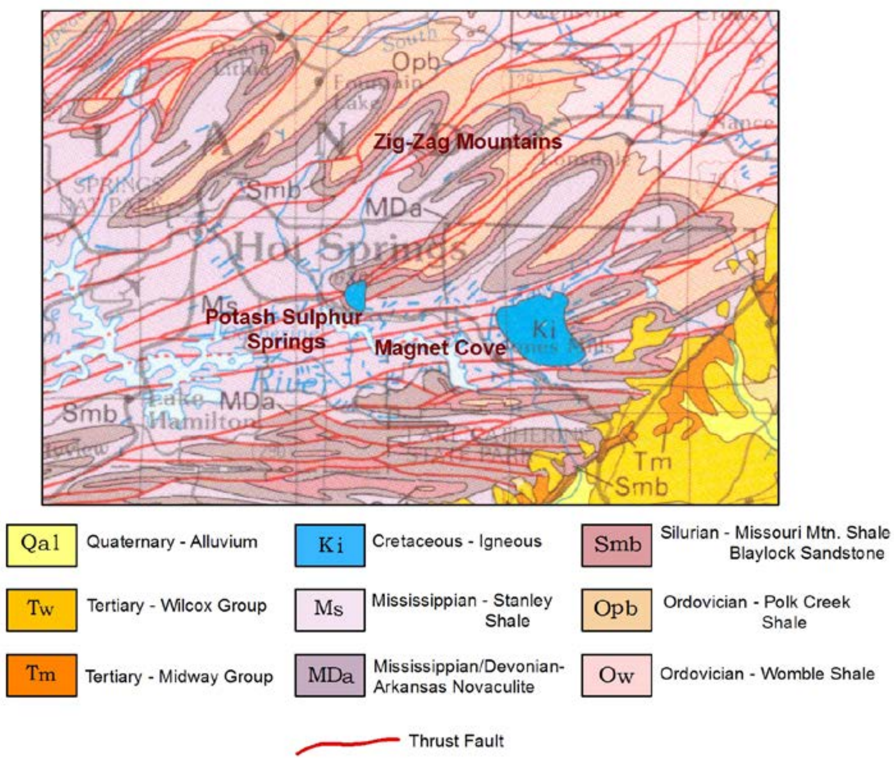
Arkansas Geological Survey, Bekki White, State Geologist

Magnet Cove is an area of unusual petrologic and mineralogic interest that derives its name from the presence of lodestone in the soil and from its basin-like shape. It is located in northern Hot Spring County, Arkansas, about 12 miles east of the city of Hot Springs. U.S. Highway 270B (Arkansas Highway 51) passes east-west across the center of the Cove.

The Cove lies at the eastern end of the Mazarn synclinorium. This is about 1.5 miles west of where Tertiary sediments of the Gulf Coastal Plain onlap folded Paleozoic rock of the Ouachita Mountains (Fig. 1). Adjacent to the Magnet Cove intrusion, ridges and valleys are the topographic expression of the strongly folded sedimentary sequence of Paleozoic rocks. The even-crested ridges are arranged in an unusual pattern, which led to the name – ZigZag Mountains.

Sedimentary rocks outcropping in the immediate vicinity of the igneous intrusion are Late Devonian and Mississippian in age. The oldest major unit is the Arkansas Novaculite, which consists of novaculite with some interbedded shale. Overlying this unit is the Stanley Shale of Mississippian age. Isotopic dates of the Magnet Cove intrusion demonstrate that is was emplaced in the early Late Cretaceous as was smaller nearby Potash Sulphur Springs body to the west.

Figure 1. Location map of Magnet Cove intrusion.



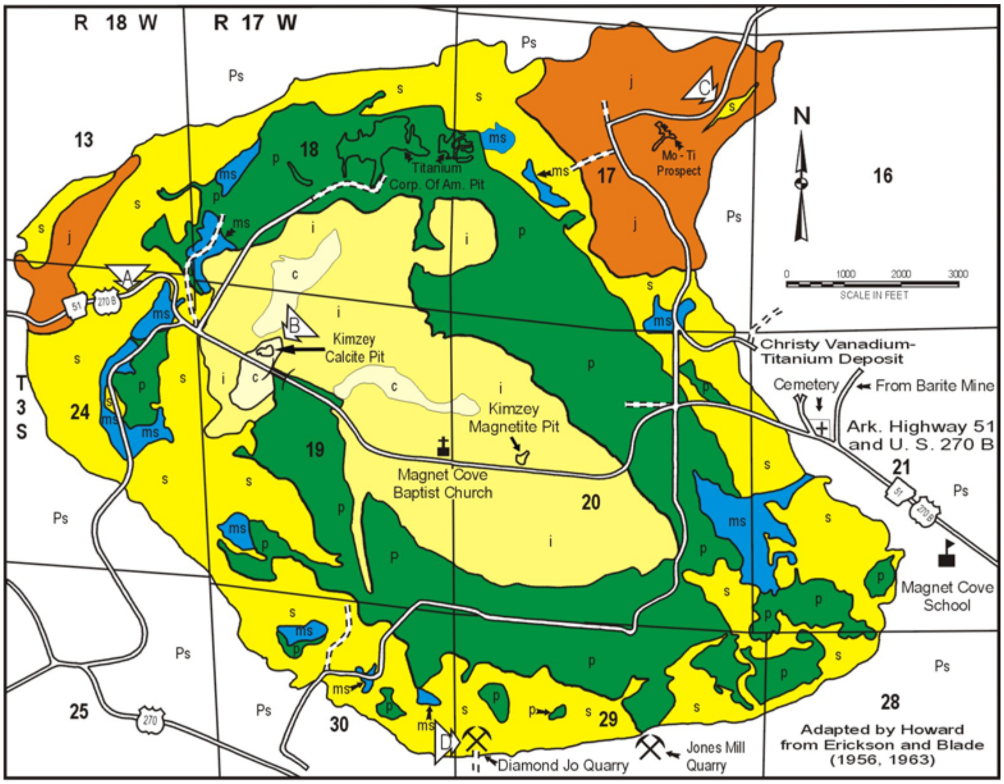


Fig. 2 **BEDROCK GEOLOGY OF MAGNET COVE INTRUSIVE, ARKANSAS**

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 ayenite, 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 adjacent band, about 2000 feet wide, is a contact metamorphic zone.

Contact - approximate, indefinite, or gradational

Graded dirt road

Paved road

Major Highways

Bridge

Open pit, trench, mine, or quarry.

The Cove itself is an elliptical basin (Fig. 2) with a maximum northwest-southeast diameter of about 3 miles. It encompasses an area of about 5 square miles. The rim (Fig. 3) of the basin is dissected at only two places, 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-trachyte. Much of the Cove's interior is covered by deep residual and alluvial soils that are underlain by ijolite. Within the ijolite core are at least two large masses of carbonatite.

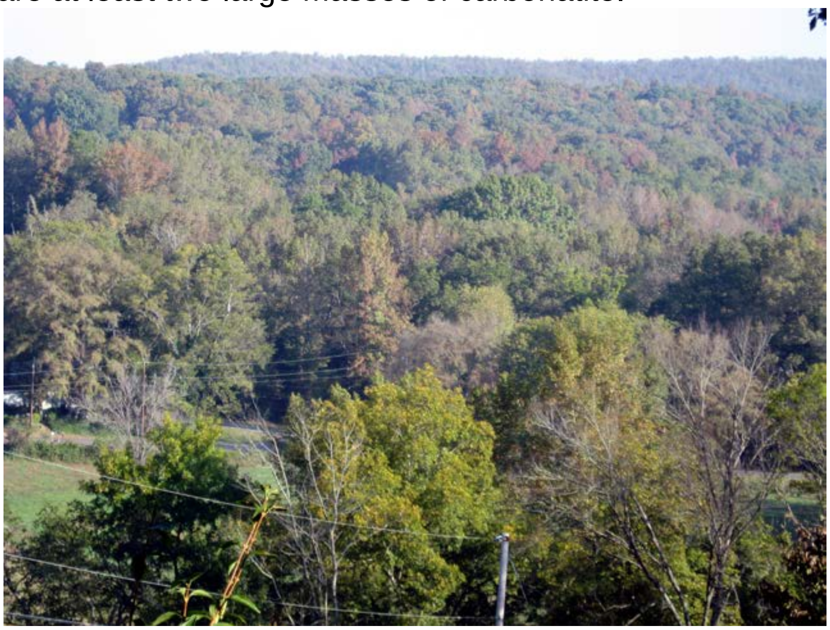


Figure 3. First ridge in background is the outer rim of Magnet Cove.
The second ridge is composed of novaculite.

The Magnet Cove complex was first mapped by J.F. Williams in 1891. A later study by Erickson and Blade involved remapping the area and included much petrographic and geochemical work on the igneous rocks. Their study was published in 1963 as U.S.G.S. Professional Paper 425 – "Geochemistry and Petrology of the Alkalic Igneous Complex at Magnet Cove, Arkansas". The authors renamed many of the rock units using current terminology and also made a number of significant corrections in William's early map. The most important change was the recognition that the band of rock on the inner rim, originally thought to be metasedimentary in origin, was igneous rock – phonolite. They also identified William's "tufa" in the cove's interior as a product of the weathering of carbonatite. In adapting their map for this leaflet, many of the minor rock units were omitted and similar rock types were combined into single units.

The Magnet Cove intrusive complex and the surrounding host rock alteration zone have long been known for the presence of unusual minerals. About 100 mineral species have been reported from the area. Some of the more outstanding minerals for collectors are: cyclic rutile eightling and sixling twins, paramorphs of rutile after brookite, brilliant black brookite crystals perched on smoky quartz crystals up to one foot long, 18-inch-long acmite crystals (first mistaken for tourmaline) in pegmatite matrix, pink eudialyte crystals, a variety of crystal forms of perovskite, clusters of octahedral magnetite, massive lodestone, black to dark brown garnet crystals intergrown with fluorapatite needles, lime-green vesuvianite crystals, pyrite crystals sometimes coated with molybdenite, mica books up to 6 inches across, and trapezohedral leucite crystals.

A visiting micromount collector should look for any rock containing cavities. Depending on the rock type, one may discover a variety of well crystallized minerals including kimzeyite, barite, pectolite, natrolite, labuntsovite, brookite, reticulated rutile, aragonite, diopside, orthoclase, acmite, taeniolite, delindeite, lourenswalsite, kolbeckite and amphibole crystals.

Eudialyte crystal .5"

Vesuvianite crystal 5/8"

Magnetite crystals 3" across

Rutile paramorphs after brookite 1 ¾"

Four selected stops, described below, are presented on the map (Fig. 2).

STOP A – Cook Mountain – West Rim

This stop is at the crest of Cook Mountain on the western rim of the complex on U.S. 270B. From here you can see the low ridges that form the outer portion of the intrusion. To the north and northeast there is a single ridge composed of sphene-nepheline syenite and garnet-pseudoleucite syenite (Fig. 4) East and south of this point are two concentric ridges. The outer core is mostly garnet-pseudoleucite syenite and is continuous with the single ridge to the north and northeast. The inner ridge consists of phonolite-trachyte.

Figure 4. Garnet-pseudoleucite exposed in ditch along road
. southeast of crest of Cook Mountain.

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. There is a sparsely exposed body of jacupirangite about 400 feet to the west and a small body of altered phonolite and breccia about 500 feet east. The garnet-pseudoleucite syenite is exposed about 75 feet farther east of the breccia. 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.

<u>Sphene-nepheline syenite.</u> Sphene-nepheline syenite comprises about 7 percent of the exposed part of the intrusive. At the crest of the hill the syenite is medium grained and has megascopically identifiable pyroxene, hornblende, feldspar, nepheline, and titanite. Most varieties of the syenite are equigranular

but some contain felsic phenocrysts. It is heterogeneous and in places, contains cognate and foreign xenoliths aligned parallel to an apparent flow lineation. About 300 feet east of the hillcrest is an outcrop of light gray sphene-nepheline syenite with a very fine-grained groundmass and phenocrysts of green pyroxene, along with less abundant phenocrysts of nepheline and alkali feldspar. The two varieties of sphene-nepheline syenite are probably separate intrusions, the finer-grained rock being younger.

STOP B – Kimzey Calcite Quarry

This stop is near the center of the Cove, where carbonatite and eudialyte-syenite pegmatite are exposed. The carbonatite underlies a north-trending area about 3,500 feet long and 500 feet wide and is best exposed in the abandoned quarry (agricultural limestone) near the southern end of this area. Other carbonatite is present in many parts of the central Cove. Erickson and Blade (1963) distinguished between carbonatite and residual phosphate derived from the carbonatite by weathering on their original map.

The eudialyte-nepheline syenite pegmatite forms a small arcuate body that is concave southeastward. The pegmatite is poorly exposed on both sides of U.S. 270B between the entrance to the quarry and the bridge over Cove Creek.

<u>Carbonatite.</u> Carbonatite (Fig. 5) occupies 1.8 percent of the exposed igneous complex and represents a late stage of igneous activity. It consists largely of medium-to-coarse-grained calcite and contains accessory minerals, which are, in approximate order of decreasing age, carbonate-fluorapatite (light yellow-green), monticellite (brown), biotite, magnetite, pyrite and perovskite. This is the type locality for kimzeyite, a dark brown zirconium-rich garnet.

Figure 5. Carbonatite near Cove Creek bridge.

Xenoliths of ijolite from a few inches to more than 50 feet across are known in the carbonatite. They have peripheral alteration zones that consist from the border inward, of magnetite, pyrrhotite, biotite, and vesuvianite. The accessory minerals in the carbonatite are enriched somewhat in titanium, vanadium, niobium and rare-earth elements.

Eudialyte-nepheline syenite pegmatite. This rock type covers less than 0.1 percent of the exposed area of the complex. It varies in texture from a fine-grained to very coarse-grained phanerite. The coarse-grained portions are well known for yielding acmite crystals up to 18 inches in length and ruby colored eudialyte crystals to 1 inch across. Williams (1891) described the mineralogy of the coarse-grained phase of this rock in some detail. He mentions garnet, ilmenite, magnetite, nepheline, orthoclase, thomsonite and wollastonite and describes acmite, astrophyllite, brucite, eudialyte, pectolite, microcline, natrolite and titanite.

STOP C. Jacupirangite at Cove Creek

Jacupirangite and various dikes are exposed here. Although jacupirangite composes 10 percent of the area of the complex, outcrops of this rock are few. The two jacupirangite bodies have been delineated by ground magnetometer surveys (which showed a high in excess of 10,000 gammas in the area) and panned saprolite concentrates. The jacupirangite (Fig. 6) is well exposed at two sites along Cove Creek: one is adjacent to the Mo-Ti prospect approximately 800 feet east of the old iron bridge and the other which is about 2,000 feet east of the iron bridge. A contact between meladiorite, an assimilation derivative of jacupirangite, and the Stanley Shale is exposed in Cove Creek some 1,000 feet upstream of this stop.

The jacupirangite is cut by both mafic and alkalic dikes. Some of the most notable at this stop include: 1) tinquaite – a 6 inch wide dike trends approximately north-south along the east side of the creek bed before separating into three smaller dikes near the northern end of the outcrop; 2) pyroxene-biotite ijolite – a 4 inch wide dike that extends east-west across the north end of the outcrop and is cut by the tinguaite; 3) garnet-biotite melteigite – near a small drill hole on the west side of the creek: 4) trachyte – near the drill hole where it cuts the garnet-biotite melteigite dike; 5) fourchite – a very fresh dike, 3 to 5 feet wide, forming a northeast trending resistant unit in the creek bed about 200 feet down stream from the southeastern limit of the jacupirangite.

Figure 6. Jacupirangite outcrop along Cove Creek.

Jacupirangite. Typically, the rock is a dark gray fine-to-medium grained phanerite that weathers to a dark brown or mottled red-brown and lime-green saprolite. Pyroxene, a primary constituent, always composes more than 50 percent of the rock. The pyroxene (salite), up to 0.4 inches in length, appear to have formed as an early crystal mush. Magnetite-ilmenite grains up to 0.25 inches in diameter constitute 2 to 25 percent of the rock. Fluorapatite, biotite, titanite, garnet and perovskite are always present in variable amounts, ranging up to 10 percent. Zeolites formed from the alteration of nepheline, calcite and cancrinite are common. Other minor accessory minerals are pyrite and pyrrhotite.

STOP D. Diamond Jo Quarry

An obscure road on the north side of U.S. 270 leads northward to this stop. Here are excellent exposures of garnet-pseudoleucite syenite, nepheline syenite pegmatite and metamorphosed Stanley Shale. The contact (Fig. 7) between the two igneous rock types is best seen at the top of the quarry highwall to the northeast. Fragments (xenoliths) of the nepheline syenite pegmatite are present in the garnet-pseudoleucite syenite at the exposed contact, indicating that the pegmatite is the earlier emplaced of the two rock types. The contact between the pegmatite and the host country rock is well exposed where the igneous rock was emplaced almost parallel to the sedimentary rock's bedding. Blue sodalite fills some joint planes in the east wall of the quarry in the pegmatite. There is little evidence of a chill zone in the pegmatite, suggesting that the pegmatite was relatively cool crystal mush when it was injected.

Figure 7. Knife pointing to contact between lighter coarse-grained nepheline syenite and darker garnet-pseudoleucite syenite.

Garnet-pseudoleucite syenite. This rock type composes 21 percent of the exposed igneous complex and forms a nearly complete ring, ranging from just a few feet to 2,000 feet in width. The typical fresh rock is light gray, medium grained and composed of leucite, feldspar, black titanium garnet , pyroxene, and nepheline. Xenoliths are abundant at some locations and include metamorphosed sedimentary rocks (Fig. 8) and fine-to-coarse grained ijolite (Fig.9) and melteigite fragments. Miarolitic cavities up to 3 inched across may be present on weathered surfaces. Typical cavity minerals are tabular white orthoclase, acicular acmite, colorless acicular pectolite and apophyllite.

Nepheline syenite pegmatite. This rock occupies 0.2 percent of the exposed area of the complex and for field mapping purposes is often referred to as coarse-grained syenite. It forms small, irregular bodies along the marginal contact of the complex with the country rock. The rock consists of light gray barian sodic feldspar, up to 2 inches in length and 1.5 inches thick, with minor interstitial nepheline and cancrinite. Black titanium garnet and zoned pyroxene are the chief mafic minerals and tend to be segregated in patches. Pyrite, calcite and magnetite are accessories. Blue sodalite and purple fluorite are present on joint planes as thin coatings and represent late degassing phases of the intrusion. The coarse-grained syenite, unlike the garnet-pseudoleucite syenite, rarely carries any xenoliths.

Figure 8. Contact between lighter garnet pseudoleucite nepheline syenite and darker metamorphosed Stanley Shale.

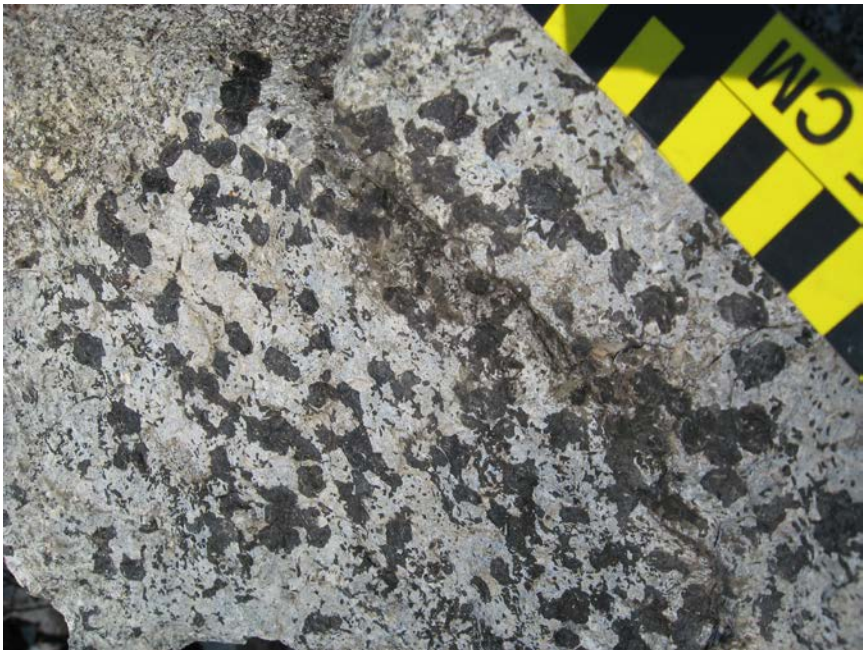


Figure 9. Black titanium garnets in ijolite xenolith.