GEOLOGY OF HARDROCK
QUARRIES
IN SONOMA COUNTY

March 1979

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Introduction

This report contains the detailed geology of all known active Sonoma county rock quarries. In addition to the geology, information on reserves, material uses, history, and owner's future plans is included where available.

This report is presented in "rough copy" to reduce expenses.

Submitted March 9, 1979

Rolfe C. Erickson

Rolfe C. Erickson, Director
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The geology of Sonoma County features Quaternary and Tertiary (0-60 million years old) sediments and volcanics which rest upon an old erosional surface cut into basement rocks of the Franciscan Complex and the Great Valley Sequence (100 million years old). The volcanics, called the Sonoma Volcanics, are basalt flows, ash and breccia layers, and felsite flows, with interrelationships which are often complex. The Tertiary sediments belong mostly to the Merced and Petaluma Formations (described below).

The Franciscan is a dominately clastic assemblage of rocks whose total thickness is unknown, but has been approximated at about 50,000 feet. It is composed of both coherent sequences and melange (see below). The Great Valley Sequence is composed of conglomerate and sandstone.

Coherent sequences in the Franciscan consist dominately of sandstone, in thin to massive beds, interbedded with siltstone and shale, and with occasional layers of red chert or pillow basalt (now greenstone). The sandstone is a well indurated clastic sedimentary rock that is composed of angular and poorly sorted grains, generally with a high content of quartz, feldspar and some rock fragments, Fresh specimens usually range from dark to light gray, to bluish gray, to greenish gray. Upon weathering, the sandstone changes color to light gray, and then to tan.

Fractures and minor faults in the sandstone are very common. Rarely is there an exposed section of sandstone which doesn't show development of these features to some degree. These
cracks often mutually cross each other in a complex fashion, resulting in offset and transposition of bedding. Veining of the sandstone by quartz and calcite is also common.

The sandstone occurs in beds from half an inch to a hundred feet thick or more. In any exposed section the bedding usually varies in thickness from a few inches to about ten feet, with all intermediate thicknesses distributed throughout the section at random.

Interbedded units of siltstone and shale which occur in the sandstone are similar mineralogically, but are finer grained. Siltstone layers are generally a few inches thick, but may run up to a foot or more. Very thick siltstone deposits are rare. Its colors follow the sandstone.

The Franciscan shales are dark gray to black, but they also occur in shades of grayish tan or olive. Surface exposures of Franciscan shales are rarely seen because the shales naturally weather faster than the other rocks, and are soon covered up by soil. Consequently artificial exposures, i.e., quarries and roadcuts provide the best areas of study.

Commonly the shales occur as thin partings between beds of sandstone and generally are no more than a few inches thick. In any typical sandstone-shale section, the shale rarely makes up any more than about 1/5 of the unit. Exceptions do occur where a dominately massive unit, with local bedding possibly preserved, composes up to a hundred or more feet of rock.

Layers of red thin-bedded chert are found in a few places in the Franciscan sediments. They may be up to 50-100 feet thick and extend for several miles.
Pillow basalt bodies up to a mile across, or more, in any direction, are locally found interbedded with the clastic rocks.

All of these various coherent units may be found interlayered in any order. Individual layers tend to not extend very far laterally and great caution needs to be used in trying to predict the nature of the buried rock from nearby exposures.

The rocks of the coherent sequences are generally moderately to strongly folded and commonly cut by faults, some up to tens of miles in length. The structural complexity further emphasizes the need for caution in predicting the nature of buried deposits.

The sandstone, where fresh, generally is an excellent quarry rock. Some massive well indurated shale units are also. Red chert has excellent quarry properties. Fresh greenstone is also an excellent quarry rock.

Melange is a Franciscan Complex unit composed of blocks of many rock types ranging in size from hand sized up to a mile or more across, contained in a more uniform matrix. The common block types are sandstone, greenstone, chert, blueschist, and limestone; a great variety of rarer types are present. The blocks may be slablike, but are usually about the same width in all directions, and are often rounded. The matrix is usually sandstone or shale, but may be serpentine. The matrix is commonly sheared, but may not be.

Franciscan melange was formed by submarine landslides; the blocks are boulders carried down by big sand or mud slides for the most part.

Engineering properties in melange are variable and unpredictable. Most blocks are very tough and strong and make excellent quarry rock; many may be blasted for fragmentation. Massive
or bedded sandstone matrix, where fresh, makes excellent quarry rock, and serpentinite matrix is generally poor. Shale can be used for fill.

The Great Valley Sequence in Sonoma County is a group of relatively poorly lithified sandstone and conglomerate units, of the same age as the Franciscan Complex (100 million years old), but separated from it by faults in most cases. Conglomerate is abundant and may be a good future quarry resource since it is rich in hard pebbles and pebble fragments easily separated from their matrix. The sandstone is not strong and has poor quarry properties save for fill uses.

Tertiary rocks in Sonoma County cover the Franciscan or Great Valley rocks above an angular unconformity (buried erosion surface). The rocks may belong to any one of several formational groupings which are listed in order of decreasing age.

The Petaluma Formation (10 million years old), consists of brackish water deposits of clay, shale, sandstone, nodular limestone, and conglomerate, whose upper portions may be correlative to the Merced Formation. This unit is exposed in the southern portions of Sonoma County.

The Ohlson Ranch Formation (10 million years old), consists of beds of sandstone, siltstone, and conglomerate occurring along ridgetops in the northwestern part of the county.

The Merced Formation (8-4 million years old), which consists of fossiliferous marine sandstones with minor zones of clay and conglomerate, is exposed extensively in the southwestern portion of the county.
A Tertiary to Quaternary deposit, the Glen Ellen Formation, marks the top of the Tertiary section in Sonoma County. This unit consists of poorly sorted deposits of silty clay, clayey gravel, and sand and gravel.

None of the Tertiary sedimentary deposits are used for anything other than fill. Pebble-rich conglomerate zones in these deposits, however, may be a good future source of stream pebbles after the modern river gravels are used up in the county.

Tertiary volcanic rocks (4-8 million years old) called the Sonoma Volcanics, consist of abundant andesite and basalt flows interbedded with a great variety of pyroclastic rocks. These pyroclastic units consist mostly of volcanic ash (tuff), but also include agglomerate, welded tuff and ash-agglomerate mixtures (tuff-breccia).

These units are exposed mostly in the southeastern portion of the county, in the Sonoma Mountains. Numerous eroded vent structures (former volcanoes) are distributed throughout this area.

In the Meacham Hill-Stony Point area, the Sonoma Volcanics interfinger with the Merced Formation along the "Washoe Anticline".

The basalts and andesites of the Sonoma Volcanics are generally good hard rocks which are presently being extracted for use as specific grades of aggregate by several rock companies. The tuff and tuff-breccias are mined by some operators for fill only, and have poor engineering properties.
Quaternary deposits in the county consist of river in-channel and flood plain deposits, and local landslide materials. River deposits are presently being heavily exploited in Sonoma County. Landslide materials are best avoided, even for fill, due to their unstable character.

Unfamiliar geologic terms can be found explained in the glossary.
SCONCHA VOLCANICS

BASALT-Dark colored, medium to coarse grained, crystalline volcanics. Found at: Brooks, Hagemann, Sonoma Rock, Spaltena, Stony Pt. and Zamarone quarries.


TUFF-Usually light colored, very fine grained, glassy volcanics. May contain crystals, lithic fragments or pumice. Found at: Mark West, Sonoma Rock, Spaltena and Zamarone quarries.

AGGLOMERATE-Poorly consolidated accumulations of volcanic rock fragments with a tuffaceous matrix. Found at: Brooks, Spaltena and Zamarone quarries.

VENT BRECCIA-Volcanic vent deposits with 1'-2' angular clasts in a tuffaceous matrix. Found at: Spaltena and Spaltena quarries.

FRANCISCAN METAMORPHICS


SEMMISHIST-Shiny, green, moderately metamorphosed, sheared shale. Found at Hartman Quarry and Bloomfield.

HIGH GRADE METAMORPHICS-Very hard blueschist, greenschist and eclogite. Found at Hartman and Graham quarries.

SILICA CARBONATE-Very hard altered serpentine containing small amounts of mercury ore. Found at Hartman Quarry.

SEDIMENTARY ROCKS

FRANCISCAN SANDSTONE-Fine grained, hard silty mudstone and sandstone. Found at: Chuychini, Bloomfield, Blue Rock, Bohan and Canelins, Canyon, Hagemann and Pasaluma quarries.

SHALE and CLAY-Poorly consolidated to well limified siltstone, shale and clay. Found at: Cecil Iman, Giovannini, Graham, SPI and Stony Pt. quarries.

INTERBEDDING SANDSTONE and SHALE-Interbedded sandstone and shale or siltstone and shale sequences. Found at: Chuychini, Bloomfield, Blue Rock, Canyon, Chenoweth, Giovannini and Pasaluma quarries.

MERGED and PETALUMA FORMATIONS-Poorly consolidated sandstone, siltstone, clay and conglomerate. Found at: Bloomfield, Hagemann, Hartman and Stony Pt. quarries.

CONglomerate-Poorly consolidated to well limified conglomerate containing well rounded clasts of various sizes in a fine grained, sandy matrix. Found at: Bloomfield and Brooks quarries.


MAP SYMBOLS

strike and dip of bedding
strike and dip of overturned beds
strike and dip of foliation
contact, dashed where inferred fault, dashed where inferred
quarry boundary

tone tailings, at Cinnabar quarry

scale on all maps
1:6000
1 inch = 500 feet
BIANCHINI QUARRIES

The Bianchini quarries consist of five separate quarries which lie to the south of Highway 1, near Bodega Bay. These quarries are located along a stretch of Highway 1, from 1 mile east of Bodega Bay to 2 miles east of Bodega Bay. Four quarries are near the highway, but the fifth, and easternmost, is set 0.2 miles off the highway along a private road (see fig. 1).

The land is now owned by TransCentury Properties Inc., 20500 Highway 1, Bodega Bay, Ca. The only quarry that has been worked recently is the easternmost, the one south of the highway on the private road. This quarry is quite small, covering about 60,000 square feet. The other four quarries, those that lie near the highway, have been inactive for many years. The largest quarry is the easternmost of the four along the highway and covers about 70,000 square feet. The pit of this quarry is now a reservoir-pumping station. The three remaining quarries, to the west of the reservoir, are also small covering a total of about 75,000 square feet.

All of these quarries have similar geology. The rock that was mined is fine grained sandstone, blue-grey where fresh, brown where weathered, with 3-12 inch interbeds of dark grey shale. The rocks are part of the Franciscan Complex and are complexly folded. The fresh bluish sandstone is quite hard, but the brown, weathered rock crumbles easily. The Franciscan sandstone in this area is fairly continuous, extending for several miles to the east along Cheney Gulch and Highway 1 from these quarries. The sandstone
is relatively massive, with few shale interbeds, in the quarries along Highway 1. The quarry that lies off the highway exposes almost equal amounts of sandstone and shale.

The quarries along Highway 1 have been inactive for many years. The only recent quarry is the one which lies southeast of the highway. It is only worked intermittently, on a very small scale when fill is needed on Transcentury property. The largest amount of rock removed from this quarry was used as road base for an unpaved service road on Transcentury property.

Many millions of tons of rock are present at this site, but it seems unlikely that the area will be exploited. Transcentury is affiliated with the Bodega Harbor housing development and it would serve their interests better to use this land as open space or for expansion of this development.

Principal Investigator - David Thormahlen
BLOOMFIELD QUARRY

Bloomfield quarry is located 1/2 miles north of Bloomfield, on Bloomfield road, which runs between Sebastopol and the Petaluma Valley-Ford Road. The quarry is owned and operated by Piombo Corporation, P.O. Box 790, Windsor, California, 95492. Piombo Corporation owns the entire parcel outlined on the map (Fig. 1). This parcel extends off the map to the south.

The quarry is relatively small, covering about 90,000 square feet. The pit lies to the south of Bloomfield Road and excavation has proceeded in a southerly direction into the hillside.

GEOLOGY

Franciscan Complex - The rock being quarried is bluish grey, massive, fine grained Franciscan sandstone. The sandstone is cut by numerous quartz veins and is well consolidated and hard. The sandstone is present as irregularly shaped blocks from 2 inches to 50 feet across. These bodies of hard sandstone are surrounded by a sheared shaley matrix that also contains lens shaped inclusions of hard sandstone from 1 to 6 inches across. Most of the exposed face of the quarry is made up of the sheared material. The large sandstone blocks are randomly distributed throughout the Franciscan Complex in the area. To the south of the pit are scattered outcrops of sandstone, chert and conglomerate. These blocks of harder rock are presumably also surrounded by an unknown amount of sheared matrix below the surface.
Merced Formation - The Franciscan rocks are overlain by poorly consolidated, yellowish tan sand and tuffaceous silt of the Merced Formation. The basal layer of the Merced Formation in the area is a 1-3 foot thick bed of grey, fossiliferous, clayey sandstone. This layer contains angular clasts of Franciscan sandstone. The Merced sediments were deposited on an uneven surface and have a sinuous contact relationship with the underlying Franciscan Complex. The Merced dips to the northeast at about 5 degrees and is not present in the southwestern part of the property.

The quarry is not being worked at present. The last time any rock was quarried was in 1977 when some 10,000 tons were used for road base on the Sonoma County Pepper Road project. Production in the past has ranged from 10,000 to 100,000 tons per year.

Piombo Corporation is planning to resume operation in the future and has purchased a mobile processing plant that will facilitate crushing and screening to provide a full range of products.

Sid Shah of Piombo Corporation estimates that some 15 million yards of rock are available at this site. Much of this volume may be sheared matrix which is inferior to the hard sandstone. As mentioned, outcrops of sandstone, chert, and conglomerate are present on the hillside to the south of the excavated area. Beyond these exposures, many closely spaced outcrops of sandstone lie to the south of the map area but
within the property boundary.

It seems that there is abundant sandstone to the south of the present pit. This area also lacks significant thicknesses of Merced Formation, leaving only soil and a weathered zone as overburden. The main problem with profitably working this site, or making precise reserve estimates is the unpredictable amount of sheared matrix in the Franciscan Complex.

Principal Investigator - David Thormahlen
BLUE ROCK CO.

Blue Rock Co. is located about 1½ miles west of Forestville at 7888 Highway 116, Forestville California 95436; the phone number is 887-2217, and the quarry owner's name is Don Wesner.

SIZE OF QUARRY

The area contained by the property lines is about 600,000 square feet, but the owner recently purchased an 18 acre parcel (Fig.1) just west of the quarry, where he hopes to soon begin operations. At the present time, however, he has no permit to quarry the new property.

GEOLGY OF SITE

The blue rock which comes out of this quarry is extracted from a dark gray to bluish, internally sheared yet massive silty mudstone. The rock is composed of very fine grains of quartz, plagioclase and potassium feldspar, which are contained in a dark gray clay matrix. The matrix to clast ratio is roughly 7:3, but since the clasts are so minute, the actual value may be slightly different.

The massive rock displays fine laminations of alternating coarse and fine material in hand sample, while bedding defined by thin interbeds of black shale in the silty mudstone, is found exposed along the eastern and southern quarry face.

This bedding is found offset repeatedly by randomly oriented shear planes, which when exposed along the quarry face
Figure 1. Geologic Map and Cross Section, Blue Rock Quarry, Sonoma County, California.
are slickensided. Tiny veinlets of quartz, usually less than 1mm thick, occur as shear fracture fillings throughout the silty mudstone.

The silty mudstone unit comprises the lower 1/2 of the quarry face, and it has no apparent lower limit. It contacts the overlying sandstone-siltstone sequence sharply, but the contact is offset by transcurrent shears.

The sandstone in the upper interbedded sequence (Fig.1) is yellowish tan, moderately well cemented, medium grained and weathers reddish brown. The sandstone is thick to massively bedded, and contains thin interbeds of black laminated siltstone. The upper unit as a whole probably defines an overburden of at least 50 feet above the massive silty mudstone. The overburden is removed and sold as fill, before the massive lower unit is mined.

STRUCTURES

The various non-uniform dip and strike directions of the stratified rocks in the quarry are perhaps their most significant structural irregularity. The structures which impart these variable dips and strikes are probably folds whose axes are oriented roughly north-south. Insufficient evidence exists at this quarry, however, to show any folds on the geologic map. The shearing of the rocks, which offsets contacts measurably, occurs along apparently random oriented planes which are often slickensided.
PRESENT USE OF ROCK

The Blue Rock Co. offers six types of rock for sale. The rocks include 1½" and 3/4" "Crushed Blue Rock", which is used for road construction; "Blue Bank Run", used for winter road construction; "Drain Rock", used for septic tank and leach line purposes; "Rocky Brown Bank" and "Fill", are both used as fill.

These rocks are currently being sold on a "per yard" basis at this quarry, but scales will soon be installed to facilitate the sale of rock "by the ton".

RESERVES AND PRODUCTION

The cumulative aggregate production rate at this quarry is about 150,000 yards per year. The probable reserves were calculated to be 3.5 million cubic yards by Mike Manson, a C.D.M.G. geologist.

Quarry safety guidelines would prohibit the extraction of all of this material, because the faces would need to be terraced. The owner feels, however, that when they begin operations on their newly acquired property, they may be able to get out a good majority of the extractable reserves.

REMARKS

Blue Rock Co. began operations 21 years ago, and is now being exploited by its fifth owner. The quarry face is already oversteepened, resulting in many daily rockfalls. It would be advisable for the quarry owner to terrace off the quarry face.
more efficiently, to ensure safe operating conditions.

PRINCIPAL INVESTIGATOR

Mark Kautsky
Bohan and Canelis Inc. is owned and operated by J. Bohan and T. Canelis on a 35 acre parcel 3 miles east of Duncan Mills Ca., 0.6 miles off highway 116 on Austin Creek road.

One geologic unit (Ss) occurs on the quarry property; a massive, grey to brown, greywacke sandstone that is part of the Franciscan complex. The rock is pervaded by fractures but bedding surfaces and flow structures are absent. Fresh samples are greyish brown, fine grained and contain abundant sub-angular amphibole grains up to 2mm in cross-section. The rock is cemented with silica and is therefore extremely hard when fresh. However, weathering alters the sandstone to a crumbly brown rock that breaks down into soil quickly thus forming a 3-5 meter soil layer over the sandstone.

Bohan and Canelis run two separate mining operations on their property (see map); a hard rock quarry and a river gravel operation. The hard rock quarry strictly mines the sandstone which is crushed and screened into sizes acceptable for use in the private sector (driveways, private roads etc.). The hard rock quarry averages a production rate of 1000 cubic yards per year but reached 3100 yards in 1978. The gravel operation supplies wholesale distributors in the western Russian River area with approximately 16,000 cubic yards per year (18,000 in 1978).

Reserves for the hard rock and gravel operations are extensive. The sandstone comprises most of the ridge the quarry pit is located in. In 25 years of operation they’ve mined less than 10% of the available sandstone. Reserves for the sandstone should last well in excess of 20 years at their present production rate.
The gravel reserves depend largely on the continued flowage of Austin Creek. When the Russian River runs at high water it backs up into Austin Creek forming a depositional basin. In the last five years the quarry company has taken bi-annual stream grade profiles which indicate that gravel deposits in excess of 18,000 cubic yards per year are laid down in the creek bed. As long as this process is allowed to continue the gravel reserves are inexhaustible at their present production rate.

Data compiled by: Randall G. Demaree
Figure 1, Geologic map of Bohan & Canelis' gravel and hard rock quarries
Sonoma County Aggregate Resource Study

Brooks Quarry

Brooks Quarry is owned and operated by Janet and Lyle George on a 26 acre parcel located on Brooks road (in Windsor) four miles north of its junction with highway 101.

Three main geologic units occur on the quarry property; a basalt porphyry, a basalt lahar, and a pebble-cobble conglomerate.

The basalt unit (Bas 1) is a plagioclase basalt porphyry flow rock. It contains clear, subhedral, lath-shaped plagioclase phenocrysts and minor amounts of olivine and pyroxene in an extremely hard, dull black, aphanitic groundmass. The elongated phenocrysts are aligned parallel to the flow direction of the basalt. The unit is massive in most parts except at the north face of the quarry pit where the flow has formed hexagonal columnar joints up to one meter in diameter.

The basalt lahar (Bas 2) underlies the basalt porphyry and is composed of angular to rounded plagioclase basalt clasts in an incoherent soil matrix that comprises 50% of the rock. Minor amounts of autobrecciated basalt also occur.

The conglomerate unit (Cg) is adjacent to and partially overlain by the basalt flow. It is composed of rounded pebbles and cobbles in a loose soil framework that comprises 65% of the rock. Minor amounts of sandstone and siltstone also occur.

The sandstone is tan, fine to medium grained and contains conglomerate lenses up to one meter thick and 5-6 meters long. The siltstone is a very fine grained, dark grey, incoherent rock that crumbles easily. Strike and dips of bedding surfaces in the sandstone and siltstone ranged from 150-156 degrees and 56-60 degrees to the southwest respectively.

The only product of Brooks Quarry is one to four foot rip-rap (derived from the basalt unit) that is used primarily for county projects {i.e. shoring up river banks}. In the 23 years the quarry has mined rip-rap they have taken out between 100-100,000 cubic yards per year. (2000 yards in 1978).
Reserves for the quarry are estimated (by quarry mgr. Wes Brooks) to last another twenty years. However, the present quarry site has expanded to within a few feet of the property boundary requiring the quarry to be relocated approximately 2000 feet to the eastern extension of the basalt flow (see map). now mined.

Data compiled by: Randall G. Demaree
Figure 1, Geologic map of Brooks Quarry, Windsor, Cal.
CANYON ROCK CO., INC.

The Canyon Rock Co. is located about 1½ miles west of Forestville, at 7525 Highway 116. Their mailing address is P.O.Box 661, Forestville, California 95436, and their phone number is 887-2634; the quarry owner's name is Adolf Trappe.

SIZE OF QUARRY

The property line of the quarry encompass three lots, whose total area is about 63 acres (Fig.1). Only about 1/4 of that area is presently being quarried. The quarry owner feels that the two eastern lots are going to confine the future extent of this quarry, since quarrying in the western lot will be unfeasible.

GEOLOGY OF SITE

The rock of principal interest in this quarry, a "blue shale", is a medium to dark gray, laminated very fine grained silty mudstone. The silt to mud ratio, although difficult to determine due to the fine grained nature of the rock, is about 1:9. The unit is exposed in the lower portion of the quarry face, and has no indication of a lower limit (Fig.1).

In northern exposures the unit is bedded. The beds are generally 2-3 inches thick, of alternating dark and light gray silty mudstone. Elsewhere, however, the unit appears massive. The rocks are invariably sheared to some degree.

Overlying the silty mudstone unit with an apparently depositional contact, are interbedded sandstones and siltstones.
Fig. 1  Geologic Map and Cross Section through quarry face, Canyon Rock Co., Inc., Sonoma County, California
The contact appears to be compositionally gradational over a few feet, marked by an upsection increase in the sand to mud ratio.

The sandstones in the upper sequence are fine grained and moderately indurated; they weather reddish brown. These sandstones occur either in massive beds, or in beds 2-5 inches thick, which contain interbedded dark gray finely laminated siltstones.

STRUCTURES

The most significant structure in the quarry is a probable northward plunging assymetric anticline (Fig.1). Minor fold axes which are exposed in the sandstones of the western portion of the quarry face should be oriented sub-parallel to the axis of the major fold, indicating that the trend of the mutually parallel fold axes is about N 15 E. The limbs of the major fold are more steeply dipping eastward than westward, thereby confirming the assymetry of the structure (Fig.1). A lower limit to the silty mudstone unit is drawn in the cross section (Fig.1) to illustrate the geometry of the fold.

Since the Blue Rock quarry is located only about 1500 feet away from the Canyon Rock Co., the quarry discussed here, it is probable that the irregularity of the bedding at Blue Rock is related to the folding that is exposed at Canyon Quarry.
PRESENT USE OF ROCK

Canyon Rock Co. offers "Bank Run Blue Shale", 3/4" and 1 1/4" "Crushed Blue Rock", "Clean Fill", and "Drain Rock" for sale. The Blue Rock is used principally as road rock, while the Drain Rock is used for septic tank, trench back fill, and leach line purposes. "Clean Fill", which is derived from the upper sandstone siltstone sequence, is used as fill material.

RESERVES AND PRODUCTION.

Mike Manson, a C.D.M.G. geologist whose report is in the possession of the quarry owner, estimated the cumulative reserves at this quarry to be about 30,168,000 tons. Currently the Canyon Rock Co. is producing aggregate at the rate of about 225,000 tons per year.

REMARKS

Operations at Canyon Rock Co. began in the 1940's, at which time only "bank-run" material from the sandstone-siltstone sequence was being used. The blue shale was encountered only later, about 1960, at which time the rock crushing equipment was installed. The present owner has been at the quarry since 1973. The quarry face is well terraced by the quarry people to ensure safe operation. According to the owner, Canyon Rock Co. is the largest producer of Blue Rock in Sonoma County.

PRINCIPAL INVESTIGATOR

Mark Kautsky
Cecil Inman Shale Pit

Cecil Inman Shale Pit is located 0.5 miles off Mill Creek road on Wallace Creek road, 2 miles west of Healdsburg. It is owned by Ollie Inman (Cecil Inman's widow) and operated (on a lease) by Gene Inman on a 39 acre parcel.

One geologic unit occurs on the quarry property; a very fine grained shale that is intensively fractured. The fracture surfaces are coated with rust red iron oxide and metallic silver colored manganese oxide which gives the rock a bright red and/or a shiny silver color. On fresh surfaces the shale is tan to yellowish grey. On weathered surfaces the rock crumbles into fragments 1-5cm across. These fragments are bound in a soil matrix that forms a weathered layer 1-2m thick on the surface of the outcrop. The unit is wholly massive (aside from abundant fractures) and shows no bedding surfaces or flow structures.

The shale pit has been in operation 35 years and generally averages 20,000-30,000 cubic yards per year (16,000 in 1978). The shale is crushed and screened to -1" and less fragments that are mostly used as roadbase. Basalt rip-rap is also sold by the quarry but is derived from clearing of a nearby farm.

The shale unit is areally extensive around the pit and is estimated (by Gene Inman) to last in excess of twenty years at their present production rate.

Data compiled by: Randall G. Demaree
CHENOWETH QUARRY

The Chenoweth Quarry is located on 5705 Harrison Grade Road in Sebastopol. To get there take the Green Valley Road west from Highway 116, and follow it until the road makes a "Y". The south directed fork is Harrison Grade Road; the quarry is 1/5 mile along it from the fork in the road.

The quarry owner's name is Bud Chenoweth. He may be reached at his home at 12801 Green Valley Road in Sebastopol; his phone number is 823-3533.

SIZE OF QUARRY

The property on which the quarry is located comprises about 8.5 acres; only 1.5 acres of this land has been quarried so far. The quarry property extends from the road to the eastern and the southern boundaries of section 14 (Figure 1).

GEOLGY OF SITE

The rock which is being extracted from the quarry consists of interbedded sandstones and siltstones probably of the Franciscan Complex. These occur at the base of the quarry, and as resistant blocks on the hill beyond the quarry face; no overburden is present (Figure 1).

The sandstones are well indurated, moderately sorted and greenish gray; they weather light to dark brown. The interbedded siltstones are black, well indurated and very fine grained. The matrix to clast ratio in the siltstones is at least 9:1.
Fig 1. Geologic Map and cross section, Chenoweth Quarry, Sonoma County, California
These two rock types are interbedded; the sandstone is far more abundant than the siltstone. Individual beds of sandstone are usually 2 or 3 inches thick, but thicker, more massive beds are also present. The siltstone beds are usually very thin; they occasionally reach up to about 2 inches maximum thickness.

The beds strike about N 30° W consistently, and have a consistent northeastward dip of about 45 degrees. Small scale offset of the beds caused by slip along minor faults has modified the structure only slightly.

No information was made available by the owner regarding the production rates or reserve potential at this quarry. The rock however is used solely for road construction. There is no rock crushing equipment per se employed at the quarry. The rock disaggregates as it is bulldozed to the quarry floor, and no further crushing is required.

PRINCIPAL INVESTIGATOR
Mark Kautsky
CINNABAR ROCK QUARRY

The Cinnabar Rock Quarry is located at 18475 Sweetwater Springs Road, Guerneville, California. The phone number at the quarry is 869-3163; the quarry owner's name is Walter Doyle.

SIZE OF QUARRY

The area of the quarry is about 5½ acres. The quarry owner owns about 500 acres in this area, of which the quarry is only a small part. Operations at the quarry are only concerned with the extraction and sale of the tailings which were dumped by a preexisting, now closed, cinnabar mine (Fig.1); after the tailings are all sold the quarry operation will halt (see below).

GEOLGY OF SITE

The tailings from the cinnabar mine occur as piles tens of feet thick that consist of angular clasts about 2-3 inches in diameter of quartz rich hydrothermal vein material. Quartz is present as apparently randomly oriented milky veinlets which are contained in a more massive and generally darker cryptocrystalline quartz. Carbonate is also present, but only to a small degree. Within the rock small gas filled cavities are common. The quartz appears to have been fractured and then recemented by new quartz veins.

The tailings lie on top of pervasively sheared Franciscan melange, which is unsuitable for aggregate; this limits the ex-
Fig. 1, Cinnabar Rock Quarry, barbed lines show extent of extractable tailings.
tent of quarry operations to removal of the old tailings.

PRESENT USE OF ROCK

The Cinnabar Quarry is currently producing 4 types of aggregate material. The first type, '1/2" minus', is used for topping driveways and walkways. The second type, '3/4" crusher run', is used for class 2 roadbase. The third type, '3/4" clean rock' is used for driveways and decoration. The fourth type is called '1½" clean rock'; it is used as roofing gravel.

RESERVES AND PRODUCTION

The owner estimates that he has 1/2 million yards of rock available for aggregate. In the past, the production only amounted to a couple of thousand yards per year, however, since the installation of new equipment last fall, the quarry output jumped to 3000 yards in October alone.

REMARKS

The cinnabar mine which contributed its tailings to their present location first began operating in 1870. The mine closed down in 1972, but ever since the 1940's the tailings have been used for aggregate. The first company to begin an aggregate operation here was called Strooo Co., Kaiser Sand and Gravel bought them out later. In 1971 the present owner began to lease from Kaiser, and in 1974, he bought them out.

PRINCIPAL INVESTIGATOR

Mark Kautsky

39
GIOVANNINI QUARRY

The Giovannini Quarry is located about 500 feet west of Green Valley Road on a small private road that leads to the Mount Gilead Bible Conference grounds. The turn off to the quarry is located about 1 mile north of the Harrison Grade Road-Green Valley Road intersection in Sebastopol. The owner of the quarry is Lewis Giovannini of 13024 Green Valley Road; his phone number is 823-3741. Business concerning the quarry, however, should be handled through his attorney, Bill Dillon, whose telephone number is 546-3663.

SIZE OF QUARRY

The quarry is located on two parcels of land, parcel 104-160-08, and parcel 84-25-10. The combined area of the two parcels is 71.63 acres. Only a small portion of the quarry land has been mined so far (Figure 1).

GEOLOGY OF SITE

Two distinctly different rock units, probably of the Franciscan Complex, are exposed within the quarry. The structurally highest unit is a siltstone-shale interbedded sequence, while the lower unit is a massive silty-mudstone(Figure 1). The massive unit occupies the lower 3/4 of the quarry cut, and is the rock of principal interest at the quarry. The contact between the upper and lower units is hereby informally designated
Figure 1  Geologic Map and cross section
Giovannini Quarry, Sonoma County, California
by a distinct laterally continuous 2 foot thick sheared dark gray shale bed. This shale unit probably represents the local base of the overlying siltstone-shale sequence. Whether the two units are in depositional or faulted contact is unclear.

The lower unit is a massive dark gray or bluish gray very fine grained well indurated silty-mudstone. It contains veins of milky carbonate which seem to occupy preexisting shear fractures in the rock. These veins are generally subplanar, usually about 1mm thick, and compose about 5% of the rock unit. A unit of similar lithology, but which is locally bedded, is exposed in a roadcut southeast of the quarry cut (Figure 1), indicating that the lower unit is extensive in the core of the hill south of the quarry.

The overlying siltstone-shale sequence is well exposed in the upper portions of the quarry cut, and in the roadcut southeast of the quarry. Based upon these exposures alone, it seems that the upper unit is at least 30-50 feet thick. The siltstones are fine grained dark greenish-gray, orange and purple weathering gritty rocks with a clay to grit ratio of about 7:3. They occur in beds about 8-12 inches thick.

The shales in this unit are dark gray, very fine grained, and weather in shades of dark purple and black. The shale is laminated with alternating light and dark gray layers; the light gray laminae are about 1mm thick, while the dark gray laminae are about 1/4 mm in thickness.

The dips and strikes of the bedding in the upper interbedded
unit are variable throughout the quarry area, suggesting that the area may be folded.

REMARKS

Sporadic operations at the quarry began in 1925, but the quarry has been in continuous operation only since 1935. The rock is loosened with dynamite, and then is carried down the bank by bulldozers. Portable rock screeners have been used in the past for private jobs, but usually the rock is taken as it comes off of the bank. The rock is used for road construction and for building driveways.

PRINCIPAL INVESTIGATOR: Mark Kautsky
GRAHAM QUARRY

Graham Quarry is located at the intersection of Harrison Grade Road and Graton Road, east of Occidental. The top of the quarry face lies along a hairpin turn on Facendini Lane. The northwest end of the quarry pit is presently a small pond. The quarry is fairly small covering about 2.75 acres. The quarry is owned and operated by T.A. Graham of 5502 Graton Road, Occidental.

GEOLOGY

The rock being quarried is very fine grained buff shale. This shale forms the matrix of the Franciscan Complex in this area. Randomly distributed blocks of blueschist, serpentinite, and greenstone up to several hundred feet across, are surrounded by this shale matrix in the general area of the quarry. Only one such block is exposed in the quarry. It is a blueschist block, about 20 feet across, which has just recently had its top exposed on the floor of the quarry. The matrix is not extensively sheared, as it often is in other parts of the Franciscan. A series of planar joint sets cut the shale and cause it to break up into small rhombohedrons, about \( \frac{1}{4} \) inch across.

PRODUCTION and RESERVES

Production at this quarry is quite small, about 200 - 500 tons per year. The rock is sold mainly to private buyers for driveways and roads on nearby ranches. The county is the biggest buyer of this rock and uses it for patching roads in the area. Up until about 3 years ago production was higher because a local contractor had been buying much of the rock. Mr. Graham states that this rock meets both state and county
specifications for road base material.

Reserves at the present site are somewhat limited. Further harvesting of the quarry face threatens to undermine the turn in Facendini Lane. Mr. Graham plans to excavate into the present quarry floor, lowering the floor level by about 10 feet. This will yield about 8,000 tons of rock. Much of this rock might be very solid blueschist from the previously mentioned block, which would probably need to be blasted and then crushed before it could be sold. Mr. Graham deals in explosives and usually blasts the rock from his quarry, but there is no rock crusher available at the site.

If more expansion in needed excavation will have to be carried out in a southerly direction. This could yield as much as 65,000 tons of rock, but there is no way to tell how much of this will be of usable quality.

Data compiled by David Thormahlen 2/2/79
HAGEMANN RANCH QUARRY

Hagemann Ranch Quarry is located 2.5 miles east of Bodega Bay on California Highway 1. It is owned and operated by Stanley Hagemann of 16000 Highway 1, Bodega Bay, California. The Hagemann ranch is outlined on the map (figure 1), and continues off the map to the east.

The quarry is moderate in size, covering about 125,000 square feet. The quarry lies to the north of the highway and excavation has proceeded in a northwesterly direction into a small spur that leads to the crest of the main ridge.

GEOLOGY

Franciscan Complex - The rock being quarried is bluish grey, massive, fine grained, Franciscan sandstone. The sandstone contains thin laminations of dark grey shale from ½ to 6 inches thick. The Franciscan in this area is not melange, but is a continuous block of sandstone and shale. Shearing is not as extensive in this area as it commonly is in other parts of the Franciscan Complex.

Merced Formation - Yellowish tan, poorly consolidated, coarse grained, tuffaceous sandstones of the Merced Formation overlie the Franciscan Complex to the northeast of the quarry. A well exposed bed of tan sandstone unconformably overlies the Franciscan in the northeastern part of the quarry area but the Merced sandstone has not been quarried. The Merced has been removed from the active quarry area by natural erosion. The Merced Formation forms an overburden as much as 200 feet thick in places and dips 7 degrees to the northeast.
Basalt - A small patch of aphanitic basalt is exposed to the northeast of the quarry. The extent of this body is unknown but it seems to be confined to this one area and is of minor significance.

PRODUCTION AND RESERVES

The rock being mined is primarily used for roads on nearby ranches. In the past some rock has been sold to the state as well as to Sonoma County. The rock has never been tested and is not crushed or screened before it is sold.

The quarry had been leased to an individual who left it inactive for many years. It has been recently reactivated by the Hagemann family but production is still fairly low.

A large volume of Franciscan sandstone is available to the west and southwest of the present quarry. This area lacks the thick Merced overburden and would be the best area for expansion in the future. The amount of Franciscan sandstone that could be quarried is on the order of 15 million cubic yards.

REMARKS

Although the rock from this quarry has not been tested, it is quite hard and is probably suitable for road base material. This is the only active quarry in this area and would be a good local source for projects in this somewhat remote part of the county.

Data compiled by David Thormahlen 1/23/79
HARTMAN QUARRY

Hartman Quarry is located on Lakeville Road near the intersection of Lakeville Road and Stage Gulch Road, southeast of Petaluma. The quarry is owned and operated by Chilotti Brothers Construction, Inc. It is moderate in size, covering about 9½ acres. The Chilotti brothers own two long, narrow parcels of land which run parallel to Lakeville Road. These parcels total 122 acres.

GEOLOGY

The rock being mined is Franciscan melange which is composed of randomly distributed blocks of greenschist, blueschist, eclogite, greenstone, interbedded chert and shale, and interbedded sandstone and shale. The blocks range from small boulders 1 foot across to large blocks over 100 feet across. The blocks lie in a sheared, green, shiny semischist matrix.

Two distinct types of melange are exposed within the quarry pit. In the southern half of the quarry is a greenstone, chert and sandstone melange with a dark green semischist matrix. Large blocks of greenstone, interbedded chert and shale, and interbedded sandstone and shale lie in the sheared semischist matrix which contains small, 1 inch to 1 foot, chips and blocks of greenstone, chert and sandstone, as well as the large blocks mentioned above.
The northern part of the quarry is composed of a predominantly blueschist melange which contains large blocks of blueschist, greenschist, greenstone and interbedded chert and shale. The matrix of this melange is a light green, sheared semischist. Sheared blueschist also forms part of the matrix.

Beyond the quarry boundary the melange is only represented by outcropping blocks of resistant blueschist, greenschist, eclogite, greenstone and chert. These blocks are presumably surrounded below the surface by the sheared semischist matrix seen in the quarry and in a few creek-beds.

The Franciscan Complex described above is in fault contact with poorly consolidated sandstone and conglomerate of the Petaluma Formation. This fault is the Tolay Fault which runs roughly parallel to the San Andreas Fault which lies about 20 miles west of the quarry.

A narrow belt of silica carbonate rock outcrops along this part of the Tolay Fault. The belt is not continuously exposed along the fault but is divided into two main outcrop areas. These are probably connected at depth. Silica carbonate is formed by hydrothermal alteration of serpentine which is commonly found along faults in Franciscan terrain. The silica carbonate exposed in this area contains small amounts of cinnabar, a mercury ore. No unaltered serpentine was found in the area.
PRODUCTION and RESERVES

Production at Hartman Quarry ranges from 25,000 to 50,000 tons per year. Much of the rock is used by the Ghilotti brothers construction company but it is also sold to the county and state as well as other construction companies. It appears that the Ghilotti brothers use nearly all of the various rock types leaving only the large, very hard blocks. Materials from this quarry are used for road base, drain rock and fill.

A conservative estimate of the reserves on this property is about 10 million yards. It is not known how much of the subsurface melange is composed of hard blocks, of various rock types, or of soft semischist matrix but they seem to be present in nearly equal volumes.

Data compiled by David Thormahlen
MARK WEST SHALE PIT

The Mark West Shale Pit is located at 4611 Porter Creek Road, near the intersection of Porter Creek Road, Calistoga Road and Petrified Forest Road. The pit is operated by Richard Malugani who leases the 87 acre parcel. The present lease expires in two years. Mr. Malugani hopes to negotiate a ten year lease when the present lease expires. The parcel is shown on the map (figure 1). A ten acre portion, on the south side of Porter Creek Road has recently been sold but is not shown on the map.

The quarry covers about 470,000 square feet and has a steep face over 200 feet high, on the north side. The quarry lies on the extremely steep north side of the Mark West Creek Valley.

GEOLOGY

The rock being mined here is a blue-green, fine grained, weakly metamorphosed pillow basalt that is cut by numerous calcite veins. Near the surface this rock is weathered to a red-brown crumbly rock that is poorer in quality than the fresh blue-green rock. This pillow basalt body is part of the Franciscan Complex and makes up most of the mountainous area north of Porter Creek Road, in the center of the map.

High on the northern slope of this mountainous area, the pillow basalt is overlain by poorly consolidated tuffs of the Sonoma Volcanics. These are coarse grained, poorly consolidated, pumiceous, vitric tuffs containing 1 to 6 inch glassy bombs and occasional pieces of silicified wood. Where
they are present, the tuffs form an overburden that may be as much as 50 feet thick. This tuff is not in the area presently being quarried.

PRODUCTION and RESERVES

The red, weathered rock is used for road sub-base and fill. The blue-green, fresh rock is used for road base and for driveways. Both types are sold as decorative rock. Napa County is probably the largest buyer, but much of the rock is sold to private, small buyers as well as to the state.

Present production ranges from 60-120 thousand tons per year. Average production is 100,000 tons per year. Mr. Malugani estimates that he has reserves on this piece of property to last another ten years at present production rates. This amounts to one million tons.

REMARKS

On the order of 75 million cubic yards of Franciscan pillow basalt are present within the large ridge that lies north of Porter Creek Road. This ridge is composed of five separate parcels owned by five separate owners. The plot that lies on the western side of the present quarry plot, has an area that was worked as a quarry from 1910 until the 1940's. In the 40's Mr. Malugani moved the operation to its present location. The plot to the east of the quarry is part of the Petrified Forest tourist stop, and will probably never be available for quarrying.

Data compiled by David Thormahlen 1/23/79
Nuns Canyon Quarry Inc.

Nuns Canyon Quarry Inc. is located between Kenwood and Agua Caliente, one mile off highway 12 on Trinity road. It is owned and operated by Kenneth and Hal Weise on a 10 acre parcel leased from Gordenker Turkey Farms Inc. on a 10 year, renewable basis (renewable in 1986).

One main rock unit occurs on the quarry property; an intrusive and flow unit of volcanic felsite with minor amounts (less than 1%) of grey, rhyolite vitrophyre. The major rock type is a hard, cream to grey-white colored, wholly aphanitic felsite. It comprises over 95% of the rock unit and is cut by three tuff-breccia dikes (up to 3 meters across) on the western face of the quarry pit. Rust-red iron-oxide veins pervade the unit and give rock fragments a distinctive red coating. Minor portions of the unit have been stained purple, yellow, and orange by hydrothermal alteration.

On a large scale the unit is a heterogenous mixture of massive flows and intrusives overlain by a thin (2-3 feet) soil layer. Surface expression of the unit can be seen in abundant littering of polyhedral fragments of felsite (up to 3 cm in diameter) within the soil. The felsite is the only significant geologic unit on the quarry property.

The felsite unit is a uniquely colored volcanic rock that is rare on the west coast. As such it is used exclusively for decorative purposes. Crushed and screened 1/2" and 3/4" fragments are the only product of the quarry, which sells 30,000-40,000 cubic yards per year. Approximately 50,000 tons of fines have accumulated (over the last three years) as a byproduct of the mining operation but isn't sold due to its poor compaction when jetted.

Reserves for the quarry appear stable over a considerable time span (due to the locally extensive nature of the rock unit) at their present rate of production, which is expected to remain within past limits.

Data compiled by: Randall G. Demaree
Figure 1, Geologic map of Nuns Canyon Quarry and adjacent area
PASALAQUA QUARRY

Pasalaqua Quarry is located on Coleman Valley Road about halfway between Bodega Bay and Occidental. The quarry is owned and operated by William A. Pasalaqua who lives near the site. Mr. Pasalaqua owns both parcels of land that are outlined on the map. The quarry is very small, covering less than ½ acre, and is only worked when rock is needed by the Pasalaquas or their neighbors.

GEOLOGY

The quarry is cut into a large block of Franciscan greenstone which is about 500 feet in diameter. The block is mostly made up of weathered, crumbly, brown rock, but irregularly distributed zones of unweathered, hard, green rock form part of the block.

The above mentioned greenstone block lies within a sheared melange matrix of interbedded sandstone and shale. This matrix is well exposed in the creekbed to the northwest of the quarry. Rounded blocks of sandstone, chert and greenstone are randomly distributed within the sheared matrix. Blocks in the melange may range in size from a few inches to over a mile across. In the immediate area the greenstone block being mined is the largest.

The irregular weathering pattern that has developed within the greenstone block being quarried is probably due to the shearing that has taken place within the melange. The greenstone is generally less weathered toward the center of the block.
Other large blocks of chert, greenstone and sandstone are shown on the map. Many smaller blocks are also present but are not mappable.

PRODUCTION and RESERVES

Production at this quarry is very low. Annual production is usually 200 to 500 tons, but the quarry is inactive much of the time.

Approximately 150,000 tons of greenstone are easily available at the site without quarrying below the level of Coleman Valley Road. Close to another 150,000 tons may lie below the level of the road, assuming the block is semi-spherical. Quarrying below the road level may not be profitable because the subsurface volume of the block is highly unpredictable.

Data compiled by David Thormahlen
QUARRY PRODUCTS, INC.

Quarry Products, Inc. (QPI) owns and operates a large quarry at 1000 Petaluma Boulevard South in Petaluma. The quarry is easily accessible, as it lies at the corner where Petaluma Boulevard passes under Highway 101, about 2500 feet from the Petaluma Boulevard South freeway interchange.

The quarry operation covers about 43 acres. A little more than half of this area is actively being quarried. The quarry boundary on the topographic map is not accurately shown. The spiked line was probably drawn from an old aerial photograph and is in error. A second, darker, spiked line indicates the actual present boundary of the quarry operation.

QPI owns three of the parcels on which quarrying is being done; the large plot that covers most of the quarry, the small, triangular plot to the east, and a small, rectangular plot to the west that lies on Petaluma Boulevard South. QPI has an agreement with the state that allows them to use the strip along the western edge of Highway 101. They also have an agreement with the Petaluma Golf and Country Club that allows them to quarry into the large hill to the south of the quarry property, which belongs to the country club.

GEOLOGY

The quarry is cut into a volcanic neck complex which is composed of three main rock types: basalt, agglomerate and breccia.

The breccia is a red, vesicular breccia which contains ¾–1½ inch, angular fragments of plagioclase crystals, basalt and exotic wall rocks. This breccia lies mainly in the
central part of the quarry pit and has irregular, intrusive contacts with the other rock types in the quarry. In a few places, large masses of basalt are completely surrounded by the breccia and in one place a small body of shale is suspended in the breccia.

The agglomerate consists of 3-12 inch angular clasts of dark gray basalt in a light brown matrix of tuff and pea sized rounded clasts. It is exposed in the northern part of the quarry. The clasts weather to a light gray, almost white outer appearance. Occasional larger clasts may be over 3 feet across.

The remaining area of the quarry is composed of massive basalt, which is redish-brown where weathered and dark gray where fresh. The basalt is cut by a series of joints that break the rock into tabular blocks from 1 inch to 1 foot thick. The basalt is probably the most abundant rock type in the quarry and makes up the large hill that lies on the southern border of the quarry.

The volcanic complex was intruded into and through the Franciscan Complex. The Franciscan is exposed on the western and eastern sides of the quarry. A thin band of Franciscan melange lies between the quarry and Highway 101. This melange consists of blocks of schist and serpentine in a sheared shaley matrix. The basalt on the western side of the quarry is in contact with Franciscan shale. The slopes in this area are littered with basalt fragments but a few bench cuts reveal the presence of the Franciscan shale. The Franciscan is highly
altered where it is in contact with the volcanics. The shales are stained blue in places where hydrothermal fluids circulated around the margins of the volcanic complex.

PRODUCTION and RESERVES

The three rock types in the quarry are used for base rock, drain rock and asphalt. The only rocks that are separated and not used are large boulders of the red breccia, which are piled up at various locations around the quarry.

The quarry has a complete crushing and screening operation as well as an asphalt plant, located on the eastern side of the quarry. An old crushing and screening operation, on the western side, is being rebuilt and moved to the eastern side.

The present production rate is about 300,000 tons per year. QPI estimates their reserves to be about 7 million tons. This would allow them another 23 years of operation at present production rates without expanding their property boundary.

The most likely direction for expansion would be to the south since the basalt continues in that direction. If QPI could obtain part of the parcel that lies to the east of the country club, they could harvest most of the large hill that lies in the southern part of the quarry.

Data compiled by David Thormahlen 2/2/79
Sonoma Rock Quarry Inc.

Sonoma Rock Quarry Inc. is owned and operated by C.R. Pedrick on a 92 acre parcel located off highway 121 five miles north of its intersection with highway 37. The land is leased from Dewey Donnell on a five year renewable basis (renewable in 1979).

Three main rock units occur on the quarry property (see map); a basalt porphyry (Bas), tuff agglomerate (Agg), and a polyolithic tuff breccia (Tuff).

The basalt unit is underlain (?) and laterally bounded on three sides (west, south, and east) by the tuff agglomerate which seems to enclose a small finger of it that extends to the south (see map). It lacks overburden and is only slightly weathered on the surface. The rock is an olivine plagioclase basalt porphyry which has an extremely hard, shiny black, aphanitic groundmass containing phenocrysts of clear, subhedral, blocky plagioclase and green, anhedral olivine, some of which has been oxidized to iddingsite. Rare occurrences of baked basalt show a purplish-brown groundmass instead of black. Intermittent seams of clay occur in the basalt unit.

The tuff agglomerate (Agg) is composed of angular blocks of basalt and felsite intermixed with sub-rounded to angular pebbles, cobbles and boulders (up to 1 meter in diameter) within an incoherent matrix of tuffaceous sand. The matrix comprises 50-60% of the rock unit. The rock unit predominates on the southern portion of the quarry property.

The polyolithic tuff breccia occurs on the northeastern corner of the quarry adjacent to and in contact with the basalt flow. The contact is depositional (?), inclined, and dips steeply to the northeast. The rock unit has a red, tuffaceous matrix containing angular fragments of black basalt (from the adjacent basalt unit) ranging from lcm to 0.5m in size. The tuffaceous matrix is soft and incoherent forming a mechanically weak unit.
Figure 1, Geologic map of Sonoma Rock Quarry Inc.
The main products of S.R. Inc. are 3/4" and 1 1/4" class 2 aggregate base (derived wholly from the basalt) and 1 1/4" and 3" screened subbase (derived from the clay seams in the basalt unit). Main byproducts are quarry sand, rip-rap, and drain rock (see Appendix 1 for a complete list of quarry products).

The subbase was initially derived from the poly lithic tuff breccia and used with favorable results by S.R. Inc. customers. However, the breccia failed durability tests and isn't mined at present.

The agglomerate unit was mined for airfield basement rock in the early 1900's but at present is considered of poor economic quality.

S.R. Inc. production during the last four years of operation has ranged from 50,000-100,000 tons (84,000 tons in 1978) most of which was basalt, by far their most profitable resource. Production is expected to continue within these limits in the foreseeable future.

Quarry reserves depend largely on the reserves of the basalt unit, which appears stable in the foreseeable future. However, long range expansion would probably require quarry relocation to the west side of highway 121. A field reconnaissance of the area on the west side of the quarry and highway 121 showed the basalt unit to be extensive thru-out this area, outcropping on hilltops and at the base of stream valleys and lacking any overburden. The portion of the basalt unit now mined, however, thins and dies out to the south but would probably still supply production needs for several years at their present rate of production.

Data compiled by: Randall G. Demaree
SONOMA ROCK COMPANY  
26650 Arnold Drive  
Sonoma, CA 95476  
Telephone (707) 938-8455  
(415) 897-4155  

The following prices will be in effect January 1, 1979:

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<thead>
<tr>
<th>Material Description</th>
<th>Price per Ton</th>
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<td>Class 2 Aggregate Base 1-1/2&quot;</td>
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<tr>
<td>Bank Run Fill Material</td>
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<td>Class 3 Screened Subbase - 1-1/2&quot;</td>
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<td>Screened Subbase - 3&quot; (when available)</td>
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<td>Quarry Sand 1/4&quot; to Dust (when available)</td>
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<td>Drain Rock 1-1/2&quot;</td>
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<td>Facing Rock 3&quot; to 8&quot; ± (when available)</td>
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<td>Rip-Rap 6&quot; to 24&quot; ± (when available)</td>
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<td>Engineers' Rock 24&quot; and larger (when available)</td>
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All prices stated herein are per ton of 2,000 lbs., f.o.b. customer's truck. Prices do not include any sales or excise taxes and are subject to change without notice. No deductions for water content will be allowed.

Discount for payment by 10th prox - 10¢ per ton.

Any unpaid balance after 30 days will incur a service charge of 1-1/2% per month or 18% annually.

Appendix 1, List of quarry products offered by Sonoma Rock Quarry Inc.
SPALETA QUARRY

Spaleta Quarry is located on Manor Lane, 2 miles from where it intersects Old Adobe Road near the Petaluma Adobe Historical Monument. The quarry is not active at present. The land is leased by Ralph Spaleta who is trying to buy it from an estate. He hopes to resume operation as soon as he renews his surface mining permit. The quarry is moderate in size, covering a little more than 5½ acres, but the plot of land is quite large leaving ample room for expansion.

GEOLOGY

The rocks being mined consist of a variety of glassy tuffs which are associated with a pyroclastic volcanic vent complex. The eastern face of the quarry exposes a cross section of the vent complex.

Exposed at the top of the face is a small outcrop of very coarse vent breccia which contains 2 inch to 2 foot angular blocks of basalt, felsite and tuff. These blocks are suspended in a glassy matrix of smaller particles.

The bulk of the face is composed of flow banded gray and white, glassy, densely welded tuff. This unit is overlain by poorly consolidated, gray, glassy breccia that is composed of fragments of the underlying, flow banded tuff. Both of these units grade into a darker gray, glassy breccia to the south.

On the north end of the east face, the predominant direction of banding in the banded tuff is cut by a white, glassy tuff breccia. This is clearly a younger unit since it cuts the
older banding at a high angle. The contact strikes due north
and dips 30 degrees to the east.

On the relatively small west face of the quarry, is a
unit of moderately welded buff, aphanitic tuff. This rock
and the banded tuff are the only hard rocks exposed in the
quarry, except for the blocks in the vent breccia. The other
poorly consolidated breccias crumble easily.

Much of the land that is leased by Mr. Spaleta is under-
 lain by the same types of tuffs as are exposed in the quarry.
An additional type of tuff is exposed on the land, composed
of 1-5mm crystals of sanidine and plagioclase in a weathered
tuffaceous matrix. This crystalline tuff is very crumbly.

A large hill, elevation 784, lies to the east-southeast
of the quarry which is almost entirely made up of dark gray
basalt. This rock is quite hard and dense. Outcrops of this
basalt are also present to the northwest of the quarry.

PRODUCTION and RESERVES

Spaleta Quarry is inactive at present. The rock has been
sold in small quantities in the past and is used for fill and
for dirt roads on the Spaleta Ranch.

Close to 150,000 tons of tuff are still present within
the hill that is now being quarried. Another 2.5 million tons
of tuff are present within the ridge that lies along the north-
eastern property line.

The basalt that is exposed in the area may be suitable
for road material but has not been tested. About 380,000 tons
of basalt lie within the large hill to the east-southeast of
the quarry.

Data compiled by David Thormahlen 2/1/79
STAGE GULCH QUARRY

The Stage Gulch Quarry is located off Stage Gulch Road (Highway 116), about 7 miles east of Petaluma. The road that leads to the quarry is also the access road to the County dump. The quarry owners name is Mr. Cabral; his telephone number is 996-5498. Mr. Don Hardister leases the quarry from Mr. Cabral. Don Hardister's telephone number is 938-3384. The quarry pit margin encloses an area of about 9 acres.

GEOLOGY OF SITE

The rocks at the Stage Gulch Quarry consist of Sonoma Volcanics basalts and agglomerates, which are interbedded with dark tuffaceous locally conglomeratic sediments of the Petaluma Formation (see below). Stratigraphic relations are concealed by bulldozed rubble in the southern portion of the quarry pit, and best exposed in the vertical cuts near the floor of the quarry.

A vertical section through the quarry reveals at the bottom a dark gray, tan weathering massive, locally vesicular basalt flow. Its thickness cannot be determined because the base of the unit is not exposed. It does however extend upwards about 25 feet above the floor of the quarry.

Overlying the basalt flow is a partial section of the Petaluma Formation. At its base is a black structureless weakly welded vitric tuff, about 6 feet thick, consisting largely of pumice lapilli and glass shards. Above it is a yellow brown weakly indurated, dark brown weathering tuffaceous sandstone about 15 feet thick, consisting of about 70% fine grained tuffaceous material, about 20% devitrified rounded pumice clasts up to 3 mm. in diameter, and about 10% largely basaltic rock fragments up to 4 mm. in diameter. Above this unit is an unbedded claystone which contains lenses up to 2 feet thick of pebble conglomerate. The pebbles are dominantly basaltic, but some are composed of red chert. This unit is quite extensive in the quarry, and seems to underlie the small hill southeast of the quarry.
Figure 1 Geologic Map and Cross Section, Stage Gulch Quarry, Sonoma County, California.
These rocks of the Petaluma Formation are overlain by a Sonoma Volcanics unit consisting generally of hard rounded basalt clasts 4–8 inches in diameter, but containing occasional clasts up to 3 feet in diameter. These lie in a yellow, purple, and tan minutely crystalline matrix of ash and dust. The clast to matrix ratio in this agglomerate is high, thereby making it the most attractive source of high grade aggregate in the quarry.

The structural geology of the quarry area in general is complex, impart due to the presence of active faults nearby. The rock units in the quarry itself are contained in a large fold which extends beyond the quarry. The geometry of the fold is easily seen looking northwest from the floor of the quarry; here basalt is present in the lower part of the quarry face, with the Petaluma Formation rising up on the right, bending over the top of the basalt, and going down on the left of the basalt (Figure 1). The Petaluma units are folded into an inverted "U" shaped structure over the basalt. Rocks in the left part of the fold(SW) have been tilted over 90 degrees and are upside down; the fold is thereby classified as overturned. Bedding strikes N43W in the folded Petaluma Formation, with 80 degree dips to the northeast present on both sides of the fold.

The rock from the quarry is used for roadbase, septic tank, and fill purposes. Mr. Hardister did not specify what class of roadbase the rock is used for. The road rock is probably derived from the agglomerate units in the upper areas of the quarry. The fill rock is probably taken from the Petaluma Formation.

Mr. Hardister estimates that the reserve potential at the quarry is about 7 million yards. Last year the total production at the quarry was about 30,000 yards. The quarry has been operated since the early 1940's; a portable rock crusher is currently located on the premises.

PRINCIPAL INVESTIGATOR-Mark Kautsky
STONY POINT ROCK QUARRY, INC.

The Stony Point Rock Quarry is located about 1500 feet south of West Sierra Road, on Stony Point Road. The phone number at the yard is 795-1775, and their mailing address is P.O. Box 215, Cotati, California, 94928. The quarry owner's name is Lynn Williams.

SIZE

The area contained by the property lines of the quarry is roughly 640,000 square feet. A five year lease, however, with an optional 5 year renewal, provides for a 500 foot extension of the property lines in a southerly direction, 1,500 feet to the north, and 200 feet to the southwest. The quarry owner will grade the quarry to a gentle slope when done.

GEOLOGY OF SITE

The northern half of the quarry face exposes horizontally bedded alternating basaltic flows and agglomerates (Fig.1). A vertical section through the quarry face in this area, beginning at the bottom and going up, consists of A) Flow Unit 1, which is a dark gray aphanitic basalt which weathers light brown or tan. Subhorizontal joints occur in intervals of 10–20 cm; the entire flow unit is about 20 feet thick. B) Agglomerate Unit 1, is about 40 feet thick, and is composed of medium to dark gray blocky amygdaloidal basaltic clasts of variable size, which are contained in a matrix of red, yellow and purple ash and dust. Although the clasts vary in size, they are generally less than 1/2 meter in
Figure 1, Geologic Map and Cross Section, Stony Point Quarry, Sonoma County, California; included regional geologic map shows trace of Toly Fault.
diameter. The overall clast to matrix ratio is about 6:4. Due to the ashy nature of the matrix, the unit as a whole is poorly to moderately lithified. C) Flow Unit 2, is a dark gray aphanitic basalt which weathers tan and light brown. It is similar in character to Flow Unit 1; it is about 15 feet thick. D) Agglomerate Unit 2, about 20 feet thick, consists of blocky gray amygdaloidal clasts of basalt, which are less than 1/4 meter in diameter; these are contained in a purple and gray matrix of ash and dust. E) Flow Unit 3 is about 10 feet thick, and only exists in the northwest corner of the quarry as a tower shaped remnant, which the owner sculptured to serve as a conversational piece.

The entire hillside which occurs to the north, beyond the quarry face, is underlain by undifferenciated basalt flows and agglomerates, which are entirely exploitable under the conditions of the lease.

Another basalt flow occurs for about 250 feet along the western quarry face. This unit extends back into the hill in a southwest direction for a few hundred feet, while gradually diminishing in thickness. It is probably about 30-40 feet thick at maximum.

Otherwise, the west and southwest faces of the quarry contain sedimentary rocks, probably of the Tertiary Merced Formation. These rocks sharply contact the volcanic rocks of the northern quarry face. Most of the Merced Formation rocks in this area are pebbly sandstones, often containing conglomerate lenses. The clasts consist mostly of sandstone ripups, volcanic and metamorphic pebbles, some cherts and minor vein quartz.
These are contained in a light to medium brown, loosely lithified wacke sandstone. Beyond the quarry face, the Merced Formation sandstones underlie grassy slopes, on which occasional pebbles are found.

STRUCTURES

The Stony Point Quarry is located just west of the crest of what has been referred to in previous state and county reports as the Washoe Anticline. Unfortunately, the small regional geologic map (Fig.1), compiled by the U.S.G.S. does not recognize this structure. The volcanic rocks in the northern portion of the quarry are horizontally bedded, while the volcanic flows in the southern portion may be dipping slightly to the southeast.

These rocks are cut by an oblique slip fault which trends N 35° W. The dip of the fault surface is presumed to be vertical because all of the fault produced features across the quarry lie along an approximately straight line. These fault produced features are listed below:

1) Slickensided surfaces on the fault where it is exposed in the southeast quarry face, indicating that the last movement was along a line which trends N 10° W, and plunges 56° NW.

2) A slide zone existing along the western quarry face, which is composed of weakened medium to dark greenish gray clay, may pose a probable hazzard.

3) Gouge zones exist in the Merced Formation sandstone. These features, coupled with an abrupt truncation of the volcanic units along the same lineament, suggest that a near ver-
tical fault cuts through the western portion of the quarry.

The Tolay Fault (Fig.1), which occurs 1 mile to the west of the quarry may bear probable relationships to this fault. This is because movement on the Tolay is regionally dominated by a right lateral strike-slip component subparallel to the trend of this fault. Movements along the Tolay Fault may have possibly generated movements along this fault in the quarry.

PRESENT USE OF ROCK

The Stony Point quarry has available several grades of rock which may be used for a variety of purposes. The mined rock is run over 3/4" or 1 1/2" screens; the material which passes through the screens is "crushed rock", and contains all sizes up to screen size; the rock which does not pass through the screen is called "drain rock", it has no fines.

The 3/4" and 1 1/2" crushed rock is used mostly for topping, and sidewalk and roadbase. The 3/4" and 1 1/2" drain rock is used for subslab, and septic tank purposes respectively. The rock type that the quarry people call "dirty birds eye" (crushed rock with a high fines content) is used mostly as drainpipe base and as trench backfill. The material which is sold as fill is derived from the Merced Formation rocks in the quarry.

RESERVES AND PRODUCTION

Since no subsurface data was available, no estimate of the reserve potential is given here. The quarry, however, is extracting rock from the site at a rate of 250,000 cubic yards per year, with 10% annual increases in production. The owner feels that at this rate, the quarry may operate through the mid 1980's
before the supply runs out.

REMARKS

The Stony Point quarry first began operations in the 1920's, but the major development of the property only began in 1973, when the present owner purchased it. Since that time the business has been expanding.

A considerable aggregate resource exists across the street from the quarry, where all of the surrounding hills are apparently underlain by hard volcanic rocks which are similar to those at the quarry.

PRINCIPAL INVESTIGATOR, Mark Kautsky
Trinity Quarry Inc.

Trinity Quarry Inc. is located on a 26 acre parcel between Kenwood and Agua Caliente 0.5 miles off highway 12 on Trinity road. The land and quarry are wholly owned and operated by Blanche Wingate. Trinity Quarry Inc. also owns a subsidiary company, Trinity Rock Co. which is located on the quarry property.

One main rock unit occurs on the quarry property; a volcanic, felsite porphyry (Fe1). The rock is a flow banded, silicic volcanic that contains clear, anhedral quartz, and milky white, subhedral, blocky K-spar phenocrysts in a thinly laminated (3-10mm) groundmass of red, purple, and reddish brown. highly vesiculated flow bands. The flow bands weather preferentially causing the rock to break into slab-like fragments. Minor amounts of massive, grey-green felsite also occur. The unit is cut by two tuff breccia dikes (up to 5m across) on the eastern face of the quarry pit, and is overlain by a thin (2-3ft) layer of soil.

Trinity Quarry Inc. only produces decorative rock; flagstone, and colored bricks. The quarry has been in operation for sixty years but has never sold more than 1000 tons per year, and generally averages 600-800 tons per year (800 in 1977).

Trinity Rock Co. was set up in 1975 (by Trinity Quarry) to crush and screen the enormous amount of tailings accumulated from the quarry mining. Their main product is 3/4" and 1¼" roadbase and drain rock. In three years of operation they have averaged 4000 cubic yards per year. The roadbase and drain rock isn't screened to government specifications and therefore sold only to the private sector (local farm roads etc.).

Reserves for Trinity Quarry are limited to the rock on the quarry property (due to lack of adjacent land holdings) which has already been extensively mined (see map). However, due to their low production rate (800 tons/year) this should suffice for several years.

Trinity Rock Co. reserves are based on tailings accumulated over the last sixty years. At their present rate of production there is enough to last at least ten years while further quarry mining should contribute another, 1-3 year supply.

Data compiled by: Randall G. Demaree
Zamaroni Quarry

The Zamaroni Quarry is located at 3500 Petaluma Hill Road about 2 miles south of its intersection with Santa Rosa Avenue. The phone number at the yard is 545-4468. Since there is rarely anybody at the yard, however, call Louis Zamaroni at 545-4166; he is the owner.

The property lines of the quarry enclose an area of about 60 acres. Close to 1/2 of this property has been quarried so far (Figure 1). The owner says that he may soon stop quarrying altogether in order to build a new home on the remaining property.

GEOLOGY OF SITE

The rocks which are exposed in the quarry, and on the hills surrounding the quarry are tuffs, tuffaceous agglomerates and massive basalts of the Sonoma Volcanics. Within the quarry the tuffs are stratigraphically complex, while the basalts which probably intrude the tuffs in the quarry pit, are stratigraphically more distinct. A lower limit to the volcanics is not exposed in the quarry. The tuffs underlie the area from the base of the present quarry cut to the knobs located in the southeast corner of the property (Figure 1). These two knobs are composed of massive basalt flows. The total exposed thickness of the tuff units is about 270 feet. Informal rock units in the tuff were chosen based upon textural and mineralogical criteria (see below), as well as upon the geographical separation of the units within the quarry.
Figure 1. Geologic Map and cross section, Zamaroni Quarry, Sonoma County, California.
Tuff unit 1 is a white to medium gray moderately welded tuff. It is exposed in the north face of the quarry (Figure 1). It extends vertically about 80 feet above the base of the quarry face; to the east the unit contacts the fault; the bottom of the unit is not exposed.

The eastern portion of the unit is a white loosely welded ash flow tuff. It is composed of 10% transparent subhedral sanidine phenocrysts less than 1 mm in diameter, 50% white pumice fragments up to 1 inch in diameter, and 40% white minutely crystalline ash and dust. Petrified wood was found in this portion of the unit.

The western portion of the unit is a gray moderately welded ash flow tuff. It consists of 25% white blocky pumice fragments up to 1 inch in diameter, and 15% red and black partially resorbed basalt clasts up to 6 inches in diameter. The remaining 60% of the rock is composed of gray minutely crystalline ash and dust.

Between the western and eastern portions of the unit, is a zone about 20 feet thick which consists of alternating bands about 6 inches thick of light colored ash flow and lithic tuff.

Tuff unit 2 occurs southeast of tuff unit 1. It is bounded to the east by the fault, and contacts the basalt to the west (Figure 1). It is a greenish moderately welded massive ash flow tuff which extends vertically about 50 feet above the quarry floor; the base of the unit is not exposed.

The unit is composed of 30% red, white, gray and black equant partially devitrified pumice fragments up to 1/2 inch in diameter, 5% euhedral sanidine phenocrysts up to 1 mm in diameter.
and 5 to 20% black equant basaltic rock fragments up to 5 mm in diameter. The remainder of the rock consists of a greenish moderately welded matrix of minutely crystalline ash and dust.

Tuff unit 3 occurs southeast of tuff unit 2. It interfingers with the basalt in the southern quarry face, becoming more extensive to the west (Figure 1).

The unit is a gray loosely welded ash flow tuff which contains about 20% gray and white equant pumice clasts up to 3 mm in diameter, about 5% euhedral sanidine phenocrysts which are up to 1/2 mm in diameter. About 75% of the rock unit is composed of minutely crystalline ash and dust.

East of the fault there are two large tuff units (Figure 1). The smaller of the two units, tuff unit 4, is bounded to the west by the fault. Eastwards tuff unit 4 contacts tuff unit 5.

Tuff unit 4 is a medium gray ash flow, while tuff unit 5 is a beige ash flow tuff. The contact between the two units is represented by a sharp color change. The thickness of tuff unit 4 is indeterminable because the base of the unit is not exposed. The top of the unit extends vertically about 100 feet above the base of the quarry cut.

Tuff unit 4 is a light to medium gray ash flow which contains locally variable amounts of light to medium gray moderately indurated slightly devitrified clasts of ash flow tuff up to 3 feet in diameter. These clasts in turn consist of about 50% white to gray pumice fragments up to 1/2 inch in diameter, 10% black acicular glass shards up to 2 mm in length, less than 10% clear euhedral sanidine phenocrysts up to 1 mm in diameter, and about 30% gray minutely crystalline matrix composed of ash and dust. Some of the larger clasts are layered with alternating
dark gray bands rich in glass shards, and light gray bands rich in pumice. The thickness of the individual bands is about 3 inches. Cooling joints are also present in some of the larger clasts. Individual fragments of black obsidian usually about 1 inch in diameter also occur in tuff unit 4.

Tuff unit 5 is a distinctive beige weathering ash flow unit of indeterminable thickness which extends east, back into the hill indefinitely. To the west it contacts both the fault and tuff unit 4 (Figure 1). It contains blocky clasts 6 to 12 inches in diameter of white moderately devitrified loosely indurated ash flow tuff. The matrix to clast ratio in the unit is about 7:3.

The clasts consist of about 5% anhedral quartz phenocrysts up to 1 mm in diameter, 10% clear euhedral phenocrysts of sanidine up to 2 mm in diameter, 40% mostly white, but some black, moderately devitrified pumice fragments about 3 mm in diameter, and 45% gray moderately welded minutely crystalline ash matrix.

In the northern-most exposures this unit is clast supported, consisting of jointed tabular clasts up to 3 feet long. East of the quarry face the unit underlies grass and oak covered slopes, where occasional resistant clasts of the unit are found randomly scattered.

Basalts occur in the floor of the quarry, in the south face of the quarry and in some knobs located close to the south-east property line (Figure 1). As a general rule the basalts in the base of the quarry are agglomeratic, becoming massive beyond the quarry pit margin. Contact relations in the quarry face, which display fingerlike extensions of the basalt agglomerate
into tuff units 1 and 2, seem to indicate that the tuffs are
intruded by the basalt agglomerate. Further evidence of intrusion
of the tuff by the basalt is that the basalt has baked the tuff
red in several places along the basalt-tuff contact.

The agglomerate portion of the basalt unit consists of
highly vesiculated blocky dark gray clasts of basalt up to 1 foot
in diameter which are distributed in apparently random concentra-
tions throughout a buff yellow or purple matrix of ash and
dust. The basalt clasts, however, range in size down to pea sized
fragments within the matrix. The more massive basalt has no ashy
matrix, and consists of dark gray fine grained brown weathering
basalt. The massive basalt occurs along the southeast property
line, and as the basalt exposed south of the southern portion of
the quarry pit margin.

STRUCTURES

Bedding in the various pyroclastic units in the quarry is
not adequately revealed due to poor exposure of the bottoms of
the units, and due to the lack of planar flattening of the pumice
clasts.

The major structure in the quarry is a N 40 W striking,
vertically dipping fault zone. The fault zone is best exposed
where tuff units 1 and 5 are separated one from another by a
15 foot thick gouge zone consisting of dark greenish gray clay.
The gouge zone continues in both directions along strike, and is
occasionally up to 20 feet thick. In places along the fault zone
pebbles not previously seen in this area are present. These are
composed of 1 to 3 inch diameter well indurated subrounded
Figure 2, Northwest portion of Preliminary Geologic Map of Eastern Sonoma County, 1973, showing location of Rodgers Creek Fault; the fault in quarry strikes subparallel to strike of minor faults along Rodgers Creek Fault.
sandstone clasts, metamorphic rock clasts, and chert and vein quartz clasts. The direction of relative offset along this fault is unclear; no slickensides were observed.

The strike of this fault zone, however, is roughly parallel to the minor faults off the Rodgers Creek Fault (Figure 2). The fault depicted by the longer of the two arrows in Figure 2 may possibly even connect with the fault in the quarry, but more field mapping would be required to establish this possibility. If the movement along the minor faults is the same as the movement along the Rodgers Creek Fault, then the movement along the fault in the quarry is right lateral strike slip.

PRESENT USE OF ROCK

The quarry owner reports that the rock from this quarry is used 99% as fill. Its soft ashy nature makes it inadequate for use in road construction.

RESERVES AND PRODUCTION

The rate of production at the quarry varies considerably from year to year, and so consequently the owner did not want to quote any figures regarding production rates. He did specify, however, that quarry operations will probably begin to slow down because he wants to build a new home of the unmined property. By crude geometric techniques I estimated the reserves at this quarry to be about 10 million cubic yards, or about 30 million tons.

PRINCIPAL INVESTIGATOR: Mark Kautsky
GLOSSARY

Agglomerate  Pyroclastic rock containing a predominance of rounded or subangular fragments greater than 32 mm. in diameter.

Amygdaloidal  A general name for volcanic rocks (ordinarily basalts or andesites) that contain numerous gas cavities (vesicles) filled with secondary minerals such as zeolites, calcite, chalcedony or quartz. The filled cavities are amygdules or amygdales. Adj. amygdaloidal.

Anhezial  A crystal showing no external faces.

Anticline  A fold that is convex upward, with older rocks toward the center of curvature.

Ash  Fine, usually unconsolidated pyroclastic material.

Auto-brecciated  Rock which has been brecciated in place by mechanical processes.

Basalt  Generally any aphanitic (fine-grained) dark colored igneous rock with or without phenocrysts.

Bedding  Signifies existence of originally horizontal planes (beds) dividing sedimentary rocks of the same or different lithology.

Block  An angular fragment over 256 mm. in diameter.

Blueschist  Metamorphic rock containing blue crystals (mineral glaucophane).

Bomb  Pyroclastic ejecta consisting of fragments of lava that were liquid or plastic at the time of ejection.

Boulder  Large (256 mm. diameter) rounded block of stone.

Breccia  A rock composed of highly angular coarse grained fragments.

Carbonate  A compound containing carbonate (CO$_3^-$), common ones are calcite (CaCO$_3$), and dolomite (CaMgCO$_3$).

Chert  A hard dense siliceous rock of varying color composed of microorganism shells or precipitated silica grains.

Classic  Consisting of fragments of rocks or minerals.
Clay A size term denoting particles, regardless of mineral composition, with diameter less than 1/256 mm.

Coarse grained Particle diameter between .5 and 1 mm.

Cobble A rounded rock fragment between 64 and 256 mm. in diameter.

Conglomerate A clastic sedimentary rock containing over 50% pebbles or larger particles.

Cryptocrystalline Rock or mineral consisting of crystals too small to be easily distinguished under the light microscope.

Dip The angle at which any planar feature is inclined from the horizontal.

Euhedral A crystal completely bounded by its own regularly developed crystal faces.

Felsic consisting dominantly of the minerals quartz and feldspar.

Felsite An igneous rock with or without phenocrysts, in which either the whole or the groundmass consists of a cryptocrystalline aggregate of felsic minerals, i.e., quartz and potassium feldspar, generally light colored.

Fine grained Consisting of grains between .25 and .125 mm. in diameter.

Gouge Finely abraded material occurring between the walls of a fault, the result of grinding movements.

Greenstone Field term applied to altered mafic igneous rocks, i.e., basalt.

Grit Sand, usually coarse sand.

Groundmass The material between the crystals or grains in an igneous porphyry rock.

Hydrothermal An adjective applied to hot aqueous solutions, to the processes in which they are concerned, and to the rocks, ore deposits, and alteration products produced by them.

Igneous rock Formed by solidification from a molten or partially molten state.
Inclusion  A term applied to rock fragments that are foreign to the body of igneous rocks in which they occur.

Indurated  A material rendered hard by heat and pressure and cementation.

Interbed  A typically thin bed of sedimentary rock material alternating with typically thicker beds of sedimentary rock.

Intrusive  Usually a body of igneous material that forcefully invades older rock; commonly used for those parts of the material which solidify under ground.

Joint  Fracture in rock along which no appreciable movement has occurred.

Lamination  Layering or bedding less than 1 cm. thick in a sedimentary rock.

Mafic  In general, synonymous with "dark minerals".

Massive  Occurring in thick beds.

Matrix  Finer grained sedimentary material in which larger grains are contained.

Medium-grained  A grain diameter of .25 to .50 mm.

Metamorphic rock  Any rock which is altered in composition, texture or internal structure from its original state. The resulting rock is formed due to a thermodynamic response to a greatly altered environment. Weathering is excluded from the category.

Melane  A heterogeneous mixture of rock materials (see text).

Pebble  A smooth rounded stone from 2-64 mm. in diameter.

Porphyry  Any rock containing conspicuous phenocrysts in a finer grained or aphanitic groundmass. The resulting texture is called porphyritic.

Pyroclastic  Fragmental volcanic materials that have been explosively ejected from a volcanic vent.

Sand  Usually pertains to rock or mineral of size range 2 to 1/16 mm. in diameter.
Schist  A medium to coarse grained metamorphic rock with subparallel orientation of the micaceous minerals which dominate its composition.

Sedimentary rock  Rock formed by typically subaqueous accumulation of rock or mineral fragments or particles (sandstone, shale or conglomerate).

Shale  A laminated, usually dark gray sedimentary rock in which the constituent particles are of the clay size.

Slickenside  Polished and scratched surface on a fault that results from friction along the fault plane.

Subhedral  Intermediate between anhedral and euhedral.

Tuff  A rock formed of compacted volcanic fragments generally smaller than 4 mm. in diameter.

Vent  Refers to volcanic conduit.

Volcanic  Pertaining to a volcano.