Mineral resource assessment of selected nonmetallic and metallic resources of the Coconino National Forest, Arizona

by

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1U.S. Geological Survey, Tucson, Arizona
EXECUTIVE SUMMARY
Assessment of selected nonmetallic and metallic resources
of the Coconino National Forest, Arizona

General

- The Coconino National Forest (CNF), located in the south-central Colorado Plateau, is an area with few base- and precious-metal mineral deposits.
- Demand for aggregate is increasing with population growth occurring in Flagstaff, Sedona, and Verde River Valley. Finding and establishing new sources of materials is a likely future issue to be faced.

Industrial Minerals

- Scoria and cinder are unconsolidated and therefore easily mined for cinder block fabrication.
- The best sources of limestones for cement fabrication are the Redwall Limestone and the Martin Formation.
- Known gypsum deposits have grades comparable to those in production, but the deposits are small; future deposits will most likely be found in the Coconino and Moenkopi Formation.
- Industrial minerals associated with lake deposits include halite, sodium sulfate, diatomite, bentonite and various types of clays

Aggregate

- Sand and gravel deposits are scarce due to the types of bedrocks present.
- The future sources for aggregate are the Redwall Limestone, the Martin Formation, and younger basalts. Outcrops of the Redwall and Martin are either few and (or) problematic; the best source may be the more widely available younger basalts.

Metals

- Manganese is the only metal with an appreciable presence in the CNF albeit in limited amounts.
- Sources of base and precious metals are likely to be from undiscovered remnants of solution-collapse breccia pipe uranium deposits. These small tonnage (< 11,000 t) deposits do not have uranium reported in production.
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ABBREVIATIONS USED

AASHTO American Association of State Highway and Transportation Officials
ADOT Arizona Department of Transportation
ASTM American Society for Testing & Materials
CNF Coconino National Forest
ft feet
g/t grams per metric ton
ha hectares
km² square kilometers
m meter
MRDS Mineral Resource Data System, See figure 2 for locations, Appendix A for list of records sorted by commodities or byproduct commodities and Appendix B for full record listing.
NF National Forest
PI plastic index
ppb parts per billion
RD Ranger district
t metric tons
ton unknown, but likely short ton
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Introduction

The Coconino National Forest (CNF), Arizona, contains approximately 814,000 hectares (ha) (2 million acres) in six Ranger Districts (RDs) as shown in fig. 1. The purpose of this assessment is to provide information useful to Forest Service land managers primarily concerning the quantity of metals and materials in deposits yet to be discovered in the CNF. Of course, known deposit types in or adjacent to the CNF are useful in identifying appropriate deposit types. Two different mineral resource assessment techniques are used: one for metals and industrial minerals and a second for uranium.

While both are types of quantitative mineral resource assessments, the first type requires mineral deposit models like those found in Cox and Singer (1986) and Bliss (1992). The procedure is described by Singer and Ovenshine (1979) and Singer and Cox, (1988) and allows predictions of how much material remains in undiscovered deposits at different levels of certainty (Root and others, 1992; Spanski, 1992). The former U.S. Bureau of Mines (BOM) also successfully used USGS assessment results in their analysis of economic potential of future mineral development within an area (the East Mojave National Scenic Area, California (U.S. Bureau of Mines, 1992) and Kootenai National Forest (NF), Idaho and Montana (Gunther, 1992)). Grade and tonnage models are needed as well as an estimate of numbers of undiscovered deposits. Deposit types lacking grade and tonnage models cannot be assessed.

The assessment of uranium in solution-collapse breccia pipe uranium deposits is handled differently. The procedure used and the assessment results are found in a previous report by Bliss and Pierson (1994). The predicted undiscovered uranium from this deposit type does not represent uranium endowments additional to those reported by Finch and others (1990), but they suggest what portion of their endowment is found within the Coconino NF, Arizona (Bliss and Pierson, 1994). One site (Appendix B, MRDS No. 101—see below for explanation of abbreviation and number) was also noted during this part of the assessment (and not noted in Bliss and Pierson, 1994) may have evidence of solution-collapse breccia pipe uranium deposits in favorable area type B (Finch and others, 1990).

Industrial minerals have been and are likely to be the primary type of mineral commodity produced in the future in the CNF. Modeling industrial mineral deposit types is not as extensive as needed (Orris and Bliss, 1991; Orris and Bliss, 1992). New types of mineral deposit models may be required (Orris and Bliss, 1989). Unfortunately, mineral deposit models are not available for most of the industrial mineral commodity types found in the CNF. Flagstone is an important industrial mineral with a long production history in the adjacent Kaibab NF. An attempt was made to develop models for flagstone in an assessment of the Kaibab NF (Bliss, 1993), but it was unsuccessful due to poor and incomplete data.

Data about mineral deposits found in or adjacent to the CNF have come from various sources. A general source for mineral deposit data is the Mineral Resource Data System (MRDS), a world-wide computer
database with locality and commodity data. Additional sources for industrial minerals include Phillips (1987) and Houser (1992). Appendix A contains a selection of some of those records in or adjacent to the CNF as recorded in May, 1995 and are listed on figure 2 using sequence numbers. The records are also ordered by sequence number (upper left hand corner of each page) in Appendix B and specific sites are noted in the text by MRDS sequence number (MRDS No.).

Industrial minerals are covered first, followed by a brief discussion of metallic mineral deposits. Most tracts noted are bounded using stratigraphy or other geologic features which are best seen on regional maps including the following: Weir and others (1989) for the geologic map of the Sedona 30' X 60' quadrangle; Ulrich, and others (1984) for the Flagstaff 1" by 2" quadrangle; Moore and others (1960) for other areas of Coconino County; Arizona Bureau of Mines (1958) for other areas of Yavapai County; and Lane (1992, plate 2) for a compiled geologic map of the CNF as a whole. The San Francisco volcanic field is shown on a series of maps including Moore and Wolfe (1987) for the east part, Newhall and others (1987) for the southwest part, Ulrich and Bailey (1987) for the SP Mountain part, Wolfe, Ulrich, and Newhall (1987) for the northwest part, and Wolfe, Ulrich, Holm, and others (1987) for the central part.

A number of other reports applicable to areas in the CNF or adjacent areas were identified during preparation of the assessment. These include Chaffee and others (1996a, 1996b) release of analytical results for rock and stream-sediments collected in the CNF; a number of studies on breccia pipes including Van Gosen and Wenrich (1989), Wenrich (1985), and Wenrich and others (1986,1988, 1989); and reports prepared for Roadless area studies including ones for Strawberry Crater (Wolfe and Hahn, 1982; Wolfe and Hoover, 1982, Wolfe and Light, 1987), Fossil Springs (Weir and Beard, 1984; Weir and others, 1983), and West Clear Creek (Ulrich and Bielski, 1983).

Another source was the mineral-resource assessment of undiscovered resources of gold, silver, copper, lead, and zinc in the conterminous United States from 1993 through 1995 (Ludington and Cox, 1996). The assessment consists of probabilistic estimates of the amounts of undiscovered gold, silver, copper, lead, and zinc in conventional types of deposits. The assessment also identified significant known deposits and gave descriptions of the mineral deposit models used. Some tracts, mineral deposits and models used in that assessment are noted briefly here.

Four models of engineering characteristics of aggregate found in the report are prepared and depicted in the same general way as in Cox and Singer (1986). One difference is that each value is identified as belonging to a site, not an aggregate deposit, which needs either an estimate of volume and (or) of geometry. Neither were identifiable in this study. This fact, together with small sample sizes, makes these models preliminary.

This report is organized into three sections: 1) industrial minerals excluding aggregate, 2) aggregate, and 3) metals. The first section contains descriptions of geology, tracts, and other details which will not be repeated in the section on aggregate. Materials not covered elsewhere (for example,
sand and gravel) will be discussed in greater detail in the aggregate section.

This report lacks figures showing geology. Nearly all tracts identified as permissive for various commodities (or deposit types) are identified by geologic unit(s). Readers who are serious about using the information herein need access to geologic maps (most of which are listed above.)

**Industrial Minerals**

**Introduction**

Industrial minerals are historically the most important mineral commodities produced in the CNF. This section focuses on industrial minerals with uses other than for aggregate. However, some discussion on the use of materials as a source of aggregate is often unavoidable.

Some industrial minerals are also classified as metals. For example, hematite used as a pigment is considered an industrial mineral while its use as a source of iron makes it a metal. In this assessment, hematite is discusses under the "metals" section.

**Marine carbonate rocks**

**Background**

Most carbonate rocks are produced for making cement, processed for lime, or crushed for use as aggregate in construction. Limestone or other calcareous rocks make up 75-80 percent of the raw material used to make cement (Harben and Bates, 1984). Limestone is composed of 50 percent or more calcite and dolomite, with calcite greater than dolomite. Ultra-pure limestone contains greater than 97 percent CaCO₃; high calcium limestone contains greater than 95 percent CaCO₃ (Harben and Bates, 1984). Cement preparation requires not only CaCO₃, but also silica, alumina, and iron, which may be contributed by the clay, sand, and chert commonly found in limestones as it is quarried. These components (as well as other materials) need to be added during cement manufacture if they are absent or are insufficient in the limestone. Dolomite is tolerated in limestones up to about 5 percent of the raw material for cement manufacture (Harben and Bates, 1984).

Other uses of limestone or derivative products (e.g., lime) include dimension stone, rip rap, road metal, roofing granules, fillers (paper, asphalt), filters (water treatment), absorbents (gold leaching), ceramics, flux (steel), agriculture, glass, and well drilling fluids (Keith, 1969c; Lefond, 1983). In Arizona the copper industry uses lime in flue gas desulphurisation (O'Driscoll, 1990). Limestone is a common source of
aggregate wherever it is found. However limestones consisting of about equal parts dolomite and calcite which are used as aggregate in cement are more likely to have alkali-carbonate reactions which may destroy concrete competency (Marek, 1991).

Geology

As noted in Lane (1992) four limestone units are found in the CNF: 1) Martin Formation, 2) Redwall Limestone, 3) Kaibab Formation, and 4) limestone facies in the Verde Formation. In Arizona the Redwall Limestone of Mississippian age is one of two formations considered best for chemical and industrial use (Keith, 1969c). The limestone is massive, strong, high calcium and low dolomite, with chert in nodules and bands as the chief impurity. This limestone and the Escabrosa Limestone have been the principal source of material for cement production in Arizona (Keith, 1969c).

Quarries and tracts

Six sites are noted for limestone in MRDS (Appendix A). All sites in CNF are in the Peaks RD. One site (MRDS No. 101) consists of a breccia site containing significant lead and may be an expression of an undiscovered solution-collapse breccia pipe uranium deposit or remnant thereof (see Introduction). Lead may be considered as a possible contaminate of the limestone (probably Kaibab Formation) if the site were to be considered as a source of crushed stone. Limestone and marble are found in several carbonate bodies within the volcanic field on the margins of San Francisco Mountain. Wolfe and others (1987b) included the Redwall Limestone and Temple Butte Formation in the unit which crops out in Little Elder Mountain (probable location of the MRDS No. 76) on the southeast margin, and White Horse Hills, northwest margin, of San Francisco Mountain. Two other sites are noted in the Kaibab Formation (MRDS Nos. 102, 103).

One site (MRDS No. 30) included in Appendix A is an important production site for limestone for use in a cement plant in the Prescott NF (fig. 2) to the west of the CNF. The Clarkdale Cement Plant limestone quarry not only produces from the Redwall Limestone but also from the Devonian Martin Formation. Lane (1992) notes that the limestone provides the necessary CaCO3, SiO2, and MgO (which is in dolomitic lenses in the limestone) needed to manufacture cement. Whole-rock analyses for limestone samples are given by Lane (1992, table 2).

Three samples of limestone from the Verde Formation, analyzed by the U.S. Bureau of Mines from three sites (Lane, 1992, plate 3, fig. 3), suggest they are suitable for use in cement manufacture (Lane, 1992, table 2). However, the limestone is interbedded with clays, and other materials which would make mining difficult.

Tracts are defined by the outcrop areas of stratigraphic units dominated by carbonates or containing significant carbonate members. All outcrops of the Redwall Limestone in the CNF are permissive. A portion of the Coconino Sandstone may be worked given information about limestone
quality including impurities (i.e., chert concentrations, dolomite) and detail end-use specifications (cement, aggregate, and so forth).

Resource estimate status

Limestone is one of a number of bedded industrial mineral deposit types that lack models or strategies for quantitative assessment. Therefore, an estimate of undiscovered limestone resources is not available.

Marine and lacustrine environments

Gypsum

Background
Gypsum, or hydrous calcium sulfate (CaSO_4·2H_2O), is the most abundant naturally occurring sulfate (Harben and Bates, 1990). Upon loss of water gypsum becomes the mineral anhydrite (CaSO_4). Use of anhydrite is minor when compared to gypsum although neither mineral is found without the other (Appleyard, 1983). Unfortunately, currently unusable anhydrite represents the larger part of the world's extensive reserves of these sulfates (Appleyard, 1983). Calcined gypsum (CaSO_4·1/2H_2O) or plaster of Paris is an important product as a component of plasterboard and accounts for 70 percent of gypsum consumption (Harben and Bates, 1990). Harben and Bates (1984, p. 130) also notes that "uncalcined gypsum is used as a retardant in cement; as a fertilizer; as a filler in paper, paint, and toothpaste; and in the production of gypsum muds for oil well drilling." Due to the wide availability of gypsum, only readily accessible deposits at the surface are being worked. Strip mining is the common extraction method, with some operations exceeding 50 m in depth (Raup, 1991). Because transportation is a major contributive cost, proximity to infrastructure and markets is critical in deciding if a deposit will be worked. Gypsum and anhydrite constitute the largest known reserve of sulfur, although it is largely untapped and is currently an uneconomic source.

Geology
Gypsum and anhydrite occur as evaporites identified in rocks of Silurian age through Quaternary age (Appleyard, 1983). The proportion consisting of anhydrite increases with geologic age of the enclosing rock. Thus, younger deposits are more likely to be worked because they contain more gypsum. Gypsum is commonly found associated with other evaporites. Due to its high solubility, primary gypsum deposits are subject to considerable post-depositional modification, recrystallization, and remobilization.
Models
Two broad types of bedded gypsum deposits are recognized for modeling purposes: marine evaporite gypsum (Raup, 1991) and lacustrine gypsum (Orris, 1992c). Both types have permissive geology in the CNF. The descriptive model by Orris (1992c) suggests that most lacustrine gypsum deposits develop in closed or nearly closed continental basins (usually fault controlled) under semiarid to arid conditions. The descriptive model by Raup (1991) notes that marine gypsum deposits develop from the evaporation of sea water in marginal marine basins.

The preliminary grade and tonnage model by Orris (1992e) for marine gypsum deposits is based on data from 14 entities that include data from a mix of districts, areas, and single deposits. Ninety percent of the deposits have a size equal to or greater than 14 million t; 50 percent have a size equal to or greater than 280 million t; and 10 percent of the deposits have a size equal to or greater than 5.6 billion t (Orris, 1992e, fig. 35). Ninety percent of the deposits have a gypsum grade equal to or greater than 82 percent; 50 percent have a gypsum grade equal to or greater than 91 percent; and 10 percent of the deposits have a gypsum grade equal to or greater than 99.8 percent (Orris, 1992e, fig. 36).

The preliminary grade and tonnage model by Orris (1992c) for lacustrine gypsum deposits is also based on data from 14 entities. Ninety percent of the deposits have a size equal to or greater than 0.78 million t; 50 percent have a size equal to or greater than 14 million t; and 10 percent of the deposits have a size equal to or greater than 247 billion t (Orris, 1992c, fig. 35). Ninety percent of the deposits have a gypsum grade equal to or greater than 74 percent; 50 percent have a gypsum grade equal to or greater than 85 percent; and 10 percent of the deposits have a gypsum grade equal to or greater than 96 percent (Orris, 1992c, fig. 36). Lacustrine deposits tend to be both smaller and of lower grade than those for marine deposits.

Deposits and tracts
Two units found in the CNF contain evaporites and are, thus, permissive for marine gypsum deposits--Permian Coconino Sandstone and the Triassic Moenkopi Formation. The Toroweap Formation is commonly included with the Coconino Sandstone.

It is the Harrisburg Member of the Coconino Sandstone which contains evaporites. Gypsum, along with dolostone, sandstone, redbeds, chert, and minor limestone comprise the sequence (Hopkins, 1990). The member thickens to the west (up to 85 m) with significant bedded gypsum present. In fact, gypsum is mined from the Harrisburg member west of Las Vegas, Nevada at the Blue Diamond Hill Mine (Hopkins, 1990). A number of undeveloped occurrences and at least one gypsum mine have been identified in either the Coconino Sandstone and (or) Toroweap Formation in northwest Arizona (Keith, 1969b). To the best of my knowledge, no significant amounts of gypsum have been identified in the Harrisburg Member in the CNF. However, the Coconino Sandstone and Toroweap Formations are permissive for bedded gypsum.
Irregular gypsum lenses totaling 330,000 t of material at a grade of 97.5 percent gypsum have been described by Keith (1969b) in the Moenkopi Formation (Keith, 1969b; table 31). This tonnage is much smaller than the size distribution of deposits used in the grade and tonnage model by Orris (1992e); however, the gypsum grade in this deposit is within the grade distribution of the grade and tonnage model (Orris, 1992e; fig. 36). No significant amounts of gypsum have been identified in the Moenkopi Formation in the CNF. However, as noted previously, all parts of the Moenkopi Formation are permissive for bedded gypsum.

Lacustrine gypsum is found in the Verde Formation of Pliocene and Miocene ages (Weir and others, 1989) particularly in an area of 190 km² of evaporites extending about 16 km northwest, and 10 km southeast of Camp Verde (fig. 1) in the Verde basin (Twenter and Metzger, 1963, fig. 24). Gypsum in the Verde Formation has been mined at the Larson quarry located in a sequence of evaporites several square kilometers in area interbedded with mudstone and volcanic ash which can be 100 ft (30 m) thick (MRDS No. 1). Lane (1992) notes that the material mined is about 70-75 percent gypsum. This suggest that the deposit is low grade within the context of the grade and tonnage model of lacustrine gypsum (Orris, 1992c). Also located in these evaporites is the Wingfiled-Mcledd gypsum deposit (MRDS No. 15) where gypsum was produced for use in agriculture. Another gypsum occurrence (MRDS No. 14) was noted near the Camp Verde Gypsum property (MRDS No. 20) and as part of the stratigraphic sequence at the Verde River Deposit (MRDS No. 16). Several other sites in the Verde Formation are noted for gypsum (MRDS No. 16, 21). For assessment purposes, these sites are discovered gypsum deposit(s). Perhaps the whole sequence exposed at the surface may be considered a deposit partially worked within the context of deposits described in the grade and tonnage model (Orris, 1992c). The Verde Formation is considered to be the permissive area for lacustrine gypsum.

Resource estimate status
No estimate of undiscovered deposits of either type was made. Marine gypsum deposits like those in the grade and tonnage model are large but it is unknown how extensive (or exhaustive) exploration has been for bedded gypsum deposits in the CNF. Existing data suggests that the situation for lacustrine gypsum is more promising than for the marine type. Grade may be a problem if the worked portion at Larson Quarry represents the best quality of material available. However, the presence of undiscovered deposits without outcrop for both types cannot be discounted.

Lacustrine halite, sodium sulfate, and brines

Background
Halite (NaCl) or salt is used by the chemical and food industries and in snow and ice removal (Orris, 1992d). Lacustrine halite becomes important only locally when marine deposits are unavailable, as in Australia (Orris, 1992d). Halite is extracted by conventional mining to depths of 100 m; and by solution mining at depths greater than 500 m (Orris, 1992d). Proximity
to infrastructure and markets is critical in deciding if a deposit will be worked, because transportation is a major contributive cost. Halite need not be directly mined but may also be extracted from natural brines and sea water.

Most sodium sulfate produced is used in the manufacture of detergents, paper, and glass (Harben and Bates, 1990). Two minerals, thenardite \( \text{Na}_2\text{SO}_4 \) and mirabilite \( \text{Na}_2\text{SO}_4 \cdot \text{H}_2\text{O} \), commonly called Glauber's salt, are commercially important. Sodium sulfate is also extracted from brines.

**Geology**
Lacustrine halite occurs as either bedded or massive bodies in continental basins (Orris, 1992d). Most deposits are late Tertiary or Quaternary. Basins are closed or semi-closed and contain sediments and evaporites developed under arid conditions. Due to high solubility, halite deposits are subject to considerable post-depositional modification, recrystallization, and remobilization. Sodium sulfate is common in alkali lakes and is found with other evaporites including halite and gypsum.

**Models**
Only the preliminary descriptive model by Orris (1992d) without an associated grade and tonnage model is available for lacustrine halite; however a constituents model is available for sodium carbonate (sulfate, chloride) brines (Orris, 1992a). These are brines considered sufficiently concentrated to be a source of their contained constituents (G.J. Orris, 1995, oral commun.) Ninety percent of the brines have a sum of \( \text{Na}_2\text{CO}_3 \), \( \text{Na}_2\text{SO}_4 \), and \( \text{NaCl} \) constituents equal to or greater than 6,400 ppm; 50 percent have a sum equal to or greater than 33,000 ppm; and 10 percent of the brines have a sum equal to or greater than 220,000 ppm (Orris, 1992a, fig. 42-44). Neither a descriptive model nor a grade and tonnage model is available for sodium sulfate minerals.

**Deposits and tracts**
Lacustrine halite is found in the Verde Formation of the Pliocene and Miocene ages (Weir and others, 1989) particularly in an area of 190 km\(^2\) of evaporites extending about 16 km northwest, and 10 km southeast of Camp Verde (fig. 1) in the Verde Basin (Twenter and Metzger, 1963, fig. 24). Halite in the Verde Formation has been mined, along with sodium sulfate, at the historic Camp Verde Mine (MRDS No. 21, Appendix A; fig. 2). The Verde Formation is a sequence of evaporites several square kilometers in area interbedded with mudstone and volcanic ash which can be as much as 100 ft (30 m) thick.

Not only are halite deposits recognized, but brines are also present. A saline water well near Camp Verde (MRDS No. 11) contains 177,000 ppm dissolved solids, predominantly sulfate and chloride. This well appears to be consistent with the concentrations noted in the brine model by Orris (1992a). This would still be true if only a half of the soluble solutes present are the same as those in the model. A sample collected in 1959 from a ground-water well about 4 mi (6 km) southeast of Camp Verde along West
Clear Creek was reported to contain 90,300 ppm dissolved solids largely dominated by sodium (+ potassium) and sulfate (Twenter and Metzger, 1963, table 10). This well may also be a source of usable brines (MRDS No. 31). Detailed chemical analyses are needed for both wells as is an estimate of the size of the brine reservoir. In addition, possible discharge rates are needed.

Lane (1992) notes that a sodium sulfate deposit was mined west of Camp Verde (Camp Verde Salt Mine, MRDS No. 21). Weisman and McIveen (1983) describe the deposit as 46 m thick. It is unusual in that it contained pure mirabilite crystals.

For assessment purposes, these sites at the surface are for discovered halite/sodium sulfate deposit(s). The Verde Formation is considered to be the permissive area for lacustrine halite/sodium sulfate deposits and sodium carbonate (sulfate, chlorite) brines.

Resource estimate status
An estimate of undiscovered lacustrine halite/sodium sulfate deposits was not made, given the absence of a grade and tonnage model. At least one and perhaps two brine reservoirs of unknown sizes are inferred to exist.

Diatomite

One occurrence of diatomite is reported south of Camp Verde (MRDS No. 16). Lane (1992) cites oral communication (Ed Davidson, Superior Materials) that diatomite is present at the gypsum deposit 6 km southeast of Camp Verde [most likely Larson Quarry, MRDS No. 1]. Samples examined from various sites in the Verde Formation appear to be of poor quality (Lane, 1992). A descriptive model by Shenk (1991) is available; a grade and tonnage model is not.

Pliocene and Miocene clays

An unspecified type of clay is noted at the diatomite deposit south of Camp Verde (MRDS No. 16) and near Clarkdale (MRDS No. 23). Brick clay is found north of Clarkdale (MRDS No. 22) and is also suitable for use in cement manufacture. Lane (1992) noted that most clays in the Verde Formation are bentonitic, although Funnell and Wolfe (1964) as cited by Lane (1992) noted that low-expanding, high-calcium montmorillonite is found southeast of Camp Verde. See Lane (1992, table 1) for the chemical and physical characteristics of some clay samples collected in Verde Formation.

Lacustrine limestone

Three samples of limestone from the Verde Formation were collected by the BOM from three different sites (Lane, 1992, plate 3, fig. 3). The analyses indicate they are suitable for use in cement manufacture (Lane,
1992, table 2). However, the limestones are interbedded with clay and other materials which will make mining difficult.

Bentonite

Bentonite found associated with gypsum at the Larson Quarry was used as canal-reservoir sealer and for iron ore pelletization (see MRDS No. 1, Appendix B, for details).

Sandstones

The Coconino Sandstone and Moenkopi Formation are found in the CNF and have been a source of sandstones usable for flagging and ashlar. In fact, flagstone (and minor ashlar\textsuperscript{1}) production from the Coconino Sandstone is an important industry in the Kaibab NF to the west and Prescott NF southwest of the Coconino NF. Models needed for making quantitative predictions about flagstone and ashlar resources have not been developed and the attempts to do so for the assessment of the Kaibab NF were largely not successful. See Bliss (1993) for details and background material which is still valid here but will not be repeated. However, one correction is needed. Extraction of flagging is easier where the sandstone bedding slopes in the same direction as the topographic slope, however, this situation does not seem to have been critical in the siting of most existing quarries.

Minor production of flagging has come from the Moenkopi Formation but the Moenkopi has chiefly been the source of large building blocks and ashlars prior to the 1930's (Keith, 1969e). The Moenkopi does not split easily for flagging. A basal, massive sandstone has provided the best material. Keith (1969e, p. 447) reports that it consists of a "poorly to well-sorted, fine to very-fine grained, lenticular bed, 20 to 40 feet thick." This massive sandstone contains about 80 percent silica, up to 4 percent iron and aluminum oxides, and 13 percent calcium carbonate (Keith, 1969e). Although the stone forms solid blocks for use in buildings, it does not retain sharp lines and angles (Burchard, 1914). Stein (1993) gave a detailed overview of the history of production from a Moenkopi sandstone quarry located three miles south of Flagstaff.

Volcanic rocks

DEFINITIONS

\textbf{Block pumice}--a legal definition, includes pumice which is greater than 5.2 cm in one dimension (Hoffer, 1991).

\textsuperscript{1}Ashlar are rectangular or square stone blocks usually smooth on two parallel sides commonly used for building facing.
Pumice—light-colored, highly vesicular volcanic glass, commonly of rhyolitic composition; vesicles are fine and uniform; glassy appearance (Harben and Bates, 1990). Fragments greater than 6.4 cm called lump pumice; 0.4 to 6.4 cm called pumice (Hoffer, 1991).

Pumicite—shattered pumice consisting of grains, flakes, threads and shard of glass less then 3 mm in diameter (also called volcanic ash, can have diverse chemistry) (Harben and Bates, 1990).

Scoria—mafic version of pumice, fragments from 0.25 mm and larger, highly vesicular, red to black pyroclastic material, usually andesitic to basaltic composition; vesicles are coarse and variable; stony appearance (Harben and Bates, 1990).

Volcanic cinder—fragments less than 0.25 mm, highly vesicular, red to black pyroclastic material usually andesitic to basaltic in composition; vesicles are coarse and variable; stony appearance (Harben and Bates, 1990). Fragments of comparable composition that are larger than 0.25 mm are called scoria (see above).

Scoria, cinder, pumice and pumicite

Background
Uses of scoria and volcanic cinder (or simply cinder in the discussion below) include those of aggregate, cinder block, concrete, horticulture and landscaping, abrasives, and railroad ballast. Key properties making scoria and pumice valuable in construction are: light weight, insulating ability, high fire resistance, and toughness (Harben and Bates, 1984; Mason, 1994). Pumice has somewhat more specialized uses than cinder. The most important uses of pumice and pumicite are shown in figure 3. A particularly interesting use is in stone washing laundries particularly of jeans in which lump pumice is used to abrade and soften denim (Scott, 1992, p. 35). Pumice and pumicite are used as an abrasive material for dressing wood or metal and in domestic and industrial cleaning of surfaces (Keith, 1986d). Uses included in "Other" in figure 3 are as an absorbent, dilutent, filter aids, roofing granules, in water treatment, and as a road metal (Bolen, 1994; Osburn, 1982).

Pumice and pumicite are primarily used in the fabrication of building bricks. Construction related uses of pumice and pumicite make up approximately 70 percent of the material consumed annually (Bolen, 1994). However, among materials produced and used as lightweight aggregate (17 to 20 million tons) in 1983 to 1989 in the US, pumice and pumicite accounted for only 2 or 3 percent of the total (350,000 to 500,000) according to Mason (1994) who used data from the former BOM. Materials used in lightweight aggregate are notable for having densities of 1.3 to 1.6 t/m$^3$ when loosely packed as compared to 2 t/m$^3$ and more for crushed stone, sand, gravel, or air-cooled slags. Pumice, pumicite, and scoria with densities between 1.4 to 1.8 t/m$^3$ can be used in lightweight concrete (Mason, 1994). Some pumice is pozzolan. When finely ground, it reacts chemically with lime to form a hydraulic cement at normal temperatures (Smith and Collis, 1993; Prentice, 1990). Pozzolan is sometimes used as
part of Portland cement to increase sulfate resistance and reduce alkali-aggregate reactions (White, 1991).

Lightweight aggregate must be tested for suitability before they can be used in construction. The dry loose weight should be between 0.881 to 1.12t/m³ (Mason, 1994). Aggregate requirement for structural concrete is given ASTM C 330. Table 1 lists the grade requirements of this test as fine aggregate, coarse aggregate, or as a combination of the two (Mason 1994). Two other ASTM tests are also applicable, C331 for concrete masonry units (blocks) the grading requirement for which is given in Table 2, and C332 for insulating concrete, the grading requirement for which is given in Table 3 (Mason, 1994; Geitgey, 1994).

Organic or iron oxide contaminants in lightweight aggregate can cause undesirable discoloration in concrete and need to be kept to a minimum. Hydration can cause obsidian fragments to expand and damage cement (Geitgey, 1994). Other impurities may adversely affect product integrity. Clay lumps need to be less than 2 percent by dry weight; loss on ignition should be less than 5 percent except for cinders where loss on ignition should be less than 35 percent (Mason, 1994).

Arizona Department of Transportation (1990) standard specifications do not address lightweight aggregate, perhaps because these types of concretes are unsuitable in highway structures. The Arizona Department of Transportation (1990) does stipulate the Portland-pozzolan cement meet ASTM C 595, but no special test is identified in their specifications for the pozzolan material. Hoffer (1994) noted that pumice (either as raw or calcined nature pozzolan) used in Portland-pozzolan cement should conform to requirements of ASTM C 618-78 which considers compressive strength, water requirement for flow, shrinkage during drying, and effective reduction of alkali reactivity (U.S. Bureau of Mines, 1969; White, 1991). Schmidt (1956) as cited in Geitgey (1994) described using pumice in controlling landslides in highway right of way.

Horticulture and landscaping
Mason (1994, p. 808) describes that "finer granular pumice is used in potting soils and as a hydroponic growth medium." Pumice helps to increase drainage in soil. Color of the cinder or scoria dictates how it is likely to be used in landscaping. Dark reddish brown material is found in vent areas; it becomes brown to dark gray with iridescent surface coatings at intermediate distances and becomes very dark gray to black in the outer edges of volcanic cone (Osburn, 1982). Color changes are related to a decreasing ferric to total iron ratio varying from 95 percent in the vent area to 5 percent in the outer edges of the cone (Osburn, 1982).

Stone washing laundries
Pumice functions in two different ways in the preparation of stone washed fabrics--as an abrasive and as an acid-impregnated absorbent. Both soften the garment and give it a worn look (Hoffer, 1994). The three most important physical properties of pumice important in stone washing are absorption capacity, apparent density, and abrasion loss; other factors include moisture content, impregnation rate, surface fines, and coloration.
(Hoffer, 1994). Pumice of different sizes gives different effects. Small fragments produce a more even worn look as compared to that produced by coarser fragments (Hoffer, 1994).

Pumice used as an abrasive is formed into solid blocks, granules, powders or bonded material. As pumice is brittle, wear produces a continuous new crop of fresh cutting edges during use (Mason, 1994). Examples of applications are: cleaning restaurant grills, cleaning tile, or for cosmetic skin removal. Pumice is also found in heavy-duty hand cleaners. (Mason, 1994). Suitability of pumice as a abrasive requires uniformly fine vesicular material several times smaller than the particle size of the surface to which it is applied (Geitgey, 1994). Nonpumice fragments, particularly those harder than the pumice, can cause undesirable scratches, and therefore, should be less than one percent. Less than 0.5 percent is better, as attributed by Geitgey (1994) to Hess (private commun., 1992). Preparation of pumice for abrasives is difficult and time-consuming; suitable deposits are uncommon and these and others factors make abrasive pumice prices up to 100 times higher than those of pumice used in aggregate (Geitgey, 1994).

Three properties which give pumice a great diversity of uses are low chemical reactivity, high surface area, and high porosity. This allows pumice to have many uses as an absorbent. It can be used as a carrier for pesticides, herbicides, and fungicides among others (Mason, 1994). Mason (1994, p. 808) also notes that "lumps of pumice about 5 cm in diameter are used in gas grills to absorb grease drippings and reduce flaming." Scoria has been substituted for pumice in this application.

**Geology**

Scoria, cinders, and pumice are all products of explosive volcanism. All involve the rapid loss of dissolved fluids from volcanic material on reaching the surface. The distinction between scoria and pumice is based chiefly on composition--mafic volcanic melts yield scoria while siliceous melts yield pumice. When pumice is less than 0.16 inches (0.4 cm) in diameter, it is called pumicite and can be carried great distances in the atmosphere (Peterson and Mason, 1983). When scoria is less than 1 inch (2.5 cm) in diameter it is called cinder (Harben and Bates, 1984).

In general, scoria and cinder are deposited near the source volcanic vent. Less dense, finer grained pumice is carried farther away. The extremely fine-grained pumicite can travel thousands of kilometers. Keith (1986d) noted that pumice is chemically comparable to rhyolite, quartz latite, and dacite. Deposits are commonly lenticular and are found interbedded with lava and tuff.

**Known pits**

Pozzolan, a highly siliceous pumice sand, is recognized at several sites (Appendix A), one of which supplied material for concrete for the Glen Canyon Dam in 1965 (MRDS No. 38) in eastern Peaks RD. About 200,000 short tons of materials was produced (Williams and Zinkl, 1965).
**Definition of permissive areas**

Wolfe, Ulrich, and Newhall (1987) and Wolfe, Ulrich, Holm, and others (1987) prepared geologic maps of the northwest part and central part of the field. Newhall and others (1987) mapped the southwest part. These maps all show a portion of the CNF.

A large number of cinder and scoria pits are particularly abundant in the Peaks RD; they also are present elsewhere in the CNF. This material has been, and will continue to be, produced. Cinder and scoria associated with volcanic cones are a resource readily identified if present. The better quality material is usually found in, or adjacent to, the youngest cones, which makes this material easy to discover. In addition, the geometry of unworked cinder cones can be one key to understanding its potential for cinder and scoria (see Improving the assessment of discovered cinder cones). Wind-fall material may not be identified so readily.

In the San Francisco volcanic field (Peaks RD, fig. 2), pumice is likely to occur in major eruptive centers with andesite, rhyolite, and dacite volcanics. Such eruptive centers include: Sitgreaves Mountain, Bill Williams Mountain, and Kendrick Peak. A portion of Kendrick Peak is in CNF; the other eruptive centers are in Kaibab NF. Pumice deposits recognized on the east flank of Bill Williams Mountain (in Kaibab NF) are poor quality as compared to 14 sources of pumice in the United States and the world (Scott, 1992). The high density and low porosity of this pumice makes it suitable only for landscaping and in road construction (Scott, 1992). Areas permissive for pumice are those with rocks of dacite and rhyolite composition.

**Models**

Models for making quantitative predictions about undiscovered cinder, scoria and pumice resources have not been developed; therefore an evaluation of undiscovered resources is not available. On the other hand, the CNF contains a considerable number of cones with identified cinder and scoria resources that will be exploited before less accessible deposits are considered. While estimates of volume of material in identified cinder cones are possible, models characterizing the chemical and physical properties of scoria, cinders, and pumice for appropriateness for their various uses have not been developed. A model for scoria, cinder and other unconsolidated basaltic material of durability in aggregate is available and described in aggregate section.

**Resource estimate status**

Osburn (1982) showed that the ratio of height to basal diameter, or the aspect ratio, is usually between 0.1-0.2 for cinder cones that can be mined. Cones with lower aspect ratios contain more flows. Cones with an aspect ratio greater than 0.2 contain agglutinate blocks which makes extraction difficult (Osburn, 1982). Measuring aspect ratio from topographic maps can help identify which cinder cones should be considered initially as a source of cinder.
Scott (1992) found that roughly half of the 200 or more cinder cones in the Chalendar and Williams Ranger District in the adjacent Kaibab NF have aspect ratios between 0.1 and 0.2. Scott (1992) also found that 75 percent of all pits are located on cones with aspect ratios between 0.1 and 0.2. No systematic relation was found by Scott (1992) between cinder cone composition type and the presence or absence of cinder quarries.

Most of the cinder and scoria in the CNF are associated with identified cinder cones. Some finer-grained material may be located beyond the cones, but represents a small amount of material in comparison with material in identified cones. Some complex cones may be difficult to assess. A portion of each cone can also be expected to contain some vesicular flows and agglutinate fragments that will make extraction difficult (Harben and Bates, 1984).

Basalt and related rocks

The main use of basalt and other dark, fine-grained igneous rocks is as crushed stone in concrete and aggregate. Harben and Bates, (1984, p. 63) notes that "basalt is *** melted and cast into floor tiles and acid-resistant equipment for heavy industrial use." Basalt use as a dimension stone is dependent on fashion. In the past it was not used as dimension stone because it was thought to have a somber appearance (Keith, 1969a). However, dark colored stone has become fashionable and can demand a premium price. Quarrying basalt can be difficult due to its lack of joints and its tendency to blast into irregular sized and shaped blocks. Basalt and related rocks are the highest density material used as aggregate, which precludes shipping it great distances. On the other hand, basalt's high density makes it preferable for other uses where high density is needed, given other rock characteristics are acceptable.

Abundant Tertiary and Quaternary basalts are found in the San Francisco volcanic field, which was active during the Pliocene and Pleistocene (Newhall and others, 1987). Compositionally the material is basalt and basaltic andesite with lesser amounts of andesite, benmoreite, and dacite.

A model developed for assessing basalt and related rock types is found in the section on aggregate. The CNF contains considerable identified basalt and related rocks in accessible outcrops that will be exploited before less obvious resources are considered. Possible suitability of basalt and related rock types as dimension stone in the CNF needs to be addressed and appropriate sampling has to be made in future assessments.

Quaternary to Recent clays

High silica clay is found adjacent to and likely extends under Roger Lake, 14 km west-southwest of Flagstaff (MRDS No. 9). Lane (1992) described the clay as a montmorillonite-kaolinite with a high bloating factor possibly suitable in fabrication of lightweight aggregate. Analysis of some of the material is reported as possibly suitable in facia brick, or tile (Lane,
An approximate endowment of the Roger Lake deposit is 18 million t (Lane, 1992). All enclosed basins, with or without lakes, within the San Francisco volcanic field should be considered as possible target areas for clay deposits, possibly comparable to the one recognized at Roger Lake. The volcanics in the Roger Lake area are predominantly Pliocene (?) and Miocene basalt flows and vent deposits (Wolfe and others, 1987). Perhaps other basins with the same type and age of adjacent rocks may be particularly suitable for the development of these clays.

Two sites with clay are noted southeast and south of the CNF in the Tonto NF. One is Chris Clay deposit (MRDS Nos. 7) and the other is for Florence Ceramics (MRDS No. 8) which contains kaolinitic clay.

Other industrial minerals

Additional investigation is needed about some industrial minerals. For example, some geologic environments may be present for several other industrial mineral deposit types that are not considered in this report. This includes lacustrine borates (Orris, 1992b) in the Verde Formation for which there is little direct evidence of mineralization. Extensive exploration for borates in 1870-1880s likely left few promising sites unexamined (G.J. Orris, verbal commun., 1995) although the exploration history of the Verde basin has not been documented. Water wells in the area should also have notable levels of B (perhaps in the 50-100 ppb) or Li (G.J. Orris, verbal commun., 1995) which may affect the suitability of using the water in agriculture. Twenter and Metzger (1963, p. 95) describe the "water from most wells and springs is generally of a chemical quality for use by plant and animals...[with a] dissolved-solids content ** less than 500 ppm." Additional checking of spring and well water chemistry is needed, however. The Pliocene and Miocene ages of the Verde Formation, and the presence of contemporaneous volcanism as suggested by locally intertongued basaltic and dacitic pyroclastic deposits (Weir and others 1989) are both characteristics of basins with borates (Orris, 1992b). Given that borate minerals can be fine-grained and often recognizable only by analysis, undiscovered borate deposits cannot be completely discounted.

Aggregate

Background

Natural aggregate include both crushed stone and sand and gravel. Processing is commonly limited to crushing, washing and sizing (Langer, 1988). There is a fundamental division in the aggregate classification between that produced by crushing stone and that produced from unconsolidated surface material. Aggregate is subdivided based on grain size. Sand and gravel deposits should consist of at least 25 percent gravel-sized (4.76-76.2 mm) grains (Langer, 1988). Coarse aggregate include
grains predominantly greater than sieve No. 4 (4.76 mm); most fine 
aggregate particles are expected to pass a No. 4 sieve (0.187-in square 
opening, 4.76 mm), retained or passed on the intervening sieves, but with 
little material passing the No. 200 sieve (0.074 mm). A few particles may be 
included between the 3/8-in sieve (9.52 mm) and No. 4 sieve (4.76 mm) 
(Huhta, 1991).

These rules define aggregate at the level of a resource base (Harris, 
1984) which includes identified (and perhaps undiscovered) material, 
suitable and unsuitable for extraction and without regard to economics. 
Cox and others (1986, p. 1) define a mineral deposit as "a mineral 
occurrence of sufficient size and grade that it might, under the most 
favorable of circumstances, be considered to have economic potential." For 
aggregate, the word "grade" may be replaced by "geotechnical 
characteristics." In some regional studies, available data may only allow 
description of aggregate in no greater detail than resource base. Perhaps a 
better general definition is possible if geotechnical details, important to 
extractors and users, are considered.

Geotechnical considerations

Use criteria for aggregate can vary from one governmental unit to 
the next, reflecting local geology, climate and local attitudes concerning 
aggregate suitability. The intended use for the aggregate is equally 
important. Suitable aggregate must behave in ways that meet minimum 
geotechnical criteria (percent fines, grain-size distribution, durability, 
reactivity) to insure roadways and structures constructed with these 
materials have acceptable longevity and are within acceptable safety limits. 
One way to measure aggregate usability is to test and use only aggregate 
that meet standards defined by ASTM, AASHTO, and by local and state 
governments. For example, see the Arizona Department of Transportation 
(ADOT) (1990) standard specifications for road and bridge construction.

Despite the large number of standards in use, some broad 
generalizations are possible. Review of studies by Zdunczyk (1991), Marek 
(1991) and Goldman (1994) suggest some general minimum specifications; 
ADOT standards are given as well if available and are as follows:

- **soundness** -- coarse aggregate should exhibit a reduction of particle 
sizes of less than 10 percent using ASTM Test C88. ADOT 
requirements for aggregate in concrete placed above 4,500 ft elevation 
are that they have a reduction of particle sizes of less than 10 percent 
using AASHTO T 104.

- **hardness and strength** -- Los Angeles abrasion (wear) test of coarse 
aggregate gives a loss of material passing the No. 12 sieve (1.68 mm) 
of less than 30 percent using ASTM Test C131. ADOT requirements 
are a loss of less than 40 percent using AASHTO T 96.

- **specific gravity** -- should be greater than 2.55 using ASTM Tests C127 
and C128.

- **grading** -- fine aggregate should contain no more than 45 percent of 
material between two consecutive standard sieve sizes. ADOT 
requires coarse aggregate gradation to conform to specifications in
AASHTO T 43 when tested in accordance with the requirements of Arizona Test Method 201.

- **fines** -- no more than 5 percent of the material should be less than the No. 200 sieve (0.074 mm). ADOT requirements are the amount of material passing No. 200 sieve not to exceed 1.0 percent.

- **fineness modulus** -- a single number index used to report the degree of coarseness or fineness of fine aggregate and computation, as described by White (1991, p. 13-8), as "adding the total percentages, by weight, of an aggregate sample retained on each of a specified series of sieves, and dividing the sum by 100." Lower values indicates a finer material and higher values a coarser material. Fineness modules is important in mix design of portland and asphalt concretes, and should be between 2.3 and 3.1.

- **sand equivalent** -- a test as described by Marek (1991, p. 3-39) "to indicate the relative proportion of plastic fines and dust to sand size particles;" the ratio should be no less than 77 percent using ASTM Test D2419.

- **absorption**--Increase in particle weight should not exceed 3 percent using ASTM Test C127.

These specifications clearly restrict the definition of a sand and gravel deposit and some crushed rocks pits; therefore the size of the aggregate resource base is reduced. For geologists and others examining or assessing sand and gravel deposits for possible consideration as a source of aggregate without use of testing facilities, two general characteristics should be noted:

1. **sand and gravel should make up at least 85 to 90 percent of the deposit.** Boulders and cobbles may also be included in this calculation if they can be readily crushed. These criteria are not as stringent as those outlined by Goldman (1994). This is because the aggregate industry currently processes material with 10 to 15 percent fines (Drake, 1995). Increased percentage of fines adds expense during extraction, dredging, hauling and disposal or stockpiling. The single problem shared by nearly all aggregate facilities is the production of unusable fines. Discovering a way to use these fines is one of the biggest challenges facing the aggregate industry.

2. **sand and gravel deposits should be well graded, not well sorted.** One of the most commonly held ideas among geologists unfamiliar with the aggregate industry is that well-sorted sand and gravel deposits are best. Only one or two mesh sizes may be represented in a well-sorted deposit. Such deposits are not economical because construction companies need sand and gravel aggregate with a mix of grain sizes as defined by the ASTM and other agencies. These standards stipulate that the material must have an interval of particle sizes within certain tolerances. Therefore, aggregate suppliers seek poorly sorted deposits that have wide range of needed grain sizes in a continuous sequence. These are well-graded deposits. As the price of aggregate goes up and the number of
readily available suitable deposits decrease, many producers will become more tolerant of sand and gravel deposits which have more silt or are better sorted. These two criteria represent only a part of the specifications which define usable aggregate.

Aggregate for specific uses, particularly in building and road construction, may require detailed evaluations of the following: fragment geometries, external coatings, impurities, fragment mineralogy and textures, flakiness, amounts of soft/friable fragments, level of hydration, alkali-silica reactivity, other types of chemical reactions, susceptibility to leaching, thermal incompatibility, excess polish and excess shrinkage. Aggregate requirements change from place to place, reflecting different climates and other local conditions. All these factors will need to be considered for modeling given adequate data and expression of assessment needs.

**Surficial alluvial aggregate**

**Introduction**

Areas that may provide a future supply of surficial alluvial aggregate are identified using three broad criteria: compilation of sites used for past production, geology and geomorphology, and soil surveys.

The qualities of aggregate deposits important to end use has been established by organizations concerned with the durability and stability of roads and others engineering structures. For example, AASHO developed a rating system with seven classes (A-1 to A-7) where A-1 is assigned to soils with the highest bearing strength (i.e., best for subgrade) and A-7 is assigned to soils which have the lowest strength when wet. ASTM has developed a large number of different standards of geotechnical measures for aggregate. The grain size distribution must be well graded. This can be demonstrated using ASTM [standard] C-33 which gives the acceptable range of grain sizes retained by various sieve sizes for use as fine grained aggregate (ASTM, 1993); 13 grade requirements have been developed of coarse aggregate (ASTM, 1993, table 2). While some standards are established with possible national and international application, local ones can be devised as well. For example, Arizona Department of Transportation (1990) has a different size requirement for fine-grained aggregate than the one given by ASTM (table 3). One useful measure of material suitability for use is the plastic index (PI). It is the range of moisture content that gives a material plastic properties (Krynine and Judd, 1957) and is used to indicate the presence of undesirable minerals in alluvium. For example, ASTM D 3515 requires PI to be 4 or less for material used in asphalt concrete mixtures (White, 1991). Other important characteristics of surficial aggregate deposits include sufficient volume to justify extraction, proximity to market and transport, accessibility (spatially and legally), and minablity.
Verde Valley study

Cox (1995) reported on the sand and gravel resources in the Verde Valley along the southwest edge of the CNF. Six tracts with geologic units known to contain sand and gravel deposits were developed using a number of recently published large scale maps of Quaternary geology including House and Pearthree (1993), Pearthree (1993), and House (1994). The quality of sand and gravel is qualitatively described for each tract as well as for the active channels of the Verde River. Cox (1995, map 1) identified sand- and gravel-bearing units as thin (< 40 feet) or thick (> 40 ft); well or poorly sorted; with or without atypical clast-lithologies (for the area); and those with or without riparian vegetation. Cox (1995) found that the details were sufficient in the large scale maps used in the study to successfully distinguish among the various types of sand and gravel resources using depositional setting or geologic age. This level of mapping of Quaternary geology is not common in Arizona for areas away from major cities.

Soils

Wheeler and Williams (1974) reported the results of a soil survey in the Long Valley area (includes all of the Blue Ridge RD, Long Valley RD, and the southern half of Beaver Creek RD; see fig. 1). Three soil series were noted as possible sources of aggregate—the Arizo which was rated good for sand and fair to good for gravel (50 to 90 percent gravel), the Cowan series which was rated good for sand but unsuitable for gravel, and the Friana soil series which was rated fair for gravel (60-70 percent gravel) but unsuitable for sand. The Arizo soil series, likely with the best quality soil in terms of clast sizes in the Long Valley Area, is mapped as a part of the Cowan soil series. The Arizo and Cowan soil series were also rated good (A-1, A-2 respectively) as a source of road fill. The Arizo is classified as very gravely coarse sand and sand with 15-55 percent passing sieve No. 4, 10-55 percent passing sieve no. 10, 5-15 percent passing sieve no. 40, and 0-5 percent passing sieve no. 200; the Cowan is classified as a loamy fine sand, fine sand loam, and loamy sand with 100 percent passing sieve No. 4, 100 percent passing sieve no. 10, 50-75 percent passing sieve no. 40, and 15-30 percent passing sieve no. 200 (Wheeler and Williams, 1974, Table 9). Depth from surface is 0 to 60 inches; depth to bedrock is usually greater than 60 inches. The Friana soil series was rated good for fill (A-1) but only below a depth of 28 inches (Wheeler and Williams, 1974, Table 10).

The Arizo series develops on various types of materials in flood plain alluvium and is particularly prominent along the West Clear Creek and the Verde River. Soil surface tends to be irregular. Wheeler and Williams (1974) noted that the primary use of the soil is as a source of sand and

\[2^2\text{AASHTO rating system with seven classes (A-1 to A-7) where A-1 is assigned to soils with the highest bearing strength (i.e., best for subgrade) and A-7 is assigned to soils which are the worst with the lowest strength when wet (i.e., clayey soils ).}\]

\[3^3\text{U.S. Department of Agriculture standard texture classification.}\]
gravel. Impurities include calcareous material throughout (pH of 8.4) and organic material in the upper part (as thick as 30 cm (12 in.)) The typical C horizon (up to 1.4 m thick) may contain up to 80 percent cobbles of which many have calcareous coatings (Wheeler and Williams, 1974). The Cowan series (in the which the Arizo is found) develops on flood plains and low terraces containing sandstone and limestone adjacent to the Verde River and West Clear Creek. Impurities included calcareous material throughout (pH of 8.4) and organic matter in the upper part (as thick as 51 cm (20 in.)) The two soil series are mapped together and these areas can have 1) one or the other soil, 2) soils adjacent to one another, and (3) one soil overlaying the other. The proportion of the two soils is highly variable and no estimate of percentages is provided by Wheeler and Williams (1974). Total area of the Cowan and Arizo soil series is 360 ha (890 acres). [Given an average thickness of 1.8 m (6 ft), the total volume of the two soils is on the order of 6.5 million m$^3$.] Perhaps about half the area (i.e., the Arizo series only) is appropriate (3.3 million m$^3$) if a source of both sand and gravel is sought. The overall thinness of the sand and gravel makes this soil less attractive. Thicker sections of sand and gravel within the soil might be sought.

The Friana series develops over very gravelly, cindery clay in old lake beds and depressions. These surfaces tend to be nearly level and are found as open parks and meadows in areas with basalts covered by pine trees. They develop from various types of material including volcanic ash, cinder, and basalt in horizons that are between 0.89 to 1.5 m (35 to 60 in.) thick. Gravel is found 0.70 m below the surface and to a depth of about 1.4 m which give an average gravel thickness of 0.7 m which in terms most sand and gravel deposits is too thin to be considered viable as a major supply. Total area of the Friana soil series is 460 ha (1140 acres). [Given an average thickness of 0.7 m (2.3 ft), the total volume of the two soils is on the order of 3.2 million m$^3$.]

A number of other soils are described and located in the report by Wheeler and Williams (1974) as good for road fill but not as a source of sand and gravel. They include the Anthony (good, A-2), Overgaard (good to 10 inches, A-2), the Sanchez (good to poor, A-2 and A-6), and the Tortugas (good, unrated using AASHTO code).

Sources of impurities

Thin layers of bituminous-rank coal have been reported in the upper Paleozoic rocks of Fossil Creek Canyon in the Fossil Springs Wilderness. This area extends south into Tonto National Forest. Coal can be a deleterious mineral to surficial aggregate, particularly for fine aggregate used in fabrication of concrete roof tiles and may result in either leaky or cracked tiles. However, coal is not a usually a problem in other types of concrete or in road construction (Prentice, 1990).
Alluvium characteristics inherited from bedrock sources

Background
Weathering and erosion of bedrock generates alluvium of varying quality. The summary that follows gives general characteristics of alluvium in basins developed along streams from various bedrock units as described by the Arizona Highway Department (1972) and Arizona Department of Transportation (1975). Geologic units are those used by Lane (1992) with some additions from Weir and others (1989) for age and lithology. Pennsylvanian and Permian rocks are particularly complex and have been variously subdivided and grouped (Wier and others, 1989). As many basins and watersheds contain a mix of bedrock lithologies, the alluvium will have a mixture of qualities, some of which are noted below for various rock types:

Basaltic volcanic rocks.
Nearly all rocks of this type weather to form clays. Streams draining the extensive outcrops of these rocks in the CNF contribute to the large areas where suitable aggregate is absent.

Silicic volcanic rocks.
Weathering and erosion of silicic volcanic rocks can generate good quality sand and some gravelly sand but gravel-rich deposits are rare. Streams basins in the Peaks RD, particularly on the flanks of the San Francisco Peaks are most likely to have this type of aggregate.

Verde Formation.
This Tertiary unit is fine grained and not a source of alluvial aggregate.

Moenkopi Formation
Parts of the Moenkopi include: siltstone, claystone, sandstones and minor conglomerate near the base (Kiersch, 1955; Weir and others, 1989), and some parts have been used as a source of dimension stone. The lithologies it contains do not make it a promising source of alluvial aggregate with the possible exception of the basal conglomerates.

Kaibab Formation
The Kaibab consists of interbedded sandy limestone, sandstone, and chert, and weathering generates a very friable mixture of material.

Toroweap Formation and Coconino Sandstone
The lower Permian Toroweap Formation (which has been variously divided and also can include the Coconino Sandstone and is sometimes included with the upper part of the Supai Formation) is a sandstone, siltstone, mudstone, and conglomerate, with some minor dolomitic limestone. The Coconino Sandstone of lower Permian age (Weir and others, 1989) weathers and erodes like the other units noted here to generate sand and silt of a quality not suited for aggregate. PI values have been found between 7 and 20.
Supai Formation
The Permian Supai Formation of thinly layered sandstone and lesser amounts of siltstones weathers and erodes to generate a silty sandy alluvium with friable fragments not suited for aggregate. PI values have been found between 7 and 20. The unit crops out extensively particularly in the Sedona RD (fig. 1).

Redwall and Martin Limestone.
Streams developing on these Mississippian and Devonian age units can contain good-quality sand and gravel deposits free of contaminates. Unfortunately the units crop out in relatively small areas in the CNF.

Tonto Group (Tapeats Sandstone only).
The lower part of the Cambrian age Tapeats Sandstone is a sandstone, both massive and crossbedded, with coarse sand and pebble lenses. It may be arkosic (Weir and others, 1989). The upper part is soft calcareous siltstone and mudstones. Weathered rocks from the lower part are free of clays and have a low plastic index (PI, a desirable property). Inspection of the geologic map by Lane (1992, plate 2) shows the Tapeats with two relatively limited outcrops along the Verde River, south of Camp Verde, in the Beaver Creek RD (fig. 1).

Precambrian Schist
Schist tends to generate soft fissile material of poor quality for use as aggregate. An outcrop of schist is noted along the Verde River south of Camp Verde (Lane, 1992) in the Beaver Creek RD (fig. 1).

Sources of crushed stone for construction and riprap

Introduction

Following is a summary of general characteristics of various geologic units (Arizona Highway Department, 1972; Arizona Department of Transportation, 1975) within the CNF and their likely suitability as sources of crushed stone. Geologic units are those used by Lane (1992) with some additions of Weir and others (1989) for age and lithology. In general, most sandstone units found in Arizona do not meet abrasion requirements and are not usable in asphalitic concrete (Langland, 1987). As noted in the section on alluvium, Pennsylvanian and Permian rocks have particularly complex stratigraphy and have been variously subdivided and grouped.

Basaltic volcanic rocks

As noted previously, basalts are abundant in the CNF. They cover more than three quarters of the forest lands, and are found in two major fields: the San Francisco volcanic field in the Peak RD and Mormon Lake RD (fig. 1), and the Mormon Mountain volcanic field found in Mormon
Lake, Blue Ridge, and Long Valley RDs, and eastern parts of Beaver Creek RD. The Mormon Mountain volcanic field is slightly older and is dominated by Pliocene (?) and Miocene basaltic volcanic rocks in flow units from about 6-12 m thick. Lesser amounts of andesite are found in domes, flows and pyroclastic deposits (Weir and others, 1989). Tertiary and Quaternary basalts are found in the San Francisco volcanic field which was active during the Pliocene and Pleistocene (Newhall and others, 1987). Compositionally the field is dominated by basalt and basaltic andesite with lesser amounts of andesite, benmoreite, and dacite. Basalts and related lithologies have been mapped and studied in numerous studies in and adjacent to the CNF, some of which are identified in the introduction.

A somewhat expanded discussion on basalt is included here because they are so prevalent in the CNF, and likely a continued important source of aggregate. Basalts found in the CNF have been used by ADOT in asphalt mix for road surfaces (Lane, 1992). A number of sites used as a source of aggregate and other construction material by ADOT are described in a material inventory of Coconino and Yavapai Counties (Arizona Department of Transportation, 1975; 1972). See figure 2 for the areas of each county within the CNF.

While basalts can be an excellent source of good quality aggregate as well as fair to excellent riprap (Kiersch, 1955), weathering produces clays, including montmorillonite, that can occur in seams which may not be apparent until quarrying is underway. Intrusive basaltic rocks are less uniform in composition and geotechnical properties and often crop out in ways that make them difficult to mine. As a general rule, younger basaltic volcanic rocks are better than older ones. Therefore, basalts found in the younger San Francisco volcanic field are likely to make better aggregate than those found in the older Mormon Mountain volcanic field.

Basalt and diabase (gabbro or basalt composition) are identified by stone producers as "trap" rocks when intrusive (Dunn, 1991). Composition and mineralogy of these rocks effect their use as aggregate. Glasses are frequently present in extrusive rocks, particularly those with more silica. These rocks then are highly reactive with the alkali in Portland cement. Basaltic and related rock types also can be mechanically weakened by the presence of the round grains of olivine, particularly if abundant. Olivine's rounded crystal form does not interlock well with other minerals or the matrix (Dunn, 1991). Quartz (albeit a mineral not commonly found in basalt) is an example of a mineral which tightly interlocks with other crystals (Dunn, 1991; Herrick, 1994). Brattli (1992) found that mechanical strength also decreased as the amphibole to pyroxene ratio increased. Dunn (1991) suggest that amphiboles (actinolite, tremolite, anthophyllite) have more brittle crystals and this may account for some of the decrease in strength as reported by Brattli (1992).

Ferromagnesian minerals in basalts and related rock-types weather rapidly under humid climates, producing swelling clays (e.g., smectite) which destroy the mechanical integrity of the rock (Prentice, 1990). Surface weathering reduces both impact strength and abrasion strength (Haraldsson, 1984). Like weathering, hydrothermal alteration of igneous and other rock types can make them unsuitable for use as aggregate.
Additional mechanically weakness may be due to deuteric alteration of the olivines (by late stage fluids associated with the magma) where the minerals formed may include clay and hydrous iron minerals (iddingsite) (B.B. Houser, written commun., 1997).

Brattli's (1992) study of basaltic igneous rocks suggests that strength increases as the mean grain size decreases and is particularly strong for mean grain sizes under 1 mm. This and possibly other geologic properties may be promising in predicting the mechanical properties (e.g., impact value, flakiness value, abrasion value, etc.) of basaltic rocks given absence of direct measurements.

Presence of cracks and flaws (e.g., holes) affect mechanical strength and are found both along grain boundaries and within the minerals. Most cracks have lengths "usually 1/10 the grain size" (Brattli, 1992, p. 37). Some dense gabbros and diabases can be nearly crack-free (Spunt and Brace, 1974). Rocks with smaller grains can also be expected to have shorter cracks which contributes to better mechanical strength.

The discussion to this point clearly shows that basalt and related rock types have both good and bad features when used as aggregate. Prentice (1990, fig. 3.5b) showed that most basalt can have the same low aggregate abrasion values (results of a UK test somewhat analogous to the Los Angeles abrasion test) as seen for granite. A preliminary model of the Los Angeles abrasion (wear) test (LAWT) results showed low aggregate abrasion values for Quaternary and Tertiary basaltic rocks (fig. 4) from 13 sites in Coconino and Yavapai Counties in and adjacent to the CNF plus 6 sites in basalts from New Mexico. All the sites have LAWT values less than 40 percent loss which is a common maximum in standards for material used as aggregate. These results, as a group, have a distribution of values which can be described using the normal distribution as a preliminary model (fig. 4). The test used to compare sample distributions of Los Angeles abrasion (wear) test values to normal distributions was Lilliefors' test, a special form of the Kolmogorov-Smirnov test (Rock, 1988). Some values in models which follow are transformed into logarithms when the histograms for engineering characteristics were skewed. In the Lilliefors' test, the Kolmogorov-Smirnov test statistic, \( d_{\text{max}} \), is compared to a table of critical values based on the mean and standard deviation from the sample data, not the parent population. The normal or lognormal distribution were rejected as being inappropriate to describe the sample distribution at the 5-percent confidence level.

Herrick (1994) reports that the average LAWT for basalt commonly used for crushed stone is 14 percent and a little lower than the mean value of 21 percent in the preliminary model (fig. 4). On the other hand, unconsolidated cinders, clinkers and other unconsolidated basaltic materials are less suitable in terms of LAWT results with slightly less than half the sites exceeding the 40 percent maximum loss usually allowed for use as aggregate (fig. 5). These results, as a group, have a distribution of values which can be described using the normal distribution as a preliminary model (fig. 5). While cinders, clinker and other unconsolidated basaltic material are easier to mine, their quality is poor.
and their low durability will make roads on which they are used subject to more frequent maintenance.

Data on basalts for sites beyond the study area as reported by others tend to have higher variability in aggregate abrasion values; about 15 percent of the samples have values greater (that is, of poor quality) than observed in granites (Prentice, 1990; fig. 3.5b). On the other hand, another UK test, the aggregate crushing test (percent fines produced when standard pressure applied to sample for 10 minutes) shows basalt to be clearly better (less fines) than granite, at least in the context of the test (Prentice, 1990; fig. 3.2b).

Silicic volcanic rocks

Rhyolites are much less abundant than basalts in the CNF. The closest lithology to rhyolites in the Mormon Mountain volcanic field is a rhyodacite dome on the south side of Mormon Mountain and a small dome south of Mormon Lake, both in the Mormon Lake RD (see Weir and others, 1989). Rhyolites are more common in the San Francisco volcanic field (Wolfe, Ulrich, Holm, and others (1987), particularly around the major eruptive centers both in or adjacent to the Peaks RD. Most outcrops are for domes although a few rhyolite flows are noted. An example of rhyolite domes outside of major eruptive centers is an outcrop six miles southwest of Flagstaff at vent 0614 (see sheet 1, Wolfe, Ulrich, Holm, and others (1987).

Three major eruptive centers in the San Francisco volcanic field and in the CNF are Kendrick Peak, O'Leary Peak and the extensive San Francisco Mountain complex. The Kendrick Peak center, in northwest Peaks RD, is partly in the CNF and partly in the Kaibab NF. Seven or eight rhyolite domes are recognized. A rhyolite dome is recognized at Robinson Crater, part of the O'Leary Peak eruptive center, northeast of San Francisco Mountain (Moore and Wolf, 1987). The San Francisco Mountain eruptive complex, north of Flagstaff, includes several rhyolite domes and a few flows of various sizes include ones seen at Core Ridge, Doyle Spring, Hochderffer Hills, Raspberry Springs, Sugarloaf Dome, and White Horse Hills (Wolfe, Ulrich, Holm, and others, 1987).

Rhyolites and related extrusive rocks can make good quality aggregate. As a rule of thumb, coarse-grained igneous rocks tend to have weaker interlocking grains than ones with fine to medium grain sizes. However, they are silica rich and are more likely to contain glass, which is highly reactive with the alkali in Portland cement (Dunn, 1991). Flow-banding may result in undesirable elongated fragments in crushing (Smith and Collis, 1993). Jointing is common and can make outcrops easier to work but may also generate oversized blocks requiring boulder blasting. Platy jointing can occur in smaller intrusive bodies and result in undesirable slabs during crushing.

A preliminary model of LAWT results is developed for rhyolites found in New Mexico (fig. 6) and may be applicable to similar, but less abundant, lithologies in the CNF. The rhyolitic model is problematic in that the highest value (39 percent loss) and lowest value (11.2 percent loss) were excluded from the data set. The distribution used to describe the
remaining data is logarithmic (log base 10) as the data are skewed. A variety of intermediate to silica-rich lithologies is included and improvement in the preliminary model is likely (and needed) given more data. In terms of LAWT results, this group of sites is very comparable to those given for basalts (fig. 4). Herrick (1994) reports that the average LAWT for felsite (includes andesite, dacite, rhyolite and trachyte) commonly used for crushed stone is 18 percent and comparable to the geometric mean of the preliminary model of 20 percent (fig. 6).

Verde Formation

Most of the unit is not sufficiently consolidated to be crushed; some of the limestone lenses may be crushable but would supply only a limited amount of materials.

Chinle Formation

The unit varies from siltstones and sandstones in the lower part, has increasing claystone in the middle, and alternating beds of siliceous limestones and siltstones near the top (Kiersch, 1955). The limestone stringers and lens are likely sources of aggregate of varying quality (Kiersch, 1955).

Moenkopi Formation

This includes an assemblage of siltstone, claystone, sandstone and minor conglomerate occurring near base (Kiersch, 1955; Weir and others, 1989). While used as source of dimension stone, its suitability for quality aggregate is not known. Some of the blocky sandstones in this formation are a fair quality riprap (Kiersch, 1955).

Toroweap Formation and Coconino Sandstone

The Toroweap Formation is predominantly a cross-bedded quartzose sandstone (Weir and others, 1989). No report on its use as aggregate or riprap was found.

The crushing strength of limestone in the Coconino is reported in Kiersch (1955) to be between 4,500 and 9,400 pounds per square inch (PSI) (320 and 1,200 kilograms per square centimeter (kg/cm²)) based on tests of 4 fine-grained, freshly quarried blocks. The average crushing strength is about 6,700 PSI (470 kg/cm²). These samples were collected in the Navajo-Hopi Indian Reservations and may not be representative of limestone in the Coconino Sandstone in the CNF.

Kaibab Formation

Langland (1987) noted that the Kaibab Formation has been considered a suitable source of limestone because it contains 70 percent or more calcium and magnesium carbonates. However, like other limestones, it
may be undesirable as a surfacing material due to poor frictional properties (Langland, 1987). Polishing of coarse aggregate in the wear surface of roadways is commonly due to uniform wearing of the aggregate microtextures, particularly those which are fine grain, like limestones. Use of limestone in the wear surface is usually considered suitable if the insolubles are 10 percent or greater (White, 1991). Kiersch (1955) reports that blocky limestone beds in this unit have provided good quality riprap.

A LAWT preliminary model of material taken from quarries and pits in the Kaibab Formation (fig. 7) in northern Arizona suggests that about a fourth of the sites have test results which are too large—exceeding the 40 percent loss limit—usually required for use in aggregate. The distribution used to describe the data is logarithmic (log base 10) as the data are skewed. Herrick (1994) reports that the average LAWT for limestone found elsewhere, outside this study, and commonly used for crushed stone is 26 percent which is lower than the geometric mean of 31 percent in the preliminary model (fig. 7).

Supai Formation.

The Permian Supai Formation consists of thinly layered sandstone and lesser amounts of siltstones. Elsewhere in the Colorado Plateau, limestone lenses have been located and used as fair quality, although small size, riprap (Kiersch, 1955). The unit crops out extensively, particularly in the Sedona RD (fig. 1).

Redwall Limestone

This Mississippian-aged unit commonly crops out as cliffs consisting of massive limestone, about half of which consists of dolomite. Chert and shale beds are also present and degrade the value of crushed stone produced if included. Mineability may be an issue, considering the nature of outcrops.

Three areas need to be checked as a location for possible production of crushed limestone within the Coconino NF as discussed previously.

Martin Limestone

This Devonian-aged unit consists mostly of dolomite that may be suitable as a crushed stone aggregate if not too reactive; particularly if the thin shale beds are avoided.

Tonto Group (Tapeats Sandstone only)

The lower part of the Cambrian age Tapeats Sandstone is both massive and crossbedded, with coarse sand and pebble lens but its suitability for crushing in unknown.
Precambrian schist

Most schist is fissile and not suitable for crushing.

Metals

Introduction

The CNF is notable for the absence of metallic deposits within its boundaries, but a number of formations which are in the CNF do host metallic deposits elsewhere. The three metallic deposit types discussed here lack deposit models: (1) strata-bound manganese, (2) replacement iron deposits, and (3) the base-metal-enriched remnant deposits of solution-collapse breccia pipe uranium deposits. Sediment-hosted Cu deposits, red-bed type, are recognized as permissible in the CNF based on tracts found in the mineral-resource assessment for undiscovered resources of gold, silver, copper, lead, and zinc in the conterminous United States conducted by the USGS from 1993 through 1995 (Ludington and Cox, 1996).

Strata-bound manganese

Four manganese occurrences have been described in the CNF in the Long Valley district. The Long Valley Ranger and Blue Ridge RDs (fig. 1), are described in MRDS Nos. 2 (Dennison Group), and 5 (Shoup Group). Other nearby occurrences are described in MRDS Nos. 3 (Lost Apache claim) and 4 (Blue Ridge property) (fig. 2). Welty and others (1989) classified the Long Valley mineralization as strata-bound and (or) stratiform. Farnham and Stewart (1958) classified these occurrences as replacement and residual deposits. The Coconino Sandstone at Long Valley has manganese in thin beds and nodular masses, some of which are as large as 100 tons (Dorn, 1969). Farnham and others (1961) described manganese mineral in soil and gravel, which may be detrital.

Dorn (1969) also suggested that some manganese may be precipitated as manganese oxides from groundwater. Cox (1991) suggested that similar-type deposits in northwest Virginia were also transported by ground water. The Coconino Sandstone may provide a geochemical trap like those for residual manganese deposits described by Force (1991) for similar-type deposits in some lower Paleozoic rocks of Virginia. Lane (1992) describes the CNF sites as containing nodules of too little material to be viable as a resource.

Grade and tonnage models for these manganese deposit types are not available. The permissive tracts for these manganese deposit types are outcrops of Coconino Sandstone which hosts the known deposits.
Replacement iron deposits

Iron has been mined from a deposit in the Redwall Limestone for use as mineral pigment (Klemic, 1969). The Seligman iron district (MRDS Record No. M003329, not shown on fig. 2), 19 miles south of Seligman, Ariz., was classified by Welty and others (1989) as stratiform. Harrer (1964) described the deposit as a replacement along the contact between the limestone and an andesite porphyry sill. The deposits was worked for hematite (with grades between 55 and 68 percent Fe). This is the only known deposit of this type hosted by the Redwall Limestone in Arizona. Other replacement iron deposits in the western United States are usually found in "volcanic rocks, brecciated igneous rocks, and limestone" (Klemic and others, 1973; p 301). Most iron replacement deposits consist of siderite which can be weathered to hematite (Laznicka, 1985).

A grade and tonnage model for replacement iron deposits is not available. Laznicka (1985) suggests, world-wide, that past production plus known reserves from iron replacement deposits in carbonates are on the order of 130 million t. A model could be attempted, given data on a sufficient number of deposits, but the discussion in Laznicka (1985) also suggests that classification of these iron deposit types will be a problem.

Permissive tracts are the outcrop of the Redwall Limestone. The presence of an intrusive like that at Seligman would be necessary but may not be seen in outcrop. If other limestone-bearing formations are also permissive, outcrops of Kaibab Formation are also possibly permissive for replacement iron deposits as well. The likelihood of intrusives (including sills) is high in most parts of CNF with the possible exception of the Beaver Creek RD.

Remnants of solution-collapse breccia pipe uranium deposits

The assessment of solution-collapse breccia pipe uranium deposits is found in Bliss and Pierson (1994). However, when these deposits become exposed at the surface, they are depleted in uranium and enriched in copper by supergene processes (Finch and others, 1992). In effect, solution-collapse breccia pipe uranium deposits become copper deposits if weathering is extensive; otherwise a copper-enriched zone is present on a solution-collapse breccia pipe uranium deposit. Supergene mineralization, either partial or relatively complete, will be called remnant deposits in this discussion. In effect, the model by Finch and others (1992) is not applicable.

Currently recognized remnant deposits like Grandview and Copper Mountain are all from the Colorado Plateau and are, on average, two orders of magnitude smaller (~ 1,000 t) than solution-collapse breccia pipe uranium deposits, which have a median size of 230,000 t (Finch and others, 1992, fig. 21). The largest remnant deposit is 11,000 t. Remnant deposits historically have been worked primarily for copper; grades are usually between 3.2 and 33 percent; the median grade is 10 percent copper. Other base metals produced as by-products include lead in about half the deposits.
and zinc in about a third. Lead grades are less than 0.6 percent and zinc grades are less than 0.8 percent. Silver is produced in nearly all the deposits with grades between 9 and 270 g/t; the median grade is 50 g/t. Gold is produced in about a third; the grades are quite low--usually less than 250 ppb. Remnant deposits are not reported as producing uranium.

All exposures of the Coconino Sandstone are permissive for these deposits. Forested areas or those covered by thin volcanic sequences are likely areas containing undiscovered deposits of this type.

**Sediment-hosted Cu deposits, redbed type**

In a mineral-resource assessment for undiscovered resources of gold, silver, copper, lead, and zinc in the conterminous United States (Ludington and Cox, 1996), small portions of two tracts found in the CNF are permissible for sediment-hosted Cu deposits, red-bed type. Tract CP01 was delineated using the presence of permeable sandstones in "the lower part of the Upper Triassic Chinle Formation (including the Shinarump and Agua Zarca Sandstone Member)" (Lindsey, 1996a, p. 72). The White Canyon deposit, Utah (530,000 t at 0.75 percent Cu) is an example of the sediment-hosted Cu deposits, red-bed type on the Colorado Plateau. The world red-bed model (Mosier and others, 1986) can be used to characterize the size and grade distributions of undiscovered deposits (Lindsey, 1996a). The total tract area is 36,300 km² including outcrops in Arizona, Colorado, New Mexico and Utah. The estimated number of undiscovered deposits for the full tract are at the following percentiles: 90th--0, 50th--0, 10th--1, 5th--2, and 1st--4.

Tract CP02 of the conterminous United States assessment was delineated using the presence of permeable sandstones in "Hermosa Group and Cutler Formation in Utah, and the Naco Formation in Arizona" (Lindsey, 1996b, p. 73). Examples of known sediment-hosted red-bed type Cu deposits in this tract are all smaller than the median red-bed tonnage of the world red-bed model (Mosier and others, 1986). Therefore, undiscovered deposits consistent with the size and grade distributions of the model are much more unlikely (Lindsey, 1996b). The total tract area is 17,800 km² including outcrops in Arizona, New Mexico and Utah and estimates of undiscovered deposits were made at the following percentiles: 90th--0, 50th--0, 10th--0, 5th--1, and 1st--3.

The low probabilities associated with the estimated numbers of undiscovered deposits of sediment-hosted Cu deposits, red-bed type, in the two tracts in the Colorado Plateau (Lindsey, 1996a, b) suggests the chance of undiscovered deposits of this deposit type are remote for the full tracts and will be even less for portions thereof within the CNF. The chance of an undiscovered deposit is slightly higher in areas of tract CP01 than for tract CP02 which may be a consideration in property exchange.
Other metallic deposit types

Tracts for porphyry copper deposits are also found in the resource assessment for undiscovered resources of gold, silver, copper, lead, and zinc in the conterminous United States (Ludington and Cox, 1996). One of the tracts in Arizona—SB10—is mostly southwest of the CNF (Cox, 1994, 1996). Parts of the tract are defined by using a 10 km buffer zone around Laramide intrusives. Several intrusives suspected to be Laramide in age are found in the southern Black Hills (Luedke and Smith, 1978) about 15 km south of Camp Verde (fig. 1). Luedke and Smith (1978) described the intrusive rocks as being of uncertain assemblage and characteristics. The buffer zone around these intrusives includes rocks in the basement of the southeast end of the Verde Basin and in the CNF southeast of Camp Verde. The area covered with Verde Formation and younger sediments is permissible for an undiscovered porphyry copper deposit.

A number of other deposits types are associated with felsic intrusions into carbonates as well as into other rock types (Cox and others, 1986, table 1) which may be part of the unexposed or poorly exposed assemblage of rocks associated with volcanic centers in the CNF. This includes the base- and precious-metal skarns, veins, and replacement deposits of various types. Evidence of mineralization with a felsic intrusive are seen in workings, including a shaft at least 15 feet (4.6 m) deep and pits at Slate Mountain (Lockrem, 1983) located in the northwest corner of the Peaks RD (located approximately as "SL" on fig. 2). The workings are located in a contact metamorphic zone where rhyolite intrudes into the Martin Formation perhaps showing evidence for skarn-type mineralization. The zone is characterized by bleaching, brecciation, and magnetite and hematite mineralization occurring in concordant and discordant veins (Lockrem, 1983). Trace amounts of copper (300-3000 ppm), lead (1000-3000 ppm), and zinc (60-1200 ppm) were detected in four particularly well-mineralized samples (Lockrem, 1983). The description is too incomplete to classify the prospect by deposit type but the presence of the site is encouraging evidence that undiscovered deposits of types associated with felsic intrusions into carbonates may exist in the CNF.
References Cited


Arizona Department of Transportation, 1975, A materials inventory of Coconino County: Arizona Department of Transportation, Highway Division and Federal Highway Administration, 123 p.

Arizona Department of Transportation, 1990, Standard specifications for road and bridge construction: Arizona Department of Transportation, Highway Division, 800 p.


Brattli, Bjørge, 1992, The influence of geological factors on the mechanical properties of basic igneous rocks used as road surface aggregates: Engineering Geology, v. 33, no. 1, p. 31-44.


Stein, P.H., 1993, From courthouse to restroom; the Flagstaff sandstone industry: Journal of the West, v. 32, p. 53-61.


Table 1. Grade requirements for lightweight aggregate for structural concrete, in percent (ASTM C 330).
[Percent is by weight passing sieves having square openings.]

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<th>Size Designation</th>
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<th>9.5</th>
<th>4.75</th>
<th>2.36</th>
<th>1.18</th>
<th>0.29</th>
<th>0.149</th>
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<tr>
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<td>80-50</td>
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<td>(12.5 to 4.75 mm)</td>
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<td>90-65</td>
<td>65-35</td>
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Table 2. Grade requirements for lightweight aggregate for concrete masonry units, in percent (ASTM C 331).
[Percent is by weight passing sieves having square openings.]

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Table 3. Grade requirements for lightweight aggregate for insulating concrete, in percent (ASTM C 332).
(Applicable to group II, non-ultra-lightweights; percent is by weight passing sieves having square openings.)

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<td>25-10</td>
<td>15-5</td>
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Fig. 1. Location of the six ranger districts of the Coconino National Forest, Arizona.
Fig. 2. Location of selected mineral deposits, prospects, and occurrences recorded in MRDS as of May 22, 1995. SL--Slate Mountains, see discussion in text.
Uses of pumice and pumicite in the USA

Figure 3. Distribution of uses of pumice and pumicite in the United States in 1993. Class designated as "Other" includes uses as absorbent, diluents, filter aids, roofing granules, water treatment, and other unspecified uses. Based on data in Bolen (1994).
Figure 4. Degradation of Quaternary and Tertiary basaltic rocks extracted from quarries in Coconino and Yavapai Counties, Arizona (N=13), and New Mexico (N=6) as measured by the Los Angeles wear test (500 rotations). Dash line for 40 percent loss which is a common maximum in several ASTM and AASHTO standards for several different uses of aggregates in construction of roads.
Figure 5. Degradation of unconsolidated cinders, clinkers, and other Quaternary and Tertiary basaltic material extracted from pits in Northern Arizona as measured by the Los Angeles degradation test (500 rotations). Dash line for 40 percent loss which is a common maximum allowed in several ASTM and AASHTO standards for aggregates used in construction of roads.
Figure 6. Probable resistance of rhyolitic rocks in CNF to degradation by abrasion and impact as measured by the Los Angeles degradation test. Based on rhyolites found in New Mexico. Highest and lowest values (not shown) excluded from model (see text). Dash line for 40 percent loss which is a common maximum in several ASTM and ASSHTO standards for several different uses of aggregates in construction of roads.
Figure 7. Probable resistance of rocks from 18 quarries and pits in the Kiabab Formation in, or adjacent to, the CNF. Degradation measured by abrasion and impact in the Los Angeles degradation test (500 rotations). Based on sites in northern Arizona. Dash line for 40 percent loss which is a common maximum in several ASTM and AASHTO standards for several different uses of aggregates in construction of roads.
Appendix A
List of MRDS records found in appendix B (which follows) sorted by commodities or byproduct commodities including MRDS sequence numbers. Some records are listed under several different commodities.

<table>
<thead>
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<th>Commodity</th>
<th>MRDS sequence numbers</th>
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<td>ash, pumiceous</td>
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<tr>
<td>basalt</td>
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<td>bentonite</td>
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<td>brine</td>
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<td>diatomite</td>
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Appendix B

Descriptions of deposits, prospects, and occurrences of selected minerals found in and adjacent to the CNF and as reported in the Mineral Resources Data System (MRDS) as of May 22, 1995. Sites listed here are also located by sequence number (in upper right-hand corner of each record) on figure 2. MRDS records are listed here in the same order.
Mineral Resources Data System (MRDS)

Report Title
Issue Date 00/00/00
Current Date Monday, April 7, 1997
Current Time 10:24:50
Number 1 of 103
Printed 1 of 103

TC10150
Site
BOLM, KAREN S.
USGS
LARSON QUARRY
ARIZONA GYPSUM, VERDE GYPSUM, CAMP VERDE GYPSUM

-- Location Information --
UNITED STATES
ARIZONA
YAVAPAI
11
15
CAMP VERDE
34-32-10N
111-46-57W
34.53611
-111.7825
428192.5

ON EAST SIDE OF VERDE VALLEY, 4.5 MILES SE OF CAMP VERDE.

-- Commodity Information --
Non-metallic
GYPSUM, BENTONITE
BENTONITE USED FOR IRON ORE PELLETIZING AND CANAL-RESERVOIR SEALER.
90% OR MORE GYPSUM, PURE, WHITE, MASSIVE, MICROCRYSTALLINE AND GRANULAR

-- Geology --
CEN
MUDSTONE, VOLCANIC ASH
CEN TERT?

Page 1
Record Number TC10150

VERDE FORMATION

CEN

Deposit Description

USGS Model Name LACUSTRINE GYPSUM

Model Number 35B.4

Deposit Type LACUSTRINE EVAPORITE, SEDIMENTARY

Thickness 100 Units FT

Deposit Desc Comm PROBABLY COVERS SEVERAL SQUARE MILES. THE GYPSIFEROUS SEQUENCE, AS MUCH AS 100 FT THICK, CONTAINS A SERIES OF NEARLY PURE, FLAT-LYING GYPSUM BEDS INTERBEDDED WITH MUDSTONE AND VOLCANIC ASH.

Production Size Yes

Development Status Intermittent Producer

Desc Workings Surface

Reference


PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERALS CARD FILE.


Info Source 12

Resv/Reso Src Info AZ BUREAU OF MINES BULLETIN 180, P. 375.

Resv/Reso Comm RESERVED AND RESOURCES ESTIMATED IN MILLIONS OF TONS

Page 2
Mineral Resources Data System (MRDS)

Record Number M002911
Record Type Site
Reporter BRIGHT, DANIEL (CREASEY, S.C.)
Reporter Affiliation USGS

Editor Name BRIGHT, DANIEL (CREASEY, S.C.)
Editor Type R
Editor Affiliation USGS
Editor Date 6/1/79

ORRIS, GRETA J.
Editor Type U
Editor Affiliation USGS
Editor Date 5/22/95

Site Name DENISON GROUP
Synonym Name BLACK DIAMOND, MCCLOSKEY CLAIM, LINESBA CLAIM

-- Location Information --
District Name LONG VALLEY DISTRICT
Country UNITED STATES
State ARIZONA
County COCONINO
Physiographic Prov 11
Drainage Area 15060203
Quad 250k HOLBROOK
Quad 24k LONG VALLEY (1965)
Elevation 6880 FT
Latitude 34-34-13N
Longitude 111-20-05W
Accuracy EST
UTM Northing 3825260
UTM Zone 12

Section 30
Section Fraction 1.5 MILES NORTHWEST OF CLINTS WELLS
Township 014N
Range 010E
Meridian GILA AND SALT RIVER

-- Commodity Information --
Commodity Type Metallic
Commodities MN
Major MN
Ore Materials PSILOMELANE, PYROLUSITE
Non-Ore Materials GANGUE CONSISTS OF SOFT SANDY LIMESTONE AND IRON OXIDES

-- Geology --

Page 1
Record Number: M002911  (....Continued)

Ore Control: MAJORITY OF DEPOSITS CONFORM TO STRIKE AND DIP OF ENCLOSING LIMESTONE

Host Rock Type: LIMESTONE
Name: PERM
Age: KAIBAB LIMESTONE

Deposit Size: Small
-- Individual Ore Bodies --
Deposit Type: BEDDED REPLACEMENT
Deposit Form: SEAMS, LENSES

Length: 10 Units FT
Width: 3 Units FT
Thickness: 8 Units FT

-- Exploration and Development --

Production Size: Small
Development Status: Developed Producer, Inactive

Desc Workings: Surface and Underground
-- Individual Workings --

Depth Below Surf: 25 Units FT
Overall Length: 200 Units FT
Overall Width: 100 Units FT
Overall Area: 20000 Units SQ FT

Workings Comments: THESE ARE THE DIMENSIONS OF THE LARGEST AND MOST PRODUCTIVE OF THE ACCESSIBLE OPEN PIT WORKINGS ON THE DENISON PROPERTY.

General Comm: DENISON PROPERTY COMPRISSES NINE PATENTED CLAIMS.
INFO.SRC: 1 PUB LIT

-- Reference --


-- Annual Production --

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<th>Item</th>
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-- Cumulative Production --

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<th>Years</th>
<th>Grade</th>
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<tr>
<td>ORE</td>
<td>EST</td>
<td>0.21600</td>
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<td>1927 - 1929</td>
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<tr>
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<td>ORE - CON EST</td>
<td>3.70000</td>
<td>TONS 1927 - 1954 40 % Mn</td>
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<td>USBM IC 7843</td>
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<td>Prod Comments</td>
<td>ITEM 10: TOTAL PRODUCTION OF DENISON PROPERTY FROM 1927 - 1954</td>
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Page 3
## Mineral Resources Data System (MRDS)

**Report Title**

**Issue Date** Monday, March 9, 1992

**Current Date** Monday, April 7, 1997

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<tr>
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<tr>
<td>Quad 250k</td>
<td>Holbrook</td>
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<td>G &amp; SR</td>
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<td>Meridian</td>
<td>G &amp; SR</td>
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<tr>
<td>Position</td>
<td>3.9 MILES SOUTHWEST OF BLUE RIDGE SPILLWAY</td>
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<tr>
<td>Location Comments</td>
<td>UTM EST</td>
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<tr>
<td>Commodity Type</td>
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<td>Commodities</td>
<td>MN</td>
</tr>
<tr>
<td>Major</td>
<td>MN</td>
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<tr>
<td>Ore Materials</td>
<td>PSILOMELANE</td>
</tr>
<tr>
<td>Host Rock Type</td>
<td>RESIDUAL SOIL FROM CLAYEY, DECOMPOSED LIMESTONE</td>
</tr>
<tr>
<td>Host Rock Age</td>
<td>PERM</td>
</tr>
<tr>
<td>Deposit Size</td>
<td>Small</td>
</tr>
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</table>

**Location Comments**

UTM EST

**Deposit Description**

**Commodity Information**

**Geology**

**Host Rock Type**

**Host Rock Age**

**Deposit Size**

--- Individual Ore Bodies ---

*Page 1*
Record Number: M002930

Deposit Type: SURFACE FLOAT
Deposit Form: FRAGMENTS AND NODULES

Deposit Desc Comm: REFERENCE STATES THAT MANGANESE DEPOSITS OCCURRED TO DEPTHS OF SEVERAL FEET WITHIN SOIL.

Production Size: Small
Development Status: Developed Producer, Inactive

Desc Workings: Surface

-- Description of Workings --

Workings Comments: EXPLORATORY OPENINGS CONSISTED OF SHALLOW PITS AND TRENCHES.


Info Source: 1

-- Cumulative Production --

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<th>Th Units</th>
<th>Years</th>
<th>Grade</th>
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<tbody>
<tr>
<td>ORE</td>
<td>EST</td>
<td>0.00200</td>
<td>TONS</td>
<td>1949</td>
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Prod Source Info: USBM IC #7843
Prod Comments: ITEM #8: REFERENCE STATES THAT PRODUCTION HAS AGGREGATED A "FEW" TONS OF ORE SINCE FIRST EXPLORED IN 1949.
## Mineral Resources Data System (MRDS)

**Report Title**

**Issue Date** Monday, March 9, 1992

**Current Date** Monday, April 7, 1997

**Record Number** M002931

**Record Type** Site

**Reporter Affiliation** USGS

**Updater** BRIGHT, DANIEL; CREESEY, S. C.

**Updater Affiliation** BLUE RIDGE PROPERTY

---

### Location Information

**District Name** LONG VALLEY DISTRICT

**Country** UNITED STATES

**State** ARIZONA

**County** COCONINO

**Physiographic Prov** 11

**Drainage Area** 1502008

**Land Status** 41

**Quadrangle** BLUE RIDGE RESERVOIR (1965)

**Quad 250k** Holbrook

**Elevation** 6580 FT

**Latitude** 34-33-02N

**Longitude** 111-09-25W

**UTM Northing** 3823020

**UTM Zone** +12

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<th>Meridian</th>
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<td>35</td>
<td>014N</td>
<td>01E</td>
<td>G &amp; SR</td>
<td></td>
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**Position** 1.4 MILES EAST OF BLUE RIDGE RESERVOIR

**Location Comments** UTM EST

---

### Commodity Information

**Commodity Type** Metallic

**Commodities** MN

**Major** MN

**Ore Materials** PSILOMELANE

---

### Geology

**Host Rock Type** RESIDUAL SOIL FROM SANDY, DECOMPOSED LIMESTONE

**Host Rock Age** PERM

**Geology Comm** MANGANESE FLOAT WAS FOUND OVER AN AREA OF MORE THAN A SQUARE MILE.

---

### Deposit Description

**Deposit Size** Small

---

Page 1
<table>
<thead>
<tr>
<th>Record Number</th>
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<tr>
<td>Deposit Type</td>
<td>REPLACEMENT/SURFACE FLOAT</td>
</tr>
<tr>
<td>Deposit Form</td>
<td>LENSES AND POCKETS</td>
</tr>
<tr>
<td>Length</td>
<td>4 Units FT</td>
</tr>
<tr>
<td>Thickness</td>
<td>8 Units IN</td>
</tr>
<tr>
<td>Depth to Top</td>
<td>3 Units FT</td>
</tr>
<tr>
<td>Deposit Desc Comm</td>
<td>PSILOMELANE REPLACES SOIL AND OVERBURDEN.</td>
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<tr>
<td>Production Size</td>
<td>Small</td>
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<tr>
<td>Development Status</td>
<td>Developed Producer, Inactive</td>
</tr>
<tr>
<td>Desc Workings</td>
<td>Surface</td>
</tr>
<tr>
<td>Overall Length</td>
<td>10 Units FT</td>
</tr>
<tr>
<td>Overall Width</td>
<td>6 Units FT</td>
</tr>
<tr>
<td>Overall Area</td>
<td>60 Units SQ FT</td>
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<tr>
<td>Workings Comments</td>
<td>PROSPECTED BY OPEN CUTS, WITH A MAXIMUM DEPTH OF 5 FT.</td>
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<td>General Comm</td>
<td>BLUE RIDGE PROPERTY CONSISTS OF 2 UNPATENTED CLAIMS.</td>
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<td>Info Source</td>
<td>1 2</td>
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<td>Item</td>
<td>Acc Amount Th Units Year Grade</td>
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<td>ITEM #1: REFERENCE STATES; &quot;A FEW TONS OF SORTED ORE WAS PRODUCED DURING 1942&quot;.</td>
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Page 2
Mineral Resources Data System (MRDS)

Report Title
Issue Date 00/00/00

Current Date Monday, April 7, 1997
Current Time 10:24:50

Number 5 of 103
Printed 5 of 103

Record Number M002985
Record Type Site
Reporter BRIGHT, DANIEL (CREASEY, S.C.)
Reporter Affiliation USGS

Editor Name
Type Affiliation Date Comments
BRIGHT, DANIEL (CREASEY, S.C.) R USGS 6/1/79
ORRIS, GRETA J. U USGS 5/22/95

Site Name SHOUP GROUP

-- Location Information --
District Name LONG VALLEY DISTRICT
Country UNITED STATES
State ARIZONA
County COCONINO
Physiographic Prov 11 COLORADO PLATEAU
Drainage Area 15060203
Quad 250k HOLBROCK
Quad 24k LONG VALLEY (1965)
Elevation 6880 FT
Latitude 34-34-30N
Longitude 111-19-28W
Accuracy EST
UTM Northing 3825780
UTM Zone +12

Section 30 29 20 19 Fraction 1.6 MILES NORTHWEST OF CLINTS WELL
Position INFO FROM LAND.ST .01, 41

-- Commodity Information --
Commodity Type Metallic
Commodities MN
Major MN
Ore Materials PSILOMELANE, PYROLYSIT
Non-Ore Materials GANGUE CONSISTS OF SOFT SANDY LIMESTONE AND IRON OXIDES

-- Geology --
Ore Control MAJORITY OF DEPOSITS CONFORM TO STRIKE AND DIP OF ENCLOSING LIMESTONE
<table>
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<tr>
<th>Host Rock Type Name</th>
<th>Age</th>
<th>Host Rock Unit Name</th>
<th>Age</th>
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<tbody>
<tr>
<td>LIMESTONE</td>
<td>PERM</td>
<td>KAIBAB LIMESTONE</td>
<td>PERM</td>
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**Deposit Size**
- Small

**Deposit Type**
- BEDDED/REPLACEMENT

**Deposit Form**
- SEAMS, LENSES

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<th>Depth to Top</th>
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<td>8</td>
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<td>50</td>
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**Age**
- PERM

**Deposit Description**
- Small Individual Ore Bodies
- BEDDED/REPLACEMENT SEAMS, LENSES

**Production Size**
- Small

**Development Status**
- Developed Producer, Inactive

**Desc Workings**
- Surface and Underground

**Depth Below Surf**
- 70 Units FT

**Overall Length**
- 500 Units FT

**Overall Width**
- 50 Units FT

**Overall Area**
- 25000 Units FT

**Workings Comments**
- SURFACE WORKINGS: TRENCHING BOTTOMED IN DETRITAL MATERIAL, REMOVING ONLY VARYING AMOUNTS OF MANGANESE FRAGMENTS. TRENCH NOT EXCEEDING 20 FT. IN DEPTH.

**General Comment**
- SHOUP PROPERTY COMPRISSES 14 LODE CLAIMS, 4 OF WHICH ARE PATENTED. ; INFO.SRC : 1 PUB LIT

**Reference**

**Cumulative Production**

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<td>0.60000</td>
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Page 2
MINERAL OCCURRENCES

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Physiographic Prov: 11
Land Status: 00
Quad 250k: HOLBROOK
Quad 24k: CHAVEZ MTN NE
Other Quad Name: CHAVEZ MTN EAST
Latitude: 34-53-00N
Longitude: 111-02-30W
Accuracy: EST
UTM Northing: 3859908.
UTM Zone: +12

Location Comments: NEAR DCG VALLEY. LAT-LONG TAKEN FROM SECS. 2, 11. IN CANYON DIABLO.

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: DIA GRF
Occurring: DIA GRF
Ore Materials: DIAMONDS, GRAPHITE
Commood Comments: SMALL BLACK DIAMONDS AND GRAPHITE AS SMALL NODULES.

-- Geology --
Deposit Desc Comm: IN 1891 A 40 LB MASS OF THE CANYON DIABLO METEORITE WAS FOUND TO CONTAIN TINY BLACK DIAMONDS. SUBSEQUENTLY, SMALL DIAMONDS EMBEDDED IN GRAPHITE HAVE BEEN FOUND IN OTHER FRAGMENTS FROM THE SAME FALL. SMALL GRAPHITE NODULES ARE ALSO CONTAINED IN THE DIABLO CANYON METEORITE FRAGMENTS.

-- Exploration and Development --
Record Number: TC00275  (....Continued)

Production Size: U
Development Status: Prospect, Inactive

-- Description of Workings --

-- Reference --
Reference: PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERALS CARD FILE.
Info Source: 1

Page 2
**Mineral Resources Data System (MRDS)**

**Record Number**  TC38875  **User Field**  "93/9

**Record Type**  Site  **File Link ID**  IMS, CIMRI

**Reporter**  ORRIS, GRETA G.  **Reporter Affiliation**  USGS

**Site Name**  CHRIS CLAY DEPOSIT

---

**Location Information**

- **Country**: UNITED STATES  **Country Code**: US
- **State**: ARIZONA  **State Code**: AZ
- **Quad 250k**: HOLBROOK
- **Latitude**: 34-17-45N  **Decimal Lat**: 34.29583
- **Longitude**: 110-54-20W  **Decimal Long**: -110.90555
- **UTM Northing**: 3794766.  **UTM Easting**: 508691.5
- **UTM Zone**: +12

---

**Commodity Information**

- **Commodity Type**: Non-metallic
- **Commodities**: CLY
- **Major**: CLY

---

**Geology**

---

**Deposit Description**

---

**Deposit Type**: SEDIMENTARY?

---

**Production Size**: No

**Development Status**: Occurrence

---

**Description of Workings**

---

**Reference**

---

*Page 1*
Mineral Resources Data System (MRDS)

Record Number: TC38873
Record Type: Site
Reporter: ORRIS, GRETA G.
Reporter Affiliation: USGS
Site Name: FLORENCE CERAMICS

-- Location Information --
Country: UNITED STATES
State: ARIZONA
Quad 250k: HOLBROOK
Latitude: 34-21-38N
Longitude: 111-25-10W
UTM Northing: 3802018
UTM Zone: +12

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: CLY3
Major: CLY3

-- Geology --
-- Deposit Description --
-- Exploration and Development --
Production Size: Small
Development Status: Little Developed Producer, Inactive

-- Description of Workings --
Desc Workings: Surface

-- Reference --
Page 1
### Mineral Resources Data System (MRDS)

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<td>Quad 100k</td>
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Record Number TC00253 (....Continued)

Deposit Desc Comm HIGH-SILICA CLAY DERIVED FROM DECOMPOSED ANDESITE AND BASALT.

-- Exploration and Development --

Production Size No

Development Status Occurrence

-- Description of Workings --

-- Reference --


Reference PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERALS CARD FILE.


Info Source 1

Prod Comments NO PRODUCTION REPORTED.
Mineral Resources Data System (MRDS)

Record Number | TC10162
---|---
Record Type | User Field
---|---
Type Affiliation | IMS
---|---
Updater | BOLM, KAREN S.
---|---
Updater Affiliation | 89 09
---|---
Editor Name | PEIRCE, H. WESLEY
---|---
Type Affiliation | AZGS
---|---
Date | 9/1/89
---|---
Comments | "92/12
---|---
Site Name | SALINE WATER WELL NEAR CAMP VERDE
---|---
Country | UNITED STATES
---|---
State | ARIZONA
---|---
County | YAVAPAI
---|---
Physiographic Prov | 12 BASIN AND RANGE
---|---
Drainage Area | 15
---|---
Quad 250k | HOLBROCK
---|---
Quad 24k | CAMP VERDE
---|---
Latitude | 34-33-45N
---|---
Longitude | 111-50-42W
---|---
Accuracy | WITHIN 1/2 MILE.
---|---
UTM Northing | 3824655.
---|---
UTM Zone | +12
---|---
Section | 32
---|---
Section Fraction | 14N
---|---
Township | 005E
---|---
Range | GILA AND SALT RIVER
---|---
Meridian | CEN
---|---

-- Commodity Information --

Commodity Type | Non-metallic
---|---
Commodities | BRINE, HALITE?, SODIUM SULFATES
---|---
Major | HAL BRI
---|---
Occurring | NA?
---|---

-- Geology --

Tectonic Setting | BASIN AND RANGE
---|---
Host Rock Type Name | LACUSTRINE SEDIMENTS, EVAPORITES
---|---
Age | CEN
---|---
Host Rock Unit Name | VERDE FORMATION
---|---
Age | CEN
---|---
BRINES ASSOCIATED WITH SODIUM DEPOSITS IN THE VERDE FORMATION

Deposit Description

Deposit Size Small

Deposit Type LACUSTRINE BRINE, EVAPORITE

Deposit Description BRINES ASSOCIATED WITH SODIUM DEPOSITS OF THE VERDE FORMATION.

Production Size No

Development Status Occurrence

Development M$ HYDROLOGIC UNIT CO

General Comment INFO.SRC : 1 PUB LIT; 2 UNPUB REPT


Reference PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERALS CARD FILE.
Record Number: TC35380
Record Type: Site
Site Name: WHITE HORSE HILLS

Country: UNITED STATES
State: ARIZONA
County: YAVAPAI
Physiographic Prov: COLORADO PLATEAU
Administrative Area: COCONINO NATIONAL FOREST
Quad 250k: HOLBROCK
Quad 100k: SEDONA
Quad 24k: WALKER MTN. (1966)
Latitude: 34-32-48N
Longitude: 111-41-07W
Accuracy: EST LOCATION, +/- 0.5 MI
UTM Northing: 3822789.
UTM Easting: 437122.3
Section: 2
Section Fraction: 13N 06E

Commodity Type: Non-metallic
Commodities: PUM
Major: PUM
Ore Materials: CINDER

Host Rock Type: CINDER CONE

Deposit Type: CINDER CONE

Location Comments: LAT-LONG IS FOR CENTER OF SEC. 2.

Production Size: U
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<td><strong>PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL FILES.</strong></td>
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**Description of Workings**

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**Reference**

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--- Location Information ---

--- Commodity Information ---

--- Geology ---

--- Deposit Description ---

--- Exploration and Development ---
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**Description of Workings**

**Reference**
PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL FILES.

**Prod Comments**
PAST PRODUCER.

Page 2
Mineral Resources Data System (MRDS)

Report Title

Issue Date 00/00/00

Current Date Monday, April 7, 1997

Current Time 10:24:50

Number 14 of 103

Printed 14 of 103

Record Number TC10149

Record Type Site

Reporter BOLM, KAREN S.

Reporter Affiliation USGS

Site Name UNNAMED OCCURRENCE

-- Location Information --

Country UNITED STATES

State ARIZONA

County YAVAPAI

Physiographic Prov 11

Drainage Area 15

Land Status 41

Quadrangle CAMP VERDE

Quadrangle 2 MIDDLE VERDE

Quad 250k HOLBROOK

Latitude 34-32-47N

Longitude 111-52-32W

Accuracy EST

UTM Northing 3822893.

UTM Zone +12

Section 1, 12, 13

Section Fraction 13N 4E

Township Range Meridian GILA AND SALT RIVER

Location Comments SEC. 1 - CAMP VERDE SALT MINE, GRAHAM-WINGFIELD SULPHATE SEC. 12 - GYPSUM BEDS

-- Commodity Information --

Commodity Type Non-metallic

Commodities GYP

Major GYP

Ore Materials GYPSUM

-- Geology --

Host Rock Type LAKE SEDIMENTS

Host Rock Age CEN

Host Rock Type Name Age Host Rock Unit Name Age

VERDE FORMATION CEN

-- Deposit Description --

Deposit Size Small

-- Individual Ore Bodies --
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**Development Status**

Occurrence

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**Reference**


PEIRCE, H.W., 1990, AZGS INDUSTRIAL MINERALS CARD FILE.

**Info Source**

12
### Location Information

- **Country**: UNITED STATES
- **State**: ARIZONA
- **County**: YAVAPAI
- **Physiographic Prov**: 11
- **Drainage Area**: 15
- **Quadrangle**: CAMP VERDE
- **Quad 250k**: HOLBROOK
- **Latitude**: 34-30-30N
- **Longitude**: 111-48-12W
- **Accuracy**: WITHIN 1/2 MILE
- **UTM Northing**: 3818618.
- **UTM Zone**: +12
- **Section**: 22
- **Section Fraction**: 13N 5E
- **Township**: GILA AND SALT RIVER
- **Range**: 13N
- **Meridian**: 5E

### Commodity Information

- **Commodity Type**: Non-metallic
- **Commodities**: GYP
- **Major**: GYP
- **Ore Materials**: GYPSUM

### Geology

- **Host Rock Age**: CEN
- **Host Rock Type Name**: VERDE FORMATION
- **Age**: CEN

### Deposit Description

- **Deposit Size**: Small
- **USGS Model Name**: LACUSTRINE GYPSUM
- **Model Number**: 35B. 4
- **Deposit Type**: LACUSTRINE SEDIMENTARY, EVAPORITE
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**Reference**


Reference

PIERCE, H.W., 1990, AZGS INDUSTRIAL MINERALS CARD FILE.

Info Source

12
Mineral Resources Data System (MRDS)

Record Number: TC10214
Report Type: Site
Reporter: BOLM, KAREN S.
Reporter Affiliation: USGS
Updater: ORRIS, GRETA J.
Updater Affiliation: USGS
Site Name: VERDE RIVER DEPOSIT

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: YAVAPAI
Physiographic Prov: 12 BASIN AND RANGE
Drainage Area: 15 LOWER COLORADO RIVER REGION
Quad 250k: HOLBROOK
Quad 24k: CAMP VERDE
Latitude: 34°31'05" N
Longitude: 111°49'40" W
Accuracy: ESTIMATED, WITHIN 0.5 MILES.
UTM Northing: 3819714.
UTM Zone: 12
Section: 16
Location Comments: DEPOSIT IS SOUTH OF CAMP VERDE IN THE VERDE VALLEY.

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: DIT GYP CLY
Major: DIT
Occurring: GYP CLY
Ore Materials: DIATOMITE, GYPSUM, CLAY
Non-Ore Materials: CALCITE

-- Geology --
Tectonic Setting: BASIN AND RANGE
Age Mineralization: MIO-PLIO
Host Rock Type: LACUSTRINE SEDIMENTS INCLUDING GYPSUM, CLAY, AND LIMESTONE
Host Rock Age: MIO-PLIO
Host Rock Type Name: VERDE FM
Age: MIO-PLIO

Page 1
-- Deposit Description --

-- Individual Ore Bodies --

**USGS Model Name**  LACUSTRINE DIATOMITE  
**Model Number**  31S  

**Deposit Type**  LACUSTRINE BIOGENIC, SEDIMENTARY  

**Depth to Top**  0  
**Units**  FT

**Deposit Desc Comm**  DIATOMITE IS INTERBEDDED WITH GYPSUM, CLAY, AND LIMESTONE.

-- Exploration and Development --

**Production Size**  No  
**Development Status**  Prospect, inactive

-- Description of Workings --

-- Reference --

**Reference**  PEIRCE, H.W., 1989. ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERALS CARD FILES.  

**Info Source**  1
Mineral Resources Data System (MRDS)

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Page 1
Record Number  TC35321  (...Continued)

Desc Workings  Surface

-- Reference --

Reference  ELEVATORSKI, E.A., 1978, ARIZONA INDUSTRIAL MINERALS, MINERAL REPORT NO. 2, ARIZONA DMR.
Reference  PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL FILES.
# Mineral Resources Data System (MRDS)

## Location Information
- **Country:** UNITED STATES
- **State:** ARIZONA
- **County:** COCONINC
- **Physiographic Prov:** 11 COLORADO PLATEAU
- **Administrative Area:** COCONINC NATIONAL FOREST
- **Quad 250k:** FLAGSTAFF
- **Quad 100k:** FLAGSTAFF
- **Quad 24k:** O'LEARY PEAK
- **Latitude:** 35.28-3CN
- **Longitude:** 111.31-22W
- **Accuracy:** ACC +/- 4 Mi

## Commodity Information
- **Type:** Non-metallic
- **Commodities:** VOL
- **Major:** VOL
- **Ore Materials:** PUMICE, CINDERS

## Deposit Description
- **Deposit Size:** Small

## Geology
- **Host Rock Type Name:** CINDER CONE
- **Age:** CEN

## Report Details
- **Record Number:** TC35324
- **Record Type:** Site
- **Report Date:** 92 10
- **Location Comments:** ON CEDAR RIDGE.

## Other Information
- **User Field:** *U95/05
- **File Link ID:** IMS, CIMRI
- **Report Date:** 10/1/92

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**Mineral Resources Data System (MRDS)**

### Location Information
- **Country**: UNITED STATES
- **State**: ARIZONA
- **County**: COCONINO
- Physiographic Prov: 11 COLORADO PLATEAU
- **Quad 250k**: FLAGSTAFF
- **Quad 100k**: FLAGSTAFF
- **Quad 24k**: O'LEARY PEAK
- **Latitude**: 35.28-42N
- **Longitude**: 111-32-30W
- **Accuracy**: ± 2 MI
- **UTM Northing**: 3926026.
- **UTM Zone**: +12
- **Section**: 9,10
- **Fraction**: 024N 008E
- **Meridian**: GILA AND SALT RIVER

### Commodity Information
- **Commodity Type**: Non-metallic
- **Commodities**: VOL
- **Major**: VOL
- **Ore Materials**: CINDERS
- Commod Comments: CINDERS ARE RED IN COLOR.

### Geology
- **Host Rock Type**: CINDER CONE

### Deposit Information
- **Deposit Size**: Small
- **Deposit Type**: VOLCANIC

**Production Size**: U
Record Number  TC35325  (...Continued)

Development Status  Prospect, Inactive

-- Description of Workings --

Desc Workings  Surface

-- Reference --


Reference  PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.

Page 2
CAMP VERDE GYPSUM

POSSIBLY DUPLICATE IN PART OR WHOLLY WITH LARSON QUARRY.

-- Location Information --

Country: UNITED STATES
State: ARIZONA
County: YAVAPAI
Quad 250k: HOLBROCK
Quad 24k: WALKER MTN. (?)
Latitude: 34-33-42N
Longitude: 111-44-50W
Accuracy: ESTIMATED LOCATION, PROBABLY WITHIN 2 MINUTES.

Section 014N 006E
Position: 5.5 MILES E OF CAMP VERDE ON STATE HIGHWAY 260.

-- Commodity Information --

Commodity Type: Non-metallic
Commodities: GYP
Major: GYP
Ore Materials: GYPSUM
Commod Subtypes: SUPPLIES GYPSUM TO PHOENIX CEMENT COMPANY PLANT AT CLARKDALE. ALSO USED FOR AGRICULTURE, IMPERVIOUS SEALING USES.

-- Geology --

Age Mineralization: CEN
Host Rock Type Name: LACustrine sediments
Age: CEN
Host Rock Unit Name: VERDE FM

-- Deposit Description --

Individual Ore Bodies:

Deposit Type: LACUSTRINE SEDIMENTARY, EVAPORITE
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--- Exploration and Development --

--- Description of Workings ---

Desc Workings | Surface |
Mineral Resources Data System (MRDS)

Report Title
Issue Date 00/00/00
Current Date Monday, April 7, 1997
Current Time 10:24:50

Record Number TC355580
Record Type Site
Reporter Name ORRIS, GRETA J.
Reporter Affiliation USGS

Current Date Monday, April 7, 1997

User Field *US4/11
File Link ID CIMRI, IMS

Number 21 of 103
Printed 21 of 103

--- Location Information ---
Country UNITED STATES
State ARIZONA
County YAVAPAI
Administrative Area PRESCOTT NATIONAL FOREST
Quad 250k HOLBROOK
Quad 100k SEDONA
Quad 24k CAMP VERDE (1969)

Latitude 34-32-42N
Longitude 111-52-25W

Section 01
Fraction 013N 004E

--- Commodity Information ---
Commodity Type Non-metallic
Commodities HAL NA ? GYP CLY
Major HAL NA ?
Occurring GYP CLY
Ore Materials HALITE, THENARDITE, MIRABILITE, GLAUBERITE, GYPSUM, CLAY
Commod Subtypes SALT FCR CATTLE FEED.

--- Geology ---
Regional Trends VERDE FAULT ZONE
Age Mineralization MIO?
Host Rock Type Name LACUSTRINE SEDIMENTS, EVAPORITES
Age MIO?
Host Rock Unit Name VERDE FM
Age CEN
Geology Comment THE VERDE FM CONSISTS OF AT LEAST 1600 FT OF SEDIMENTS THAT ACCUMULATED IN A BASIN FORMED DURING THE OLIGOCENE, POSSIBLY AS A RESULT OF MOVEMENT ALONG THE VERDE FAULT
ZONE. DURING THE MIocene, THE DRAINAGE THROUGH THE SOUTH END OF THE BASIN WAS BLOCKED
BY VOLCANICS RESULTING IN A CLOSED BASIN WHERE A SALINE-ALKALINE LAKE FORMED. THE
EVAPORITES WERE EXPOSED WHEN THE VERDE RIVER BREACHED THE VOLCANICS DURING THE
PLEISTOCENE.

Deposit Type
LAGUSTRINE EVAPORITE
Thickness
46. FT

Deposit Desc Comm
THE EVAPORITE SEQUENCE WHICH CONSISTS OF HALITE, MIRABLITE AND GLAUBERITE IS AS MUCH AS
46 FT THICK AT THIS SITE. THE SEQUENCE GRADES INTO GYPSUM AND HALITE IN THE DEEPER PART OF
THE BASIN SOUTHEAST OF CAMP VERDE.

Production Size
Small
Year 1st Production
PRE-COLUMBIAN
Production Years
PRE-COLUMBIAN, 1920'S-1933
Development Status
Developed, Producer, Inactive
Expl/Dev Comments
THIS DEPOSIT HAS BEEN KNOWN FOR 2000 YEARS AND MAY BE THE OLDEST MINE IN ARIZONA.
EVIDENCE OF PRE-COLUMBIAN ACTIVITY, INCLUDING ARTIFACTS AND THE REMAINS OF A MINER, WERE
DISCOVERED WHEN THE MINE WAS OPERATED DURING THE 1920'S. THE MINE IS BELIEVED TO HAVE
BEEN VISITED BY EXPLORERS ANTONIO DE ESPEJO IN 1583 AND MARCOS FARFAN DE LOS GODOS IN
1598. WESTERN CHEMICAL CO. BEGAN SURFACE MINING OPERATIONS DURING THE 1920'S AND WAS
ACQUIRED BY THE ARIZONA CHEMICAL CORPORATION IN THE 1930'S. EXPLORATION BY STAUffer
CHEMICAL CO IN THE 1960'S.

Development M$
HYDROLOGIC UNIT CO

Desc Workings
Surface and Underground

Workings Comments
WORK IN THE 1920'S WAS BY SURFACE METHODS. IN THE 1930'S, AMERICAN CHEMICAL CORPORATION
BEGAN MINING BY ROOM AND PILLAR.

General Comm
THIS RECORD CONTAINS DATA FROM DUPLICATE RECORD TC38872 WHICH HAS BEEN DELETED FROM
MRDS.

Reference
RESOURCES REPORT 4, 185 P.

Reference
EYDE, TED, WILKINSON, P.A.K., AND WEILAND, E.F., 1986, FIELD TRIP TO SELECTED INDUSTRIAL MINERAL
DEPOSITS OF ARIZONA, IN BEATTY, BARBARA, AND WILKINSON, P.A.K., EDS., FRONTIERS IN GEOLoGY AND
ORE DEPOSITS OF ARIZONA AND THE SOUTHWEST: ARIZONA GEOLOGICAL SOCIETY DIGEST, V. XVI, P.
312-318.
Mineral Resources Data System (MRDS)

Report Title

Issue Date 00/00/00

Current Date Monday, April 7, 1997

Current Time 10:24:50

Number 22 of 103

Printed 22 of 103

Record Number TC10262

Record Type Site

Reporter CARBONARO, MARGUERITE

Reporter Affiliation USGS

Updater ORRIS, GRETA J.

Updater Affiliation USGS

Site Name CLARKDALE CLAY QUARRY

Synonym Name LAKEBED

-- Location Information --

Country UNITED STATES

State ARIZONA

County YAVAPAI

Quad 250k PRESCOTT

Quad 62.5k CLARKDALE

Latitude 34-46-1 ON

Longitude 11 2- 06- 30V/

Accuracy EST

UTM Northing 3847838.

UTM Zone +12

Section 18

Section Fraction NORTH OF CLARKDALE, AZ.

Position 016N 003E GILA AND SALT RIVER

-- Commodity Information --

Commodity Type Non-metallic

Commodities CLY7 SHL

Major CLY7 SHL

Ore Materials CLAY SHALE

Commod Subtypes CLAY USED IN PORTLAND CEMENT AND BRICK PRODUCTION.

-- Geology --

Host Rock Type SHALE

Host Rock Age CEN

Host Rock Type Name SHALE

Age CEN

Host Rock Unit Name VERDE FORMATION

Age CEN

-- Deposit Description --

-- Individual Ore Bodies--

Deposit Type SEDIMENTARY

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**-- Description of Workings --**

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- PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERALS CARD FILE.
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<td>USGS</td>
<td>Report Date</td>
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-- Location Information --

-- Commodity Information --

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<tr>
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<td>Major</td>
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-- Geology --

-- Deposit Description --

-- Exploration and Development --

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<tr>
<th>Production Size</th>
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<tr>
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-- Description of Workings --

-- Reference --
## Minerl Resources Data System (MRDS)

**Report Title**

**Issue Date** 00/00/00

**Current Date** Monday, April 7, 1997

**Current Time** 10:24:50

**Number** 24 of 103

---

**Record Number** TC35793

**Record Type** Site

**Reporter** ORRIS, GRETA J.

**Reporter Affiliation** USGS

**Editor Name** ORRIS, GRETA J.

**Type Affiliation Date** R USGS 3/1/93

**Location** CINDER F.T.

---

### Location Information

**Country** UNITED STATES

**State** ARIZONA

**County** COCONINC

**Administrative Area** COCONINC NATIONAL FOREST

**Quad 250k** FLAGSTAFF

**Quad 100k** FLAGSTAFF

**Quad 24k** WINONA (1974)

**Latitude** 35-11-4 CN

**Longitude** 111-24-25 W

**Decimal Lat** 35.19444

**Decimal Long** -111.40722

### Section Details

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<td>23; 14</td>
<td>NW OF NE; SW OF SE</td>
<td>02N</td>
<td>009E</td>
<td>GILA AND SALT RIVER</td>
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**Location Comments** LAT-LONG IS FOR THE SOUTHERNMOST PIT.

---

### Commodity Information

**Commodity Type** Non-metallic

**Commodities** VOL

**Major Commodities** VOL

**Ore Materials** CINDER

---

### Geology

**Host Rock Type Name** VOLCANICS

**Age**

**Host Rock Unit Name**

**Age**

---

### Deposit Description

**Deposit Type** VOLCANIC

---

### Exploration and Development

**Production Size** Small

---

Page 1
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<td>PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERALS CARD FILES.</td>
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Page 2
Mineral Resources Data System (MRDS)

TC35416
Site
ORRIS, GRETA J.
USGS
WILDCAT HILL PIT
UNITED STATES
ARIZONA
COCONINO
11
41
COCOCONINO NATIONAL FOREST
FLAGSTAFF
FLAGSTAFF EAST
35-13-19N
111-32-52W
35.22194
-111.54777
ACC
021N
008E
GILA AND SALT RIVER
VOL STN1
VOLCANIC CINDER
USED FOR AGGREGATE
VOLCANIC

PEIRCE GIVES LOCATION AS SECTION 7.

-- Commodity Information --

Non-metallic
VOL STN1
VOL STN1
VOLCANIC CINDER

-- Geology --

-- Deposit Description --

--Individual Ore Bodies--

VOLCANIC
Record Number  TC35416  (....Continued)

--- Exploration and Development ---

Production Size  Yes

Development Status  Developed Producer, Active

Owner  FLAGSTAFF CINDER SALES INC.

Development M$  HYDROLOGIC UNIT CO

--- Description of Workings ---

Desc Workings  Surface

General Comm  THIS RECORD CONTAINS DATA FROM DUPLICATE RECORD TC35323 WHICH HAS BEEN DELETED FROM MRDS.

--- Reference ---


Reference  PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERALS CARD FILE.


Page 2
Mineral Resources Data System (MRDS)

-- Location Information --

Country: UNITED STATES
State: ARIZONA
County: COCONINO
Physiographic Prov: 11
Quad 250k: FLAGSTAFF
Quad 100k: FLAGSTAFF
Quad 24k: SUNSET CRATER WEST
Latitude: 35-21-35N
Longitude: 111-34-57W
Accuracy: EST
UTM Northing: 3912993
UTM Zone: +12

Section: 19
Section Fraction: 023N
Township: 008E
Range: Meridian:

Location Comments: THERE ARE AT LEAST 3 PUMICE PITS IN THIS SECTION.

-- Commodity Information --

Commodity Type: Non-metallic
Commodities: PUM VOL
Major: PUM VOL
Ore Materials: PUMICE, PUMICEOUS VOLCANIC ASH
Commmod Subtypes: FOR POZZOLANIC PUMICE AND LIGHTWEIGHT REDIMIX; ALSO BLOCK PUMICE FOR STONEWASHING.

-- Geology --

-- Deposit Description --

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<tr>
<td>Owner</td>
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<td>-- Exploration and Development --</td>
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Reference

Reference
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<th>Current Date Monday, April 7, 1997</th>
<th>Current Time 10:24:50</th>
<th>Number 27 of 103</th>
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<td><strong>Site Name</strong></td>
<td>MORE SAND AND MOON SAND</td>
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<td>COCONINC NATIONAL FOREST</td>
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<td><strong>Land Status</strong></td>
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<td><strong>Quad 250k</strong></td>
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<td><strong>Quad 100k</strong></td>
<td>FLAGSTAFF</td>
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<td><strong>Quad 24k</strong></td>
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<td>13, 14, 23, 24</td>
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--- Commodity Information ---

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<tbody>
<tr>
<td><strong>Commodities</strong></td>
<td>PUM VOL</td>
</tr>
<tr>
<td><strong>Major</strong></td>
<td>PUM VOL</td>
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<tr>
<td><strong>Ore Materials</strong></td>
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--- Geology ---

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<td><strong>Host Rock Age</strong></td>
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Page 1
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<th><strong>Deposit Desc Comm</strong></th>
<th>PUMICE FRAGMENTS ARE COARSE TO FINE, ANGULAR TO ROUNDED, BEDDED OR UNSORTED, AND LOOSELY CONSOLIDATED. THE DEPOSITS ARE UP TO 200 FT THICK.</th>
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<td><strong>Desc Workings</strong></td>
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Mineral Resources Data System (MRDS)

Report Title
Issue Date 00/00/00
Current Date Monday, April 7, 1997
Current Time 10:24:50
Number 28 of 103
Printed 28 of 103

Record Number TC35408
Record Type Site
Reporter ORRIS, GRETA J.
Reporter Affiliation USGS

Editor Name ORRIS, GRETA J.
Type R
Affiliation USGS
Date 10/1/92
Comments

Editor Name ORRIS, GRETA J.
Type U
Affiliation USGS
Date 5/1/95

Site Name DARLING CINDER PIT

-- Location Information --
Country UNITED STATES
State ARIZONA
County COCONINO
Physiographic Prov 11
Land Status 41
Administrative Area CCOCISCO NATIONAL FOREST
Quad 250k FLAGSTAFF
Quad 100k FLAGSTAFF
Quad 24k WINONA (1974)
Latitude 35-13-35N
Longitude 111-24-34W
Accuracy ACC

Section 02,11
Section Fraction 021N
Township 009E
Range GILA AND SALT RIVER
Meridian

Position E OF FLAGSTAFF ON CINDER MOUNTAIN.

-- Commodity Information --
Commodity Type Non-metallic
Commodities VOL
Major VOL
Ore Materials VOLCANIC CINDERS
Commod Subtypes USED TO MAKE BUILDING BLOCKS, AGGREGATE, BALAST.

-- Geology --
Host Rock Type Name VOLCANIC ROCKS
Age
Host Rock Unit Name
Age

-- Deposit Description --
-- Individual Ore Bodies --
Record Number: TC35408

Deposit Type: VOLCANIC

Production Size: Yes

Development Status: Intermittent Producer

Owner: SUPERLITE BLOCK COMPANY (1994)

Operator: SUPERLITE BLOCK COMPANY (1994)

Development M$: Mill MS

Economic Comments: BLOCK PLANTS IN PHOENIX AND TEMPE.

-- Description of Workings --

Desc Workings: Surface

General Comm: THIS RECORD CONTAINS DATA FROM DUPLICATE RECORD TC35322 WHICH HAS BEEN DELETED FROM MRDS.

-- Reference --


Reference: PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.

# Mineral Resources Data System (MRDS)

**Record Number**: TC35407  
**Record Type**: Site  
**Reporter**: ORRIS, GRETA J.  
**Reporter Affiliation**: USGS  
**Site Name**: CROWN CLAIMS

---

## Location Information

- **Country**: UNITED STATES  
- **State**: ARIZONA  
- **County**: COCONINO  
- **Physiographic Prov**: 11  
- **Land Status**: 41

**Administrative Area**: COCONINO NATIONAL FOREST  
**Quad 250k**: FLAGSTAFF  
**Quad 100k**: FLAGSTAFF  
**Quad 24k**: O'LEARY PEAK (1983)

- **Latitude**: 35-23-58N  
- **Longitude**: 111-36-33W

**Accuracy**: EST, MAY BE 5 MILES OFF.

**Section**: 01?  
**Section Fraction**: ABOUT 12 MILES N OF FLAGSTAFF.

**Township Range Meridian**: 023N 007E GILA AND SALT RIVER

---

## Commodity Information

- **Commodity Type**: Non-metallic  
- **Commodities**: PUM  
- **Major**: PUM  
- **Ore Materials**: PUMICE

**Commod Subtypes**: POZZOLANIC PUMICE FOR LIGHTWEIGHT REDIMIX; BLOCK MATERIAL FOR "STONE WASHING".

---

## Geology

<table>
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## Exploration and Development

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<td>Operator</td>
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--- Description of Workings ---

-- Reference --

**Reference**
**Mineral Resources Data System (MRDS)**

**Report Title**

**Issue Date** 00/00/00

**Current Date** Monday, April 7, 1997

**Current Time** 10:24:50

**Number** 30 of 103

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<td><strong>Site Name</strong></td>
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<td><strong>Meridian</strong></td>
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<td><strong>Location Comments</strong></td>
<td>CEMENT PLANT AT T16N, R3E, N1W/4 SEC. 19. LAT-LONG GIVEN ABOVE IS FOR CENTER OF A LARGE QUARRY IN SW/4 OF SEC. 11.</td>
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<td><strong>Major</strong></td>
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<td><strong>Ore Materials</strong></td>
<td>CEMENT ROCK, LIMESTONE</td>
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<td><strong>Commmod Subtypes</strong></td>
<td>CEMENT, SUGAR REFINING, OTHER</td>
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<td>TRANSITION ZONE</td>
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<td><strong>Age Mineralization</strong></td>
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<td>MISS DEV</td>
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---

*Page 1*
### Host Rock Type Name
- **LIMESTONE**
- **LIMESTONE**

### Age
- **MISS**
- **DEV**

### Host Rock Unit Name
- **REDWALL LIMESTONE**
- **MARTIN FM**

### Age
- **MISS**
- **DEV**

---

### Deposit Description

- **THE LIMESTONE IS MASSIVELY BEDDED, OFTEN CHERRY, GRAY AND COARSELY CRYSTALLINE ROCK WITH FEW IMPURITIES.**

---

### Production Size
- **Yes**

### Development Status
- **Developed Producer, Active**

### Operator
- **PHOENIX CEMENT CO. (A GIFFORD-HILL COMPANY)**

### Expansion M$ Mill Capacity
- **$**
- **630,000 TPA.**

### Economic Comments

- FOR CLARKDALE CEMENT PLANT, USE IN SUGAR REFINING, BUILDING INDUSTRY; MARKETED IN ARIZONA, NEW MEXICO, AND UTAH; 107 EMPLOYEES. MILL CAPACITY 630,000 TPA.

---

### Description of Workings

- **ACTIVE QUARRY**

---

### General Comments

- **THIS RECORD CONTAINS DATA FROM DUPLICATE RECORD TC10700 OF K.S. BOLM WHICH HAS BEEN DELETED FROM MAIN MRDS.**

---

### Reference

- **ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES, 1988, DIRECTORY OF ACTIVE MINES IN ARIZONA; INCORPORATING SAND AND GRAVEL OPERATIONS: DEPARTMENT OF MINES AND MINERAL RESOURCES, 13 P.**

- **PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERALS CARD FILE.**


---

### Info Source
- **12**

---

### Annual Production

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<th>Th Units</th>
<th>Year</th>
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<td>550</td>
<td>TON</td>
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**Prod Comments**

ANNUAL CAPACITY OF 0.55 MILLION TONS OF CEMENT.
Mineral Resources Data System (MRDS)

Record Number: 1001572
Record Type: Site
Reporter: ORRIS, GRETA J.
Updater: CARBONARO, MARGUERITE M.

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: YAVAPAI
Physiographic Prov: 12 BASIN AND RANGE
Drainage Area: 15 LOWER COLORADO
Land Status: 41
Administrative Area: CCCONINC NATIONAL FOREST
Quad 250k: HOLBROOK
Quad 100k: SEDONA
Quad 24k: CAMP VERDE
Latitude: 34°31'05"N
Longitude: 111°48'35"W
Accuracy: ACC +/- 1 MILE
UTM Northing: 3819701
UTM Zone: +12
Section: 15

Location Comments: LAT-LONG IS FOR CENTER OF SEC. 15.

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: BRI HAL NA ?
Major: BRI HAL
Occurring: NA ?
Ore Materials: BRINE, SODIUM SULFATES
Analytical Data: BRINE CONTAINS 90,300 PPM DISSOLVED SOLIDS, LARGELY SODIUM AND CHLORIDE.
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-- Exploration and Development --
Record Number  TC38480  (....Continued)

Production Size  Small
Development Status  Little Developed Producer, Inactive

-- Description of Workings --

Desc Workings  Surface

-- Reference --

Reference  PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.

Page 2
Mineral Resources Data System (MRDS)

Report Title

Issue Date 00/00/00

Current Date Monday, April 7, 1997

Current Time 10:24:50

Number 33 of 103

Printed 33 of 103

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Section 15

Section Fraction SE OF SE

Township 22N

Range 004E

Meridian GILA AND SALT RIVER

Position 1.5 MI N OF PARKS.

-- Commodity Information --

Commodity Type Non-metallic

Commodities VOL

Major VOL

Ore Materials CINDER

-- Geology --

-- Deposit Description --

---Individual Ore Bodies---

Deposit Type VOLCANIC

-- Exploration and Development --

Production Size Small
Record Number: TC36496 (Continued)

Developent Status: Little Developed Producer, Inactive

-- Description of Workings --

Desc Workings: Surface

-- Reference --


Reference: PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.

Page 2
Mineral Resources Data System (MRDS)

Record Number: TC38481
User Field: *93/6

Report Title
Current Date: Monday, April 7, 1997
Current Time: 10:24:50
Number 34 of 103
Printed 34 of 103

Record Type: Site
File Link ID: CIMRI, IMS

Reporter: ORRIS, GRETA J.
Reporter Affiliation: USGS
Site Name: STONEMAN LAKE NO. 1 CINDER PIT

Country: UNITED STATES
State: ARIZONA
County: COCONINO
Physiographic Prov: 11 COLORADO PLATEAU
Drainage Area: 15 LOWER COLORADO
Land Status: 41
Administrative Area: COCONINO NATIONAL FOREST
Quad 250k: HOLBROCK
Quad 100k: SEDONA
Quad 24k: STONEMAN LAKE (1965)
Elevation: 6460 FT
Latitude: 34-45-49N
Longitude: 111-32-27W
Accuracy: ACC

Section: 19
Section Fraction: NW OF NE
Township: 16N
Range: 008E
Meridian: GILA AND SALT RIVER
Position: ABOUT 1.5 Ml SW OF STONEMAN LAKE.
Location Comments: ABOUT 0.6 Ml E OF COCONINO-YAVAPAI COUNTY BOUNDARY.

Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: CINDER

-- Geology --

-- Deposit Description --

Deposit Type: VOLCANIC

-- Exploration and Development --
Record Number: TC38481

Production Size: Small
Development Status: Little Developed Producer, Inactive

--- Description of Workings ---

Desc Workings: Surface

--- Reference ---


Reference: PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.

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Mineral Resources Data System (MRDS)

Report Title
Issue Date 00/00/00

Current Date Monday, April 7, 1997
Current Time 10:24:50

Number 35 of 103
Printed 35 of 103

Record Number TC38482
Record Type Site
Reporter ORRIS, GRETA J.
Reporter Affiliation USGS

Site Name SUNSET CRATER EAST NO. 4 CINDER PIT

Country UNITED STATES
State ARIZONA
County COCONINO
Physiographic Prov 11 COLORADO PLATEAU
Drainage Area 15 LOWER COLORADO
Land Status 41
Administrative Area COCONINO NATIONAL FOREST
Quad 250k FLAGSTAFF
Quad 100k FLAGSTAFF
Quad 24k SUNSET CRATER EAST (1959)
Elevation 6970 FT
Latitude 35-21-13N
Longitude 111-29-05W
Accuracy ACC

Section Section Fraction Township Range Meridian
30 NW OF NW 23N 009E GILA AND SALT RIVER

Position ABOUT 1 MI SE OF SUNSET CRATER.

Commodity Type Non-metallic
Commodities VOL
Major VOL
Ore Materials CINDER

Deposit Type VOLCANIC

Production Size Small
Record Number: TC38482

Developent Status: Little Developed Producer, Inactive

Desc Workings: Surface

Reference:

PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.
Record Number: TC38483
Record Type: Site
Reporter: ORRIS, GRETA J.
Report Date: 93 04
Site Name: SUNSET CRATER EAST NO. 3 CINDER PIT

Location Information:
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Physiographic Prov: 11 COLORADO PLATEAU
Drainage Area: 15 LOWER COLORADO
Land Status: 41
Administrative Area: COCONINO NATIONAL FOREST
Quad 250k: FLAGSTAFF
Quad 100k: FLAGSTAFF
Quad 24k: SUNSET CRATER EAST (1969)
Elevation: 6375 FT
Latitude: 35-16-29N
Longitude: 111-22-45W
Accuracy: ACC

Section: 19
Section Fraction: SW OF SW
Township: 22N
Range: 010E
Meridian: GILA AND SALT RIVER

Position: ABOUT 5 MI SE OF SUNSET CRATER.
Location Comments: NEAR THE SOUTHERN BASE OF COCHRANE HILL.

Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: CINDER

Deposit Type: VOLCANIC

--- Commodity Information ---

--- Geology ---

--- Deposit Description ---

--- Individual Ore Bodies ---

--- Exploration and Development ---
Record Number | TC38483  
---|---
Production Size | Small  
Development Status | Little Developed Producer, Inactive  

-- Description of Workings --

Desc Workings | Surface  

-- Reference --
Reference | PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.
### Mineral Resources Data System (MRDS)

**Record Number**: TC36499

**User Field**: "93/6

**Record Type**: Site

**File Link ID**: CIMRI, IMS

**Reporter**: ORRIS, GRETA J.

**Reporter Affiliation**: USGS

**Site Name**: WHITE HORSE HILLS NO. 1 CINDER PIT

---

**Location Information**

**Country**: UNITED STATES

**Country Code**: US

**State**: ARIZONA

**State Code**: AZ

**County**: COCONINO

**Physiographic Prov**: 11 COLORADO PLATEAU

**Drainage Area**: 15 LOWER COLORADO

**Land Status**: 41

**Administrative Area**: COCONINO NATIONAL FOREST

**Quad 250k**: FLAGSTAFF

**Quad 100k**: FLAGSTAFF

**Quad 24k**: WHITE HORSE HILLS (1974)

**Elevation**: 8060 FT

**Latitude**: 35-25-39N

**Decimal Lat**: 35.4275

**Longitude**: 111-44-40W

**Decimal Long**: -111.74444

**Accuracy**: ACC

---

**Commodity Type**: Non-metallic

**Commodities**: VOL

**Major**: VOL

**Ore Materials**: CINDER

---

**Geology**

**Deposit Description**

**Individual Cre Bodies**

**Deposit Type**: VOLCANIC

---

**Exploration and Development**

**Production Size**: Small

**Development Status**: Little Developed Producer, Inactive
Record Number: TC36499

Description of Workings:

Surface

Reference:


PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.
Mineral Resources Data System (MRDS)

Report Title

Record Number TC36500
Record Type Site
Reporter ORRIS, GRETA J.
Reporter Affiliation USGS

Current Date Monday, April 7, 1997
Current Time 10:24:50

Country UNITED STATES
State ARIZONA
County COCONINO
Physiographic Prov 11 COLORADO PLATEAU
Drainage Area 15 LOWER COLORADO
Land Status 40
Administrative Area COCONINC NATIONAL FOREST
Quad 250k FLAGSTAFF
Quad 100k FLAGSTAFF
Quad 24k SUNSET CRATER WEST (1983)
Lat 35-21-35N
Lon 111-34-57W
Accuracy ACC +/- 0.5 MI

-- Location Information --
Position ABOUT 4.5 MI W OF SUNSET CRATER.
Location Comments THERE ARE 3 PUMICE PITS IN SEC. 19. LAT-LONG IS FOR PIT IN SW/4 OF SE/4.

-- Commodity Information --
Commodity Type Non-metallic
Commodities PUM
Major PUM
Ore Materials PUMICE
Commod Subtypes USED FOR POZZOLAN IN THE CONSTRUCTION OF THE GLEN CANYON DAM.

-- Geology --
Age Mineralization MIO-PLIO
Host Rock Type Name RHYOLITIC PUMICE
Age MIO-PLIO

Page 1
Record Number  TC36500  

**Deposit Description**

- Individual Cre Bodies

**Deposit Type**  VOLCANIC

**Thickness**  200.  

**Units**  FT

**Deposit Desc Comm**  PUMICE FRAGMENTS ARE COARSE TO FINE, Angular TO ROUNDED, BEDDED OR UNSORTED, AND LOOSELY CONSOLIDATED. THE DEPOSITS ARE UP TO 200 FT THICK.

**Production Size**  Small

**Development Status**  Developed Producer, Inactive

**Development MS**  HYDROLOGY UNIT CO

**Desc Workings**  Surface

**General Comm**  THIS RECORD INCLUDES DATA FROM DUPLICATE RECORD TC35342 WHICH HAS BEEN DELETED FROM MRDS.

**Reference**  PHILLIPS, K.A., 1987, ARIZONA INDUSTRIAL MINERALS. ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES REPORT 4, 185 P.

**Reference**  PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.
## Mineral Resources Data System (MRDS)

### Record Information
- **Record Number**: TC38484
- **User Field**: *93/6
- **Sampler**: USGS
- **Report Type**: Site
- **Reporter**: ORRIS, GRETA J.
- **Reporter Affiliation**: USGS
- **Report Date**: 93 04
- **Site Name**: SUNSET CRATER EAST NO. 2 CINDER PIT

### Location Information
- **Country**: UNITED STATES
- **State**: ARIZONA
- **County**: COCONINC
- **Physiographic Prov**: 11 COLORADO PLATEAU
- **Drainage Area**: 15 LOWER COLORADO
- **Land Status**: 41
- **Administrative Area**: COCONINC NATIONAL FOREST
- **Quad 250k**: FLAGSTAFF
- **Quad 100k**: FLAGSTAFF
- **Quad 24k**: SUNSET CRATER EAST (1969)
- **Elevation**: 6550 FT
- **Latitude**: 35-15-40N
- **Longitude**: 111-28-29W
- **Accuracy**: ACC

### Geographical Coordinates
- **Decimal Lat**: 35.26111
- **Decimal Long**: -111.47472

### Section Information
- **Section**: 29
- **Section Fraction**: SW OF NW
- **Township**: 22N
- **Range**: 009E
- **Meridian**: GILA AND SALT RIVER

### Location Comments
- ABOUT 7 Ml S OF SUNSET CRATER.
- ABOUT 0.5 Ml NW OF O'NEILL CRATER.

### Commodity Information
- **Commodity Type**: Non-metallic
- **Commodities**: VOL
- **Major**: VOL
- **Ore Materials**: CINDER

### Exploration and Development
- **Deposit Type**: VOLCANIC
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--- Description of Workings ---

**Desc Workings**
- Surface

--- Reference ---

**Reference**
- PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.
Mineral Resources Data System (MRDS)

Record Number: TC38485
User Field: *93/6

Record Type: Site
File Link ID: CIMRI, IMS

Reporter: ORRIS, GRETA J.

Reporter Affiliation: USGS

Site Name: SUNSET CRATER EAST NO. 1 CINDER PIT

-- Location Information --

Country: UNITED STATES
State: ARIZONA
County: COCONINC
Physiographic Prov: 11 COLORADO PLATEAU
Drainage Area: 15 LOWER COLORADO
Land Status: 41
Administrative Area: COCONINC NATIONAL FOREST
Quad 250k: FLAGSTAFF
Quad 100k: FLAGSTAFF
Quad 24k: SUNSET CRATER EAST (1969)
Elevation: 6240 FT
Latitude: 35-15-25N
Longitude: 111-23-53W
Accuracy: ACC

Section: 25
Section Fraction: W2 OF SW
Township: 22N
Range: 009E
Meridian: GILA AND SALT RIVER

Position: ABOUT 10.5 MI SE OF SUNSET CRATER.

-- Commodity Information --

Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: CINDER

-- Geology --

-- Deposit Description --

Deposit Type: VOLCANIC

-- Exploration and Development --

Production Size: Small

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# Mineral Resources Data System (MRDS)

**Record Number**: TC36486  
**Record Type**: Site  
**Report Type**: MPR  
**Reporter**: ORRIS, GRETA J.  
**Reporter Affiliation**: USGS  
**Site Name**: DUTTON HILL NO. 1 CINDER PIT  
**User Field**: "93/6"  
**File Link ID**: CIMRI, IMS  
**Report Date**: 93 04  
**Country**: UNITED STATES  
**State**: ARIZONA  
**Physiographic Prov**: COCONINO  
**County**: COCONINO  
**Drainage Area**: COLORADO PLATEAU  
**Land Status**: 41  
**Administrative Area**: COCONINO NATIONAL FOREST  
**Quad 250k**: FLAGSTAFF  
**Quad 100k**: FLAGSTAFF  
**Quad 24k**: DUTTON HILL (1980)  
**Elevation**: 7260 FT  
**Latitude**: 35-05-05N  
**Longitude**: 111-49-08W  
**Accuracy**: ACC  

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**Commodity Type**: Non-metallic  
**Commodities**: VOL  
**Major**: VOL  
**Ore Materials**: CINDER  

**Geology**  
**Deposit Description**  
** Individual Ore Bodies**  
**Deposit Type**: VOLCANIC  

**Production Size**: Small

---

Page 1
Record Number: TC38486 (....Continued)

Development Status: Little Developed Producer, Inactive

-- Description of Workings --

Desc Workings: Surface

-- Reference --


Reference: PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.
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- **Desc Workings**: Surface

--- Reference ---

- **Reference**: PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILE.
## Mineral Resources Data System (MRDS)

**Record Number:** TC38488  
**User Field:** '93/6  
**File Link ID:** CIMRI, IMS  
**Report Date:** 93 04  
**Country:** UNITED STATES  
**Country Code:** US  
**State:** ARIZONA  
**State Code:** AZ  
**County:** COCONINCG  
**Physiographic Prov:** 11 COLORADO PLATEAU  
**Drainage Area:** 15 LOWER COLORADO  
**Land Status:** 41  
**Administrative Area:** COCONINCG NATIONAL FOREST  
**Quad 250k:** FLAGSTAFF  
**Quad 100k:** FLAGSTAFF  
**Quad 24k:** FLAGSTAFF WEST (1983)  
**Elevation:** 7180 FT  
**Latitude:** 35-09-42N  
**Longitude:** 111-43-15W  
**Accuracy:** ACC  

### Location Information

- **Section:** 35  
- **Section Fraction:** SE OF NE  
- **Township:** 21N  
- **Range:** 006E  
- **Meridian:** GILA AND SALT RIVER  
- **Position:** ABOUT 3.75 MI SW OF FLAGSTAFF.  

### Commodity Information

- **Commodity Type:** Non-metallic  
- **Commodities:** VOL  
- **Major:** VOL  
- **Ore Materials:** CINDER  

### Geology

- **Deposit Type:** VOLCANIC  
- **Geology:** --  

### Exploration and Development

- **Production Size:** Small  
- **Deposit Description:** --  

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Page 1
Record Number: TC38488  (Continued)

Development Status: Little Developed Producer, Inactive

Description of Workings:
- Surface

Reference:
- PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILE.
### Mineral Resources Data System (MRDS)

**Report Title**

**Issue Date** 00/00/00

**Current Date** Monday, April 7, 1997

**Current Time** 10:24:50

**Record Number** TC36889

**Record Type** Site

**Reporter** ORRIS, GRETA J.

**Reporter Affiliation** USGS

**Site Name** SEDGE SPRING CINDER PIT

---

**Country** UNITED STATES

**State** ARIZONA

**County** COCONINO

**Physiographic Prov** 11 COLORADO PLATEAU

**Drainage Area** 15 LOWER COLORADO

**Land Status** 41

**Administrative Area** COCONINO NATIONAL FOREST

**Quad 250k** HOLBROOK

**Quad 100k** SEDONA

**Quad 24k** MORMON LAKE (1974)

**Elevation** 7240 FT

**Latitude** 34-54-13N

**Longitude** 111-25-37W

**Accuracy** ACC

---

**Section** 34

**Section Fraction** NW OF NE

**Township** 18N

**Range** 009E

**Meridian** GILA AND SALT RIVER

**Position** ABOUT 2 MI SSE OF MORMON LAKE, AZ.

---

**Commodity Type** Non-metallic

**Commodities** VOL

**Major** VOL

**Ore Materials** CINDER

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**Deposit Type** VOLCANIC

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**Production Size** Small
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--- Location Information ---

--- Commodity Information ---

--- Geology ---

--- Deposit Description ---

--- Individual Ore Bodies---

--- Exploration and Development ---
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*Page 2*
Mineral Resources Data System (MRDS)

Record Number TC36891
Record Type Site
Reporter ORRIS, GRETA J.
Reporter Affiliation USGS
Site Name KENDRICK PEAK NO. 2 CINDER PIT

-- Location Information --
Country UNITED STATES
State ARIZONA
County COCONINO
Physiographic Prov 11 COLORADO PLATEAU
Drainage Area 15 LOWER COLORADO
Quad 250k FLAGSTAFF
Quad 100k FLAGSTAFF
Quad 24k KENDRICK PEAK (1966)
Land Status 41
Administrative Area COCONINO NATIONAL FOREST
Elevation 7320 FT
Latitude 35-29-45N
Longitude 111-48-27W
Accuracy ACC

Section 6
Section Fraction NW OF NW
Township 24N
Range 006E
Meridian GILA AND SALT RIVER

Location Comments 2 MILE E OF THE PEAK OF SLATE MOUNTAIN. ON SW FLANK OF A SMALL HILL.

-- Commodity Information --
Commodity Type Non-metallic
Commodities VOL
Major VOL
Ore Materials CINDER

-- Geology --

-- Deposit Description --
-- Individual Ore Bodies--
Deposit Type VOLCANIC

-- Exploration and Development --
Production Size Small

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--- Description of Workings ---

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Reference: PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILE.
**Mineral Resources Data System (MRDS)**

**Report Title**

**Issue Date** 00/00/00

**Current Date** Monday, April 7, 1997

**Current Time** 10:24:50

**Number** 47 of 103

**Printed** 47 of 103

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**Location Information**

- **Country**: UNITED STATES
- **State**: ARIZONA
- **County**: COCONINO
- Physiographic Prov: 11 COLORADO PLATEAU
- Drainage Area: 15 LOWER COLORADO
- Land Status: 41
- Administrative Area: COCONINO NATIONAL FOREST
- Quadrangle 250k: FLAGSTAFF
- Quadrangle 100k: FLAGSTAFF
- Quadrangle 24k: KENDRICK PEAK (1986)
- Elevation: 8040 FT
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- Accuracy: ACC

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**Location Comments**: ABOUT 4 MI ESE OF KENDRICK PEAK.

---

**Commodity Information**

- **Commodity Type**: Non-metallic
- **Commodities**: VOL
- **Major**: VOL
- **Ore Materials**: CINDER

---

**Geology**

---

**Deposit Description**

---

**Individual Ore Bodies**

---

**Deposit Type**: VOLCANIC

---

**Exploration and Development**

---

**Production Size**: Small
Record Number  TC36892  (....Continued)

Development Status  Little Developed Producer, Inactive

-- Description of Workings --

Desc Workings  Surface

-- Reference --

Reference  PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILE.

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Position: ABOUT 4 MI E OF FLAGSTAFF.

Location Comments: AT SW BASE OF TURKEY HILLS.

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Deposit Type: VOLCANIC

--- Exploration and Development ---
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**Desc Workings**

Surface

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**Reference**


Reference

PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILE.
Mineral Resources Data System (MRDS)

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-- Individual Ore Bodies--

Deposit Type VOLCANIC

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**Desc Workings**

Surface

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**Reference**


PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILE.
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**Geology**

**Deposit Description**

| Deposit Type | VOLCANIC |

**Production Size**

- Exploration and Development -

Small
Record Number: TC38495 (....Continued)

Developed Status: Little Developed Producer, Inactive

--- Description of Workings ---

Desc Workings: Surface

--- Reference ---


Reference: PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.

Page 2
Mineral Resources Data System (MRDS)

Record Number: TC38496
Record Type: Site
Reporter: ORRIS, GRETA J.
Report Affiliation: USGS
Site Name: TURKEY HILLS CINDER PIT

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Physiographic Prov: COLORADO PLATEAU
Drainage Area: LOWER COLORADO
Land Status: 41
Administrative Area: COCONINO NATIONAL FOREST
Quad 250k: FLAGSTAFF
Quad 100k: FLAGSTAFF
Quad 24k: FLAGSTAFF EAST (1983)
Elevation: 7420 FT
Latitude: 35-13-47N
Longitude: 111-30-42W
Accuracy: ACC

Section: 2
Section Fraction: NW OF SE
Township: 2tN
Range: 008E
Meridian: GILA AND SALT RIVER
Position: ABOUT 5 MI ENE OF FLAGSTAFF.
Location Comments: ON SE PEAK OF TURKEY HILLS.

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: CINDER

-- Geology --

-- Deposit Description --
-- Individual Ore Bodies --
Deposit Type: VOLCANIC

-- Exploration and Development --

Page 1
Record Number: TC38496

Production Size: Small
Development Status: Little Developed Producer, Inactive

-- Description of Workings --

Desc Workings: Surface

-- Reference --


Reference: PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILE.

Page 2
Mineral Resources Data System (MRDS)

Record Number: TC36898
Record Type: Site
Reporter: ORRIS, GRETA J.
Report Type: USGS
Site Name: STAR NO. 23 CINDER PIT

Location Information:
- Country: UNITED STATES
- State: ARIZONA
- County: COCONINO
- Physiographic Prov: 11 COLORADO PLATEAU
- Drainage Area: 15 LOWER COLORADO
- Land Status: 41
- Administrative Area: COCONINO NATIONAL FOREST

Country Code: US
State Code: AZ

Quad 250k: FLAGSTAFF
Quad 100k: FLAGSTAFF
Quad 24k: WING MOUNTAIN (1974)
Elevation: 7580 FT
Latitude: 35-16-18N
Longitude: 111-46-18W
Accuracy: ACC

Section 20: NE OF SW
Section Fraction: 22N 006E
Meridian: GILA AND SALT RIVER

Location Comments: ON EASTERN FLANK OF WING MOUNTAIN.

Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: CINDER

Deposit Type: VOLCANIC

Production Size: Small
Record Number: TC36898

(Continued)

Development Status: Little Developed Producer, Inactive

-- Description of Workings --

Desc Workings: Surface

-- Reference --


Reference: PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.
Mineral Resources Data System (MRDS)

Record Number: TC38499
Record Type: Site
Reporter: ORRIS, GRETA J.
Reporter Affiliation: USGS
Site Name: SPITZ SPRING CINDER PIT

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Physiographic Prov: 11 COLORADO PLATEAU
Drainage Area: 15 LOWER COLORADO
Land Status: 41
Administrative Area: KAIBAB NATIONAL FOREST
Quad 250k: FLAGSTAFF
Quad 100k: FLAGSTAFF
Quad 24k: PARKS (1980)
Elevation: 7100 FT
Latitude: 35-15-57N
Longitude: 111-58-10W
Accuracy: ACC

Section: 21
Section Fraction: S2 OF SE
Township: 22N
Range: 004E
Meridian: GILA AND SALT RIVER

Location Comments:
ABOUT 1.25 MI WNW OF PARKS.
ABOUT 0.4 MI NNE OF SPITZ SPRING.

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: CINDER

-- Geology --

-- Deposit Description --
Individual Ore Bodies--

Deposit Type: VOLCANIC

-- Exploration and Development --
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**Description of Workings**

- Reference -

**Reference**


Reference

PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.
Mineral Resources Data System (MRDS)

Record Number: TC38500
Record Type: Site
Reporter: ORRIS, GRETA J.
Reporter Affiliation: USGS
Site Name: MORMON MTN. NO. 1 CINDER PIT

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Physiographic Prov: 11 COCONINO PLATEAU
Drainage Area: 15 LOWER COLORADO
Land Status: 41
Administrative Area: COCONINO NATIONAL FOREST
Quad 250k: HOLBROCK
Quad 100k: SEDONA
Quad 24k: MORMON MTN. (1974)
Elevation: 7470 FT
Latitude: 34-54-33N
Longitude: 111-32-10W
Accuracy: ACC

Location Comments: ABOUT 1/4 SSE OF BURT LEE PARK.

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: VOL
Ore Materials: CINDER

-- Geology --

-- Deposit Description --
Deposit Type: VOLCANIC

-- Exploration and Development --
Production Size: Small
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--- Description of Workings ---

**Desc Workings**

Surface

--- Reference ---

**Reference**


**Reference**

PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILE.
Report Title: LARRY'S STORE

Location Information:
- County: ARIZONA
- State: COCONINO
- Physiographic Prov: COLORADO PLATEAU
- Drainage Area: LOWER COLORADO
- Land Status: 41
- Administrative Area: COCONINO NATIONAL FOREST

Location Comments:
ON THE NE FLANK OF WING MOUNTAIN. THERE ARE TWO CINDER PITS IN THE SE/4 OF THE SE/4 OF SEC. 17. THE LAT-LONG IS FOR THE NORTHERNMOST PIT. THE SECOND PIT IS ABOUT 0.15 MI SSW OF THE FIRST.

Commodity Information:
- Commodity Type: Non-metallic
- Commodities: VOL
- Major: VOL
- Ore Materials: CINDER

Deposit Type: VOLCANIC
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-- Location Information --

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Page 1
Record Number | TC38471 | (....Continued)

**Developent Status**  | Little Developed Producer, Inactive

--- **Description of Workings** ---

**Desc Workings**  | Surface

--- **Reference** ---


**Reference**  | PEIRCE, H.W., 1990. ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.
Mineral Resources Data System (MRDS)

Report Title
Issue Date 00/00/00
Current Date Monday, April 7, 1997
Current Time 10:24:50
Number 57 of 103
Printed 57 of 103

Record Number TC38472
Record Type Site
Reporter ORRIS, GRETA J.
Reporter Affiliation USGS
Site Name ANGELL NO. 2 CINDER PIT

-- Location Information --
Country UNITED STATES
State ARIZONA
County COCONINO
Physiographic Prov 11 COLORADO PLATEAU
Drainage Area 15 LOWER COLORADO
Land Status 41
Administrative Area COCONINO NATIONAL FOREST
Quad 250k FLAGSTAFF
Quad 100k FLAGSTAFF
Quad 24k ANGELL (1953)
Elevation 6090 FT
Latitude 35-10-49N
Longitude 111-20-20W
Accuracy ACC

Section 28
Section Fraction SE OF NW
Township 21N
Range 010E
Meridian GILA AND SALT RIVER
Position ABOUT 2.2 MI WSW OF ANGELL.

-- Commodity Information --
Commodity Type Non-metallic
Commodities VOL
Major VOL
Ore Materials CINDER

-- Geology --

-- Deposit Description --
-- Individual Ore Bodies --
Deposit Type VOLCANIC

-- Exploration and Development --
Production Size Small

Page 1
Record Number: TC38472  
(....Continued)

**Development Status:** Little Developed Producer, Inactive

--- Description of Workings ---

**Desc Workings:** Surface

--- Reference ---

**Reference**


PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.

*Page 2*
Mineral Resources Data System (MRDS)

Record Number: TC38473
Record Type: Site
Reporter: ORRIS, GRETA J.
Reporter Affiliation: USGS
Site Name: ANGELL NO. 1 CINDER PIT

--- Location Information ---
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Physiographic Prov: 11 COLORADO PLATEAU
Drainage Area: 15 LOWER COLORADO
Land Status: 41
Administrative Area: COCONINO NATIONAL FOREST
Quad 250k: FLAGSTAFF
Quad 100k: FLAGSTAFF
Quad 24k: ANGELL (1983)
Elevation: 6100 FT
Latitude: 35-09-20N
Longitude: 111-19-20W
Accuracy: ACC

Section: 3
Section Fraction: NW OF NE
Township: 20N
Range: 010E
Meridian: GILA AND SALT RIVER
Position: ABOUT 2.5 MI S OF ANGELL.

--- Commodity Information ---
Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: CINDER

--- Geology ---
Deposit Type: VOLCANIC

--- Exploration and Development ---
Production Size: Small
Record Number: TC38473 (Continued)

Development Status: Little Developed Producer, Inactive

Desc Workings

-- Description of Workings --

Reference


PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.

Page 2
Mineral Resources Data System (MRDS)

Record Number: TC38475
Record Type: Site
Reporter: ORRIS, GRETA J.
Site Name: BAKER PIT

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Physiographic Prov: 11 COLORADO PLATEAU
Drainage Area: 15 LOWER, COLORADO
Land Status: 41
Administrative Area: COCONINO NATIONAL FOREST
Quad 250k: FLAGSTAFF
Quad 100k: FLAGSTAFF
Quad 24k: WINCNA, (1974)
Elevation: 6425 FT
Latitude: 35-13-16N
Longitude: 111-25-12W
Accuracy: ACC

Section: 10 NE OF NE
Position: ABOUT 1.5 MI NW OF WINONA.
Location Comments: ABOUT 1 MI W OF CINDER MOUNTAIN.

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: CINDER

-- Geology --

-- Deposit Description --
-- Individual Ore Bodies --

Deposit Type: VOLCANIC

-- Exploration and Development --
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-- Description of Workings --

Desc Workings | Surface |

-- Reference --

Reference | PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES. |
Record Number: TC35340
Record Type: Site
Reporter: WELLS, TINA M.
Reporter Affiliation: USGS
Site Name: O'LEYAR PEAK

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Quad 250k: FLAGSTAFF
Quad 24k: O'LEYAR PEAK
Latitude: 35-24-N
Longitude: 111-31-W
Accuracy: EST
UTM Northing: 3917325.
UTM Zone: +12
Section: 10
Section Fraction: 023N 008E
Country Code: US
State Code: AZ
Decimal Lat: 35.4
Decimal Long: -111.51666
UTM Easting: 453082.5

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: PUM
Major: PUM
Ore Materials: PUMICE

-- Geology --
Host Rock Type: RHYOLITIC VOLCANIC ROCKS
Host Rock Type Name: RHYOLITIC VOLCANIC ROCKS
Age: --
Host Rock Unit Name: Age

-- Deposit Description --
Deposit Type: VOLCANIC
Deposit Desc Comm: PUMICE IS RHYOLITIC.

-- Exploration and Development --
Production Size: No
Development Status: Occurrence
Record Number: TC35340 (Continued)

-- Description of Workings --

Desc Workings: Surface

-- Reference --


Reference: PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERALS CARD FILE.

Page 2
Mineral Resources Data System (MRDS)

Report Title
Issue Date 00/00/00
Current Date Monday, April 7, 1997
Current Time 10:24:50
Number 62 of 103
Printed 62 of 103

Record Number TC36493
Record Type Site
Reporter ORRIS, GRETA J.
Report Number USGS
Site Name NORTH AND SOUTH SHEBA CRATERS

Country UNITED STATES
State ARIZONA
County COCONINO
Physiographic Prov 11 COLORADO PLATEAU
Drainage Area 15 LOWER COLORADO
Land Status 30
Quad 250k FLAGSTAFF
Quad 100k FLAGSTAFF
Quad 24k MERRIAM CRATER (1969)
Latitude 35-18-33N
Longitude 111-15-48W
Accuracy +/- 1.0M

Section 7,8,17,18
Section Fraction 7,8,17,18
Township 22N
Range 011E
Meridian GILA AND SALT RIVER
Location Comments LAT-LONG IS FOR A POINT BETWEEN THE NORTH AND SOUTH SHEBA CRATERS. THIS POINT LIES IN THE CENTER OF SECTION 7.

Commodity Type Non-metallic
Commodities VOL
Major VOL
Ore Materials CINDER

Deposit Type VOLCANIC
Deposit Desc Comm CINDER CINER
Production Size No

Page 1
Record Number: TC36493 (Contd.)

Development Status: Occurrence

-- Description of Workings --

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**Reference**


PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.
Mineral Resources Data System (MRDS)

Record Number: TC36911
User Field: *93/6
Record Type: Site
File Link ID: CIMRI, IMS
Reporter: ORRIS, GRETA J.
Reporter Affiliation: USGS
Site Name: HUMPHREYS PEAK NO. 1 CINDER PIT

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Physiographic Prov: 11 COLORADO PLATEAU
Drainage Area: 15 LOWER COLORADO
Land Status: 41
Administrative Area: COCONINO NATIONAL FOREST
Quad 250k: FLAGSTAFF
Quad 100k: FLAGSTAFF
Quad 24k: HUMPHREYS PEAK (1983)
Elevation: 8560 FT
Latitude: 35-21-56N
Decimal Lat: 35.36555
Longitude: 111-44-54W
Decimal Long: -111.74833
Accuracy: ACC

Location Comments:
THERE ARE 2 CINDER PITS IN N/2 OF SECTION. LAT-LONG IS FOR WESTERNMOST PIT.

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: CINDER

-- Geology --

-- Deposit Description --
-- Individual Ore Bodies--
Deposit Type: VOLCANIC

-- Exploration and Development --
Production Size: Small
Record Number: TC36911 (Continued)

Development Status: Little Developed Producer, Inactive

-- Description of Workings --

Desc Workings: Surface

-- Reference --


Reference: PEIRCE, H.W., 1990. ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.
Mineral Resources Data System (MRDS)

Record Number: TC35343
Record Type: Site
Reporter: WELLS, TINA M.
Reporter Affiliation: USGS
Site Name: ROBINSON CRATER AREA

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Quad 250k: FLAGSTAFF
Quad 24k: O'LEARY PEAK
Latitude: 35-24- N
Longitude: 111-33- W
Accuracy: EST
UTM Northing: 3917343.
UTM Zone: +12

Section: 4, 9, 10
Section Fraction:
Township: 023N
Range: 008E
Meridian: GILA AND SALT RIVER

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: PUM
Major: PUM
Ore Materials: PUMICE SAND

-- Geology --
Deposit Type: VOLCANIC?
Deposit Desc Comm: PUMICE SAND.

-- Exploration and Development --
Production Size: U
Development Status: Prospect, Inactive

-- Description of Workings --
Record Number: TC35343 (Continued)

Reference:


PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERALS CARD FILE.
Mineral Resources Data System (MRDS)

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**Record Type**: Site  
**Report**: ORRIS, GRETA J.  
**Affiliation**: USGS  
**Site Name**: SHEEP HILL

**Location Information**

- **Country**: UNITED STATES  
  - **State**: ARIZONA  
  - **County**: COCONINO  
  - **Physiographic Prov**: 11 COLORADO PLATEAU  
  - **Drainage Area**: 15 LOWER COLORADO  
  - **Land Status**: 41  
  - **Administrative Area**: COCONINO NATIONAL FOREST  
  - **Quad 250k**: FLAGSTAFF  
  - **Quad 100k**: FLAGSTAFF  
  - **Quad 24k**: FLAGSTAFF EAST (1983)  
  - **Elevation**: 6920 FT  
  - **Latitude**: 35-13-55N  
  - **Longitude**: 111-33-48W  
  - **Accuracy**: ACC  

**Section**: 5 NE OF SE  
**Township**: 21N  
**Range**: 006E  
**Meridian**: GILA AND SALT RIVER  
**Position**: ABOUT 3 Mi NE OF FLAGSTAFF.  
**Location Comments**: AT SOUTHERN BASE OF SHEEP HILL. THERE ARE FOUR OTHER CINDER PITS IN SECTION.

---

**Commodity Type**
- Non-metallic
- VOL
- VOL
- CINDER

---

**Deposit Type**: VOLCANIC

---

**Exploration and Development**
Record Number: TC36913 (....Continued)

Production Size: Small
Development Status: Little Developed Producer, Inactive

-- Description of Workings --

Desc Workings: Surface

-- Reference --

Reference: PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILE.
Mineral Resources Data System (MRDS)

Record Number       TC36917
Record Type         Site
Reporter            ORRIS, GRETA J.
Reporter Affiliation USGS
Site Name           STAR NO. 29 CINDER PIT

-- Location Information --
Country              UNITED STATES
State                ARIZONA
County               COCONINO
Physiographic Prov   11 COLORADO PLATEAU
Drainage Area        15 LOWER COLORADO
Land Status          41
Administrative Area  COCONINO NATIONAL FOREST
Quad 250k            FLAGSTAFF
Quad 100k            FLAGSTAFF
Quad 24k             WING MOUNTAIN (1974)
Elevation            7560 FT
Latitude             35-16-26N
Longitude            111-46-07W
Accuracy             ACC

Section              21
Section Fraction     NW OF SW
Township             22N
Range                006E
Meridian             GILA AND SALT RIVER

Location Comments    AT EASTERN BASE OF WING MOUNTAIN.

-- Commodity Information --
Commodity Type       Non-metallic
Commodities         VOL
Major               VOL
Ore Materials       CINDER

-- Geology --
Deposit Type         VOLCANIC

-- Exploration and Development --
Production Size      Small

Page 1
Record Number  TC36917  (....Continued)

Development Status  Little Developed Producer, Inactive

Description of Workings  

Surface

Reference  


PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.
Mineral Resources Data System (MRDS)

Report Title
Issue Date 00/00/00
Current Date Monday, April 7, 1997
Current Time 10:24:50
Number 68 of 103
Printed 68 of 103

Record Number TC36918
Record Type Site
Reporter ORRIS, GRETA J.
Reporter Affiliation USGS

Editor Name ORRIS, GRETA J.
Type R
Affiliation USGS
Date 4/1/93
Comments 93 04

Site Name RED HILL PIT

-- Location Information --
Country UNITED STATES
State ARIZONA
County COCONINO
Physiographic Prov 11 COLORADO PLATEAU
Drainage Area 15 LOWER COLORADO
Land Status 41
Administrative Area COCONINO NATIONAL FOREST
Quad 250k FLAGSTAFF
Quad 100k FLAGSTAFF
Quad 24k FLATSTAFF EAST (1983)
Elevation 6880 FT
Latitude 35-13-20N
Longitude 111-32-52W
Accuracy ACC

Section 9
Section Fraction NW OF NE
Township 021N
Range 008E
Meridian GILA AND SALT RIVER

Position ABOUT 3 Ml E OF FLAGSTAFF.
Location Comments ON THE SE FLANK OF WILDCAT HILL.

-- Commodity Information --
Commodity Type Non-metallic
Commodities VOL
Major VOL
Ore Materials CINDER
Commod Subtypes USED FOR TREATMENT OF ICY HIGHWAYS, ROAD BEDS, AND LANDSCAPING.

-- Geology --

-- Deposit Description --
--Individual Ore Bodies--
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Page 2
### Mineral Resources Data System (MRDS)

**Report Title**

**Issue Date** 00/00/00

**Current Date** Monday, April 7, 1997

**Record Number** TC36919

**Record Type** Site

**Report Number** USGS

**Site Name** SHEEP PIT

--- Location Information ---

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**County** COCONINC

**Physiographic Prov** 11 COLORADO PLATEAU

**Drainage Area** 15 LOWER COLORADO

**Land Status** 41

**Administrative Area** COCONINC NATIONAL FOREST

**Quad 250k** FLAGSTAFF

**Quad 100k** FLAGSTAFF

**Quad 24k** FLAGSTAFF WEST (1983)

**Latitude** 35-14-50N

**Longitude** 111-32-00W

**Accuracy** ACC +/- 1 MILE

**Section** 34

**Position** ABOUT 5 1/2 NENE OF FLAGSTAFF.

**Location Comments** NO CINDER PIT IN SECTION. LAT-LONG IS FOR CENTER OF SECTION 34.

--- Commodity Information ---

**Commodity Type** Non-metallic

**Commodities** VOL

**Major** VOL

**Ore Materials** CINDER

**Commod Subtypes** USED FOR TREATMENT OF ICY HIGHWAYS.

--- Geology ---

**Deposit Type** VOLCANIC
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**-- Exploration and Development --**

**Production Size**
Yes  

**Development Status**
Intermittent Producer  

**Development M$**
Mill M$  

**Desc Workings**
Surface  

**Reference**

**Reference**
PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILE.
Mineral Resources Data System (MRDS)

Record Number: TC36520
Record Type: Site
Reporter: ORRIS, GRETA J.
Reporter Affiliation: USGS
Site Name: HORSE TANK CINDER PIT

Country: UNITED STATES
State: ARIZONA
County: COCONINO
Physiographic Prov: 11 COLORADO PLATEAU
Drainage Area: 15 LOWER COLORADO
Land Status: 41
Administrative Area: KAIBAB NATIONAL FOREST

Quad 250k: FLAGSTAFF
Quad 100k: CAMERON
Quad 52.5k: EBERT MOUNTAIN
Quad 24k: EBERT MOUNTAIN (1999)
Elevation: 6710 FT
Latitude: 35-33-35N
Longitude: 111-54-07W
Accuracy: ACC

Section: 7
Section Fraction: S2 OF S2
Township: 25N
Range: 005E
Meridian: GILA AND SALT RIVER

Location Comments: ABOUT 2 MI E OF EBERT MOUNTAIN.

Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: CINDER

Deposit Type: VOLCANIC

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**Desc Workings**  
Surface

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**Reference**  

**Reference**  
PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.
## Mineral Resources Data System (MRDS)

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Development Status  Little Developed Producer, Inactive

-- Description of Workings --

Desc Workings  Surface

-- Reference --


Reference  PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILES.

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Mineral Resources Data System (MRDS)

Report Title
Issue Date 00/00/00
Current Date Monday, April 7, 1997
Current Time 10:24:50
Number 72 of 103
Printed 72 of 103

Record Number TC36922
Record Type Site
Reporter ORRIS, GRETA J.
Reporter Affiliation USGS
Site Name MCCORMICK

-- Location Information --
Country UNITED STATES
State ARIZONA
County COCONINO
Physiographic Prov 11 COLORADO PLATEAU
Drainage Area 15 LOWER COLORADO
Land Status 41
Administrative Area COCONINO NATIONAL FOREST
Quad 250k FLAGSTAFF
Quad 100k FLAGSTAFF
Quad 24k SUNSET CRATER WEST (1983)
Elevation 8210 FT
Latitude 35-21-43N
Longitude 111-36-18W
Accuracy ACC +/- 1 MI

Section 24
Section Fraction
Township 23N
Range 007E
Meridian GILA AND SALT RIVER

Position ABOUT 6 MI W OF SUNSET CRATER.
Location Comments ON E-NE FLANK OF SUGARLOAF OF SAN FRANCISCO MOUNTAIN. THERE ARE THREE GRAVEL PITS IN SECTION 24. LAT-LONG IS FOR THE PIT CLOSEST TO THE CENTER OF THE SECTION.

-- Commodity Information --
Commodity Type Both
Commodities VOL PER U
Major VOL PER
Occurring U
Ore Materials PERLITE, OBSIDIAN, CINDER

-- Geology --

Deposit Type VOLCANIC
Record Number: TC36922 (Continued)

Deposit Desc Comm: PERLITE WITH OBSIDIAN IN CINDER BED.

-- Exploration and Development --

Production Size: No

Development Status: Occurrence

-- Description of Workings --

-- Reference --

Mineral Resources Data System (MRDS)

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--- Geology ---

--- Deposit Description ---

--- Individual Ore Bodies ---

| Deposit Type | VOLCANIC |

--- Exploration and Development ---
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-- Description of Workings --

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PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY: INDUSTRIAL MINERAL CARD FILES.
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--- Location Information ---

--- Commodity Information ---

--- Geology ---

--- Deposit Description ---

--- Individual Ore Bodies---

--- Exploration and Development ---
Record Number  TC36925  (....Continued)

Developent Status  Little Developed Producer, Inactive

-- Description of Workings --

Desc Workings  Surface

-- Reference --


Reference  PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILE.
Mineral Resources Data System (MRDS)

Record Number: TC36927
Record Type: Site
Reporter: ORRIS, GRETA J.
Reporter Affiliation: USGS
Site Name: LAVA CLAIM

Country: UNITED STATES
State: ARIZONA
County: COCONINO
Physiographic Prov: 11 COLORACO PLATEAU
Drainage Area: 15 LOWER COLORADO
Land Status: 41
Administrative Area: COCONINO NATIONAL FOREST
Quad 250k: FLAGSTAFF
Quad 100k: FLAGSTAFF
Quad 24k: FLAGSTAFF WEST (1983)
Elevation: 7150 FT
Latitude: 35-09-52N
Longitude: 111-42-22W
Accuracy: ACC

Section: 36
Section Fraction: NW OF NE
Township: 21N
Range: 006E
Meridian: GILA AND SALT RIVER

Position: ABOUT 3 MI SW OF FLAGSTAFF.
Location Comments: THERE ARE TWO CINDER PITS MARKED ON TOFC. LAT-LONG IS FOR THE SOUTHERNMOST PIT.

Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: CINDER

Deposit Type: VOLCANIC

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**-- Description of Workings --**

**Desc Workings**

Surface

**-- Reference --**

**Reference**


PEIRCE, H.W., 1990, ARIZONA GEOLOGICAL SURVEY INDUSTRIAL MINERAL CARD FILE.
### Mineral Resources Data System (MRDS)

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#### Location Information
- **Country**: UNITED STATES
- **State**: ARIZONA
- **County**: COCONINO
- **Physiographic Prov**: 11
- **Land Status**: 41
- **Administrative Area**: COCONINO NATIONAL FOREST
- **Quad 250k**: FLAGSTAFF
- **Quad 100k**: FLAGSTAFF
- **Quad 24k**: SUNSET CRATER WEST
- **Latitude**: 35-18-49N
- **Longitude**: 111-37-33W
- **Accuracy**: ACC

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#### Commodity Information
- **Commodity Type**: Non-metallic
- **Commodities**: LST MBL
- **Major**: LST MBL
- **Ore Materials**: LIMESTONE, MARBLE

#### Geology
- **Host Rock Type Name**: LIMESTONE, MARBLE
- **Age**: MISS
- **Host Rock Unit Name**: REDWALL FM
- **Age**: MISS

#### Deposit Description
- **Deposit Type**: SEDIMENTARY
- **Deposit Desc Comm**: WHITE LIMESTONE AND MARBLE

#### Exploration and Development
- **Production Size**: U
Record Number  TC40400  (....Continued)

Development Status  Prospect, Inactive

-- Description of Workings --

Desc Workings  Surface

-- Reference --


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Mineral Resources Data System (MRDS)

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### Exploration and Development

**Production Size**: Small  
**Development Status**: Developed Producer, Inactive  

### Description of Workings

**Desc Workings**: Surface  
**Workings Comments**: QUARRY.

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### Reference

**Info Source**: 94/07/20
Mineral Resources Data System (MRDS)

Record Number: 1008459
Record Type: Site
Reporter: ORRIS, GRETA J.
Reporter Affiliation: USGS
Site Name: CINDER PIT

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Land Status: 41
Administrative Area: COCONINO NATIONAL FOREST
Quad 250k: FLAGSTAFF
Quad 24k: FLAGSTAFF WEST (1983)
Latitude: 35.09 - 42N
Longitude: 111 - 43-16W
Accuracy: ACC

Section: 35
Section Fraction: NE
Township: 021N
Range: 006E
Meridian: GILA AND SALT RIVER

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: VOLCANIC CINDERS

-- Geology --
Host Rock Type: VOLCANICS
Host Rock Type Name: VOLCANICS
Age: --
Host Rock Unit Name: --
Age: --

-- Deposit Description --
Deposit Type: VOLCANIC

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Production Size: Small
Development Status: Little Developed Producer, Inactive
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Page 1
Record Number 1008460 (Continued)

-- Description of Workings --

Desc Workings Surface

-- Reference --

Reference U.S. GEOLOGICAL SURVEY, 1983, FLAGSTAFF WEST 1:24,000 TOPOGRAPHIC QUADRANGLE.
Mineral Resources Data System (MRDS)

Record Number: 1008461
Record Type: Site
Reporter: ORRIS, GRETA J.
Reporter Affiliation: USGS
Site Name: GRAVEL PIT

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Quad 250k: FLAGSTAFF
Quad 24k: FLAGSTAFF WEST (1983)
Latitude: 35-14-42N
Longitude: 111-30-54W
Accuracy: ACC

Section: 33

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: SDG
Major: SDG
Ore Materials: GRAVEL

-- Geology --
Host Rock Type Name: SEDIMENTARY ROCKS
Age: Host Rock Unit Name: GILA AND SALT RIVER

-- Deposit Description --
Deposit Type: SEDIMENTARY

-- Exploration and Development --
Production Size: Small
Development Status: Developed Producer, Inactive

-- Description of Workings --
Desc Workings: Surface
Record Number 1008461 (....Continued)

Reference

U.S. GEOLOGICAL SURVEY, 1983, FLAGSTAFF WEST 1:24,000 TOPOGRAPHIC QUADRANGLE.

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Mineral Resources Data System (MRDS)

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Record Number 1008462
Record Type Site
Reporter ORRIS, GRETA J.
Reporter Affiliation USGS
Site Name CINDER PIT

-- Location Information --
Country UNITED STATES
State ARIZONA
County COCONINC
Quad 250k FLAGSTAFF
Quad 24k FLAGSTAFF WEST (1983)
Latitude 35-10-18N
Longitude 111-41-57W
Accuracy ACC

Section 30
Section Fraction NW OF SE
Township Range Meridian 021N 007E GILA AND SALT RIVER

-- Commodity Information --
Commodity Type Non-metallic
Commodities VOL
Major VOL
Ore Materials VOLCANIC CINDERS

-- Geology --
Host Rock Type VOLCANICS
Host Rock Type Name Age Host Rock Unit Name Age
VOLCANICS

-- Deposit Description --
Deposit Type VOLCANIC

-- Exploration and Development --
Production Size Small
Development Status Little Developed Producer, Inactive

-- Description of Workings --
Desc Workings Surface
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- **Current Time**: 10:24:50
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### Location Information

- **Country**: UNITED STATES
- **State**: ARIZONA
- **County**: YAVAPAI
- **Land Status**: 41
- **Administrative Area**: COCONINO NATIONAL FOREST
- **Quad 250k**: HOLBROCK
- **Quad 24k**: CASNER BUTTE (1955)
- **Elevation**: 4895 FT
- **Latitude**: 34.44.30N
- **Longitude**: 111.41.34W
- **Accuracy**: ACC

### Commodity Information

- **Commodity Type**: Non-metallic
- **Commodity**: VOL
- **Major**: VOL
- **Ore Materials**: SCORIA, VOLCANIC CINDERS

### Geology

- **Host Rock Type**: VOLCANICS
- **Host Rock Type Name**: VOLCANICS

### Deposit Description

- **Deposit Type**: VOLCANIC

### Exploration and Development

- **Production Size**: Small
- **Development Status**: Little Developed Producer, Inactive
Record Number: 1008348  (...Continued)

-- Description of Workings --

Desc Workings: Surface

Workings Comments: QUARRY.

-- Reference --


Page 2
Mineral Resources Data System (MRDS)

Record Number: 1008250
Record Type: Site
Reporter: ORRIS, Greta J.
Site Name: BELLEMCT NO. 3 CINDER PIT

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Land Status: 50
Administrative Area: NAVAJO ARMY DEPOT
Quad 250k: FLAGSTAFF
Quad 24k: BELLEMCT (1980)
Latitude: 35-11-44N
Longitude: 111-48-15W
Accuracy: ACC

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: VOLCANIC CINDERS

-- Geology --
Host Rock Type: VOLCANICS
Host Rock Type Name: Age
Host Rock Unit Name: Age

-- Deposit Description --

-- Individual Ore Bodies --

-- Exploration and Development --
Production Size: Small
Development Status: Little Developed Producer, Inactive
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**Reference**

Record Number: 1008291

Title: BELLEMONT NO. 4 CINDER PIT

Type: Site

Reporter: ORRIS, GRETA J.

Affiliation: USGS

Date: 9401

Country: UNITED STATES

State: ARIZONA

County: COCONINO

Quad 250k: FLAGSTAFF

Quad 24k: BELLEMONT (1980)

Latitude: 35-11-55N

Longitude: 111-48-06W

Accuracy: ACC

Commodity Type: Non-metallic

Commodities: VOL

Major: VOL

Ore Materials: VOLCANIC CINDERS

Host Rock Type: VOLCANICS

Deposit Type: VOLCANIC

Production Size: Small

Development Status: Little Developed Producer, Inactive

Desc Workings: Surface
Reference

## Mineral Resources Data System (MRDS)

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<th>Current Date Monday, April 7, 1997</th>
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| Record Number | 1008292          | User Field | "94/3" |          |                   |
| Record Type   | Site              | File Link ID | CIMRI, IMS |          |                   |
| Reporter      | ORRIS, GRETA J.   |            |        |          |                   |
| Reporter Affiliation | USGS |            |        |          |                   |
| Site Name     | BELLEMONT NO. 5 CINDER PIT |            |        |          |                   |

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--- Deposit Description ---

| Deposit Type | VOLCANIC |          |          |          | |

--- Exploration and Development ---

| Production Size    | Small |          |          |          |
| Development Status | Little Developed Producer, Inactive |          |          |          |

--- Description of Workings ---

| Desc Workings | Surface |          |          |          |
Record Number: 1008292 (Continued)

Workings Comments: QUARRY.

Reference:

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#### Location Information

- **Country:** UNITED STATES
- **State:** ARIZONA
- **County:** COCONINO
- **Quad 250k:** FLAGSTAFF
- **Quad 24k:** BELLEMONT (1980)
- **Latitude:** 35-14-46N
- **Longitude:** 111-52-07W
- **Accuracy:** ACC
- **Section:** 33
- **Decim. Lat:** 35.24611
- **Decim. Long:** -111.86361
- **Township Range Meridian:** 022N 005E GILA AND SALT RIVER

### Commodity Information

- **Commodity Type:** Non-metallic
- **Commodities:** VOL
- **Major:** VOL
- **Ore Materials:** VOLCANIC CINDERS

### Geology

- **Host Rock Type:** VOLCANICS
- **Host Rock Type Name:** VOLCANICS
- **Age:**
- **Host Rock Unit Name:**
- **Age:**

### Deposit Description

- **Deposit Type:** VOLCANIC
- **Deposit Description:**
- **Individual Ore Bodies:**

### Exploration and Development

- **Production Size:** Small
- **Development Status:** Little Developed Producer, Inactive

### Description of Workings

- **Desc Workings:** Surface

---

Page 1
Record Number 1008293 (....Continued)

Workings Comments QUARRY.

Reference

Mineral Resources Data System (MRDS)

Record Number: 1008294
Record Type: Site
Reporter: ORRIS, GRETA J.
Reporter Affiliation: USGS
Site Name: BELLEMONT NO. 7 CINDER PIT

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Quad 250k: FLAGSTAFF
Quad 24k: BELLEMONT (1980)
Latitude: 35-15-02N
Longitude: 111-52-13W
Accuracy: ACC

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: VOLCANIC CINDERS

-- Geology --
Host Rock Type: VOLCANICS
Host Rock Type Name: VOLCANICS

-- Deposit Description --
Individual Ore Bodies:
Deposit Type: VOLCANIC

-- Exploration and Development --
Production Size: Small
Development Status: Little Developed Producer, Inactive

-- Description of Workings --
Desc Workings: Surface
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Page 2
### Mineral Resources Data System (MRDS)

**Record Number**: 1008295  
**User Field**: *94/3

**Record Type**: Site  
**File Link ID**: CIMRI, IMS

**Reporter**: ORRIS, GRETA J.  
**Reporter Affiliation**: USGS

**Site Name**: GARLAND PRAIRIE NO. 1 CINDER PIT

---

**Country**: UNITED STATES  
**Country Code**: US

**State**: ARIZONA  
**State Code**: AZ

**County**: COCONINO

**Land Status**: 41

**Administrative Area**: KAIBAB NATIONAL FOREST

**Quad 250k**: FLAGSTAFF  
**Quad 24k**: GARLAND PRAIRIE (1974)

**Elevation**: 7040 FT

**Latitude**: 35-14-42N  
**Decimal Lat**: 35.245

**Longitude**: 111-55-58W  
**Decimal Long**: -111.93277

**Accuracy**: ACC

**Section**: 35  
**Section Fraction**:  
**Township**: 022N  
**Range**: 004E  
**Meridian**: GILA AND SALT RIVER

---

**Commodity Type**: Non-metallic

**Commodities**: VOL

**Major**: VOL  
**Ore Materials**: VOLCANIC CINDERS

---

**Host Rock Type**: VOLCANICS

**Host Rock Type Name**: VOLCANICS

---

**Deposit Type**: VOLCANIC

---

**Production Size**: Small

**Development Status**: Little Developed Producer, Inactive
Record Number: 1008295

-- Description of Workings --

Desc Workings: Surface

Workings Comments: QUARRY.

-- Reference --


Page 2
Mineral Resources Data System (MRDS)

Record Number: I008296
User Field: 94/3

Record Type: Site
File Link ID: CIMRI, IMS

Reporter: ORRIS, GRETA J.
Reporter Affiliation: USGS

Site Name: GARLAND PRAIRIE NO. 2 CINDER PIT

-- Location Information --
Country: UNITED STATES
State: ARIZONA
County: COCONINO
Land Status: 50
Administrative Area: NAVAJO ARMY DEPOT
Quad 250k: FLAGSTAFF
Quad 24k: GARLAND PRAIRIE (1974)
Elevation: 7470 FT
Latitude: 35-11-25N
Longitude: 111-53-29W
Accuracy: ACC

Section: 20
Section Fraction: 021N 005E

-- Commodity Information --
Commodity Type: Non-metallic
Commodities: VOL
Major: VOL
Ore Materials: VOLCANIC CINDERS

-- Geology --
Host Rock Type: VOLCANICS
Host Rock Type Name: VOLCANICS
Age: 
Host Rock Unit Name: 
Age: 

Deposit Type: VOLCANIC

-- Exploration and Development --
Production Size: Small
Development Status: Little Developed Producer, Inactive
Record Number: 1008296 (....Continued)

--- Description of Workings ---

Desc Workings: Surface

Workings Comments: QUARRY.

--- Reference ---

Mineral Resources Data System (MRDS)

Report Title
Issue Date 00/00/00
Current Date Monday, April 7, 1997
Current Time 10:24:50
Number 91 of 103
Printed 91 of 103

Record Number 1008297
Record Type Site
Reporter ORRIS, GRETA J.
Reporter Affiliation USGS
Site Name HAPPY JACK NO. 2 CINDER PIT

-- Location Information --
Country UNITED STATES
State ARIZONA
County COCONINO
Quad 250k HOLBROOK
Quad 24k HAPPY JACK (1965)
Latitude 34°44'25"N
Longitude 111°25'18"W
Accuracy ACC

-- Commodity Information --
Commodity Type Non-metallic
Commodities VOL
Major VOL
Ore Materials VOLCANIC CINDERS

-- Geology --
Host Rock Type VOLCANICS
Host Rock Type Name VOLCANICS
Age
Host Rock Unit Name
Age

-- Exploration and Development --
Production Size Small
Development Status Little Developed Producer, Inactive

-- Description of Workings --
Desc Workings Surface
Reference

### Mineral Resources Data System (MRDS)

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**Record Number** 1008298  
**Record Type** Site  
**Reporter** ORRIS, GRET A J.  
**Reporter Affiliation** USGS  
**Site Name** HAPPY JACK NO. 3 CINDER PIT

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**Page 1**
Mineral Resources Data System (MRDS)

--- Location Information ---
Country: UNITED STATES
State: ARIZONA
County: COCONINO

Administrative Area: COCONINO NATIONAL FOREST
Quad 250k: FLAGSTAFF
Quad 24k: FLAGSTAFF WEST (1983)

Latitude: 35-12-19N
Longitude: 111-44-53W
Accuracy: ACC

Section: 15
Section Fraction: 021N 006E
Township: 021N
Range: 006E
Meridian: GILA AND SALT RIVER

--- Commodity Information ---
Commodity Type: Non-metallic
Commodities: VCL
Major: VOL
Ore Materials: VOLCANIC CINDERS

--- Geology ---
Host Rock Type: VOLCANICS

--- Deposit Description ---
Deposit Type: VOLCANIC

--- Exploration and Development ---
Production Size: Small
Development Status: Little Developed Producer, Inactive
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**Record Number**: 1008300
**User Field**: 94/3
**Report Type**: Site
**File Link ID**: CIMRI, IMS
**Report Title**: FLAGSTAFF WEST NO. 4 CINDER PIT

**Current Date**: Monday, April 7, 1997
**Current Time**: 10:24:50
**Number**: 94 of 103

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## Location Information

- **Country**: UNITED STATES
- **State**: ARIZONA
- **County**: COCONINO
- **Land Status**: 41
- **Administrative Area**: COCONINO NATIONAL FOREST
- **Quad 250k**: FLAGSTAFF
- **Quad 24k**: FLAGSTAFF WEST (1983)
- **Latitude**: 35-10-32N
- **Longitude**: 111-42-03W
- **Accuracy**: ACC

## Commodity Information

- **Commodity Type**: Non-metallic
- **Commodities**: VOL
- **Major**: VOL
- **Ore Materials**: VOLCANIC CINDERS

## Geology

- **Host Rock Type**: VOLCANICS

## Deposit Description

- **Individual Crs Bodies**: VOLCANICS

## Exploration and Development

- **Production Size**: Small
- **Development Status**: Little Developed Producer, Inactive
Record Number 1008300 (....Continued)

-- Description of Workings --

Desc Workings  Surface
Workings Comments QUARRY.

-- Reference --

Page 2
Mineral Resources Data System (MRDS)

Record Number 1008301
Record Type Site
Reporter ORRIS, GRETA J.
Reporter Affiliation USGS
Site Name FLAGSTAFF WEST NO. 5 CINDER PIT

-- Location Information --
Country UNITED STATES
State ARIZONA
County COCONINO
Land Status 41
Administrative Area COCONINO NATIONAL FOREST
Quad 250k FLAGSTAFF
Quad 24k FLAGSTAFF WEST (1983)
Latitude 35-10-27N
Longitude 111-42-22W
Accuracy ACC
Section 25
Section Fraction SE OF NE
Township 021N
Range 006E
Meridian GILA AND SALT RIVER

-- Commodity Information --
Commodity Type Non-metallic
Commodities VOL
Major VOL
Ore Materials VOLCANIC CINDERS

-- Geology --
Host Rock Type VOLCANICS

-- Deposit Description --
-- Individual Ore Bodies --
Deposit Type VOLCANIC

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Production Size Small
Development Status Little Developed Producer, Inactive
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| Basalt |

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*Page 1*
### Record Number
1008302

#### Developent Status
Occurrence

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--- Description of Workings ---

--- Reference ---

#### Reference
### Mineral Resources Data System (MRDS)

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--- Location Information ---

- **Country**: UNITED STATES
- **State**: ARIZONA
- **County**: YAVAPAI
- **Land Status**: 41
- **Administrative Area**: COCONINO NATIONAL FOREST
- **Quad 250k**: HOLBROOK
- **Quad 24k**: CASNER BUTTE (1865)
- **Latitude**: 34.43-38N
- **Longitude**: 111-38-07W
- **Accuracy**: ACC

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--- Commodity Information ---

- **Commodity Type**: Non-metallic
- **Commodities**: VOL
- **Major**: VOL
- **Ore Materials**: SCORIA, VOLCANIC CINDERS

--- Geology ---

- **Host Rock Type**: VOLCANICS
- **Host Rock Type Name**: VOLCANICS
- **Age**: | Host Rock Unit Name | Age |

--- Deposit Description ---

- **Deposit Type**: VOLCANIC

--- Exploration and Development ---

- **Production Size**: Small
- **Development Status**: Little Developed Producer, Inactive
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Page 1
-- Exploration and Development --

**Production Size**  
Small

**Development Status**  
Developed Producer, Inactive

-- Description of Workings --

**Desc Workings**  
Surface

**Workings Comments**  
QUARRY.

-- Reference --

**Reference**  

**Info Source**  
94/07/20
Mineral Resources Data System (MRDS)

Report Title

Issue Date 00/00/00

Current Date Monday, April 7, 1997

Record Number 1006289

Record Type Site

Reporter ORRIS, GRETA J.

Reporter Affiliation USGS

Site Name BELLEMONT NO. 1 CINDER PIT

- Location Information -

Country UNITED STATES

State ARIZONA

County COCONINO

Land Status 41

Administrative Area COCONINO NATIONAL FOREST

Quad 250k FLAGSTAFF

Quad 24k BELLEMONT (1980)

Latitude 35-12-10N

Longitude 111-45-03W

Accuracy ACC

Section 15

Section Fraction

Township Range Meridian

021N 006E GILA AND SALT RIVER

- Commodity Information -

Commodity Type Non-metallic

Commodities VOL

Major VOL

Ore Materials VOLCANIC CINDERS

- Geology -

Host Rock Type VOLCANICS

Host Rock Type Name VOLCANICS

Age

Host Rock Unit Name

Age

- Deposit Description -

-- Individual Ore Bodies--

Deposit Type VOLCANIC

- Exploration and Development -

Production Size Small

Development Status Little Developed Producer, Inactive

Page 1
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Page 2
## Mineral Resources Data System (MRDS)

**Record Number**: 1008458  
**Record Type**: Site  
**Reporter**: ORRIS, GRETA J.  
**Site Name**: PHOENIX CEMENT CO. CLAIMS

### Location Information
- **Country**: UNITED STATES  
- **State**: ARIZONA  
- **County**: YAVAPAI  
- **Land Status**: 41  
- **Administrative Area**: PRESCOTT NATIONAL FOREST  
- **Quad 250k**: PRESCOTT  
- **Quad 24k**: CLARKDALE  
- **Latitude**: 34-47-45N  
- **Longitude**: 112-07-25W  
- **Accuracy**: ESTIMATED LOCATION, +/- 0.5 MILE.

### Commodity Information
- **Commodity Type**: Non-metallic  
- **Major Commodities**: LST  
- **Ore Materials**: LIMESTONE

### Geology
- **Host Rock Type**: LIMESTONE

### Deposit Description
- **Deposit Type**: SEDIMENTARY

### Exploration and Development
- **Production Size**: No  
- **Development Status**: Prospect, Inactive

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**Description of Workings**

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**Current Time** 10:24:50

**Number** 101 of 103

**Printed** 101 of 103

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**Location Information**

- **Country**: UNITED STATES
- **State**: ARIZONA
- **County**: COCONINO
- **Physiographic Prov**: 11
- **Quad 250k**: FLAGSTAFF
- **Quad 100k**: FLAGSTAFF
- **Quad 24k**: TUSAYAN WEST, RED BUTTE
- **Latitude**: 35-08-41N
- **Longitude**: 111-36-00W
- **Accuracy**: EST. +/- 0.5 MILE

---

**Commodity Information**

- **Commodity Type**: Both
- **Commodities**: PB LST
- **Major**: PB
- **Minor**: LST
- **Ore Materials**: LIMESTONE?

---

**Geology**

- **Deposit Description**
  - LIMESTONE BRECCIA FRAGMENTS IN BASE-METAL MINERALIZED BRECCIA PIPE.

---

**Production Size**

- **U**

**Development Status**

- Prospect, Inactive

---

**Description of Workings**

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Reference


Prod Comments

INACTIVE PROSPECT
# Mineral Resources Data System (MRDS)

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**-- Location Information --**

| **Country**          | UNITED STATES       | **Country Code**                   | US                    |
| **State**            | ARIZONA             | **State Code**                     | AZ                    |
| **County**           | COCONINO            | **Physiographic Prov**              | 11                    |
| **Administrative Area** | COCONINO NATIONAL FOREST | **Quad 250k**                      | FLAGSTAFF             |
| **Quad 100k**        | FLAGSTAFF           | **Quad 24k**                        | FLAGSTAFF WEST (1983) |
| **Latitude**         | 35-03-40N           | **Longitude**                      | 111-37-55W            |
| **Accuracy**         | EST                 |                                   |                       |
| **Section**          | 02, 03              | **Section Fraction**               | 020N                  |
| **Position**         | APPROXIMATELY 3 MILES SE OF FLAGSTAFF. | **Township** | 007E                  |
| **Location Comments** | PARTLY IN COCONINO NATIONAL FOREST AND POSSIBLY WITHIN THE FLAGSTAFF CORPORATE BOUNDARY. | | GILA AND SALT RIVER |

**-- Commodity Information --**

| **Commodity Type**   | Non-metallic        |
| **Commodities**      | LST                 |
| **Major**            | LST                 |
| **Ore Materials**    | LIMESTONE           |

**-- Geology --**

| **Age Mineralization** | PERM                |
| **Host Rock Type Name** | LIMESTONE PERM      |
| **Age**                | PERM                |
| **Host Rock Unit Name** | KAIBAB LST PERM    |

**-- Deposit Description --**

| **Deposit Type**     | SEDIMENTARY         |

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Prod Comments
INACTIVE OCCURRENCE

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**Commodity Information**

- Commodity Type: Non-metallic
- Commodities: LST
- Major: LST
- Ore Materials: LIMESTONE

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**Deposit Description**

- Deposit Type: SEDIMENTARY

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**Exploration and Development**

- Production Size: U
- Development Status: Prospect, Inactive

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Page 1
Record Number   TC41205   (....Continued)

-- Description of Workings --

Desc Workings   Surface

-- Reference --


Prod Comments   INACTIVE PROSPECT

Page 2