Mineral Resource Potential of Public Lands Located within the Agua Caliente Solar Energy Zone in Yuma County, Arizona

February 2015
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NOTATION

The following is a list of acronyms, abbreviations, and units of measure used in this document. Some acronyms used only in tables may be defined only in those tables.

GENERAL ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>AZGS</td>
<td>Arizona Geological Survey</td>
</tr>
<tr>
<td>BLM</td>
<td>Bureau of Land Management</td>
</tr>
<tr>
<td>DOI</td>
<td>U.S. Department of the Interior</td>
</tr>
<tr>
<td>GIS</td>
<td>geographic information system</td>
</tr>
<tr>
<td>IBLA</td>
<td>Interior Board of Land Appeals</td>
</tr>
<tr>
<td>I.D.</td>
<td>Interior Department</td>
</tr>
<tr>
<td>LR2000</td>
<td>Land and Mineral Legacy Rehost 2000 System</td>
</tr>
<tr>
<td>MRDS</td>
<td>Mineral Resource Data System</td>
</tr>
<tr>
<td>P.L.</td>
<td>Public Law</td>
</tr>
<tr>
<td>ROD</td>
<td>Record of Decision</td>
</tr>
<tr>
<td>ROW</td>
<td>right of way</td>
</tr>
<tr>
<td>RMP</td>
<td>Resource Management Plan</td>
</tr>
<tr>
<td>SEZ</td>
<td>Solar Energy Zone</td>
</tr>
<tr>
<td>USC</td>
<td>United States Code</td>
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<td>U.S. Geological Survey</td>
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**UNITS OF MEASURE**

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<tr>
<td>MW</td>
<td>megawatt(s)</td>
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<td>m.y.</td>
<td>million years</td>
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MINERAL RESOURCE POTENTIAL
OF PUBLIC LANDS LOCATED WITHIN THE
AGUA CALIENTE SOLAR ENERGY ZONE
IN YUMA COUNTY, ARIZONA

LANDS INVOLVED
Covering 2,560 acres of public land in Yuma County, Arizona
T5S, R12W, sections 15, 17, 20, 22, 23, 26, 28, 29, and 33
Gila and Salt River P.M.

Prepared by:

[Signature]

Terri L. Patton, Geologist
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MINERAL RESOURCE POTENTIAL
OF PUBLIC LANDS LOCATED WITHIN THE
AGUA CALIENTE SOLAR ENERGY ZONE
IN YUMA COUNTY, ARIZONA

EXECUTIVE SUMMARY

This report assesses the mineral resource potential of public lands located within the Agua Caliente Solar Energy Zone (SEZ) that have been identified for withdrawal from location or entry under the mining laws on behalf of the U.S. Department of Interior (DOI), Bureau of Land Management (BLM). The report was prepared in consultation with Mr. Jeff Garrett, Mining Engineer and Mining Law Program Lead (Arizona State Office). Mr. Matt Shumaker, Chief Mineral Examiner (Division of Solid Minerals), provided guidance on the content and format of the mineral resource assessments prepared for the original 17 SEZs (in 2012); his guidance was also followed in the preparation of this report. Mr. Lane Cowger, Project Manager (Arizona State Office), prepared the legal description for the SEZ.

There are no documented occurrences of locatable mineral deposits within the Agua Caliente SEZ. Most of the metallic minerals in the region are concentrated in the mountain ranges to the northwest. The nearest known occurrences of locatable minerals (copper ore) are in the Palomas Mountains about 5 mi (8 km) northwest of the SEZ. Placer gold occurrences are associated with gravels deposited in streams and washes that drain these mountains. Modern alluvial deposits below the SEZ are estimated to be greater than 1,600 ft (490 m) deep, although the local stratigraphy has not been well characterized. The potential for metallic (lode) minerals within the SEZ is low (level of certainty B). And because there is no evidence (assay or evidence of past production) to suggest that placer deposits occur within or in close proximity to the SEZ, the potential for placer deposits within the SEZ is also low (level of certainty A).

The Agua Caliente SEZ is an area with a high potential for the occurrence of sand and gravel (level of certainty C). The SEZ is underlain by alluvial and basin-fill sediments; however, based on the absence of free-use permits or mineral materials contracts within the SEZ, the demand for these resources is assumed to be low.

There are no active oil and gas leases within the Agua Caliente SEZ, and there has been no history of oil and gas production within or near the SEZ or in the Yuma Field Office planning area (the only areas producing oil and gas are located in Apache County in northeastern Arizona). Although eight oil and gas leases covered most of the SEZ in the past, these leases

---

1 Definitions of mineral potential are from the mineral potential classification system outlined in BLM Manual 3031 (BLM 1985). Mineral potential ratings of low, moderate, or high are assigned where the geologic environment and inferred geologic processes indicate low, moderate, or high potential for accumulation of mineral resources. Levels of certainty are defined as follows: A – available data are insufficient to support or refute the occurrence of mineral resources; B – available data provide indirect evidence to support or refute the occurrence of mineral resources; C – available data provide direct but quantitatively minimal evidence to support or refute the occurrence of mineral resources; and D – available data provide abundant direct and indirect evidence to support or refute the occurrence of mineral resources.
were closed in 1980, 1986, and 1997. The SEZ is an area with low potential for oil and gas resources (level of certainty A).

There also are no known coal resources within the immediate region of the Agua Caliente SEZ (Palomas Plain); and although helium (a commodity associated with and extracted from natural gas) does occur in Arizona, all of the known occurrences are adjacent to the Defiance uplift in the northeastern portion of the state. Given the absence of active leases within or in close proximity to the SEZ and the absence of coal and oil and gas (and, therefore, helium) exploration and production activity in the Yuma Field Office planning area, the potential for coal and helium resources within the SEZ is low (level of certainty A).

There are no recorded salt (halite) deposits within or near the Agua Caliente SEZ; the only produced salt deposits in Arizona are in the Holbrook Basin on the Colorado Plateau, a few hundred miles to the northeast of the site, and in the Luke Basin just west of Phoenix. There has been no commercial production of potash on BLM-administered lands in Arizona; the nearest known occurrence is in the Holbrook Basin (BLM 2012). The potential for finding salt and potash resources within the SEZ, therefore, is low (level of certainty B).

The Agua Caliente SEZ is located in the Hyder area, a region of known or potential geothermal resources. Although there are no active or historical geothermal leases within the SEZ and there are no nominated lands for geothermal sale within the SEZ or in the immediate region, there are several low-temperature geothermal wells scattered throughout the area adjacent to the SEZ (on private land between the east and west parts of the SEZ) and within 10 mi (16 km) of the SEZ to the east, south, and southeast. The status of these wells has not been confirmed; however, given the projected temperatures within the basin and the presence of geothermal wells in close proximity to the SEZ, the potential for geothermal energy resources within the SEZ is moderate (level of certainty B).
1 INTRODUCTION

1.1 PURPOSE OF REPORT

The purpose of this report is to assess the mineral resource potential of 2,560 acres (10.4 km²) of public lands within the Agua Caliente Solar Energy Zone (SEZ) in southwestern Arizona, which the Secretary of the Interior may decide to withdraw from potentially conflicting uses through the issuance of a Public Land Order. If the order is approved, the public lands within the SEZ would be withdrawn, subject to valid existing rights, from location or entry under the mining laws, as follows:

- New mining claims could not be filed on the withdrawn lands; however, valid mining claims filed prior to the date the lands were segregated (i.e., the date the withdrawal application notice was published in the Federal Register) would take precedence over future solar energy development right-of-way (ROW) application filings.

- Withdrawn lands would remain open to mineral leasing, geothermal leasing, and mineral material and public land laws; the Bureau of Land Management (BLM) could elect to lease the oil, gas, coal, or geothermal steam resources, or to sell common-variety mineral materials such as sand and gravel, if the authorized officer determined there would be no unacceptable impacts on future solar energy development. These discretionary actions would comply with the management objectives outlined in the Yuma Field Office Record-of-Decision (ROD) and Approved Resource Management Plan (RMP) (BLM 2010).

- Withdrawn lands would remain open to ROW authorizations and land leases or permits authorized under Section 302 of the Federal Land Policy and Management Act of 1976 (FLPMA). These decisions would comply with the management objectives outlined in the Yuma Field Office ROD and Approved RMP (BLM 2010).

1.2 LEGAL DESCRIPTION OF THE SUBJECT LANDS

The Agua Caliente SEZ is located in BLM’s Yuma Field Office planning area in Yuma County. Its full legal description is provided below:

Gila and Salt River Meridian

T. 5 S., R. 12 W.,
Sec. 15, S½NE¼NE¼, S½NW¼NE¼, S½NE¼, s½NE¼NW¼, S½NW¼NW¼, SE¼;
Sec. 17, SE¼NE¼, SE¼;
Sec. 20, NE¼, SE¼NW¼, E¼SW¼, SE¼;
Sec. 22, E¼NE¼, E¼SE¼;
Sec. 23, W½;
Sec. 26, N½NE¼NW¼, NW¼NW¼;
Sec. 28, W½NE¼, W½, W½SE¼;
Sec. 29, NE¼, E½NW¼, E½SW¼, SE¼;
Sec. 33, NW½NW¼NE¼, N½NW¼, NW½SW¼NW¼.

The location of the SEZ is also shown in Figure 1.

1.3 METHODOLOGY AND RESOURCES

The assessment presented in this report focuses on locatable mineral resources, including those classified as strategic and critical, in the vicinity of the Agua Caliente SEZ proposed land withdrawal area; it also includes a discussion of leasable minerals and commercial saleable mineral values. The conclusions concerning mineral occurrence and development potential follow the methodology outlined in BLM Manual 3031 (BLM 1985) and are based on a review of topographic maps; geologic maps; mineral resource maps and reports; the scientific literature on the geology and mineral resources of Arizona; and consultation with the Jeff Garrett, mining law program lead at the BLM Arizona State Office. No mapping or field sampling was conducted as part of this assessment.

Digital data for the geologic map in Figure 2 (pages 12–13) was obtained from the U.S. Geological Survey (USGS) (Ludington et al. 2007). The dataset was digitized from previously published geologic maps ranging in scale from 1:100,000 to 1:1,000,000. Detailed map unit descriptions for this map are based on the published state geologic map by Richard et al. (2000). The large-scale, folded map (Map 1) provided in the back of this report shows the public land survey system grid (township and range) and should be consulted to locate mines and landscape features discussed in the text.

The BLM’s Legacy Rehost System (LR2000; BLM 2015b) was queried on February 10, 2015, for information on active and historical (unpatented) mining claims and various leases and permits, including oil and gas leases, coal leases, geothermal leases and land nominations, free use permits, and mineral materials contracts that were issued on public lands within and around the Agua Caliente SEZ proposed land withdrawal area.

Mines and mineral prospects and occurrences and their descriptions are those reported in the USGS’s Mineral Resource Data System (MRDS) (USGS 2014b; Lipin 2000) and supplemented with information provided by BLM and the open literature. The MRDS is a large database containing historical records of the USGS and the U.S. Bureau of Mines (which is now part of the USGS). These records are of variable quality and currency, so it is possible that some information will be found to be out of date (the revision and refinement of the database is an ongoing effort at the USGS). The mining activity map in Figure 3 (page 16) was prepared from the MRDS and is intended to provide a general picture of the location and nature of mining activity in the vicinity of the Agua Caliente SEZ. Refinements with regard to the status of particular mines are included in the text as warranted on the basis of conversations with BLM mineral specialists.
FIGURE 1  Location of the Agua Caliente SEZ
Geographic information system (GIS) data for mining districts in Arizona were not available; however, the mining districts originally listed in Keith et al. (1983a and 1983b) and Welty et al. (1985a, b) are easily identified as areas of clustered mining activity and are acknowledged in the discussion of locatable minerals for the SEZ (Section 4.1), as applicable.2 The Arizona Geological Survey (or AZGS, which consolidated with the Arizona Department of Mines and Mineral Resources in 2011) publishes maps and data on mines, prospects, quarries, and processing mills and plants by county and available at http://mines.az.gov/Publications/.

1.4 LOCATABLE MINERALS

Under U.S. mining laws, minerals fall into three categories: locatable, leasable, and salable. Because these categories were created by acts of Congress, they do not fall into simple economic or mineralogical divisions. Creating an exact and thorough list of locatable minerals (e.g., those subject to appropriation by using mining claims) is therefore difficult. Metallic minerals (e.g., gold, silver, copper, mercury, aluminum, antimony, lithium, molybdenum, tungsten, uranium, vanadium, and rare earths) are considered to be locatable. Numerous uncommon varieties of nonmetallic minerals may also be locatable, depending on their chemical content, quality, uses, and characteristics, as well as certain associated economic and legal matters. These nonmetallic minerals could include barite, calcite, specialty clays, bentonite, diatomite, feldspar, some gemstones (e.g., opals and diamonds), gypsum, chemical-grade limestone, perlite, chemical-grade silica sand, specific types of stone, talc, zeolites, and specific and uncommon types of dolomite. The determination of the actual locatability of uncommon varieties of nonmetallic minerals and the validity of mining claims for them is complex and relies on Public Law (P.L.) 84-167 (United States Code, Title 30, Section 601 et seq. [30 USC 601 et seq.]) and applicable case law (e.g., U.S. v Kenneth McClarty, 17 Interior Board of Land Appeals [IBLA] 20, 1974 [81 Interior Department (I.D.) 472]) (Shumaker 2011).

1.5 ARIZONA MINERAL PRODUCTION

Arizona’s nonfuel raw mineral production in 2009 decreased from its 2008 level by about 34% (which had increased by about 7.8% from its 2007 level). From 2005 through 2008, Arizona had the highest total nonfuel mineral production in the nation; however, in 2009 (the latest year for which statistics are available), it dropped in rank to second, accounting for 8.8% of the total U.S. production value. Copper accounted for more than 73% of the state’s total nonfuel mineral production value (and 60% of total U.S. copper production) in 2009. The remaining 27% of Arizona’s total nonfuel mineral production value was from the production of molybdenum, construction sand and gravel, and portland cement. The reduction in Arizona’s total production value was attributed to a significant decrease in the production value of copper. Other significant decreases in production value occurred with sand and gravel, crushed stone, molybdenum, and portland cement. Concurrently, however, there were significant increases in the production values of lime, salt, zeolites, and industrial sand and gravel. In 2009, Arizona’s rank among other

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2 The closest historical district to the Agua Caliente SEZ proposed land withdrawal area is the Neversweat District, located in T4S, R15 W, on the west side of the Palomas Mountains (Map 1).
producing states in produced gemstones, zeolites, gold, and lime increased to first, fourth (among six states), ninth (among 11 states), and 10th (among 33 states), respectively (USGS 2014a).

1.6 STRATEGIC AND CRITICAL MINERALS

Strategic and critical minerals are those minerals necessary for national defense and national security; for the nation’s energy infrastructure (e.g., pipelines or renewable energy production); to support domestic manufacturing, agriculture, housing, and telecommunications; or for the Nation’s economic security and balance of trade. Table 1 lists the nonfuel strategic and critical nonfuel minerals that are imported by the United States for its National Defense Stockpile, as authorized by the Strategic and Critical Materials Stock Piling Act (50 USC 98 et seq.). The recent National Strategic and Critical Minerals Production Act of 2013 (H.R. 761) requires the U.S. Department of the Interior (DOI) and the U.S. Department of Agriculture to develop domestic sources of these mineral materials. Several of the minerals produced in Arizona are classified as strategic and critical minerals. These include beryllium, copper, manganese, tungsten, vanadium, and zinc.

TABLE 1  Strategic and Critical Nonfuel Minerals

<table>
<thead>
<tr>
<th>Antimony</th>
<th>Copper</th>
<th>Platinum group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asbestos</td>
<td>Copper (industrial)</td>
<td>Quartz crystals</td>
</tr>
<tr>
<td>Bauxite and alumina</td>
<td>Fluorspar</td>
<td>Rutile (titanium)</td>
</tr>
<tr>
<td>Beryllium</td>
<td>Graphite</td>
<td>Silicon</td>
</tr>
<tr>
<td>Bismuth</td>
<td>Iodine</td>
<td>Tantalum</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Manganese</td>
<td>Thorium</td>
</tr>
<tr>
<td>Chromium</td>
<td>Mercury</td>
<td>Tin</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Mica sheet</td>
<td>Tungsten</td>
</tr>
<tr>
<td>Columbian</td>
<td>Nickel</td>
<td>Vanadium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zinc</td>
</tr>
</tbody>
</table>

2 BACKGROUND

2.1 LANDS INVOLVED

The Agua Caliente SEZ is located on public lands managed by BLM’s Yuma Field Office, Yuma County. The SEZ lies within sections 15, 17, 20, 22, 23, 26, 28, 29, and 33 of Township 5 south, Range 12 west (T5S, R12W), Gila and Salt River Principal Meridian. The original SEZ boundaries were revised to include buffers around major washes and to avoid several known archaeological sites and lands with wilderness characteristics. The northern portion of the original footprint was also removed to maintain the area of potential tortoise migration between the Palomas Mountains and Baragan Mountain (BLM 2012). The SEZ and various landscape features in the region are shown on the location map in the back of this report (Map 1).

As of June 2014, there were no pending solar project applications within the SEZ, and one pending solar project application (Pacific Solar Inv., Inc.) located within a 25-mile (40-km) radius (and to the northeast) of the SEZ. A 290-MW photovoltaic (PV) facility (NRG Energy) is located on private land adjacent to the SEZ; it came online in 2014 (BLM 2015a).

2.2 LAND STATUS

According to the LR2000, accessed on February 10, 2015, there are no locatable mining claims or active mines within the Agua Caliente SEZ proposed land withdrawal area (BLM 2015b).

There are no free use permits or mineral materials contracts within the SEZ (BLM 2015b). The SEZ remains open for the disposal of saleable mineral materials (e.g., sand and gravel).

There are no active oil and gas leases within or around the Agua Caliente SEZ; however, most of the SEZ was leased for oil and gas in the past (a total of eight leases, closed in 1980, 1986, and 1997) (BLM 2015b). (According to the Arizona Oil and Gas Conservation Commission, all of Arizona’s oil and gas development occurs in Apache County; see AOGCC 2013.) There are no active or historical salt, potash, coal, helium, or geothermal leases within the SEZ. The SEZ remains open for the discretionary leasing of these commodities.

2.3 PHYSICAL FEATURES AND ACCESS

The Agua Caliente SEZ is located in an area that is sparsely populated with limited economic development. The surrounding area is predominantly agricultural (to the east and south) and undeveloped desert (to the north and west). The nearest major road access is Interstate 8, about 12 mi (19 km) south of the SEZ. A Yuma County road, Palomas Road, passes just to the south; it also provides access to the SEZ (BLM 2012).
3 GEOLOGIC SETTING

The Agua Caliente SEZ proposed land withdrawal area is located within the Palomas Plain, a northwest-trending, broad, alluvial (extensional) basin within the Basin and Range physiographic province in southwestern Arizona. The plain is bounded on the southwest by the Palomas Mountains (part of the Kofa-Tank Mountains complex). The Agua Caliente Mountains are about 7 mi (11 km) to the east of the SEZ; the Aztec Hills are about 11.5 mi (18.5 km) to the south. The SEZ lies between two ephemeral washes, the Hoodoo Wash to the west, and the Baragan Wash to the east, which discharge to the Gila River a few miles to the south (Figure 2). Several small washes intersect the SEZ.

Precambrian metamorphic rocks (schist and gneiss – Xm) and granite (Xg) are exposed in portions of the Tank and Palomas Mountains and in the Aztec Hills to the south (YXg), as shown in Figure 2. These rocks are highly faulted and fractured, and they are intruded by quartz-dominated pegmatite dikes and veins. Most of the mineralization in the Palomas Mountains (chrysocolla, malachite, hematite, and quartz) is located along the northern margin of Tertiary granite and foliated granitic rocks (Tg) (Skotnicki and Ferguson 1994). Tertiary volcanic rocks (Tv) comprise the Agua Caliente Mountains and occur throughout the Tank and Palomas Mountains (Jones 1979).

Basin fill beneath the Palomas Plain is estimated to be about 8,850 ft (2,700 m) deep. The uppermost sediments consist of unconsolidated sand, gravel, silt, and clay that overly an older, more indurated sequence of arkosic sediments and fanglomerates. These older sediments are about 4,600 ft (1,400 m) thick and sit unconformably atop Tertiary sediments, volcanics, and volcanic detritus from pre-Tertiary bedrock. The basin itself is underlain by a basement complex of granite and undifferentiated metamorphic rocks (Jones 1979; Armstrong and Yost 1958; and BLM 2012).
FIGURE 2  Geologic Map of the Agua Caliente SEZ
Cenozoic (Quaternary, Tertiary)

- **Qr** River deposits (alluvium)
- **Q** Surficial deposits, including wind-blown sand (0 to 2 m.y.)
- **Qm** Surficial deposits (10,000 to 750,000 yr)
- **Qo** Older surficial deposits (750,000 to 3 m.y.)
- **QTb** Basaltic rocks
- **Tsy** Consolidated conglomerate and sandstone
- **Tv** Volcanic Rocks
- **Tg** Granitic rocks

Precambrian

- **YXg** Early and middle Proterozoic granitic rocks, undivided (1,400 to 1,800 m.y.)
- **Xg** Granitic rocks (1,600 to 1,800 m.y.)
- **Xm** Metamorphic rocks (Yavapai Supergroup and Pinal Schist)

FIGURE 2 (Cont.)
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4 MINERAL HISTORY AND RESOURCE POTENTIAL

This chapter assesses the mineral potential of 2,560 acres (10.4 km²) of public lands identified for withdrawal from location or entry under the mining laws. The purpose of the land withdrawal is to protect and preserve, for a 20-year period, the area known as the Agua Caliente SEZ, which is located 65 mi (104 km) northeast of the city of Yuma, and 60 mi (97 km) southwest of Buckeye in Yuma County in southwestern Arizona. Under the withdrawal, the lands would be closed to locatable mineral entry but would remain open for discretionary leasing for oil and gas and other leasable minerals and for the disposal of saleable minerals (see also Section 1.1).

There has been no documented mining within the Agua Caliente SEZ proposed land withdrawal area. Mining activity in the immediate region has been limited to the historical small-scale mining of copper in the Palomas Mountains about 5 mi (8 km) to the west of the SEZ (Figure 3). Currently, there is no mining activity within or in close proximity to the SEZ, and there are no major active mines within Yuma County (USGS 2014b; AZGS 2011).

4.1 LOCATABLE MINERALS

There are no known locatable mineral deposits or prospects and no mining claims or active mines identified within the Agua Caliente SEZ proposed land withdrawal area (BLM 2015b). The nearest occurrence of locatable minerals is of copper ore (chrysocolla and malachite), historically produced from the Engles-Adams Mine in the south-central part of the Palomas Mountains, about 5 mi (8 km) to the west (in section 16 of T5S, R13W; see Map 1). Workings include several short tunnels and four deep shafts (30 to 100 ft deep); however, production records for the mine are not available. A copper prospect, identified in the MRDS as Rainbow and Valley, is also located in section 16 of T5S, R13W. Both occurrences are associated with quartz-feldspar porphyry and basaltic dikes in Tertiary granitic rocks (Tg); neither is considered economically significant (USGS 2014b; Skotnicki and Ferguson 1994).

The nearest mining district to the Agua Caliente SEZ is the Neversweat District, located on the west side of the Palomas Mountains (in T4S, R15W), some 16 mi (26 km) to the northwest of the SEZ (based on the historical mining districts delineated by Keith et al. [1983a] and Welty et al. [1985a, b]; see Map 1). The district produced lead, gold, copper, and silver. Mineralization is associated with middle Tertiary rhyolite and andesite dikes (Keith et al. 1983a). Several inactive small mines, most of which produced copper, silver, and gold (with some reports of mica, tungsten, and lead), are located in the Kofa Mountains (Kofa District) much farther to the northwest (in T1S and T2S, R17W) (USGS 2014b). Some of these mines are placer operations and coincide with gold placer districts identified by Wilson (1981).
FIGURE 3 Map Showing Mines and Mineral Prospects near the Agua Caliente SEZ
(Source: USGS 2014b)
The Agua Caliente SEZ crosses none of the historical mining districts delineated by Keith et al. (1983a), Welty et al. (1985a, b), or Wilson (1981), and there has been no hard rock or locatable mineral activity within or in close proximity to the SEZ. Modern alluvial deposits below the SEZ extend to a depth of at least 1,600 ft (490 m) (Richard et al. 2007) and are underlain by a thick sequence of Tertiary volcanics similar to those exposed in the adjacent mountains. Mineralization below the SEZ is unconfirmed; however, based on available geologic data, it would likely be very deep (below basin sediments) if present. Therefore, the potential for metallic (lode) minerals (e.g., copper, iron, gold) is low (level of certainty B). Several washes intersect the SEZ; however, there are no major streams running through it. And there is no direct evidence (assay or past production) to suggest that placer deposits (such as gold) occur within or in close proximity to the SEZ. Therefore, the potential for placer deposits within the SEZ is also low (level of certainty A).

4.2 SALEABLE MINERAL MATERIALS

Saleable mineral materials in the region are mainly sand and gravel, stone, and crushed stone. These commodities are produced by the Aztec Granite Quarry, about 11.5 mi (7.1 km) to the south in section 28 of T7S, R12W (see Map 1) (USGS 2014b). According to the LR2000, accessed on February 10, 2015, there currently are no active free use permits or mineral materials contracts within the SEZ (BLM 2015b).

The Agua Caliente SEZ is underlain by alluvial and basin-fill sediments and is, therefore, a high potential area for sand and gravel deposits (level of certainty C). However, based on the absence of free use permits or mineral materials contracts within the SEZ, the regional demand for these materials is assumed to be low.

4.3 LEASABLE MINERALS

There are no active oil and gas leases within the Agua Caliente SEZ (BLM 2014b), and there are no active oil and gas leases within the Yuma Field Office planning area (BLM 2010). A total of eight leases covered most of the SEZ at one time; however, these leases were closed in 1980, 1986, and 1997 (BLM 2015b). There has been no history of oil and gas production in Yuma County; the only areas of the state currently producing oil and gas are located in Apache County in northeastern Arizona (AOGCC 2013; Rauzi 2011). There also are no known coal resources within the immediate region of the Agua Caliente SEZ (Palomas Plain); the most extensive coal reserves are in Cretaceous rocks such as those in the Black Mesa and Pinedale Fields in northeastern and eastern Arizona (Peirce et al. 1970). Helium (a commodity associated with and extracted from natural gas)\(^3\) does occur in Arizona; however, all of the known occurrences are adjacent to the Defiance uplift (trapped within the anticlinal structures of the Holbrook Basin and in the oil and gas fields near in the four corners region) in the northeastern portion of the state (Rauzi 2003). Given the geologic conditions dictating oil and gas, coal, and

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\(^3\) Helium is not a leasable mineral but is included here because it is associated with oil and gas production (as stated in the Yuma Field Office RMP [BLM 2012]).
helium development in the state and the absence of exploration and production activity in the Yuma Field Office planning area (and the absence of active leases within or in close proximity to the SEZ), the potential for oil and gas, coal, and helium resources within the SEZ is low (level of certainty A).

There are no recorded salt (halite) deposits within or near the Agua Caliente SEZ. Permian-age salt deposits in Arizona occur (and are produced) in the Holbrook Basin on the Colorado Plateau, a few hundred miles to the northeast of the site, and in the Luke Basin just west of Phoenix. Massive salt deposits are also known to occur in the Hualapai Valley north of Kingman (BLM 2012). There has been no commercial production of potash on BLM-administered lands in Arizona. The nearest potash deposit occurs in the Permian Supai Formation in the Holbrook Basin (BLM 2012). The potential for finding salt and potash resources within the SEZ, therefore, is low (level of certainty B).

The Agua Caliente SEZ is located in the Hyder area, a region of known or potential geothermal resources (BLM 2008; INEEL 2003; Jones 1979). According to the LR2000, there are no active or historical geothermal leases within the SEZ, and there are no nominated lands for geothermal sale in the immediate region (BLM 2015b). However, there are several low-temperature geothermal wells scattered throughout the area adjacent to the SEZ (on private land between the east and west parts of the SEZ) and within 10 mi (16 km) of the SEZ to the northeast, east, and south (Figure 3; see also Map 1) (USGS 2014b). The status of these wells has not been confirmed. Jones (1979) estimates a normal temperature gradient of 35°C (95°F)/km for the basin, and projects temperatures of 200°C (392°F) at depths as shallow as 6,560 ft (2,000 m) in some places. INEEL (2003) places wells in the Hyder area in the $\geq 20$°C ($\geq 68$°F) and $\leq 50$°C (122°F) range. Given the projected temperatures within the basin and the presence of geothermal wells in close proximity to the SEZ, the potential for geothermal energy resources within the SEZ is moderate (level of certainty B).
5 SUMMARY

Table 2 provides a summary of the mineral resource potential for the Agua Caliente SEZ proposed land withdrawal area.

**TABLE 2  Summary of Mineral Resource Potential for the Agua Caliente SEZ Proposed Land Withdrawal Area**

<table>
<thead>
<tr>
<th>Mineral Category</th>
<th>Mineral History/Background</th>
<th>Mineral Resource Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locatable Minerals</td>
<td>No known locatable mineral deposits or prospects; no mining claims or active mines. Nearest occurrences are in the Palomas Mountains (copper). SEZ does not cross historical mining districts.</td>
<td>Metallic (lode) minerals – low (level of certainty B)   Placer deposits – low (level of certainty A)</td>
</tr>
<tr>
<td>Saleable Mineral Materials</td>
<td>Materials in region include sand and gravel, stone, and crushed stone. No active free use permits or mineral contracts within SEZ; low regional demand.</td>
<td>Sand and gravel – high (level of certainty C)</td>
</tr>
<tr>
<td>Leasable Minerals</td>
<td>Oil and gas leases covered most of the SEZ at one time; leases closed in 1980, 1986, and 1997 (no active oil and gas leases). No known coal resources in the immediate region of the SEZ. No known helium resources in the immediate region of the SEZ. No known salt or potash deposits in the immediate region of the SEZ. SEZ is located in the Hyder area, a region of known or potential geothermal resources, but there are no geothermal leases within the SEZ and no nominated lands in the immediate region. Several test wells adjacent to the SEZ and in the vicinity.</td>
<td>Oil and gas – low (level of certainty A)   Coal – low (level of certainty A)   Helium – low (level of certainty A)   Salt, potash – low (level of certainty B)   Geothermal – moderate (level of certainty B)</td>
</tr>
</tbody>
</table>
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6 REFERENCES


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