

Chapter E. Mineral Resource Potential of the Arden, Bird Spring, and Sloan Rock Art Areas of Critical Environmental Concern, Clark County, Nevada

By Stephen B. Castor, Brett T. McLaurin, Kathryn S. Flynn, and Steve Ludington

Summary and Conclusions

The Arden Area of Critical Environmental Concern (ACEC) contains known deposits of silica that were mined in the past. These deposits help define an area in the ACEC that has high potential for the occurrence of silica deposits. The Arden ACEC contains a gypsum deposit that was mined in the past, but the potential for the occurrence of undiscovered gypsum deposits in this area is low. Two small uranium prospects are near the Arden ACEC, but these imply only low potential for the occurrence of uranium deposits. There is no potential for the occurrence of other deposits of locatable or leasable minerals.

The Arden ACEC contains areas with both low and moderate potential for the occurrence of crushed-stone aggregate deposits. The ACEC also contains tracts with high potential for the occurrence of sand and gravel aggregate deposits.

The Bird Spring ACEC contains no known mineral deposits. There is no potential for the occurrence of other deposits of locatable or leasable minerals. The ACEC has areas of both moderate and low potential for the occurrence of crushed-stone aggregate deposits, and a tract with high potential for the occurrence of sand and gravel aggregate deposits.

The Sloan Rock Art ACEC contains no known mineral deposits. There is no potential for the occurrence of other deposits of locatable or leasable minerals. The ACEC has moderate potential for the occurrence of crushed-stone aggregate deposits; sand and gravel aggregate does not occur.

Introduction

This report was prepared for the U.S. Bureau of Land Management (BLM) to provide information for land planning and management, and, specifically, to determine mineral resource potential in accordance with regulations at 43 CFR 2310, which governs the withdrawal of public lands. The Clark County Conservation of Public Land and Natural Resources Act of 2002 temporarily withdraws the lands described herein from mineral entry, pending final approval

of an application for permanent withdrawal by the BLM. This report provides information about mineral resource potential on these lands.

The Arden, Bird Spring, and Sloan Rock Art Areas of Critical Environmental Concern (ACECs) were studied in the field to confirm descriptions of the geology that were gleaned from the scientific literature. Samples were collected and analyzed, and representatives of the companies with mining operations in and near the areas were contacted.

Definitions of mineral resource potential and certainty levels are given in appendix 1, and are similar to those outlined by Goudarzi (1984).

Lands Involved

The Arden ACEC, Bird Spring ACEC, and the Sloan Rock Art ACEC are described together in this report because they are in close proximity. The areas are south of Las Vegas near Interstate 15 (fig. 1). Arden and Bird Spring can be accessed by various primitive roads that extend west from the Sloan exit on Interstate 15 or south from the Blue Diamond Road (Nevada Highway 160), although some access roads from the Blue Diamond Road are partially blocked by new housing developments. Sloan Rock Art ACEC is within both the Sloan Canyon National Conservation Area and the North McCullough Wilderness. It is accessed from a primitive road that extends east from Las Vegas Boulevard near the Sloan exit off I-15. A legal description of these lands is included in appendix 2.

Physiographic Description

The Arden ACEC consists primarily of hills that reach elevations of more than 1,300 m; Longwell and others (1965) referred to them as "hills near Sloan." They are drained by alluvial fans that range between 800 and 900 m in elevation along north- to northeast-draining valleys. The Bird Spring ACEC ranges in elevation from 1,250 to 1,450 m on the

EXPLANATION

- Qu
Undivided surficial deposits (Pleistocene and Holocene)—Alluvium, colluvium, lake, playa, landslide, terrace, and eolian sand deposits
- Tvy
Young volcanic rocks (middle and upper Miocene)-Rhyolite, andesite, and basalt lava flows, tuff, and tuffaceous sediments
- JTRs
Sedimentary rocks (Triassic and Jurassic)—Shale, mudstone, siltstone, sandstone, and carbonate rock; some sparse volcanic rock. Includes Lower Jurassic Glen Canyon Group (Navajo Sandstone, Kayenta and Moenave Formations, Wingate Sandstone, Aztec Sandstone) and Chinle and Moenkopi Formations
- uPzc
Carbonate rocks (Mississippian to Permian)-Limestone, dolomite, and some shale. May include Kaibab, Callville, Ely, Tippisah, Temple Butte, Rogers Spring, Monte Cristo, and Redwall Limestones, Toroweap Formation, Coconino Sandstone, and Bird Spring Formation
- uPzs
Sedimentary rocks (uppermost Devonian to Permian)—Siltstone, sandstone, shale, and conglomerate; some limestone, dolomite, chert, marble, and gypsum. May include Queantoweap Sandstone, Hermit Shale, Coconino Sandstone, Supai Group, Pakoon Formation, Pilot and Chainman Shales, Eleana and Diamond Peak Formations, and Joana, Narrow Canyon, and Mercury Limestones
- iPzc
Dolomite and Limestone (Cambrian to Devonian)-Dolomite, limestone, and minor amounts of sandstone, shale, and siltstone. May include Sevy, Simonson, Laketown, Lone Mountain, Ely Springs Dolomites, Devils Gate and Muav Limestone, and Guilmette, Nevada, Carrara, Bonanza King, and Nopah Formations, Dunderberg and Pioche Shales, Pogonip Group, and Eureka Quartzite
- contact, certain
- fault, certain
- fault, approximate
- fault, concealed
- thrust fault
- mine or prospect
- sample site, with sample number

Figure 1.—Continued.

northeast slope of the Bird Spring Range. The Sloan Rock Art ACEC is an area of small hills with a valley that drains north on the east side of the ACEC. The area ranges in elevation from 900 to 1,150 m, and is on the west flank of the McCullough Range.

Geologic Setting

The area is part of the Basin and Range Physiographic Province, characterized by north trending mountain ranges and intervening valleys. The Arden and Bird Spring ACECs are in the southern part of the Spring Mountain structural block, an area mainly characterized by west- to north-dipping Paleozoic and Mesozoic sedimentary rocks that are cut by major Mesozoic thrust faults and Cenozoic normal faults (Burchfiel and others, 1974). The Sloan Canyon ACEC is in the northern part of the McCullough Range structural block, an area that is mainly underlain by west-dipping Miocene volcanic rocks.

Geology

Bedrock in the Arden ACEC consists of, from oldest to youngest: cherty carbonate rocks of the Pennsylvanian-Permian Bird Spring Formation; Permian redbeds; and Permian cherty carbonate strata of the Kaibab and Toroweap Formations. The Permian redbeds were originally correlated with the Supai Formation (Hewett, 1931) but later correlated with the Hermit Shale and placed in the Hermit Formation (Longwell and others, 1965). Strata in these units mostly dip gently westward; however, Longwell and others (1965) mapped north-east-trending folds south of the ACEC, and they described the overall structure in the hills near Sloan as an elongate dome. They noted that all the Paleozoic strata in the area have dips of less than 10°. Northwest-striking Cenozoic normal faults cut the bedrock.

The Bird Spring ACEC is notable for exposures of the Bird Spring thrust fault, which dips about 25° west. It separates the Pennsylvanian-Permian Bird Spring Formation in the upper plate from Mesozoic rocks (mostly Chinle and Moenkopi Formations) in the lower plate.

Rocks of the Sloan Rock Art ACEC consist of Miocene basalt and andesite flows. Some details of the volcanic geology of the area were studied by Bridwell (1991).

Mining History

At least seven inactive silica and gypsum open-pit mines are in and near the Arden ACEC, mostly in the Arden Quarries area (fig. 1). In addition, there are some inactive underground mines and several prospects. Within 10 km of the area, gypsum, dolomite, limestone, silica, stone, and construction aggregate have all been mined.

The mining of limestone in the Sloan area, about 5 km southeast of the Arden ACEC, began in 1910 (Longwell and others, 1965), and dolomite mining was initiated in the same area in 1928 and continued until 1997. Both limestone and dolomite were used to produce lime at a plant in Henderson. Carbonate rock mining at Sloan has resumed, but the rock is now used in construction aggregate.

Gypsum mining in the Arden area, about 3 km north of the Arden ACEC, began in 1909 and continued until 1931. Mining in the Bard area within the Arden ACEC (fig. 1) took place at about the same time (Papke, 1987). In 1925, mining began at the Blue Diamond gypsum deposit, about 10 km northwest of the Arden ACEC. This operation, which was scheduled to cease in 2005 to make way for housing development, has likely produced more gypsum than any other deposit in Nevada.

Silica mining began in 1930 at a locality about 5 km north of the Arden ACEC (described by Murphy [1954] as the Arden operation). Foundry sand and glass sand were reportedly produced there. Steel-molding sand was shipped in 1934 from the Bard operation, which mined silica from sites in the Arden ACEC and nearby areas. Building stone may also have been produced from these sites. Silica was also reportedly shipped as glass sand from a deposit near Jean, about 12 km south of the Arden ACEC, although this production may actually have come from the Nevada Royale and Gary Allen Quarries, which are further north, closer to the Arden and Bird Spring ACECs.

There are no known mines or prospects in the Bird Spring ACEC. Significant amounts of base and precious metals were mined in the Goodsprings district, about 20 km to the southwest. Stone and aggregate are presently mined at the Las Vegas Rock Quarry 7 km to the west. Minor amounts of silica and stone were mined in the past, about 5 km to the east at the Nevada Royale and Gary Allen Quarries.

The Sloan Rock Art ACEC has no history of mining. Sand and gravel have been mined from alluvial fans about 8 km to the north. Limestone, dolomite, and crushed stone have been mined at Sloan, about 10 km to the northwest of the ACEC. An abandoned mineshaft is about 2 km to the southwest, but no mineral deposit has been described from the area.

Mineral Deposits

Arden Quarries

Silica-rich sandstone is exposed in several quarries and underground excavations (figs. 2 and 3), now closed, along the west edge of the Arden ACEC. These deposits occur in a relatively resistant unit of white to light-pink, cross-bedded quartz arenite about 50 m thick that is likely correlative with the Coconino sandstone (fig. 4). The northernmost quarry, in the Arden ACEC, is a narrow pit, about 300 m long and 15 m

wide. Chip samples from exposures just south of this quarry that represent about 40 m of section contain 93.19 percent to 94.39 percent SiO_2 (Ludington and others, 2005). X-ray diffraction (XRD) analysis and petrographic examination show that the major impurities are K-feldspar, calcite, and dolomite. To the south is a 250-m-long and 10-m-wide open cut that has a series of portals to room-and-pillar workings cut into its west wall. A sample of representative rock from the open cut contains 95.6 percent SiO_2 (Ludington and others, 2005).

The chemical analyses of the sandstone samples from the Arden Quarries suggest that the material will not meet specifications for glass sand (table 1; Ludington and others, 2005). In comparison with analyses of the Baseline Sandstone from the Simplot Silica operation at Overton, Nevada, which is used as glass sand, sandstone from the Arden Quarries area contains too little silica and too many impurities for glass sand, which requires at least 98.5 percent silica (table 1). It is possible that the quality can be upgraded by simple processing; however, examination of a thin section of the best material that we collected from the Arden Quarries showed that carbonate occurs as small rhombs intergrown with quartz at grain boundaries (fig. 5), and it is unlikely that glass sand can be produced from it by inexpensive processing.

Bard Gypsum Deposit

The Bard gypsum deposit is in the Arden ACEC (fig. 1), where it is exposed in an abandoned open pit that is 75 m x 15 m. The gypsum has a maximum exposed thickness of 5 m in a bed that is nearly horizontal. The gypsum is of only fair quality because of interbeds of clayey and silty material. X-ray diffraction of a sample showed small amounts of quartz, montmorillonite, and illite (Papke, 1987). The gypsum is overlain by about 5 m of reddish-brown sandstone and about 15 m of gray limestone. This sequence is capped by cherty limestone of the Kaibab Formation.



Figure 2. Narrow open cut at the North Arden Silica Quarry.

Table 1. Composition of sandstones from Arden Quarries.

[Simplot Silica Plant data are from Murphy (1954); container glass specifications are from Zdunczyk and Linkous (1994).]

Element	AP-001M	AP-001T	AP-006C	Simplot Silica mine	Simplot Silica Plant	Container glass specification
SiO ₂	94.39	93.19	95.56	97.25	98.93	98.5 min
Al ₂ O ₃	1.51	1.65	0.77	1.38	0.65	0.5 max
Fe ₂ O ₃	0.31	0.37	0.4	0.19	0.03	0.035 max
MgO + CaO	1.62	2.03	1.22	0.27	0.05	0.2 max
TiO ₂	0.05	0.08	0.02	0.08	0.03	0.03 max
Cr ₂ O ₃	0.027	0.024	0.031	0.00	nd	0.001 max



Figure 3. Concrete-barricaded portals in Coconino Sandstone at the South Arden Quarry site.



Figure 4. Relatively resistant cliffs of Coconino Sandstone (red rocks in lower part of face), Arden Quarries area.

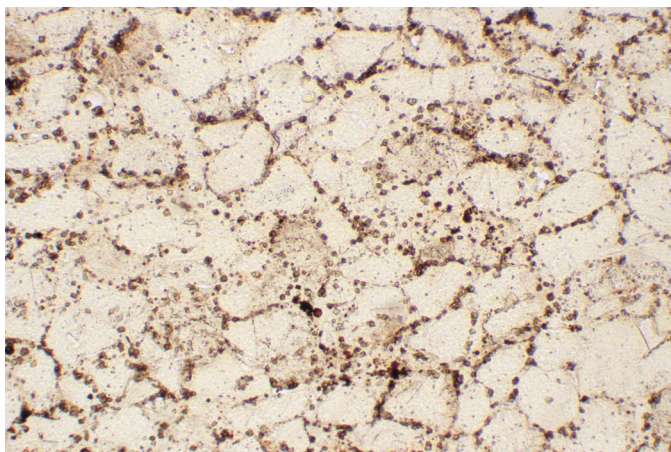


Figure 5. Photomicrograph, in plane-polarized light, of silica-rich sandstone from the South Arden Quarry (sample AP-006) showing tiny dolomite rhombs along grain borders and within sand grains. Horizontal field of view is 1.25 mm.

Uranium Prospects

Two uranium prospects are about 5 km southeast of the Arden ACEC. One, called the Little Snake and Purple Valentine prospect (fig. 1), was visited during this study. In a small pit there (fig. 6), yellow and greenish-yellow fracture coatings are present in the most radioactive part of an exposed shear zone, where maximum radioactivity is about 20 times background. A grab sample (sample AP-007, fig. 1) of the most radioactive rock contains 384 ppm U along with elevated Sr and V (Ludington and other, 2005). The occurrence does not correspond with any commercial uranium deposit models, although Johnson (1982) and Johnson and Glynn (1982) compared carnotite occurrences in the area with the potentially commercial Yeelirie calcrete carnotite deposit in western Australia. However, the Yeelirie deposit is a 6-km-long, 3-km-wide, and 8-m-thick deposit in calcrete that was deposited in a broad valley, which is unlike the occurrence examined.



Figure 6. Hematitic radioactive shear zone in uranium prospect, hammer for scale.

Mineral Exploration and Development

The Arden, Bird Spring, and Sloan Rock Art ACECs contain no active mining claims, and there is no current exploration activity.

Mineral Resource Potential

Locatable Minerals in Arden ACEC

A part of the Arden ACEC is considered to have high potential for deposits of silica, with a moderate certainty level (tract ABS03, fig. 7). The samples that we took indicate that the sand is probably not pure enough for the production of glass,

although it was reportedly used for that purpose in the past. It may be suitable for commodities with less rigorous specifications, such as foundry sand, for which it was used in the past. The amount of silica-rich sandstone in the area is large, and we estimate that about 20 million short tons of resource could be mined by open-cut methods without removal of overlying rock in the area of the Arden quarries. The certainty level for this determination is moderate because it is unclear whether or not the silica product that could be produced from the sandstone is of sufficient quality for commercial use.

A small part of the Arden ACEC has low potential, with a moderate certainty level, for sedimentary gypsum deposits (tract ABS02, fig. 7). The potential area surrounds the Bard gypsum mine, where the exposed gypsum is thin and of relatively poor quality. The potential area extends beneath Quaternary alluvium in this area, where removal of overburden would be necessary. Potential for economically viable gypsum deposits is low here because mining of thin, low-grade gypsum deposits under cover is too expensive. The gypsum undoubtedly extends under the Kaibab Formation to the west; however, successful commercial extraction of such material is highly unlikely.

In the past, gypsum mining in the Arden area was by underground methods, which are not now competitive. Modern gypsum mining in Nevada is by surface mining methods in areas with little overburden. At the BPB operation at Blue Diamond, high-grade gypsum (>92 percent gypsum) was mined until recently from erosional remnants of gypsum that cap resistant limestone of the Kaibab Formation. At the PABCO and Pioneer Mines, low-grade (70-85 percent gypsum) ore is mined from very large deposits (Castor, 2003; Papke, 1987). The PABCO ore is easily beneficiated by washing to a purity of 92-95 percent gypsum, which is suitable for wallboard and plaster. At both mines, mining and beneficiation costs are low. The Pioneer Mine produces low-cost gypsum for agricultural uses only.

There is no evidence for deposits of other locatable minerals.

Leasable Minerals in Arden ACEC

The area is within the region considered by the BLM to be moderately favorable for oil and gas (Smith and Gere, 1983). The Arden Dome, a structure that lies mostly to the north and northeast of the area, was the site of oil exploration drilling between 1929 and 1944. Six wells were drilled to test the structure, one more than 1,100 m deep. Two of six wells in the area had hydrocarbon showings (Lintz, 1957). Miller (1945) suggested that the dome was formed during nearby intrusive activity rather than by compressive tectonism and that the chance of finding carbon dioxide exceeded that of finding hydrocarbons.

There is no indication of potential for brine or evaporite deposits of sodium and potassium. The ACEC contains no known deposits of leasable minerals, and the potential for their occurrence is low.

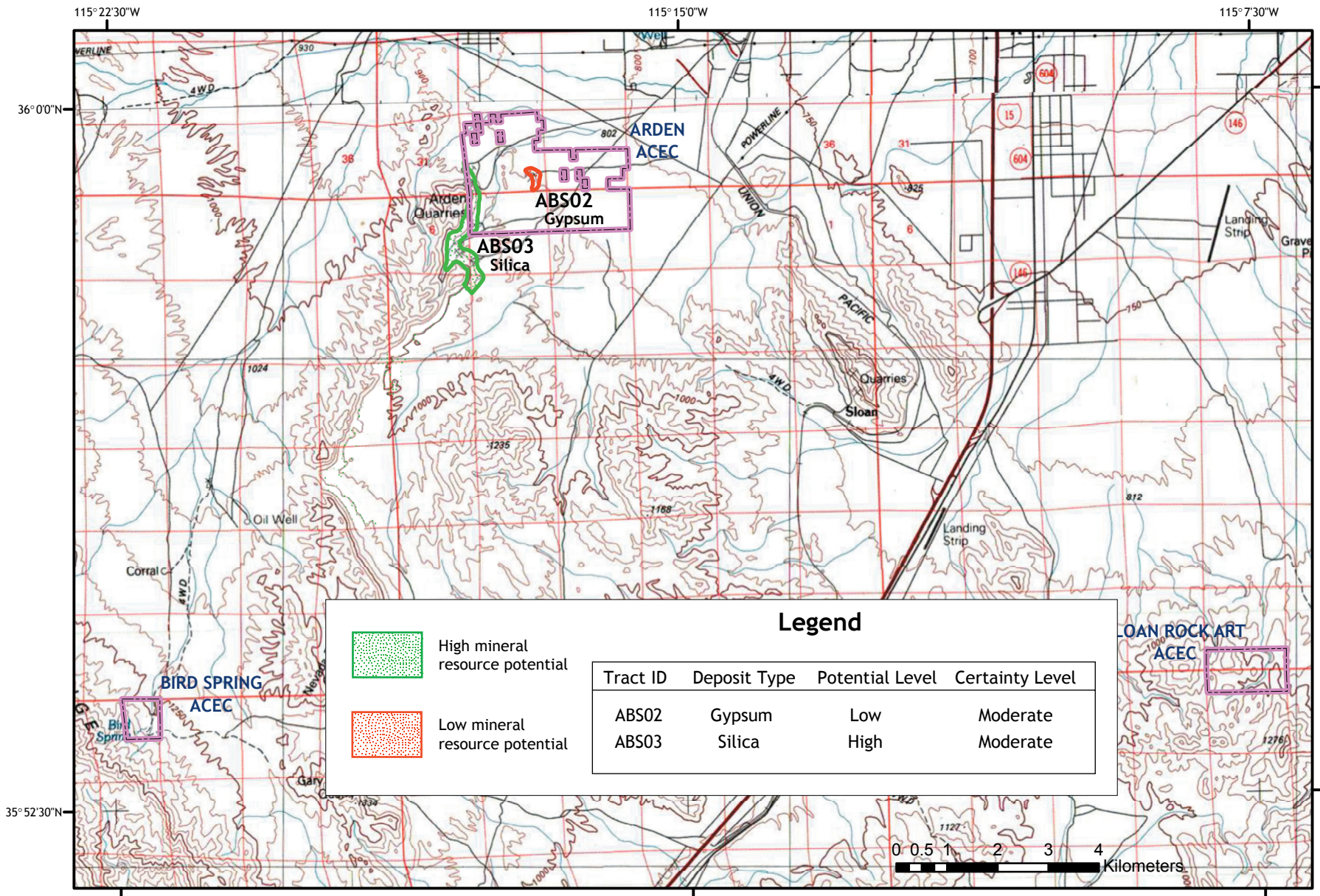


Figure 7. Mineral resource potential tracts for gypsum and silica deposits in the Arden, Bird Spring, and Sloan Rock Art Areas of Critical Environmental Concern (ACECs; outlined in pink).

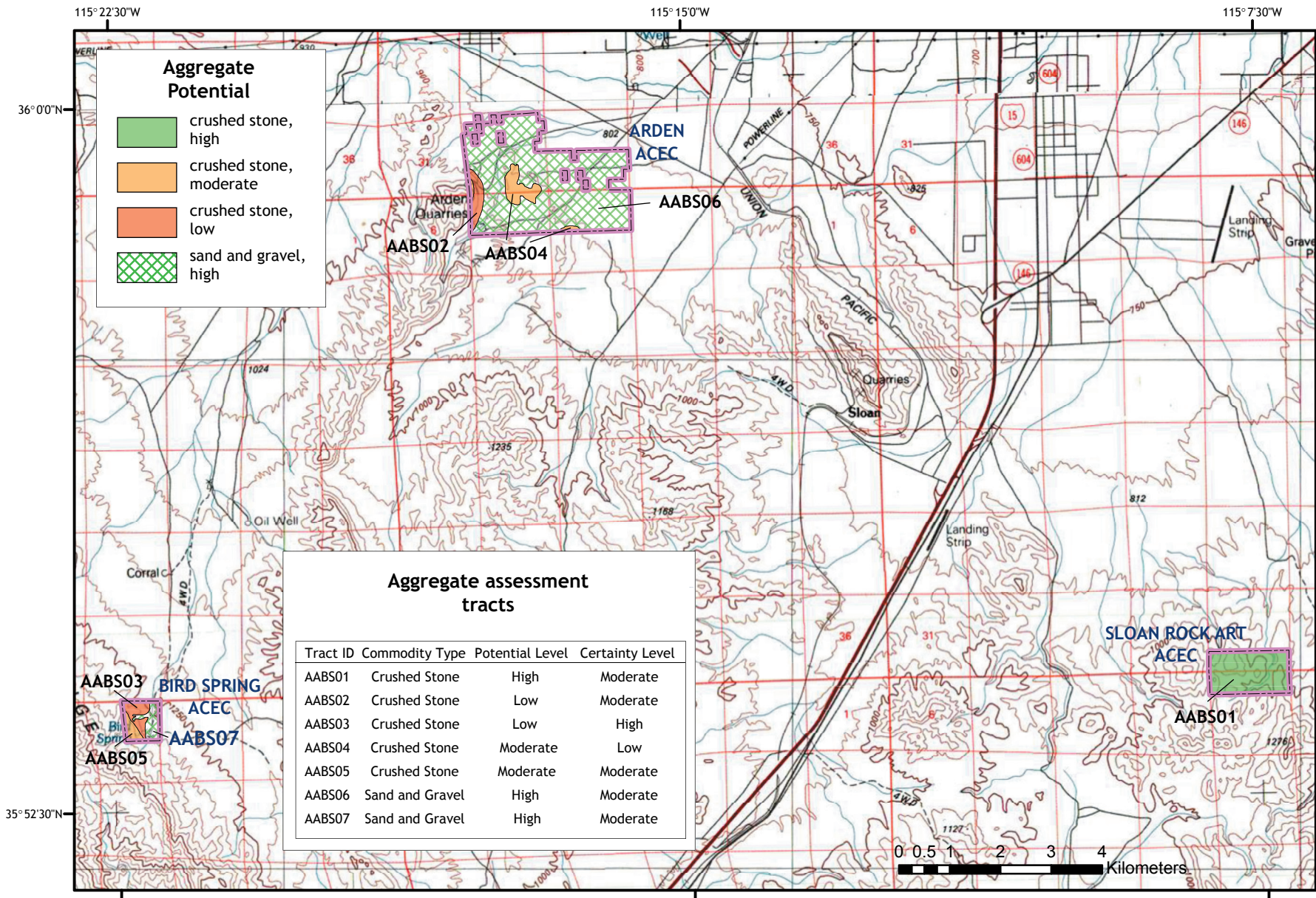


Figure 8. Mineral resource potential tracts for aggregate resources in the Arden, Bird Spring, and Sloan Rock Art Areas of Critical Environmental Concern (ACECs; outlined in pink).

Salable Minerals in Arden ACEC

Crushed Stone.—West-dipping Coconino Sandstone, Toroweap Formation, and Kaibab Limestone characterize the western side of this ACEC. The Coconino Sandstone has been quarried for stone, but the friable nature of most of the unit means it will not make high-quality aggregate. The Coconino does have zones that are more strongly lithified, but overall the material is not suitable for high-quality aggregate. Areas where Coconino Sandstone crops out are assigned a low potential for crushed-stone aggregate deposits, with a moderate certainty level (tract AABS02, fig. 8). Cherty zones in the Bird Spring and Toroweap formations and the Kaibab Limestone lead to assignment of a moderate potential for crushed-stone aggregate deposits, with a low certainty level (tract AABS04, fig. 8) in areas where these units are exposed.

Sand and Gravel.—Although friable clasts of Permian sandstone occur in alluvial deposits, carbonate clasts derived from adjacent highlands means that much of the available aggregate material is of high quality. Carbonate clast sources include the Bird Spring Formation, the Toroweap Formation, and the Kaibab Limestone. Most of the area that is underlain by alluvium has high potential for sand and gravel aggregate, with a moderate certainty level (tract AABS06, fig. 8).

Locatable Minerals in Bird Spring ACEC

The Bird Spring ACEC contains no known deposits of locatable minerals, and there is no potential for their occurrence.

Leasable Minerals in Bird Spring ACEC

There is no indication of potential for brine or evaporite deposits of sodium and potassium in the Bird Spring ACEC. The area contains no known deposits of leasable minerals, and the potential for their occurrence is low.

Salable Minerals in Bird Spring ACEC

Crushed Stone.—This ACEC is along the south end of the Bird Spring thrust fault, where Paleozoic carbonate rocks overlie siltstone and sandstone of the Triassic Moenkopi Formation. Carbonate rocks in the hanging wall that are interbedded with chert define a tract with moderate potential for crushed-stone aggregate deposits, with a moderate certainty level (tract AABS05, fig. 8). The Moenkopi Formation is a slope former, dominated by shale and some sandstone. This unit has low potential for crushed-stone aggregate deposits, with a high certainty level (tract AABS03, fig. 8).

Sand and Gravel.—Alluvial deposits with mostly carbonate clasts occur on the eastern side of this ACEC, covering the lower slopes and filling in the northward-draining wash. This area has high potential for sand and gravel aggregate deposits, with a moderate certainty level (tract AABS07, fig. 8).

Locatable Minerals in Sloan Rock Art ACEC

The Sloan Rock Art ACEC contains no known deposits of locatable minerals, and there is no potential for their occurrence.

Leasable Minerals in Sloan Rock Art ACEC

There is no indication of potential for brine or evaporite deposits of sodium and potassium in the Sloan Rock Art ACEC. The area contains no known deposits of leasable minerals, and the potential for their occurrence is low.

Salable Minerals in Sloan Rock Art ACEC

Crushed Stone.—The rocks of this ACEC are faulted and fractured basaltic andesites and basalt. They define an area of high potential for crushed-stone aggregate deposits, with a moderate certainty level (tract AABS01, fig. 8).

Sand and Gravel.—A canyon drains this ACEC, and the wash contains clasts of volcanic rocks. However, the alluvial deposits are too small to be significant, and the area has no potential for sand and gravel aggregate deposits.

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