Preliminary evaluation of mineral resources of the Santa Cruz Valley National Heritage Area, Arizona

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Introduction

In March 2019, President Donald Trump signed a public lands bill creating the Santa Cruz Valley National Heritage Area in Santa Cruz and Pima Counties. This is the culmination of more than a decade of effort on the part of U.S. Representative Raul Grijalva and others working towards the cultural preservation, economic development, and geotourism of the area (Nogales International, 18 Mar. 2019).

The Santa Cruz Valley National Heritage Area (Figure 1) covers a wide swath of historic and productive porphyry copper mining in southern Arizona, and mining has long played an important role in the history of this region. This report provides a brief assessment of the mineral resources of the roughly 3,600 square miles (9,378 square kilometers; 2,304,000 acres) of those portions of Pima and Santa Cruz Counties encompassed by the Santa Cruz Valley National Heritage Area.

The Arizona Geological Survey and US Geological Survey have published numerous geologic maps and reports relevant to the mineral resources of the area. See Abridged References for a list of literature resources; this is not, however, an exhaustive list of mineralogic, geologic and hydrologic resources for the Santa Cruz River Valley and environs.

Mineral assessment is largely confined to metallic minerals - copper, gold, silver, lead, zinc and molybdenum - extracted from the 20 metallic mineral districts within the heritage area (Figure 2). Hundreds of mines were worked in these mineral districts (Figure 3). Aggregate resources, the building block of human society, are also an important component of the mineral resources of the Santa Cruz Valley area.

Location

The national heritage area is situated in the upper Sonoran Desert of Arizona's Basin and Range Province. Mountain ranges encompassed in whole or in part, include, from north to south: the Tortolita, Santa Catalina, Rincon, Tucson, Sierrita, Santa Rita, San Cayetano, Patagonia and Pajarito Mountains. Other geographic features, from north to south: Oro Valley, Tucson Basin, Santa Cruz River, Avra Valley and Green Valley.

Mineral Resources

The footprint of the Santa Cruz Valley National Heritage coincides with the heart of southern Arizona’s porphyry copper belt. For decades, the porphyry copper mines of Arizona, including Sierrita, Mission and Twin Buttes of the heritage zone – contributed nearly 65% of America’s copper production (USDI Natural Resources Revenue Data for Pima County, Arizona).

Table 1. Recent copper, lead, zinc, silver and molybdenum mineral production from porphyry copper mines in the heritage area

- Mission Mine produced more than 68.2K short tons of copper in 2017. From 1963 to 2017 more than 3.3M short tons of copper were produced here. In that same time frame, there was substantial production of lead (1,506 short tons), molybdenum (6,891 short tons), zinc (3,115 short tons) and silver (49M troy ounces).
- Sierrita Mine Complex produced ~ 80K short tons
of copper in 2017. From 1970 to 2017 more than 4.2M short tons of copper were produced here. Over that same time frame, there was substantial production of molybdenum (413k short tons), lead (1,582 short tons), zinc (153 short tons), and silver (11.1 M troy ounces) and gold (4,823 troy ounces).


Metallic Mining Districts included in the proposed Santa Cruz RV Heritage area

Table 2. Pending* Metallic Mines in the heritage area.

i. Hudbay’s Rosemont Porphyry Copper project in the Helvetia mining district. Annual production is estimated at 140K tons of copper annually during the first 10 years of production. Total life span of mine estimated at 19 years.

ii. Hermosa-Taylor Zinc-Lead-Silver Carbonate Replacement project in the Patagonia mining district. See the case study below for details of the deposit.

Pending metallic mines are scheduled to begin extracting and producing ore in the next several years.

Aggregate Resources. There are nearly 20 aggregate operations in Pima and Santa Cruz Counties. All but one resides in the heritage zone (Figure 6). Any effort to reduce or withdraw existing aggregate operations would require establishing plants at greater distance from the Tucson metropolitan center; the second largest population center in Arizona. Transportation costs of aggregate and infrastructure costs (road repair) would increase proportionally with distance between Tucson and the source aggregate.

Mining Employment. In 2015, the U.S. Dept. of the Interior reported 2,230 workers employed in copper mining and related activities in Pima County. Mining represents about 1 percent of employment in Pima County. Jobs in the mining industry frequently pay substantially better than do jobs in the service or tourism industries.

New mineral resources in the Patagonia Mountains: case study. Silver was discovered in the Patagonia Mountains of southeastern Arizona in the 1870s. Mining operations continued there through World War II - manganese was mined in support of the war effort - and mining was a pillar of the economy and society of southern Santa Cruz County into the 1950s. By 1964 the first pulse of mining in the Patagonia Mountains ended.

In 2010, exploration geologist Don Taylor initiated a drilling program to evaluate a suspected zinc-silver-lead, carbonate replacement deposit near Hershaw, Arizona; a once bustling mining town turned ghost town. This exploration led to the discovery of the large Hermosa-Taylor Zn-Pb-Ag deposit in the Patagonia Mining District. In 2018, Taylor was awarded the prestigious Thayer Lindsley award for ‘Best Global Discovery’ at the Prospectors and Developers Association of Canada Convention in Toronto, Canada.

A report by David Wichner of the Arizona Daily Star estimates that mineral extraction at the Hermosa-Taylor project will pump $676 million into the Arizona economy.

Figure 2. Metallic Mining Districts included in the Santa Cruz Valley Heritage Area. Color coding: orange – gold with or without copper or lead; yellow – uranium in veins or fissures; brown – copper porphyry with or without molybdenum, manganese, gold and peripheral zinc, lead and silver; blue – lead, zinc and silver veins and replacements (Keith and others, 1983).
annually. So over the 32-year life span of the mine, it would yield $21 billion in mineral products.

Table 3. Select characteristics of the Taylor Deposit, Patagonia Mtns., Santa Cruz County

- 43-101 Report (1/2018): 15.2 million tons at 4.2% Zn, 4.0% Pb, and 1.6 opt silver (OPT = troy oz per ton);
- Deposits reside on patented or private lands in SE Arizona’s Patagonia Mountains;
- A carbonate replacement deposit with sulfides of Zn-Pb-Ag;
- Located about 55 miles south of Tucson, Arizona.
- Underground mine project;
- Estimated mine life of ~32 years;
- Estimated 946 M lbs of zinc equivalent and 9.5 M oz of silver production in concentrate in first 5 years.

For additional information on the Hermosa-Taylor project and the nearby Central silver-manganese-zinc manto oxide deposit, see the Arizona Mining website.

Summary – This brief report scratches the surface of historic and ongoing mining and mineral production within the Santa Cruz Valley Heritage Area. The recent discovery of the Hermosa-Taylor Zn-Pb-Ag deposits indicates a substantial potential for discovery of greenfield mineral resources.
**Figure 4.** Mineral production data of metallic mineral districts of Pima County (marked by orange X) that reside in whole, or in part, in the Santa Cruz Valley Heritage Area (Keith, 1974).
TABLE 1
PRODUCTION SUMMARY OF BASE AND PRECIOUS METALS
THROUGH 1972
(Including estimates for years data not available)

<table>
<thead>
<tr>
<th>MINING DISTRICT</th>
<th>Short Tons</th>
<th>Pounds Copper</th>
<th>Pounds Lead</th>
<th>Pounds Zinc</th>
<th>Ounces Gold</th>
<th>Ounces Silver</th>
<th>Total Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ore (1,000's)</td>
<td>(1,000's)</td>
<td>(1,000's)</td>
<td>(1,000's)</td>
<td>(100's)</td>
<td>(100's)</td>
<td>(1,000's)</td>
</tr>
<tr>
<td>Greaterville</td>
<td>2</td>
<td>40 (670 lbs)</td>
<td>—</td>
<td>12</td>
<td>63</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Harshaw</td>
<td>1,312</td>
<td>6,286</td>
<td>180,698</td>
<td>172,720</td>
<td>4,347</td>
<td>51,963</td>
<td>41,526</td>
</tr>
<tr>
<td>Nogales</td>
<td>1</td>
<td>17</td>
<td>191</td>
<td>—</td>
<td>1,019</td>
<td>142</td>
<td>64</td>
</tr>
<tr>
<td>Oro-Blanco</td>
<td>900</td>
<td>5,113</td>
<td>50,107</td>
<td>52,583</td>
<td>188,469</td>
<td>46,914</td>
<td>23,941</td>
</tr>
<tr>
<td>Pajarito</td>
<td>1</td>
<td>5</td>
<td>317 (420 lbs)</td>
<td>—</td>
<td>216</td>
<td>424</td>
<td>68</td>
</tr>
<tr>
<td>Palermo</td>
<td>152</td>
<td>11,004</td>
<td>440</td>
<td>2</td>
<td>212</td>
<td>780</td>
<td>2,103</td>
</tr>
<tr>
<td>Patagonia</td>
<td>691</td>
<td>28,665</td>
<td>43,025</td>
<td>53,771</td>
<td>7,267</td>
<td>32,655</td>
<td>17,862</td>
</tr>
<tr>
<td>Red Rock</td>
<td>(530 tons)</td>
<td>41</td>
<td>42</td>
<td>4</td>
<td>4</td>
<td>56</td>
<td>15</td>
</tr>
<tr>
<td>Tyndall</td>
<td>56</td>
<td>1,036</td>
<td>18,782</td>
<td>5,513</td>
<td>1,201</td>
<td>4,766</td>
<td>3,645</td>
</tr>
<tr>
<td>Wrightson</td>
<td>4</td>
<td>237</td>
<td>951</td>
<td>—</td>
<td>366</td>
<td>508</td>
<td>158</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>(100 tons)</td>
<td>3</td>
<td>1</td>
<td>—</td>
<td>38</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>3,105</td>
<td>60,447</td>
<td>288,555</td>
<td>284,733</td>
<td>141,242</td>
<td>177,561</td>
<td>73,381</td>
</tr>
</tbody>
</table>

Santa Cruz County Mineral Production (Keith, 1975)

Figure 5. Mineral production data of metallic mineral districts of Santa Cruz County. The two districts not included in the heritage area are lined out in orange (Keith, 1975).

 Aggregate Plants and Quarries of Pima and Santa Cruz Counties
Source: Arizona Mine Inspector's Office

Figure 6. Aggregate plants and quarries of Pima and Santa Cruz County. All but one plant is situated in the Santa Cruz Valley Heritage Area. Data source: Arizona Mine Inspector's Office.
ABRIDGED REFERENCES

Dozens of geologic reports and maps relevant to a comprehensive mineral assessment of the heritage area exist. Referenced below are geologic products of the AZGS and USGS particularly relevant to mineral resource assessment. By no means is this an exhaustive list of pertinent literature resources.

Arizona Geological Survey Publications


United States Geological Survey Publications


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