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PREAMBLE

As a result of the large contribution of minerals to national, regional, and local economies, resource assessment in support of land-use planning is one of the most consequential activities to be performed. Decisions made today will affect society for generations to come.

Resource Science, Inc. 1994

Land-use planners are increasingly required to respond to land-use conflicts between mineral industries and alternative land uses. In resolving these conflicts, planners seek to be responsive to current and future needs of society when choosing between varied, alternative land uses. Land-use planning, however, has increasingly become a resolution of competing ideologies, and land-use planners are struggling to acquire the objective information necessary to make informed decisions. An increased understanding of natural science has proven useful in this regard. If proposed land-uses can be cast within a holistic model of the natural world, then more informed decisions are possible. This report seeks to convey to land-use planners an essential piece of information, an inventory of mineral resource potential across eastern Pima County.

Mineral production has always been viewed as an essential industry, not only to generate wealth and provide employment, but also for the array of products that are consumed by a society. Terms such as Bronze Age and Iron Age have served to demonstrate the essential role of minerals in improving a societies standard of living. Today, in what we have come to call the Technology Age, the demand for minerals and mineral-bearing products has grown exponentially. This is not surprising, over the last four thousand years societies with mineral technologies have flourished, while those lacking mineral resources have either conquered to take others or have ultimately perished.

The American mining industry pioneered Arizona. For more than one hundred years, metal and aggregate companies have operated under the rules and regulations set out in legal frameworks. Few anticipated that they would lose access to land for future mineral development. Viewed as a societal good, access to the land encouraged growth. The mineral products provided much needed materials for construction, trade and local economies. Land-use planning was motivated by economic development needs, manifest in the desire for improved tax bases and infrastructure. Therefore mining plays a key role.

More recently, land-use planning has become a very public process, and some groups have cited the industrial practices of one hundred years ago as justification for deciding what lands future generations will have available for mineral resources. Termed "zoning away", the loss of resource lands to alternative uses is rarely reversible and leads to an ever decreasing inventory from which future societies may rely. This squeeze on land has already impacted the Arizona aggregate industry and prevented several new copper mines from development. The justification for zoning away lands relies on urban legend to suggest that mineral-based activities are not consistent with the ideals of sustainable development. Since refuted, legends seem to outlive economic reality. Unless access to exploration and mining development is maintained in those areas having the maximum potential, the mineral production which will be needed to sustain our current standard of living will be lost. Where is all this mineral production being consumed? It is in new homes, schools, senior and daycare centers, and recreational facilities -- clearly, "that which is not grown is mined".

Over the last decade, many mining companies have retreated to developing nations. Often these countries are those jurisdictions that do not have environmental standards comparable to those found in Arizona. As such, the impetus for new mining technologies and improved environmental standards is gone.

As new technologies are developed, the style of mining will change from dominantly open pit mines to underground or in situ operations. These kind of operations will have minimal impact on the

environment and will lessen or remove the need for pits, those “unsightly holes in the ground” that are the focus of much current debate.

As different segments of society draw contradictory conclusions about the impact of zoning away resource lands, the process continues unabated. Land-use conflict leads to delay, uncertainty, and perhaps political paralysis. These factors drive away the investment capital necessary for mining. Thus, it is in everyone's interest that the architects of the Sonoran Desert Conservation Plan integrate the information contained herein into the plan prior to making final recommendations. If so, resulting land-use decisions will be predicated on sound and relevant information about the value to society of the various alternative uses, some of which may be a sequence of two or more uses.

This report contains mineral-resource information that was readily supplied by the geoscientific community, was collected by one individual at modest personal cost, and is deemed to be representative of several hundred years of cumulative exploration experience. We thank you for the opportunity to present this information.

At the request of the Southwestern Minerals Exploration Association, this Preamble was written by Dr. Michael Stanley, Mineral Economist for Resource Science, Inc., a Tucson based consulting firm specializing in mineral economics and resource assessment.

EXECUTIVE SUMMARY

Mineral production is essential to our civilization because minerals provide the raw materials which allow our society to function. Pima County is endowed with many mineral resources, not only copper mines, but also the important products such as sand, gravel, and limestone used everyday in supporting the infrastructure of our cities. It is essential that these mineral resources, and the lands where they occur, remain available for exploration and development.

Mining is a significant part of Pima County's economy. Last year, copper producers bought $186 million worth of goods and services from Pima County firms. Local governments in the Tucson Metropolitan area received $10 million in direct tax payments. Residents received over $88 million in personal income directly from the copper industry. When revenue from other mining operations and the economic multiplier effect of expenditures is taken into account, the real value of mining is nearly five times greater than these numbers.

This report presents an assessment of the mineral resources of Pima County based on hard data derived from many experienced geologists working in the private sector and from publications of state and federal government agencies.

Pima County has a unique, and complex, geological history which makes it critical habitat for large copper deposits, geothermal resources, and many industrial minerals such as sand, gravel, gypsum, and limestone. This report documents known occurrences of these mineral deposits, and delineates areas with the greatest potential for future discovery of additional mineral deposits, based on existing geological and geochemical data, and upon proven methods of investigation.

Most areas favorable for mineral deposits coincide with portions of the Sonoran Desert Conservation Plan's proposed biological reserves. We should note that mineral exploration and production is not necessarily incompatible with conservation. The Sonoran Desert Conservation Plan addresses six elements: ranching, historical and cultural preservation, mountain parks, riparian protection, critical and sensitive habitats, and biological corridors. An important seventh element is missing: mineral resources.

This report outlines seven areas which are critical habitats for undiscovered mineral deposits, areas which need to be as carefully protected and defined as are habitats for endangered species. If these prospectable areas are withdrawn from exploration and development, the availability of our future sand and gravel, porphyry copper deposits, and other mineral deposits will become endangered and, in a real sense, the availability of vital minerals will eventually become extinct in Pima County. The impact of such a development on Pima County and the Tucson Metropolitan area will be considerable. If the sand and gravel deposits can no longer operate within a reasonable distance of construction sites, the costs of new construction and of renovations of existing infrastructure will greatly increase. Although the direct impact of curtailing copper exploration and development will not be immediately noticeable to most citizens of Pima County, the longer term impact could affect the cost and availability of many common products we use today, and also could be detrimental to the future national security of the United States.

Members of the Southwestern Minerals Exploration Association strongly recommend that the potential mineral bearing areas be kept available for future development, and urge the planners of the Sonoran Desert Conservation Plan to consider minerals as a critical Seventh Element in the planning process - an element that needs protection as much as many of the "vulnerable" species being considered.

MINERAL POTENTIAL OF EASTERN PIMA COUNTY, ARIZONA

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INTRODUCTION

The Southwestern Minerals Exploration Association (SMEA) is a group of exploration and mining geologists and engineers who meet on a regular basis to review Federal and State laws and regulations governing mineral exploration. The group was formed about 35 years ago and some of the members work for mining companies, some are active geological consultants and some are presently retired. The combined experience in the Sonoran Desert Region within the group of 45 – 50 members exceeds 1000 years. Most of the members are concerned about the desert and its fauna and flora, for they have spent most of their professional careers working in the desert and mountains of the Southwest U. S. They are also concerned about the continued availability of non-renewable natural resources.

When the SMEA members realized that only a minimum of data on the mineral resources of eastern Pima County is presently available to the Sonoran Desert Conservation Plan (SDCP) committees, a special Task Force was assembled to provide such information to Pima County. This report and accompanying maps provide a general overview of the mineral potential of eastern Pima County and should be an important part of the data considered by the Sonoran Desert Conservation Plan committees in formulating areas for preservation.

The SDCP presents recommendations for preservation and protection for each of the six elements of the plan, namely: Ranch Conservation; Cultural Resources; Mountain Parks; Riparian Protection; Management and Restoration; Habitat and Corridor Protection. No where in the plan is the all-important Seventh Element – Exploration and Mining – included in the plan description, let alone discussed.

OUTLINE OF REPORT

This report initially includes a general discussion on the unique geological nature of southeastern Arizona and eastern Pima County and on the multiple and best use concept which has guided management of Federal and State lands in Arizona since statehood. Following this is a brief discussion of exploration geology, geochemistry and geophysics. Then comes a detailed description of metallic and non-metallic mineral potential in Pima County and recommendations by SMEA for establishment of mineral reserves for protection of areas favorable for the discovery and development of new mineral properties. References cited in the report are in footnotes and in the Selected References section at the end of the report.

ACKNOWLEDGEMENTS

This overview of the mineral potential is a joint effort of many SMEA members under the guidance and coordination of Charles P. Miller, consulting geologist and President of Miller Resources, Inc. a geological consulting firm. The individual members who have contributed are listed on the title page of this report and their specific contribution is listed below. Special recognition is given to Michael Stanley and Josef Marlow of Resource Science, Inc. who made many valuable suggestions on the use of the GIS software used to prepare maps for this report and who generously plotted many of the maps without compensation and to the staff of the Arizona Geological Survey and the Arizona Department of Mines and Mineral Resources who provided reference materials used in this study. Other geologists in the Tucson Community also provided information and guidance.

Specific contributions on mineralized districts by individual geologists are listed below:

Geologist	Area	Years Experience in Arizona	Arizona Registration Number
Dirk Den-Baars	Korn Kob	50	O4032 S-Re
Russell Corn	Las Guijas Mountains Granite Peak Sierrita-Sahuarita	41	8885
Jonathan DuHamel	Cerro Colorado Mountains San Luis Mountains	26	19194
Ted Eyde	Non-Metallic Minerals	40	07483
Richard Hahman	Geothermal Potential	30	31410
Kenneth Lovstrom	Geochemistry	20	-
Robert Metz	Sierrita-Sahuarita Mildred Peak	42	5868
Charles Miller	Rosemont-Helvetia	40	8887
James Sell	Silver Bell Mountains	45	-
USGS OFR 90-276 & Bull. 2083 summarized by Charles Miller	Sierrita Mountains, Silver Bell, eastern Pima County, Northern Santa Rita Mountains		

UNIQUE GEOLOGICAL NATURE OF SOUTHEASTERN ARIZONA AND THE IMPORTANCE OF MINERAL INDUSTRIES TO PIMA COUNTY'S ECONOMY

Spencer R. Titley, University of Arizona Professor, wrote in 1982,[1],[2]:

> "The porphyry copper deposits of southeastern Arizona and contiguous regions compose one of the richest copper metallogenic provinces on earth and perhaps the richest of seven separate porphyry copper provinces which surround the Pacific Basin. At least thirty-five separately named significant occurrences of porphyry-intrusion-related concentrations of copper occur here (Fig. 2-1) and the record of discovery suggests that more will be found"

The uniqueness of southeastern Arizona, including Pima County, can also be seen in the complexity of geologic structures extending over a long period of geologic time and in the numerous papers and symposium detailing the unusual geologic environment of this region. Pima County contains 6 major copper deposits one of which has been in operation for 40 years (Mission-Pima Mines) and one for 100

[1] References cited in report are listed in a footnote and in Selected References at end of report.
[2] Titley, Spencer R., 1982, Advances in Geology of the Porphyry Copper Deposits, Southwestern North America: University of Arizona Press, Tucson Arizona 560 pp.

years (Silver Bell). To be unable to explore and develop new mining properties in this region could have a significant impact on future national security.

George Leaming[3] in a report on the Arizona Copper industry in 2000 writes:

> "The Tucson Metropolitan Area (Pima County) also shared substantially in both the direct and indirect contributions of the copper industry to Arizona's economy in 2000. Copper producers brought almost $186 million worth of products and services from firms in Pima County last year. That was more than 25% of the total of copper industry purchases made in the state. Local governments in the Tucson Metropolitan Area received nearly $10 million in tax payments directly from the copper industry in 2000. That was about 15% of the industry's total direct contributions of state and local governments in all of Arizona.
>
> Residents of Pima County gained more than $88 million in personal income directly from the copper industry in 2000. That was 20% of the industry's total direct contribution to personal income in the state and reflected both employment in Pima County mines and the Tucson residence of some of the copper workers employed in nearby areas of Pinal County. Because of its role as a regional trade center, the Tucson Metropolitan Area's share of indirect personal and business income generated by the copper industry was even greater than its Share of direct income" (page 5)

Not all of the copper revenues reported by Leaming came from Pima County Mines. However, the revenue and impact on Pima County by all of the Arizona mines is impressive and worthy of maintaining. If the Pima County mines were to close or if no new mines were developed to replace the old mines, then a significant decrease in revenues for Pima County would result.

The sand and gravel industry also contributes significant revenue to Pima County in the form of wages paid to employees and for services purchased in the Tucson Metropolitan area. No actual dollar figures are presently available, but more than 7 million tons of sand and gravel are produced in the Tucson area annually. This sand and gravel is essential for the construction of new houses, streets, roads, water and sewer lines. Without adequate supplies of these raw materials, construction would be difficult, costly and greatly reduced in volume.

MULTIPLE USE LAND DESIGNATION

Federal Land Policy and Management Act of 1976

In 1976, the U. S. Congress passed the Federal Land Policy and Management Act of 1976 (FLPMA) which was designed as guidelines and laws governing the management of public lands. The reference to this law is Title 43, Chapter 35. Sections of the USC 1701 and 1702 summarize the purpose of the law. The basic concept which has been followed over the years is "multiple Use" which is defined in the code section 1702 as follows:

> "The term "multiple use" means the management of the public lands and their various resource values so that they are utilized in the combination that will best meet the present and future needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; the use of some land for less than all of the resources; a combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources, including, but not limited to, recreation, range, timber, minerals, watershed, wildlife

[3] Leaming, George, 2001, The Economic Impact of the Arizona Copper Industry, 2000: Western Economic Analysis Center, Marana, Arizona, 52 p.

and fish, and natural scenic, scientific and historical values; and harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources and not necessarily to the combination of uses that will give the greatest economic return or the greatest unit output."

This means that public lands administered under FLPMA 1976 should be managed to support various activities that are not incompatible. These are recreation, range, timber, minerals, watershed, wildlife and fish, natural scenic, scientific and historical values. This concept has worked well for many years and with proper management should work for many more.

Although the FLPMA provides for the protection of ecological and environmental values, this protection is tempered by the need for the lands to be open for mineral development. Three statements in the Declaration of Policy in the act clarify these points:

> "The public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use;
>
> The United States receive fair market value of the use of the public lands and their resources unless otherwise provided for by statute;
>
> The public lands be managed in a manner which recognizes the Nation's need for domestic sources of minerals, food, timber, and fiber from the public lands including implementation of the Mining and Minerals Policy Act of 1970 (84 Stat. 1876, 30 U.S.C. 21a) as it pertains to the public lands; "

Arizona State Trust Lands

The Arizona State lands are managed in a somewhat similar manner. The Mission Statement published on the Arizona State Land Department web site is as follows:

> **"Mission Statement**
>
> To manage state trust lands and resources to enhance value and optimize economic return for the Trust beneficiaries, consistent with sound stewardship, conservation and business management principles supporting socio-economic goals for citizens here today and generations yet to come. To manage and provide support for resource conservation programs for the well being of the public and the state's natural environment."

The website also had a historical overview of the management of state lands:

> **"Historical Overview of State Trust Land**
>
> For more than eighty years, the Land Department has administered the State Trust lands. These lands were granted to Arizona by the Federal Government on its establishment as a territory in 1863. Additional lands were conveyed to Arizona as it prepared for statehood under the Enabling Act of 1910. Arizona, through creation of the Land Department, accepted the responsibility of Trust land management and revenue production for the fourteen Trust beneficiaries as a condition of statehood. Trust beneficiaries include the public schools, colleges, hospitals, charitable institutions, and specialized schools as well as others. Perhaps, you have heard the phrase "school sections". This term derives from the original sections granted by the Federal Government designating the beneficiary to be public schools. Today the Trust

controls approximately 9.4 million acres, which represents thirteen percent of all the land in Arizona.

It is the State Land Department's responsibility on behalf of the beneficiaries to assure the highest and best use of the Trust lands. The Federal Enabling Act and State Constitution mandate that fair market value must be obtained from all Trust land transactions which include sales and commercial leasing. All revenues derived from the sale of Trust lands are placed in the Permanent Fund which is administered by the State Treasurer. The Fund is invested in interest-bearing securities with earned interest distributed among the beneficiaries. Revenues from commercial leases are paid directly to the designated beneficiaries. The Trust's diversity of lands has always been its most valuable resource. This is reflected in the unique properties offered for sale and/or commercial lease."

Most of the land with the exception of fee simple land within the preliminary biological reserve system proposed in May 2001 by the Sonoran Desert Conservation Plan is either Arizona State lands or land managed by the Bureau of Land Management. The mandate for both organizations is the concept of multiple use. The Arizona State Land Department has the additional charge to maximize the economic benefit of the use of the lands.

It would seem appropriate that Pima County in the development of the Sonoran Desert Conservation Plan would follow the procedures for the lands which they are proposing to set aside in biological reserves. Although, in the May 2001 report the SDCP lists a category of "Multiple Use", that definition does not specifically include exploration and mineral development. It is mute on this point as the definition given below which was taken from page 8 of the May 2001 report indicates[4]:

> "Multiple Use areas are primarily open space areas with high biological value that will be managed for biological conservation but may include other land uses, such as ranching. These are areas not designated as biological or critical habitat core."

Thus, the term "Multiple Use" as used in the Sonoran Desert Conservation Plan refers to areas that have less biological value than areas designated as biological core areas or critical habitat, but which still have "high" biological values. Other uses such as mining and logging are not included in the definition.

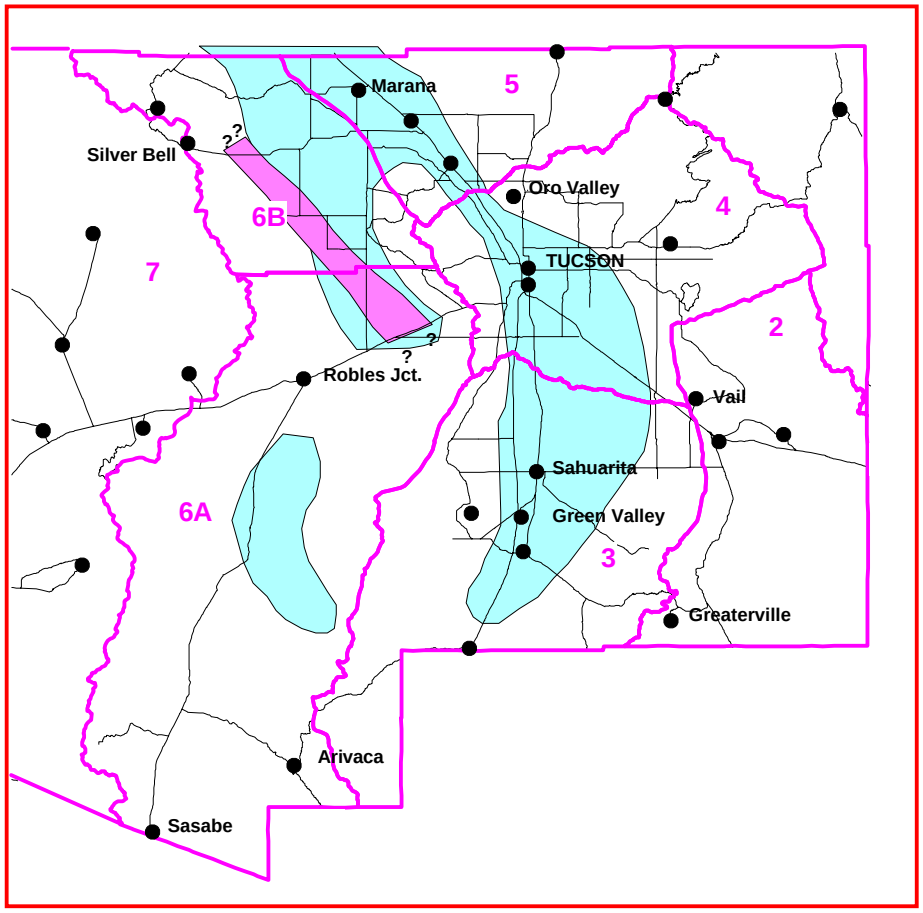
GEOTHERMAL POTENTIAL OF EASTERN PIMA COUNTY

Two areas in Eastern Pima County have potential for the development of geothermal resources. These are Avra Valley and the Tucson Basin shown on Map 1.

Avra Valley

The geothermal waters in Avra Valley constitute a low temperature resource suitable for space heating and cooling for industrial parks and residential developments such as apartments, town houses, condominiums and neighborhoods composed of single-family dwellings. This type of resource is also suitable for aquaculture and greenhouse agriculture. If the use of geothermal energy is planned into a project or a project planned around a geothermal resource, the development costs are generally less than the costs incurred in the development of the geothermal resource and retrofitting the currently existing buildings to utilize the new energy source.

[4] Huckelberry, C. H., 2001, Reserve Design Process Update, Sonoran Desert Conservation Plan: Pima County, Tucson Arizona, pp.2, with text and maps.



MAP 1

SOUTHWESTERN MINERAL EXPLORATION ASSOCIATION

GEOTHERMAL POTENTIAL IN EASTERN PIMA COUNTY ARIZONA

Low Temperature Geothermal Waters

Mercury Anomaly
75-750 ppb Hg
ADEQ Allowable Residental 6700 ppb Hg

2 — Sonoran Desert Conservation Plan Planning Areas

1. Hahman, W. R. and Allen, T. J., 1981, Subsurface stratigraphy and geothermal resource potential of the Avra Vally, Pima County Arizona: Arizona Bureau Geol & Min. Technology, OFR 81-5

2. Witcher, J. C., Stone, C. and Hahman, W. R., 1982, Geothermal Resources of Arizona: Arizona Bureau Geol. & Min. Technology Map 15-2

3. Druitt, C. E. and Conley, J. N., 1977, Geothermal Areas: Arizona Oil and Gas Conservation Commission August 1977

0 10 20
Miles

Charles P. Miller
SMEA Project Coordinator
July 15, 2001

Stone and Witcher, (1983), based on the residual Bouguer gravity map of Arizona divide the Avra Valley into two basins separated by a basement high and point out that "steep gravity gradients ... suggest a northwest trending linear (fault or Silver Bell - Bisbee discontinuity(?) of Titley, 1976) down the length of the valley." This gravity feature coincides with the northwest-trending mercury geochemical soil anomaly identified by Hahman and Allen, (1981). This mercury anomaly, open at both ends, extends from U. S. highway 86 from the Ryan Field area northwest to the ASARCO Silver Bell mine property. The fact that the gravity linear and the geochemical anomaly coincide supports the probability that the mercury anomaly reflects a major basement structure (possibly related to or a part of the Sawmill Canyon lineament?) beneath Avra Valley.

"South and southwest of the linear mercury anomaly, 30^{o}C water is ubiquitous at depths of 300 m". (Stone and Witcher, 1983). Water geochemical thermometry studies and heat flow studies indicate that higher temperature water may exist at depth. The geothermal waters north of the mercury geochemical anomaly are not well defined and may not be present.

East of the Silver Bell mine, on the west side of Avra Valley, heat flow studies and water geothermometry indicate a potential for 50^{o} to 55^{o}C water at a depth of 1,000 m which might prove useful in the copper leaching process (Stone and Witcher, 1983). There is an undefined geothermal potential west of Ryan Field that might prove useful to the airport; however, additional geological work would be necessary to define the resource.

Tucson Basin

Deep well information and Bougeur gravity modeling (Davis, 1967; Oppenheimer and Sumner, 1981) show the Tucson basin as an en echelon zig-zag complex of interconnected grabens that are filled with clay, sand and gravel. In the Tucson basin, the major grabens are oriented in a north-northeast direction and the minor grabens are oriented in a northwest direction.

The primary source of ground water in the Tucson basin is from precipitation in the surrounding mountains of the Santa Cruz drainage system. The meteoric water enters the ground water reservoir by infiltration from stream flow and runoff near the mountains. Additional water is obtained from underflow from adjacent basins. In general, the ground water flows from south to north along the basin axis as well as from the mountains toward the central basin axis.

More than 200 wells located in the Tucson basin are operated by the city of Tucson, water companies and industry. Some of these wells pump thermal water in excess of 30^{o} C. In 1982 , Tucson Electric Power Company owned the hottest wells in the basin. The Irvington and I-10 geothermal anomaly was discovered by the Tucson Electric Power Company in 1956 in their water well drilling program for the Irvington Road power Plant. The TEP wells in this anomaly produce the hottest known water at temperatures ranging from 52^{o} to 57^{o} C from depths below 400 meters. In addition Agua Caliente, a thermal spring discharges 30^{o} to 32^{o} C water near Tanque Verde.

In the Tucson basin, the deep geothermal aquifer, greater than 300 meters in depth, appears to be confined and hydrologically separate from the shallow aquifers, that are less than 200 meters in depth. These deep aquifers apparently contain a large volume of thermal water suitable for direct heat utilization (Stone and Wichter, 1983) and have the potential for water with temperatures for thermal cooling.

The geothermal waters of the Tucson are a viable resource just waiting to be utilized.

GEOLOGY AND GEOCHEMISTRY

The most important geologic tool that the exploration geologist has at his disposal is a geologic map which shows the distribution of rocks and domains favorable for the occurrence of mineral deposits. The geologist begins his search for a new deposit with an understanding of the regional geology and of areas

permissive for mineral deposits. Field reconnaissance and mapping of alteration and mineralization are the first step in the exploration program. Once the bedrock areas are studied the geologist must turn to the pediments adjacent to the mountains ranges. These pediments are usually covered with a mantle of alluvium which prevents visual inspection of these areas. The next weapon in the geologists arsenal is usually a regional geochemical survey, which with careful planning and execution possibly can lead the geologist to buried or covered targets. Ground based and aerial geophysical surveys frequently follow. In this section, the exploration geology of porphyry copper deposits is briefly discussed and the results of a regional government survey for copper and molybdenum is presented. These descriptions hopefully will illustrate the need for open lands for the exploration and certainly if a discovery is made, the need for adequate access for development.

Exploration Geology of Pima County

Map 2 is simplified exploration geologic map of Pima County. It summarizes the most likely areas for porphyry copper deposits to occur.

Most exploration geologists describe the geology of potential areas as containing three classes of rocks, Pre-mineral, Syn-mineral and Post-mineral.

> Pre-mineral rocks are those rocks that are older than the age of the mineralization and provide host rocks for the mineralization itself. These rocks can be of any age and any type. Most frequently, the best pre-mineral host rocks are limestone, extrusive volcanic rocks and other reactive rocks. On Map 2, the Pre-mineral rocks are shown in a medium brown color.
>
> Syn-Mineral Rocks are those rocks with which the mineralization is accompanied and also provide a host for the mineralization. The most common age of the Syn-mineral rocks is Laramide, a period of geologic time which encompasses the period of about 75 to 40 million years ago. These rocks are both extrusive and intrusive igneous rocks. The extrusive rocks are commonly andesites or similar volcanic rocks. The intrusive rocks can range in type from diorite to rhyolite, but most commonly are quartz monzonite and granodiorite. On Map 2, these rocks are shown in gray and red tones, extrusive and intrusive rocks respectively.
>
> Post-mineral rocks are those rocks which are younger than the mineralization and frequently cover or hide the Syn and pre-mineral rocks. These most commonly are gravels, alluvium and young volcanic rocks such as basalt. On Map 2, these rocks are shown in a light yellow color.

Utilizing such a simplified geologic map, with three classes of rocks, greatly facilitates the planning stage of an exploration program. Depending on what area the geologist is working and for which commodity he is exploring, the three classes of rocks – Pre-mineral, Syn-mineral and Post-mineral – would probably be different. For Pima County and for porphyry copper exploration, Map 2 provides a first pass of delineating areas favorable for exploration.

Deep Basin fill and shallow pediments

If the exploration geologist wishes to explore on the gravel or alluvium covered pediment areas adjacent to the bedrock, the first step is to define the extent of the deep basins. Following U. S. Geological Survey practice, the first cut is to eliminate any basin that is deeper than 1 kilometer. On Map 2, taken from a map published by the University of Arizona, basins deeper than 1kilometer are shown in light green color. The area of the pediment or valley that lies between the deep basins and the bedrock rocks are within reach of current exploration technology and are thus considered permissive for the occurrence of porphyry style mineralization. Perhaps as technology improves, deeper parts of the basins may become permissive.

Areas Permissive for the Occurrence of Porphyry Copper Deposits – Pima County, Arizona

Map 2, in addition to illustrating the exploration geology and depth of basins, is also a presentation of areas permissive for the occurrence of porphyry copper mineralization and porphyry copper deposits. Essentially any outcrop or bedrock area adjacent to the Syn-mineral rocks is favorable for the occurrence of porphyry copper deposits. These areas have definite geology that are known to have hosted porphyry copper deposits elsewhere in Pima County and Arizona. However, the areas between the deep basins and the bedrock are in addition permissive for the presence of porphyry copper deposits. They are relatively unexplored and may hide buried porphyry mineralization.

By reviewing Map 2, and considering the favorable and permissive areas, it can readily be observed that most of eastern Pima County is either favorable or permissive for porphyry copper exploration. Regional structures or lineaments and the occurrence of known mineralization would narrow the search areas considerably. However, it is entirely possible that many of the post-mineral domains illustrated on Map 2, could be permissive for porphyry copper deposits. With new technology and renewed exploration activity, it is highly likely that new deposits will be found in the future in areas where the only indication today is the permissive character of the gravel covered areas. To indiscriminately lock out many alluvium-covered areas from exploration is a risk that we should not take.

Geochemistry

Sediment collected in stream channels has been used successfully throughout the world as a geochemical sampling medium to delineate mineralization. Reconnaissance geochemical surveys utilizing stream sediments have been extensively employed in semi-arid regions of the southwestern United States. Such a survey was conducted in Arizona as part of the U.S. Department of Energy's National Uranium Resource Evaluation (NURE) program. The NURE copper and molybdenum stream sediment data were evaluated for eastern Pima County**.**

Classic copper (Cu) and molybdenum (Mo) stream sediment dispersion anomalies outline the known porphyry copper deposits in eastern Pima County as well as characterize anomalous areas which might contain additional copper deposits. These characterizing anomalies are in part a result of past and present mining activity as well as dispersion from natural, in place mineralization. Maps 3 and 4 included with this report show the distribution of the copper and molybdenum stream sediment values as well as the anomalous zones.

The Silver Bell District, located in SDCP Planning Areas 6B and 7 and as Area D described in the section on Base and Precious Metal Potential of Eastern Pima County below is characterized by strongly anomalous Cu and Mo in stream sediments draining to the northwest and east. Weak to moderate Cu and Mo anomalies west, southwest and east may indicate possible additional mineralization. (Maps 3 and 4)

The porphyry copper deposits of Mission-Pima, Twin Buttes and Sierrita-Esperanza, located in Planning Area 3 and as Area G below, are characterized by weak to strongly anomalous Cu and Mo in sediments with dispersion trains outlined some 10 miles down pediment. The entire eastern and northeastern covered pediment of the Sierrita Mountains contains anomalous Cu and Mo in stream sediments ranging from Esperanza Wash to the south to Highway 86 to the north. Anomalous Cu in sediments ranges from 50 to greater than 500 parts per million (ppm) with Mo ranging from 5 to greater than 15 ppm. Additional Cu deposits may exist south in the Arivaca area and on the west side of the Sierrita Mountains. (Maps 3 and 4)

The explored but undisturbed Rosemont and Helvetia copper deposits are located in the northern Santa Rita Mountains in Planning Areas 2 and 3. Weak to moderately anomalous Cu and Mo outline the Rosemont and Helvetia mineralization in drainage sediments. Outcropping Cu mineralization, located at the northern end of the Santa Rita Mountains (Cuprite and Total Wreck Prospects) is also characterized by anomalous Cu and Mo in sediments. Additional copper deposits may exist in the northern portion of

the range where stream sediment anomalies are outlined in the Helvetia and Rosemont areas. (Maps 3 and 4)

The Marble Peak Mining District, located on the northeast side of the Catalina Mountains in Planning Area 1, is characterized by weak to moderate Cu in stream sediments. This dispersion anomaly is outlined down-pediment to the San Pedro River. Additional weak Cu anomalies are noted in the area possibly indicating additional mineralization.

Stream sediment surveys are not the only geochemical technique which can delineate mineralization. Well water and biogeochemical surveys are effective techniques in outlining alluvial covered copper deposits along mountain ranges. Public domain well water data and mining company mesquite tree data clearly outline the above mentioned porphyry copper deposits as well as outlining numerous anomalies which may indicate concealed mineralization. These untested but viable anomalous areas are located northwest and east of Silver Bell, west of the Sierrita Mountains, northwest of Helvetia and southeast of Rosemont, north of the Empire Mountains and the western covered pediment of the Silver bell Mountains. More detailed geochemical surveys would more definitely define these anomalous areas and possibly locate additional anomalous areas.

Geophysics and Remote Sensing

Geophysical surveys and Remote Sensing are additional methods to explore within the bedrock areas and on the adjacent covered pediments. Techniques such as electrical surveys (Induced Polarization and Resistivity), gravity surveys and magnetic surveys. All can aid in the delineation of favorable target areas for further exploration. Insufficient data were available at this time to include in the report.

Non-disturbance Character of Exploration.

The exploration strategy and techniques described above have little effect or impact on the land. They are all non-invasive and can be conducted with little or no surface disturbance. It is not until sufficient evidence from the geologic, geochemical and geophysical surveys is compiled to suggest an occurrence of porphyry style mineralization, that more invasive types of exploration such as drilling are conducted. At that point, the probability of a porphyry system is high enough to warrant such activity.

MINES AND MINERAL PRODUCTION

Map 5 is a compilation of mines and prospects in eastern Pima County taken from the Arizona Department of Mines and Mineral Resources AZMILS data base as modified by the Arizona Geological Survey and a compilation of significant copper deposits by the U. S. Geological Survey. Deposits of precious and base metals are shown as red Xs and deposits of non-metallic deposits are shown as black Xs. In addition, the mining districts of eastern Pima County, from a map published by the Arizona Geological Survey as modified, are also shown as green polygons. The major mining districts are outlined by a green circle and are listed on Map 5. The major districts are:

A. Silver Bell
B. Tucson Mountains
C. Sedimentary Hills-Amole
D. Sierrita Mountains
E. Cerro Colorado-Las Guijas
F. Helvetia-Rosemont
G. Santa Rita Mountains
H. Control or Marble Peak
I. Korn Kob

A brief description of the mining districts together with production data is given in the table following page 9.

Table 1: Mining Districts and Mineral Production in Pima County, Arizona

Classification is from Keith et al. [1983], numbers are explained below. Age abbreviations are standard geologic age abbreviations. Major commodity based on reported production data (through 1981, Keith et al., 1983). Production data: Tons is total rock processed, Cu is pounds of copper; Pb is pounds of lead; Zn is pounds of zinc; Ag is Troy ounces silver; Au is Troy ounces gold.

NAME	Comments	Classification	Age	Major Commodity	Tons	Cu	Pb	Zn	Ag	Au
AGUIRRE PEAK	not much to go on	8	eT	W	270	6000	00	00	540	10
AJO	Major porphyry copper deposit	1a	TK	Cu	4300398820	60263947460	294420	10810	196677050	15617580
AJO CORNELIA	Peripheral copper deposit related to Ajo?	1b	KT	Cu						
AMADO		3*	J	Au	32100	141370	2003420	268000	257780	16630
AMOLE	Includes limestone for cement quarries at Twin Peaks. Numerous small mines and prospect pits in border zone around Laramide pluton.	4*	lK	poly	136470	3576610	4719390	100000	127180	6000
ARIVACA	Very few sites	4	T	PbZnAg	25450	241560	724220	5000	136320	6470
BABOQUIVARI	Very few sites	3	mT	Au	2326020	282470	12510	00	5350000	447760
BEN NEVIS	Very few sites	5	mT	Ag						
BLACK DRAGON	No mines or prospects in any of the databases. 117,000 lbs Mn production reported	6a	mT	Mn						
BLUE ROCK	Reported prod. for district: 85 lb U3O8; U in Mid Tertiary rocks??	10c	eT?	U						
BROWNELL	Very few sites	1a	KT	poly	24320	784270	98010	00	137220	70
CABABI	Combine 2 blobs from Keith into one blob; widely scattered small miners and prospects in Jurassic igneous rocks	4*	TK	poly	71830	1823260	3189210	22000	758820	30190
CADILLAC	One MRDS location, Mn listed as commodity	6a	mT	Mn						
CANADA DEL ORO	Location based on prospects in MRDS, no production, prospects not on 24K quad map	3	mT	Au						

NAME	Comments	Classification	Age	Major Commodity	Tons	Cu	Pb	Zn	Ag	Au
CARDINAL AVE	location not very good; U in late T sediments	10b	mT	U						
CATALINA	Pontatoc Mine and scattered prospects near Catalina Detachment fault	1a	TK	Cu	50040	4158240	1760	00	23230	10
CAVE CREEK		3	mT	poly	210190	3200180	65890	00	195300	94450
CERRO COLORADO		5	lK	Ag	53420	300510	556510	00	3594690	810
CERRO DE FRESNAL		3	mT	Ag	680	1550	00	00	10790	440
CIMARRON MTNS	Split district to correspond with distribution of workings	6a	KT	Ag	800	32830	68850	00	3360	300
COMOBABI	Not much to go on; distinction from Cababi district very unclear	5*	eT	Ag	260	2170	00	00	13620	00
COYOTE		1a	TK	Cu	21950	4074640	00	00	35360	570
CUPRITE	Split Cuprite District to include hanging wall of Davidson Canyon normal fault, mostly base metals	1a	KT	poly	24860	2434440	987180	11620	44760	30
Cross Hill (new name)	Clay rich mudstone facies of Pantano Formation, active mines produce clay for brick.		mT	clay						
EASTER		8	lK	W	20	00	00	00	30	60
EMPIRE	Pz rocks in footwall Davidson Canyon normal Fault; veins in Epitaph, Rainvalley; also have gypsum in Epitaph. White marble abundant where Escabrosa and Horquilla limestones are intruded by Laramide stock within district, potential decorative rock.	4	K	PbZnAg	178240	2266340	70500630	1523640	1095560	4860
GREATERVILLE		4	K?	PbZnAg	30660	547750	12730630	220000	297210	5210
GREENBACK	one mine, no data	3	mT	Ag	8000	20000			32000	1000

NAME	Comments	Classification	Age	Major Commodity	Tons	Cu	Pb	Zn	Ag	Au
GROWLER	Extent poorly defined; mines in this area report silica flux, and skarn industrial mineral production, probably related to metamorphosed Pz rocks	4	eT?	PbZnAg	410	23480	76070	00	1850	10
GUNSIGHT	Adjust district outline to distribution of MRDS sites & mine shafts; district apparently confined to Tg and TKg	5	TK	Ag	63090	32480	516560	2000	1335340	490
HELVETIA-ROSEMONT	Significant porphyry copper system, thoroughly explored, major known resource. Marble for decorative stone produce from Paleozoic carbonate rocks in western part of district.	1a	TK	Cu	4827910	402343040	4451250	9944090	4776890	18090
JACKSON		1a	KT	Cu	2060	373080	00	00	9980	10
KEYSTONE	distinction from Papago district unclear	3	lK	poly	2180	7250	58500	2000	8370	1320
KITT PEAK	Location unclear, no mines to relate to	1a	J	Cu						
LAKESHORE	Significant porphyry copper deposit, mined underground and by open pit, currently inactive	1a	TK	Cu	146568770	2326111970	38740	00	133240	20080
LAS GUIJAS	Some Tungsten production; minor silver & copper; gold & tungsten placers in area	8	eT	W						
MAGONIGAL	split in 2 parts based on MRDS/MILS locations	1a?	KT	Cu	3130	156000	00	00	60	00
MARBLE PEAK	Adjust outline to distribution of Pz rocks near Kd from Mt. Lemmon to NE base of range	1a	TK	Cu	2695370	123339010	806000	373000	1992790	5640
MILDRED PEAK	match to distribution of mines & prospects	5*	TK	Ag	57190	2144740	114650	00	368220	13300
MINE CANYON	not much to go on	5*	lK	Ag	37050	1092000	00	00	22700	160
MONTEZUMA		5*	eT	poly	11820	1984530	154550	00	99250	200
OCEANIC		3	mT	Au	15010	300	3000	00	4050	6050
OLD BALDY		4	lK	PbZnAg						

NAME	Comments	Classification	Age	Major Commodity	Tons	Cu	Pb	Zn	Ag	Au
PAPAGO		4	TK?	PbZnAg	94140	903170	14457070	2800	508560	2770
PIMA	Giant porphyry copper system, much of which is buried beneath pediment on southeast side of Sierrita Mountains. Outline adjusted to combine Mission and San Xavier north into one blob.	1a	TK	Cu	9712952440	82860341310	762972410	1329641190	567551600	271050
QUIEN SABE		1a	KT	Cu	178950	2854960	9000	00	28770	220
QUIJOTOA	Adjust outline to split district into two pieces	3*	TK	Au	51550	653140	284070	00	160740	14430
QUINLAN		8	TK	W	10	00	12400	00	300	00
QUITOBAQUITO	No data, no reported production, no mine shafts on topo maps.	4	eT	PbZnAg						
REDINGTON	Mines in Pz at end of Kd sill, NE boundary uncertertain, covered by QTs	1a	KT	Cu	910	115710	00	00	1360	00
RINCON	District outline shows zone of silicification and calcite-silica veining in rocks along NE edge of Pz rocks at Colossal Cave	2	mT	poly	1980	127320	8000	00	2940	1180
ROADSIDE	Significant Mn production	3	lK?	Au	270	00	00	00	120	220
ROSKRUGE	Need to look at detailed geology to delineate; porphyry copper prospect in this area. Silver mineralization is probably peripheral to copper system.	1a	KT	Ag	2790	95500	00	00	79790	20
SAGINAW HILL	Split district outline into two parts.	1a	TK	poly	55740	1061310	1862270	4340000	140760	2850
SANTA ROSA	not much to go on	1a	KT	poly	2210	213910	63430	00	12610	550
SEDIMENTARY HILLS	USGS calls Amole district in MRDS	1a	KT	Cu	20	1050	00	00	110	00
SILVER BELL	Large, complex mineralized porphyry copper system with active open-pit mine; SE extent beneath alluvium based on data from J. Briscoe, northern part may include T	1a	TK	Cu	905554370	12988428730	48007720	407797050	58942610	22060

NAME	Comments	Classification	Age	Major Commodity	Tons	Cu	Pb	Zn	Ag	Au
	mineralization in the vicinity of Ragged Top									
WATERMAN	Two significant mines in Paleozoic carbonate rocks. Mineralization localized along veins and faults.	4	K	poly	510490	32307750	12673190	8210500	1625100	1010
unnamed	MRDS/ MILS sites indicate possible Marble source			Marble?	00	00	00	00	00	00

Explanation of numbers in Classification column:

1a: porphyry copper with or without Mo, Mn, Au, and peripheral PbZnAg
1b: stratabound copper in rock of Age
2: Vein mineralization, Cu with or without Au or Pb.
3: Gold with or without Cu or Pb.
3*: like 3, but with significant silver
4: PbZnAg veins and replacements
4*: like 4, but with significant production of Cu and Au
5: Ag with or without Pb and Zn, veins and replacements
5*: like 5, but with significant Cu production
6a: Mn veins with or without Ba, Pb, Ag.
8: Tungsten, skarn and veins or pegmatites with or without Be or Li.
10b: Uranium with or without vanadium, stratabound in rocks of Age

Table 1is taken from: Richard, Stephen M., 2001, Brief Overview of mineral resources of Pima County: Arizona Geological Survey, Draft Report, May 9, 2001 6 p.

BASE AND PRECIOUS METAL POTENTIAL OF EASTERN PIMA COUNTY

All information compiled and presented in this report constitutes hard data, that is data that has been obtained through field work by individual geologists or through publications of the U. S. Geological Survey. No speculative material is included in this report. Map 6 outlines the areas favorable for porphyry copper deposits and Map 8 summarizes the Mineral Potential of eastern Pima County related to the Biological Preferred Reserve System described in the May 2001 report of the SDCP.

The field work by individual geologists, members of SMEA, all of whom have worked in exploration and mining geology in Arizona for many years, ranged from geologic mapping, drilling and geological reconnaissance or from knowledge of such work obtained from company reports or geologic field trips and field inspections. Thus, "hard data" is data that can be verified by independent studies. In order to qualify as inclusion in this report, the data had to include definite information on mineralization and alteration related to mineral deposit occurrence.

The U. S. Geological Survey work was obtained from official government publications and was conducted by reputable geologists, geochemists and geophysicists . This information may also be considered hard data.

In the following sections, each area outlined either by SMEA geologists or by the U. S. Geological Survey is briefly described. Each area has potential for the discovery of a new mineral deposit.

1. Areas Favorable For Exploration And Discovery Of Porphyry Copper Deposits - Defined by Members of the Southwestern Minerals Exploration Association

A. Las Guijas Mountains (Map 6 – Areas 5 and 8)

Mineralization in the Las Guijas area is closely associated with an elongate, northwest-trending granitic stock of Laramide age. The stock was emplaced into non-reactive Mesozoic volcanic and sedimentary rocks and is cut by later diorite porphyry and rhyolite-latite dikes.

The extensive quartz veins containing tungsten mineralization that are localized along the north flank of the granitic intrusive are related to the area of erratic, but widespread, fluorine and boron-rich alteration exposed at the western end of the stock. Geologic relationships suggest that rocks in this area have undergone structural rotation and displacement on low angle faults.

Previous exploration drilling in both the western part of the stock and the adjacent Cretaceous sedimentary rocks by several companies has indicated that the erratic fluorine and boron-rich alteration and the tungsten mineralization could be a distal reflection of concealed porphyry molybdenum or porphyry copper-molybdenum mineralization.

B. Cerro Colorado Mountains (Map 6 - Area 6)

A major mining company drilled 28 drill holes and conducted geophysical surveys during the early 1970s in the Rancho Seco area. The drill holes intersected primary porphyry copper mineralization hosted mainly in breccia pipes. This mineralization occurs under private, state and federal land.

In addition geochemical sampling identified a silver district in andesites just south of the Arivaca road to the south of the Rancho Seco project area and in the Mary G mine area north of the highway.

C. San Luis Mountains (Map 6– Area 7)

A major mining company drilled 12 holes and conducted several geophysical surveys in 1972. This work discovered two sections of a detached porphyry copper system on the pediment just west of the San Luis Hills.

D. Greater Silver Bell Area (Map 6 – Area 1)

The greater Silver Bell district has produced many million tons of ore from 1865 to the present ranging from 0.5% to 3.5% copper. Copper production is continuing today by mining lower grade material which is placed on dumps, leached and the copper recovered in a solvent extraction-electrowinning (SXEW) plant.

Drilled mineral resources or reserves are still being found today in the Silver Bell district as exploration thoughts and strategy are being re-examined.

The pattern of the main Silver Bell ore zone was reported by Richard and Courtright in 1966. The eastward extension of the alteration-mineralized zone is covered by alluvium or gravels. Asarco drilled a number of holes through the alluvial cover which indicated that the mineralized zone extended to the east underneath the alluvium. In addition geologic work on the west end of the zone indicated that the zone curved to the west just before the zone was cut by the Atlas fault. Although several holes were drilled west of the Atlas fault, no extension of the Silver Bell zone was found. Displacement of the Silver Bell mineralized zone by the Atlas fault was possibly greater than anticipated. Porphyry copper alteration and mineralization were subsequently found in the West Silver Bell mountains.

Work by Peter Lipman of the U. S. Geological Survey in the Silver Bell Mountains suggested that the Silver Bell Mountains were part of a caldera with associated mineralization. This work followed an early study on resurgent calderas which documented the various styles of mineralization found within and around the calderas. Further work by Sawyer proposed the Silver Bell caldera with monzonite porphyry stocks intruded along the margin of the ring zone. Sawyer also noted the eastern tilt of the rock units and that the ring structure on the eastern side would be covered by alluvial material. He also noted that the northeast side of the ring structure would be cut off by the west-trending Ragged Top fault. North of the Ragged Top fault, the exposed rock units do not indicate any alteration or mineralization, suggesting a large strike-slip fault movement has occurred along the fault. A possible location of the ring structure on the east side of the Silver Bell mountains was discovered by recent exploration under the alluvial valley.

The individual orebodies at Silver Bell occur along the ring structure like " beads along a string". Insufficient drilling along the ring structure both within the main Silver Bell district and on the westward and eastward extensions may have missed other such beads.

Exploration based on renewed theories, known facts and improved technology should be encouraged in the greater Silver Bell area as the likelihood of additional discoveries is great.

E. Granite Peak-Mine Canyon (Map 6 – Area 4)

Mineralization in the Granite Peak-Mine Canyon area at the south end of the Whetstone Mountains and at the southeast corner of Pima County is associated with a Laramide intrusive complex emplaced into Paleozoic limestones and Cretaceous sedimentary and volcanic rocks. Skarn and replacement type copper and lead deposits occur in the Paleozoic limestones on the northern and eastern sides of the intrusive complex with widespread, but less intense, scattered copper mineralization present in the non-reactive Cretaceous sedimentary and volcanic rocks in Pima County to the west.

The intrusive complex consists of a granodiorite stock cut by later granodiorite porphyry sills and rhyodacite, quartz gabbro, granite porphyry and quartz monzonite porphyry dikes. The intrusive complex appears to have been emplaced into the sedimentary units at a relatively shallow level.

Previous exploration drilling by several companies has established the presence of a porphyry copper alteration system centered on the intrusive complex with mineralized breccias and a zone of primary disseminated copper mineralization located in intrusive rocks on the eastern side of the stock.

F. Rosemont-Helvetia (Map 6– Area 3)

In the Helvetia-Rosemont district according to Stanton B. Keith of the Arizona Bureau of Mines[5] fifty or more small to medium mines and prospects have been opened or worked in the Helvetia-Rosemont districts since the early 1880s. Copper, silver, zinc, lead and minor gold, molybdenum and tungsten were recovered. In a recent paper, S A. Anzalone of Asarco[6], reported that approximately 570 holes have been drilled in the district by several mining companies over the years. This work has resulted in the delineation of 4 centers of porphyry copper style alteration and mineralization, aligned along an arcuate zone extending from the Rosemont deposit in the south through the Broad Top Butte, Copper World to the Peach Elgin deposit in the north. The Greaterville district, which has many porphyry copper characteristics lies south of the Rosemont deposit. This arcuate trend from Greaterville to Peach Elgin extends for about 7 miles along the northern Santa Rita Mountains and in the pediment to the west of the range. The Rosemont geological mineral reserve was defined by Anamax in 1977 at 328 million tonnes of sulfide mineralization of 0.61% copper, 0.019% molybdenum and 8.5 grams per ton silver based on a 0.30% copper cutoff. Anzalone stated that in addition Asarco defined an additional 60 million tonnes of copper oxide at 0.53% copper. Exploration was still continuing in 1995 with expectations that additional ore grade mineralization will be discovered.

The Helvetia-Rosemont district has undergone over one hundred years of mining and exploration and is still being actively explored with expectations of new discoveries. The Rosemont deposit constitute a major source of new copper for Arizona and the nation. To block development of this deposit and to restrict further exploration would be a great loss to our local and national economy.

G. Sierrita-Sahuarita (Map 6 – Area 2)

Serious mining activity in the Sierrita-Twin Buttes district dates back to the late nineteenth century when early prospectors developed a number of small vein and replacement deposits of base and precious metals. Minor production continued through the post World War II era, but was limited to the well known near-surface deposits. Much of the surrounding area was covered by alluvium and thought by many, including the U. S. Geological Survey, to be non-mineral in character. Beginning in the late 1940s several discoveries were made by astute explorationists aided by improvements in the understanding of the geology of copper deposits. Many of the new deposits lay beneath post-mineral cover. Continued technological developments have made it possible for these mines to produce much-needed metals under economic conditions unimaginable fifty years ago. These mines contribute significantly to the several billions of dollars contributed annually by the copper industry to the economy of Arizona.

[5] Keith, Stanton B., 1974, Index of Mining Properties in Pima County, Arizona: Arizona Bureau of Mines, Bulletin 174, p.123

[6] Anzalone, S. A., 1995, The Helvetia area porphyry systems, Pima County, Arizona *in* Pierce, Frances Wahl and Bolm, John G., *eds*., Porphyry Copper Deposits of the American Cordillera: Arizona Geological Society Digest 20, pp. 436 – 431.

It is entirely reasonable to expect the trend of technological progress and refinement of geological interpretation to continue and, under the proper conditions, to lead to additional valuable discoveries in this geological favorable district. Favorable host and generative rock types extend throughout the district and may be expected to occur at even greater depth under the alluvial cover, although it may seem uneconomic to explore at present. Several of these deposits are truncated by low-angle faults and presumably, the mineralization has been offset elsewhere, as occurred with the Mission-Twin Buttes deposits. The faulted geologic model may be reasonably expected to occur in other locations within the prospective area, awaiting resolution by future generations if not locked away in a restrictive biological reserve.

H. Mildred Peak (Map 6 – Area 9)

The Mildred Peak area is an area of generally subtle Laramide-Tertiary mineralization in intrusive and meta-sedimentary rocks. The most obvious mineralization is at the Jupiter Mine, which produced high-grade gold and silver ore, primarily from veins, mainly between 1938 and 1941 (when gold production was halted by government order).

The Jupiter Mine is peripheral to a zoned copper-molybdenum geochemical anomaly; a strong magnetic anomaly was also detected in the area by Duval Corporation exploration crews during a program in 1980-1981. The company sponsored a M.S. thesis by Sheila Seaman at the University of Arizona which provided further detail on geology of the area. Drilling was limited by budget constraints and, although mineralization was encountered, nothing of economic value was found. Potential remains, however, on he alluvial covered pediment east of Mildred Peak.

I. Korn Kob (Map 6 – Area 10)

The Korn Kob property has developed proven copper oxide reserves exceeding 40 million tons of about 0.35% soluble copper, of which 23 million tons is minable in two small open pits. More than 120 holes were drilled in sections 13, 14, 23 and 24 T 12 S, R 17 E. The copper mineralization occurs mostly in skarn and tactite in Paleozoic altered rocks. Another company encountered a quartz monzonite porphyry at a depth of 2003 feet to the east and northeast of the Korn Kob mineralization. This monzonite was possibly related to the oxide copper mineralization. Pyrite and chalcopyrite were found in the rocks near the quartz monzonite porphyry. Many of the exotic oxide copper deposits, similar to Korn Kob, occur adjacent to a mineralized porphyry system in bedrock. Such a porphyry system has not yet been found at Korn Kob but the possibility remains valid.

J. Greaterville

Since 1875 and up to until 1948 gold was produced by small-scale hand methods, drag lines, dry land dredge and dry land washing plants from a number of placer deposits scattered along the arroyos in the Greaterville district. Some small-scale placer mining continues to the present. Nuggets up to 37 ounces have been recovered adding to the allure of the district. The source of the gold is believe to be gold bearing veins associated with a Laramide quartz latite porphyry.

Although known mainly for its gold production, other metals found in the veins are copper, zinc, lead, silver and barium. Geochemically a zoning pattern exists suggestive of a (buried) porphyry copper system with a central zone of copper-zinc-lead and arsenic-antimony-silver-gold peripheral to the former. The possibility of a porphyry copper deposit led the New Jersey Zinc Company, in the 1970s, to drill a number of exploration holes. Although no deposit was found at that time, the potential for a buried porphyry system remains viable today.

2. Tracts permissive or favorable for the occurrence of porphyry copper deposits defined by the U. S. Geological Survey

a.) U. S. Geological Survey Open File Report 90-276[7]

Several zones were outlined which were permissive for the occurrence of porphyry copper deposits. Although the Open File Report gave no details as to how areas were chosen, extensive geochemical and geophysical surveys were utilized in the preparation of the Open File Report. These included NURE (National Uranium Resource Evaluation Program) stream sediment, stream. Well and spring water and rock geochemical data; RASS and PLUTO data bases for rock analyses; magnetic and non-magnetic heavy-mineral concentrates from stream sediments; and aeromagnetic and gravity geophysical surveys. Elements considered in the U. S. G. S. study were silver, arsenic, gold, bismuth, copper, mercury, molybdenum, lead, antimony, tin tellurium, uranium, tungsten and zinc. In the Preface to the Open File report the authors state "This report makes available to the public the scientific information provided in that preliminary administrative document and in no way should be looked upon as a completed assessment of the Tucson Nogales 1^{o} by 2^{o} quadrangles." The locations of the permissive porphyry copper tracts are shown on Map 6 in light yellow color and labeled as indicated below.

The description of each of the tracts within eastern Pima County which were assessed as permissive for porphyry copper deposits is described below. The descriptions are quoted directly from the Open File Report.

Sierrita Mountains (Map 6 – Area G3)
"Four of the major porphyry copper deposits in the study area are within this tract. The core of the range, the Ruby Star granodiorite is known to be barren. The tract boundary includes shallowly buried rocks on the pediment, as determined from gravity data. The pediment areas have the best potential in the tract for the discovery of additional porphyry copper deposits."

Santa Catalina Mountains (Map 6 – Area G2)
"This range includes the San Manuel-Kalamazoo porphyry copper system. Cox and Singer (1988) have recently defined and described porphyry copper-gold-molybdenum-type deposits based in part on geochemical work at the Kalamazoo orebody (Chaffee, 1982b). This deposit type is intermediate between porphyry copper-molybdenum (type 21a), such as in the Pima district, and porphyry copper-gold (type 20c), such as in the Dos Pobres district in Graham County east of the study area, and represents a continuum between the two end members…."

Silver Bell Area (Map 6 – Area G1)
No information was reported for the Silver Bell tract delineated in OFR 90-276.

Northern Santa Rita Mtns. (Map 6 – Area G4)
No information was reported for the Northern Santa Rita Mountains tract delineated in OFR 90-276.

b) U. S. Geological Survey Bulletin 2083[8]

[7] Peterson, Jocelyn ed., 1990, Preliminary mineral resource assessment of the Tucson and Nogales 1^{o} by 2^{o} quadrangles, Arizona : U. S. Geological Survey Open-File Report 90-276, 129 pp, 24 pls, scale 1:250,000

[8] Du Bray, Edward A. ed., 1998, Mineral resource potential and geology of Coronado National Forest, Southeastern Arizona and Southwestern New Mexico, Edward A. du Bray: U. S. Geological Survey Bulletin 2083-A-K, 170 p, 32 pls., Scales various.

Northern Santa Rita Mountains (Map 6 – Area SR1)
According to Bulletin 2083, Tract SR-1, in the Northern Santa Rita Mountains is favorable for the discovery of tungsten skarn deposits, polymetallic vein deposits and porphyry copper-skarn mineralization. Tract SR-1 was assigned a Certainty Level C. This level indicates that available information gives a good indication of the level of mineral resource potential. The tracts were divided into Low to Moderate potential and High potential for the occurrence of undiscovered mineral deposits. Only the High potential areas are shown on the maps included with this report. High potential tracts possess the following criteria and (or) contain known mineral occurrences:

> "They contain areas that coincide with steeply dipping, northwest striking faults;
>
> They contain areas in which favorable host rocks and felsic intrusions are juxtaposed; and
>
> They contain areas for which stream-sediment and panned-concentrate samples have anomalous abundances of Au, Ag, As, Bi, Cd, Cu, Mo, Pb, Sb, W, Zn, Ba, Mn and Sn " (page 165)

Bulletin 2083 further states on page 165 "The tracts include a large area concealed by a thin cover of Quaternary alluvium. Most of this area is east of the Santa Rita Mountains, where geophysical data indicate that the thickness of alluvium is less than 1 km. The Helvetia-Rosemont, Jackson, Old Baldy, Tyndall, Duranium, Salero, Ivanhoe, Mansfield, Wrightson, Cave Creek and Greaterville districts are within these tracts." The Tyndall, Duranium, Salero, Ivanhoe, Mansfield, and Cave Creek districts are in Santa Cruz County.

Tract SR-1 is shown on Map 6 in a dark green color and labeled SR1

3. Tracts Favorable for the Exploration and Discovery of Gold-Silver, Polymetallic and Tungsten Deposits – Defined by the U. S. Geological Survey

Two areas were delineated by the U. S. Geological Survey for the occurrence of undiscovered gold-silver, polymetallic and tungsten deposits in eastern Pima County. These are the Northern Santa Rita Mountains (Tract SR 1) and the Atascosa, Pajarito, San Luis and Tumacacori Mountains, and Cobre and Coches Ridges (Tract T-1)

Northern Santa Rita Mountains. (Map 6 – Area SR1)
Tract SR-1 has potential for the discovery of Tungsten Skarn deposits, polymetallic vein deposits and porphyry copper-skarn mineralization. Tract SR-1 was assigned a Certainty Level C. This level indicates that available information gives a good indication of the level of mineral resource potential. The tracts were divided into Low to moderate potential and High potential for the occurrence of undiscovered mineral deposits. Only the High potential areas are shown on the maps included with this report. High potential tracts possess the following criteria and (or) contain known mineral occurrences:

> "They contain areas that coincide with steeply dipping, northwest striking faults;
>
> They contain areas in which favorable host rocks and felsic intrusions Are juxtaposed; and

> They contain areas for which stream-sediment and panned-concentrate samples have anomalous abundances of Au, Ag, As, Bi, Cd, Cu, Mo, Pb, Sb, W, Zn, Ba, Mn and Sn " (page 165) "
>
> Bulletin 2083 further states on page 165 "The tracts include a large area concealed by a thin cover of Quaternary alluvium. Most of this area is east of the Santa Rita Mountains, where geophysical data indicate that the thickness of alluvium is less than 1 km. The Helvetia-Rosemont, Jackson, Old Baldy, Tyndall, Duranium, Salero, Ivanhoe, Mansfield, Wrightson, Cave Creek and Greaterville districts are within these tracts." The Tyndall, Duranium, Salero, Ivanhoe, Mansfield, and Cave Creek districts are in Santa Cruz County.

Tract SR-2 that has High Potential for Gold Placer Deposits. Tract SR-2 coincides with Tract SR-1 described above. On Page 165, Bulletin 2083 states:

> "Tracts SR-2…consists of areas in which fluvial deposits of sand and gravel have moderate to low potential, certainty Level C, for the presence of undiscovered gold placer deposits hosted by stream gravels. Tracts were delineated on the basis of historic placer mining in the Greaterville mining district, the presence of known and potential lode deposits upstream, and anomalous abundances of Au, Ag, As, Cd Cu, Mo, Pb, Sb w and Zn (stream-sediment) and Ag, Cd and Ba (panned-concentrate) in samples from the area. The degree to which previous placer mining operations extracted all recoverable gold, thereby exhausting the resource potential, is indeterminate; therefore the tract has been assigned a moderate to low potential."

Pajarito Mountains
Two areas were also identified in the Pajarito Mountains.

"Tract labeled T-1 (fig.3 and pl. 29) have high or moderate to low potential certainty level B for the occurrence of undiscovered polymetallic vein deposits. These tracts include the Oceanic, Arivaca, Austerlitz and Oro Blanco mining districts." (page 165)

> Certainty level B is defined as "Available information suggests the level of mineral potential." Only the Arivaca district is in Pima County.
>
> "Tracts were delineated on the basis of favorable host rocks, known ore mineral occurrences, alignment along extensive, if somewhat discontinuous, northwest-striking faults and anomalous abundances of Au, Ag, As, Bi, Cd, Cu, Mo, Pb, Sb, W, Zn Ba, Mn and Sn (stream sediment) and Au, Ag, Bi, Cd, Cu, Mo, Pb, Sb, Zn, Ba, Mn and Sn (panned concentrates) in samples from the area" (page 165)

Tract, T-2, which was estimated to have low to moderate potential, certainty level B, for the occurrence of undiscovered tungsten vein and placer deposits…" (page 165) This is a small tract just north of Cumero Mountain.

> Tract T-2 "…is primarily indicated by the presence of the Easter mining district, which includes placer and vein tungsten deposits…….mineralized rock may be associated with peraluminous Tertiary granite that crops out within the tract or may be related to a buried intrusion." (page 165)

Tract T1 is shown on Map 6 in a dark green color and labeled T1. Only areas indicated in Bulletin 2083 plate 29 as High Potential are shown on the maps in this report.

On Map 6, three large areas or regions favorable for the exploration and discovery of porphyry copper deposits were defined by members of the Southwestern Minerals Exploration Association:

Area A is a large crescent shaped zone extending from the town of Sasabe north of Sahuarita and extending to the Granite Peak district on the Pima Cochise County line. All of this area is permissive for the occurrence of porphyry copper deposits and constitutes one of the premier exploration areas for copper in the Western United States. Several open pit copper mines – Sierrita and Pima-Mission - are in production in this Area as well as two main undeveloped deposits – Helvetia and Rosemont.

Area B covers the Waterman and Silver Bell Mountains. This area still has potential for the discovery of additional copper deposits. The Silver Bell mine is in production in this zone.

Area C covers part of the Central and Eastern Catalina Mountains. Two areas of porphyry copper mineralization – Marble Peak-Control and Korn Kob - occur within this area.

In addition to the three areas described above and shown on Map 6, additional land outside the areas is permissive for porphyry copper mineralization, as described above in the Section on Geology and Geochemistry. The land extending northwestward from Robles Junction to Silver Bell is particularly favorable for new discoveries.

Recommendations for maintaining these Areas open for mineral exploration and development are included in the section below titled " Areas Recommended for Mining and Exploration and Multiple Use"

NON-METALLIC MINERAL POTENTIAL OF EASTERN PIMA COUNTY

The main non-metallic mineral potential in eastern Pima County consists of sand and gravel, marble, clay and minor limestone. All information compiled and presented in this report constitutes hard data, that is data that has been obtained through field work by individual SMEA geologists or through publications of the U. S. Geological Survey. No speculative material is included in this report. Map 7 outlines the areas favorable for non-metallic minerals and Map 8 summarizes the mineral potential of eastern Pima County related to the Biological Preferred Reserve System described in the May 2001 report of the SDCP. The two main sources of information on non-metallic minerals came from the U.S. Geological Survey Miscellaneous Investigation Series Map I-844-J and by members of the Southwestern Minerals Exploration Association. Areas currently being mined are not shown on Map 7.

1. Areas Favorable for Sand and Gravel

As outlined on Map 7, five areas are shown as favorable for sand and gravel deposits. Favorable areas are labeled "SG" on Map 7. These are:

A. Santa Cruz Terrace and Los Robles Wash (Map 7 – Area A)

The Santa Cruz Terrace and Los Robles Wash area lies northwest of Tucson near the town of Marana. These two areas are undeveloped at this time but constitute a potential major source of sand and gravel for the future development of infrastructure in the northwest Tucson metropolitan area.

Current production of sand and gravel is ongoing along the Santa Cruz River within the Tucson metropolitan area by several companies. These operations are under considerable urban pressure and may find it difficult to expand the operations. The Marana area may face the same pressure in the future.

B. San Pedro River (Map 7 – Area B)

The potential area of sand and gravel along the San Pedro river extends about 6 miles north of the town of Redington and 5 miles south. No current sand and gravel operations are working in this resource area and until development and need for more infrastructure reach this area these deposits will probably remain dormant.

C. Pantano Wash (Map 7 – Area C)

Several small sand and gravel pits have operated along the Pantano wash and significant potential remains on a short stretch of the wash.

D. South of Tucson International Airport (Map 7- Area D)

A large resource of sand and gravel occurs along an alluvial fan east of the Santa Rita Mountains and in part on terraces of the Santa Cruz River. Part of this resource is currently being mined. Part of this resource constitutes a major source of aggregate for the Tucson Metropolitan area. Additional potential remains in this area.

E. Santa Cruz River and Terraces Tucson to Arivaca Junction (Map 7 – Area E)

Potential alluvial aggregate deposits occur along the East Side of the Santa Cruz river from Valencia road to the Santa Cruz county line at Arivaca Junction. One major pit is under production on the East Side of the river south of Green Valley and another just south of the Tucson International Airport. This large tract has considerable potential for supplying aggregate for the expanding development along the Tucson-Nogales corridor.

2. Area Favorable for marble deposits

A crescent shaped area containing several marble quarries and with potential for additional resources of marble occurs in the north end of the Santa Rita and Empire Mountains about 3.5 miles south of Mountain View. This zone strikes about east west in the northern part, but curves to the south along the east side of the Northern Santa Rita Mountains. Several marble quarries are currently in operation, producing architectural aggregate and cattle feed supplements. Included in these are the Andrada Ranch, White Cliffs, White Hope and Davidson marble deposits. Favorable areas are labeled “M” on Map 7.

3. Pantano Clay District

The Pantano clay district is adjacent to the small town of Pantano and is within the Pantano mining district. This district is currently producing structural clays used in brick manufacturing and high alumina clay for a local cement plant. The deposit is the only source of high alumina clay in southern Arizona and the only source of brick clay, which will fire to a variety of colors. The Pantano clay deposit is labeled “C” on Map 7.

4. Limestone Deposits

One limestone quarry and several small properties suitable for future development at present in eastern Pima County. The quarry is located at Twin Peaks near Marana. One of the limestone properties is in the Waterman Mountains and other straddles the Pima-Pinal County line north of Tucson. Other possible sources of limestone are probably present in eastern Pima County, but have not been identified in this review. Favorable areas are labeled “LS” on Map 7.

5. Gypsum Deposits

Two areas of potential gypsum deposits have been identified in eastern Pima County. One was defined by the U. S. Geological Survey in Miscellaneous Investigations Series Map 844-J-I. This occurs along the eastern flank of the Empire Mountains. It extends from just south of Interstate

Highway I-10 for a distance of about 8 miles. Some production has come from small pits in this area. The other area was defined by members of the Southwestern Minerals Exploration Association as well as the U. S. Geological Survey. This area lies west of the town of Sahuarita near Mission Road. No production is known to have occurred from this occurrence. Both these areas have been considered for production over the years and possibly constitute a viable source of gypsum for the future. Gypsum localities are labeled "G" on Map 7.

5. Silica Deposits

Several areas of silica rock occur along the east side of the Baboquivari Mountains from Mildred Peak north for about 6 miles. Although the potential is present for possible commercial production, the occurrences are isolated and far from an end use. The Silica localities are labeled "S" on Map 7.

7. Other Non-Metallic Mineral Potential

Other potential non-metallic commodities occur within eastern Pima County, such as sources of rip-rap, barite, actinolite-tremolite, silica and alunite in the Santa Rita Mountains; fluorite and actinolite-tremolite in the western slopes of the Sierrita Mountains; barite and fluorite in the Silver Bell Mountains, barite near the small town of Pantano; and actinolite-tremolite in the Santa Catalina Mountains. These occurrences have unknown potential at this time.

MINERAL POTENTIAL AND SDCP BIOLOGICAL RESERVES

Map 8 is an overlay of eastern Pima County mineral potential (Maps1, 6 and 7) on the May 2001 SDCP biological reserve map. Map 8 clearly shows that several of the most favorable and permissive areas for exploration and discovery of porphyry copper and other deposits cover large areas that are being considered for the biological reserves. These favorable mineral potential areas are outlined in blue on Map 8 and labeled A through G. Detailed descriptions of and recommendations for these areas are given the following section of this report titled "Areas Recommended For Mining And Exploration And Multiple Use"

Careful consideration should be given to protecting the favorable mineral potential areas from being locked out from future exploration and development.

MINERAL POTENTIAL AND PIMA COUNTY LAND STATUS

Map 9 is an overlay of eastern Pima County mineral potential (Maps1, 6 and 7) on a map showing the land status for eastern Pima County. Map 9 clearly indicates that the areas favorable for exploration and discovery of new mineral deposits lie mostly on Arizona State land and to a lesser extent on National Forest Lands and private fee land. The Silver Bell potential area also is partly on the Ironwood National Monument and partly on Tohono O'Odam Nation lands.

AREAS RECOMMENDED FOR MINING AND EXPLORATION AND MULTIPLE USE
The Missing Seventh Element in the SDCP Plan

Mining Reserves: Recommendations for Protecting Favorable Mining Areas

On Map 8, seven tracts, marked A through G, are outlined as favorable for exploration, discovery and development of mineral deposits. In addition to tracts favorable for porphyry copper deposits these areas include four occurrences of relatively undisturbed sand and gravel, one large zone favorable for marble, two areas of gypsum occurrences and several small occurrences favorable for limestone deposits. The areas shown on Map 1 as geothermal resource areas, on Map 6 as being favorable for porphyry copper deposits and on Map 7 as being favorable for non-metallic deposits are included in the tracts in this section.

These seven areas are critical habitats[9] for undiscovered mineral deposits and as such need to be as carefully protected and defined as are habitats for endangered species***. If these prospectable areas are withdrawn from exploration and development, the availability of our future sand and gravel, porphyry copper deposits and other mineral deposits will become endangered and in a real sense the availability for minerals eventually will become extinct in Pima County.*** The impact of such a development on Pima County and the Tucson Metropolitan area will be considerable. If the sand and gravel deposits can no longer operate within a reasonable distance of new developments, the costs of these and of renovations of existing infrastructure will greatly increase. Although the direct impact of shutting off copper exploration and development will not immediately be noticeable to the citizens of Pima County, the longer term impact could effect the cost and availability of many of the common things we use today and also could be detrimental to the future national security of the United States. Foreign copper resources are prone to cartels similar to oil resources.

Sand and gravel deposits are a special type of mineral deposit. U. S. Geological Circular 10[10] states on page 9:

> "Aggregate occurs where nature placed it, not where people need it"

Aggregate is a non-transferable high-bulk, low-cost commodity and transportation cost from the quarry to the site of use is a major part of the total cost. Natural aggregate generally is not cost-effective if the end use site is more than 30 to 50 miles from the quarry or extraction site. "The supply area is controlled by the geology of the area, ownership of the land, zoning, land use, and transportation" (page 23.) Thus, if nearby sources of aggregate are closed or zoned away, the cost of necessary aggregate product increases proportionally. If the Tucson Metropolitan area is to continue to construct and replace highways, roads and streets and if new ones are to be built and if new buildings, housing developments, and other infrastructure is to constructed then a nearby, reliable source of aggregate is essential. To zone away such areas for biological corridors, critical habitats or riparian areas is to ignore and neglect one of the most important and critical natural mineral products necessary to maintain or improve our standard of living. In fact, such actions border on public irresponsibility.

The members of the Southwestern Minerals Exploration Association strongly recommend that the potential mineral bearing areas described below be kept available for future development and urge the planners of the Sonoran Desert Conservation Plan to consider minerals as a critical Seventh Element in the planning process – an element that needs protection as much as do many of the endangered species being considered for protection.

Area A – Silver Bell and Vicinity – Porphyry Copper

As noted above in the report, the Silver Bell area has significant potential for the discovery of additional porphyry copper mineralization, both to the east and to the west of the present mining operations. With improved exploration technology, it is almost certain that more discoveries will be made in this region. Unfortunately, the Ironwood National Monument has effectively shutout exploration in much of this favorable region.

This area was assessed by the U. S. Geological Survey in 1990 as permissive for the presence of porphyry copper deposits and was also defined by members of the Southwestern Minerals Exploration Association as an excellent area for exploration for porphyry copper deposits. The recommendations by both organizations were based on fieldwork and on personal experience of the government geologists and exploration geologists who have worked in the area. It is unfortunate that the U. S. government did not take advantage of their own professional people's assessment of this area and maintain its multiple use classification for future development of a major natural resource – low grade copper deposits.

[9] Habitat " The place where a thing or a person is usually found." Random House Dictionary

[10] Langer, William H. and Glanzman, V. M., 1993, Natural Aggregate: Building America's Future: U.S. Geological Survey Circular 1110, ` 39p.

Area B – Santa Cruz Terrace and Los Robles Wash - Sand and Gravel

Parts of the terraces north of the Santa Cruz River and a short stretch of Los Robles wash have significant potential for excellent sand and gravel deposits, urgently needed for construction of roads and infrastructure in the Tucson Metropolitan area. The Los Robles wash area is south of the Santa Cruz river and within a zone that has been earmarked as multiple use or Outside the plan by the Sonoran Desert Conservation Plan May 2001 plan. The Santa Cruz River terraces slightly overlap an area marked as critical habitat/Recovery core area. By moving the boundaries of this critical habitat area slightly to the north, this important resource of construction aggregate could be maintained for future use.

Area C – Eastern Santa Catalina Mountains – Copper

The eastern part of the Santa Catalina Mountains north of Redington pass contain a small deposit of leachable oxide copper. However the area surrounding this deposit is highly prospectable for porphyry copper mineralization. In addition the U. S. Geological Survey included a large portion of the Santa Catalina Mountains, including the copper occurrence at Korn Kob, as permissive area for the presence of porphyry copper deposits. The members of the Southwestern Minerals Exploration Association also outlined an area adjacent to the Korn Kob property as a zone of porphyry copper alteration and mineralization.

Area D – Pantano Wash – Sand and Gravel

Several small sand and gravel pits have operated along the Pantano wash in the past. Additional reserves of sand and gravel occur along a small stretch of the wash. This area could provide a good source of construction aggregate for the booming development in eastern Pima County. The reserve lies along the wash and on adjacent terraces in an area that is partially designated as outside of the SDCP plan and partially within the Pantano riparian zone.

Area E – Pantano Mining district – Clay

The Pantano clay deposit is near Cross Hill on state mineral leases. It is currently being mined for structural clays used in brick manufacture. It is entirely within an area designated as multiple use in the SDCP May, 2001 plan.

Area F – Southeastern Part of eastern Pima County – Copper, Tungsten, Gold Silver, Marble and limestone

Area F encompasses a large area – about 30 by 60miles – in the southeastern part of eastern Pima County. It is similar to the Area “A” on Map 6, although slightly larger. The mineral endowment of this area is diverse, from porphyry copper deposits in the central part of the area, to gold and polymetallic veins and placer gold occurrences in the eastern part, to scattered occurrences of marble quarries in the eastern part and to tungsten and molybdenum occurrences in the southern part. The area is one of the major porphyry copper exploration areas in southern Arizona and in the United States.

Within this Area F, the U. S. Geological Survey in 1990 outlined two very large areas permissive for the presence of porphyry copper deposits and the members of the Southwestern Minerals Exploration Association have outlined eight areas containing significant porphyry copper alteration and mineralization. In addition, the U. S. Geological Survey in 1998 defined two tracts – one in the Pajarito Mountains and the other in the Santa Rita Mountains favorable for the presence of undiscovered mineral deposits.

Sand and gravel deposits also occur along the Santa Cruz and San Pedro Rivers in Areas B, C, D and F, which could provide a much-needed source of construction aggregate for the expanding development within the Tucson Metropolitan Area.

A review of Map 6 indicates that this region has been very productive in producing much needed resources of copper in the past and has potential for an extremely productive future. The area labeled on Map 6, as the Sierrita-Sahuarita porphyry copper exploration zone is particularly important for exploration and development of new copper resources. The Helvetia-Rosemont area is just below the Sierrita-Sahuarita area in potential for copper. Geochemical surveying has outlined large areas of prospectable ground in both these areas. To shut out exploration and development in Area F would put our nation at risk in the future for vital commodities needed to maintain our standard of living and economy. The SDCP planning group is urged to look closely at the mineral potential in Area F and consider the importance of this Area to Arizona and the United States.

Area G – Mildred Peak – Copper, Molybdenum, Gold

A small area surrounding Mildred peak and the Mildred Peak mining district has been designated by members of the Southwestern Minerals Exploration Association as containing porphyry copper alteration and mineralization. It is therefore prospectable for porphyry copper deposits and should be protected under a multiple use designation.

Quite a large portion of Area F has been designated by the SDCP for multiple use, but large portions have also been classed as critical habitat or biological core.

MINERAL RESERVES

Areas A through G described in the previous section are strongly recommended to be kept open for mineral exploration and possible development. The areas contain high potential for the discovery of new mineral deposits which will be important for the development of Pima County and for the future security of the United States. Once areas are zoned prohibiting mining , it is difficult if not impossible to re-open them at a later date.

Similar to biological reserves, mineral reserves should be established recognizing the important potential for mineral discovery and development. Within these mineral reserves, no restrictions should be established hindering the future development of mineral deposits.

The Southwestern Minerals Exploration Association strongly recommends the establishment of mineral reserves. Multiple use classification could be an important adjunct to the mineral reserves.

COMMENTS AND DISCUSSION

The Tohono Indian Nation represents 42% of the area of Pima County. It contains many of the habitats found elsewhere in the county and provides a vast biological corridor from Mexico to the northern edge of Pima County and into Pinal County. The reservation contains mountain ranges, broad valleys, springs and streams that would serve as sufficient habitats to many of the threatened and endangered species in the County. If Pima County could obtain the cooperation of the Tohono O'Odam Nation, the Tohono O'Odam Indian Nation could supply much of the mitigation habitat needed for a section 10 permit from the Fish and Wildlife Service.

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SOUTHWESTERN MINERALS EXPLORATION ASSOCIATION

MAP SUPPLEMENT

To

Southwestern Mineral Exploration Association Report

"MINERAL POTENTIAL OF EASTERN PIMA COUNTY, ARIZONA"

Dated July 15, 2001

Charles P. Miller
Project Coordinator
Sonoran Desert Conservation Project
September 21, 2001

MAP SUPPLEMENT

TO

MINERAL POTENTIAL OF EASTERN PIMA COUNTY, ARIZONA

INTRODUCTION

Maps 8 and 9 of the Southwestern Minerals Exploration Association report " Mineral Potential of Eastern Pima County, Arizona" contain multi-layers of information including proposed biological reserve zones of the Sonoran Desert Conservation Project, metallic and non-metallic mineral potential and land ownership. The complex nature of these maps may be difficult for the non-technical reader to decipher.

Maps 10, 11 and 12 are parts of Maps 8 and 9 which show the mineral potential, land ownership and biological reserves respectively as separate layers. On each of these maps are the areas proposed by SMEA as favorable for new mineral discoveries. Utilizing these maps, the reader of the SMEA report on the Mineral Potential of Eastern Pima County can more readily comprehend the complexities of Maps 8 and 9.

LIST OF MAPS

MAP 10 – MINERAL POTENTIAL OF EASTERN PIMA COUNTY, ARIZONA

MAP 11 - LAND OWNERSHIP IN EASTERN PIMA COUNTY

MAP 12 – SDCP BIOLOGICALLY-PREFERRED RESERVE SYSTEM
EASTERN PIMA COUNTY, ARIZONA