Looking down the road, we are continuing our planning process with collaborative efforts from the Department of Administration and Opus in getting "the Bucket," "the Tire," "the Stamp Mill," and "the Mural" incorporated into their master plan. The Bucket is out at Palo Verde being prepped and painted. The Tire has been cleaned up and ready for construction of the cradle to display it. The Stamp Mill was waiting on a new tool to redrill the guide holes. The proposed Mural on the backside of the building is still in the preliminary stages of development. We are planning an Open House for the installation of the Bucket and Tire in the front of the Museum. You won't want to miss it. Watch for the date.

We are looking forward to having an awesome 2002. Come down and see us!

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1502 West Washington
Phoenix, Arizona 85007

Address Correction Requested

A R I Z O N A No. 30 February, 2002

Mineral Resource

Arizona State Land Department's Mineral Assessment Asset Management Geographical Information System (MAAMGIS)

by Keenan Murray,
Geologist, State Land Department

Introduction

Increasingly, the Arizona State Land Department (ASLD) is required to respond to land-use conflicts. This is a complex problem affecting any number of lease and sale programs within the State Land Department and increasingly is an issue affecting mineral development on state land. Clearly, land-use decisions made today affect the Trust and society for generations to come. In resolving these conflicts, the ASLD as a trustee, needs to carefully weigh the alternatives, including mineral resources, considering not only the immediate highest and best use of the land for the beneficiaries, but their future needs as well.

For example, in an ideal world, construction aggregate resources would be extracted from State Trust Land for building infrastructure that contributes to improved quality of life for the local population. Then capitalizing on the multi-use concept, these sites would be reclaimed and used as open space or residential and commercial development. However, in reality, due to issues associated with rapid urban growth in many cities, these limited resources are not realized. Land managers are often forced to react and make decisions based on partial information without considering optional land-use alternatives. This results not only in loss of revenue for the State Trust, but may have the affect of escalating construction prices. After many such decisions, some key questions come to mind: "where are these alternative aggregate resources, what is their quality, and are they commercially viable?" Resource assessment programs, such as the one ASLD initiated, can proactively answer these questions and support the ASLD in making more informed land-use decisions. Mineral resource assessments are one of many vital tools used for land management today.

MAAMGIS

Motivated by the Arizona Preserve Initiative, the Arizona State Land Department (ASLD) was required to develop and implement a mineral resource assessment study. The ultimate objective of this project was to create a system to facilitate and improve on-going real-time land-use decisions by the ASLD. The initial assessment focused on porphyry copper and aggregate resource potential in high-priority land-use planning areas within Maricopa, Pima and Pinal Counties. The term high-priority land-use planning areas refers to a collection of sub-areas within each county having:

- a high concentration of state land parcels, largely within rural or suburban settings;
- a high resource potential for alluvial aggregate and/or porphyry copper mineralization;
- an expectation for high levels of urban growth, leading to potential land-use conflicts.

The end result of this project was MAAMGIS, a Mineral Assessment Asset Management Geographic Information System that acts as a dynamic resource evaluation tool. The project represents the integration of several diverse disciplines:

- construction of a geographic information system to support geologic assessments and for economic modeling of supply and demand;
- geologic assessments of resource potential for alluvial aggregate and porphyry copper;
- *N-Heads*, a group-decision software developed to facilitate mineral resource estimations as probability distributions, reflecting the uncertainty that may result from incomplete information;
- economic assessments of the alluvial resource potential considering market conditions and engineering cost relationships associated with commercial production; and
- development of an across-time aggregate demand model derived from spatial forecasts of construction activity.

The geographical information system acts as the data warehouse for the system and contains over 14 gigabytes of spatial information. Entered in ArcView GIS, it contains data for use in the geological assessments and economic analyses and provides the link to other geographic data sets within the ASLD's Arizona Land Resources Information System (ALRIS). Examples of data used by the system includes geologic maps, topographic maps, satellite imagery, aerial photographs, alluvial aggregate production sites, urban areas and general infrastructure, areas of high aggregate potential, digital elevation models, and known mineral occurrences.

Another program, TransCAD, a transportation GIS program, is used in the economic modeling of aggregate supply and demand. It provides a transportation network analysis that generates a cost matrix of the various delivery costs in response to the proximity of potential aggregate suppliers to demand sites. This is important because transportation costs of aggregate materials are strong determinants of market share and the size of the market area.

Two separate geological assessments were performed, one for alluvial aggregate resources and one for porphyry copper. For each assessment a panel of experts, selected for their professional affiliation with government agencies, academia, and industry, worked together using *N-Heads* decision making software to develop descriptive deposits models for the different resources.

Utilizing the descriptive model deposits, ADOT borrow pit data, geologic maps, personal experience, and other geologic data, the alluvial aggregate assessment generated assessment tracts, sub-areas within the larger assessment regions of each county, that experts rank-ordered according to favorable geologic conditions in terms of resource quantity and quality (Figure 1). These tracts were further divided into 1 mile stretches called sub-tracts. Due to time constraints, many low-priority tracts were removed from consideration allowing the experts to concentrate on assessing the high-priority tracts in detail.

Whereas the alluvial aggregate assessment focused on known resource areas such as the Agua Fria or New River alluvial systems, the porphyry copper assessment focused on the number of undiscovered deposits in an area. Similar to the alluvial aggregate assessment, a panel of experts was selected and using geologic maps, personal experience, and other geologic data they developed a descriptive deposit model. They then divided up the county areas into smaller assessment tracts. Although the porphyry copper assessment rank-ordered the tracts according to favorable geologic conditions similar in fashion to the aggregate assessment, all tracts were assessed, including the low-priority tracts. For each of the tracts, the experts estimated the depth to the top of the un-

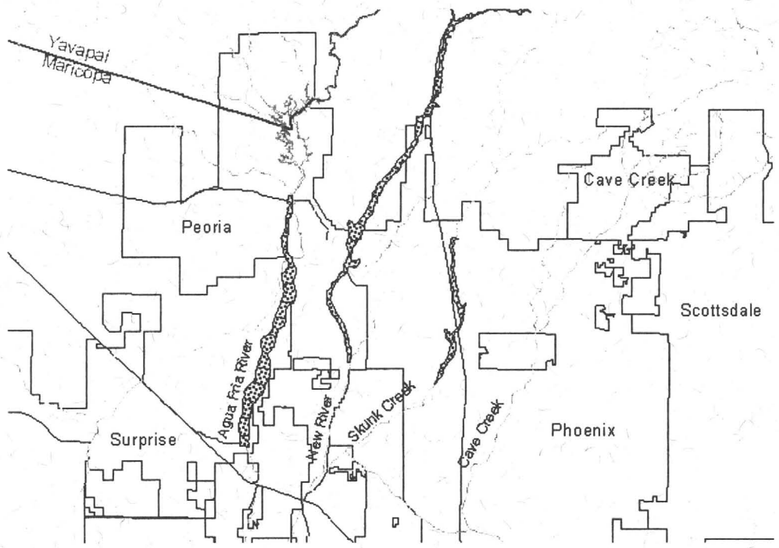


Figure 1 - Aggregate resource assessment tracts (stippled pattern) in the northern portion of the greater Phoenix area.

Museum News

Museum Reaches Out to Remote Schools

Understaffed, the Arizona Mining & Mineral Museum has long been unable to provide much in the way of outreach programming to the public, private, and charter schools of Arizona. Now, thanks to a dedicated volunteer and part-time tour guide, Liz Anderson, some of the state's remotest schools are being reached.

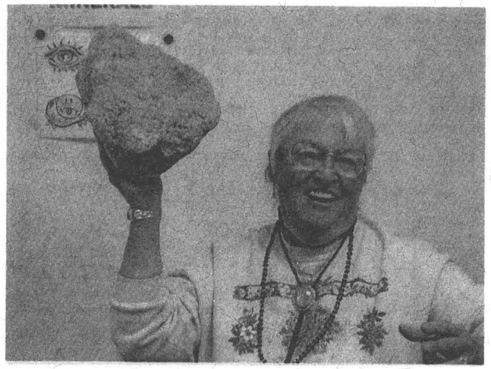
In August, letters offering our program went to out to all the school districts outside of, but in geographic contact with Maricopa County. The response was immediate! Calls began to pour in from teachers and administrators excited to have someone come to teach about rocks and minerals and their role in our everyday lives.

Since September, Liz has visited 12 schools, including such far flung places as Elfrida, Kingman, Sasabe, Topock, Tucson, Yuma and Yucca. There she enthusiastically and actively involves the children in a session of discovery about what rocks and minerals are, how they can be explored physically and to what uses they have been put. For example, the children are very surprised to find out that every time they chew a piece of gum, they are eating some limestone; that walls are composed of gypsum; that babies' bottoms are dusted with a ground up mineral (talc); and that pumice is used to soften up their blue jeans.

- "I never knew that Baby Powder, Peto bismo (sic), and food had rock in it."
- "I am writing and sitting on minerals."
- "When we were writing this letter to you it reminded me of how nice you are coming all the way from Pheonix (sic)."
- "I think rocks are very cool!"

Ms. Anderson has dedicated Mondays to volunteer for the Outreach Program. She is "so very excited to be able to have so much FUN with some of the most delightful kids and teachers in Arizona." The program is available to those counties outside Maricopa County. There is a nominal charge: $35 per class OR each student purchases a $2 Treasure Bag, plus a mileage fee.

Do you need this information in an alternative format? Please call the Department at 602-255-3795.



Liz Anderson shows the style and zest that has made her so popular in the Museum's outreach program.

Update January 2002

We are very excited about 2002! Our kids' program has continued to provide an excellent supplement to the State's academic standards for the earth science curriculum. We saw over 2000 kids each month from October to December 2001. We distribute free mineral identification teachers kits to help facilitate hands on learning back in the classroom. We continue to get awesome feedback from the kids and teachers on their experience from the field trip to the Museum. Our hats are off to Alice, Ann, Shirley, Liz, Nat, Joanne, Carl, Doug and all the others that make this program outstanding!

The backbone of this Museum is our Volunteers. We received over 11,829.75 hours in service in 2001 from our dedicated team. That's an increase of over 2000 hours from 2000. We want to acknowledge and thank them with a special evening here at the museum. On Friday, March 8th we will be having our Volunteer Appreciation Celebration. We want to remember those who aren't able to attend this year's dinner too. We were very fortunate to have been blessed with their dedication and service for many years and we want to remember them.

A hurdle we face for 2002 is our parking situation. The bus drivers have been more than accommodating in making this present challenge workable. We are looking forward to a smoother transition for pick-ups and drop-offs with the proposed new parking area on the northside of the Museum. We have been very apologetic to all those who have needed to utilize the handicapped parking across the street, while this construction is taking place. We thank you too, for your patience and understanding.

Continued on next page

discovered ore deposit(s) and the possible number of deposits (given as a probability distribution).

The economic assessment is constrained to the alluvial aggregate mineral resources. Developed in Analytica, a mathematical modeling software program, it models the economic viability of each sub-tract at different rates of production considering the geologic resource assessment (quantity and quality), capital and operating costs, materials loss to mining, market prices for various aggregate products (e.g. ABC, asphaltic concrete, etc.), depreciation, taxation, depletion, permitting, bonding and royalties.

Certain sub-tracts would be uneconomic at any production rate due to physical constraints such as quantity of aggregate, while others may be economic only at rates of production exceeding 1000 tons per day. The dynamic capabilities of the modeling program allow the user to edit the variables such as price data for aggregate products or bond and royalty rates to construct "what-if" scenarios to see what their affect on a sub-tract's net present value (economic viability) would be if changed.

Another dynamic element of the system is the across-time aggregate demand model derived from spatial forecasts of construction activity. Driving the aggregate demand model is another Analytica-based program called the Growth Scenario, a detailed projection of market growth covering seven key construction categories that represent the leading aggregate consumers:

- single family homes
- multi-family homes
- residential streets
- mixed-use buildings (commercial and industrial)
- schools
- major roads and airports
- urban core maintenance

The Growth Scenario uses population and employment projections as well as various highway and transportation construction plans to calculate construction costs for the seven key construction categories (Figure 2). Construction costs can then be translated into aggregate demand by simple engineering relationships reported in reference trade journals such as R.S. Means (2000).

For example, a single family home is reported to use 1.0 ton of aggregate per $1000 of construction cost . So, if the construction cost of a home is $150,000 then it would consume approximately 150 tons of aggregate. As with the economic viability model, the Growth Scenario is fully dynamic allowing the user to the change variables and play the "what-if" game.

Essentially, the Growth Scenario estimates the construction costs per year per specific geographic area (market growth projections) which are then translated into an across-time aggregate demand model (aggregate demand per year per specific geographic area).

Principal Components of MAAMGIS

The principal components of MAAMGIS are:

- The Growth Scenario;
- The Geologic Assessment;
- The Economic Assessment.

Separately, each component provides valuable information for the user. The Growth Scenario forecasts market growth. It can be used to estimate the number of homes and schools that an area might need based on population projections as well as the amount of aggregate those structures might use. The Geologic Assessment

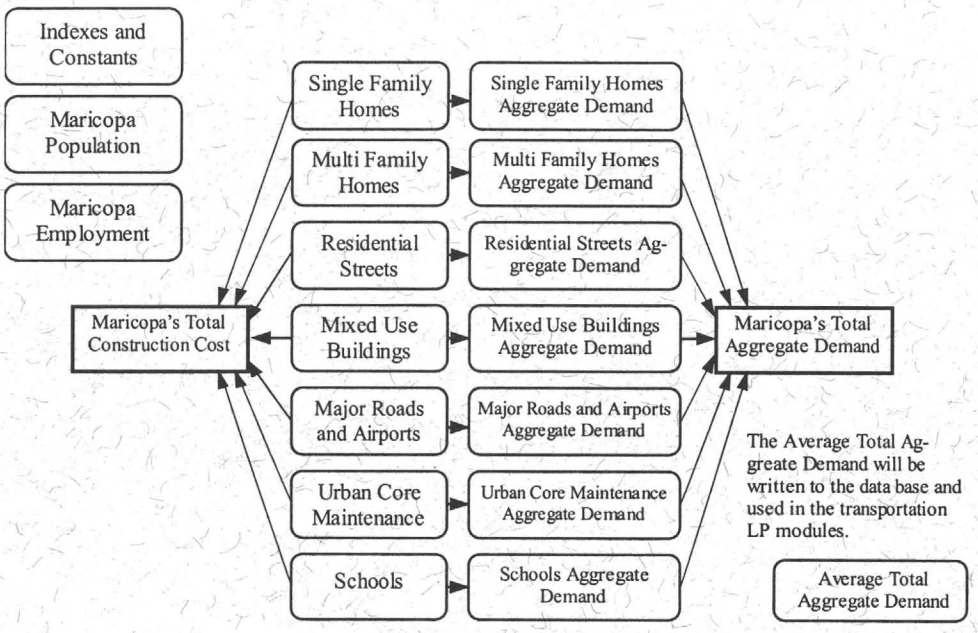


Figure 2 - The seven key construction categories used in the Growth Scenario modeling program to calculate construction costs that are then translated into aggragate demand.

gives detailed information on the quantity and quality of the aggregate resource of a particular sub-tract. It can also be used to estimate the life of a potential pit at different rates of aggregate production. The Economic Assessment calculates the net present value of a potential pit for a specific sub-tract at different rates of production. This can be used to evaluate the break-even point of an operation or how a change in royalty rate might affect the break-even point.

Working in concert, the principal components allow the ASLD to run a market simulation competing existing commercial pits with potential pits based on future aggregate demand, estimated geologic resources, transportation costs and overall economic viability of a potential operation. The end results shows areas favorable for new aggregate pit locations and the estimation of net present value of royalty and lease payments on State Trust Land coinciding with those pits.

Conclusion

As part of the Arizona Preserve Initiative, MAAMGIS is a strong beginning for ASLD's mineral assessment study and a powerful land management tool. The structure of the system honors its primary objective, which is the economic evaluation of alluvial aggregate resources in high-priority land-use areas and creates a system to facilitate and improve land-use decisions. Its fully dynamic modeling capabilities is pivotal in the ever-changing market allowing the ASLD to capitalize on the multiple land-use concept, avoid land-use conflict, and facilitate the realization of mineral potential on State Trust Land.

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Phelps Dodge Leaching Demonstration Plant

Phelps Dodge has announced it will begin construction of a $40 million copper concentrate leaching demonstration plant at the Bagdad mine, Yavapai County, in the second quarter of 2002. The plant is designed to recover commercial-grade cathode copper from chalcopyrite concentrates. The facility will be the first of its kind in the Western Hemisphere.

When completed in mid-2003 the plant will process 150 tons per day of concentrate produced by the existing mill and flotation operation. At full capacity it is expected to produce 35 million pounds of copper cathode from concentrate annually, accounting for approximately 15 percent of Bagdad's total copper production capacity.

In October 2001 Phelps Dodge and Placer Dome, Inc announced their agreement to further develop and commercialize proprietary technology for the extraction and recovery of copper, gold, silver, and other co-products from base and precious metal concentrates. In the concentrate leaching process, flotation concentrates will be subjected to pressure leaching, and copper will be recovered through conventional solution extraction electrowinning (SX-EW) technology. If this plant is successful it will have ramifications for existing smelters, perhaps even rendering them obsolete.

Bagdad produced 247 million pounds of copper in 2000, but a cutback of 50 percent was announced in November of 2001. Phelps Dodge reported at the end of 2000 that Bagdad had a 916 million ton sulfide reserve of 0.36 percent copper, as well as 17.7 million tons of leach material of 0.29 percent copper.