CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
416 W. Congress St., Suite 100
Tucson, Arizona 85701
520-770-3500
http://www.azgs.az.gov
inquiries@azgs.az.gov

The following file is part of the

James Doyle Sell Mining Collection

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File

ASARCO

Southwestern Exploration Division

March 27, 1992

J.D. Sell

Screen Capture
Kingman GIS Update

Dean Turner has turned over the screen capture project to Dan Dansereau for completion. The attached letter to Dan describes what we have requested as a product. Dan said the program will run on any P.C. He estimated approximately $200 to produce the product. In your absence, I ok'd the expenditure.

MAM:mek

Mark A. Miller

ASARCO

Exploration Department

TELECOPIER

DATE: 3/27/92

TO: FAX 303-989-~~0147~~ 3091

NAME: Dan Dansereau

LOCATION:

FROM: Mark A. Miller

MESSAGE:

You will receive 6 page(s) of copy including this sheet.
If you do not receive all pages, please call: 602-792-3010
Ext. 324

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703
1150 North 7th Avenue FAX (602) 792-3934 Phone (602) 792-3010

3091

FAX 303-989-~~0147~~

3/26/92

Screen Capture
Kigman GIS -

DAN,

WITH REGARD TO SCREEN CAPTURE FOR DISPLAY PURPOSES, DEAN CREATED 18 SLIDES WHICH SHOWED THE PROGRESSION OF GIS FROM DISPLAYING VARIOUS DATA BASES & THEMES TO INTEGRATION OF THESE THEMES TO TARGET SELECTION. THE SLIDES ARE DETAILED IN THE FOLLOWING EXERPTS OF HIS REPORT. (PAGES 5,6,7, I BELIEVE THAT DEAN SET UP MACROS TO RUN THE SHOW ~~THAT~~ WE COMPOSED THE 18 SLIDES)

WE PLAN TO RUN THIS ON A 386 (316) DELL P.C. w/ 8 mg Ram 400 mg H.D (WE RECENTLY UPGRADED DONS MACHINE). THIS HAS SUPER VGA GRAPHICS AND WILL PROBABLY DISPLAY THE SCREENS CLEARER. I WOULD ALSO LIKE TO BE ABLE TO RUN THIS ON MY HOME P.C. 386 SX 4 mg Ram 150 Mg H.D.

SLIDE LISTING - KINGMAN GIS

1 ARIZ/ NEVADA GEOLOGY.
2 EXAMPLE OF MEASURING ON SCREEN
3 MILS, MRDS, ASARCO POINTS
4 MAPEXT DEGUTM, MAPEX * (Pick AN AREA TO ZOOM.
5 ZOOMED AREA;
6 BUFFERS ON GEOLOGIC BASE
7 BUFFERS ON GEOLOGIC BASE w/ MILS, MRDS, ASARCO POINTS
8 AEROMAGNETIC MAP.
9 GRAVITY
10 MAGNETICS w/ LINEAMENT INTERPRETATION
11 " " " " " & MILS, MRDS, ASARCO pts
12 GOLD DEPOSITS ASSOC w/ AEROMAG HIGH
13 " " " " " " & GEOCHEM
ANOMALIES.
14 PE ROCKS, T. INTRUSIVES & ALL GOLD OCCURRENCES.
15 " " " " " " "
AND AEROMAG HIGHS & GEOCHEM ANOMALIES.
16 TARGET AREAS picked
17 AEROMAG HIGH OVER T. BASIN - Zoomed in
18 TARGET AREA 2 SHOWING AEROMAG HIGH, + SCATTERED
Au DEPOSITS IN "FAVORABLE ROCKS

omitted for the initial demonstration. On the other hand, digital elevation models (ie, DEM) from the USGS were acquired, and would have proved useful, but were not used because of PC ARC/INFO limitations. In addition, Landsat TM data for a portion of the Kingman quad was obtained for a separate study conducted by D.A. Dansereau, but was not used for the GIS study. In the future, the incorporation of DEM and Landsat data will prove quite valuable for GIS integration and interpretation.

Data Sets To Be Acquired For Future Work. There are a number of government and public domain data sets that should be purchased for Phase II GIS analysis, such as age date, heat flow, land status, and other types of information. A list of specific data sets to be acquired should be drawn up as an initial step of the Phase II study.

Copies of the data sets used for the study were provided to Carl Windels as a four volume tape set in early November, 1991. The tapes contain data in both ASCII and ARC format, and also include macros and programs written during Phase I. An updated series of tapes which include the digitized California geology and a suite of digital maps will be provided on request.

PRELIMINARY DATA INTERPRETATION AND GIS DEMONSTRATION

In preparation for the demonstration of Phase I results, approximately three days were spent (ie, October 28-30, 1991) making preliminary interpretations and target selections by Mark Miller and the author in the Asarco-Denver office. A number of maps were generated for screen display, and macros written in preparation for the demo, which was given 10/31/91 to staff members from Asarco-Tucson (ie, J. Sell, W. Gay, D. Milhado) and Asarco-Denver (ie, C. Windels, D. Fletcher, P. Bartos). Slides of the screen displays presented to the geologic staff are included as Appendix I. Note that the slides do not include California geology, which was not yet digitized at the time of the demonstration. Select hardcopy laser print maps are included as Appendix II.

Target selection was based upon an exploration model which included disseminated gold deposits hosted by detachment fault terranes in the Mojave region of western Arizona, southern Nevada, and southeastern California. These detachment terranes occur primarily in Precambrian crystalline rocks which are represented in shades of gray in slide I-1 (also see map II-1). The deposit occurrences are shown in slide I-2 (yellow=gold deposit, grey=silver, green=copper, and blue=lead/zinc) and maps II-2,3,4. DLG data for roads and political boundaries are included for reference. Slide I-3 shows the various deposit types plotted on the geologic map. Obvious relationships not

only include the occurrence of various Au-Ag and Cu deposits in Precambrian rocks, but as well their close spatial affinity with Tertiary intrusives (ie, bright red units). In the northwest area are a series of Pb-Zn deposits hosted by Paleozoic sediments (ie, blue and purple units), but as opposed to the Au-Ag/Cu deposits there are no proximal intrusives. Slide I-4 shows the windowed area represented in slide I-5. Slide I-5 not only demonstrates the detail of the digital data which can be easily accessed by simple changes of scale, but also gives an example of how the gold deposits are often associated peripheral to, but not within the Tertiary intrusives. This relationships holds for other areas within the study region as well. Slides I-6 and I-7 accentuate this peripheral relationship as 5 km buffers constructed around the intrusives and over-plotted with deposit locations. The intuitive hypothesis is that the Tertiary intrusives serve as the heat engine and/or fluid source for mineralization, and that peripheral to these systems mineralization is concentrated by structure, such as detachment faults in Precambrian crystalline rocks. As a result, proximity to Tertiary intrusives may be an important criterion for regional exploration in the Kingman quadrangle.

In order to map possible intrusives which may be covered, as well as determine regional scale structural alignments, the aeromagnetics data was examined (see slide I-8 and map II-5). From the aeromagnetics, a general Walker Lane structural fabric of NW-SE can be seen as alignments of anomalies in the western two thirds of the map. This same structural alignment is manifest in the gravity (see slide I-9 and map II-6). A rather perfunctory attempt to interpret aeromag gradient lineaments is represented in slide I-10, which accentuates the NW-SE Walker Lane fabric, as well as an antithetic NE-SW alignment. Attempts to discern a relationship between gold occurrences (ie, white dots) and/or NURE geochem anomalies for As, Sb, and Hg (large blue circles) with aeromag lineaments was inconclusive (see slide I-11). Nevertheless, it does appear that some lineament intersections have geochem anomalies and clusters of deposits associated with them. This should be investigated further. (Note that the geochem anomalies represent 1 km buffers around anomalous As, Sb, and Hg samples - see map II-7 for complete NURE geochem sample distribution). A detailed view showing gold deposits associated with an aeromag high is given in slide I-12, and with geochem anomalies (ie, large blue circles) in slide I-13.

The preliminary analysis yielded the following exploration criteria for the Kingman quad: 1) proximity to Tertiary intrusives, 2) occurrence of aeromagnetic highs which may indicate intrusives buried beneath cover, 3) occurrence of Precambrian crystalline rocks, and 4) proximity of NURE As, Sb, and Hg anomalies. Obviously these criteria are simplistic and incomplete, but are reasonable results from a first pass effort

of two to three days of work. Slide I-14 and map II-8 show Tertiary intrusives, Precambrian crystalline rocks, and gold occurrences. Slide I-15 represents these same features, and in addition, aeromag highs (ie, green contours) and geochem anomalies. Based upon recognition of these criteria, three example target areas were selected for closer examination (slide I-16). Area 1 represents a strong aeromag anomaly that has a sparse number of gold deposits on the north flank, and three geochem anomalies on the south flank (refer to slide I-15). However, closer examination of this area shows that the aeromag anomaly is centered over a Tertiary basalt (slide I-17)! Nonetheless, the area may still of interest since there are gold deposits hosted by Precambrian rocks and geochem anomalies associated with the aeromag anomaly; perhaps the basalt forms a post-ore cover on favorable units which are evidenced by the geochemistry to the south. Area 2 is another aeromag anomaly with fringing geochem anomalies (refer to slide 15). A detailed view of the area is given in slide I-18, revealing Tertiary intrusives, Precambrian crystalline rocks, and a spotty population of gold deposits associated with the aeromag anomaly. These Precambrian units may indeed be prime exploration targets in this area, and further follow-up is warranted. Area 3 was selected because of the occurrence of Tertiary intrusives, aeromag anomalies over Quaternary cover, and strong geochem anomalies in an area not heavily populated with known gold occurrences.

Admittedly, these preliminary targets are based upon rather simplistic analysis and interpretation of the data. However, given the very limited amount of time actually taken for interpretation, quite a bit was learned about the geology and metallogeny of the area. Most significantly, during the demonstration many participants offered ideas and interpretations of their own, which were tested "on the fly". This sort of interactive "what if" data analysis is truly the strength of using a GIS system as a tool for exploration. Another advantage is the capability of rapidly changing scale, allowing the explorationist to quickly move from regional to district scale views of the data. A further strength of GIS is its analytical capabilities, which were not even exploited for Phase I. For example, what is the average distance of gold deposits to Tertiary intrusives, how many deposits occur within Precambrian crystalline units, and so on. Clearly, Phase I of the study has only demonstrated what the possibilities are, and has generated more questions than answers.

ASARCO

Southwestern Exploration Division

March 18, 1992

J.D. Sell

CIM GIS Article

The attached article very succinctly describes the use of GIS in an exploration program and in many ways is similar to the GIS exercise we completed on the Kingman Quadrangle. The author states that there is need for discretion when inputting data because a good majority of the time is spent in data entry, and the data entered needs to be as complete and accurate as possible. This will help in the interpretation of the data.

As one can see, all the data used to create the GIS for the test study is public domain. State and Federal agencies in the United States are heading in the direction of digitization of data and the use of many data bases which can be utilized by a GIS.

In summary, this paper is a good explanation of the use of GIS in exploration and very similar to the approach we took for the Kingman 2° sheet.

MAM:mek

Mark A. Miller

cc: C. O. Windels

ASARCO

Southwestern Exploration Division

February 20, 1992

FILE NOTE

GIS Pilot Study
Kingman AZ-CA-NV 1° x 2°
Phase I Report

Attached is Mr. Dean Turner's Phase I Report on the GIS study of the 1° x 2° Kingman AZ-CA-NV sheet.

The Tucson SWED file copy also has 18 color slides which Dean mentions in the text.

Backup tapes of the demonstration presented in Denver are in the Tucson office, but are unusable with the present equipment available.

Dean is putting together a "still clip" of the various themes which will be runnable on the Tucson system computers, but no interaction will be possible from this disk.

Dean is available to present the demonstration in Denver where interaction with the computer is available to those viewing the presentation.

The value of GIS over hardcopy is the ability to review the data in various ways and layers of data.

James D. Sell

James D. Sell

JDS:mek
Att.

cc: G.D. Van Voorhis (w/att.)
F.T. Graybeal (w/att.)
W.L. Kurtz (w/att.)
C.O. Windels (w/o att.)
M.A. Miller (" ")

ASARCO GIS PILOT STUDY
KINGMAN QUADRANGLE

PHASE I REPORT

Dean D. Turner
January, 1992

DEAN D. TURNER

Jim,

Attached is preliminary version of the report. After re-reading I noted a section to add. Nevertheless, the basic idea is still there as is.

Take a look at the maps & tell me which ones you want color plotted. This can be done AM tomorrow.

Whatever, take a look at things & let me know what you think. I will be out until 10 PM, but call & leave a msg if you get the chance. (989-2898). Thanks, Dean

DEAN D. TURNER

Jim,

Enclosed find:

1. Updated report. Substrture for 1st version, insert slides as Appendix I.
2. Updated invoice. All invoices are being submitted directly to you.
3. Invoice from DSI for Calif geology digitizing.

Thanks,

Dean

1/16/92

Dean

What format Kingman now on.

Tapes 240 MB

COW-indeb has them

Will input the CALIF geol ore & redo geol map.

To JDS

Date 1/17 Time 10:19 ☐ AM ☐ PM

WHILE YOU WERE OUT

M Dean Turner

of

Phone (303) 989-2898

Area Code Number Extension

TELEPHONED	✓	PLEASE CALL	✓
CALLED TO SEE YOU		WILL CALL AGAIN	
WANTS TO SEE YOU		URGENT	
RETURNED YOUR CALL			

MESSAGE FOR

NAME Jim Sell

ROOM # 1123

TURNER AND ASSOCIATES

1/92

Custom Computer Solutions for Geology and Engineering

Analysis Software Hardware

DEAN D. TURNER

Consulting Geologist and Software Engineer

1951 S. Van Gordon St. Lakewood, Colorado 80228

(303) 989-2898

PHONE MEMO

TO: Jim Sell	DATE: 1-16-92	TIME: 9:16 AM / PM	
FROM: Dean Turner	AREA CODE		
OF	NO. 989-2898		
	EXT.		

MESSAGE

Please call me

Met up w/ Dean 4:30 PM / 1/16/92 & returned projector. Ask him to bill up + set up demo for VanVoorhis/Windle/Grayhead/Kurtz.

SIGNED: Barb PBX

PHONED	CALL BACK	RETURNED CALL	WANTS TO SEE YOU	WILL CALL AGAIN	WAS IN	URGENT
☒	☒	☐	☐	☐	☐	☐

MEMORANDUM

TO: J.D. Sell
FROM: D.D. Turner
SUBJECT: GIS Pilot Project - Phase I Report
DATE: December 2, 1991
January 14, 1992 (Revised)

SUMMARY OF RECOMMENDATIONS

Phase I of the pilot study for the Kingman quadrangle demonstrated the utility of using GIS for integrating and interpreting regional digital data sets. As a result, the following steps are recommended for the Phase II implementation of GIS within Asarco's Southwest Exploration Group:

Hardware and Software Acquisition. The package used for the Phase I study, ARC/INFO, should be purchased and installed on a PC based workstation in Tucson. Further, a high-end PC system must be acquired and dedicated to running ARC/INFO and other exploration related software. The cost of PC ARC/INFO and yearly maintenance is approximately $ 7500, and a high end PC can be purchased for around $6000. **Estimated cost: $13,500.**

Training of Asarco Personnel. Initially, one individual should be selected to concentrate on learning and applying ARC/INFO to areas of exploration interest. This will require formal ARC/INFO training, followed by 3 months of intensive follow-up use in the Tucson office. The training course costs $ 1500, with associated travel costs estimated at $ 1200. **Estimated cost: $ 2700 + 3 man-months.**

GIS Target Selection and Field Follow-up. Initially as part of the training process, and subsequently as part of standard procedure, areas of high regional exploration interest should have the digital data compiled, loaded into ARC/INFO, interpreted, and selected target areas followed up in the field. **Estimated cost: ongoing.**

The above recommendations are designed to implement GIS with a minimum outlay for capital and personnel expenses. Successful execution of this Phase II plan will lead to the Phase III implementation of GIS as a standard exploration tool within Asarco.

INTRODUCTION

The first phase of the Asarco GIS pilot study has been completed. The study to date has consisted of 1) project definition, 2) data acquisition and preparation, 3) preliminary data interpretation and presentation of results to Asarco staff members from Tucson and Denver, and 4) Phase II recommendations for GIS implementation within Asarco. A review of Phase I progress, and detailed recommendations for Phase II are presented below.

PROJECT DEFINITION

The goals defining the GIS pilot project were originally outlined during discussions with Asarco-Tucson personnel and Carl Windels during July and August, 1991. In review, these goals were:

1) learn more about the regional geology and metallogeny of the region within the Kingman 2 degree AMS quadrangle as a step towards developing exploration targets,

2) determine the general applicability of GIS and related technologies to Asarco's exploration efforts, and

3) define the hardware, software, and staff requirements of employing these technologies within Asarco.

In large measure all three of the goals above have been met during the course of the Phase I study. For a detailed discussion of the project definition and goals see memo from D. Turner to C. Windels, 8/20/91.

DATA ACQUISITION AND PREPARATION

Data sets from public domain and in-house Asarco sources were acquired, reformatted, and loaded into ARC/INFO for subsequent analysis and interpretation. As part of this process all data was projected to UTM coordinates in meters for zone 11. Data outside of the Kingman quad were screened by latitude and longitude. It should be emphasized that the majority of time was spent on this phase of the project (ca. 60 %). As part of Asarco's long term GIS implementation, data acquisition and loading should be standardized and macros written to streamline and automate this process. Eventually, technician level personnel should be able to reformat and load data for use by the

geologic staff. The data sets used for the Phase I study include:

MRDS Mineral Occurrences. The USGS MRDS data for the Kingman quad were selected from the Arizona, California, and Nevada portions of the database. Although there are a large number of fields available within the original database, many are often not filled in by the USGS. As a result, only a subset of the fields was used for demonstration purposes. Most importantly this subset included the deposit name, coordinate, commodities, and deposit type fields.

MILS Mineral Occurrences. The USBM MILS data for the Kingman quad was also used. As with MRDS, only a subset of the original data fields warranted loading for demonstration: deposit name, coordinates, and commodities. Although the MILS data overlaps the MRDS data for some occurrences, it also has fills in gaps not in MRDS and vice versa.

Asarco Mineral Occurrences. Deposit information from the Asarco-Tucson files was provided by Mark Miller, and included deposit name, UTM coordinates, and commodities. Preliminary discussions were held concerning the entry of Asarco's entire file system into a computer database. However, it was agreed that this would be a major project requiring significant programming and data entry efforts. This topic should be deliberated further within Asarco, with the property file cover sheets now being used in Denver and Tucson providing a good starting point for discussion.

Bouguer Gravity. NURE gravity data was bouguer corrected and gridded at 0.5 km spacing using a minimum curvature algorithm. The gridded data was contoured using USGS contouring software. The original, as well as processed data was provided by D.A. Dansereau. The gravity data was imported into ARC/INFO as contour lines with associated bouguer gravity values in mgals. This representation allowed selection and color coding of gravity contour lines by mgal ranges. Although this yielded useful maps for interpretation, the products were clearly inferior to shaded relief images of the same data produced Carl Windels using the Geosoft software package. This points out an important deficiency of the PC ARC/INFO package in representing gridded data. Accordingly, Geosoft maps should be used in conjunction with ARC maps for interpreting gridded geophysical data.

Aeromagnetics. NURE aeromagnetics data was leveled, gridded at 0.5 km, and processed in a manner similar to the gravity data.

Multielement Geochemistry. NURE multielement stream sediment geochemistry was reformatted and loaded into ARC/INFO. In total there were over 60 elements included in the dataset, but only As, Sb, Hg, Ba, and Zn were considered. These elements were statistically analyzed, and preliminary thresholds determined. The other elements with analytic results include major rock forming constituents (ie, K, Na, etc.) and REEs (ie, Yt, Sc, Rb, etc.) Although these elements could be very important for geochemical mapping and interpretation, they were not considered in the Phase I study.

Mapped Geology and Structure. The geology and structure for the Kingman quad was compiled from three different sources: 1) Arizona geology was digitized from the 1:1,000,000 scale state geologic map, 2) Nevada geology was acquired in digital format from the USGS as derived from the 1:500,000 scale state geologic map, and 3) California geology was digitized from the 1:750,000 state map in November, subsequent to initial Phase I analysis. The digitizing of the Arizona and California geology represented an in-house effort by Asarco, and was subcontracted to Drafting Specialists, Inc. of Denver. It must be emphasized that the geologic base is frequently the most important for exploration analysis, yet is also the most time consuming and expensive data set to acquire. For the Phase I study, maps ranging in scale from 1:500,000 to 1:1,000,000 were compiled and used as a base for interpretation at 1:250,000 scale. This was done for the sake of expediency and demonstration purposes, but for subsequent work the compilation of geology and structure at more detailed scales is strongly suggested. Further, if Asarco eventually endeavors to digitize geology in-house, Autocad, supporting hardware, and appropriate training should be provided in Tucson.

DLG Data. USGS 1:2,000,000 scale Digital Line Graph (ie, DLG) data was used for providing map reference, specifically roads and political boundaries. Nevertheless, more detailed 1:100,000 scale data should be acquired for any subsequent GIS work. This detailed information will provide data for streams, rivers, water bodies, etc. which will be useful when used in conjunction with the NURE stream sediment geochemistry.

Data Sets Acquired But Not Used. A USGS whole rock database (Rock Analysis Storage System, RASS) and Arizona mineral district database (ie, AZMIN) from the Arizona Geological Survey were acquired by Mark Miller, but not used in the study. In large measure these datasets overlapped with 1) NURE geochemistry and 2) MILS, MRDS, and Asarco data sets,

respectively. As a result, they were omitted for the initial demonstration. On the other hand, digital elevation models (ie, DEM) from the USGS were acquired, and would have proved useful, but were not used because of PC ARC/INFO limitations. In addition, Landsat TM data for a portion of the Kingman quad was acquired for a separate study conducted by D.A. Dansereau, but was not used. In the future, the incorporation of DEM and Landsat data will prove quite valuable for GIS analysis.

Data Sets To Be Acquired For Future Work. There are a number of government and public domain data sets that should be acquired for Phase II GIS analysis, such as age date, heat flow, land status, and other types of information. A list of specific data sets to be acquired should be drawn up as an initial step of the Phase II study.

PRELIMINARY DATA INTERPRETATION AND GIS DEMONSTRATION

In preparation for a demonstration of Phase I results, approximately three days were spent (ie, October 28-30, 1991) making preliminary interpretations and target selections by Mark Miller and the author in the Asarco-Denver office. A number of maps were generated for screen display, and macros written in preparation for the demo, which was given 10/31/91 to staff members from Asarco-Tucson (ie, J. Sell, W. Gay, D. Melhado) and Asarco-Denver (ie, C. Windels, D. Fletcher, P. Bartos). Slides of the screen displays presented to the geologic staff are included as Appendix I. Note that the slides do not include California geology, which was not digitized by the time of the demonstration. Select hardcopy laser print maps are included as Appendix II.

The preliminary exploration model included disseminated gold deposits hosted by detachment fault terranes in the Mojave region of western Arizona, southern Nevada, and southeastern California. These detachment terranes occur primarily in Precambrian crystalline rocks which are represented in shades of gray in slide I-1 (also see map II-1). The deposit occurrences are shown in slide I-2 (yellow=gold deposit, grey=silver, green=copper, and blue=lead/zinc) and maps II-2,3,4. DLG data for roads and political boundaries are included for reference. Slide I-3 shows the various deposit types plotted on the geologic map. Obvious relationships not only include the occurrence of various Au-Ag and Cu deposits in Precambrian rocks, but as well their close spatial affinity to Tertiary intrusives (ie, bright red units). In the northwest area are a series of Pb-Zn deposits hosted by Paleozoic sediments (ie, blue and purple units), but as opposed to the Au-Ag/Cu deposits there are no proximal intrusives. Slide I-4 shows the windowed area represented in slide I-5. Slide I-5 not only demonstrates the detail of the digital data which can be

easily accessed by simple changes of scale, but also gives an example of how the gold deposits are often associated peripheral to, but not within the Tertiary intrusives. This relationships holds for other areas within the study region as well. Slides I-6 and I-7 accentuate this peripheral relationship as 5 km buffers constructed around the intrusives and over-plotted with the deposits. The preliminary hypothesis is that the Tertiary intrusives serve as the heat engine and/or fluid source for mineralization, and that peripheral to these systems mineralization is concentrated by structure, such as detachment faults in Precambrian crystalline rocks. As a result, proximity to Tertiary intrusives may be an important criterion for regional exploration in the Kingman quad.

In order to map possible intrusives which may be covered, as well as determine regional scale structural alignments, the aeromagnetics data was examined (see slide I-8 and map II-5). From the aeromagnetics, a general Walker Lane structural fabric of NW-SE can be seen as alignments of anomalies in the western two thirds of the map. This same structural alignment is manifest in the gravity (see slide I-9 and map II-6). A rather perfunctory attempt to interpret aeromag gradient lineaments is represented in slide I-10, which accentuates the NW-SE Walker Lane fabric, as well as an antithetic NE-SW alignment. Attempts to discern a relationship between gold occurrences (ie, white dots) and/or NURE geochem anomalies for As, Sb, and Hg (large blue circles) with aeromag lineaments was inconclusive (see slide I-11). Nevertheless, it does appear that some lineament intersections have geochem anomalies and clusters of deposits associated with them. This should be investigated further. (Note that the geochem anomalies represent 1 km buffers around anomalous As, Sb, and Hg samples - see map II-7 for complete NURE geochem sample distribution). A detailed view showing gold deposits associated with an aeromag high is given in slide I-12, and with geochem anomalies in slide I-13.

The preliminary analysis yielded the following exploration criteria for the Kingman quad: 1) proximity to Tertiary intrusives, 2) occurrence of aeromagnetic highs which may indicate intrusives buried beneath cover, 3) occurrence of Precambrian crystalline rocks, and 4) proximity of NURE As, Sb, and Hg anomalies. Obviously these criteria are simplistic and incomplete, but are reasonable results from a first pass effort of two to three days of work. Slide I-14 and map II-8 show Tertiary intrusives, Precambrian crystalline rocks, and gold occurrences. Slide I-15 represents these same features, and in addition, aeromag highs (ie, green contours) and geochem anomalies. Based upon recognition of these criteria, three example target areas were selected for closer examination (slide I-16). Area 1 represents a strong aeromag anomaly that has a sparse number of gold deposits on the north flank, and three geochem anomalies on the south flank (refer to slide I-15).

However, closer examination of this area shows that the aeromag anomaly is centered over a Tertiary basalt (slide I-17)! However, the area may still of interest since there are gold deposits in Precambrian rocks and geochem anomalies associated with the aeromag anomaly; perhaps the basalt forms a post-ore cover on favorable units which are evidenced by the geochemistry to the south. Area 2 is another aeromag anomaly with fringing geochem anomalies (refer to slide 15). A detailed view of the area is given in slide I-18, revealing Tertiary intrusives, Precambrian crystalline rocks, and a spotty population of gold deposits associated with the aeromag anomaly. These Precambrian units may indeed be prime exploration targets in this area, and further follow-up is warranted. Area 3 was selected because of the occurrence of Tertiary intrusives, aeromag anomalies over Quaternary cover, and strong geochem anomalies in an area not heavily populated with known gold occurrences.

Admittedly, these preliminary targets are based upon rather simplistic analysis and interpretation of the data. However, given the very limited amount of time actually taken for interpretation, quite a bit was learned about the geology and metallogeny of the area. Most significantly, during the demonstration, many participants offered ideas and interpretations of their own, which were tested "on the fly". This sort of interactive "what if" data analysis is truly the strength of using a GIS system as a tool for exploration. Another advantage is the capability of rapidly changing scale, allowing the explorationist to quickly move from regional to district scale views of the data. A further strength of a GIS is its analytical capabilities, which were not even exploited for Phase I. For example, what is the average distance of gold deposits to Tertiary intrusives, how many deposits occur within Precambrian crystalline units, and so on. Clearly, Phase I of the study has only demonstrated what the possibilities are, and has generated more questions than answers. Only with serious study of current data sets, incorporation of new data sets (ie, TM data, age dates, etc.), and field follow-up will the true value of GIS to Asarco's exploration efforts be determined.

Dean D. Turner

DEAN D. TURNER

Distribution: M. Miller
C. Windels

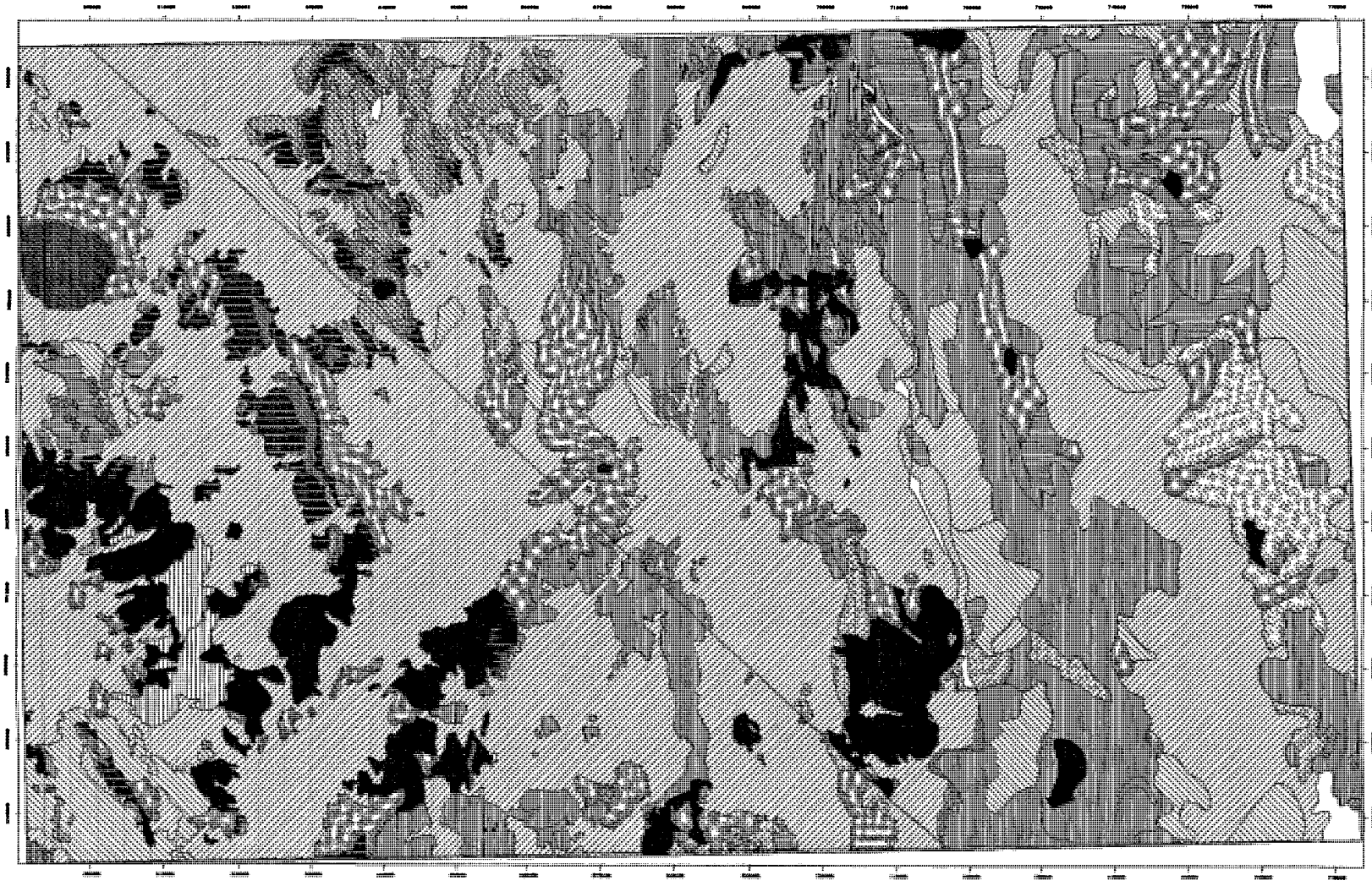
APPENDIX I

GIS Demonstration Slides

APPENDIX II

GIS Laser Print Maps

KINGMAN 1 X 2 QUAD



UTM PROJECTION ZONE 11
UTM COORDINATES POSTED AT 10000 METER INTERVALS
SCALE 1:250000

EXPLANATION

LITHOLOGIC UNITS

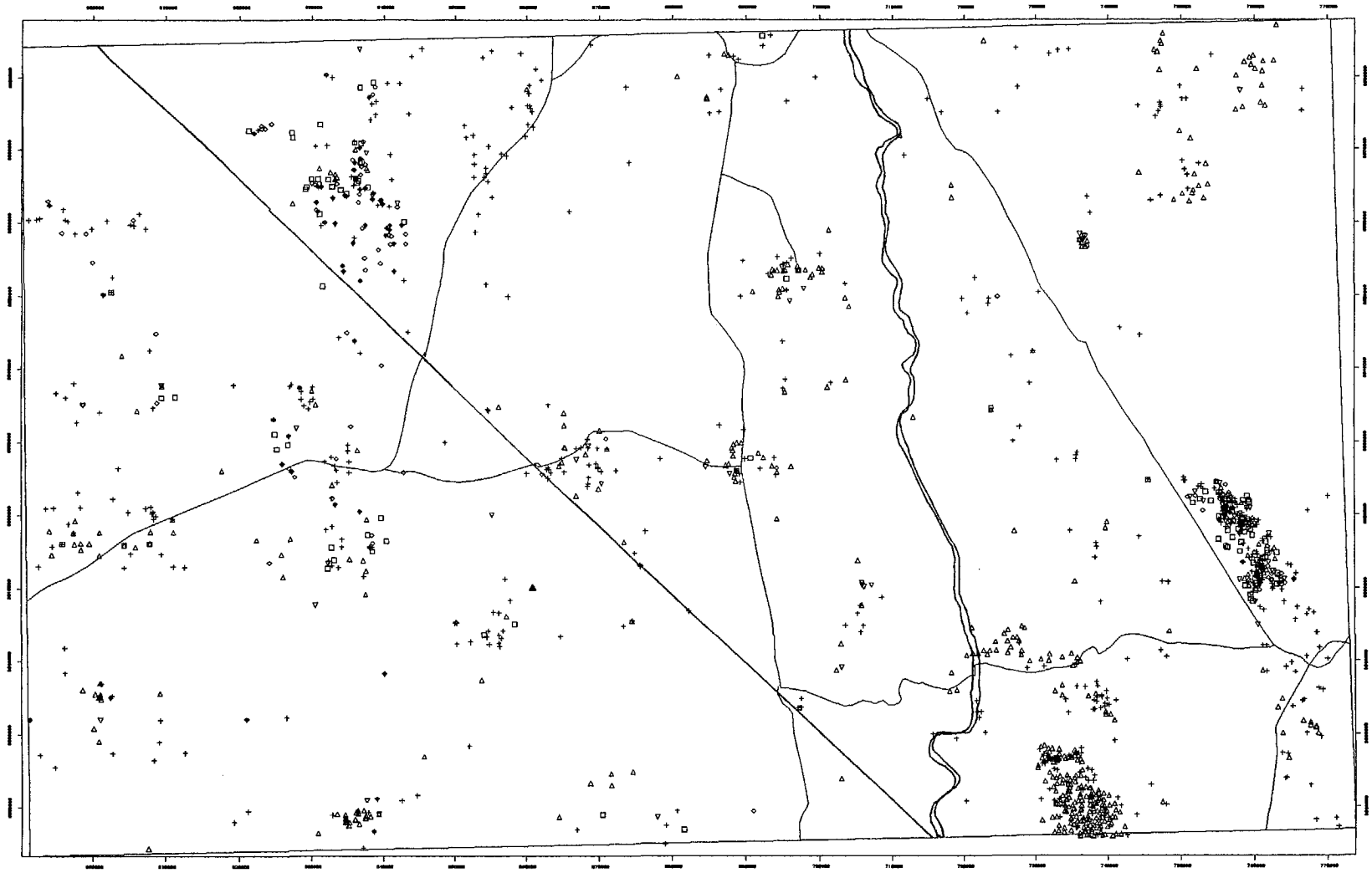
CA	NV	AZ
Q	Qa	Q
QPc,Qa	Qb,QTeo	Qv
Qrv,Qr		
Ta	Ta3	Tam,Tmy
Tv,Tv/p	Tbr,Tt3, Ta3,Tbc,Tr3	Tb,Tv
Ti	Ti	Tg
gr/Ca		
Rev		
gr/Mz	Kgr	
K		
J	JTRe	
	TRet	
c,Pz	PPc,Pmc, Pct,Mb	
D	Du	
C	OCa	
gr/pC	Ygr	YXg,Yg
pC	Xm	Xp,Xee
		Xo
gr/m,gr		

ASARCO, INC.
DENVER, COLORADO

KINGMAN GIS STUDY

NOVEMBER 1991

KINGMAN 1 X 2 QUAD



UTM PROJECTION ZONE 11
UTM COORDINATES PLOTTED AT 10000 METER INTERVALS
SCALE 1:250000

EXPLANATION

MILS DATA
DEPOSIT LOCATIONS

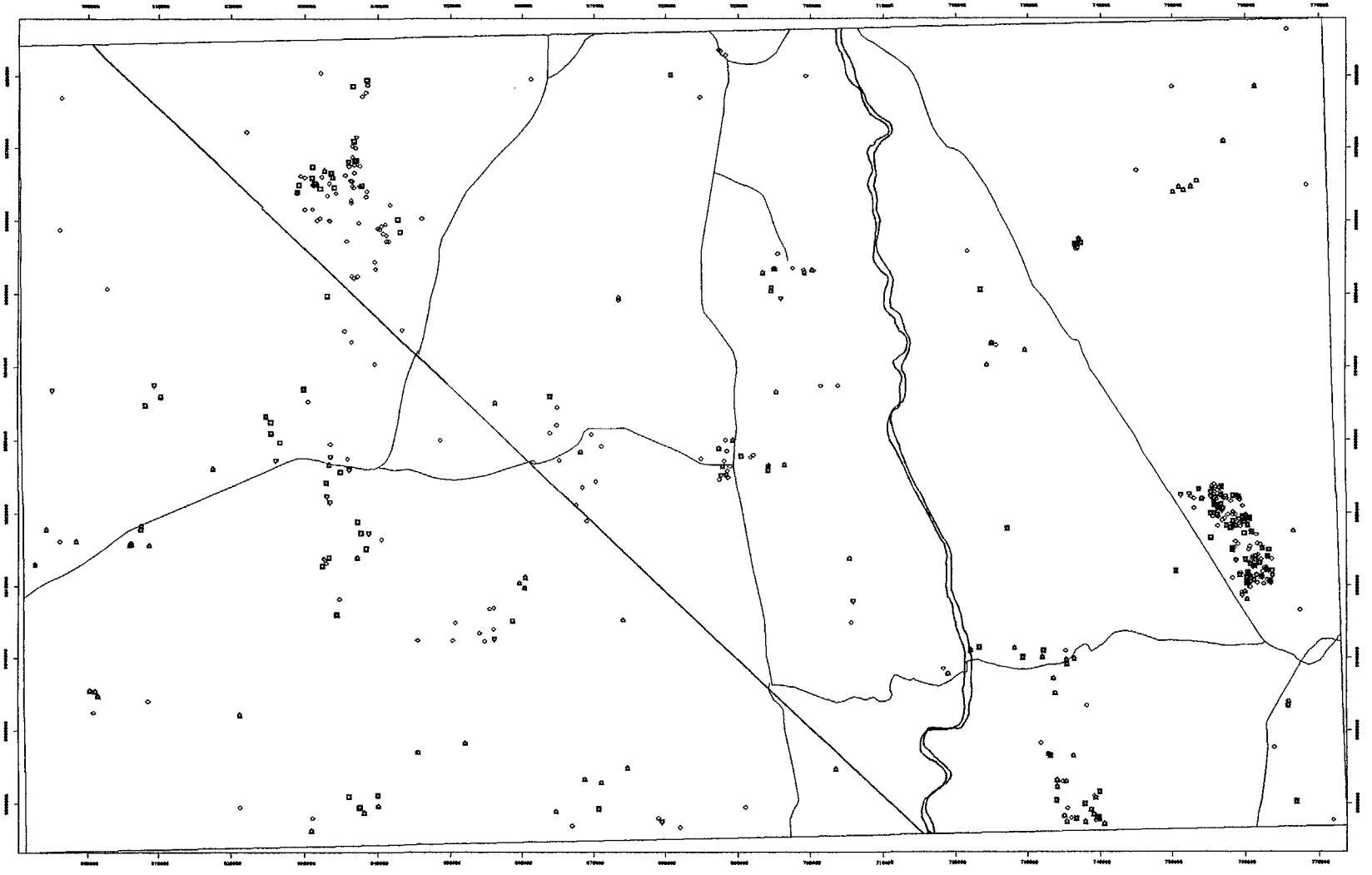
- Primary gold occurrences
- Primary silver occurrences
- Primary copper occurrences
- Primary lead/zinc occurrences
- Other types of occurrences

ASARCO, INC.
DENVER, COLORADO

KINGMAN GIS STUDY

NOVEMBER 1991

KINGMAN 1 X 2 QUAD



UTM PROJECTION ZONE 11
UTM COORDINATES PLOTTED AT 10000 METER INTERVALS
SCALE 1:250000

EXPLANATION

MRDS DATA
DEPOSIT LOCATIONS

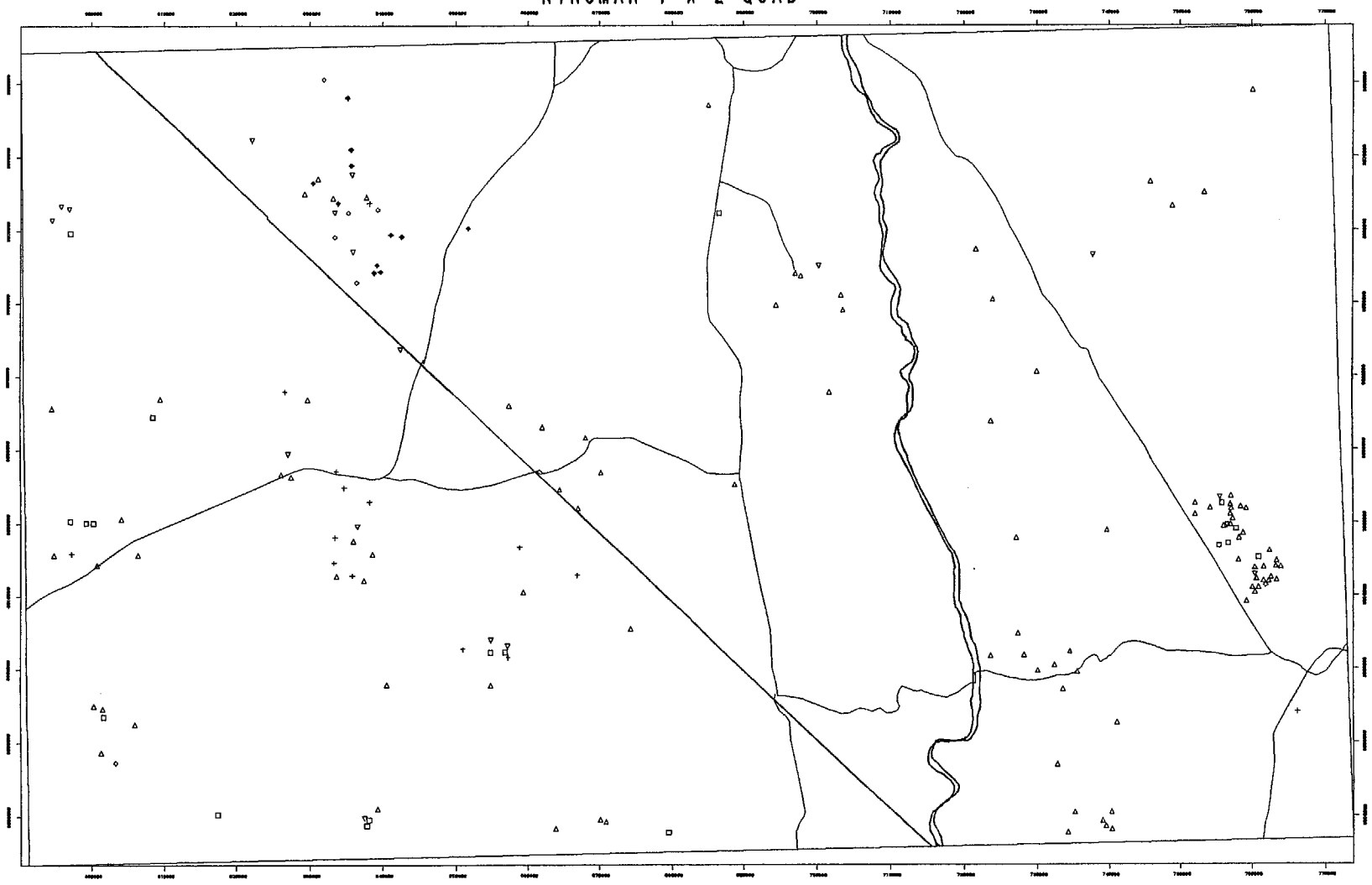
- Primary gold occurrences
- Primary silver occurrences
- Primary copper occurrences
- Primary lead/zinc occurrences
- Other types of occurrences

ASARCO, INC.
DENVER, COLORADO

KINGMAN GIS STUDY

NOVEMBER 1991

KINGMAN 1 X 2 QUAD



UTM PROJECTION ZONE 11
UTM COORDINATES POSTED AT 10000 METER INTERVALS
SCALE 1:250000

EXPLANATION

ASARCO DATA
DEPOSIT LOCATIONS

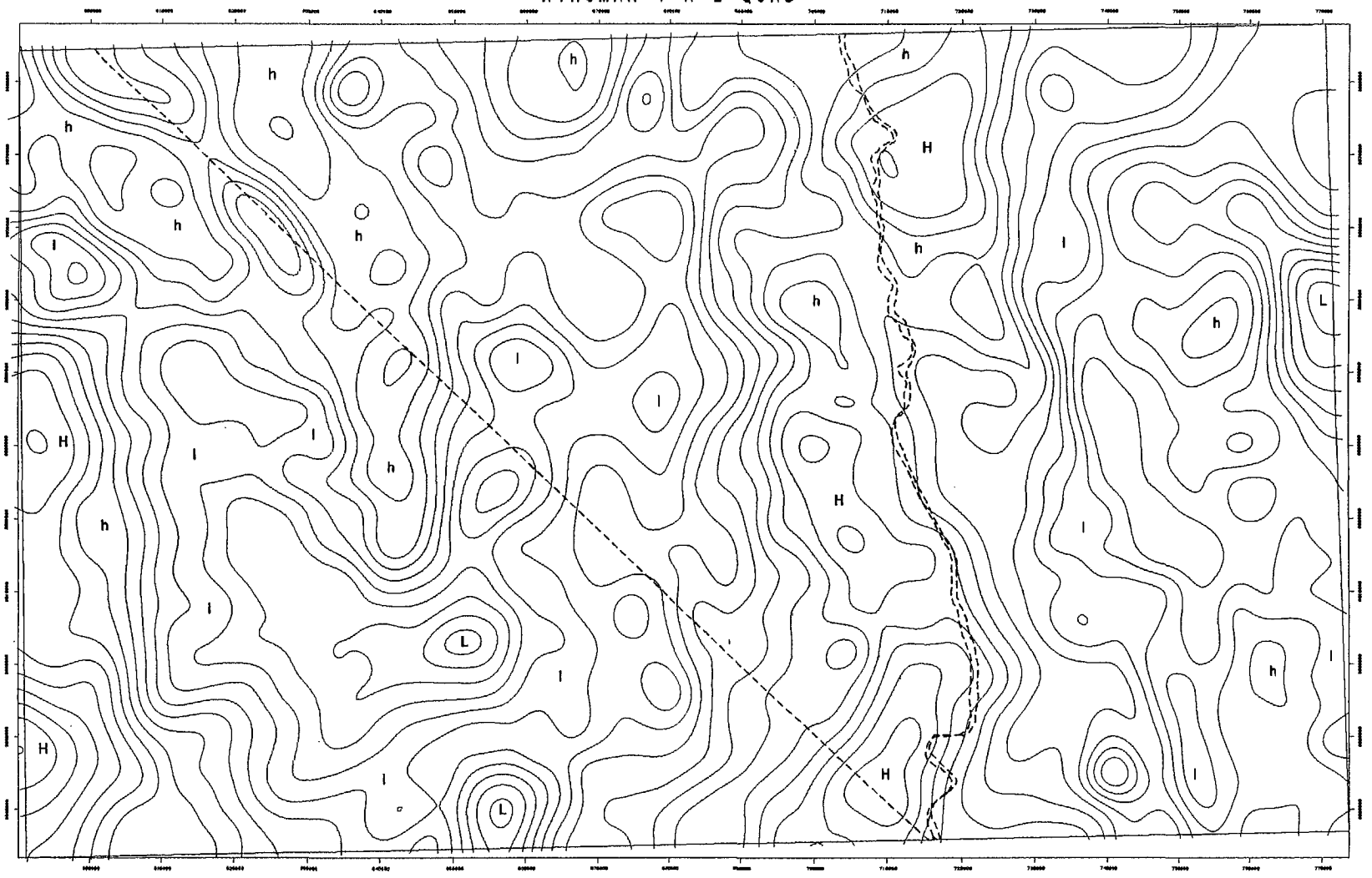
- Primary gold occurrences
- Primary silver occurrences
- Primary copper occurrences
- Primary lead/zinc occurrences
- Other types of occurrences

ASARCO, INC.
DENVER, COLORADO

KINGMAN GIS STUDY

NOVEMBER 1991

KINGMAN 1 X 2 QUAD



EXPLANATION

BOUGUER GRAVITY
NURE DATA SOURCE

Contour values from -150 to -50 mgals

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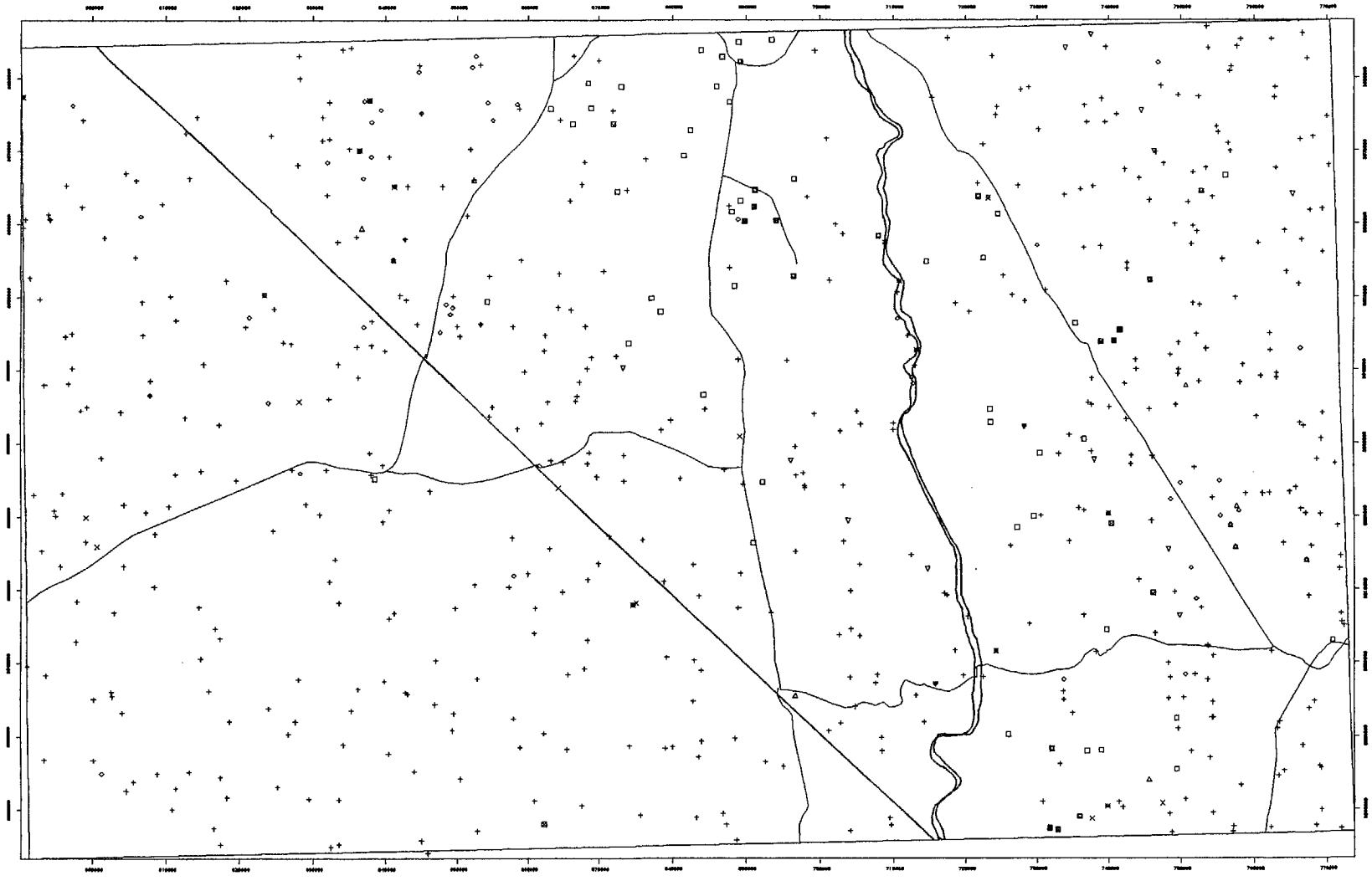
KINGMAN GIS STUDY

NOVEMBER 1991

KINGMAN 1 X 2 QUAD



UTM PROJECTION ZONE 11
UTM COORDINATES POSTED AT 10000 METER INTERVALS
SCALE 1:250000

EXPLANATION

NURE STREAM SEDIMENTS GEOCHEMICAL ANOMALIES

- Zn anomalies > 200 ppm
- Hg anomalies > 1000 ppm
- Ba anomalies > 1000 ppm
- As anomalies > 0 ppm
- Sb anomalies > 3 ppm
- Other sample locations

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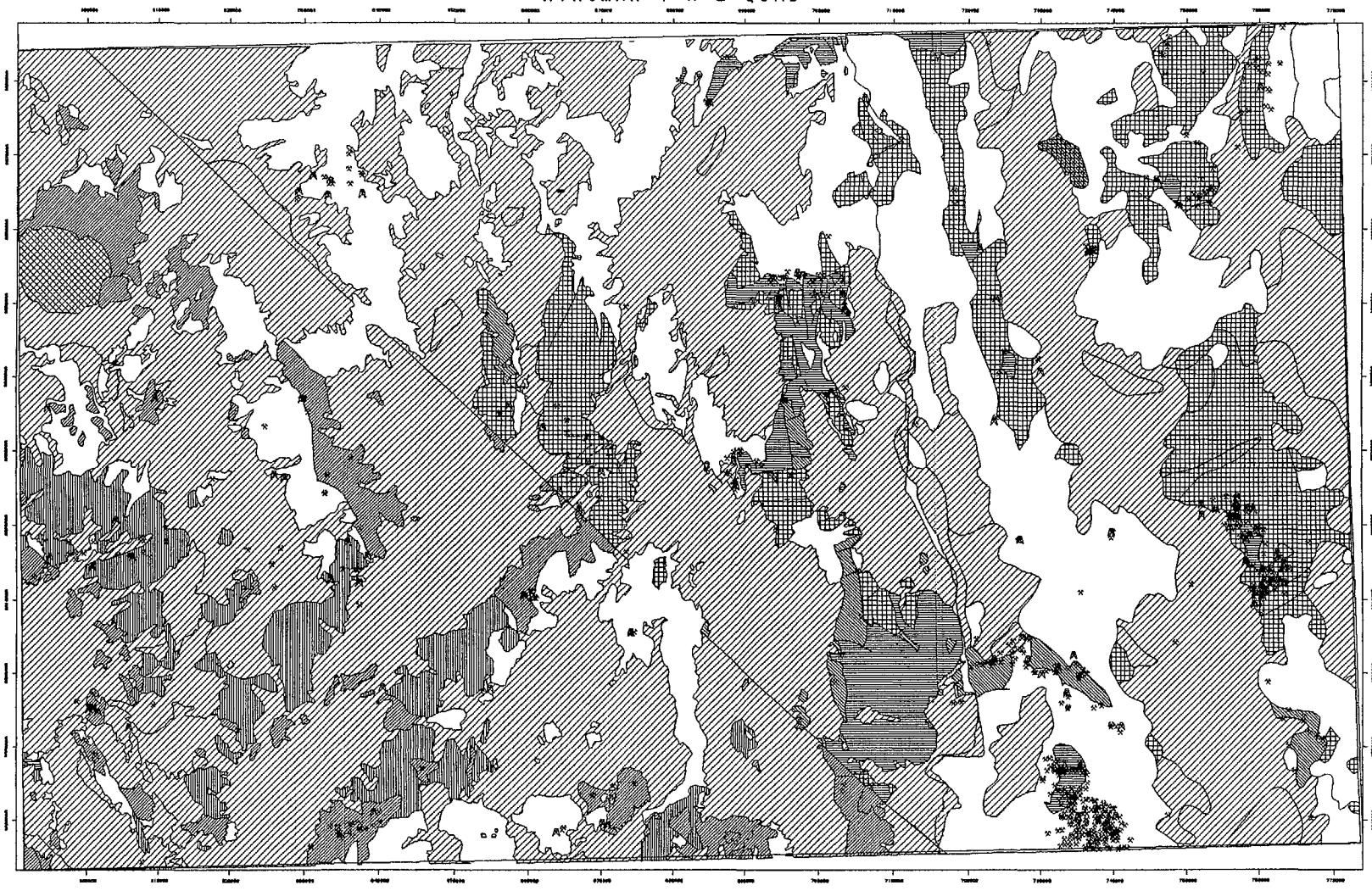
KINGMAN GIS STUDY

NOVEMBER 1991

KINGMAN 1 X 2 QUAD



UTM PROJECTION ZONE 11
UTM COORDINATES POINTED AT 10000 METER INTERVALS
SCALE 1:250000

EXPLANATION

MILS, MRDS, & ASARCO GOLD LOCATIONS

- MILS, MRDS occurrences
- ASARCO file occurrences

SELECTED ROCK UNITS FOR TARGET ID

- Quaternary alluvium and volcanic cover
- Cenozoic granite in CA
- Tertiary intrusives
- Mesozoic granites in CA
- Precambrian X rocks in AZ and NV
- Precambrian Y rocks in AZ and NV
- Precambrian and meso undif. granites in CA

ASARCO, INC.
DENVER, COLORADO

KINGMAN GIS STUDY

NOVEMBER 1991

FILE

ASARCO

Southwestern Exploration Division

October 21, 1991

FILE NOTE

Risk GIS?

Mr. Henry Truebe, 3113 E. Table Mtn Road, Tucson, AZ 85718, who recently completed a GIS dissertation on the E½ of the Tucson 1° x 2° AMS sheet, sent this article which I feel is germane to Asarco and SWED today.

James D. Sell

James D. Sell

JDS:mek
Att.

cc: F.T. Graybeal
W.L. Kurtz
C.O. Windels

FILE

ASARCO

Southwestern Exploration Division

September 10, 1991

J.D. Sell

Asarco Prospect Compilation
for GIS Study
Kingman AMS Sheet

The attached printout is the compilation result from digitizing the Asarco prospect locations on the Kingman AMS sheet. This has been saved on flopy disk and is called GISCOM.COM. A copy of the file of disk and hard copy has been sent to D. Turner on September 10, 1991 for inclusion into the GIS.

MAM:mek

Mark A. Miller

LOCATION NUMBER	PROSPECT NAME	COMMODITY	NORTHING	EASTING
1.00	PIUTE	Ag,Pb,Zn	3963396.70	595751.50
2.00	KAME HILL	Ag,Pb	3963021.80	596881.20
3.00	BECK	Cu,Fe	3959730.80	597031.80
4.00	CRYSTAL SPRING MINE	Ag,Pb,Zn	3961495.10	594492.40
5.00	EASTERN STAR	Au,Ag,Pb	3935728.60	594494.50
6.00	GOLD HILL	Au,Ag,Pb,Zn	3936962.10	609504.00
7.00	SHADOW MTN MINES	Cu	3934490.30	608502.30
8.00	TURKOIZ	Cu,Mo	3920372.40	597001.10
9.00	ARROWHEAD GOLD	Au	3915710.80	594734.30
10.00	TRIANGLE YTTRIUM	Y	3915854.40	597173.60
11.00	KENNECOTT COPPER	Cu	3920123.10	599236.60
12.00	HUFF TURQUIOSE MTN	Cu	3920076.90	600227.20
13.00	HALLORAN SPRINGS DISTRICT	Au	3914320.40	600747.50
14.00	TELEGRAPH	Au	3915726.60	606352.10
16.00	SHADOW MTN RECON	Au	3920651.70	603990.70
17.00	PAYMASTER MINE	Au	3895045.30	600325.20
18.00	ORO FINO	Au	3894672.80	601561.30
19.00	BRANNIGAN	Cu	3893560.30	601661.90
20.00	GRAY GHOST	Au,Ag	3892579.30	605861.90
21.00	LUCKY	Au,Ag	3888722.70	601284.40
22.00	BIG LIME	Pb	3887352.10	603238.60
23.00	RAM HORN	Cu	3880312.00	617429.40
24.00	GREEN MONSTER	Ag,Pb,Zn	3972344.30	622139.70
25.00	POTISI MINE	Pb,Zn	3980647.80	631907.70
26.00	DOUBLE UP	Zn	3978124.40	635216.10
27.00	PILGRIM	Zn	3971075.60	635640.80
28.00	PRAIRIE FLOWER	Zn	3968910.10	635709.30
29.00	YELLOW PINE	Ag,Pb,Zn	3967647.60	635825.90
30.00	CHAQUITA	Au,Ag,Cu	3967139.30	631140.20
31.00	ISLAND	Zn	3966546.40	630414.80
32.00	BOSS(DIST) FILE	Au,Cu,Pt	3965111.40	629288.90
33.00	CLEMENTINE DIST FILE	Au,Cu	3964518.10	633185.70
34.00	BILL NYE DIST FILE	Zn	3963795.80	633916.30
35.00	WHALE DIST FILE	Ag,Zn,Ag,V	3962501.30	633457.40
36.00	HOOSIER DIST FILE	Pb,Zn	3962487.80	635324.20
37.00	COLUMBIA	Au,Ag,Cu,Zn,Co	3964717.10	637765.80
38.00	ARGENTENA	V	3963793.30	638175.30
39.00	MOUNTAIN TOP DIST FILE	Pb,Zn	3962936.90	639341.10
40.00	SINGER DIST FILE	Pb,Zn	3959126.00	633478.40
41.00	SULTAN	Ag,Pb,Zn	3957147.20	635953.90
42.00	INGOMAR DIST FILE	Pb,Zn	3952943.40	636444.90
43.00	BULLION DIST FILE	Zn	3954262.80	638813.40
44.00	VALENTINE DIST FILE	Zn	3954365.30	639731.80
45.00	ANCHOR DIST FILE	Zn	3955287.30	639240.90
46.00	MONTE CRISTO DIST FILE	Zn	3959470.40	641124.10
47.00	IRELAND DIST FILE	Zn,Cu	3959203.70	642602.10
48.00	JEAN STOCKPILE	Zn	3960326.20	651676.70
49.00	STATELINE-SILVER RAM	Ag,Pb,Zn	3943768.00	642461.30
50.00	POCO MOWO	REE	3937951.50	626705.00
51.00	COLOSSEUM	Au	3936881.80	629767.20
52.00	COPPER WORLD	Ag,Cu,Pb,Zn	3929499.20	627105.50
53.00	MOHAWK MINE	Au,Ag,Cu,Pb,Zn	3926758.90	626141.20
54.00	YUCCA QUEEN	Au,Ag,Cu,Pb,Zn	3926376.40	627490.30
55.00	MOUNTAIN PASS MINE	REE	3927113.30	633673.90

LOCATION NUMBER	PROSPECT NAME	COMMODITY	NORTHING	EASTING
56.00	MINERAL HILL GROUP	REE	3924920.60	634745.10
57.00	IVANPAH DIST		3922988.80	638171.50
58.00	CARBONITE KING	Ag,Pb,Zn	3919600.70	636545.60
59.00	SILVER STAR	W	3918096.30	633486.10
60.00	CIMA DIST	Au,Ag,Cu	3917671.10	635976.10
61.00	IVANPAH AERIAL RECONN		3914648.10	633339.70
62.00	STANDARD NO. 2	Au,Ag,Pb,Zn	3912833.30	633675.70
63.00	ALM HILLS MINES CO.		3912863.10	635798.20
64.00	MORNING STAR	Au,Ag	3912230.10	637416.10
65.00	ALLURED AND NEW TRAIL	Au,Ag	3915757.10	638544.00
66.00	DEATH VALLEY MINE	Au,Ag,Pb	3897960.10	640580.50
67.00	COLUMBIA	Au,Ag,Cu,Pb,Zn	3881138.80	639281.40
68.00	FRANCES	Ag,Cu,Pb,Zn	3879838.60	637482.40
69.00	HUFF PROSPECT	Cu	3879577.10	638095.90
70.00	KELSO AERIAL RECONN	Cu	3878806.20	637800.40
71.00	BIG HUNCH	Mo	3902807.60	650953.90
72.00	GOLDEN QUAIL	Au	3897818.30	654882.50
73.00	GIANT LEDGE	Cu,Pb,Zn,W	3902333.40	654854.10
74.00	WESTERN SOLDIER	Ag,Cu,Zn,W,CaF2	3904000.30	654897.30
75.00	DOOR TUNGSTEN	W	3901650.40	657299.90
76.00	SAGAMORE	Cu,Pb,Zn,W	3902386.10	656882.20
77.00	BRONZE	Ag,Cu,Zn	3903195.60	657220.60
78.00	VANDERBELT MINE AND RECONN	Au,Ag,Pb	3910605.30	659424.40
79.00	LAST CHANCE	V	3916737.30	658895.50
80.00	LUCY GREY	Au,Ag,Cu	3936045.80	657494.50
81.00	PLUMBERS	Au,Ag,Cu,Zn	3933112.60	662046.20
82.00	SILVER BOWL	Au,Ag,Pb	3931698.60	668122.60
83.00	CRESCENT PEAK	Au,Ag,Cu,Pb	3927030.30	670208.80
84.00	BLUE CRYSTAL	Au,Ag,CaF2,Pb,	3924647.50	664351.00
85.00	LILY GROUP	Au,Ag	3922103.60	667033.60
86.00	ORO BELLE		3912893.70	666900.30
87.00	VALLEY VIEW	Au,Ag	3905558.10	674214.80
88.00	DENVERS CLAIMS	Au	3878361.30	663740.10
89.00	LOUISIANA CALIFORNIA	Au,Ag,V	3879602.10	670049.90
90.00	VON TRIGGER	Au,Cu	3879351.90	670882.40
91.00	LEISERRAY AERIAL RECON	Cu,V	3877814.90	679517.00
92.00	QUARTETTE	Au,Ag,Cu,Pb,V	3925314.40	688793.30
93.00	CAMP DUPONT GRP	Au,Ag,Cu,Co	3937844.90	701808.90
94.00	SILVER LEGION	Au,Ag,Cu,Pb	3949809.40	694519.80
95.00	CAPITAL HILLS GOLD	Au,Ag	3949109.90	703617.40
96.00	NEVADA EAGLE	Au,Ag	3951145.30	703339.00
97.00	HERLAND	Au,Ag,Cu,Pb,Zn	3953812.60	697841.40
98.00	COPPER MTN GRP	Au,Ag	3954184.10	697106.40
99.00	DOLPH, JOHN D	Ag,Pb	3955134.40	700310.10
100.00	SEGGERSON PRESENTATION	Cu,Co	3962411.80	686639.90
101.00	BLUE QUARTZ	Au, Ag	3977044.90	685101.80
102.00	POPE MINE	Au, Ag	3957452.30	721639.40
103.00	GOLD BUG AND MOHAVE	Au, Ag	3950596.30	723919.80
104.00	PULOSKY	Au, Ag	3940646.60	730035.30
105.00	KLONDIKE	Au, Ag	3933855.80	723683.60
106.00	PORTLAND	Au, Ag	3918020.90	727165.80
107.00	PILGRIM	Au, Ag	3919066.50	739711.90
108.00	GOLD CHAIN	Au, Ag	3904886.20	727398.10
109.00	KATHERINE	Au, Ag	3901855.20	723590.70

LOCATION NUMBER	PROSPECT NAME	COMMODITY	NORTHING	EASTING
110.00	BLACK DYKE	Au, Ag	3901955.60	728241.90
111.00	ROADSIDE	Au, Ag	3899817.90	730069.60
112.00	SHEEPTRAILS BLVD	Au, Ag	3900547.30	732376.60
113.00	TRYO MINE	Au, Ag	3902437.60	734512.80
114.00	FRISCO	Au, Ag	3899655.90	735566.10
115.00	ARABIA AND PHILDELPHIA	Au, Ag	3897298.40	733547.10
116.00	SECRET PASS	Au, Ag	3892754.80	741066.90
117.00	MOSS	Au, Ag	3887083.00	732716.60
118.00	MIDNIGHT	Au, Ag	3880569.70	735189.60
119.00	VIVIAN	Au, Ag	3877772.40	734201.60
120.00	UNITED EASTERN	Au, Ag	3879442.80	739035.90
121.00	TOM REED	Au, Ag	3878670.50	739498.40
122.00	HARTMAN	Au, Ag	3878219.60	740316.60
123.00	GOLD ROAD ANNEX	Au, Ag	3880598.60	740274.60
124.00	SENATOR	Au, Ag	3966618.00	745792.90
125.00	CYCLOPTIC	Au, Ag	3963345.00	748911.80
126.00	OK EXCELSIOR, ELDORADO	Au, Ag	3965229.90	753271.60
127.00	JOHNSTON	Au, Ag	3979083.90	760093.90
128.00	WHITE HILLS DIST	Ag	3956599.80	737723.90
129.00	ARIZONA MAGMA	Au	3922731.90	752066.50
130.00	TINTIC	Au	3921235.30	752082.10
131.00	SILVER HILL	Au,Ag,Pb,Zn	3922058.30	754098.70
132.00	ELKHART	Ag,Pb	3923486.60	755481.40
133.00	TENNESSEE	Cu	3922666.50	755769.60
134.00	HERCULES	Au,Ag,Pb,Zn	3923710.90	757067.10
135.00	PAYROLL	Au,Ag,Pb,Zn	3922555.90	756955.80
136.00	RAINBOW	Au,Ag,Pb,Zn	3922232.10	758403.80
137.00	SAMOA	Au,Ag,Pb	3921968.80	759211.50
138.00	MARY BELL	Au,Ag,Cu,Pb,Zn	3921976.20	757075.60
139.00	MINN. CONNOR	Au,Ag,Cu,Pb,Zn	3921259.50	756960.50
140.00	HIDDEN TREASURE	Au,Ag	3920622.10	757294.50
141.00	EL ORO	Au,Ag,Pb,Zn	3919757.60	757013.70
142.00	MERIDITH	Ag	3919652.50	756527.60
143.00	MIDNITE	Au,Ag,Zn	3919559.40	756016.10
144.00	MORGAN	Cu	3919156.10	757822.90
145.00	KEYSTONE	Au,Ag	3918620.80	758787.20
146.00	WHITE HORSE	Au,Ag,Cu,Pb,Zn	3917961.80	758182.30
147.00	MINERAL PARK-ITHACA PK	Cu	3917156.80	756672.50
148.00	EMERALD ISLE	Cu	3916862.80	755320.10
149.00	ARK	Au,Ag	3914872.40	758109.10
150.00	GRANDVIEW	Cu,Pb,Zn,Mo	3915268.50	760905.90
151.00	WHITE EAGLE	Au,Ag,Cu,Pb	3916198.70	762412.80
152.00	SEMISON	Au	3913916.50	760398.30
153.00	SUMMIT	Au,Ag,Cu,Pb,Zn	3914013.50	761623.60
154.00	COD	Au,Ag,Cu,Pb,Zn	3914842.90	763377.10
155.00	I.X.L.	Au,Ag,Cu,Pb,Zn	3913997.80	763941.30
156.00	WRIGLEY	Au,Ag,Cu,Pb,Zn	3914088.60	763256.60
157.00	MID. GOLCANDA	Ag,Zn	3912952.20	760407.80
158.00	GOLCANDA	Au,Ag,Zn	3912387.00	760614.90
159.00	WALLAPAI	Au,Ag,Pb,Zn	3912077.10	761574.10
160.00	FOUNTAINHEAD	Au,Ag,Cu,Pb,Zn	3912614.20	762601.40
161.00	ALTA	Au,Ag,Cu,Pb,Zn	3912198.30	763312.40
162.00	DE LA FONTIANE	Au,Ag,Cu,Pb,Zn	3912061.80	762275.90
163.00	GOLDCONDA ANNEX	Pb	3911457.80	761882.60

LOCATION NUMBER	PROSPECT NAME	COMMODITY	NORTHING	EASTING
164.00	FLORES	Au	3911209.80	760078.30
165.00	CERBAT	Au,Ag,Cu,Pb,Zn	3911184.90	760905.60
166.00	GOLDEN GEM	Au,Ag	3910490.90	760414.10
167.00	CHAMPION	Au,Ag,Cu,Pb,Zn	3909318.00	759244.80
168.00	BI-METAL		3894183.10	766212.00