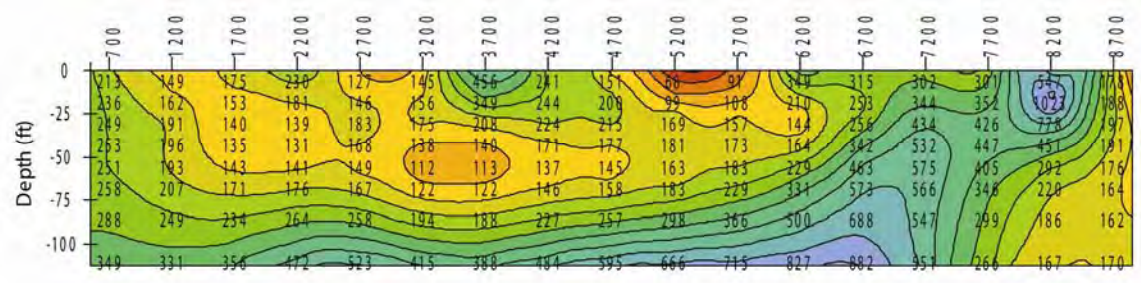
Silver Bell Mining District

Comparison of Four Electrical Geophysical Survey Methods

Two-Dimensional Smooth-Model Inversion Results
500 foot Dipole-Dipole Resistivity (ohm-m)



Electrical geophysical surveys at Silver Bell provide a comprehensive study of the north pit porphyry copper ore zone. Data for these surveys were collected with a Zonge GDP receiver and GGT-series transmitter. This case history shows the high resolution and diagnostic capabilities inherent in modern geophysics. Demonstrated is the unique flexibility of the Zonge geophysical system in adapting to different survey applications.

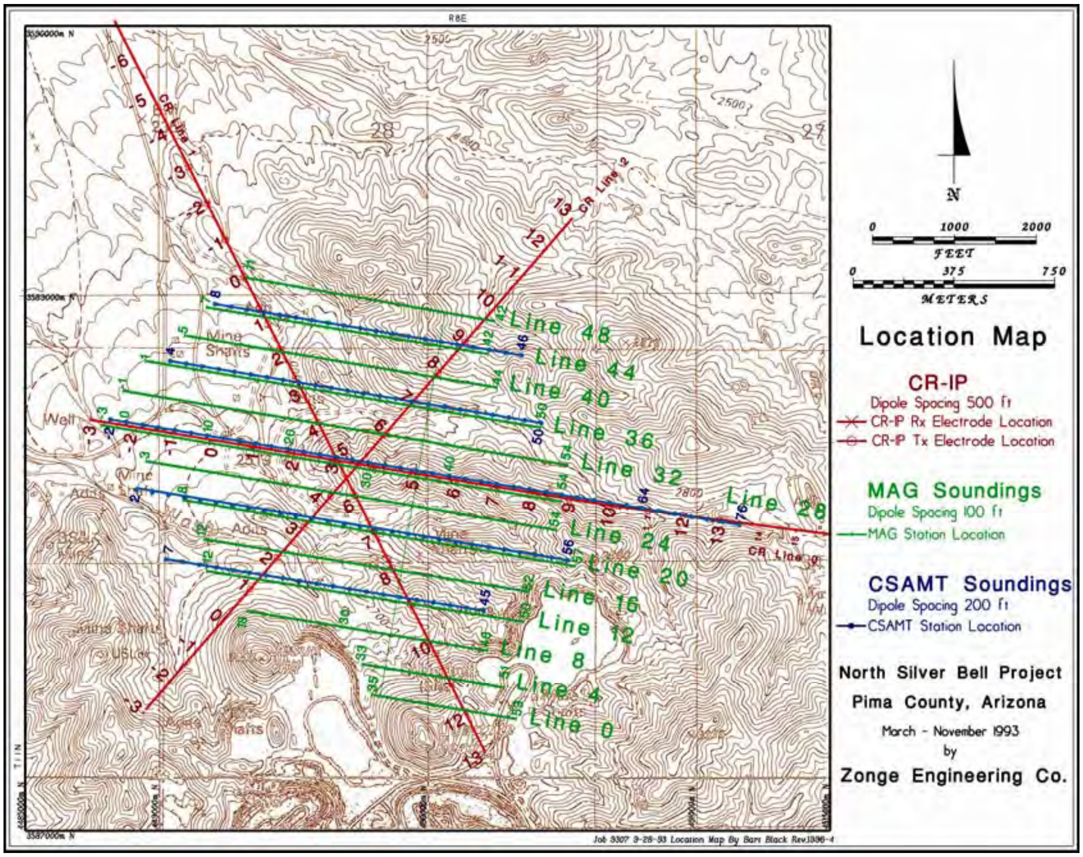
THE NORTH SILVER BELL PORPHYRY COPPER DEPOSIT

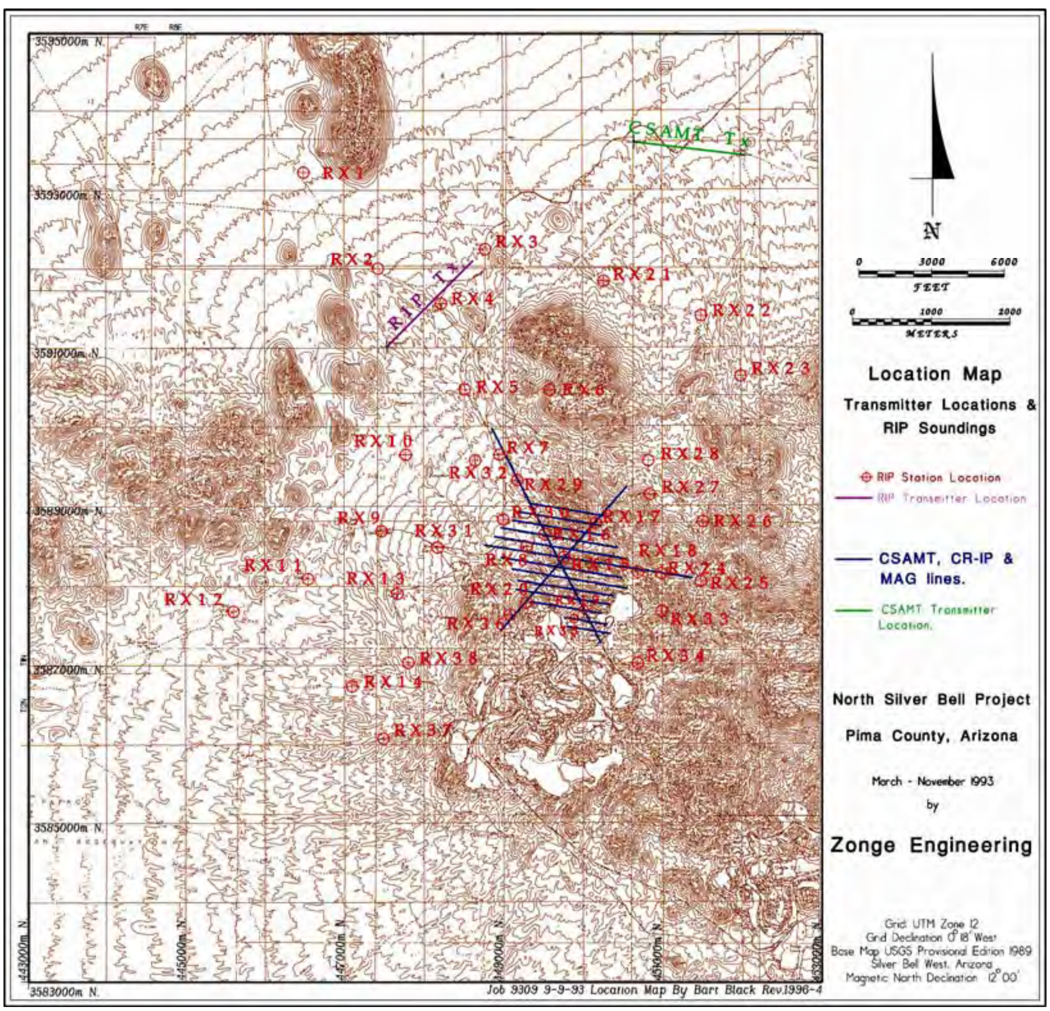
The Silver Bell District is located 35 miles northwest of Tucson in a small rugged mountain range. Porphyry copper mineralization in this area lies along the southwest flank of the mountains in hydrothermally altered igneous rocks. Mining of oxidized copper ores began in 1885, and 75.6 Mt of 0.8% copper ore was mined in the adjacent El Tiro and oxide sulfide deposits between 1954 and 1977.

Zonge ran four different geophysical surveys in the North Silver Bell area as part of an in-house (CSAMT), complex resistivity induced polarization (CR-IP), reconnaissance or vector IP (RIP or VIP), and ground magnetics (Mag) surveys were all completed over the proposed site of the new mine. The GDP-32 receiver system and a GGT-series transmitter were used to obtain the CSAMT, CR-IP, and RIP data.

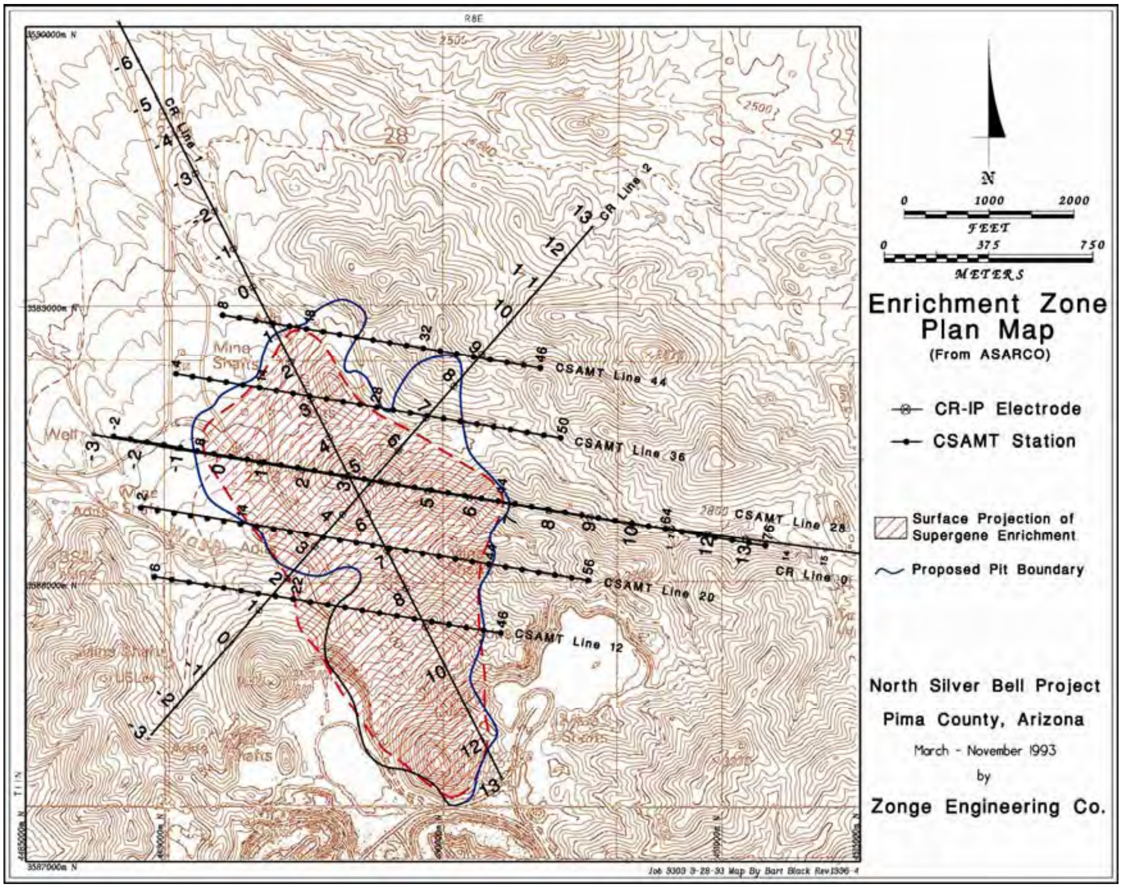
The following plots and graphs give a comparison of the results of the different survey methods along with the geology determined from drill hole data and surface expressions of the assemblages.

Location Map shows the position of three geophysical surveys run in the North Silver Bell Project area. The CR-IP stations are plotted in red, numbered Lines 0, 1, 2. Magnetic data were acquired along the green lines. CSAMT data were acquired on every other magnetic survey line, and are shown in blue. Mag Line 28, CSAMT Line 28 and CR-IP Line 0 all correspond to the same location, and will be used to demonstrate a comparison of the three geophysical survey results.

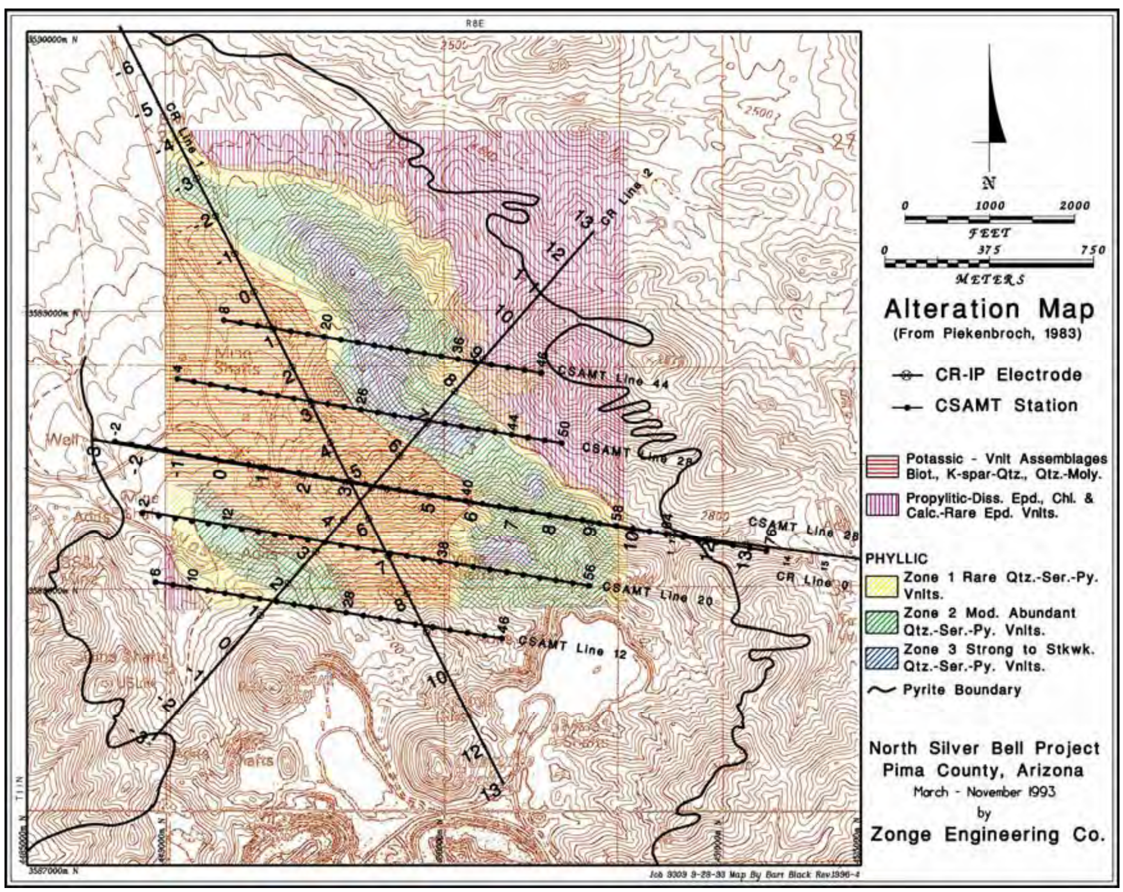




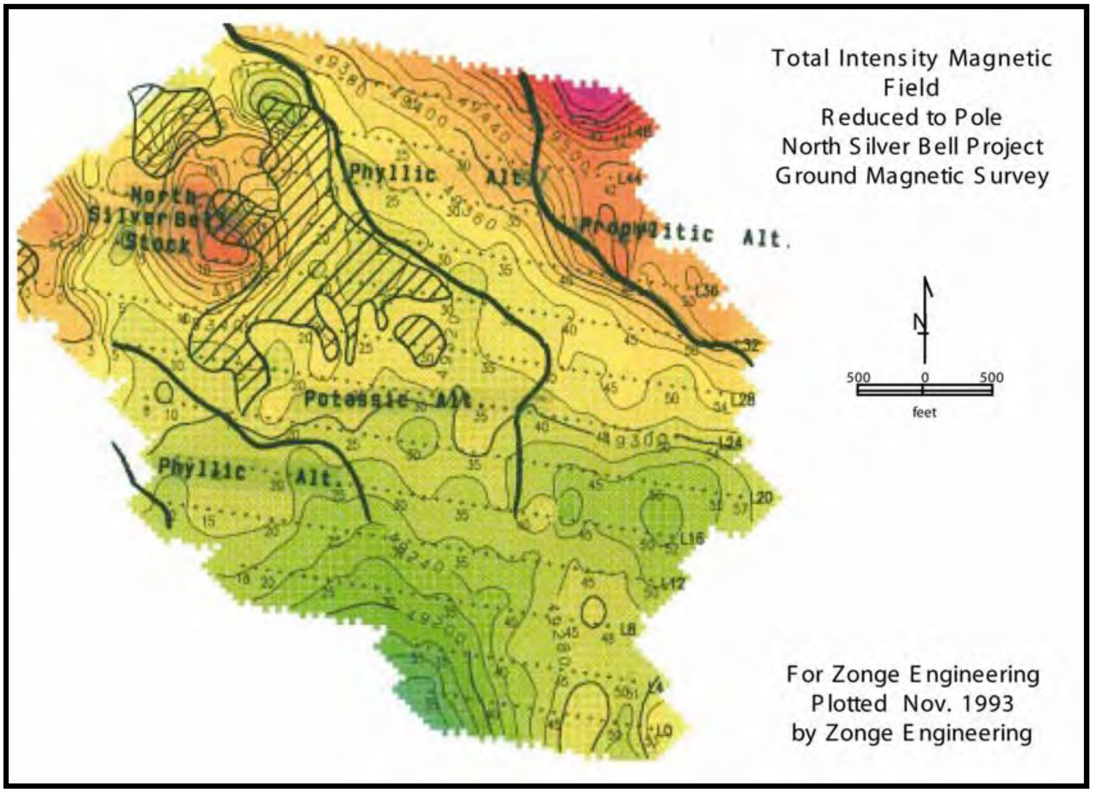
Tx & RIP Location Map shows the location of the RIP transmitter and associated receiver locations. This method uses the same equipment as a standard IP survey, but single sounding stations are spread out over the entire area of interest.



Enrichment Zone Plan Map shows the location of the surface projection of the supergene enrichment zone along with the boundary of the proposed pit site. The enrichment zone is defined as containing greater than 0.4% total copper sulfides.

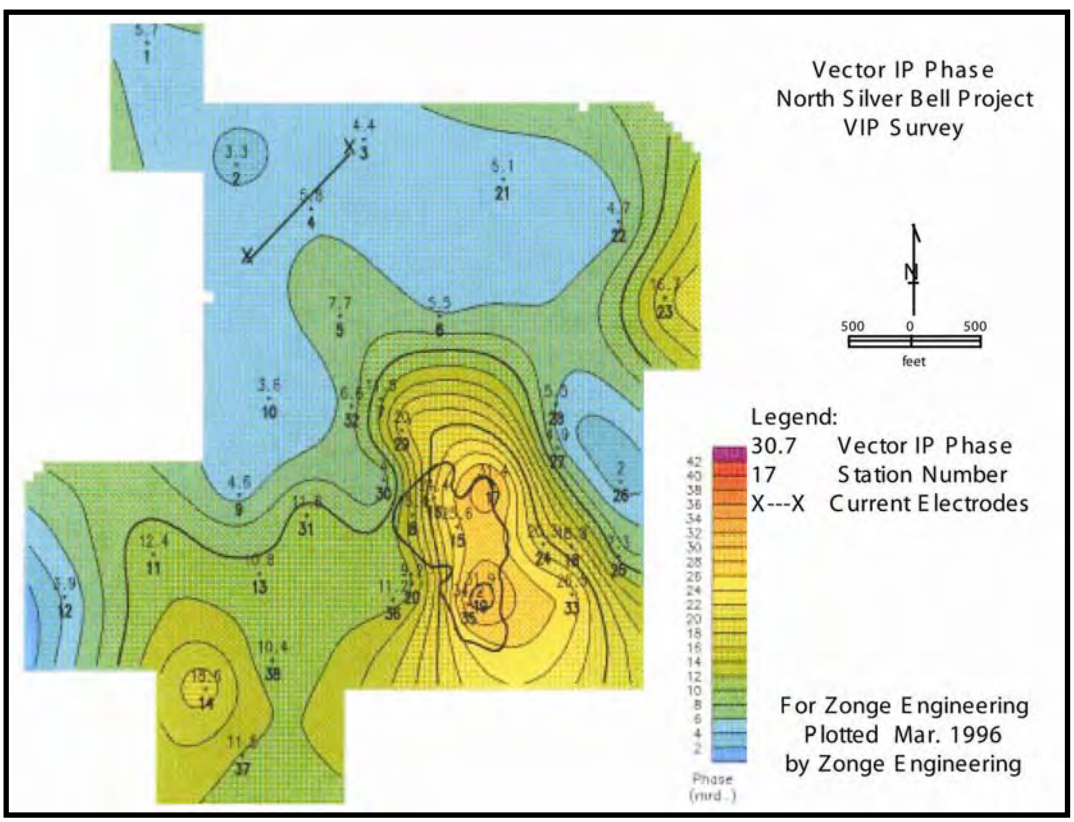


Alteration Map outlines the major geologic assemblages. The CR-IP and CSAMT line locations are overlaid on both maps. The Alteration Map shows the boundary between the potassic, propyllitic, and three phyllic zones. The different phyllic zones are defined by the abundance of Qtz.-Ser.-Py. veinlets.

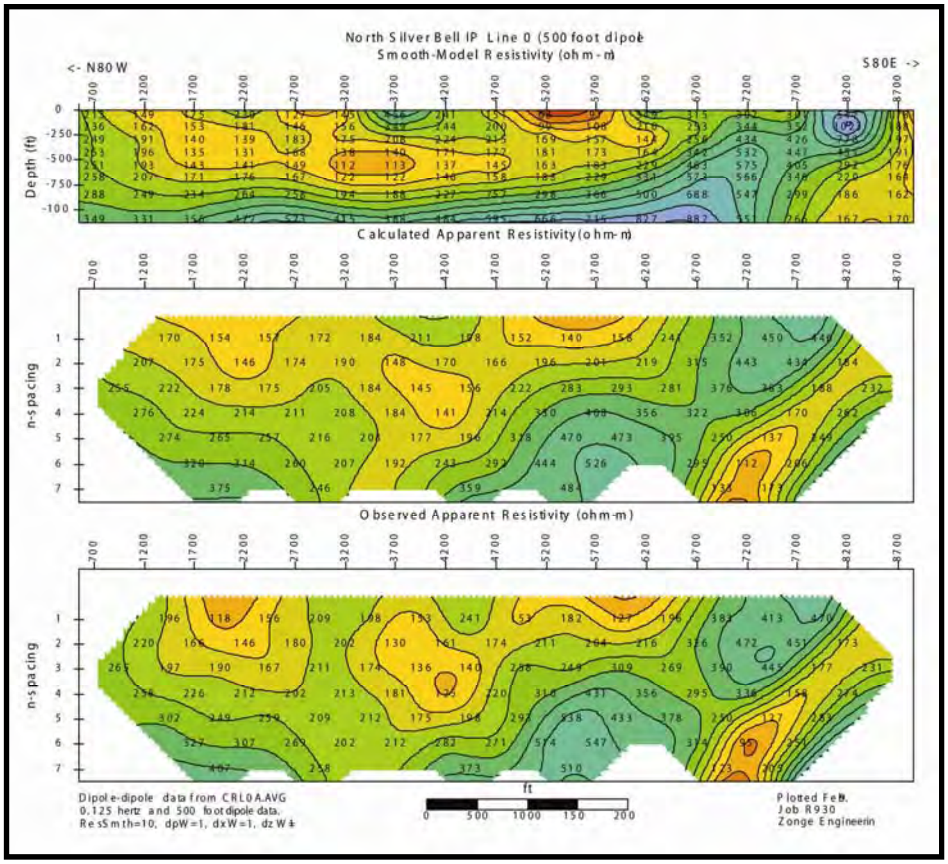


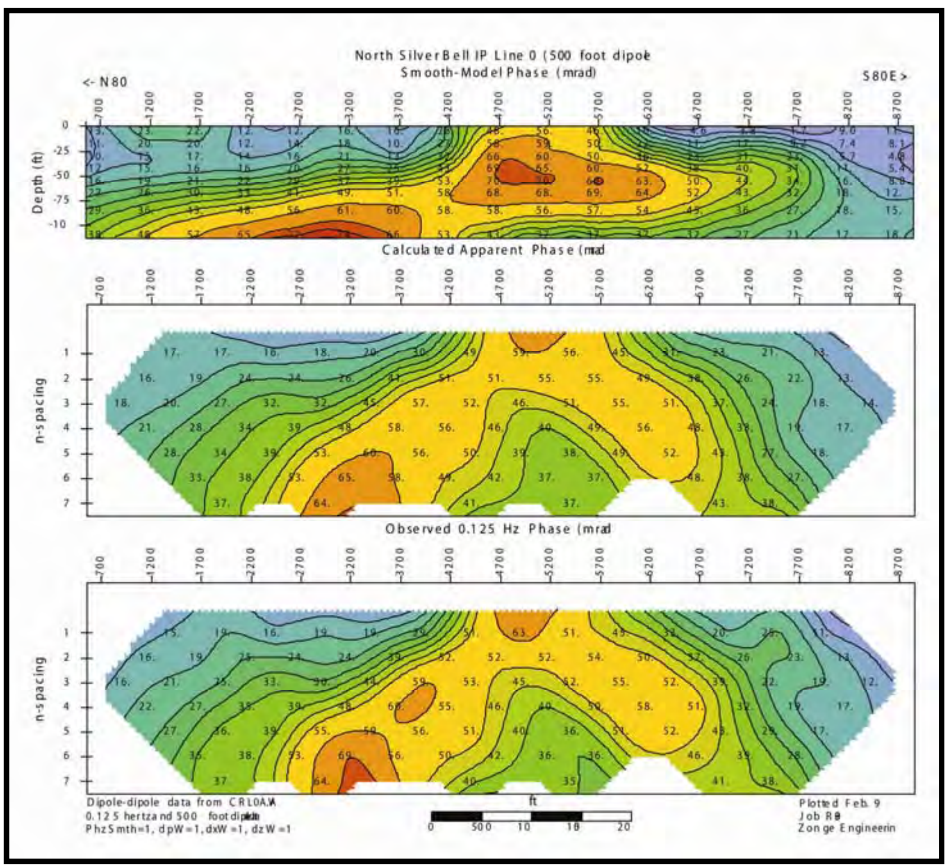
<u>Total Intensity Magnetic Field Plot</u> displays the results from the ground magnetic survey, with the alteration zones superposed on the magnetic data. Note that the magnetic corresponds to the edge of the propylitic alteration zone.

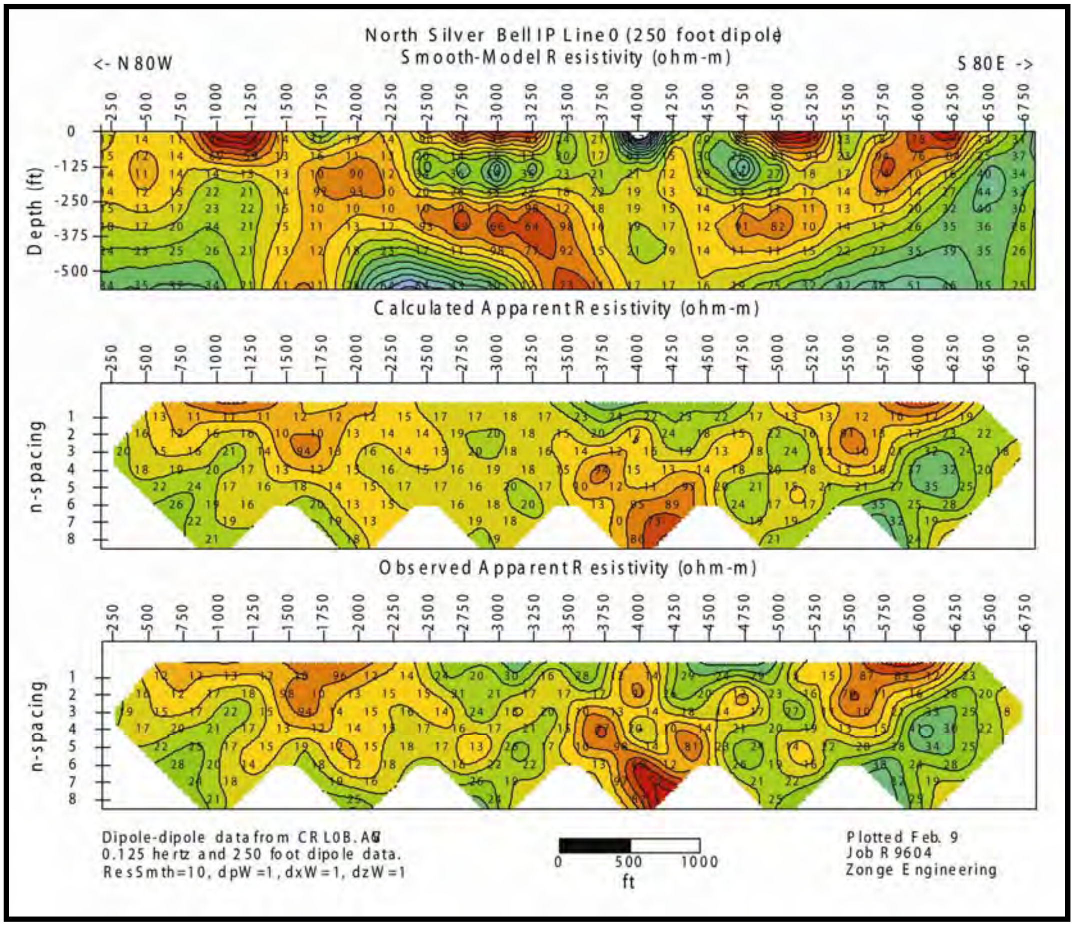
<u>Vector IP Phase Plot</u> shows the results of the reconnaissance IP survey with the proposed pit outline superposed on the data. Notice the good correlation between the anomalous IP area and the proposed pit.

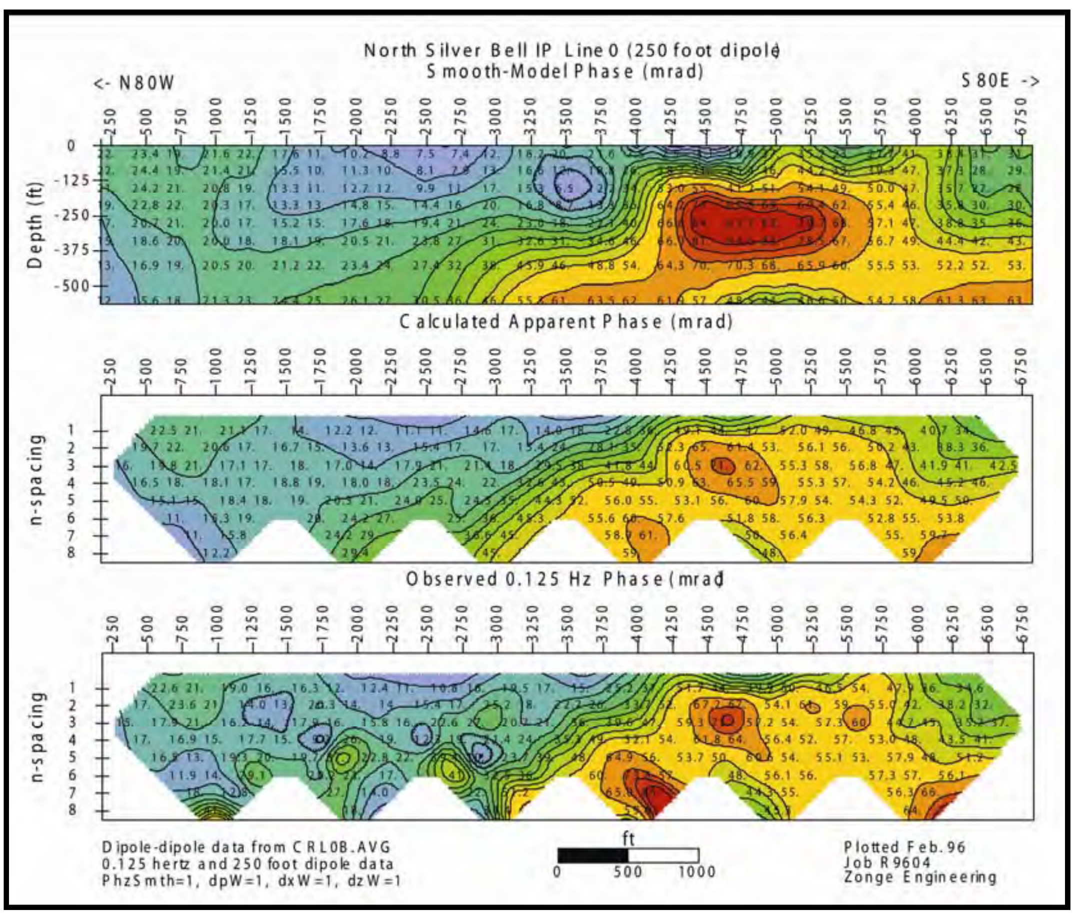


Silver Bell CR Line 0, Smooth-Model Resistivity and Smooth-Model Phase Plots show the observed data and the smooth-model results from CR-IP Line 0. The models are presented on separate figures, one displaying the resistivity information, the other the IP phase results. Data plots are presented for both 500 ft. and 250 ft. dipole-dipole arrays. Each figure consists of three separate panels. The top panel shows the results of the two-dimensional IP smooth-model. The vertical axis is depth from the surface in feet, with station numbers across the top. Notice that the station numbers on this CR-IP line have been scaled to match the CSAMT station numbers. The central panel of each diagram is the calculated response of the model. The bottom panel in each figure is the observed data, either the apparent resistivity or the 3-point decoupled IP phase response. Comparison of the observed data with the model-calculated response provides a qualitative estimate of the ability of the modeled section to match the observed data. The IP phase and resistivity response is displayed using a variable color scheme, with areas of low IP phase and high resistivity responses in cool colors, and high phase and low resistivity responses in warm colors.






North Silver Bell IP Line 0 (250 foot dipole)
Smooth-Model Resistivity (ohm-m)
<- N80W
S 80E ->
Depth (ft)
Calculated Apparent Resistivity (ohm-m)
n-spacing
Observed Apparent Resistivity (ohm-m)
Dipole-dipole data from CRL0B.AVG
0.125 hertz and 250 foot dipole data.
ResSmth=10, dpW=1, dxW=1, dzW=1
0 500 1000
ft
Plotted Feb. 9
Job R9604
Zonge Engineering

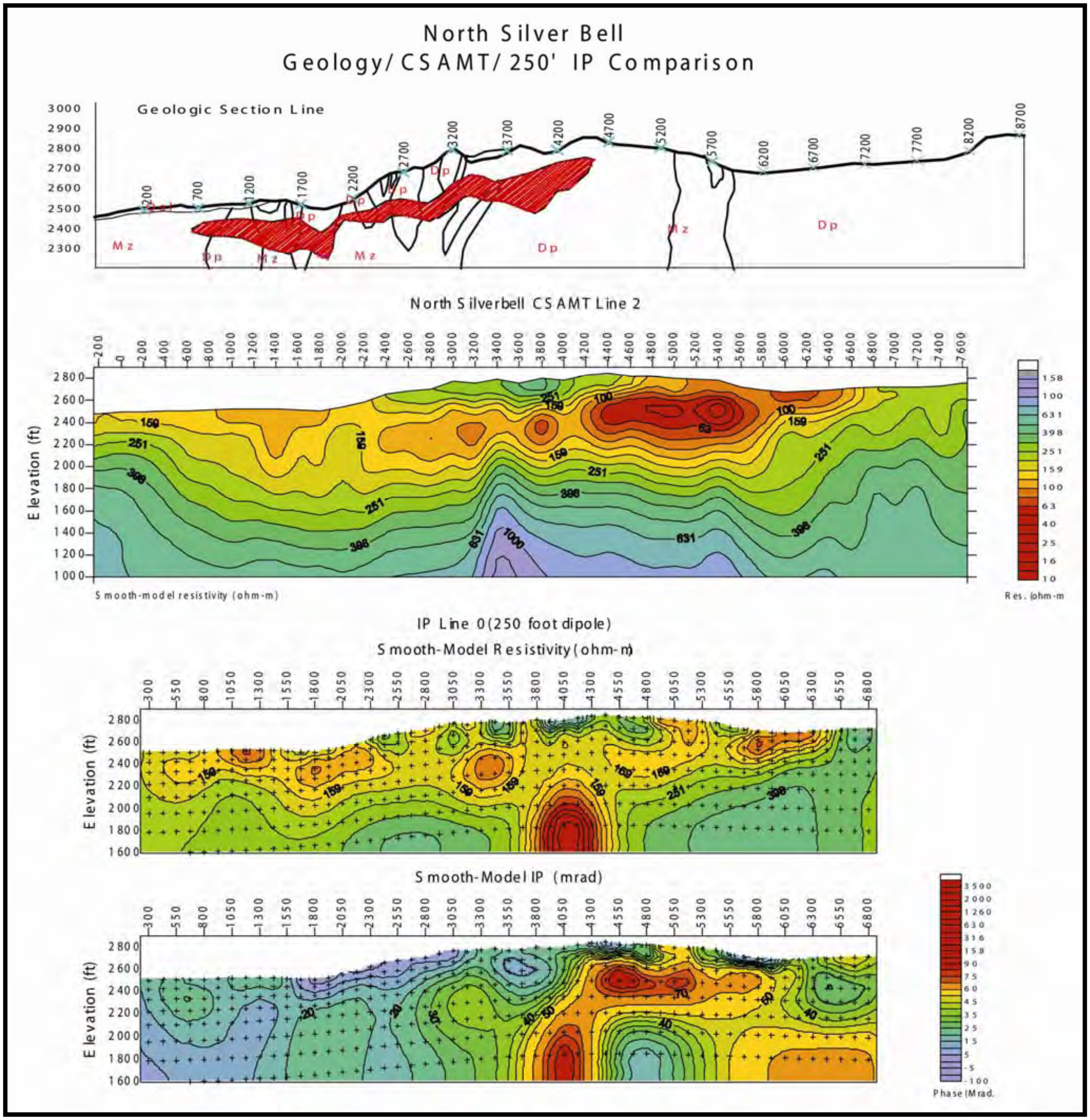

North Silver Bell IP Line 0 (250 foot dipole)
Smooth-Model Phase (mrad)
<- N80W
S 80E ->
Depth (ft)
Calculated Apparent Phase (mrad)
n-spacing
Observed 0.125 Hz Phase (mrad)
Dipole-dipole data from CRL0B.AVG
0.125 hertz and 250 foot dipole data
PhzSmth=1, dpW=1, dxW=1, dzW=1
ft
0 500 1000
Plotted Feb. 96
Job R9604
Zonge Engineering

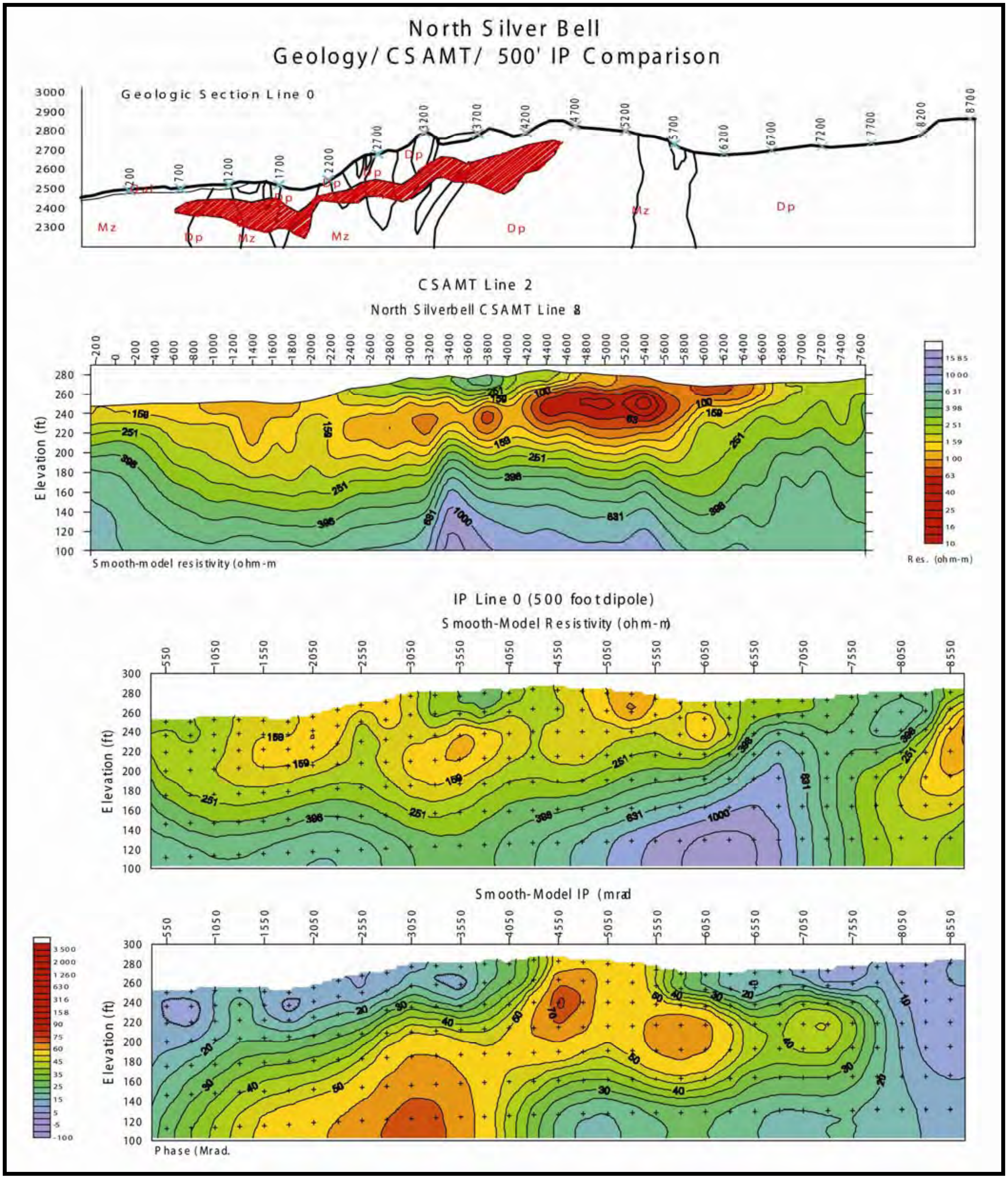
Geology/CSAMT/IP Comparison Plots
contrast the CSAMT and IP data with mineralization data obtained from drill holes along CR Line 0.

The geologic cross section shows the two main geologic units, an intrusive quartz monzonite, Mz, and the host dacite porphyry, Dp. The red shaded chalcocite enrichment blanket was determined from drill hole data. Drill hole data typically does not extend below 250 ft from the surface. The enrichment blanket is defined as containing greater than 0.4% total copper sulfides.

Smooth-model CSAMT data follow the same color scheme as the CR-IP models. Low resistivity and high IP phase are shown in warm colors. The CR-IP models are repeated from the smooth-model IP data plots.

The low resistivity zone in the CSAMT data and the coincident high IP phase response centered beneath station 5000 are due to the IP halo which circles the deposit. The enrichment zone shows up as a reasonably good conductor, but does not have a corresponding IP response. There is insufficient drill hole data to determine the source of the IP high which occurs well below the enrichment blanket.





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