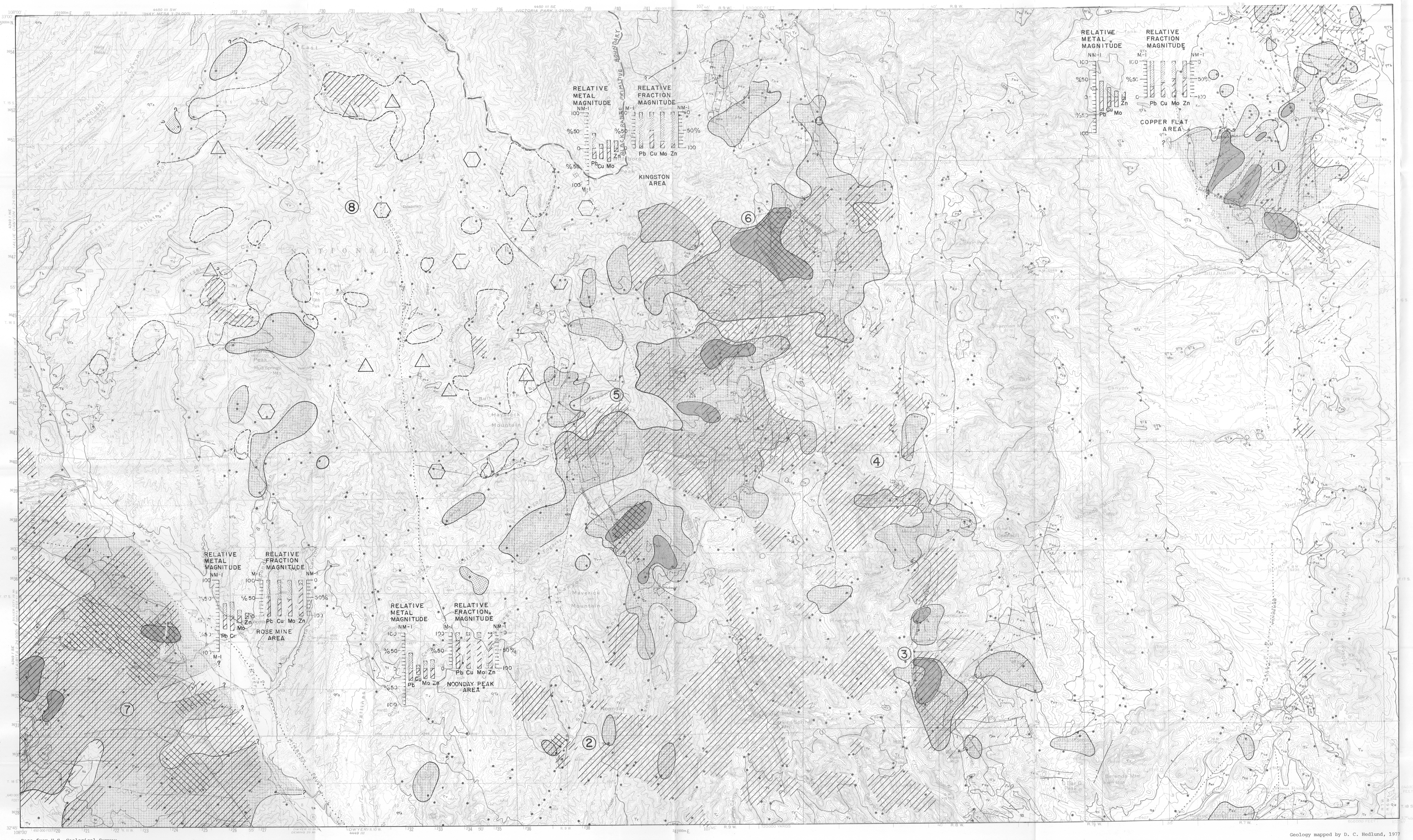
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-900G
HILLSBORO AND SAN LORENZO QUADS., NEW MEXICO



Base from U.S. Geological Survey, Hillsboro, 1940 and San Lorenzo, 1956, 1:62,500

UTM GRID AND 1956 MAGNETIC DECLINATION AT CENTER OF

SCALE 1:48 000

Geology mapped by D. C. Hedlund, 1977

CORRELATION OF MAP UNITS

SURFICIAL DEPOSITS

Qs } QUATERNARY

SEDIMENTARY AND VOLCANIC ROCKS

QTb, QTs } QUATERNARY AND TERTIARY

Trl, Trn, Tv, Tr } TERTIARY

Kv, Ks } CRETACEOUS

Pzu } PALEOZOIC

IGNEOUS AND METAMORPHIC ROCKS

p€u } PRECAMBRIAN

INTRUSIVE ROCKS

Tri, Trs, Tas } TERTIARY

Tql, Ta, Trsd } TERTIARY

Ka, Kql, Ki } CRETACEOUS

LIST OF MAP UNITS

		Qs	UNCONSOLIDATED SEDIMENTARY DEPOSITS (QUATERNARY)
		QTs	GILA AND SANTA FE FORMATIONS (QUATERNARY AND TERTIARY)
		QTb	BASALTIC LAVA AND GILA AND SANTA FE FORMATIONS (QUATERNARY AND TERTIARY)
		Tv	LAVAS AND ASH-FLOW TUFFS (OLIGOCENE)
Tr	Trl	Trn	RHYOLITE FLOWS AND DOMES (OLIGOCENE)
	Tri	Trs	RHYOLITE PLUGS, STOCKS AND SILLS (OLIGOCENE)
		Tas	ANDESITE SILLS AND DIKES (OLIGOCENE)
		Tql	QUARTZ LATITE DIKE OR SILL (OLIGOCENE?)
		Ta	ANDESITE SILLS (OLIGOCENE?)
		Trsd	RHYOLITE SILLS AND DOMES (OLIGOCENE?)
		Ka	ANDESITE DIKES AND SILLS (UPPER CRETACEOUS)
		Ki	QUART MONZONITE, GRANITE, MONZODIORITE AND DIORITE (UPPER CRETACEOUS)
		Kql	QUARTZ LATITE DIKES OF COPPER FLAT (UPPER CRETACEOUS)
		Kv	ANDESITIC FLOWS OF COPPER FLAT (UPPER CRETACEOUS)
		Ks	BEARTOOTH QUARTZITE (UPPER? CRETACEOUS)
		Pzu	UNDIVIDED SEDIMENTARY ROCKS (PALEOZOIC)
		p€u	UNDIVIDED GRANITIC AND HORNBLENDIC ROCKS (PRECAMBRIAN)

CONTACT--Dotted where concealed

FAULT--Dashed where approximately located; dotted where concealed. Where known, ball and bar on the downthrown side. U, upthrown side; D, downthrown side

ANTICLINAL AXIS--Showing crestline. Dashed where approximately located

ANOMALOUS CONCENTRATIONS

Anomalous values of four elements defined as follows:

	Magnetic (M-1) fraction (ppm)	Nonmagnetic (NM-1) fraction (ppm)
Pb	200	150
Cu	150	150
Mo	detected at 10	detected at 10
Zn	2,000	200

Areas within which two or three of the metals (Pb, Cu, Mo, Zn) occur in anomalous concentrations in the NM-1 (sulfide) fraction (2NM anomalies)

Areas within which all four metals (Pb, Cu, Mo, Zn) occur in anomalous concentrations in the NM-1 (sulfide) fraction (4NM anomalies)

Areas within which two or three of the metals (Pb, Cu, Mo, Zn) occur in anomalous concentrations in the M-1 (oxide) fraction (2M anomalies)

Areas within which all four metals (Pb, Cu, Mo, Zn) occur in anomalous concentrations in the M-1 (oxide) fraction (4M anomalies)

Areas within which only one of the metals (Pb, Cu, Mo, Zn) occur in anomalous concentrations in either fraction. Shown only in the northwestern quarter of the map area

AEROMAGNETIC CENTERS

High centers--Shown only in the northwestern quarter of the map area

Low centers--Shown only in the northwestern quarter of the map area

Discussion

This interpretational geochemical map is intended to serve as a condensation of the major geochemical features, within the map area, pertinent to mineral exploration. It is based on the occurrence of Pb, Cu, Mo, and Zn in anomalous concentrations in the nonmagnetic (NM-1) and magnetic (M-1) fractions of pan concentrates of stream sediments. The four-metal association (Pb, Cu, Mo, and Zn) was chosen as a framework for this map because these metals are important components in all of the known ore deposits within the map area; they also show all of the major features of the geochemical anomalies. In this map emphasis is placed on the degree of common occurrence of these four metals in anomalous concentrations within the individual sample fractions [nonmagnetic (NM-1) and magnetic (M-1)] rather than single metal anomaly intensity.

Sample Types

Metal content(s) of pan-concentrated stream sediment has been determined spectrographically for each sample. The sample material consists of the portion of pan-concentrated stream sediment having a specific gravity greater than that of bromoform (2.9). The sample material was subsequently separated magnetically into two fractions labeled magnetic (M-1) and nonmagnetic (NM-1). The magnetic (M-1) fraction is that portion of such material not magnetic at 0.1 ampere but magnetic at a 1.0-ampere setting on a Frantz Isodynamic Separator (forward slope 25°, side slope 15°). The portion that is not magnetic at a 1.0-ampere setting is labeled nonmagnetic (NM-1). Material labeled magnetic (M-1) is comprised dominantly of limonite, manganese oxides, and mafic rock-forming minerals. The nonmagnetic (NM-1) is composed of light-colored, rock-forming accessory minerals and primary and secondary ore minerals.

Analytical Methods

Elements were determined by a semiquanitative spectrographic method described by Grimes and Marranzino (1968). Results of these spectrographic analyses are reported within geometric intervals having the boundaries 1,200, 830, 560, 380, 180, 120, and so on in ppm, but are shown in the histograms by approximate geometric midpoints such as 1,000, 700, 500, 300, 200, 150, and 100. Precision of a reported value is approximately plus or minus one interval at 68 percent confidence, or plus or minus two intervals at 95 percent confidence.

Geochemical Interpretation

An attempt has been made to quantify the interelemental, intrafraction relationship within four selected mineralized areas; the areas and number designations are Copper Flat (1), Noonday Peak (2), Kingston area (6), and Rose Mine area (7). Each of four metal anomalies (Pb, Cu, Mo, Zn) is characterized on the basis of intensity and areal extent within each sample fraction and the result is expressed in percent and termed the relative metal magnitude (RMM).

The Relative Metal Magnitude (RMM) is calculated for Pb, Cu, Mo, and Zn as follows:

(1) Blocking out of selected area. The Pb, Cu, Mo, and Zn contents of the NM-1 and M-1 fractions from all the sample localities falling within this area will be considered.
(2) Determine the percentages of the total sample population containing anomalous concentrations of Pb, Cu, Mo, and Zn in the M-1 and NM-1 fractions. The percent of the population containing anomalous concentrations of Pb in the NM-1 fraction is the NM-1 Pb area factor = $A(NM\text{-}1)_{Pb}$.
(3) Determine the mean values of Pb, Cu, Mo, and Zn for the anomalous portions of the M-1 and NM-1 populations in terms of n times Pb, Cu, Mo, and Zn thresholds. The mean value of Pb for the anomalous portion of the NM-1 fraction sample population is the Pb NM-1 intensity factor = $I(NM\text{-}1)_{Pb}$.
(4) Calculating the RMM of Pb in the NM-1 fraction in the Pb, Cu, Mo, and Zn system:

$$RMM(NM\text{-}1)_{Pb} = \frac{[A(NM\text{-}1)_{Pb} \times I(NM\text{-}1)_{Pb}]}{[A(NM\text{-}1)_{Pb} \times I(NM\text{-}1)_{Pb}] + [A(NM\text{-}1)_{Cu} \times I(NM\text{-}1)_{Cu}] + [A(NM\text{-}1)_{Mo} \times I(NM\text{-}1)_{Mo}] + [A(NM\text{-}1)_{Zn} \times I(NM\text{-}1)_{Zn}]}.$$

It is hoped that this form of anomaly characterization will provide a basis of comparison for anomalies associated with suspected concealed mineral deposits with those associated with known ore deposits.

A second calculation was made for the same four areas to determine the intraelement partitioning between the magnetic (M-1) and nonmagnetic (NM-1) fractions. The resultant is termed the relative fraction magnitude (RFM) and is expressed in percent.

The Relative Fraction Magnitude (RFM) is calculated for PB (or Cu, Mo, Zn) as follows:

(1) Block out selected area. The Pb contents of the NM-1 and M-1 fractions from all the sample localities falling within this area will be considered.
(2) Determine the percentages of the total sample population containing anomalous concentrations of Pb in the M-1 and NM-1 fractions. The percent of the population containing anomalous concentrations of Pb in the NM-1 fraction is the NM-1 Pb area factor = $A(NM\text{-}1)_{Pb}$.
(3) Determine the mean values of Pb for the anomalous portions of the M-1 and NM-1 populations. The mean value of Pb for the anomalous portion of the NM-1 fraction sample population is the Pb NM-1 intensity factor = $I(NM\text{-}1)_{Pb}$.
(4) Calculating the RFM of Pb in the NM-1 and M-1 fractions:

$$RFM(NM\text{-}1)_{Pb} = \frac{A(NM\text{-}1)_{Pb} \times I(NM\text{-}1)_{Pb}}{[A(NM\text{-}1)_{Pb} \times I(NM\text{-}1)_{Pb}] + [A(M\text{-}1)_{Pb} \times I(M\text{-}1)_{Pb}]}$$

and

$$RFM(M\text{-}1)_{Pb} = 100 - RFM(NM\text{-}1)_{Pb}.$$

This calculation measures the degree of transfer of elements from a presumed sulfide parent nonmagnetic (NM-1) fraction to the oxide minerals magnetic (M-1) fraction. The resultant varies markedly within these quadrangles and this variation is here interpreted to reflect the depth of the metal source.

Eight general localities believed to merit more detailed exploration are indicated on the map. These are as follows:

(1) The Copper Flat area
(2) The Noonday Peak area
(3) The PA Mountain area
(4) The Log Cabin Peak-Tierra Blanca area
(5) The Sawyers Peak-Seven Brothers Mountain area
(6) The Kingston area
(7) The Rose Mine area
(8) The Hendricks Peak area.

The numerical order of listing does not indicate rank of priority and serves only for identification purposes on the map. Map construction in area 8 (northwestern corner of the map) differs from that in the rest of the map in that single-metal anomalies and aeromagnetic high and low centers are shown in addition to the standard two sets of multi-metal anomalies.

Description of Anomalies

(1) Copper Flat Area

The Copper Flat area (northeastern corner of the map) is characterized by a large, roughly circular outcrop of andesite intruded by a quartz monzonite stock and associated, radially arranged, quartz latite dikes. Paleozoic rocks occur to the north and the south; these were intruded in the north by a few quartz latite dikes and the quartz diorite of Tank Canyon and in the south, by the quartz monzonite and quartz monzodiorite of the Warm Springs Canyon stock. Several smaller Tertiary rhyolite porphyry bodies and dikes also occur in the southern area. The main fracture system is radial around the Copper Flat stock with a preferred northeasterly orientation. North-south- and northwest-southeast-trending faults predominate in the Paleozoic outcrop areas.

The two major geochemical multi-metal anomalies occur to the north and south of the Copper Flat stock exposure. The larger one is centered some 2 mi (3.2 km) to the south of this exposure. In this area 4NM anomalies (areas in which all four metals (Pb, Cu, Mo, and Zn) are anomalous in the nonmagnetic fraction) delineate a discontinuous northwest-trending belt extending from Ready Pay Gulch to Empire Peak. A more sporadic and areally restricted, northwest-trending belt, roughly paralleling the quartz latite dike swarm, extends from Empire Peak into the Copper Flat stock exposure. The far more extensive 2NM anomaly (area in which two or three of the metals Pb, Cu, Mo, and Zn are anomalous in the nonmagnetic fraction) covers the southern and southwestern half of the andesite outcrop area extending into the area of Paleozoic rocks and associated intrusives in the extreme southwest. This anomaly shows a clearly defined northeastward trend encompassing the Copper Flat stock exposure. The 4M anomaly (area in which all four metals (Pb, Cu, Mo, and Zn) are anomalous in the magnetic fraction) is areally restricted, in the south, and occurs immediately to the southeast of the southern end of the 4NM belt. The 2M anomaly (area in which two or three of the metals Pb, Cu, Mo, or Zn are anomalous in the magnetic fraction) is nearly as extensive as the 2NM, but is displaced southward into the area of predominant Paleozoic outcrops. Elements of the NM northwest and northeast trends are visible in the M anomaly configuration.

No four-metal association, in either fraction, occurs in the northern anomaly. The 2M anomalous area is areally more extensive than the 2NM area and occurs nearly exclusively in the Paleozoic rocks.

The central portion of a pronounced aeromagnetic high, centered some 2 mi (3.2 km) south of the Copper Flat stock exposure, shows a close spatial correlation with the southern geochemical anomaly. The northern geochemical anomaly occurs within a northern "nose" of this same aeromagnetic anomaly.

The quartz diorite of Tank Canyon, the quartz monzonite of Copper Flat and associated quartz latite dikes, and quartz monzonite and quartz monzodiorite of the Warm Springs Canyon stock are believed to be genetically related. The coincidence of the main geochemical and geophysical anomalies 2 mi (3.2 km) to the south of the Copper Flat stock exposure suggests that this may be the center of mineralization in this area. The >50-percent sulfide/oxide trace metal partitioning (RFM) indicates that the mineralization is at a shallow to intermediate depth. Surficial geologic evidence and geochemical relative metal magnitude (RMM) suggest that the mineralization is of porphyry copper or copper skarn type.

The most extensive anomaly system occurs in the central portion of the map. Viewed as a whole it forms a roughly rectilinear pattern consisting of nearly east-west and north-northwest and northeasterly trends. The north-component anomaly trends are indicated predominantly by 2NM associations and generally occur along major mapped faults. The westernmost of these occurs along the Grandview fault and its extension which represents the western margin of this anomaly system. The eastern margin is delineated by NM associations along the Pierce Canyon fault zone.

The east-west trends occur along the following lines: Noonday Peak-PA Mountain, Sawyers Peak-Log Cabin Peak, and Cross-O Mountain-Kingston. All are delineated predominantly by 2M associations. Surficial geology lends little support to these geochemicl lineaments, and they trend at nearly right angles to the regional structural fabric and cross a number of geologic boundaries. The authors believe they represent older, deep-seated structural control--probably in the Precambrian basement rocks.

A third major lineament trending northeast is delineated by a combination of 4NM and 4M anomalies and extends from the Noonday Peak area in the south to Ladrone Gulch in the north. Numerous Tertiary rhyolite porphyry bodies and dikes are emplaced along this zone. The authors believe that the five main intersections (areas 2-6) are the most favorable exploration targets within this anomaly system, and these will be discussed individually.

(2) Noonday Peak Area

The outcrops in the Noonday Peak area are composed of extrusive Tertiary volcanics. No intrusives have been observed at the surface though widespread alteration and some evidence of east-west-trending breccia zones was noted. Two NM anomalies are intermittent and local. Two M anomalies, here, constitute the western end of the Noonday Peak-PA Mountain geochemical lineament. The Noonday Peak area is believed to be a triple intersection area of the Grandview fault system, the east-west geochemical lineament, and the northeast-trending 4M-4NM anomaly and rhyolite intrusive lineament.

A minor aeromagnetic high occurs in the Noonday Peak area, one of two, along a linear aeromagnetic high paralleling the Noonday Peak-PA Mountain geochemical lineament. It could well indicate a concealed intrusive emplaced within the intersection area. The <20-percent sulfide/oxide partitioning suggests that the mineralization is at substantial depth (thousands of feet). The relative Pb, Cu, Mo, and Zn anomaly magnitudes show a striking resemblance to the Kingston area.

(3) PA Mountain Area

The PA Mountain area multi-metal anomalies occur in rock types ranging from Tertiary acid volcanics through Paleozoic limestones. Several Tertiary rhyolite porphyry bodies are emplaced along the Pierce Canyon fault zone--the dominant structure within the area. Two M anomalies are more extensive than the 2NM anomalies and represent the eastern termination of the Noonday Peak-PA Mountain 2M geochemical lineament. This area, like Noonday Peak, is considered to be an intersection of the north-south-trending Pierce Canyon fault zone and the east-west 2M geochemical lineament. Two NM and 4NM anomalies give a strong indication of the skarn in the Pierce Canyon fault zone, but an area to the south of Pine Spring Mountain, showing a coincidence of 2M and aeromagnetic anomalies is considered to be of equal interest as an exploration target.

(4) Log Cabin Peak-Tierra Blanca Area

Tertiary acid volcanics, Cretaceous andesites, and Paleozoic limestones are equally represented in the Log Cabin Peak-Tierra Blanca area. These are intruded by a number of Tertiary rhyolite porphyry bodies along the Pierce Canyon fault zone, which is the major structural feature here. An intersection area of the mineralized Pierce Canyon fault zone and the east-west-trending 2M geochemical lineament connecting areas 4 and 5 occurs here. Two M anomalies are more extensive than the 2NM anomalies and occur predominantly in portions of the area covered by andesites and rhyolites. The combination of the two anomaly types forms a semicircular halo around the Tertiary intrusives clustered in the central portion of the area. A major north-south-trending aeromagnetic low, reflecting the uplifted limestones on the east side of the Pierce Canyon fault zone, covers area 4.

(5) Sawyers Peak-Seven Brothers Peak Area

The Sawyers Peak-Seven Brothers Peak area is located at the western end of the same east-west-trending 2M geochemical linement terminating at area 4 in the east. Area 5 is underlain predominantly by Cretaceous andesites and Paleozoic limestones. The major structural feature is the Grandview fault zone bounding the area to the west and intersecting the east-west 2M geochemical lineament. Two NM anomalies form a circular pattern around Sawyers Peak and are somewhat more extensive than the 2M anomalies. The latter occur predominantly in the eastern and southern portions of the area. The 4M-NM northeast-trending geochemical lineament bounds the area on the south. Area 5 is covered by the north-south-trending portion of a semicircular aeromagnetic high extending from the PA Mountain area in the south to the Kingston area in the north. This linear aeromagnetic high is believed to be produced by a combination of intrusives and shear zones.

(6) Kingston Area

The area to the west and northwest of the town of Kingston is believed to be one of the more promising exploration targets within the Hillsboro-San Lorenzo quadrangles. Geologically the area is very complex, incorporating a great variety of rock types. This is an area of intersection of the north-south-trending fault systems, east-west-trending 2M geochemical lineaments and the northeast-trending 4M-4NM geochemical and intrusive lineament. Two M and 2NM anomalies are widespread with the latter dominant. The combination of the two anomaly types forms a semicircular pattern with 4M and 4NM anomalies near the center just south of Picket Spring Canyon. Relative fraction magnitude calculations indicate that sulfide mineralization may occur at shallow to intermediate depth. Near-surface lead-zinc replacement deposits are indicated by >95-percent NM-1 RFM values for Pb and Zn. Copper and Mo may occur at a greater depth as indicated by M-1 RFM values of 40 percent and 20 percent, respectively. This same trend is indicated by the RMM values. Here, Pb, Mo, and Zn are the predominant components in the NM-1 (sulfide) fraction, whereas Mo, Pb, and Cu are the predominant components in the M-1 (oxide) fraction. The authors believe that the known lead-zinc-silver mineralization represents the outer periphery of an unexposed porphyry copper at a relatively shallow depth. The aeromagnetic picture in this area is complex, but shows, in general terms, an aeromagnetic low centered in the Picket Spring Canyon area and surrounded to the west, south, and east by aeromagnetic highs.

(7) Rose Mine Area

The Rose Mine area (southwestern corner of the map) is predominantly underlain by Paleozoic sedimentary and Tertiary volcanic rocks. The major intrusive within this area is the rhyolite sill of Lampbright Draw (Oligocene?). The majority of the faults trend northwest while a few trend east-west. The whole area is bounded to the east and northeast by the Mimbres fault.

Two M and 2NM anomalies are nearly coextensive and blanket the whole outcrop area. Extensive 4M anomalies form a northwest-trending belt along the eastern and northeastern margin of the area. Four NM anomalies are more restricted areally and indicate a northeastern trend through the central portion of the area. A major aeromagnetic high coincides with the 4M and 4NM anomalies. Sulfide/oxide trace metal partitioning (RFM) shows that slightly less than 50 percent of the trace metals are sulfide related and thus indicates an intermediate depth to mineralization. Surficial evidence and relative metal magnitude calculations suggest that this is porphyry copper type mineralization.

(8) Hendricks Peak Area

Map symbols in the Rabb Park caldera area (northwestern corner of the map) differ from those in the rest of the map area in that in addition to the multi-metal anomalies, single-metal anomalies and aeromagnetic high and low centers are shown. The area is generally underlain by Tertiary extrusive rocks overlapped along the western margin by Quaternary basalts and containing a few Cretaceous andesite and Paleozoic limestone exposures in the southern portion. A series of Tertiary rhyolite intrusives are emplaced along the broad southern boundary. Fractures occur predominantly in the southern portion of this area. The major trend of the fractures is northwesterly though a north-south trend is present in the central portion of the area. The central portion of the area contains a cluster of three aeromagnetic low centers surrounded by nine aeromagnetic high centers in an oval configuration. These latter are assumed to be associated with the caldera walls and, possibly, post-collapse intrusives. Scattered 2M and 2NM anomalies ring the area to the north, west, and south. Single-metal anomalies complement the multi-metal anomaly pattern. The mineralization in this area is believed to be related to the caldera and is minor or at great depth.

INTERPRETIVE GEOCHEMICAL MAP OF THE HILLSBORO AND SAN LORENZO QUADRANGLES EXCLUSIVE OF THE BLACK RANGE PRIMITIVE AREA, SIERRA AND GRANT COUNTIES, NEW MEXICO

By
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1978

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