INTERPRETATION OF THE SOIL GEOCHEMICAL EXPRESSION OF THE MINERALIZATION WITHIN THE EL CALLAO GOLD MINING DISTRICT, VENEZUELA

By

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ABSTRACT

The surface geochemical expression of the gold mineralization within El Callao mining district has been studied.

Soil anomalies formed in relation to the mineralization include Au, Ag, Pb, and Zn if the dissection level of the present surface cuts the region of gold deposition. If the present surface dissects the mineralization much above the region of Au deposition, soil anomalies include Mn, V, and As. Hg, on the other hand, is common to all levels of dissection.

The environments of jungle and savanna do not essentially alter the mineralization pattern in soils if care is taken not to sample lateritic crusts.

Previously unknown geochemical anomalies are interpreted as to their spatial relationship with respect to Au deposition. Two anomalies are within the Au deposition zone, 18 are somewhat above it, and 2 are far above it.

Geological data taken from the literature, combined with detailed field observations, analytical results, and chemical principles have been used to propose a dispersion model for hydrothermal deposits in general, where the most important elements are deposited in the order Au, Ag, Hg, Cu, Zn, Pb, As, Mn and V going from high to low temperature and/or ionic strength of the ore solutions. The dispersion model is in general agreement with a model postulated for epithermal gold deposits of Siberia, and has been extended to the elements V and Mn, which make it more useful for regional exploration.

Approximately 600 samples of rocks and soils have been analyzed for Be, W, Bi, Mo, Sn, Hg, Au, Ag, Cu, Co, Ni, Pb, Zn, As, Mn and V by optical emission spectrography, and approximately 150 samples were analyzed for Hg and Au by atomic absorption spectrometry.

Further work in the theoretical and economical aspects of the study is suggested.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS AND DATA

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The author wishes to acknowledge all persons that contributed to the realization of this thesis. If a fairly complete list of people and institutions is prepared, and their contributions described in detail, it would take a small book, and an entertaining one at that. In the interest of brevity only those that had a more direct influence will be mentioned.

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INTRODUCTION

The purpose of this study is to analyse the surface geochemical expressions of the gold mineralization within the El Callao mining district, and their possible relationship with the formation of hydrothermal ore deposits in general.

The characteristics of the surface expression of the gold mineralization will be used as a basis for the planning of an exploration program of the El Callao mining district which produced large quantities of gold around the turn of the century and is now in decadence because of lack of enough reserves for a large-scale economical operation.

The ordering of elements in the haloes produced by the mineralization will be used to attempt a correlation of ore deposition with a more solid chemical basis than the one presented by Barnes and Czamanske (1967, p. 338). The stated order of complex stability in their work is Hg, Cd, Pb, Cu, Zn, Sn, Ni, Fe, Co and Mn, an order which groups chemically dissimilar elements and does not consider important elements such as Au and Ag.

The El Callao mining district is found in the Guayanan shield in the State of Bolivar, Venezuela (see plate, back pocket). Its areal extent is approximately bound by latitudes 7° 05' to 7° 50' north and longitudes 61° 25' to 62° 20' west. The region is at around 250 meters above sea level and has a humid tropical climate with an annual average temperature of 26 °C and an average rainfall of 1500 mm distributed unequally between the rainy and dry seasons. Two vegetation types are common, jungle and savanna, the jungle being a densely wooded, humid environment, the savanna being a grassy, dry environment very sparsely populated with trees, commonly used for grazing.

This study is based on soil and rock samples taken along traverses that cut critical geologic features, and also taken irregularly within the district in order to establish background values. The soil samples were taken at a depth of around 10 to 15 centimeters. Rock and soil samples were analysed for Be, W, Bi, Mo, Sn, Hg, Au, Ag, Cu, Co, Ni, Pb, Zn, As, Mn and V.

The study reports briefly on the regional geology with some emphasis on the stratigraphy most closely associated with the gold deposits, the descriptive part of the gold deposits, and the previous geochemical work. The discussion and interpretation of results contains a critical description of analytical data for every traverse and its possible meaning, a short section on the effect of weathering and a section where results are correlated with the aid of coordination chemistry. Conclusions, recommendations, an appendix containing explanations on methods of sample collection, analytical techniques and a table of data pertinent to weathering and selected references complete the text. The back pocket contains a computer print-out with the analytical data for the samples within traverses, their graphical representation, and a plate where traverses and samples are located geographically and geologically.

REGIONAL GEOLOGY

Introduction

The area of this study is located within Precambrian terrain of the Guayanan-Brazilian shield. The Venezuelan part of the shield is limited essentially by the Orinoco river, Brazil, and Guyana. The region has been incompletely covered by geologic studies which have concentrated to the northern and eastern portions that are more accessible. Four geologic provinces have been described in the northern part of the shield, Imataca, Pastora, Cuchivero, and Roraima. In the eastern portion rocks of Imataca and Pastora form bands that trend ENE. Imataca is to the north of Pastora, and Pastora is followed by Roraima which consists of flat laying clastic sediments that extend south into Brazil and east to the Orinoco river in a discontinuous form (see figure 1, p. 4)

Imataca Province

The Imataca province contains the oldest rocks of the Venezuelan part of the shield. It contains paragneisses, ferruginous quartzites, minor pyroxenitic amphibolites, and it has been intruded by granites

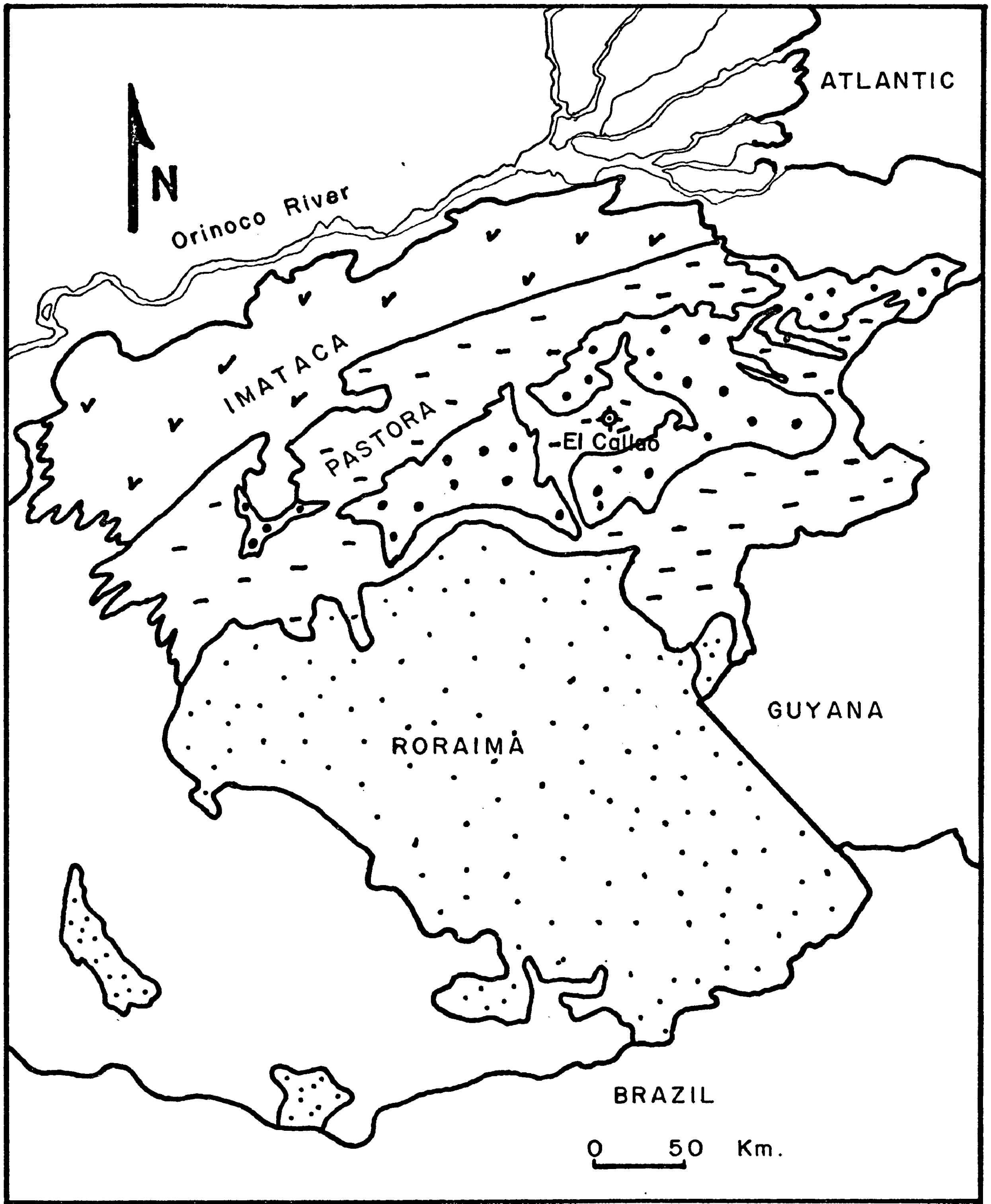

Figure 1. Geologic provinces of south-eastern Venezuela after Bellizzia (1969). Imataca ✓ ✓. Pastora – –. Roraima ⁘. Undifferentiated ☐. Supamo complex ● ●.

and quartz monzonites (Chase, 1965, p. 108). The regional metamorphism varies from the amphibolite to the granulite facies (Chase, 1965, p. 179-180). The age of the rocks is Lower Precambrian being deposited before 3000 m.y. ago, metamorphosed for the first time around 3000 m.y. ago, intruded with acidic plutons in the approximate interval 1500-2000 m.y. ago (Martin-Bellizzia, 1968). The term province indicates areal extent, the proper geological term for the rocks of this area is Imataca Complex (Boletin de Geologia, 1970, p. 307).

Pastora Province

The Pastora province is found to the south of the Imataca complex, and it is separated from it by two large faults (Kalliokoski, 1965, p. 96). The dominant rock types are basic and acidic volcanics and associated sedimentary products that have been metamorphosed slightly, and locally up to the amphibolite facies (Menendez V. de V., 1968, p. 313). Basic disagreement on the stratigraphy of these rocks is to be found in the literature (Menendez V. de V., 1968, and Martin-Bellizzia, 1968), and the results of the detailed study of Menendez V. de V. are used here since his area of study completely encompasses the El Callao gold mining district and there is no other available work of comparable detail published, although there are several in preparation (Martin-Bellizzia, Espejo, Benaim, personal communication). It is believed that no error is introduced by adopting Menendez' stratigraphic interpretation, even if it differs grossly from conclusions drawn by detailed work of others in nearby areas. The author believes that the origin of the disagreement resides in the attempt to correlate similar units which belong to different greenstone belts as described by Anhaeusser and others (1969), and not to different interpretation of basic geologic observations.

Menendez V. de V. (1968) has subdivided the rocks of the Pastora province into supergroup Pastora that contains the Carichapo group and the El Callao, Cicapra, and Yuruary formations, separated by a structural discontinuity from the Caballape formation, and all of these intruded by acidic igneous rocks and migmatites that have not been differentiated and constitute the Supamo complex. The stratigraphic relationships are presented schematically in figure 2 (p. 7). The age of concordant granitic bodies within Supamo varies from 1740 to 2000 m.y. It has been assumed that the metasedimentary rocks of Pastora are younger than the metasedimentary rocks of Imataca.

The rocks of the Pastora province around the El Callao area include basic volcanic rocks and associated sedimentary units that occupy tectonic basins surrounded by acidic intrusives domes (Menendez V. de V., 1968, p. 310, see also the plate, back pocket). This setting would make this area a good example of a Precambrian greenstone belt as described by Anhaesser and others (1969), and it may be worthwhile to look at the distribution of ages of the Supamo complex for evidence of a crust onto which the volcanics were deposited.

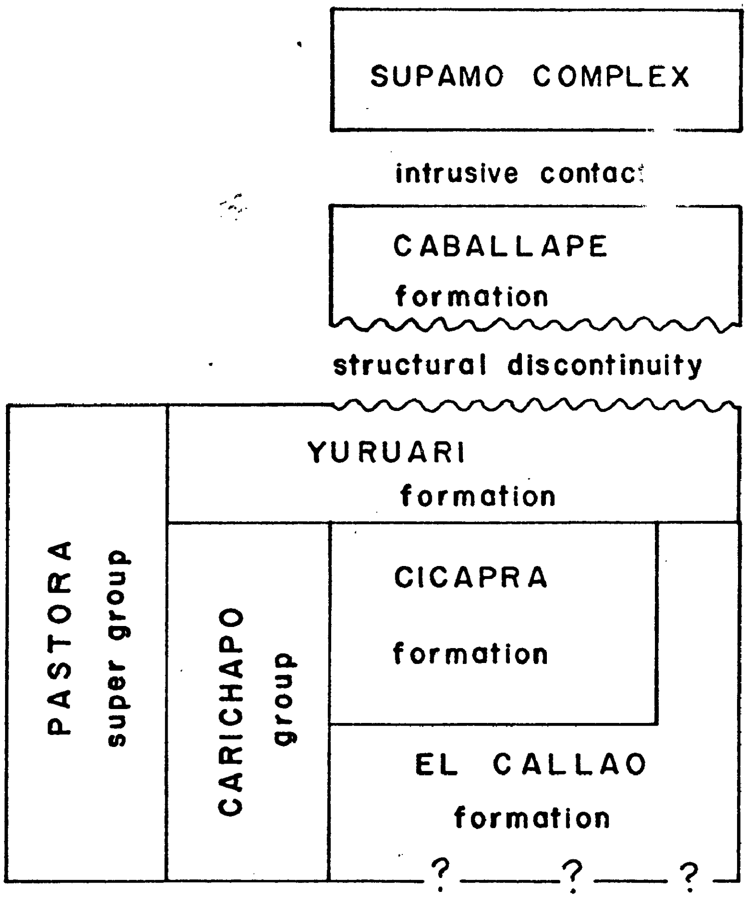

Figure 2. Stratigraphic relationships within the Pastora province after Menendez V. de V. (1968).

El Callao

The El Callao formation (Menendez V. de V., 1968, p. 322), with a maximum thickness of about 3000 meters is composed of amphibolitic metalavas of basaltic composition which have been metamorphosed generally to the greenschist facies and locally to the amphibolite facies. Most lavas are isoclinally folded and present pillow structures at intervals in the section. The bulk of the gold production from the El Callao district has come from deposits within this formation.

Cicapra

The Cicapra formation (Menendez V. de V., 1968, p. 322) of a maximum thickness around 2000 meters is composed mainly of porphyroblastic-actinolite-biotite schists that represent the metamorphism of basic water-laid tuffs, and graywackes, interbedded with minor amounts of volcanic breccias and agglomerates. This formation has been intruded by quartz-porphyry granite stocks that are sometimes associated with gold mineralization. The age of one of these stocks has been determined to be 1510 m.y. (Olmeta, 1968). The Cicapra and the El Callao formations constitute the Carichapo group. The Cicapra formation overlies the El Callao formation and transitionally passes into the overlying Yuruary formation.

Yuruary

The Yuruary formation (Menendez V. de V., 1968, p. 328) of estimated thickness of around 1000 meters is composed of fine-grained laminated epiclastic rocks interbedded with metamorphosed feldspathic to volcanic medium to coarse bedded sandstones. Dacitic volcanism has controlled the composition of the rocks of this formation. The formations El Callao, Cicapra and Yuruary form the Pastora supergroup.

Caballape

The Caballape formation (Menendez V. de V., 1968, p. 310). with a minimum estimated thickness of 5000 meters, is composed mainly of volcanic mudstones, graywackes, and conglomerates, with some tuffs and pyroclastic breccias. It is slightly metamorphosed, and presents only open folds in contrast with the isoclinal folding of older rocks.

Supamo

The Supamo complex (Menendez V. de V., 1968, p. 310) includes a series of intrusives acidic igneous rocks, migmatites, and quartz-feldspar gneisses that have not been differentiated but in certain instances have been observed to have discordant relationships with surrounding rocks of all types. The age of two of these discordant young bodies within the Supamo complex (Iap in the plate, back pocket) have been determined to be 2000 and 1510 m.y. old (Martin-Bellizzia and others, 1968).

Roraima Province

The Roraima province is found to the south of the Pastora province. The rocks of Roraima discordantly overlie on the volcanics of Pastora (Boletin de Geologia, 1970, p. 537), and probably over the older rocks of the Supamo complex; these rocks had been considered a formation, but recently have been raised to group status and subdivided into four formations (Allan Reid, personal communication, 1971). The most common rocks are quartz conglomerates, petromictic conglomerates, quartz sandstones, and feldspathic sandstones, with some red shales and jasper horizons. These rocks have suffered very slight metamorphism, only observable in the shales, and are normally flat lying. Extensive intrusions of diabase sills occur at several places in the stratigraphic section, and radiometric determinations have revealed ages of 1500 to 2100 m.y. (McDougall and others, 1963 and Snelling, 1963).

Younger Rocks

Some basic igneous rocks are found in the El Callao district that are not included in the general scheme of provinces described. Some metamorphosed gabbroic rocks intrude concordantly into the formations El Callao, Yuruary and Caballape. These rocks (Ibm on plate, back pocket) are predominantly exposed in synclinal structures on both sides of the Nacupai fault zone; their age has not been established.

Another group of rocks that do not fit into the described stratigraphy is made up of unmetamorphosed diabases in the form of small dikes or long fracture-filling dikes (Laguna dike), and a shallow-plate-shaped intrusion as in the mesa of Nuria (Ib on plate, back pocket). The age of these rocks has not been determined in this area, but similar rocks have been determined to the north and east to be 400 m.y. (Martin-Bellizzia, 1968, p. 363).

A very minor group of ultrabasic rocks, serpentinites and pyroxenites, intrudes the Supamo complex and the El Callao formation in the western portion of the area under study (see plate, back pocket).

GOLD DEPOSITS

The regional plot of gold occurrences outlines a band that starts in Venezuela extends ENE through Guyana, Surinam, French Guiana and Brazil, being approximately 900 kilometers long and 200 kilometers wide (Emmons, 1937, p. 293). In Venezuela production has come from El Callao, Cicapra (50 km west of El Callao), and Botanamo (100 km ESE of El Callao). The production from El Callao has been much greater than from the other two.

The gold in these deposits is found in three forms (Bernet, 1925):

1. In massive quartz veins as elemental gold.
2. In quartz veins with associated pyrite.
3. In the pyrite of sheared lavas, without quartz.

The first form is the most common one, and the mineralization is frequently accompanied by calcite and/or ankerite, and tourmaline. Hydrothermal alteration associated with the mineralization is variable, and shows that within the district there exist deposits that can be considered hypothermal, mesothermal, or epithermal (Park and MacDiarmid, 1970, p. 146-159). In some of the veins at El Callao (Newhouse and Zuloaga, 1929, p. 806), veinlets of tourmaline are common, and at Quebrada de Oro, tourmaline becomes massive, forming schorl-rock with quartz, indicating a high temperature of formation (Park and MacDiarmid, 1970, p. 178). In most veins chlorite is the most common alteration mineral together with sericite; and in others, such as La Culebra vein, the alteration reaches at least 20 meters on either side and is composed of sericite and kaolinite in approximately equal amounts.

Several authors (Bernet, 1925; Duparc, 1922; Newhouse and Zuloaga, 1929) have expressed their opinions on the origin of ore deposits of El Callao district. Bernet (1925) suggested that the deposits were formed by the injection of the products of extreme differentiation of a granitic magma, reasoning that the large amounts of jasperoid formed close to certain veins would have to come from silica-rich rocks. Newhouse and Zuloaga (1929) relate the entire gold belt, from Venezuela to Brazil, to an episode of intrusion of diabases. With the data now available it seems unreasonable and unprofitable to this author to go beyond the idea that these deposits are of hydrothermal origin.

Kalliokoski (1965, p. 85) asserts that the gold mineralization is older than the Laguna dike, while Geoscience Inc. (1966, p. A6) sustains that the evidence is not clear, and that if the relationships with other minor granitic dikes are considered, the mineralization is relatively contemporaneous with the intrusion of dikes. Neither the Laguna dike nor the granitic dikes have been dated, but dikes similar to Laguna have been dated to the north and east to be 400 m.y. (Martin-Bellizzia, 1968, p. 363).

Within the El Callao district there are approximately 250 known mineralized quartz veins. These veins are more common within the El Callao formation but are also found within the formations Cicapra, Yuruary and Caballape (Menendez V. de V., 1969), and there is no indication that there is any decrease in ore grade with distance from the center of the district (Geoscience Inc., 1966, p. E5). Quartz veins are also found within the Supamo complex but their concentration in gold is only 1 to 2 parts per million (Duparc, 1922, p. 30).

The veins that are found around the town of El Callao are of the order of several hundred meters long, although in some cases reach up to 4 kilometers. The gold is distributed irregularly within the veins and has the tendency to decrease in concentration with depth, although some exceptions are known. The veins found at Cicapra and Quebrada de Oro are less continous than the ones around El Callao, and their gold is even more irregularly distributed but of very high values (Newhouse and Zuloaga, 1929, p. 294).

In the period from 1826 to 1968 the district has produced approximately 185,000,000 grams of gold, of which nearly half came from the Viejo Callao mine (Locher, in preparation, p. 64-65), which is located under the town of El Callao. The average grade has been of 21.5 grams per ton over the district (Geoscience Inc., 1966, p. B1).

PREVIOUS GEOCHEMICAL WORK

A consulting firm, Geoscience Inc., performed some geochemical testing in the El Callao area during a 4-month period in 1966, under contract of the Ministry of Mines of Venezuela. The results of this work have been published by Nason and others (1968).

The stated objectives of this work (Nason and others, 1968, p. 38) are:

1. To discover if the gold veins could be detected by the enrichment presented by the alluvial deposits along local water courses.
2. Investigate if the presence of gold in the vegetation of the area could be used as an indicator in geochemical exploration.
3. To determine the dimensions of gold haloes over gold veins.
4. To evaluate the sensitivity, efficiency and cost of exploration processes in order to select the most adequate one.

Samples of sediments and plants were taken along a water course before, over, and after crossing a known mineralized vein. Samples of soils were taken across several known mineralized veins at intervals of 50 meters. The sediments and plants were analysed for gold by atomic absorption and neutron activation (Nason and others, 1968, p. 32). The soils were analysed for heavy metals (CXHM) by cold extraction

(Bloom, 1955), for Au and Ag by atomic absorption, and for Au by fire assay after a preconcentration of heavies by panning.

The stated conclusions of this work (Nason and others, 1968, p. 39) are:

1. The gold can be detected in soils and sediments by different analytical techniques. With some of these techniques determinations can be carried out directly, and with others preconcentration is necessary.
2. High concentrations of gold in sediments of water courses are related to known gold veins in a dispersion pattern modified by surficial processes that may attenuate or displace the gold halo downstream.
3. The gold content of plants does not bear any relationship to the concentration of gold in the soils over which they grow.
4. Silver anomalies apparently have some relationship to the high gold contents.
5. Cold-extractable-heavy metals values cannot be consistently correlated with auriferous veins.
6. The best pattern for geochemical soil sampling for the detection of auriferous veins is considered to be the sampling of every 25-meter interval along lines 500 meters from each other and perpendicular to the regional strike.

In 1970 (Ramon Bisque, unpublished report) another geochemical reconnaissance was reported. This work, representing a 3-day reconnaissance included:

1. Collection and analyses of soil samples over the geological formations described in the area to establish a background or reference.
2. Collection and analyses of samples over the Nacupai fault zone to test the possible relationship of the fault zone to the mineralization.
3. Collection and analyses of samples across two known veins to test for possible indicator elements.

Data on the content of Cu, Pb, Zn, Hg, and Au were reported.

The indications of Bisque's work were:

1. Hg in the fine fraction of soils does not appear to have a direct relationship to mineralization, although Hg is high on either side of veins in certain cases.
2. Trace Cu and Zn in the fine fraction of the soil present broad anomalies which would be useful in regional geochemical prospecting. Pb, Ag and Mo appeared to have no useful relationship to mineralization.
3. The Nacupai fault zone is low in those metals that appear to reflect mineralization in adjacent areas.

Bisque's report included data that disagreed with the work of Nason and others (1968); specifically the relationship of Cu and Zn with the mineralization, and also raised some fundamental questions that have guided the objectives of this author's work.

DISCUSSION AND INTERPRETATION OF RESULTS

In this chapter the analytical data generated by this work will be related to the regional geology and known areas of gold mineralization in order to establish the basis for a dispersion model of chemical elements close to the zone of Au deposition. This model is then extended, by analogy, to levels of dissection removed from the zone of Au deposition in the direction of assumed flow of hydrothermal solutions (generally upward).

The model, developed entirely on the basis of this work's analytical data, will be compared to similar models developed by other authors and rationalized on the basis of principles of coordination chemistry.

The geologic map of the area studied with the location of samples are found in the plate (back pocket), sample collection, analytical methods and manner of presentation of data are described in the appendix (p. 50).

Traverses

Yuruary-El Peru-Mocupia

This traverse was selected as a regional guide to the variation of elements in soils because it cuts the Nacupai fault zone, the veins of several important mines close to the town of El Peru, and the complete section of El Callao formation (for location see the plate and graph N^o 1, back pocket).

In the portion of this traverse represented by samples 580 to 632, the veins of the Laguna mine, the D lode, the Austin mine, the Chile mine, and Cenicero are located. If this section is compared with regions on either side in the traverse, it can be observed that the Cu in the central region is generally higher than 120 ppm (122 ppm Cu is the average for the whole traverse); Pb wherever detected, is found to be very closely associated with the intersection of the known vein with the surface; Zn is commonly associated with Pb, but not always; Mn forms a pronounced high concentration area over the whole central region and falls off on either side; V is closely related to Mn in behavior, but does not show the variability of Mn; Ni and Co follow Mn and V in their local fluctuations, but regionally they do not show any appreciable increase or decrease within the area under consideration.

Within this section of the traverse, samples 590 to 600 and 627 to 634 were selected for Hg and Au analyses. Sample 597 in the first group and samples 628, 630, and 631 in the second group, were found to contain appreciable Hg (0.5 to 0.6 ppm); and samples 590, 591, 595 and 600 in the first group and 630 and 632 in the second group were found to contain appreciable Au. In the first group of samples, taken across the Laguna and "D" lode veins, the Hg and Au do not coincide in position, while in the second group of samples taken over the Cenicero vein they are roughly coincident. From this observation it becomes evident that the known mineralization is related to, and is shown by, Hg and Au, and also that the relationship is not one of coincidence. Since the outcrops of these veins is generally not known with precision, it is not possible, just from this case to determine if, and how much, either Hg and/or Au are displaced from the veins by weathering phenomena.

When the present topographic surface dissects the mineralization within the zone of gold deposition, the analyses of soils developed on that surface show broad anomalous high concentrations of Cu, Mn, and V and localized anomalous high concentrations of Pb, Zn, Au and Hg.

The area just considered, around the town of El Peru is the best known. Other sections of the traverse Yuruary-El Peru- Mocupia having similar characteristics to it were selected for Hg and Au analyses. The section represented by samples 178 to 196 is not related to known mineralization (see graph No. 1, back pocket), has relative highs in Cu, Pb and Zn; a very high anomaly in Mn dropping to very low values; a regional high in V, Ni, and Co; and samples 190, 191 and some other soil samples taken close to them outside the traverse, contain around 200 ppm As. This section is within the Nacupai fault zone and has most of the characteristics of known mineralization to the south plus the anomalous As. As seen in the print out (back pocket), the Hg content of these samples is appreciable all along the section, but Au is not detected.

Two other sections, represented by samples 212 to 217 and samples 224 to 232 have similar characteristics to the known mineralized zone of El Peru. Hg analyses indicate again anomalous contents, and again Au is not detected. At this point it looks as if Cu, Pb, Zn, Mn and V could be incidental to the mineralization around El Peru.

Another section within the Yuruary-El Peru-Mocupia traverse, related to a mineralized vein discovered by this work sheds much light on the problem of surface geochemical expression of the mineralization in this region. This section, represented by samples 246 to 553, is within a minor regional high in Mn, an anomaly in Pb and Zn, low values of Cu, and fluctuating values of Ni and Co. Hg in these samples increases towards the center of the anomaly (around sample 256) reaching a high of 10 ppm, and drops slowly towards the south. Au also increases dramatically from 0.00 to a maximum of 3.45 ppm at sample 256, and falls off again to the south. Sample 256 is also unique in that it was the only sample, of all samples collected for this work, where Ag was ~~detected~~ (approximately 1 ppm).

The author interprets the above results to mean that the Yuruary-El Peru-Mocupia traverse crosses several mineralized areas that are dissected by the present erosional surface at different levels with respect to the mineralization of Au and its attending haloes of associated elements. It seems as if the portions of the Yuruary-El Peru-Mocupia traverse that have been considered in this chapter represent: 1) A mineralization dissected by the topographic surface within the region where gold was originally deposited by hydrothermal solutions in the section of samples 246 to 553, 2) a mineralization dissected close to the top of the regions where gold was originally deposited in sections represented by samples

590 to 600 and 627 to 634, and 3) mineralizations dissected much above the region of gold deposition in sections represented by samples 178 to 196, 212 to 217 and 224 to 232.

With the above interpretation in mind, it seems also reasonable to consider the section represented by samples 172 to 222 (see graph N° 1, back pocket), which crosses the Nacupai fault zone, as an example of a mineralized zone of large proportions which is dissected at a level far removed from the deposition of gold. This interpretation is supported by the striking symmetry shown by the concentrations of Mn which are extremely high at both ends and very low in the middle. This symmetry is shown by high and low concentration of V, Ni and Co. In each case the lows are coincident around samples 199 to 203 and highs are at different regions for Ni and Co, Mn and V.

A brief consideration of every traverse studied in the light of the above interpretation is considered useful and follows.

Laguna Dike

The Laguna Dike traverse was selected because it cuts the Nacupai fault zone over topographically low terrain and cuts the Laguna Dike which has been mentioned to be of importance in its association with the Au mineralization (see the plate and graph N° 3, back pocket). This traverse shows an extensive central area of low values of Cu, Mn, V, Ni and Co. On either side of this central area the value of all elements increases appreciably. It may be that the soils of this area are developed substantially on materials of the valley floor (very few outcrops are to be found along the traverse), and at places rounded pebbles of quartz are observed and represent older sedimentation products of a large area. The high concentration of elements to the south is probably due to the fact that the traverse leaves the alluvial flat and covers soils developed on the El Callao formation. The high values towards the north are probably due to the removal of alluvial-flat material by erosion as seen by the appreciable topographic slope developed at this end (rock outcrops are first seen at this end around sample 328).

Puente de El Callao

This traverse was selected because it cuts across the Nacupai fault zone at its greatest development and is close to the El Viejo Callao mine (see the plate, and graph N° 2, back pocket).

The section of the traverse that corresponds to the fault zone is characterized by low values of Cu, Zn, Co, Ni (with some fluctuations), Mn, and V. The section of the traverse that is outside the fault zone is characterized by higher values of all elements except Pb. This situation is very similar to case 3 (p. 22), where the mineralization is dissected much above the region of gold deposition, but here only one side of the anomaly is detected. It is predicted that the other side of the anomaly would be detected by extending this traverse to the south. It is interesting to note here that the El Viejo Callao mine, the richest mine of the area, is located 400 meters to the south and 400 meters to the west of the southern end of this traverse, under the town of El Callao.

Some differences between this traverse and case 3 (p. 22) of the traverse Yuruary-El Peru-Mocupia that may be of importance are the developments of higher values of Cu, Ni, and Co. These differences are not caused by higher values of the elements in the gabbroic rocks, since part of the traverse of case 3 (p. 22) is also developed in these rocks, and do not show such high values.

Pela Bollo

During the regional collection of samples for background study it was noted that in a new road cut the lavas of El Callao formation were fractured and slightly sheared (see the plate, back pocket). Since mineralization is thought to be controlled by sheared zones within El Callao formation (Bernet, 1925; Menendez, 1969), this traverse was located to discover a possible anomaly. In graph N° 4 (see the plate, back pocket, for location) an anomaly in the contents of Pb, Mn, Ni and Co is easily detected in the central region. This anomaly is interpreted to indicate mineralization dissected just above the region of gold deposition, since gold has been detected (0.10 ppm) in samples 333 and 334.

This interpretation is not completely satisfactory because towards the SW end of the traverse an anomalous region of low concentrations is detected that could point towards the center of a large fault zone, shear zone, or mineralization zone. Unfortunately, the scarcity of outcrops does not permit any detailed geological work, and much longer traverses would be needed to clarify the situation. On the other hand, because of the lack of outcrops, regional geochemical traverses would probably be the most economical way to effectively prospect for gold mineralization in this region.

Maestre Vein

This traverse was selected because it is found completely within the Yuruary formation (see the plate and graph N^o 5, back pocket) and cuts across a quartz vein with abundant tourmaline between samples 374 and 375, a larger quartz vein without tourmaline attendended by jasperoid and smaller veinlets around sample 378, a quartz vein at sample 394, and a shear zone around sample 385.

Within the immediate area there are several small mines operating, but the veins described in this traverse have not been worked and their gold content is unknown. The traverse was selected for the purpose of evaluating the ability of the soil geochemical method, as used by the author, to detect undisturbed quartz veins within the Yuruary formation.

The quartz vein that contains abundant tourmaline, thought to be formed at high temperature, is indicated geochemically in soils by a modest increase in Co, while Pb is low around the vein, and the other elements studied are close to average. This situation is interpreted to mean that the vein is dissected at a low level where Pb would not be precipitated.

The quartz veins around samples 378 and 394 are indicated clearly by high Pb concentrations, while the rest of the elements studied do not clearly show any relationship. This lack of apparent relationship is probably caused by a combination of factors; the expression of veins and mineralization is probably different within the Yuruary formation as compared with the mineralization within El Callao formation (see La Culebra traverse, p. 27), the direction of the traverse is roughly perpendicular to the tourmaline containing vein but not to the other features, and the traverse is not long enough to portray the regional fluctuations of concentration of elements. Again, as in the Pela Bollo traverse (p. 24), it becomes evident that at least a relatively long traverse, say 3 to 4 kilometers, is generally necessary through any specific area to give enough background for confident interpretation of small features like veins.

The shear zone around sample 385 is indicated modestly by detectable values of Pb and Zn, and by high values of Co, Ni, V and Mn. This shear zone is interpreted as an indication of mineralization at depth, similar to case 3 (p. 22), where quartz and gold are not detected but associated elements present a definite anomaly.

La Culebra

This traverse (see the plate and graph N° 6, back pocket) was selected because it is found completely within the Yuruary formation and cuts across La Culebra vein which has produced some Au in the past and which is characterized by hydrothermal alteration to white-cream sericite and kaolinite for 20 meters on either side of the vein. This hydrothermal alteration is unique within the known El Callao district and is taken to represent a large temperature difference between hydrothermal solutions and surrounding rocks (Parks and MacDiarmid, 1970, p. 146-159).

The outcropping La Culebra vein is shown geochemically by high concentrations of Pb, Cu, Ni, Mn, and V giving support to the expression of known mineralization found close to the town of El Peru. The outstanding feature of this traverse is that it shows much lower values for background concentration than all other traverses, while the relative order of magnitude of the anomalous values over background is kept constant for all elements, excepting Cu which is not a good indicator elsewhere.

All samples of this traverse were selected for Hg and Au analyses. Hg is found in appreciable concentrations (see print out, back pocket) close to the vein, but not directly above it. Au shows the vein very clearly, but some of the high values could be due to surface scattering of mine material (a piece of quartz left at the surface contained 0.70 ppm Au, and the kaolinite-sericite alteration 1.05 ppm Au). Notice that there is another major anomaly centered at sample 477, and two minor anomalies centered at samples 473 and 488; all these are shown by lower Au concentrations.

This traverse is interpreted as dissecting auriferous veins within the region of gold deposition. The lower concentration of elements with respect to other traverses studied is interpreted as being caused by effective leaching of hydrothermal solutions which can be more active at low pressures (Park and MacDiarmid, 1970, p. 41) because of increased porosity and permeability.

Another effect that may be important in determining the extent of hydrothermal alteration at low pressures is the probable availability of more water obtained by mixing or recirculating with surface waters, and hence being able to leach more thoroughly.

Quebrada de Oro

This traverse starts within the quartz-porphyry granite stock of Mandingal and cuts across a known mineralized zone located at the contact of the stock with the Cicapra formation (see the plate and graph N° 7, back pocket). The traverse does not pass through the main mineralized zone because this zone was much disturbed (practically turned over) during the mining operations around the start of this century.

This location was selected to evaluate the surface geochemical expression of a gold mineralization as shown by soils developed in a savanna environment. Unfortunately the comparison will not be a good one since the type of mineralization here is different from the mineralization found around the town of El Callao. Here the quartz veins are discontinous (Newhouse and Zuloaga, 1929, p. 294; Juan Boada, 1971, personal communication), and much richer than around El Callao. In graph N° 7 (back pocket), samples 404 to 409 represent background over the quartz-porphyry granite stock; the mineralized area is indicated by high values of Pb, Co, Ni, V and Mn, very much like at El Peru and La Culebra. The section of the traverse represented by samples 410 to 452, was selected for Hg and Au analyses. The Hg content shows an anomalous interval in samples 410 to 446, and again in sample 449. The Au content fixes the mineralized zone at samples 415 and 446.

This traverse is interpreted as dissecting the mineralization near the top of the zone of Au deposition in the known mineralized area. The two other anomalies around sample 405 and samples 455 to 457 are similarly located, and should be investigated. The lack of symmetry displayed by the haloes around the mineralized zone, samples 410 to 451, probably indicate the lower permeability of the quartz porphyry with respect to the metasediments of the Cicapra formation.

Carichapo Fault Zone

This traverse was selected (see the plate and graph N° 8, back pocket) for comparison with the Nacupai fault zone. The traverse is all within the Yuruary formation, but within the traverse vein quartz and jasperoid form the only outcrops observed except for an outcrop of Yuruary in the Carichapo river bed.

If the geological information of regional character presented by Menendez V. de V. ("no date", circa 1970) in his map of the Guasipati region is valid in detail, and it is used to interpret this traverse, the undisturbed Yuruary formation (samples 501 to 552) would present an area of very low background values of the elements studied, and the fault zone itself would be shown by a zone of high values of Cu, Pb, Co, Ni, V and Mn. The high values represented by samples 544 to 550 at the southeastern end of the traverse would similarly indicate a fault or a mineralized zone.

The sections of this traverse represented by samples 517 to 522 and 539 to 540 were selected for Hg and Au analyses, samples 519, 520, and 521 (see print out) are the center of a Hg anomalous area; and samples 539 and 540 show no detectable Hg. Au has not been detected in any of these samples.

It is interesting to note that the fault zone is detectable by surface geochemical methods. This detection seems to hinge on the fact that the fault zone has been invaded by veins of hydrothermal origin that display surface geochemical expressions entirely similar to the auriferous veins of the region. Assuming that these veins are mineralized with Au, the anomalous sections of this traverse (samples 517 to 522, 502 to 504, and 545 to 549) are interpreted as dissecting the veins somewhat above the region of Au deposition. It may well be worth investigating the matter since a find in this area would make the whole fault zone a possible target.

Weathering

Samples of rocks of the different geologic formations and of soils developed over them were taken during this study. It should be possible then to give an idea of background values, or ranges, for the trace elements studied for the rocks and for the soils, and also to determine the effects of weathering. In the appendix (p. 54) and in the plate (back pocket), selected data for each formation are presented, and the location of samples can be found; it would be noted that the samples of rocks and soils do not correspond to the same localities, so that only tendencies of the effect of weathering can be pointed out. Some of the samples will be located on traverses.

Since the samples collected come from a mining district, the problem of separating those that come from mineralized areas is definitely present. In the appendix (p. 54) those samples that are thought to be influenced by mineralization are distinguished.

Taking into account the limitations mentioned above, it still seems reasonable to conclude that Cu is depleted in the top 10 centimeters of soil around 3 times in terms of concentration with respect to the rock from which the soil is developed. Pb is in general concentrated in the same part of the soil with respect to the rock around 2 times. Zn is depleted from the rock to the same interval (top 10 centimeters) of the soil, but a semiquantitative idea of the dilution factor is not possible since the Zn content of soil is most times lower than the detection limit of the method used. Mn is depleted to about half the amount present in the rock, while Ni is depleted to around one fourth the amount present in the rock. Co seems to maintain roughly its concentration while the rock is transformed to soil.

Although the distribution of major elements during tropical weathering has been studied for several types of rocks (see for example Harrison, 1933; and Pasquali, Lopez and Meinhard, 1972), it would be useful to study in detail the effect of weathering on Co because of its apparent constancy and its association with hydrothermal ore deposits.

To determine the effect of vegetation type, jungle or savanna, over the expression of mineralization in soils was one of the purposes of this study. The distribution of the gold veins did not permit a comparison between the two environments while keeping every other important variable constant.

Most traverses were localized in jungle, except Quebrada de Oro and the Carichapo fault zone. At Quebrada de Oro mineralization is not of the same type as the one found close to the town of El Callao and hence not comparable, but because of a general gross similarity of results here and at the Carichapo Fault Zone it is concluded that for Cu, Pb, Zn, Mn, V, Ni, Co, Hg and Au in going from jungle to savanna the general pattern of expression of mineralization in soils is maintained.

Dissection Levels

The analysis of the analytical data and their relationship with known mineralization leads the author to propose an integral model that explains all anomalies observed.

It is envisioned that the hydrothermal solution, traveling in a certain direction going down a thermal gradient (probably towards the surface from depth), will deposit quartz first (perhaps together with tourmaline), then Au, Ag and Hg together, then Cu, Ni and Co, then Pb and Zn then As, and finally Mn and V.

The process is to be considered continuous, although quartz is deposited first it is still deposited up to the main zone for Pb and Zn. Mn, for example, starts its deposition with quartz and Au, but its main release from solution occurs when most other metals have precipitated; in consequence it would have traveled farther laterally and vertically so that it should potentially show a much wider anomaly than elements that precipitate mainly before (at higher temperatures).

The precipitation order outlined above includes only the elements that have been considered in this work. When its relationship with chemical principles is attempted, an idea of how other elements would behave will be presented (p. 39). On the other hand, within the elements studied, there may be a change in order of deposition because of large variations of concentration. A given element may be too dilute to be able to precipitate at a certain temperature-pressure-ionic strength field, or another element that forms minerals which readily accept it in their structure may be of such high concentration that it will precipitate the given element before its customary order.

A schematic representation of the model outlined above

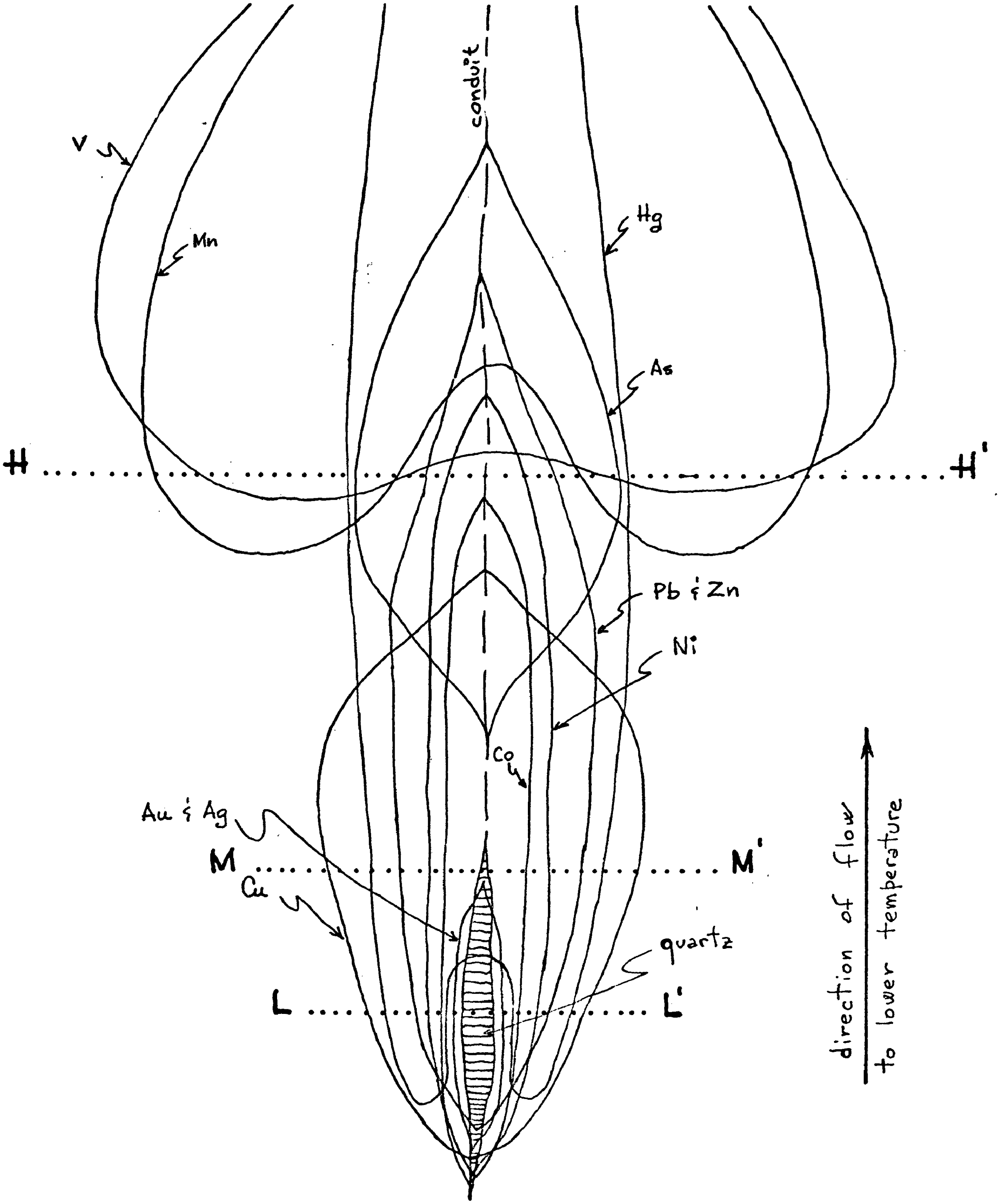

Figure 3. Cross section. Schematic representation of the relative positions of maximum concencentration of elements in a hydrothermal system around its conduit as shown in soils. Dissection levels shown in detail in figures 4,5 and 6.

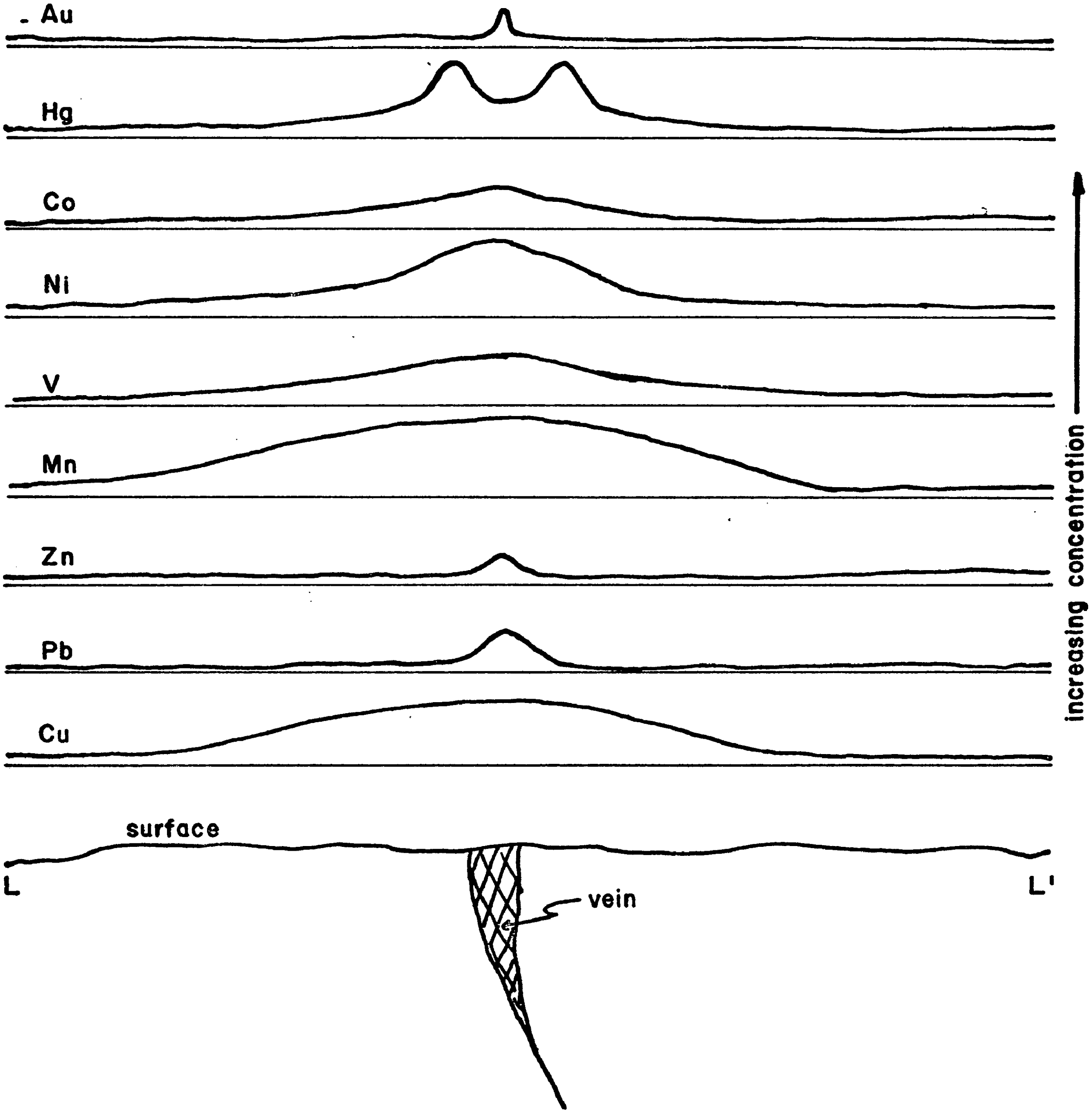

Figure 4. Cross section. Generalized soil anomaly over mineralized vein dissected within zone of Au deposition.

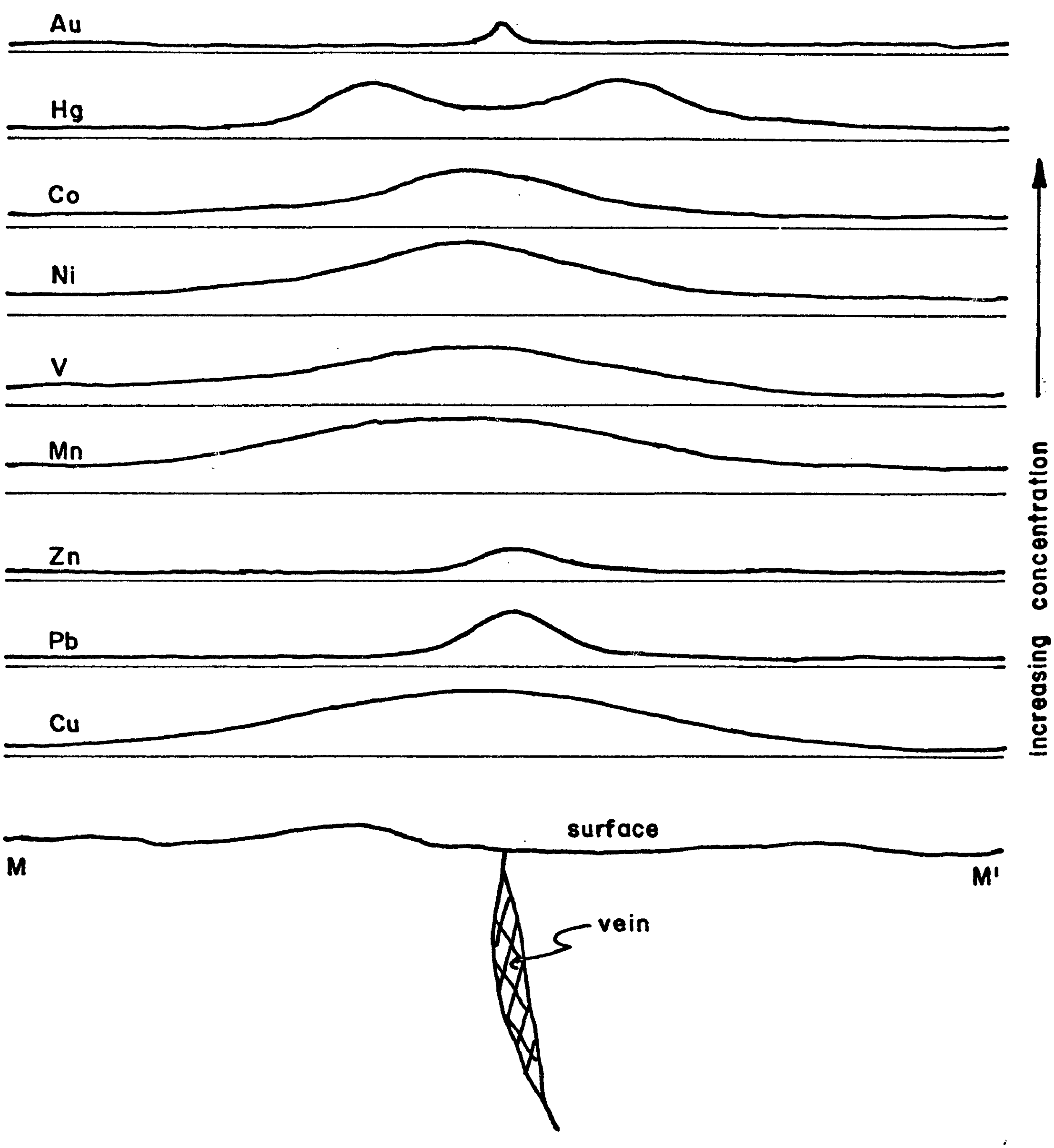

Figure 5. Cross section. Generalized soil anomaly over mineralized vein dissected just above zone of Au deposition.

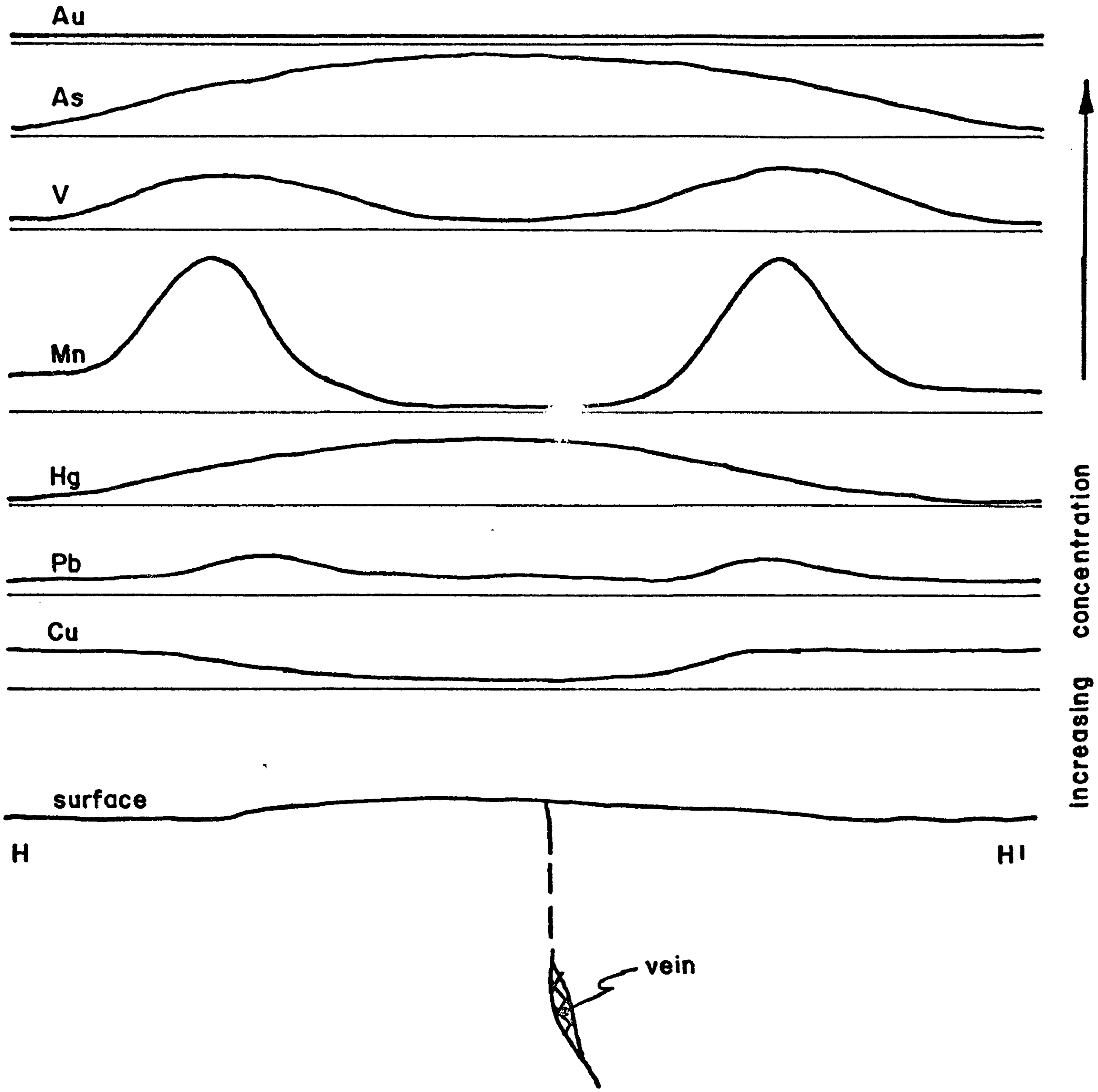

Figure 6. Cross section. Generalized soil anomaly over mineralized vein dissected well above zone of Au deposition.

is shown in figure 3 (p. 34), where the regions of maximum expected concentration of each element studied are drawn. If sections at different levels are drawn across the diagram, the change of an anomaly of a given vein with erosion level can be clearly envisioned (see lines H-H', M-M', and L-L', p. 34). A generalized anomaly for each erosional level is shown in figures 4, 5 and 6 (pages 35, 36 and 37).

This same sort of distribution of elements has been recognized and used for prospecting by Polikarpochkin and Kitaev (1971), and Ovchinnikov and Grigoryan (1971).

Ovchinnikov and Grigoryan have attemped to describe a zoning order within haloes for most types of sulfide deposits and distinguish between lateral and vertical zoning. Polikarpochkin and Kitaev consider the haloes of epithermal gold-bearing deposits and equate the zoning in the horizontal and vertical directions (1971, p. 382). The main features of these last authors' work are in agreement with this work's model as shown by figure 3 (p. 34), namely the high-temperature position of Au and Ag, subsequent positions of Cu, Pb, and Zn.

The addition of Mn and V into the model (see figure 3, p. 34) extends considerably the known effects of hydrothermal action towards the low temperature field and makes it more useful for geochemical prospecting in two respects. First, the expressions of hydrothermal action are recognized at a greater distance (generally upward from the deposit), and would discover deep-seated deposits. Second, the expressions of hydrothermal action become wider as they represent lower temperatures and their usefullness for regional prospecting is proportionally enhanced.

Theoretical Considerations

Water at high temperatures

It is known that as the temperature of water is changed certain of its properties vary considerably. Of influence on ore deposits is its decrease in dielectric constant and decrease in viscosity with increased temperature. If ionic solutes are added to water, such as NaCl, there will be another decrease in bulk dielectric constant that depends on the ionic strength of the solution and the kinds of ions in it (Hasted, Ritson and Collie, 1948). The subject of water at high temperatures has been treated in a general way by Cobble (1966), and more recently in its pertinence to ore forming solutions by Bisque, Pasquali, and Pyrih (in preparation).

In essence, the decrease in dielectric constant with temperature has the effect of favoring the solubility of less polar covalent compounds and the association of ions into uncharged species (Prue, 1958; Kraus and Raridon, 1959). The first effect is related to the fact that substances will dissolve in like substances, and as the dielectric constant of water decreases, the water will become a better host for covalent-bonded chlorides and sulfides of ore metals. The second effect is due to the increase in attraction of ions in solution due to Coulomb's Law when the dielectric constant of the medium is decreased,

$$F = \frac{z_1 \, z_2 \, e^2}{\varepsilon \, d^2}$$

F is the force of attraction of unlike charges, z_1 and z_2 the number of unit charges e per ion, d the distance between centers of ions, and ε the dielectric constant.

The ion pairs formed can then be stabilized in solution by coordinating with adjacent $-O^-$ and $-OH$ groups of silicates which in solution are present as small chains and plates surrounded by these groups.

This is undoubtly an extremely simplified presentation, and the reader who wishes a more complete treatment is referred to Bisque, Pasquali, and Pyrih (1972, in preparation).

Polar-covalent bonds

Ore deposits described as being of hydrothermal origin typically contain a relatively small number of elements that are concentrated in these deposits. The relative abundance of these elements in these deposits varies from deposit to deposit, and regularly within the same deposit, but their association as a group is stricking. Within the periodic table these elements should have been separated by their distinct chemical behavior, and so they have been.

In coordination chemistry the stability or facility of formation of complexes of metals with different ligands is modernly viewed in terms of elements of classes (a) and (b) Ahrland and others (1958), or in terms of hard and soft acids and bases (Pearson, 1953).

Ahrland and others (1958) classify electron acceptors as (a) type if they form stable complexes with ligands of the first group of the periodic table (C, N, O, and F), and of (b) type if they form stable complexes with elements of the second or subsequent groups (P, S, Cl, As, Se, Br, ect.). Elements of type (a) are not polarizable, generally small, and in a high oxidation state; typical examples are Na^+, K^+, Ca^{++}, Mg^{++}, Y^{+++}, and Fe^{+++}. These elements or ions will prefer to combine with nonpolarizable, highly electronegative elements or anions such as N, $O^=$, and F^-. Elements of type (b) are polarizable, generally large, and in low oxidation states; the most typical are Rh, Ir, Pd, Pt, Au, Cu^+, Hg^{++}, and Tl^+. These elements or ions combine readily with polarizable elements or anions such as P^{-3}, S^{-2}, Cl^-, Se^{-2}, ect. There is an intermediate group of elements of which the most typical are Cu^{++}, Pb^{++}, Zn^{++}, Fe^{++}, Co^{++}, Ni^{++}, Mo^{++}, and Mn^{++}. Notice also that a given element can be of (a), (a+b), or (b) character depending on its oxidation state.

Pearson (1963) views the reaction of metals to form complexes as examples of reactions between Lewis acids and bases. Acids are then classified as hard or soft, and these are roughly comparable to class (a) and (b) elements respectively; bases are similarly classified as hard or soft, and these are comparable to the ligands of the first group, and ligands of the second or subsequent groups respectively. Also in this scheme border line cases are found for acids and bases.

The study of the chemical behavior of all bases and acids indicates that hard acids react easily with hard bases, soft acids react easily with soft bases, but that a hard acid with a soft base or vice-versa do not produce stable compounds. This behavior is explained with defferent success by different theories namely ionic-covalent, π-bonding, electron correlation, and solvation (Pearson, 1963, p. 3537).

It is seen that hydrothermal ore deposits are formed by the geochemically abundant elements of class (b) plus elements of class (a+b), or by soft acids and soft bases plus borderline cases of acids. The order of deposition of elements from high to low temperature seems to follow diminishing (b) character from Au, Ag, Cu^{+}, Hg^{+}, to Cu^{++}, Fe^{++}, Pb^{++}, Zn^{++}, Ni^{++}, and Co^{++}. Mn, one of the elements studied in this work, would be expected to behave very similarly to Fe^{++} (but having to compete with Fe^{++} for the base), since it is assumed to be present as Mn^{++} in hydrothermal solutions, and have (a+b) character. V, presumed to be present as V^{+++} in hydrothermal solutions whould have (a+b) character, but a bit more (a) character than Mn^{++} since its oxidation state is higher, and would therefore be deposited at lower temperatures. As^{+++}, which is considered a hard acid (Pearson, 1963, p. 3534), should be deposited at low temperatures far removed from Au; its seemingly abnormal position with respect to Mn and V may be due to its low overall concentration in the system (Mason, 1966, p. 23), and/or to its more nearly equal electronegativity to sulfur (Cotton and Wilkinson, 1967, p. 103). Figure 3 (p. 34) shows an order of deposition consistent with the analytical data and with the above discussion. The order of deposition mentioned can also be rationalized in terms of increasing polarity for the covalent bond between sulfur or chlorine and the metals.

Au and Ag involve metallic bonds instead of covalent bonds and seem to be out of place. On the other hand it is known that soft bases such as S^{-2}, Se^{-2}, and Te^{-2} coordinate with metals of strong (b) character in their zero oxidation state (this is the way that metallic catalysts are commonly poisoned), it may be that these noble metals are transported at high temperatures by neutral complexes of uncharged character (Au, nH_2S).

Hg which is of strong (b) character would be deposited at high temperatures, but it is found at all levels of dissection of mineralization. It is postulated that its distribution is also controlled by the fact that it is easily reduced to metallic Hg and in this state it is very volatile and exceeds the hydrothermal solutions in fluidity.

ANOMALIES OF ECONOMIC IMPORTANCE

During this study several anomalies were found over suspected and unknown mineralized areas. Some of them have characteristics that make them good prospects for immediate drilling, and others, whose economic importance is a matter of opinion and depends on the interpretation of data. Before drilling, it is recommended that for all anomalies located by just one traverse, additional lateral traverses be run to find the center of the anomaly.

Anomalies that clearly represent Au mineralization that is found close to the surface are the sections represented by samples 246 to 553 within the Yuruary-El Peru-Mocupia traverse and by samples 475 to 479 within La Culebra traverse. It is expected that shallow drilling at these sites will locate gold-bearing veins.

Anomalies that are interpreted as being above Au mineralization but not far removed from it (an estimate would place them at 100 to 200 meters) are listed below:

Samples	Traverse
226-230	Yuruary-El Peru- Mocupia
240-242	"
556	"
561	"
636-641	"
662-664	"

Samples	Traverse
677-679	"
694-695	"
267-273	Puente de El Callao
276-278	"
359-361	Pela Bollo
340-354	"
376-379	Veta Maestre
384	"
405	Quebrada de Oro
455-458	"
518-520	Caríchapo Fault Zone
546-549	"

It is expected that intermediate drilling at these sites would find Au mineralization. A regional exploration program should drill a few of the most extended anomalous sections to test the correctness of this interpretation.

Anomalies that are interpreted as reflecting mineralization at considerable depth are the sections represented by samples 174 to 224 within the Yuruary-El Peru-Mocupia traverse and samples 270 to 466, and to the south, within the Puente de El Callao traverse. Before doing any drilling at these sites, regional extension of these anomalies should be studied, because only deep boreholes are expected to find mineralization. On the other hand, these are large anomalies that because of their position resemble most the very rich mine of El Viejo Callao.

CONCLUSIONS

The analysis of geological, geochemical and chemical data presented in this work has led the author to draw four main conclusions:

1. The geochemical surface expression of the gold mineralization of El Callao district varies greatly with the level of dissection presented by today's surface. Au, Ag, Hg, Pb, and Zn, in that order characterize the mineralization if dissected through the zone of gold deposition. As, V, and Mn characterize the mineralization if dissected well above the zone of gold deposition. Intermediate dissection levels will be shown by a combination of elements of the two levels, and would commonly include Cu, Ni, and Co.
2. The El Callao mining district is by no means considered explored, and the several anomalies outlined in this work prove that it deserves an investment in a comprehensive exploration program.
3. Within the El Callao district two types of vegetation are found, jungle and savanna. If soil samples are collected in such a way so as to evade lateritic crusts, the general pattern of expression of mineralization is maintained going from soils developed within a vegetation type to the other.

Cu, Zn, Mn, and Ni are generally depleted in the soil with respect to the rock on which the soil develops, while Pb is concentrated, and Co remains essentially the same.

4. The apparent order of deposition of elements, from high to low temperature, within a hydrothermal system, can be explained by considering the chemical system formed by a solvent of changing characteristics and solutes that fit more or less comfortably in it depending upon the type of bonds that form them.

   As the temperature of water is increased its dielectric constant is lowered and charged ions will tend to associate to form uncharged species. The water will also lose some of its effective polarity and become a better solvent for polar-covalent compounds such as silicates and sulfides.

   As the temperature of water is decreased, these polar-covalent compounds will precipitate in an order that depends on their (b) character and on their concentration in solution. An approximate order for El Callao district is Au, Ag, Hg, Cu, Pb, Zn, As, Mn and V; and it is not expected to change grossly for hydrothermal deposits in general.

RECOMMENDATIONS

It is felt that on the basis of the present work several suggestions for further work are in order:

Field

1. Extension of the study of the surface geochemical expression of hydrothermal mineralizations to include other elements such as Si, Cr, Ti, S, and Cl to see how they fit into the haloes.
2. Study within the El Callao district the location of unfound mineralization by geochemical soil sampling using Mn, Hg, Pb and Au as indicator elements of different mobilities.

Laboratory

1. Study the effects of ionic strenth at high temperature on the dielectric constant of ionic solutions.
2. Study the effects of the change of dielectric constant of the

solvent on the solubility of ionic, covalent, and polar-covalent compounds of different combinations of oxidation numbers of the constituent atoms.

3. Study the possibility of uncharged soluble complexes of the metals Au and Ag with soft bases in water at high temperatures.
4. Study the solubility variation of SiO_2 (total) with different concentrations of ions common to hydrothermal fluid inclusions.
5. Study the solubility variation of common metal sulfides with different concentrations of SiO_2 (total).

APPENDIX

Collection of Samples

This work is based upon results of analytical work done on samples of soils and rocks taken along traverses across known and suspected auriferous veins, across fault zones, and irregularly over all geologic formations within the 8000 square kilometers covered by the geologic map of Menendez V. de V. ("no date", circa 1970).

Eight traverses were sampled, the position of each traverse is shown in the plate (back pocket) together with the number of samples involved (print out, back pocket). Traverses were first established by cutting small paths with machetes, and were then surveyed geologically and sampled. Typical information gathered for every 50-meter interval was distance from origin of traverse, direction of traverse, mean slope in degrees from the horizontal, maximum slope direction, rock type, presence of vein quartz, shearing, hydrothermal alteration, presence of prospecting pits, houses, water courses and their directions of flow, and type of vegetation.

Along traverses, one soil sample was taken to represent every 50-meter interval. Each sample was made up of four subsamples taken roughly at 12.5-meter intervals. The subsamples, approximately equal in size, were collected on a sheet of plastic, broken up, and quartered at the end of each interval, and put into numbered plastic bags. Soil samples were taken at a depth of 10 to 15 centimeters where, in most instances, the visible organic matter had greatly diminished or disappeared.

The rock and soil samples over all geologic formations of the area were collected in an irregular fashion dictated by easy access, reduced chances of contamination, and distance from other equivalent samples taken. The location of these samples is shown on the plate (back pocket).

Analytical Methods

The content of the elements Be, W, Bi, Mo, Sn, Hg, Au, Ag, Cu, Ni, Pb, Zn, As, Mn, and V was estimated by emission spectrography using a variation of a comparative method described by Ward and others (1963, p. 91-94). Most adaptations of the method were taken from Larry Jennings of Earth Sciences Inc. of Golden (1971, personal communication).

Air-dried soil samples previously passed through an 80-mesh plastic screen were hand pressured into a lower graphite electrode (National, AGKS, L 4309) 1/4-in. in diameter with a thin-walled cup of 6 mm, set against an upper electrode (National, AGKS, L 4303) 1/8-in. in diameter with a 120° point, burned for 10 seconds without any preburn in a 1.5-meter Jarrel-Ash Wadsworth-mounted grating spectrograph, at 10 amperes and 220 volts d.c., and using no filter. The spectrum was recorded on Kodak SA #1 film. The spectra of samples were compared visually with the spectra of standards using a comparator with 20X magnification. The standards were constructed diluting commercially available mixtures of spectroscopically pure compounds with spectroscopically pure quartz. It has not been found necessary to mix the samples with graphite because, for the type of samples studied, the matrix changes do not introduce larger errors than the visual comparisons.

The observed limits of detection (in parts per million) by this method for the elements studied and lines used are as follows: As, 200; Pb, 5; Au, 5; Hg, 5; Mn, 10; Bi, 20; Cu, 1; Ag, 1; Be, 100; Zn, 50; Ni, 20; Co, 20; V, 20; Sn, 50; Mo, 20; and W, 100. The standards were prepared in the following concentrations in parts per million (ppm): 0, 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, and 5000.

The elements Be, W, Bi, Mo, Sn, Hg and Au were found to be below the limit of detection of the emission spectrography method described in all samples of soils and rocks. Of those elements Hg and Au were considered of critical importance for this investigation and were determined in selected samples by atomic absorption spectrometry using the methods of Pyrih and Bisque (1969 and 1970) and Thompson and others (1968) respectively. The limit of detection observed for both Hg and Au as determined by atomic absorption spectrometry was 0.01 part per million.

Presentation of Data

The large number of data obtained by emission spectrography for the soil samples of the traverses are printed out by computer and included in the back pocket. In this form, samples are organized in groups corresponding to the traverses located in the plate (back pocket), and are ordered by their position within the traverse.

Each sample is identified by its number, distance from the origin of the traverse, mean slope in degrees (+ if above the horizontal, - if below horizontal), presence or absence of vein quartz (Q or Z respectively), presence or absence of prospecting pits (P or N respectively), and the concentration in ppm of Cu, Pb, Zn, Mn, V, Ni and Co (when an element was not detected it is given an arbitrary value of 1 ppm). At the end of every traverse the average and standard deviation for every element are listed. These same data are plotted so that the abscissa represents distance and the ordinate the concentration of the elements (see graphs in the back pocket); in this form the data can be quickly interpreted.

The Hg and Au contents of the selected samples of soils will be included in the print out (back pocket), but will not be averaged. Since 1 ppm is a large value for Hg, some samples where Hg was not detected are distinguished by the letters ND.

The analytical data of rocks and soil samples collected for the purpose of establishing background values and studying the effects of weathering are tabulated (see p. 54), and ordered by geologic formations from which they were derived.

Analytical Background Values for the El Callao Area. Table.

Sample No.	Rock or Soil	Cu ppm	Pb ppm	Zn ppm	Mn ppm	V ppm	Ni ppm	Co ppm	Hg ppm	Au ppm	Mineral.
Carichapo Group											
490	R	120	nd	150	300	250	150	40	0.00	0.01	X
428	S	10	15	nd	200	50	10	nd	0.00	0.00	X
429	S	150	nd	nd	300	110	60	40	0.00	0.00	X
491	S	70	15	nd	300	190	30	50	-	-	X
El Callao Formation											
172A	R	350	nd	100	300	300	200	40	-	-	X
585A	R	350	nd	100	500	400	150	60	0.00	0.00	V
620A	R	350	nd	100	500	250	200	70	0.00	0.01	V
621A	R	350	nd	100	500	300	180	60	0.00	0.01	V
627A	R	350	nd	100	500	350	180	60	0.00	0.04	V
629A	R	400	nd	100	500	300	200	60	0.00	0.00	V
702A	R	450	nd	100	500	300	200	60	-	-	X
726A	R	450	nd	100	500	350	200	60	0.00	0.01	X
726B	R	350	nd	50	500	250	200	60	-	-	X
681	S	70	nd	nd	250	90	30	40	-	-	X
700	S	70	nd	nd	200	120	100	60	-	-	X
720	S	90	nd	nd	250	80	40	50	-	-	X
295	S	200	14	nd	250	200	170	70	-	-	X
425	S	300	nd	50	400	350	160	150	0.70	-	V
426	S	300	nd	50	400	350	300	150	0.00	-	V
Cicapra Formation											
403	R	20	30	nd	220	300	50	nd	0.00	0.01	V
446A	R	20	40	nd	200	250	30	nd	-	0.00	V
447A	R	20	30	nd	250	300	50	nd	0.00	0.00	V
452	S	50	20	nd	150	100	30	nd	0.00	0.00	X
728	S	70	10	nd	150	60	30	10	0.00	0.01	X
Yuruary Formation											
444A	R	20	60	nd	200	200	30	nd	-	-	X
373A	R	190	nd	100	250	200	150	40	0.00	0.00	X
386A	R	180	nd	150	200	80	400	60	-	-	V
545A	R	40	10	nd	400	180	20	40	-	-	X
547A	R	90	20	nd	350	100	20	nd	-	-	X
420	S	4	15	nd	250	40	nd	nd	0.00	0.01	X
421	S	4	10	nd	100	40	nd	nd	0.00	0.00	X

Sample No.	Rock or Soil	Cu ppm	Pb ppm	Zn ppm	Mn ppm	V ppm	Ni ppm	Co ppm	Hg ppm	Au ppm	Mineral.
Yuruary Formation (continued)											
x 422	S	50	70	nd	80	300	120	nd	0.00	0.00	X
x 423	S	10	30	nd	80	80	10	nd	0.00	0.00	X
444	S	10	70	nd	150	150	20	nd	-	-	X
424	S	300	nd	50	150	150	150	nd	-	-	V
419	S	300	70	50	150	300	170	60	-	-	V
443	S	150	75	nd	140	200	60	nd	-	-	V
445	S	150	80	nd	300	250	130	70	-	-	V
Caballape Formation											
433	R	20	15	nd	160	200	30	nd	-	-	X
431	S	80	80	nd	150	250	40	nd	0.00	0.00	X
432	S	90	20	nd	70	80	40	nd	-	-	X
436	S	10	30	nd	70	120	10	nd	-	-	X
438	S	10	15	nd	70	80	10	nd	-	-	X
439	S	150	80	nd	150	300	150	20	-	-	X
441	S	180	nd	150	180	220	150	70	-	-	X
Supamo Complex											
416	S	4	20	nd	10	70	nd	nd	0.15	0.00	X
418	S	3	15	nd	110	nd	nd	nd	-	-	X
427	S	80	15	nd	190	100	20	nd	0.00	0.04	X
430	S	5	90	nd	150	40	nd	nd	0.00	0.00	X
435	S	20	15	nd	30	70	10	nd	-	-	X
Acidic Intrusives (Mandingal Stock)											
493	R	2	10	nd	110	70	nd	nd	0.00	0.02	X
409	S	2	15	nd	50	nd	nd	nd	-	-	X
727	S	2	5	nd	15	nd	nd	10	0.00	0.00	X
Metamorphosed Basic Intrusives (Ibm)											
213A	R	190	15	50	350	200	300	60	-	-	X
235A	R	180	10	100	350	300	150	60	-	-	X
281A	R	110	nd	nd	300	200	110	60	-	-	X
330A	R	160	nd	nd	250	300	50	30	-	-	X
440A	R	700	30	150	500	110	700	180	-	-	V
232	S	80	nd	nd	180	70	40	80	-	-	X
330	S	60	20	nd	300	200	20	40	-	-	X
434	S	180	15	nd	300	400	160	120	-	-	X
440	S	400	nd	nd	800	250	400	200	-	-	V

Note: (nd) under detection limit, (X) not mineralized, (V) mineralized.

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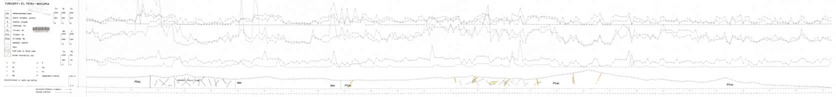
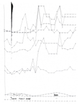
GRAPH No. 1

YURUARY—EL PERU—MOCUPIA



GRAPH No. 2

PUENTE DE EL CALLAO



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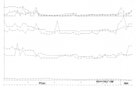
LAGUNA DIKE



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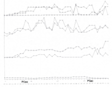
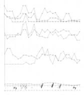
PELA BOLLO



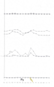
GRAPH No. 5

MAESTRE VEIN



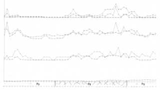
GRAPH No. 6

LA CULEBRA



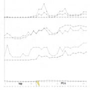
GRAPH No. 8

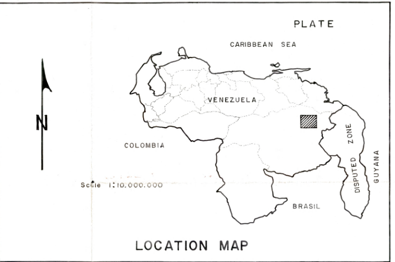
CARICHAPO FAULT ZONE



GRAPH No. 7

QUEBRADA DE ORO





LOCATION MAP

EXPLANATION

SCALE 1:100.000
0 1 5 kilometers 10
0 1 5 miles 10

Basic and ultrabasic intrusives (unknown age)

Ib	unmetamorphosed, basic
Iu	ultrabasic, serpentinites and pyroxenites
Ibm	metamorphosed, basic

Acidic intrusives

Iap	quartz porphyry granite (differentiated Supamo)
Iag	granite (differentiated Supamo)
S	Supamo Complex (undifferentiated) quartz-feldspar gneisses, granites and migmatites

Stratified units

C	Caballape formation	volcanic mudstones	
Py	Yuruary formation	detrital volcanic rocks, metamorphosed	PASTORA SUPER GROUP
PCc	Cicapra formation	actinolite-biotite shists	CARICHAPO GROUP
PCec	El Callao formation	amphibolitic metalavas	CARICHAPO GROUP
PC	Carichapo group (undifferentiated)		CARICHAPO GROUP

PRECAMBRIAN

	syncline
	anticline
	geologic contact
f	fault
Db	basic dike
	synclinal axis with direction of dip of axial plane (overturned)
	anticlinal axis with direction of dip of axial plane (overturned)
	road
○ 123	sample
	traverse

Geology taken from: Menendez V. de V., Alfredo, "no date" (circa 1970), Mapa geológico de la región de Guasipati: Caracas, Ministerio de Minas e Hidrocarburos

GEOLOGIC AND GEOGRAPHIC LOCATIONS OF SAMPLES AND TRAVERSES
EL CALLAO AREA, VENEZUELA

JEAN PASQUALI Z.　T-1463　PLATE

GRAPH LEGEND

Ibm	metamorphosed, basic
lap	quartz porphyry granite
S	Supamo complex
C	Caballape formation
Py	Yuruary formation
PCc	Cicapra formation
PCec	El Callao formation
·······	geologic contact
―	fault
≋	fault zone or shear zone
╱	known mineralized vein

z	Co	⍑	V
⊼	Ni	+	Pb
×	Zn	△	Cu
◇	Mn	⬡	topographic surface

Concentrations in parts per million

Zn	Ni	Co
200	200	200
100	100	100
0	0	0

Mn	V
400	200
200	100
0	0

Cu	Pb
200	50
100	25
0	0

200 m

0 m

horizontal distance in meters →

sample numbers →

Computer printout of data

```
YURUARY - EL PERU - MOCUPIA                                          PAGE 1

  S    DIST    A  Q  P     CU    PB    ZN    MN     V    NI    CO      HG     AU

152       0    9  Z  N     50    30     1   700   220    40    60
153      50    0  Z  N     80    30     1   600   220   180   150
154     100   -7  Z  N     40    20     1   300   210    30    10
155     150    2  Z  N    110    30    50   500   210   100    70
156     200   -2  Q  P    110    30    50   400   220    80    60
158     250    1  Q  N    110    30    50   600   240    60    80
159     300    1  Q  N     90    30    50   300   210    30    40
160     350   -1  Q  N     90    20    50   300   220    30    20
161     400    0  Z  N     70     1     1   150    70    20     1
162     450    0  Z  N     70     5     1   180   180    40    40
163     500    0  Z  N    120     5     1   250   210    80    60
164     550    0  Q  N    150    25    50   250   220   100    70
165     600    0  Q  P    150    20    50   300   210   120   100
166     650    0  Z  N    120    15    50   400   180    80    90
167     700    2  Q  N    130    15    50   400   180    50    80
168     750    4  Z  N    160    15    50   400   220   110    70
169     800   -7  Z  N    130     5    50   400   250    60    60
170     850    4  Q  N    150     5    50   450   250    50    70
171     900   -3  Q  N    120     1     1   400   180    40    70
172     950    5  Q  N    120     5     1   500   150    70    80
173    1000   -3  Z  N    120     1     1   500   200    70    70
174    1050    2  Z  N    110     1     1   400   200    40    30
175    1100    4  Z  N    140     1     1  2000   250   170   170
176    1150   10  Q  N    150     1     1   800   250   170   150
177    1200    3  Z  N    170     1     1  4000   250   350   250
178    1250    1  Z  N    140     1     1  3000   180   170   140   0,000  0,000
179    1300   10  Z  N    160     1     1  3000   350   180   150   0,000  0,000
180    1350   15  Z  N    180     1    50  2000   350   250   160   0,700  0,000
181    1400   -1  Z  N    180     1    50  2000   350   170   120   0,300  0,000
182    1450  -10  Q  N    180     1    50  1500   350   150   140   0,250  0,000
183    1500   -7  Q  N    300     5   100  5000   400   180   180   0,450  0,000
184    1550  -18  Z  N    150     1     1   800   350   150   130   0,500  0,000
185    1600   -6  Z  N    150    15    50   550   400   120    60   0,000  0,000
186    1650    4  Z  N    150     1     1   350   350   130    70   0,150  0,000
187    1700    6  Q  N    180     1    50   700   400   170   130   0,160  0,000
188    1750   15  Z  N    180     1    50   800   400   180   130   0,000  0,000
189    1800   10  Z  P    180    30    50   180   400   150    20   0,080  0,000
190    1850    0  Z  N    150    35     1    90   250    40     1   0,300  0,000
191    1900   10  Z  N    185    35     1   100   350   120     1   0,150  0,000
192    1950    0  Q  N     90    15     1    30   170    30     1   0,000  0,000
193    2000   23  Z  N    110     5     1    30   150   100     1   0,150  0,000
194    2050   10  Z  N     80     1     1    15    80    30     1   0,000  0,000
195    2100  -23  Z  N    140     5     1    60   210    40     1   0,250  0,000
196    2150  -18  Q  N    140     1     1    80   120    30     1   0,250  0,000
197    2200  -18  Z  N    180     1    50   250   110   110    10
198    2250   -2  Z  N    120     5     1   150    60    90    10
199    2300   10  Q  N    100     1     1    70    60    90     1
200    2350   -5  Z  N     70     1     1    60    60    20     1
201    2400   -1  Z  N     80     1     1    60    70    20     1
202    2450   -3  Z  N    100     1     1   150    70    30     1
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  YURUARY - EL PERU - MOCUPIA                                        PAGE 2

  S    DIST    A O P    CU    PB    ZN    MN     V    NI    CO    HG     AU

 203   2500   -2 Z N    80     1     1   150    60    30    20
 204   2550   -6 Z N   120     1     1   180   100    50    30
 205   2600   -9 Q N   110     1     1   150   100    40    20
 206   2650    0 Z N   150     5     1   300   150   120    30
 207   2700  -13 Q N    70     1     1   250   150    30    10
 208   2750   -2 Z N   110     1     1   150   190    70    10
 209   2800   -2 Z N   120    10     1   350   250   110    20
 210   2850   -4 Z N   120     5     1   150   110   110    20
 211   2900    1 Z P   130    15    50   350   200   150    80
 212   2950    2 Z N   110    15     1   350   200   100    70  0.450  0.000
 213   3000    1 Z N    80    15     1   350   200    40    60  0.150  0.000
 214   3050    1 Z N   120    30     1  2500   300   120   110  0.150  0.000
 215   3100    5 Z P   150    15     1   500   300   110   120  0.150  0.000
 216   3150    4 Z P   120     5     1   400   110   120    70  0.170  0.000
 217   3200    5 Z N   120     1     1   300    80   110    70  0.000  0.000
 218   3250    6 Z N    80     1     1   300    70    90    60
 219   3300    6 Z N   150    10     1  3000   150   180   150
 220   3350    6 Z N   180    10     1  1500   210   180   120
 221   3400    5 Z N   180     5     1   500   150   180   120
 222   3450    5 Z P   160     5     1   450   120   170    90
 223   3500   10 Z P   300     5     1   700   200   210   120
 224   3550    5 Z N   150     1     1   300    60   170    80  0.250  0.000
 225   3600  -11 Z N   170     5     1   300   110   190   160  0.150  0.010 ✓
 226   3650  -12 Z N   160     5     1   400   110   180   160  0.300  0.000
 227   3700  -13 Z N   160     5     1   300    70   160    80  0.250  0.000
 228   3750   -9 Z P   180    40     1   450   150   180   150  0.250  0.000
 229   3800  -11 Z P   140     5     1   300   120   150    80  0.250  0.000
 230   3850  -11 Z P    90    10     1   400   150    40    60  0.000  0.000
 231   3900    7 Z N    60     1     1   190    80    20    30  0.000  0.000
 232   3950    5 Z P    80     1     1   180    70    40    80  0.000  0.000
 233   4000    0 Z N   110     1     1   160    50    30    30
 234   4050    1 Z N    90     1     1   170    60    30    30
 235   4100    1 Z N   120     1     1   170    70    40    30
 236   4150    2 Z N    80     1     1   150    60    30    20
 237   4200    4 Z P   120     1     1   175    80    40    30
 238   4250    0 Z N   110     1     1   170    60    40    20  0.250  0.010 ✓
 239   4300    1 Z N    80     1     1   120    60    30    20
 240   4350   -1 Z N   120     1     1   150    50    30    20
 241   4400    1 Z N   130     5     1   400   300    50    80
 242   4450    2 Z N   120     5     1   330   150    80    70
 243   4500    3 Z N   120     1     1   300   120    40    30
 244   4550    4 Z N   150     1     1   250   120   120    40
 245   4600   -4 Z N   150     5     1   400    80   150    70
 246   4650   -6 Z N   130     1     1   400    80   150    80  0.000  0.000
 247   4700  -17 Z N   170     5     1   400    90   150    90  0.000  0.000
 248   4750  -12 Q N    90     5     1  1100   150   300   180  0.000  0.000
 249   4800   -7 Q P   300    20     1  1100   180   400   200  0.000  0.010 ✓
 250   4850   -1 Z N    80     5     1   400   180   200   100  0.000  0.040 ✓
 251   4900    0 Z N    15     1     1   300   200    40    50  0.000  0.020 ✓
 252   4950    0 Z N    90     5    50   700   220   300   140  0.000  0.040 ✓
```

S	DIST	A	G	P	CU	PB	ZN	MN	V	NI	CU	HG	AU
253	5000	-1	Z	N	50	5	1	400	120	30	30	0,260	3,200
254	5050	2	Z	N	90	5	1	600	200	300	150	0,160	1,000
255	5100	-2	Z	N	50	5	1	400	150	50	70	0,310	3,250
256	5150	-1	Z	N	70	30	100	500	180	60	60	9,990	3,450
257	5200	8	Q	P	70	40	300	500	150	60	150	1,400	0,600
258	5250	5	Q	P	70	30	150	500	180	50	90	0,000	0,480
259	5300	-5	Q	P	70	5	50	400	180	50	90	0,150	0,050
260	5350	-1	Q	N	100	5	100	300	150	200	150	0,500	0,320
261	5400	-4	Q	P	100	1	1	600	200	200	100	0,370	0,040
553	5450	-2	Q	P	160	1	1	300	250	120	70	0,370	0,400
554	5500	0	Q	N	130	1	1	250	210	110	60		
555	5550	-2	Q	P	70	1	1	190	150	40	60		
556	5600	6	Z	N	180	10	50	250	300	180	70		
557	5650	-3	Z	N	130	1	1	150	250	80	30		
558	5700	2	Z	N	120	1	1	250	140	90	60		
559	5750	0	Z	N	160	1	1	250	150	120	70		
560	5800	2	Z	N	160	1	1	250	90	150	110		
561	5850	0	Z	N	150	10	1	400	220	130	90		
562	5900	-1	Z	P	150	1	1	300	250	120	70		
563	5950	-1	Q	N	110	1	1	500	120	80	60		
564	6000	1	Z	N	120	1	1	300	120	60	60		
565	6050	2	Z	N	110	1	1	300	180	50	40		
566	6100	0	Z	N	130	1	1	300	210	60	40		
567	6150	-4	Z	N	180	1	1	300	180	130	60		
568	6200	5	Z	N	130	1	1	300	110	120	80		
569	6250	3	Z	N	130	1	1	400	100	110	80		
570	6300	4	Z	N	130	1	1	350	150	80	70		
571	6350	7	Q	N	140	1	1	350	250	50	60		
572	6400	3	Q	N	180	1	1	400	250	150	90		
573	6450	2	Q	N	170	1	1	400	200	160	80		
574	6500	2	Z	N	160	1	1	600	250	110	80		
575	6550	6	Z	N	150	1	50	800	300	60	80		
576	6600	10	Q	N	130	1	1	400	350	140	120		
577	6650	12	Q	N	400	1	100	800	300	140	120		
578	6700	-5	Z	N	180	10	100	700	400	120	120		
579	6750	5	Z	N	180	10	50	700	450	120	70		
580	6800	-1	Z	N	180	5	50	700	400	130	70		
581	6850	-14	Q	N	180	1	50	700	350	150	80		
582	6900	-10	Q	N	150	1	100	700	300	150	110		
583	6950	8	Q	N	160	1	50	600	250	120	80		
584	7000	8	Q	N	170	1	100	800	400	120	90		
585	7050	6	Q	N	150	1	50	600	250	120	80		
586	7100	4	Q	N	170	10	100	700	350	150	110		
587	7150	12	Z	N	180	10	100	800	300	150	150		
588	7200	-7	Z	N	70	10	1	400	300	20	20		
589	7250	-4	Z	N	140	10	1	400	350	40	70		
590	7300	8	Z	N	70	1	1	600	250	20	20	ND	0,050
591	7350	12	Z	N	150	1	1	400	300	40	70	0,000	0,020
592	7400	11	Z	N	70	1	1	400	150	30	60	0,000	0,000
593	7450	-14	Z	N	140	10	1	700	300	110	60	0,000	0,000

YURUARY - EL PERU - MOCUPIA

S	DIST	A	Q	P	CU	PB	ZN	MN	V	NI	CO	HG	AU
594	7500	-15	Z	N	200	15	100	400	400	150	80	0,000	0,010
595	7550	-5	Z	N	200	15	100	550	400	160	50	0,000	0,020
596	7600	-3	Z	N	200	15	150	700	400	200	16	0,000	0,000
597	7650	3	Z	N	200	15	100	1100	400	190	170	0,600	0,000
598	7700	-1	Z	N	180	15	1	1500	250	180	180	ND	0,000
599	7750	-8	Z	N	80	5	1	150	250	80	10	0,000	0,000
600	7800	-7	Z	N	120	5	1	400	300	80	55	ND	0,050
601	7850	-2	Z	N	170	5	1	550	300	120	60		
602	7900	-2	Z	N	180	5	100	180	180	100	60		
603	7950	2	Q	P	150	10	100	400	300	90	80		
604	8000	4	Z	N	150	1	1	600	300	120	70		
605	8050	-8	Z	N	180	5	100	600	250	130	80		
606	8100	-10	Q	P	100	1	1	250	200	30	60		
769	8150	0	Q	P	200	70	100	350	300	200	70		
607	8200	7	Z	N	150	15	1	300	210	170	70		
608	8250	4	Q	N	130	10	1	350	210	150	80		
609	8300	-5	Q	N	500	5	150	400	250	300	150		
610	8350	-10	Q	P	110	1	1	150	300	160	20		
611	8400	-20	Q	N	150	15	1	90	100	40	10		
612	8450	10	Q	N	110	5	1	400	250	150	90		
613	8500	4	Q	N	120	5	1	500	250	150	120		
614	8550	6	Q	N	130	10	1	600	300	160	140		
615	8600	5	Q	N	130	10	1	600	300	160	140		
616	8650	6	Q	N	130	10	1	600	300	120	70		
617	8700	8	Q	P	180	10	1	700	250	150	150		
618	8750	12	Q	P	160	10	1	700	250	150	130		
619	8800	11	Q	N	150	10	1	700	300	150	110		
620	8850	12	Q	N	160	15	1	800	300	150	120		
621	8900	10	Q	N	110	1	1	400	250	130	110		
622	8950	9	Q	N	150	1	1	700	250	130	100		
623	9000	8	Q	N	110	1	1	300	250	110	60		
624	9050	13	Q	N	40	1	1	150	160	40	20		
625	9100	8	Q	N	90	1	1	300	150	130	60		
626	9150	5	Q	N	20	1	1	80	50	20	10		
627	9200	5	Z	N	20	1	1	150	80	20	20	0,000	0,000
628	9250	10	Z	N	90	1	1	400	150	80	60	0,500	0,010
629	9300	12	Z	N	70	1	1	300	100	40	40	0,000	0,000
630	9350	14	Z	N	120	5	1	400	150	150	70	0,500	0,030
631	9400	6	Z	N	70	1	1	120	80	100	40	0,500	0,010
632	9450	8	Z	N	20	1	1	80	80	30	1	0,000	0,020
633	9500	13	Z	N	4	1	1	30	1	10	1	0,000	0,000
634	9550	18	Z	N	20	1	1	40	1	30	1	0,000	0,000
635	9600	8	Z	N	60	1	1	60	10	40	1		
636	9650	-13	Z	N	70	1	1	70	20	110	10		
637	9700	-8	Z	P	160	5	1	220	100	190	70		
638	9750	-20	Z	N	150	1	1	150	90	150	40		
639	9800	-8	Z	N	18	10	100	400	190	210	80		
640	9850	-12	Z	N	20	1	1	150	80	110	20		
641	9900	-13	Z	N	30	1	1	80	30	30	1		
642	9950	-6	Z	N	40	1	1	120	40	30	10		

S	DIST	A	Q	P	CU	PB	ZN	MN	V	NI	CO	HG	AU
643	10000	-10	Z	N	20	1	1	80	20	30	1		
644	10050	-11	Z	N	90	1	1	250	130	150	70		
645	10100	-12	Z	N	150	1	1	600	210	180	80		
646	10150	-17	Z	N	150	1	1	450	280	160	70		
647	10200	1	Z	N	150	1	1	300	350	150	70		
648	10250	-6	Z	N	140	1	1	350	400	150	60		
649	10300	-8	Z	N	150	1	1	400	350	150	70		
650	10350	2	Z	N	300	1	1	700	300	210	150		
651	10400	-14	Z	N	10	60	1	300	70	20	10		
652	10450	-12	Z	N	110	5	1	400	300	150	70		
653	10500	-8	Z	N	120	1	1	300	200	110	50		
654	10550	-16	Z	N	130	1	1	400	220	110	60		
655	10600	-12	Z	N	80	1	1	300	210	80	30		
656	10650	-11	Z	N	90	5	1	300	220	50	60		
657	10700	-12	Z	N	160	5	1	400	220	150	80		
658	10750	20	Q	N	70	1	1	300	120	40	30		
659	10800	0	Q	N	110	1	1	400	210	110	30		
660	10850	-8	Z	N	90	1	1	300	150	70	30		
661	10900	13	Q	N	70	1	1	300	120	30	30		
662	10950	6	Z	N	150	10	1	600	250	140	70		
663	11000	-8	Z	N	160	10	1	800	300	150	80		
664	11050	-10	Z	N	90	1	1	500	300	60	80		
665	11100	-6	Z	N	90	1	1	500	300	60	80		
666	11150	-13	Z	N	90	1	1	500	300	60	80		
667	11200	-2	Q	N	80	1	1	350	250	50	70		
668	11250	-4	Q	N	150	1	1	400	250	110	80		
669	11300	-6	Z	N	80	1	1	300	300	30	30		
670	11350	-11	Q	N	100	1	1	350	300	70	70		
671	11400	10	Q	N	110	1	1	350	300	70	70		
672	11450	12	Z	N	120	1	1	400	300	120	70		
673	11500	-7	Z	N	120	1	1	400	280	100	70		
674	11550	-6	Z	N	80	1	1	250	250	40	40		
675	11600	-10	Z	N	90	1	1	300	300	70	60		
676	11650	-12	Q	N	90	1	1	150	150	40	30		
677	11700	2	Z	N	100	5	1	400	150	40	80		
678	11750	2	Q	N	70	1	1	300	200	30	40		
679	11800	3	Z	N	120	5	1	500	200	60	60		
680	11850	11	Z	N	90	1	1	150	150	30	30		
681	11900	9	Q	N	70	1	1	250	90	30	40		
682	11950	8	Z	N	70	1	1	250	100	40	30		
683	12000	14	Z	N	150	1	1	400	120	150	80		
684	12050	16	Z	N	120	1	1	300	120	120	30		
685	12100	18	Q	N	130	1	1	250	150	120	60		
686	12150	19	Z	N	140	1	1	350	250	150	70		
687	12200	-11	Z	N	90	1	1	150	80	50	30		
688	12250	-24	Z	N	60	1	1	100	30	30	10		
689	12300	-22	Z	N	150	1	1	400	180	150	120		
690	12350	-18	Z	N	120	1	1	350	150	80	40		
691	12400	-18	Z	N	150	1	1	250	120	150	60		
692	12450	-11	Q	N	190	1	1	250	200	180	80		

YURUARY - EL PERU - MOCUPIA

S	DIST	A	Q	P	CU	PB	ZN	MN	V	NI	CO	HG	AU
693	12500	-8	Z	N	70	1	1	150	80	40	20		
694	12550	-7	Z	N	150	1	1	300	180	150	80		
695	12600	2	Z	N	110	15	1	300	180	150	60		
696	12650	5	Z	N	90	1	1	180	150	40	30		
697	12700	2	Z	N	40	1	1	150	80	40	20		
698	12750	-10	Z	N	40	1	1	150	60	40	20		
699	12800	-13	Z	N	120	1	1	150	100	100	40		
700	12850	-19	Z	N	70	1	1	200	120	100	60		
701	12900	-12	Z	N	150	1	1	300	120	150	80		
702	12950	-2	Z	N	100	1	1	300	100	120	20		
703	13000	-2	Z	N	90	1	1	220	150	100	10		
704	13050	-1	Z	N	100	1	1	250	80	50	20		
705	13100	-4	Z	N	100	1	1	400	100	120	70		
706	13150	-3	Z	N	100	1	1	250	100	40	20		
707	13200	-2	Z	N	100	1	1	250	150	120	30		
708	13250	4	Z	N	60	1	1	200	120	40	30		
709	13300	-2	Z	N	70	1	1	200	90	50	20		
710	13350	-5	Z	N	40	1	1	120	60	20	10		
711	13400	-8	Z	N	120	1	1	250	80	120	70		
712	13450	-5	Z	N	80	1	1	300	90	30	20		
713	13500	-2	Z	N	90	1	1	250	100	20	10		
714	13550	-2	Z	N	120	1	1	300	120	50	30		
715	13600	-1	Z	N	160	1	1	400	300	150	80		
716	13650	0	Z	N	150	1	1	300	200	120	40		
717	13700	-1	Z	N	90	1	1	250	150	30	20		
718	13750	-2	Z	N	90	1	1	150	100	20	1		
719	13800	-2	Z	N	60	1	1	150	90	20	1		
720	13850	-1	Z	N	90	1	1	250	80	40	50		
721	13900	-3	Z	N	130	1	1	300	100	60	70		
722	13950	-6	Q	N	70	1	1	150	80	40	10		
723	14000	-3	Q	N	140	1	1	300	150	100	90		
724	14050	-5	Z	N	150	1	1	250	120	150	90		
725	14100	-6	Q	N	110	1	1	300	100	100	60		
726	14150	-8	Q	N	150	20	1	200	80	120	60		
AVERAGES:					122	5	14	450	190	102	65		
STANDARD DEVS:					55	9	34	534	98	63	44		

PUENTE EL CALLAO

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 S    DIST    A Q P    CU    PB    ZN    MN     V    NI    CO    HG    AU

466      0    5 Q N   150    15     1   140   210    30     1
467     50   11 Q N    70     1     1    30   250    10     1
468    120   22 Q N    20     1     1    20   150     1     1
469    150   18 Q N    10     1     1    15   110     1     1
470    220    5 Q N    70     5     1    60   150    10     1
471    250    0 Q N    60    15     1    70   220    20     1
262    300   -4 Q N    20    20     1   140   200    40     1
263    350    1 Q N    90    30     1   150   200   250     1
264    400  -12 Z N    80    10     1   150   500   350     1
265    450  -10 Q N    80    30     1   100   300    70     1
266    500  -13 Q N    80    20     1   150   250    50    20
267    550  -16 Q N   300    40    50   300   300   150    30
268    600    7 Z N    50    10     1   500   150   100    70
269    650    6 Z N   450    40    50  5000   250   500   500
270    700    5 Z N   600    25    50  1000   250   500   150
271    750   12 Z N   700    25    50  1500   200   500   170
272    800   10 Z N   500    20   120  1500   200   300   170
273    850    7 Z N   400    10    50  1500   200   300   170
274    900   10 Z N   400    10    50   900   200   250   150
275    950   12 Z N   400    10     1   900   200   250   150
276   1000    4 Z N   400    20    50  1500   200   400   300
277   1050   -4 Z N   800    20     1  2000   150   500   200
278   1100  -11 Z N   500    20     1  1000   150   300   150
279   1150  -13 Z N   500    25     1  1500   250   300   150
280   1200  -16 Q N   480    25     1  1500   300   300   150
281   1250  -18 Q N   500    40    50  1500   300   300   150
282   1300   -7 Q N   500    25     1  1500   400   300   150
283   1350    7 Q N   600    25    50  1500   500   300   150

AVERAGES:             314    19    21   933   240   227   106

STANDARD DEVS:        240    11    30  1035    95   169   114
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LAGUNA DIKE

S	DIST	A	Q	P	CU	PB	ZN	MN	V	NI	CO	HG	AU
298	50	5	Z	N	200	20	1	250	300	160	20		
297	100	-5	Z	N	180	15	1	200	200	150	30		
296	150	-1	Z	N	180	15	1	300	200	170	70		
295	200	-2	Z	N	220	14	1	250	200	170	70		
294	250	-1	Z	N	180	15	1	250	250	170	90		
293	300	-6	Z	N	180	70	100	300	200	150	60		
292	350	-2	Z	N	160	15	1	240	180	150	40		
291	400	7	Z	N	200	40	150	250	250	170	40		
290	450	-3	Z	N	150	18	50	150	250	120	20		
289	500	2	Z	N	160	15	50	300	200	100	60		
288	550	-1	Z	N	160	15	1	250	200	40	70		
287	600	1	Z	N	150	15	1	250	180	40	70		
286	650	0	Z	N	70	10	100	500	150	70	150		
285	700	1	Z	N	50	25	1	300	160	40	25		
284	750	2	Z	N	4	25	1	150	140	25	1		
299	800	5	Q	N	20	20	1	150	150	20	10		
300	850	5	Q	N	10	16	1	120	110	10	10		
301	900	-6	Q	N	10	15	1	100	100	10	10		
302	950	-3	Q	N	10	15	1	150	100	10	1		
303	1000	-7	Q	N	10	16	1	150	100	10	1		
304	1050	-5	Z	N	10	15	1	250	300	10	10		
305	1100	2	Z	N	50	16	1	250	75	20	1		
306	1150	-1	Z	N	50	16	1	250	75	20	1		
307	1200	1	Q	N	70	15	1	250	80	40	10		
308	1250	-3	Z	N	50	18	1	250	70	40	10		
309	1300	-2	Z	N	50	16	1	250	70	40	10		
310	1350	-1	Z	N	80	15	50	250	90	40	10		
311	1400	-1	Z	N	80	5	1	250	60	40	10		
312	1450	-1	Z	N	40	1	1	200	50	1	1		
313	1500	-1	Z	N	40	1	1	250	70	20	1		
314	1550	2	Q	N	40	10	1	250	70	20	1		
315	1600	1	Z	N	40	1	1	250	70	20	1		
316	1650	1	Z	N	40	1	1	250	70	20	20		
317	1700	1	Z	N	50	5	1	250	100	30	20		
318	1750	1	Z	N	15	1	1	250	70	20	20		
319	1800	2	Q	N	15	1	1	250	60	20	20		
320	1850	1	Z	N	15	20	1	250	130	20	20		
321	1900	2	Q	P	50	5	1	250	140	30	20		
322	1950	1	Z	N	70	20	1	250	150	20	20		
323	2000	-1	Z	N	60	5	1	250	150	20	20		
324	2050	0	Z	N	60	5	1	250	100	20	20		
325	2100	-1	Z	N	80	5	1	250	100	30	30		
326	2150	1	Z	N	50	5	1	250	70	10	20		
327	2200	-4	Q	N	90	15	1	300	250	30	50		
328	2250	-7	Q	N	120	20	1	350	300	60	150		
329	2300	-4	Z	N	70	20	1	400	400	30	80		
330	2350	0	Z	N	60	20	1	300	200	20	40		
331	2400	-3	Z	N	70	60	1	500	200	40	50		
332	2450	-1	Q	P	80	60	1	500	200	100	80		
AVERAGES:					79	16	11	258	150	53	32		
STANDARD DEVS:					61	14	30	82	80	53	34		

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PELA BOLLO                                                                PAGE 1

 S     DIST     A  Q  P    CU     PB     ZN     MN      V     NI     CO    HG     AU

352      0      3  Q  N    10      1      1    150     20      1      1
351     50      2  Z  N    10      1      1    100     10      1      1
350    100     -1  Z  N    15      1      1    150     50     20      1
349    150     -2  Z  N    10      1      1    100     50     20      1
348    200     -3  Z  N    15     10      1    250     75     40     30
347    250     -1  Q  N    20     15      1    300    120     40     30
346    300     -2  Q  N    80      1      1    300    100     40     70
345    350      2  Q  N    80      1      1    300    150     40     70
344    400     -7  Z  N   150      5      1    250    300     40     70
343    450      0  Z  N   140      1      1    275    250    150     80
342    500     -2  Z  N   140      1      1    200    100    150     80
341    550     -4  Q  N   140     10      1    250    150    150     70
340    600      3  Q  N   140     10      1    500    200    150    150
339    650      5  Z  N   150     15      1    500    300    150    150
338    700     -4  Q  N   150     15      1    500    300    150    150
337    750      6  Z  N   140     15      1    700    250    150    160    ND    0.000
336    800      7  Q  N   150      1      1    300    150    150    110    ND    0.000
335    850     -1  Q  N   150     15      1    300    170    150    150    ND    0.000
334    900      5  Q  N   150      5      1    250    110    120    130    ND    0.010
333    950      2  Q  N   130     15      1    700    250    150    200    ND    0.010
353   1000     -4  Q  N   120      5      1    500    200    150    150
354   1050     -3  Q  N   110      5      1    300    300    110     50
355   1100     -1  Q  N   120      1      1    300    300    100     50
356   1150     -1  Z  N   150      1      1    200    180    150     50
357   1200      1  Z  N   180      1      1    400    220    150     70
358   1250      2  Q  N   180      1      1    150    150    150     80
359   1300     12  Q  N   170      1      1    150    100     50      1
360   1350     -4  Q  N   200      1    200    300    300    180      0
361   1400     -3  Q  N   200      1      1    150    180    150     20
362   1450      4  Q  N   150      1      1    140     70    140      1
363   1500      5  Q  N   180     10      1    150    100    150      1
364   1550    -12  Q  N   180     10      1    150    150    120      1
365   1600    -13  Q  N   200     15      1    200    200    180      1
366   1650     -8  Z  N   160      1      1    250    200    180     50
367   1700     -3  Z  N   180     30      1    300    200     40     50
368   1750     -2  Z  N    60     40      1    250     70     20      1
369   1800     -5  Z  N   170     15     50    300    180    100     60
370   1850      0  Z  N   180      5      1    300    150    160     80
371   1900     -1  Z  N   300     20    150    400    200    250    150
372   1950      0  Q  N   300     10      1    300    150    190    150

AVERAGES:                  136      7     10    289    167    114     68

STANDARD DEVS:              69      8     39    143     82     62     58
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MAESTRE VEIN

S	DIST	A	Q	P	CU	PB	ZN	MN	V	NI	CO	HG	AU
392	0	0	Z	N	200	1	150	300	190	300	150		
391	50	1	Z	N	300	1	100	300	80	200	90		
390	100	1	Z	N	300	1	100	300	120	200	70		
389	150	-4	Z	N	180	1	1	300	120	200	70		
388	200	-2	Z	N	150	1	1	300	120	40	70		
387	250	1	Z	N	100	1	1	300	180	100	60		
386	300	0	Z	N	120	1	1	300	150	150	70		
385	350	3	Z	N	170	1	1	700	250	300	150		
384	400	1	Z	N	170	10	140	800	250	300	150		
383	450	2	Z	N	150	1	1	300	100	160	80		
382	500	-11	Z	N	160	1	1	400	150	170	80		
381	550	-10	Z	N	130	5	1	700	250	250	150		
380	600	3	Q	N	100	40	1	300	200	40	10		
379	650	3	Q	N	120	60	1	250	150	40	10		
378	700	16	Q	N	190	80	1	250	250	150	20		
377	750	14	Q	N	180	40	1	200	200	250	20		
376	800	8	Z	N	170	70	1	200	250	170	20		
375	850	0	Z	N	180	20	1	400	200	190	70		
374	900	-1	Q	N	170	1	1	300	200	150	70		
373	950	-8	Q	N	160	40	1	400	250	170	70		
393	1000	-16	Q	N	70	15	1	250	200	90	50		
394	1050	-8	Q	N	60	50	1	300	220	30	10		
395	1100	-7	Z	N	100	60	1	150	250	40	1		
396	1150	-11	Z	N	180	30	1	180	220	150	1		
397	1200	1	Z	N	180	30	1	300	220	150	25		
398	1250	-10	Z	N	90	25	1	300	140	25	20		
399	1300	0	Z	N	80	50	1	300	150	25	20		
400	1350	2	Z	N	20	20	1	100	140	20	1		
401	1400	11	Z	N	70	20	1	100	210	30	1		
AVERAGES:					146	23	17	320	186	141	55		
STANDARD DEVS:					62	24	43	161	51	90	48		

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LA CULEBRA                                                                   PAGE 1

 S    DIST    A Q P    CU    PB    ZN   MN     V    NI    CO    HG     AU

481      0   -1 Z N     6     5     1  150    20     1     1 0,000 0,015
480     50   -2 Z N     5     5     1  150    20     1     1 0,000 0,025
479    100   -2 Z N     7    15     1  180    30     1     1 0,380 0,030
478    150    0 Z N    10    20     1  180    70    10     1 1,000 0,025
477    200    0 Z N    20    30     1  210    60    10     1 0,000 0,025
476    250    3 Q N    10    20     1  210    55     1     1 0,000 0,225
475    300    3 Z N     4     5     1  150    20     1     1 0,000 0,035
474    350    2 Q N     2     5     1   70     1     1     1 0,000 0,040
473    400   -1 Q N     5    15     1   90    40     1     1 0,000 0,080
472    450   -1 Q P     3     5     1  110    50     1     1 0,000 0,100
482    500   -3 Q P    70    40     1  180    80    10     1 0,250 0,745
483    550    0 Q N    20    25     1  200    40    10     1 0,390 0,080
484    600   -1 Z N     4     5     1  150    30     1     1 0,000 0,020
485    650   -1 Q N     3     1     1  150     1     1     1 0,100 0,030
486    700    2 Z N     2     1     1  150     1     1     1 0,250 0,000
487    750   -1 Q N     3     1     1  150     1     1     1 0,300 0,015
488    800    2 Z N     4     5     1  180     1     1     1 0,300 0,020
489    850   -3 Z N     4     1     1  150     1     1     1 0,200 0,000

AVERAGES:              10    11     1  156    28     3     1

STANDARD DEVS:         15    11     0   37    26     3     0
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QUEBRADA DE ORO                                                          PAGE 1

 S     DIST    A  Q  P     CU     PB     ZN     MN      V     NI     CU     HG      AU

404       0   -7  Q  N      3     20      1     40     60      1      1
405      50   -7  Q  N      4     70      1     50    100     10      1
406     100   -5  Q  N      3     30      1     40     70      1      1
407     150   -3  Z  N      3     15      1     40     20      1      1
408     200   -2  Z  N      3     15      1     60      1      1      1
409     250   -1  Z  N      2     15      1     50      1      1      1
410     300   -1  Z  N      2     15      1     50      1      1      1  0.200  0.000
411     350   -1  Z  N      2     30      1    120     20      1      1  0.300  0.000
412     400   -1  Z  N      2     20      1    100     20      1      1  0.200  0.000
413     450    0  Q  N      2     20      1    250     70      1      1  0.610  0.000
414     500    0  Q  N     10     50      1    150     70     10      1  0.390  0.000
415     550    0  Q  P     10     60      1    300    140     20      1  0.380  0.250
446     600   10  Q  N     20     60      1    180    100     30      1  0.250  0.290
447     650    4  Q  P     90     60      1    300    160    150     60  0.000  0.000
448     700    0  Q  N     60     50      1    300    150    150     40  0.000  0.000
449     750    2  Q  N     70     60      1    400    190    250     90  0.320  0.000
450     800    2  Q  N     70     60      1    300    200    110     55  0.000  0.000
451     850    1  Q  N     40     30      1    160    150     25      1  0.000  0.000
452     900   -2  Q  N     50     20      1    150    100     30      1  0.000  0.000
453     950    0  Q  N     50     20      1    150    100     30     10
454    1000   -2  Q  N     50     30      1    210    110     40     40
455    1050   -1  Q  N     70     60      1    300    200    110     60
456    1100    0  Q  P     90     40      1    180    220    110     50
457    1150   -3  Q  N    170     60      1    300    250    160     75
458    1200   -5  Q  N     90     60      1    250    250     60     30
459    1250   -2  Q  N     90     55      1    400    250     40     30
460    1300    1  Q  N    130     60      1    300    220     30     40
461    1350   -1  Q  N    120     60      1    300    230     30     50
462    1400   -2  Q  N    140     60      1    300    240     30     40
463    1450   -1  Q  N    140     70      1    400    240     40     60
464    1500    0  Q  N    120     80      1    300    230    100     60
465    1550    0  Z  N    150     80      1    300    220    100     60

AVERAGES:                  58     44      1    210    136     52     27

STANDARD DEVS:             53     21      0    116     86     61     28
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CARICHAPO FAULT ZONE

S	DIST	A	Q	P	CU	PB	ZN	MN	V	NI	CO	HG	AU
552	0	-1	Z	N	10	10	1	350	60	20	10		
551	50	-2	Z	N	80	1	1	350	300	150	70		
550	100	-1	Q	N	7	15	1	180	40	10	1		
549	150	-1	Z	N	10	15	1	210	70	30	10		
548	200	-2	Z	N	50	40	1	300	100	30	10		
547	250	6	Z	N	60	50	1	300	180	40	20		
546	300	-4	Q	N	10	30	1	300	110	10	10		
545	350	3	Q	N	5	15	1	150	50	10	10		
544	400	5	Q	N	4	20	1	120	40	10	10		
543	450	-1	Q	N	2	10	1	70	30	10	10		
542	500	0	Q	N	3	10	1	70	10	10	10		
541	550	1	Q	N	2	1	1	60	1	10	10		
540	600	1	Q	N	3	1	1	80	1	10	10	0.000	0.000
539	650	-1	Q	N	2	1	1	90	1	10	10	0.000	0.000
538	700	0	Q	N	4	1	1	90	1	10	10		
537	750	0	Q	N	3	15	1	150	50	1	1		
536	800	1	Z	N	4	15	1	150	50	1	1		
535	850	1	Q	N	2	15	1	140	10	1	1		
495	900	0	Q	N	2	1	1	100	1	1	1		
496	950	0	Q	N	3	1	1	100	1	1	1		
497	1000	0	Z	N	5	15	1	150	10	1	1		
498	1050	1	Z	N	5	15	1	120	10	1	1		
499	1100	1	Q	N	3	15	1	120	10	1	1		
500	1150	3	Q	N	4	15	1	150	70	30	1		
501	1200	-1	Q	N	10	15	1	150	70	30	1		
502	1250	-1	Q	N	60	15	1	210	90	70	30		
503	1300	-1	Z	N	80	25	1	250	150	150	60		
504	1350	0	Q	N	80	15	1	170	100	70	30		
505	1400	0	Q	N	70	30	1	200	120	40	40		
506	1450	-1	Q	N	20	20	1	150	70	25	1		
507	1500	0	Q	N	60	20	1	180	150	30	10		
508	1550	-3	Q	N	80	20	1	150	150	40	10		
509	1600	-1	Q	N	70	20	50	250	180	40	20		
510	1650	1	Q	N	30	30	1	250	150	30	20		
511	1700	0	Q	N	20	40	1	220	90	30	1		
512	1750	3	Q	N	20	40	1	220	90	30	1		
513	1800	5	Q	N	70	40	1	150	150	40	10		
514	1850	2	Q	N	80	30	1	220	120	70	40		
515	1900	2	Q	N	60	15	1	180	100	140	20		
516	1950	4	Q	N	80	20	1	220	110	150	60		
517	2000	2	Q	N	90	40	1	250	100	150	70	0.000	0.000
518	2050	-2	Q	N	100	20	1	250	110	150	40	0.100	0.000
519	2100	1	Q	N	90	30	1	600	120	250	200	0.370	0.000
520	2150	1	Q	N	80	60	1	300	100	150	60	0.300	0.000
521	2200	-3	Q	N	70	15	1	150	110	150	10	0.250	0.000
522	2250	-1	Q	N	120	30	50	300	220	190	60	0.100	0.000
523	2300	0	Z	N	120	15	50	300	140	170	60		
524	2350	0	Z	N	50	15	1	300	150	90	30		
525	2400	3	Q	N	70	40	1	350	100	110	80		
526	2450	2	Q	N	70	30	1	300	80	110	30		

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  CARICHAPO FAULT ZONE                                                       PAGE 2

 S    DIST     A  Q  P     CU     PB     ZN     MN      V     NI     CO     HG     AU

527   2500    -1  Q  N     20     20      1    150    150     40      1
528   2550    -2  Q  N      5     15      1    120     70     10      1
529   2600     7  Q  N      4     30      1    120     70      1      1
530   2650     5  Q  N      4     20      1     70     50      1      1
531   2700     2  Q  N     10     20      1     70     60     30      1
532   2750    -3  Q  N      4     15      1    170    110     30      1
533   2800    -4  Q  N     20     40      1    170     80     50     10
534   2850    -4  Q  N     20     30      1    160    100     40      1

AVERAGES:                  36     20      3    193     86     53     21

STANDARD DEVS:             36     12     10     96     60     60     32
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